European Offshore Wind Deployment Centre

Non-Technical Summary
Aberdeen Offshore Wind Farm Limited

Volume 1 of 4

July 2011

VATTENFALL

Technip

areg
Aberdeen Renewable Energy Group

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

Introduction

This document is a Non-Technical Summary (NTS) of the Environmental Statement for the proposed European Offshore Wind Deployment Centre (EOWDC).

The purpose of this document is to provide an overview of the key findings of the offshore Environmental Impact Assessment undertaken by Aberdeen Offshore Wind Farm Limited (AOWFL).

This NTS provides the project details, including information relating to the scientific studies that have been undertaken and the key findings of these studies. For a more in depth evaluation of the information provided here please refer to the main Environmental Statement.

Aberdeen Offshore Wind Farm Limited (AOWFL)

This application is being made by Aberdeen Wind Offshore Wind Farm Limited (AOWFL). AOWFL is an established legal entity owned by Vattenfall Wind Power Ltd (VWPL) (75 %) and Aberdeen Renewable Energy Group (AREG) (25 %).

The project is being part-funded by a grant under the EU [Economic Recovery Programme in the field of Energy]. Consortium members in this grant action are AOWFL, VWPL, AREG and Technip UK Ltd.

Vattenfall

VWPL's ultimate holding company is Vattenfall AB (Vattenfall). Vattenfall is owned by the Swedish state. Vattenfall is Europe's fifth largest generator of electricity and the continent's largest producer of heat.

Vattenfall currently operates over 500 Mega Watts of onshore wind and almost 700 Mega Watts of offshore wind across northern Europe. This portfolio includes Kentish Flats Offshore Wind Farm and Thanet Offshore Wind Farm, both located off the UK's Kent coast.

Vattenfall is currently constructing Ormonde Offshore Wind Farm off Barrow-in-Furness which will be completed during 2011. An application to build Kentish Flats Offshore Wind Farm Extension is planned for August 2011. Vattenfall is also in partnership with ScottishPower Renewables to develop the Round 3 East Anglia Offshore Wind Farm. This project is expected to deliver around 7,200 MW of wind capacity which would provide clean electricity for the equivalent annual demand of around 4 million UK homes.

The north east of Scotland is an important region for VWPL with the planned EOWDC, the Clashindarroch onshore scheme, approved for consent in December 2010, and the planned Aultmore onshore scheme.

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AREG is an incorporated company representing the interests of over170 member organisations. Established in 2001, AREG aims to ensure that Aberdeen City and Shire and its businesses play a major role in the energy revolution. AREG has been supported by the Energising Aberdeen Fund of Aberdeen City Council. The Fund represents a £22.25 million investment in the future of Aberdeen over five years by the Scottish Government.

Technip

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Through its Aberdeen based operating centre, Technip provides best-in-class subsea products and services to oil and gas companies operating offshore in the UK, Denmark, the Netherlands and West Coast of Ireland. Further to its established subsea business, Technip is rapidly developing capability to support the growing offshore wind sector.

Project Details

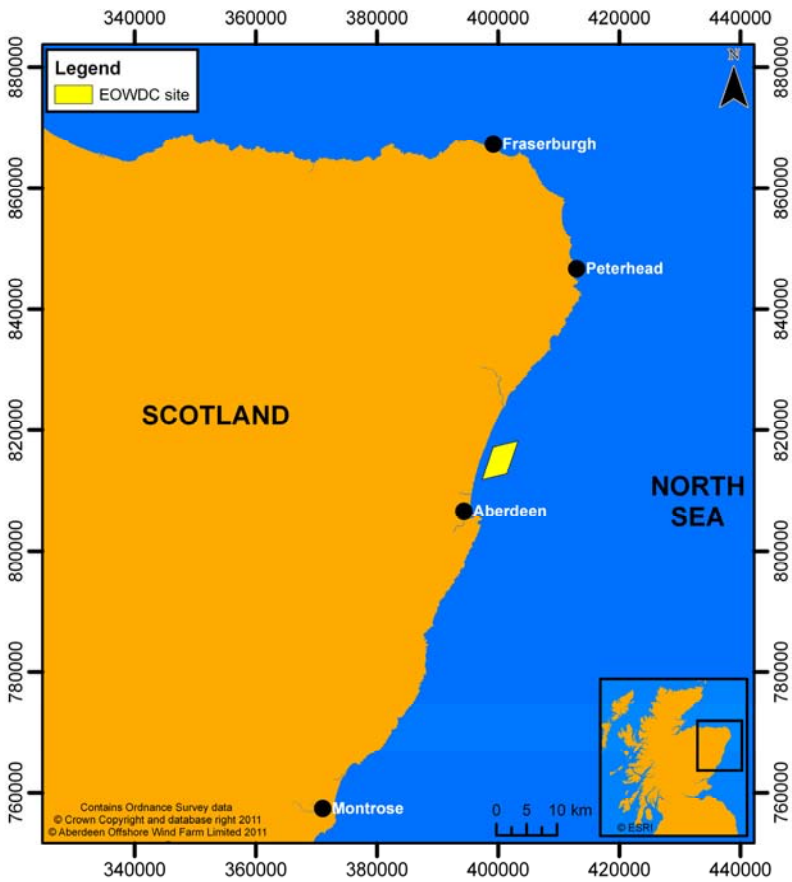
The proposed EOWDC is an innovative offshore wind turbine deployment facility proposed off the Aberdeenshire coast.

The project is part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy. In December 2010 a grant of up to 40 million Euros was awarded to the EOWDC project by the European Union (EU) as part of wider proposals to invest in key energy projects throughout Europe. The vision of this project is:

"To deploy new equipment, systems, processes, and initiate R&D to improve the competitiveness of offshore wind energy production, whilst generating environmentally sound, marketable electricity and to increase the supply chain capabilities in Scotland, the wider UK and Europe."

The Applicant was awarded a lease for the seabed from The Crown Estate earlier this year. The project consists of up to 11 wind turbines with a maximum power generation of up to 100 Mega Watts. The wind turbines would export the electricity onshore to a new substation and then to the National Grid. Additional onshore facilities may include a deployment centre with a research and development centre.

Location of the Proposed European Offshore Wind Deployment Centre



The onshore works associated with the proposed EOWDC would be subject to a separate planning application later in 2011 but are likely to be:

- a small substation
- underground cables connecting the wind turbines to the substation
- possible research and development facilities next to the substation

Key Project Characteristics	
Maximum EOWDC capacity	100 Mega Watts
Maximum Number of Wind Turbines	11
Approximate Distance from EOWDC to Shore	2.4 kilometres
Water Depth across the Wind Turbine Locations	20 metres to 30 metres below Lowest Astronomical Tide
Maximum Rotor Diameter	150 metres
Maximum Hub Height	120 metres
Maximum Tip Height	195 metres
Minimum Clearance Above Sea Level	22 metres above Mean High Water Spring level (MHWS)
Indicative Spacing between Wind Turbines	Between 790 metres and 1,050 metres
Foundation type	There are currently five options: Monopile Gravity Base Tripod Steel Jacket Suction Caisson / Bucket
Inter array Cables	Maximum number of 12 Total length of 13 kilometres
Export Cables	Maximum number of four would run from the wind turbine array back to Mean High Water Spring (MHWS) Total length of 26 kilometres

Regulatory Consents and the Purpose of the Environmental Statement

A number of regulatory consents are required for the construction and operation of the proposed EOWDC.

The following consents will be applied for:

- consent under Section 36 of the Electricity Act 1989 (as amended), for the installation of any offshore generating station with a permitted capacity of 1 Mega Watt or above
- a Marine Licence, established via the Marine (Scotland) Act 2010

Marine Scotland and Scottish Ministers will be responsible for determining the outcome of the application process.

In addition consents will be required for onshore work associated with the EOWDC development. This will be a separate application due later in 2011.

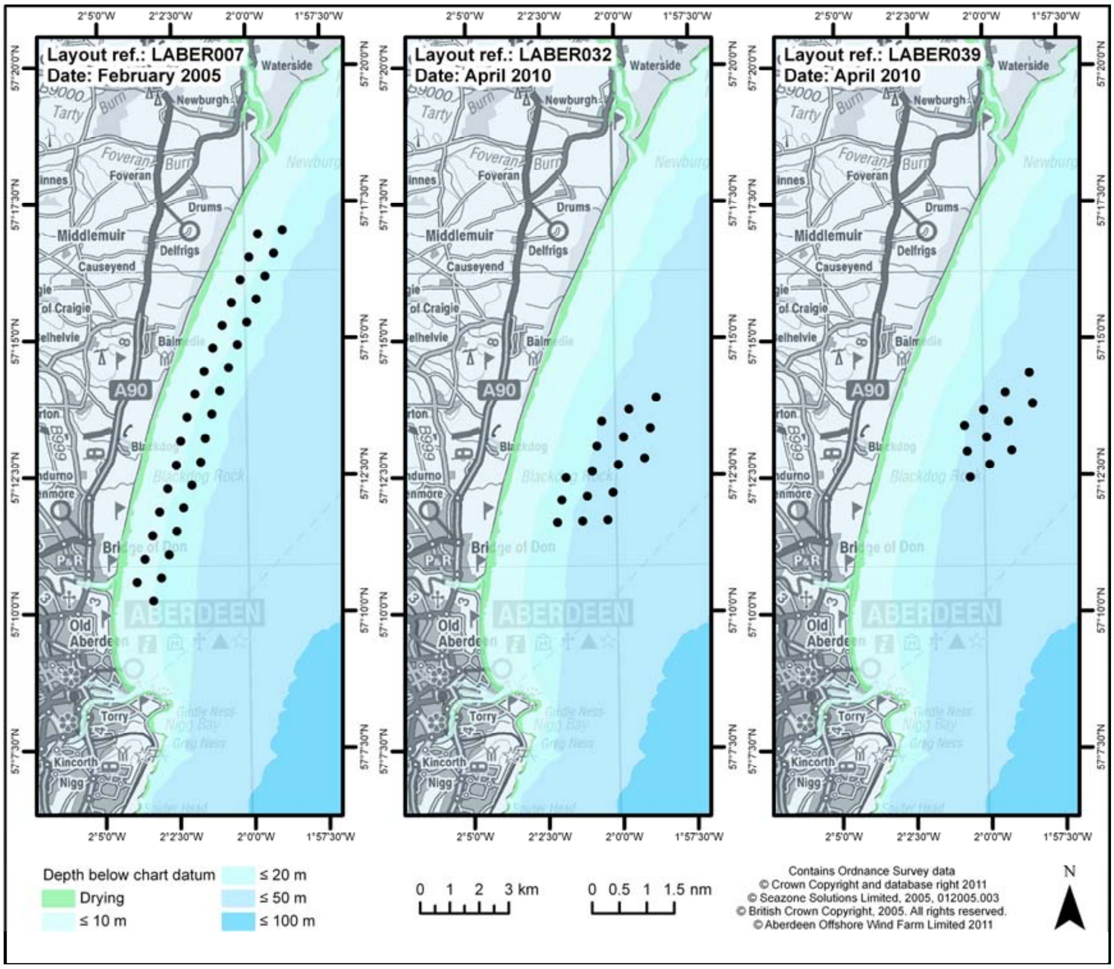
Site Selection and Alternatives

The proposed EOWDC site location has undergone a number of changes that have been determined through a long process of examining the constraints, undertaking consultations, and conducting surveys, studies and assessments.

These changes have primarily been a result of consultation with Aberdeen Harbour Board, the aviation industry, the Ministry of Defence and key environmental stakeholders.

Examples of the numerous site iterations can be found below. Further details are described within the Environmental Statement.

Three Site Iterations from 2005 and 2010 Including the Final Iteration from April 2010



Environmental Impact Assessment

Environmental Impact Assessments were undertaken in order to assess the possible impacts that the proposed EOWDC might have upon the local physical, biological and human environment.

To account for all possible scenarios a worst case impact has been assessed for each study. This ensures that any possible negative impacts upon the environment resulting from the development of the EOWDC would never be more than, and are likely to be less than, the findings of the Environmental Impact Assessment.

Where it is possible that there would be a negative impact upon the environment appropriate mitigation is suggested. The purpose of mitigation is to reduce the level of impact, for example this could be by following specific guidelines or not constructing at certain times of the day.

The key findings of the Environmental Impact Assessment are presented within this Environmental Statement.

Wind Turbines Awaiting Installation at the Ormonde Offshore Wind Farm (Copyright Tony West Photography)

Scoping, Consultation and Public Exhibitions

Public exhibitions have played an important role in informing and communicating with the population of Aberdeen and the wider area. A number of exhibitions have taken place since 2005, most recently in November 2010.

In 2010 public exhibitions were held between 22 and 26 November in:

- The Palace Hotel, Peterhead
- Udny Arms Hotel, Newburgh
- Kirk Centre, Ellon
- Beach Ballroom, Aberdeen
- White Horse Inn, Balmedie

Shortly after the Section 36 and Marine Licence applications are submitted for the proposed EOWDC further exhibitions will be held to give members of the public and interested organisations an opportunity to ask questions about the project and review the outcome of the various environmental studies.

Physical Environment

Coastal Processes

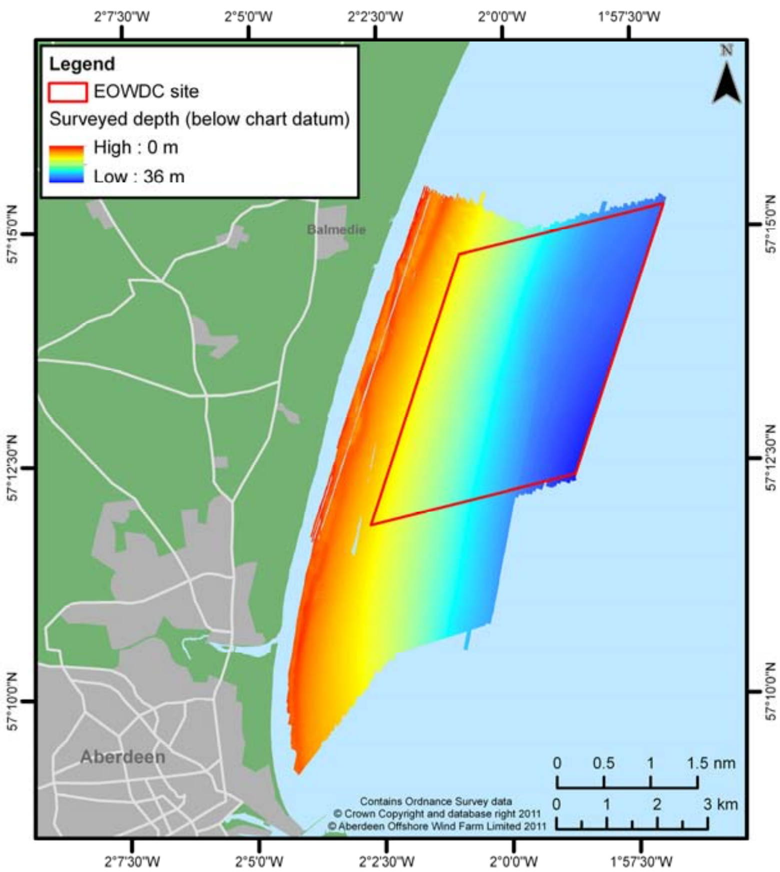
The assessment includes consideration of the potential changes to geology, waves, currents, sediment, seabed features and water quality.

Studies have provided an assessment of the potential impacts of the proposed EOWDC development within Aberdeen Bay upon the existing coastal processes. To assess the potential impacts relative to the baseline (existing) coastal environment, qualitative assessment of site data, empirical evaluation and detailed numerical modelling have been used.

It is shown that the majority of potential impacts can be considered of negligible significance. The impacts that have been assessed as minor are scour (natural removal of sediment around wind turbine foundations), increase in suspended sediment as a result of foundation and cable installation and removal activities, and changes to processes maintaining the Aberdeen Bay coastline as a result of the presence of turbine foundations.

Mitigation is not considered necessary except for the case of scour where scour protection measures are advised (this could include material being placed in the sea bed surrounding the wind turbine).

Geophysical Assessment Results Showing Depth of Aberdeen Bay



Biological Environment

Designated Sites

There are no designated sites of local, regional or national importance within the lease boundary for the proposed EOWDC.

Potential impacts upon designated sites within close proximity to the proposed EOWDC have been assessed within the Environmental Impact Assessments.

Ornithology

Three different types of ornithological surveys have been undertaken since 2005. The results from these surveys along with additional information have been used to help inform the Environmental Impact Assessment.

A total of 79 species of birds were recorded during ornithological surveys. Thirty seven of these species were either a qualifying species for a Special Protection Area (protected sites for rare or vulnerable birds) or were recorded in numbers that could be of concern should there be an impact from the proposed EOWDC development. These 37 species were assessed in detail.

Possible impacts to birds could include displacement and disturbance effects throughout the construction, operation and decommissioning stages.

For the majority of species the impact from the proposed EOWDC is deemed to be negligible. However, for some species, such as the red throated diver, the impact is deemed to be minor or moderate.

Possible mitigation for these impacts could include minimising vessel movements by using existing shipping lanes, avoiding significant piling operations during periods of high seabird sensitivity and minimising use of lights.

Razorbills Were Frequently Spotted Throughout the Survey Area

Marine Ecology

Desk top review and survey work have been undertaken in order to assess the possible environmental impacts of the proposed EOWDC on the marine ecology of the area.

The majority of the site is covered by fine well sorted sands and fine muddy sands. The most common species at the site are worms and shellfish. On the seabed brittle stars, brown shrimp and swimming crabs are common whilst fish species in the area are predominantly made up of plaice, dab, hooknose and whiting.

Possible impacts to species in the area include temporary loss of and disturbance to the seabed, resuspension of sediment and effects generated from electromagnetic fields from subsea cables.

Overall the impacts have been assessed as being negligible to minor with the exception of the worst case impact from construction noise upon fish which is considered to be of minor to possibly moderate significance. Possible mitigation could include a ‘soft start’ procedure. During this procedure noise from construction begins quietly, allowing for fish (or marine mammals) to leave the area before the noise becomes too loud.

Marine Mammals

Boat based surveys, land based vantage point surveys and desk top review were used to inform the marine mammal Environmental Impact Assessment.

A number of marine mammals make use of Aberdeen Bay throughout the year; the more commonly sighted species are the harbour porpoise, bottlenose dolphin and grey and common seal.

Marine mammals can be affected by impacts such as physiological damage from construction noise, exclusion of the site during construction and suspended sediment levels. These impacts have been assessed as being of negligible to minor significance.

In some instances behavioural disturbance and displacement during possible construction activities is considered to be of moderate to potentially major significance.

A number of mitigation strategies have been suggested in order to minimize any impacts upon marine mammals. A Marine Mammal Protection Plan (MMPP) would be developed to address and mitigate any of the impacts identified as being of concern. The final MMPP would be developed in consultation with advice from statutory consultees. The applicant would follow any advice provided by Marine Scotland on the European Protected Species licences to apply for, if these are required.

Grey Seal Swimming in Aberdeen Bay

Human Environment

Commercial Fisheries

Desk based review and thorough consultation with the Scottish Fishermen's Federation (SFF), local fishermen and the District Fishery Officer provided information to inform the Environmental Impact Assessment.

Commercial fishing activities in the area surrounding the proposed EOWDC are considered to be at relatively low levels. Potting for crab and lobsters; trawling for whitefish; and dredging for scallops account for the majority of the activity.

It is understood that at the time of writing only four, 11 metre and under trawlers actively fish in the area of the site. Whilst larger trawlers operating out of Aberdeen may transit through the site, the area is not sufficiently productive to justify such vessels actually fishing within it.

Given the limited number of wind turbines proposed, the small area of the site and the low level of fishing activity within it, the overall impacts on commercial fishing are expected to be negligible, although for a small number of local vessels, the potential impacts may be of moderate significance. It is expected that fishing would be able to continue within the proposed EOWDC during operation which should help to mitigate this impact.

24 metre Vessel fishing in Barrow Offshore Wind Farm (Copyright Brown and May Marine)

Salmon and Sea Trout

Extensive consultation was undertaken to inform this assessment. Meetings were held with all the salmon fishery boards located within the north-east region of Scotland and with representatives of the netting fishery.

Scottish salmon populations are recognised as being of national and international importance. In addition to their ecological value, salmon and sea trout are species of importance from a socioeconomic perspective.

Potential impacts upon local salmon and sea trout populations arise from the noise and vibration associated with the development of the site, increased suspended sediments, electromagnetic fields generated from subsea cables and the physical presence of the wind turbines.

The majority of impacts have been assessed as having negligible impact although it is possible that construction activities could have a negligible to minor impact following mitigation. Mitigation could include specific scheduling of construction periods so that peak times of salmon entering or exiting local rivers are not affected. Further consultation will be held with statutory consultees and salmon fisheries boards when construction methods and timing are considered further.

Seascape, Landscape and Visual Character

Site specific desk studies, field work and consultation with local Councils and statutory consultees have helped to inform the Environmental Impact Assessment process. The area within a 40 kilometres radius of the development was used for assessment.

Many possible receptors were identified including residential communities, road, rail and ferry users, sailing and boating users and National Trails and National Cycle route users. Numerous potential impacts were identified but only a limited number were considered to be significant.

The visual impact on Aberdeen is limited by the densely built up nature of the city. The significant number and diversity of built elements along the coastline would also help to absorb the visual profile of the proposed wind turbines.

The overall visual effect is therefore considered to be moderate to major with only localised and isolated areas of more significant effect. These significant effects are described in further detail within the Environmental Statement.

The proposed European Offshore Wind Deployment Centre as seen from Aberdeen Beach (image is for illustrative purposes only as not to scale). A full size representation of this photomontage is available in Volume 4 of the Full Environmental Statement found on the DVD at the back of this document.

The proposed European Offshore Wind Deployment Centre as seen from Balmedie Beach (image is for illustrative purposes only as not to scale). A full size representation of this photomontage is available in Volume 4 of the Full Environmental Statement found on the DVD at the back of this document.

Shipping and Navigation

Site surveys, desk based review and consultation have helped to inform a full Navigational Risk Assessment (NRA) for the proposed EOWDC. The NRA provides background information on local commercial and recreational navigational issues and then assesses the potential impact that the proposed EOWDC development could have upon local navigation.

A number of potential impacts were identified, the majority of these are considered to be negligible or cause no impact. Compared to the marine accident risk levels in the UK, the increase in risk to both people and the environment caused by the proposed EOWDC is low.

Extensive consultation with Aberdeen Harbour Board (AHB) and key consultees has resulted in a number of changes being made to the site layout. Recent consultation has indicated that the current site is acceptable and all hazards were identified to be low.

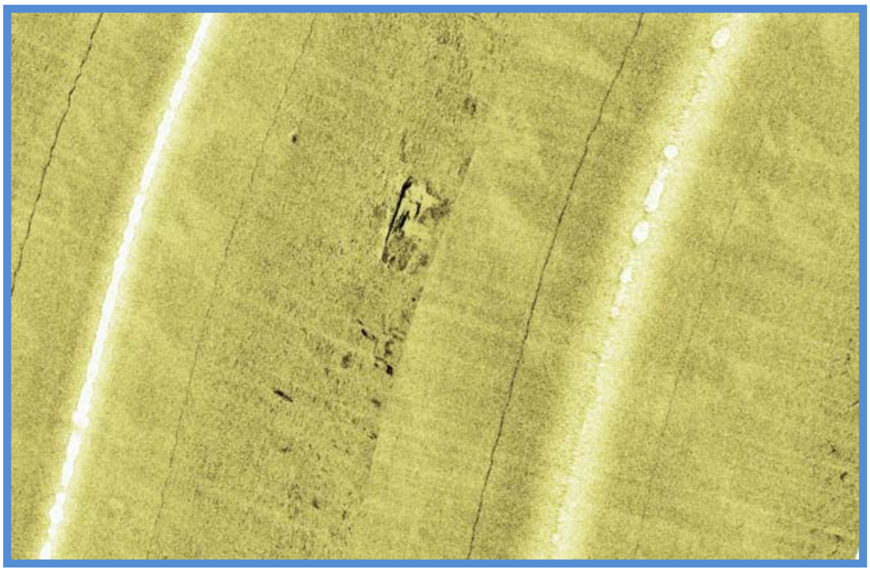
The Passenger Ferry Hjaltland Passes by the Proposed European Offshore Wind Deployment Centre Site during One of the Five Marine Traffic Surveys Undertaken

Maritime Archaeology

A maritime archaeological assessment was carried out via consultation with relevant bodies, a full desk top review, and a thorough examination of geophysical information collected for the site.

The geophysical survey has identified several anomalies which may be man-made or natural features. Of these a potential impact has been predicted for one unidentified wreck which lies in close proximity to Wind Turbine 8. The proposed mitigation for this wreck is an exclusion zone to ensure there are no impacts upon this potentially valuable site. After mitigation the impact has been assessed as of minor significance.

Geophyscial Evidence of the Unidentified Wreck by Wind Turbine Location 8 (Copyright Wessex Archaeology (2011), Data Supplied by Osiris Projects, 2010)



Cultural Heritage

Site survey and desk based review have been used to assess the potential impact that the proposed EOWDC could have upon the setting of all nationally important designated cultural heritage assets within 10 kilometres of the wind turbines and selected assets beyond this limit.

Potential impacts have been identified in five cases: Torry Battery (Scheduled Monument), Peterseat Cairns (Scheduled Monument), Hare Cairn (Scheduled Monument), Orrok House and Girdle Ness Lighthouse (Grade A-listed buildings). The impacts have been assessed as being of minor significance with the exception of Girdle Ness Lighthouse for which the impact is considered of Minor to Moderate. No mitigation is proposed in relation to these impacts, they would persist throughout the lifetime of the EOWDC and end upon decommissioning.

Aviation Radar

In order to address any potential aviation issues that could arise from the proposed development an Aviation Working Group was established in 2005.

Possible impacts to aviation included changes to helicopter routeing and impacts upon local radar facilities.

Early and ongoing consultation has helped all parties to move forward together with these issues. The Applicant has entered a contract with National Air Traffic Services Limited in order to apply for an Air Space Change. This would be implemented by NATS, in consultation with the Aviation Working Group. The Applicant is also currently negotiating a contract with NATS to determine the most efficient and effective technical solution to overcoming any primary and/or secondary radar issues.

Ministry of Defence

Consultation with the Ministry of Defence has been ongoing since 2005. Two possible impacts have been highlighted, these are the effect of the wind farm on the operability of the defence radar installation at Peterhead and the possible effect to the Black Dog Firing Range – a small-arms firing range on the coast nearby.

The project has had a long-term relationship with the MoD during its development, through the MoD Defence Estates department in Birmingham. The Applicant understands that plans for the area of the Black Dog Firing Range are acceptable, although further discussions will be needed on operational aspects. There will now need to be an intensive period of work to address recent MoD concerns regarding the Peterhead radar issue.

Unexploded Ordnance (UXO)

Although not a statutory requirement, given the history of Aberdeen during World Wars One and Two and the presence of local MoD facilities the risk of encountering unexploded ordnance has been assessed.

Between 2007 and 2010 three studies were undertaken to inform the project on the risk of UXO across the site. The conclusion of the latest assessment in 2010 was that the main ordnance threat was due to the Black Dog Firing Range. Outside this area there is a low UXO risk to the development of the proposed EOWDC.

Other Marine Users

The proposed EOWDC has the potential to impact a variety of other marine users such as surfers and recreational sailors. Most impacts are anticipated to be negligible.

Through consultation with the Royal Yachting Association two potential impacts on recreational sailing have been identified: impacts to navigational safety and loss of routes and sailing and racing areas. Such impacts can occur during construction, operation and decommissioning of the development. After mitigation such as the enforcement of safety zones it is anticipated that these impacts would be of negligible significance.

Surfers Enjoying the Scottish Coast

Socioeconomics, Recreation and Tourism

Through a process of thorough consultation and desk based assessment the potential socioeconomic, tourism and recreational impacts of the proposed EOWDC were assessed.

Consultees felt that the project would play a significant role in supporting the development of the offshore renewables industry including research and development. Impacts resulting from the project were for the majority moderate (positive), with no impact falling below negligible.

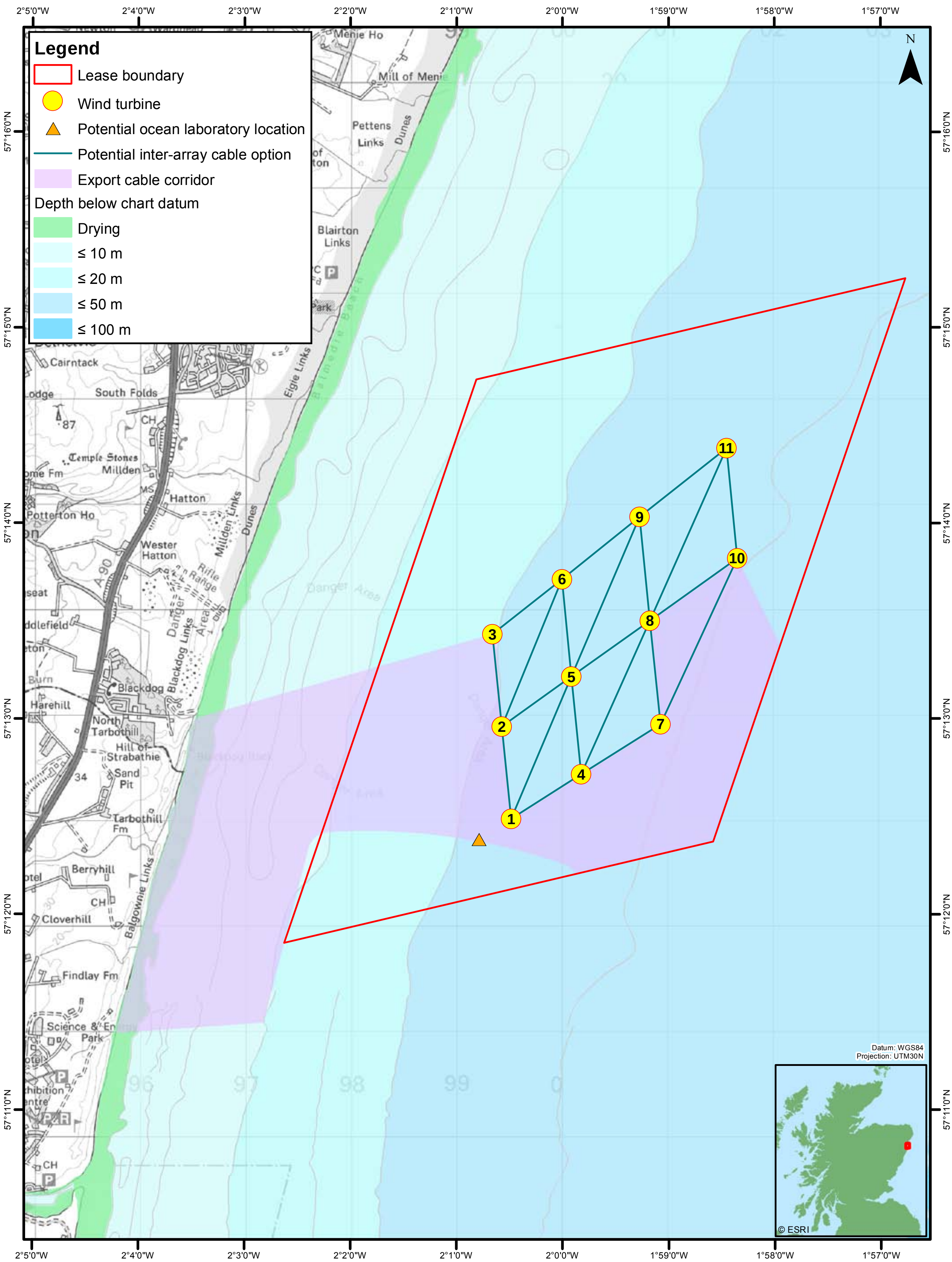
The impact of the proposed development on tourism and recreation is considered to be of negligible significance.

In Air Noise

Background noise measurements and wind speeds were measured on site over a period of 3 weeks. Consultation was carried out with the local authorities and key guidance documents were also used for the assessment.

The noise impact from the construction, operation and decommissioning of the proposed EOWDC on residential properties was assessed using suggested national limits as well as more stringent local noise limits.

The operational noise was assessed as being of negligible significance. For the noise associated with the construction of the proposed EOWDC it is anticipated that the impact during the day would be of minor significance. For night time hours mitigation suggests that certain construction activities are not carried out during this time, this resulting in a negligible significance.



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0 0.5 1 km

0 0.25 0.5 nm

Original A4 Plot Scale 1:50,000

European Offshore Wind Deployment Centre

Site Layout

Layout	By	Date	Rev	Dwg No.
LABER039	LH	21/06/2011	A	6129-530-PA-088

Figure 1

www.vattenfall.co.uk/en/aberdeen-bay.htm

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

European Offshore Wind Deployment Centre

Environmental Statement
Aberdeen Offshore Wind Farm Limited

Volume 2 of 4

July 2011

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PREFACE

Aberdeen Offshore Wind Farm Limited (AOWFL) is applying to the Scottish Ministers under Section 36 of the Electricity Act 1989 (as amended) and a Marine Licence in terms of the Marine (Scotland) Act 2010 to construct, operate and decommission an offshore wind farm and deployment centre off the coast of Aberdeen, known as the European Offshore Wind Deployment Centre (EOWDC).

The planning application comprises an Environmental Statement (ES), prepared in accordance with the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (as amended) and Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended) and follows current best practice.

The complete submission comprises the following volumes:

- Volume 1 – Non-Technical Summary
- Volume 2 – Environmental Statement
- Volume 3 – Figures
- Volume 4 – Technical Appendices

Where to View the Consent Application
The complete submission may be viewed at the following locations during normal office hours:

Vattenfall Wind Power Ltd 3rd Floor The Tun Holyrood Edinburgh EH8 8AE	Balmedie Library Eigie Rd Balmedie AB23 8YF
Aberdeen Central Library Rosemount Viaduct Aberdeen AB25 1GW	Peterhead Library 51 St Peter Street Peterhead AB42 1QD
Ellon Library Station Road Ellon AB41 9AE	Bridge Of Don Library Scotstown Road Bridge Of Don Aberdeen AB22 8HH

The Environmental Statement can also be viewed at the Scottish Government Library at Victoria Quay, Edinburgh, EH6 6QQ.

OBTAINING YOUR OWN COPY OF THE PLANNING APPLICATION

Volumes 1, 2 and 3 of the ES are available on the Vattenfall website. Volume 4 is not available on the Vattenfall website however the complete set of submitted documents may be obtained (free of charge for a data DVD or £350 for a hard copy) by contacting Vattenfall at the Hexham address:

Vattenfall
Bridge End
Hexham
Northumberland
NE46 4NU

http://www.vattenfall.co.uk/en/aberdeen-bay.htm

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 1: Introduction

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A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

1 INTRODUCTION

1.1 The European Offshore Wind Deployment Centre (EOWDC)

1 Aberdeen Offshore Wind Farm Limited (AOWFL) is proposing to develop an offshore wind farm and deployment centre off the coast of Aberdeen, known as the European Offshore Wind Deployment Centre (EOWDC) (see Figure 1.1).

2 The proposed project would combine a small commercially operated wind farm with a test and research centre, allowing manufacturers to test “first of run” wind turbines and innovative foundation solutions along with related operation and maintenance access logistics.

1.2 The Applicant

3 This application is being made by Aberdeen Wind Offshore Wind Farm Limited (AOWFL). AOWFL is an established legal entity owned by Vattenfall Wind Power Ltd (VWPL) (75 %) and Aberdeen Renewable Energy Group (AREG) (25 %).

4 The project is being part-funded by a grant under the European Union [Economic Recovery Programme in the field of Energy]. Consortium members in this grant action are AOWFL, VWPL, AREG and Technip UK Ltd.

1.2.1 Vattenfall

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7 Vattenfall is currently constructing Ormonde Offshore Wind Farm off Barrow-in- Furness which will be completed during 2011. An application to build Kentish Flats Offshore Wind Farm Extension is planned for August 2011. Vattenfall is also in partnership with ScottishPower Renewables to develop the Round 3 East Anglia Offshore Wind Farm. This project is expected to deliver around 7,200 MW of wind capacity which would provide clean electricity for the equivalent annual demand of around 4 million UK homes.

8 The north-east of Scotland is an important region for VWPL with the planned EOWDC, the Clashindarroch onshore scheme approved for consent in December 2010, and the proposed Aultmore onshore scheme.

1.2.2 Aberdeen Renewable Energy Group (AREG)

9 AREG is an incorporated company representing the interests of over 170 member organisations. Established in 2001, AREG aims to ensure that Aberdeen City and Shire and its businesses play a major role in the energy

revolution. AREG has been supported by the Energising Aberdeen Fund of Aberdeen City Council. The Fund represents a £22.25 million investment in the future of Aberdeen over five years by the Scottish Government.

1.2.3 Technip

10 Technip is a world leader in the fields of project management, engineering and construction offering innovative solutions to the global oil and gas industry.

11 With 23,000 employees, integrated capabilities and proven expertise in underwater infrastructure, offshore facilities and large processing units and plants on land, Technip is a key contributor to the development of sustainable solutions for the energy challenges of the 21st century.

12 Through its Aberdeen based operating centre, Technip provides best-in-class subsea products and services to oil and gas companies operating offshore UK, Denmark, the Netherlands and West Coast of Ireland. Further to its established subsea business, Technip is rapidly developing capability to support the growing offshore wind sector.

1.3 External Consultants

13 A number of external consultants have supported this Environmental Statement (ES). Table 1.1 summarises the consultants' participation and a summary of their qualifications and experience can be found in Appendix 1.1 (Volume 4).

TABLE 1.1
External Consultants Used

Coastal Processes	ABPmer
Geology and Bathymetry, Meteorological Conditions, Geology and Bathymetry	HarmoniQuay
Cultural Heritage	Headland Archaeology
Ornithology, Marine Mammals, Bats, EMF, Energy and Emissions, Other Marine Users and Technical Review	Genesis Oil and Gas Consultants
Shipping and Navigation	Anatec UK Ltd
In Air Noise	Hayes McKenzie
Seascape, Landscape and Visual Impact	LDA Design
Offshore Archaeology	Wessex Archaeology
Marine Ecology	Institute of Estuarine and Coastal Studies (IECS)
Commercial Fisheries	Brown and May Marine
Underwater Noise Modelling	Subacoustech Environmental Ltd
Socioeconomics, Recreation and Tourism	DTZ

1.4 Introduction of the Project

1.4.1 Background to the Proposal

14 In 2005 there was an intention to develop a project comprising 33 commercially operating wind turbines off the coast of Aberdeen. Due to constraints on the layout which became apparent at an early stage, the size

of the project was reduced considerably. Recent rapid developments in technology and the need for further research in key areas led, in 2008, to the development of the project to its current form. The project is now known as the European Offshore Wind Deployment Centre (EOWDC), which is both a small (11 wind turbine) commercially operated wind farm and a test and research facility.

15 As well as delivering renewable electricity to the National Grid, the Deployment Centre would allow supply chain companies to test a variety of products and applications in a real time offshore environment before commercial deployment, with the aim of reducing large scale development risks and capital costs to industry. The Deployment Centre also provides a platform for environmental research and development.

1.4.2 Support under the European Economic Plan for Recovery in the field of Energy

16 The project is part-funded by the European Union (EU) under the European Economic Plan for Recovery in the field of Energy.

17 The origin of the European Energy Programme for Recovery (EEPR) is the global €200 billion European Economic Recovery Plan presented by the Commission on 26 November 2008. The focus of the Plan is on containing the impact of the global financial crisis: protecting jobs and purchasing power, boosting infrastructure and creating jobs in the low carbon sectors of the future. The Recovery Plan sets out how Member States and the European Union could coordinate their policies in order to provide new stimulus to the European economy and increase Union spending in strategic sectors. Investments in energy projects were considered an important tool to support the economic recovery.

18 The EEPR helps to speed up and secure investments in the energy sector, which will have a direct impact on the EU economy and employment. It will also help to improve the security of supply of the most vulnerable Member States and link ‘energy islands’ to the rest of the EU energy market.

19 The EEPR Regulation created the basis for providing substantial co-financing from the Union budget to key energy projects. Never before has the EU agreed to dedicate such a significant amount to energy infrastructures. The €3.98 billion budget for the implementation of the Regulation is allocated as follows:

- gas and electricity infrastructure projects: €2.365 billion (60 % of budget)
- offshore wind energy projects (OWE): €0.565 billion (14 % of budget)
- carbon capture and storage projects (CCS): €1.05 billion (26 % of budget)

1.4.3 The Project Vision

20 Thanks to financial support from the European Union, the EOWDC would provide a platform to deploy and demonstrate new concepts, products and services in offshore wind whilst enabling research in this new sector – ideal for a partnership with Europe’s renewables industry, academia and research community.

21 The vision is:

"To deploy new equipment, systems, processes and initiate R&D to improve the competitiveness of Offshore Wind Energy production, whilst generating environmentally sound marketable electricity and to increase the supply chain capabilities in Scotland, the wider UK and Europe."

22 This project is targeted at both enabling and encouraging increased competition into the European wind turbine supply chain by providing sites for manufacturers both to prove new and innovative solutions and also to allow the acquisition of offshore "hands-on" design, build and operational and maintenance experience, in advance of Round 3.

23 This project would allow "first of run" production wind turbine systems to be operated in the marine environment so that developers, owners and financiers can gain confidence in wind turbine manufacturer's new machine designs, allowing the development of the supply chain in this area. The intention is to highly instrument the equipment to provide maximum learning opportunity.

24 The EOWDC has the potential to promote and enable the deployment of pre-production innovative foundations, or foundation production methods. It may also be available as a platform to test energy storage and/or Flexible Alternating Current Transmission Systems (FACTS) devices.

25 In addition and as indicated, the Applicant will also look at increased monitoring which would improve understanding of wind farm design and operation to ensure increased efficiency and operation.

26 There is potential for an Ocean Laboratory that could hold meteorological masts, environmental monitoring equipment and be used for access training. The inclusion of an Ocean Laboratory would allow environmental monitoring during and after deployments but would be subject to a separate application. Environmental data may also be collected through a series of planned surveys. The environmental effects of the deployment centre could be closely monitored and data collected prior to Round 3 offshore wind farms being installed.

27 Environmental monitoring would provide stakeholders with information on associated environmental impacts prior to large scale deployments ie Scottish Territorial Waters or Round 3. Via the EU grant, a proposal has been made to allocate in excess of £2.7 million, funded jointly by the Applicant and the EU to environmental studies over the project lifetime including the development of environmental research with external partners. Details of exact activities, and confirmation of EU matched funding, will be achieved as research proposals and requirements are received and selected.

1.4.4 Environmental Research and Development Opportunities

28 A key aspect of the proposed EOWDC is to encourage and enable environmental monitoring through ongoing research and development in advance of the larger build and operational experience of Scottish Territorial Water Developments and Round 3.

29 The agreed environmental monitoring programme would be in excess of the industry norm and would seek to answer outstanding questions on environmental impacts of offshore wind, which will be of benefit to all stakeholders. The programme would provide stakeholders with information on the environmental impacts of new technologies, processes and operations, and the Applicant hopes to encourage University level research especially that from nearby Aberdeen and Robert Gordon Universities.

30 As part of the Environmental Impact Assessment (EIA) for the EOWDC, advice has been sought from the relevant consultants as to future research and monitoring opportunities for the site. These opportunities are provided in the Environmental Statement in addition to any monitoring put forward for the purposes of consent.

31 The Applicant will shortly embark on an exercise to scope out the potential environmental research opportunities for the site and will encourage input from interested parties including statutory nature conservation agencies and research organisations and external Consultants working in the offshore wind sector.

1.4.5 Supply Chain Participation

32 The proposed EOWDC is keen to attract pre-commercial deployment of offshore wind turbines and other associated technologies. The proposed EOWDC could provide the opportunity to deploy technologies, goods and services ahead of the major development of the Round 3 offshore wind farms.

33 The Applicant is therefore keen to speak to wind turbine manufacturers, component manufacturers, installation contractors, other supply chain companies, universities and research establishments about their participation.

34 The Applicant is engaging with the supply chain to identify how the project could add value. This will be carried out via number of events and other methods of consultation. Interested parties are likely to include:

- wind turbine manufacturers
- foundation manufacturers
- cable manufacturers
- cable installers
- offshore construction companies
- vessel suppliers
- offshore wind turbine access solution providers
- universities and research establishments

1.4.6 The Proposed Development

35 The Applicant is proposing to construct 11 wind turbines off Aberdeen Bay each with a nominal output of up to 10 MW and a maximum output for the wind farm of up to 100 MW. A summary of the key project characteristics associated with the proposal is provided in Table 1.2.

TABLE 1.2 **Key Project Characteristics**	
Maximum Capacity	100 MW
Maximum Number of Wind Turbines	11
Lease Boundary Area	20 km^2
Approximate Distance to Shore	2.4 km
Water Depth across the Wind Turbine Locations	20 – 30 m below Lowest Astronomical Tide
Individual Wind Turbine Capacity	4 to 10 MW
Maximum Rotor Diameter	150 m
Maximum Hub Height	120 m
Maximum Tip Height	195 m
Minimum Clearance Above Sea Level	22 m above mean high water springs level (MHWS)
Indicative Spacing between Wind Turbines	Between 790 m and 1050 m
Foundation Types	Potential foundations include monopiles, jackets, tripods, gravity base structure, suction caisson/ buckets
Inter-array Cables	Maximum number of 12. Total length of 13 km.
Export Cables	Maximum number of 4 would run from the wind turbine array back to Mean High Water Spring (MHWS) Total length of 26 km

36 The proposed EOWDC site can be seen on Figure 1.2. The onshore works for the project are currently unknown but they are likely to comprise the following:

- onshore cables
- miscellaneous cable joints/ cable protection and cable/pipeline crossings
- temporary pre-assembly construction facilities onshore (location currently unknown)
- Onshore substation and deployment centre

37 The onshore works will be applied for separately under the Town and Country Planning (Scotland) Act 1997 as amended. The Local Planning Authorities in proximity to the site are Aberdeenshire Council and Aberdeen City Council. The boundaries of the two jurisdictions are shown on Figure 1.3. Once the onshore works are defined a planning application will be made to the relevant authority. Both of the two councils will be consultees in the Section 36 and Marine Licence process.

Plate 1.1 A 5 MW Installed Wind Turbine at the Ormonde Offshore Wind Farm

38 A full description of the proposed construction, operation and decommissioning of the development is given in Chapter 3 Description of the Proposed Project.

1.5 The Purpose of this Environmental Statement

39 This ES presents the findings of the EIA of the proposed EOWDC. The document is in 4 volumes as outlined in Table 1.3.

TABLE 1.3 Structure of this ES
Volume 1 Non Technical Summary
Volume 2 Environmental Statement
Chapter 1 Introduction
Chapter 2 Site Selection
Chapter 3 Description of the Proposed Project
Chapter 4 EIA Methodology, Scoping and Consultation
Chapter 5 Meteorological Conditions
Chapter 6 Geology and Bathymetry
Chapter 7 Offshore Ordnance
Chapter 8 Coastal Processes
Chapter 9 Marine Ecology, Intertidal Ecology, Sediment and Water Quality
Chapter 10 Ornithology
Chapter 11 Bats
Chapter 12 Marine Mammals
Chapter 13 Electromagnetic Fields
Chapter 14 Statutory Designations and Conservation
Chapter 15 Shipping and Navigation
Chapter 16 Aviation
Chapter 17 Ministry of Defence
Chapter 18 Maritime Archaeology
Chapter 19 Seascape, Landscape and Visual Assessment
Chapter 20 Cultural Heritage
Chapter 21 Commercial Fisheries
Chapter 22 Salmon and Sea Trout
Chapter 23 Socioeconomics, Recreation and Tourism
Chapter 24 In Air Noise
Chapter 25 Energy Use and Emissions
Chapter 26 Electromagnetic Interference
Chapter 27 Other Marine Users
Chapter 28 Mitigation, Management and Monitoring
Chapter 29 Information to Inform the Habitats Regulation Appraisal
Chapter 30 Summary
Volume 3 Figures
Volume 4 Technical Appendices

1.5.1 Data Gaps and Uncertainties

1.5.1.1 Data Gaps

40 The Applicant acknowledges that there is still a requirement from statutory bodies for further bird and marine mammal boat-based survey data. AOWFL contracted further monthly boat-based surveys which started in August 2010 and which will run until July 2011. Four months of this survey data has been analysed and is included in the bird and marine mammal impact assessments within this ES. The remaining eight months of data will be analysed and

submitted to Marine Scotland as an Addendum to this Environmental Statement as soon as practicable.

1.5.1.2 Uncertainties

41 As the project is a deployment centre there is still a need to obtain a certain degree of flexibility when applying for consents as there is still uncertainty as to the size and type of foundations to be installed. It should be noted that, in defining the project that has been assessed during the EIA, the "Rochdale Envelope" approach (see Chapter 4) has been adopted. By adopting this approach, it will be possible to conclude that the environmental impact of the proposed development will be no greater than set out in this ES.

42 The Applicant has undertaken an EIA, which is based on the optimum design and layout information available to the project when making the application, involving an assessment allowing for different types of wind turbines and foundations.

43 As not all the details of the proposed development are known at this time, a worst case approach has been undertaken, according to the principles described as the "Rochdale Envelope". What is considered to be the worst case is different depending on the receiving environment affected (eg birds, shipping & navigation etc) and the activity undertaken (construction/de-commissioning or operation). It should be noted that when carrying out the assessment the possibility of mixed foundation types within the development has been considered, however, in each case a single foundation type at each location has been identified as the worst case ie for the coastal processes assessment 11 gravity bases structures are considered.

1.6 Development Context

1.6.1 The Need for Offshore Wind Energy

44 Climate change represents one of the greatest environmental threats faced by the world today with far reaching implications for the global environment and economy. Renewable electricity generation is vital for decarbonising the global energy system and hence global climate change mitigation. Wind energy is one of the most competitive technologies in renewable energy. However, large scale implementation offshore, whilst offering potential for significant opportunity to develop vast wind resource capacity, also poses huge challenges, requiring technological innovation, industrial & market development and, in parallel, significant cost reduction to become cost competitive with other forms of energy sources.

45 The UK, and specifically Scotland, has some of the best wind resource in Europe.

46 The Scottish Government aims to achieve a target of 100 % of Scottish demand for electricity from renewable sources by 2020. The Scottish Parliament passed the Scottish Climate Change Act in 2009. It demanded a 42 % cut in greenhouse gas emissions by 2020 and 80 % cuts by 2050, based on a 1990 baseline. The development of Scotland's offshore wind

potential will be crucial to the delivery of Scotland's legal obligations on climate change.

47 The rapid development of offshore wind capacity is central to the delivery of the UK's share of the EU target of 20 % renewable energy by 2020. The Crown Estate, as the seabed owner, has announced proposals to deliver up to 25 Giga Watts (GW) of new offshore wind farm sites by 2020 through the Round 3 licensing. This is intended to provide a stimulus throughout the EU and to provide an important contribution to both reducing CO_2 emissions and improve security of energy supply to the wider EU. This builds on the 8 GW of offshore wind farm projects currently under development and to be delivered by Rounds 1 and 2. If successful, the addition of the capacity from Round 3 and the Scottish Territorial Waters Round together with any additional smaller sites, could lead to a potential total of 39.5 GW of offshore wind energy.

48 The scale of the challenge in delivering such a large programme means that the equipment and services supply chains need to be dramatically enhanced in a very short timescale. The central requirement of the industry is for live operational experience of the various wind farm components with validated data. This requires an area to deploy novel technologies to gain data during actual operational hours in a controlled offshore environment.

49 The EOWDC's focus is on proving new technology, processes and operations, and improving existing technology, processes and operations with the key objectives of increasing reliability, efficiency and reducing cost. As such, the EOWDC would directly contribute to the delivery of not only the UK Round 3 and Scottish Territorial Water Rounds, but also the wider European programme of offshore development.

50 The maximum output of the EOWDC, as governed by The Crown Estate lease conditions, is 100 MW. Assuming a 35 % capacity factor, the EOWDC could provide enough capacity to meet the demand of over 68,400 homes, equating to a supply large enough to meet over 65 % of the domestic need of the Aberdeen City population[1]. The 2013 household estimate for Aberdeen is 108,150 (See Appendix 1.2).

1.6.2 Creation of Employment from Wind Energy

51 Estimates vary as to the global job creation potential for wind power (on and offshore). However a middle case scenario suggests 462,000 by 2010 and 1.3 million by 2020 with a potential maximum recognised as 572,000 by 2010 and 2.2 million by 2020 (GWEA, 2008). As Europe is a particularly intensive area for wind development, it is to be expected that the proportion of global employment secured could be significantly higher than implied by the population or land mass and sea area. The European Wind Energy Association estimates that European employment in wind power will increase to almost 330,000 in 2020 and to 375,000 by 2030, 57 % of the latter figure being accounted for by offshore wind (EWEA, 2008).

[1] This assumes number of households in Aberdeen was 102,900 in 2008. This is based on the "Household Projections for Scotland 2008-based" from the General Register Office for Scotland (2010).

1.7 Statutory and Regulatory Framework

52 The construction and operation of the EOWDC will require a consent under Section 36 of the Electricity Act 1989 (as amended). The Electricity Act 1989 (Requirement of Consent for Offshore Generating Stations) (Scotland) Order 2002 requires Section 36 consent for the installation of any offshore generating station with a permitted capacity of 1 MW or above.

53 Section 57(2) of the Town and Country Planning (Scotland) Act 1997 provides that the Scottish Ministers can direct that planning permission for development of the Section 36 application or ancillary development can be deemed to be granted. The requirement for planning permission may apply to only a small portion of the export cable.

54 In formulating an application for a Section 36 consent the Applicant is obliged to have regard to the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and in protecting sites, buildings and objects or architectural, historic or archaeological interest. Furthermore the Applicant is obliged to do what he reasonably can to mitigate any effects which the proposal would have on such matters. In considering any proposals the Scottish Ministers are obliged to have regard to the desirability of preserving the list of assets and also the extent to which the Applicant has complied with their duty reasonably to mitigate any effects. The applicant is also obliged to avoid so far as possible causing injury to fisheries or to the stock of fish in any waters. These matters have been addressed in this ES.

55 In addition to a Section 36 Consent the EOWDC will also require a marine licence in terms of the Marine (Scotland) Act 2010. This Act imposes a number of duties upon the Scottish Ministers in respect of the grant of any marine licence. It includes obligations under Section 3 to act in a way which is best calculated to further the achievement of sustainable development, including the protection or where appropriate the enhancement of the health of that area, and under Section 4 to act in a way best calculated to mitigate, and adapt to, climate change so far as consistent with the purpose of the function concerned. In terms of Section 15 all public authorities are obliged to take authorisation decisions in accordance with appropriate marine plans unless relevant considerations indicate otherwise. Furthermore, in the determination of a marine licence application, Section 27 implies certain statutory requirements on the determination process. The Scottish Ministers must have regard to the need to protect the environment, human health and prevent interference with legitimate uses of the sea and such other matters as the Scottish Ministers consider relevant. These are all matters which have been considered and assessed within the ES.

56 The Applicant has determined that the development is an EIA development and this Environmental Statement has been produced to comply with the requirements contained in the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (as amended) and the relevant marine regulations, The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended).

57 The Conservation (Natural Habitats, & c.) Regulations 1994 (as amended) provide the requirement to consider the potential effects of the project on European sites and species. The Scottish Ministers will be the appropriate

authority in determining the extent to which an appropriate assessment will be required, or issuing any European Protected Species licences. These matters have been considered in terms of the relevant chapters of the ES. The regulations also regulate activities which could potentially disturb European protected species.

58 More information on the applicable statutory and regulatory framework may be found in the Appendix 1.3 to this ES.

1.8 Legislative Policy

59 The determination of both a Section 36 Consent and a marine licence potentially involve a wide range of material considerations. This is likely to include Energy Policy, published and emerging Marine Policy, relevant Development Plans and National Planning Policy. Where the policies are relevant to a particular assessment they have been referred to as the relevant material in the ES. It should be noted that the planning policies would only directly be applicable to support a small portion of the onshore export cables from the mean low water mark up until the mean high water spring tide level. In addition a number of the effects of the offshore elements of the EOWDC will potentially have impacts onshore. Planning policy may assist in carrying out an assessment of the potential affects on such onshore receptors. Where relevant to a particular assessment these have been referred to.

60 The overall determinations will have to have regard to a wide range of policy and they will be important in evaluating the consenting balance having regard to both the positive, neutral and negative aspects arising from the EOWDC.

1.8.1 Energy Policy

61 There are three levels of applicable renewable energy legislation and policy: (1) European, (2) UK, and (3) Scottish. Common to each level is a presumption that offshore wind can make a significant and meaningful contribution to environmentally friendly electricity production, which is a key priority for the European Community and the UK and Scottish Governments. More information on renewable energy legislation and policies may be found in Appendix 1.3 to this ES.

1.8.2 Marine Policy

62 In Scotland, the legislation allows for three levels of planning – a UK wide Marine Policy Statement, a Scottish National Marine Plan and regional plans. Consistent throughout each is a presumption in favour of sustainable marine development. Underlying this presumption is a key marine planning policy objective to maximise sustainable economic and social growth, which the Scottish Government believe to be intrinsically linked to such development. The North East Region is highlighted as having favourable conditions for marine development, particularly in the offshore wind context, which is noted as being critical to the future security of energy supply in Scotland. More information on the relevant legislation and guidance may be found in the Appendix 1.3 to this ES.

1.8.3 Planning Policy

63 In terms of the offshore elements of the EOWDC project only a small section of the proposal will directly engage the onshore planning system. That relates to the area between the low water mark and the mean high water spring tide. This represents the overlap between the Marine and Onshore Licensing Regimes. More information on the relevant planning policy may be found in Appendix 1.3 to this ES. It is not the subject matter of the Annex to assess the development proposals against development plan policy but to identify the relevant policy elements. Some of the impacts of the EOWDC will affect land based receptors and where relevant these have been referred to within the technical appendices and assessment chapters.

1.9 References / Bibilography

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GWEA (2008). Global Wind Energy Outlook 2008. http://www.gwec.net/fileadmin/documents/GWEO08-graphs/GWEO_A4_2008_42b.jpg [Accessed July 2010]

Legislation

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Electricity Act 1989 Town and Country Planning (Scotland) Act 1997

Acts of the Scottish Parliament
Marine (Scotland) Act 2010
Climate change (Scotland) Act 2009

Statutory Instruments
Marine Works (Environmental Impact Assessment) Regulations 2007
Electricity Act 1989 (Requirement Of Consent For Offshore Generating Stations) (Scotland) Order 2002
Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000
Conservation (Natural Habits, & c.) Regulations 1994

European Directives
Renewable Energy Directive (Directive 2009/28/EC)

Government Reports / Policy Statements
National Renewable Energy Action Plan for the UK, UK Government (July 2010)

A Prevailing Wind: Advancing UK Offshore Wind Deployment, UK Government (June 2009)

Renewables Action Plan, Scottish Government (June 2009)

Blue Seas – Green Energy: A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters, Scottish Government (March 2011)

UK Marine Policy Statement, UK Government (March 2011)

Draft Scotland National Marine Plan Statement, Scottish Government (March 2011)

Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters, Scottish Government (March 2011)

Planning Policy Documentation
National Planning Framework for Scotland – NPF2 (June 2009)

Scottish Planning Policy (February 2010)

The Aberdeen City & Shire Structure Plan (Approved 14 August 2009)

The Aberdeenshire Local Plan (Adopted June 2006)

The City of Aberdeen Local Plan (Adopted June 2008)

The Aberdeenshire Proposed Local Development Plan

Aberdeen Proposed Local Development Plan

Other
Scottish Government Press Release, 18 May 2011 (http://www.scotland.gov.uk/News/Releases/2011/05/18093247)

Scottish Parliament Debate, 2 June 2011 (http://www.scotland.gov.uk/News/Speeches/renewenergyJune2011)

European Offshore Wind Deployment Centre
Environmental Statement

Chapter 10: Ornithology

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

10 ORNITHOLOGY

10.1 Introduction

1 The Ornithological Baseline and Impact Assessment report provides a detailed assessment of the potential impacts and possible effects on the birds present within the proposed European Offshore Wind Deployment Centre (EOWDC) area. The assessment is based on the findings from site specific bird surveys undertaken to help inform the impact assessment along with desk-based studies using published data from existing offshore wind farms.

2 This chapter provides a condensed summary of the findings presented in the Ornithological Baseline Impact Assessment report, which should be referred to for further information. Genesis Oil and Gas Consultants carried out the ornithological assessment.

10.2 Data Information and Sources

3 Three different types of surveys have been undertaken since 2005 in order to obtain a representative sample of bird data to inform the EIA and, if required, a Habitats Regulations Appraisal.

4 Monthly boat-based surveys were undertaken between February 2007 and April 2008 and an additional 12 months of surveys commenced in August 2010. In addition to the boat-based surveys, two years of Vantage Point surveys were undertaken from March and October 2005 and from April 2006 to March 2008 and three radar surveys were carried out in October 2005, April 2006 and April 2010.

5 The data obtained from these surveys along with additional information from other offshore wind farms have been used to help inform the Environmental Impact Assessment (EIA).

10.2.1 Boat-based Surveys

6 There have been two periods of boat-based bird surveys undertaken in support of the proposed development.

7 Between February 2007 and April 2008 boat-based surveys were undertaken on a monthly basis. Each survey covered an area of 101.6 km^2, which included the then proposed development site plus a buffer zone and a control survey area located immediately to the north (Figure 10.1). The control survey area of 50.8 km^2 was the same size as the then proposed development site (including the buffer zone). The site proposed at the time the surveys were being undertaken represented 12 % of the total area surveyed, and 24 % of the proposed EOWDC survey area. The distance of the shoreline to the proposed EOWDC survey area varied between 0.6 km to 7 km and the control survey area between 0.5 km to 6 km. The control survey area was positioned in an area exhibiting similar physical attributes (bathymetry and seabed type) to that of the then development site (IECS 2008).

8 Following the completion of the Year 1 bird surveys (February 2007 – April 2008), the location and size of the proposed development was revised. Although the original boat-based surveys did cover the revised location, the potential for future monitoring was improved by using an alternative survey strategy designed for the surveys undertaken since August 2010 (Figure 10.1). Three blocks have been surveyed each month out to 25 km from the shoreline, allowing a gradient approach of potential impact areas to be used (SMRU 2011). The total area surveyed each month was 339 km^2, comprising of three strata: 150.8 km^2 (north), 82.8 km^2 (south) and 105.2 km^2 (offshore).

10.2.2 Vantage Point Surveys

9 Vantage Point (VP) surveys have been undertaken from a total of six sites (four in any one year) within Aberdeen Bay over a period of three years between March 2005 and October 2005 and April 2006 and March 2008 (Figure 10.2) (EnviroCentre 2007; Alba Ecology 2008).

10 Watches were conducted by a single observer with binoculars and telescope for one to two hours from each VP site. Observations were carried out during daylight hours and in conditions of good visibility. Up to four surveys per month were undertaken.

11 A total of 294 VP surveys and 582 hours of surveys have been undertaken over a period of three years across six different areas of Aberdeen Bay (Table 10.1).

TABLE 10.1
Vantage Point Survey Summary

Site	No. of VP surveys	No. of Hours
Drums	55	114
Balmedie	52	102
Blackdog	84	167
Murcar *	10	16
Donmouth	83	163
Promenade *	10	20
Total	294	582

* = Data collected between March and October 2005 only

10.2.3 Bird Detection Radar Surveys

12 Bird Detection radar has been used on three occasions during periods predicted to be of high migration in Aberdeen Bay: October 2005, April 2006 and April 2010. Original surveys were undertaken at Easter Hatton and Drums, but later moved to Blackdog, closer to the proposed development area. The survey areas of the radar surveys are shown on Figure 10.2

13 Bird movements were tracked continuously up to a range of 11 km, including during periods of darkness or poor weather conditions. The radar could detect bird movements, their flight trajectory, flight speed and altitude to a height of 1.4 km.

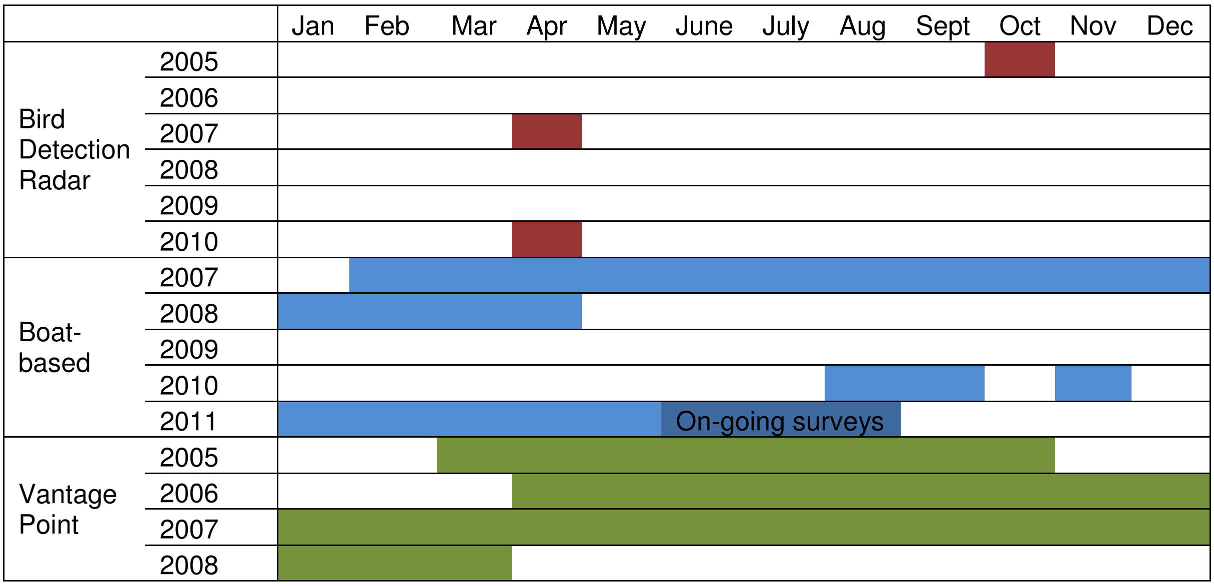

Diagram 10.1 Ornithological surveys undertaken in Aberdeen Bay 2005 – 2011

14 Diagram 10.1 outlines the survey coverage to date.

15 A summary of the main survey reports and studies used in the EIA for birds is presented below:

- Alba Ecology (2008a). Preliminary Vantage Point species accounts of seabird movements at the proposed Aberdeen Bay offshore wind farm: April – September 2007. Report for AMEC Wind Energy
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10.2.4 Consultation

16 Consultation with key stakeholders, specifically SNH, JNCC and Marine Scotland occurred at an early stage of the project in 2006 and continued throughout the scoping stage of the EOWDC. Key issues raised were the potential impacts upon birds, specifically red-throated diver and common scoter and also the potential adverse effects to birds from Special Protection Areas (SPAs).

10.3 Impact Assessment Methodology

17 Potential impacts on birds arising from the proposed development have been identified based on site specific data from Aberdeen Bay. Other published information on the birds likely to be present in the area has also been drawn upon.

18 Whenever possible, additional information from existing offshore wind farms

19 Three potentially significant impacts on birds have been identified:

- Collision risk: Birds are at risk of colliding with wind turbines. The level of collision depends on the location and size of the development and the species present. Species such as Auks, Divers and Scoter, fly predominantly below rotor height, whereas other species such as Gulls may fly more frequently at rotor height and therefore be at a greater risk.

- Displacement: Birds that would otherwise use an area may avoid entering the wind farm and therefore be displaced. Birds may be also be displaced if the availability of their prey is reduced or if they are disturbed by vessels associated with the proposed development. The significance of any displacement is largely dependent on the scale and duration of the impact and whether other suitable sites are available to which the birds may go should they be displaced
- Barrier effects: Birds may avoid flying through the proposed EOWDC and select to fly either over or around it. Should this occur then this might entail the birds flying further than would otherwise have been the case. Many species of bird have been recorded avoiding offshore wind farms, often by altering course at a distance of 1 km or more, eg wildfowl and gannets

20 The impact assessment has been based on the above potential effects.

21 There are four main phases in the development of the proposed programme that have been considered whilst undertaking the impact assessment.

- pre-construction
- construction
- operation
- decommissioning

22 For the purposes of this EIA an evidence based approach has been used to determine potential impacts as well as expert judgement based on the baseline information and results from other offshore wind farms. Impact specific matrices have been used to provide a structure and consistency of approach and also as tool to help inform the impact assessment. The structure and content of the tables are based on those originally developed by Percival et al. (1999) and developed further by Maclean et al. (2009). However, the results from the impact matrices have not been considered to be definitive, nor in isolation. The assessment is ultimately based on the latest published data available on potential impacts, ie wherever possible an evidence based approach has been adopted.

23 A species specific sensitivity assessment has been undertaken in line with recommendations made in Maclean et al. (2009). Sensitivities of species groups to particular impacts are ranked and combined with the non-impact sensitivities to give an overall sensitivity.

24 By combining the overall sensitivity of a species with the potential magnitude of the impact, an indicative overall sensitivity of the species to the potential impact is obtained (Table 10.2). However, it is recognised that this is only an indicative sensitivity and evidence from existing wind farms and consequently expert judgement is used to determine whether the potential impact is likely to be significant or adverse.

Table 10.2 Potential Significance of Impact				
Magnitude	**Overall Sensitivity of Receptor**			
	Very High	**High**	**Medium**	**Low**
Very High	Major	Major	Major	Moderate
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Minor
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

10.3.1 Initial Screening Results

25 The results from the initial impact indicated that the following species were at a potentially moderate or major risk of:

- collision mortality: gannet , kittiwake, herring gull, lesser black-backed gull, great black-backed gull, common tern and Arctic tern
- barrier effects: pink-footed goose, barnacle goose, common eider, common scoter, velvet scoter and red-throated diver
- displacement and disturbance: common eider, long-tailed duck, common scoter, velvet scoter, red-breasted merganser, red-throated diver, cormorant and shag

10.3.2 Designated Sites

26 Although the proposed site does not lie within a designated area, there are a number of SPAs along the east coast of Scotland that have the potential to be impacted by the proposed development. For the purposes of the EIA, qualifying species from SPAs 74 km to the north between Troup, Pennan and Lion's Head and the Forth Islands SPA approximately 134 km to the south, have been considered and assessed against the relevant Conservation Objectives. The selection of sites is based largely on the potential foraging areas or known passage routes of the species recorded during surveys undertaken within the proposed development area (Roos 2010).

10.3.3 Implications of Significance

27 Where the potential significance is identified as being negligible or minor this is considered to be of limited or no concern. Moderate significance is of concern but may be tolerable depending on the causes that give rise to the potential impact. Major concerns are considered to be a potentially significant effect.

10.3.4 Determining Potential Adverse Effects

28 To determine potential adverse effects the assessment is based on the Conservation Objectives and qualifying species of the site.

29 To identify whether an impact is potentially adverse with respect to potential impacts on population levels a measure based upon the 1 % of baseline mortality rate has been used as a guide. It is not considered to be a definitive

'cut-off' but a tool to indicate whether the potential impact could cause an adverse effect.

10.3.5 Assessment of Cumulative Impacts

30 The cumulative impact assessment considers all other industries which have the potential to impact on the birds that may be present at the proposed development location, these include:

- offshore wind farms
- shipping
- aggregates
- dredging
- oil & gas

31 Offshore renewable projects that have been identified as having the potential for a cumulative effect include two developments in the Moray Firth and three in the Firth of Forth. The sites in the Moray Firth are approximately 150 km to the north and those in the Firth of Forth approximately 120 km to the south of the proposed development.

32 The construction of the proposed EOWDC may overlap with construction activities being undertaken at other planned developments. However, given the stage of development of the renewable projects yet to be constructed and the uncertainty as to the types of foundations and wind turbines that will be used, there is sparse information available to incorporate into any impact assessment, which limits the effectiveness of cumulative assessments considering conceptual projects yet to be subject to a formal consent application and for which no environmental or design data are currently available.

33 Therefore, the cumulative impact assessment can only be undertaken with data available from the currently operating Beatrice demonstrator project in the Moray Firth. Although, the assessment does wherever possible consider potential cumulative impacts from other yet unconsented renewable projects.

34 Shipping associated with the harbour which has been undertaken in Aberdeen Bay over many centuries with currently approximately 16,000 vessel movements per year. There are no known plans that are likely to cause a significant increase in the level of shipping currently being undertaken in Aberdeen Bay and any impacts shipping may currently be having on the birds within Aberdeen Bay will be part of the baseline.

35 There are no aggregates activities within Aberdeen Bay. There are no licensed dredging sites within Aberdeen Bay but occasional dredging of the harbour may occur, with the next dredging scheduled for 2012.

36 Aside from shipping there are no oil and gas related activities within Aberdeen Bay.

10.3.6 Assessment of In-combination Impacts

37 The Conservation (Natural Habitats, & c.) Regulations 1994 (as amended) require that a Habitats Regulations Appraisal (HRA) must be conducted by a competent authority. The HRA considers the implications for European sites in view of the European sites conservation objectives, in respect of any plan or project which is not directly connected with or necessary to the management of the European site for conservation purposes and which is likely to have a significant effect on the European site either alone or in-combination with other plans or projects.

38 Therefore the term 'in-combination' will be used when considering the impacts of the proposals with other plans or projects on European sites.

39 The main industries considered for potential in-combination impacts are proposed offshore wind farms, aggregate industry, dredging, oil and gas and shipping. Of these, proposed offshore wind farms and shipping are the only activities identified for which there is a potential for an in-combination impact.

10.4 Baseline Assessment

40 The ornithological environmental baseline draws upon results from project specific surveys undertaken to inform the EIA and existing published information on the birds present in the wider area.

41 A total of 79 species of bird have been recorded from site specific surveys, of which 37 species are either a qualifying species for a SPA or were recorded in numbers that could be of concern should there be an impact and were therefore further assessed.

42 *Wildfowl*: The most frequently recorded wildfowl were common eider and common scoter, both of which were recorded in relatively large numbers particularly during the winter and summer months. Peak counts of eider from boat-based surveys were obtained during the winter months with up to 556 birds being recorded. For common scoter the peak recorded was 1,157 birds counts during the spring and summer months. Evidence from other sources indicated that up to approximately 3,000 of each species may occur in Aberdeen Bay during the summer months. Other species of potential concern included pink-footed goose and barnacle goose, both of which were recorded flying through the area during the spring and autumn.

43 *Divers*: The red-throated diver was the only species of diver frequently recorded during the surveys. They were recorded throughout the survey area in water depths of less than 20 m. Peak numbers occurred during the winter and spring with up to 25 birds recorded within the EOWDC area during May.

44 *Seabirds*: A total of 20 species of seabird were recorded during the surveys undertaken in Aberdeen Bay.

- **Fulmars** were widespread throughout the area during most of the year. Highest densities were recorded during September and December
- **Gannets** were recorded throughout the area and throughout the year with peak numbers during August and September. The majority of

sightings were between 2-3 km offshore and most were recorded flying below turbine height

- **Cormorant and shags** were recorded regularly during site specific surveys predominantly within 2 km of the coast. All those recorded in flight were below turbine height
- **Skuas**. Both great skua and Arctic skua were recorded in low numbers between April and November with the majority of sightings during the autumn
- **Gulls.** Kittiwakes were the most frequently recorded gull. Birds were present throughout the year but peak numbers occurred in June and July when over 2,000 kittiwakes were in the whole of the surveyed areas. Of those recorded in flight, 22 % were at rotor height and therefore at risk of potential collision. Other species of Gull recorded included black-headed, common, lesser black-backed, herring and great black-backed
- **Terns.** Four species of Tern were recorded during surveys. The most frequently recorded species was Sandwich tern with peak numbers between May and August with up to 43 birds recorded. The majority of sightings were of birds within 2 km from shore but 44 % were at rotor height. There were fewer records of little, common and Arctic terns with the majority of sightings within 2 km of the coast and relatively few within the proposed development area
- **Auks.** Puffins, guillemots and razorbills were frequently recorded throughout the surveyed area. Peak numbers occurred during the summer and early autumn when up to 80 birds/km^2 and an estimated abundance of approximately 4,000 birds present to the north of the proposed development area
- **Other species.** A total of 43 other species of bird were recorded in low numbers from all the surveys undertaken. Due to the low numbers recorded they were not considered to be at risk of a likely significant impact or an adverse effect

10.5 Impact Assessment

TABLE 10.3
Summary of Impact Assessments

Impact	Environmental effect	Probability of effect occurring	Magnitude	Duration	Spatial extent	Significance level	Mitigation	Residual impacts	Monitoring
Construction									
Disturbance	Displacement away from the area by presence of construction vessels	High	Negligible to Medium for more sensitive species, e.g. red-throated diver.	Temporary	Species dependent. Potentially up to 2 km for some species such as red-throated diver and common scoter	Negligible to Moderate for red-throated diver	Minimise vessel movements and use existing shipping routes as far as practicable.	Localised temporary displacement	Reporting protocol
Sound (piling)	Reduction in availability of prey species due to displacement away from sound source or increased mortality	High	Negligible to Medium for Terns and Divers	Temporary	Species dependent. Local.	Negligible to Moderate	Minimise as far as practicable significant piling operations during periods of high seabird sensitivity	Displacement away from construction area.	Tern breeding colony monitoring and boat-based bird surveys.
Operation									
Collision with turbines	Increased mortality	Negligible to Low	Negligible to minor for some Gulls,	Long-term	Local	Minor	None	Possible collision mortality	If practicable, possible

TABLE 10.3
Summary of Impact Assessments

Impact	**Environmental effect**	**Probability of effect occurring**	**Magnitude**	**Duration**	**Spatial extent**	**Significance level**	**Mitigation**	**Residual impacts**	**Monitoring**
			Terns and barnacle geese						land-based surveys.
Lighting of turbines	Passerines and other birds may be attracted to the turbines.	Negligible	Negligible	Long-term	Local	Negligible	Minimise use of lights as far as practicable	Possible collision mortality	None
Barrier effect	Increased distances flown causes increased energetic expenditure	High	Negligible to minor for some seaduck and cormorants	Long-term	Local	Minor	None	Potential increase in energetic expenditure	If practicable possible land based surveys.
Disturbance	Displacement away from the area by presence of maintenance vessels	High	Negligible to Medium	Long-term	Local	Negligible to Minor	Minimise vessel movements and use existing shipping routes as far as practicable.	Localised temporary displacemen t	Reporting protocol
Decommissioning									
Disturbance	Displacement away from the area by presence of decommissioning vessels	High	Negligible to Medium	Long-term	Local	Negligible to Minor	Minimise vessel movements and use existing shipping routes as far as practicable.	Localised temporary displacemen t	Reporting protocol

10.5.1 Mitigation and Monitoring

45 Detailed mitigation and monitoring measures would be further developed to avoid, remove or reduce any potentially significant impacts during consultation with the Regulator and their statutory advisors and other stakeholders.

46 The main potential impacts arising from the proposed development relate primarily to direct or indirect displacement effects on Divers and Terns. Mitigation measures that may be considered as measures to help avoid, remove or reduce them include:

47 *Minimising the proposed development area:* By reducing as far as practicable the overall area of the proposed development at the earier design stage of the proposed EOWDC, the total area and consequently the total number of red-throated divers or other species that may be displaced has been minimised.

48 *Vessel management plans:* The potential disturbance of seaduck and Divers and other seabirds from the proposed development area by vessels may be reduced by minimising the number vessels used and by ensuring that all vessels, as far as practicable, use the existing shipping lanes.

49 *Foundation types*: The use of monopiles may require the use of pile-driving to install them. By selecting alternative foundation types, there is the potential to reduce the risk of an impact on the prey species and therefore reduce the possibility of a displacement effect being caused by construction activities.

50 *Timing and duration of installation*: The timing and duration of installation have still to be determined. Although it may not be possible to select a period for construction activities to take place that is of lower sensitivity. It would be taken into consideration when developing potential project schedules.

51 *Minimising aviation and navigation lighting:* Birds can be attracted to bright lights, e.g. lighthouses, particularly during poor weather conditions. In order to reduce the risk of birds being attracted to the proposed development all lighting would be kept as far as practicable to a minimum but still kept within the requirements to ensure safety.

52 It is essential that any monitoring undertaken is designed to address specific concerns or potential impacts identified during the EIA process. Poorly designed ad hoc monitoring is likely to be inefficient and not provide useful or meaningful results. It is therefore important that any monitoring programme is developed in collaboration with the Regulator and statutory advisors and takes note of key stakeholders comments arising from the consultation period.

53 A detailed monitoring programme aimed at specific issues or concerns would be developed with the Regulator and advisors should consent be granted.

10.6 Summary

54 Site specific boat-based and land based surveys undertaken in Aberdeen Bay identified a total of 80 species of bird, of which 36 species were considered as being at potential risk of being impacted by the proposed development. Three

possible impacts were identified: collision, displacement and barrier effects. A detailed impact assessment undertaken indicated that for most species the proposed EOWDC is only likely to have a negligible or at worse a minor effect on the species present. However, for red-throated diver and three species of tern (Sandwich, little and common terns), the possible effect was considered to be of potentially moderate significance due to displacement effects arising from disturbance or reduced prey availability, however this displacement effect is likely be of a very temporary nature.

55 Further assessment based on evidence from other offshore wind farms indicates that potential effects are unlikely. A detailed monitoring programme would be developed in conjunction with the Regulator and statutory advisors.

56 Information to Inform a Habitats Regulations Appraisal (HRA) with respect to birds can be found in Appendix 29.1.

European Offshore Wind Deployment Centre
Environmental Statement

Chapter 11: Bats

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

11 BATS

11.1 Introduction

1 This section has been prepared by Genesis Oil and Gas Consultants and reviews the information available for bats that are present in the Aberdeen Bay area with the focus being on bats that could be present in the offshore area beyond the high water mark. All bat species found in Scotland are classified as European Protected Species and are fully protected under the Conservation (Natural Habitats) Regulations 1994 as amended. This lists a number of offences in relation to bats and the places which they live.

2 Surveys for any bat roosts and feeding areas will be carried out to inform the onshore environmental impact assessment. These surveys will be conducted using qualified surveyors at the proposed substation and cable landfall and the results will be presented in the Onshore Environmental Statement.

3 The impacts considered in this report are all related to the operational phase and are listed as:

- physical impacts from direct collision or flying close proximity to wind turbine blades
- indirect impacts, changing foraging behaviour of bats by attraction to lights and increased risk of physical impacts from collision

3 The following technical reports support this chapter:

- Bat Environmental Impact Assessment (EIA)Technical Report (Appendix 11.1)

11.2 Summary

4 Six species of bats are thought to occur in north-east Scotland, although only three of them are common species. The bats are not expected to use the waters of Aberdeen Bay for feeding and there are no known flyways or migration corridors in the area. Once the proposed EOWDC is operational there is the small possibility that the EOWDC could attract insects and bats offshore due to the small lights required for safety reasons on the wind turbines. The evidence suggests a lack of bats in the offshore waters of Aberdeen Bay. Impacts from the construction, operation and subsequent decommissioning of the EOWDC on bat species are considered to be negligible.

5 A thorough survey for bat species and their associated roosts will be undertaken as part of the environmental surveys carried out for the onshore Environmental Impact Assessment to look at the impact of the onshore works.

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 12: Marine Mammals

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

12 MARINE MAMMALS

1 This Environmental Statement (ES) chapter provides a condensed summary of the marine mammal baseline and presents the findings of the EIA technical report. Genesis Oil and Gas Consultants carried out the marine mammal assessment.

2 The structure of the marine mammal assessment can be summarised as follows:

- Marine Mammal Baseline Report (Appendix 12.1): this provides a summary of the existing information relating to the distribution and abundance of marine mammals in Scotland with a focus on Aberdeen Bay. This report draws on the findings of a desk based study, marine mammal research studies and also dedicated marine mammal surveys carried out for the purpose of supplementing the baseline for the EOWDC
- Marine Mammal EIA Technical Report (Appendix 12.2): provides an assessment of the impact of the project on marine mammals in the study area

12.1 Introduction

12.1.1 Methodology Consultation

3 Consultation with key stakeholders, specifically Scottish Natural Heritage (SNH), Joint Nature Conservation Committee (JNCC) and Marine Scotland occurred at an early stage of the originally proposed development and has continued throughout the scoping stage of the EOWDC. Key issues raised were potential impacts upon marine mammals from underwater sound and potential impacts to marine mammal species from nearby Special Areas of Conservation (SACs).

12.1.2 Data Information and Sources

12.1.2.1 <u>Boat-based Surveys</u>

4 Boat-based surveys were carried out during to collect species-specific data on marine mammals within the proposed EOWDC area and its immediate surroundings from 2007- 2008 by IECS and 2010-2011 by SMRU Ltd (Figure 10.1). Surveys were conducted once every month during daylight hours and efforts were made to undertake the survey over two consecutive days. All surveys utilised at least two trained marine mammal observers, an additional two marine mammal observers were utilised in the surveys conducted between 2010 and 2011. Details of the methodology and survey areas are covered are provided in Appendix 12.1.

5 A towed Passive Acoustic Monitoring (PAM) system was used on during both the IECS and SMRU Ltd boat surveys to collect information on vocalising marine mammals.

12.1.2.2 Vantage Point Surveys

6 Shore-based vantage point bird surveys were conducted for two hours weekly at Blackdog and Donmouth and fortnightly at Drums and Balmedie covering a distance of up to 2 km from shore (Figure 10.2). These surveys were designed primarily for bird observations, but collected information on marine mammals observed. Vantage point surveys were conducted from August 2005 until March 2008 (Alba Ecology and Envirocentre 2008).

12.1.2.3 Desk-based Study

7 In order to establish and better understand the marine mammal species present in the Aberdeen Bay and wider area an in-house desk based study was completed to form the basis of the baseline marine mammal report.

12.1.2.4 Underwater Sound Modelling

8 During the scoping stage of the project the potential impacts of sound from construction activities was identified as an issue requiring detailed investigation. The Applicant commissioned Subacoustech Ltd to carry out predictive noise modelling and an impact assessment of the piling sound on the marine mammal receptors (Appendix 3.1)

12.1.3 Key Guidance Documents

9 A summary of the main survey reports and studies used in the EIA for marine mammals is presented below:

- Envirocentre and Alba Ecology (2008). Shore based Vantage Point counts of marine mammals 2005 – 2008 in Aberdeen Bay
- IECS (2008). Aberdeen Offshore Wind Farm – ship-based Marine Mammal Survey Results (February 07- January 08). The Institute of Estuarine & Coastal Studies (IECS)
- Gordon, J (2008). Analysis of acoustic detections of porpoise from AMEC surveys off Aberdeen. Ecologic UK Ltd Report. 11pp
- RPS (2008). Review of Bird and Marine Mammal Data, RPS
- SMRU Ltd (2010) Marine Mammal Data Review. Sea Mammal Research Limited
- SMRU Ltd (2011) 4 month boat based survey report. Sea Mammal Research Limited
- Travers, S., Thomson, S. and Mander, L. (2008). Institute of Estuarine & Coastal Studies, University of Hull. 68pp. Monthly boat based marine mammal survey reports February-April 2008. The Institute of Estuarine & Coastal Studies (IECS)

12.2 Baseline Assessment

10 The marine mammal environmental baseline drew upon existing research surveys conducted on marine mammals in the wider area as well as several years of land based and boat surveys of the wider EOWDC development area. Several marine mammal species have been recorded (sighting and/or stranding) in Aberdeen Bay and the surrounding area; including 12

odontocete species, three mysticete species and three pinniped species. Of these, bottlenose dolphins, harbour porpoises, white-beaked dolphins, minke whales, Risso's dolphins, harbour seals and grey seals occur regularly in the area, with other species only being recorded occasionally or rarely.

11 Bottlenose dolphins in the Aberdeen area are part of the resident population from the Moray Firth Special Area of Conservation (SAC) and Aberdeen is recognised as an important area for bottlenose dolphins. Bottlenose dolphin were the second most frequently sighted cetacean species during the surveys carried out as part of the EOWDC, with a total of 200 individuals being detected.

12 Harbour porpoises are the most common species of cetacean in the North Sea and have a wide range and distribution in both coastal and offshore areas. Harbour porpoises were the most recorded cetacean species during the EOWDC boat surveys with over 420 individuals detected visually and was also the species detected most frequently during acoustic surveys. The harbour porpoise was the only species that was detected in sufficient numbers to enable density estimates to be generated.

13 White-beaked dolphins are present in the central and northern North Sea throughout most of the year. Sightings data suggests their presence in the coastal waters off Aberdeenshire is seasonal, with sightings recorded between June and August. White beaked dolphins were detected during the EOWDC surveys over the course of several years during the month of August.

14 Minke whales occur throughout the central and northern North Sea, particularly during summer months. The seasonal movement of minke whales into coastal waters during the summer is thought to be related to prey availability. Six minke whales have been observed as part of the EOWDC surveys.

15 In the northern and central North Sea, Risso's dolphins are primarily observed around Shetland and Orkney. Risso's dolphins have been recorded off Aberdeenshire since 2005 at various times of the year. Risso's dolphins were observed during vantage point surveys, but not during any of the EOWDC boat surveys. The increase in sightings of Risso's dolphins may point towards an increase in the use of the Aberdeen area in comparison to historic levels.

16 Both grey and harbour seals are regularly present and frequently sighted in Aberdeen bay, especially at the entrances to the rivers Dee and the Don. Grey seals were the most frequently observed seal species recorded during the boat surveys carried out in 2007-2008. Almost equal proportions of grey and common seals were recorded during boat surveys carried out during 2010-2011.

17 Designated coastal SACs for harbour seals are present along the east coast of mainland Scotland, these are situated in the Dornoch Firth and Morrich Moore in the Moray Firth and Firth of Tay and Eden estuary.

18 Designated SAC's for grey seals along the east coast of Scotland include the Isle of May at the entrance of the Firth of Forth, and it can be expected that individual seals from these colonies may be passing through and the EOWDC development area.

19 Other marine mammal species including white-sided dolphins, killer whales, common dolphins, striped dolphins, long-finned pilot whales, sperm whales, humpback whales, fin whales, beaked whales and other seal species, although present in the area off north-east Scotland this is only a marginal part of their habitat, and is likely to be inhabited only during a restricted part of the year by relatively few individuals.

12.3 Impact Assessment

12.3.1 Impact Assessment Methodology

20 All cetacean species and seals that are likely to be found in Aberdeen Bay are of either national or international importance due to their conservation status. All cetacean species and seals are considered to be receptors of high importance due to the national and international protection measures afforded to them.

21 The Habitats Directive outlines a number of protection measures for marine mammals and has been implemented in Scotland through the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) termed the 'Habitat Regulations'. The Habitat Regulations provide the protection afforded to European Protected Species (EPS) animals listed on Annex IV of the Habitats Directive which includes all species of cetacean whose natural range occurs in Great Britain.

22 The European Protected Species (EPS) provisions create a number of offences that relate to causing injury or disturbance to EPS species as defined in regulation 39 of the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). Before an EPS licence can be issued there are three tests which must be met by the appropriate licensing authority, which in the case of a renewable energy development would be issued by the Scottish Government. The EPS licence process and other protection measures for marine mammals are explained in more detail in Appendix 12.2.

23 The harbour seal, common seal, the harbour porpoise and bottlenose dolphin are listed on Annex II of the Habitats Directive and require member countries to consider the designation of Special SACs for these animals. The cetacean species which require the designation of SACs are the bottlenose dolphin and the harbour porpoise.

24 The Marine (Scotland) Act 2010 introduces a number of measures for seal protection to update and replace the earlier Conservation of Seals Act 1970. It is now an offence to kill or take any seal at any time (with exceptions only under specific licence or for animal welfare) and it is also now an offence to harass seals at their haul-out sites.

25 For each impact, the assessment aims to describe the magnitude of effect (i.e the change created by an activity in terms of its spatial extent, duration and scale) and the sensitivity of each receptor, that is, the resources that would be affected (based on the importance of the receptor and its recoverability). The combination of the effect and the sensitivity of the receptor were used to derive the significance of the impact.

26 Whilst the matrix approach was used in the impact assessment as a way to categorise and assess the significance of any potential impacts to marine mammals, discussions with SNH have reiterated the importance of also applying rigorous professional judgement in determining the significance of any potential impacts.

27 Impact significance is then given as major, moderate, minor or negligible guided by the following matrix.

TABLE 12.1
Matrix for significance of impact (based on importance and recoverability

	Sensitivity of Receptor				
Magnitude of Effect (based on spatial, duration and scale of effect)		**Very High**	**High**	**Medium**	**Low**
	Very High	Major	Major	Major	Moderate
	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

28 All marine mammal species are protected species, as such their sensitivity within the impact assessment is considered to be 'Very high', and therefore even when the magnitude of effect has been assessed as being of negligible significance, this still results in a 'minor' significant impact.

12.3.2 Impact Assessment

12.3.2.1 Construction Phase

Impact of Noise: Physiological Damage

29 The impact assessment has considered the risks and impacts to marine mammals from the construction, operation and decommissioning of the EOWDC.

30 The significance of potentially killing a marine mammal during the piling of the EOWDC was assessed as being of major significance, however, with the successful adoption of the mitigation measures for piling, there are not anticipated to be any residual risks given that a marine mammal would have to be present in such close proximity to the pile driver (3 m) to be at any risk. It is considered the risk of marine mammals receiving sound levels capable of causing their death appears to be remote.

31 Other forms of physical injury (non-auditory) are estimated to occur out to a greater range (60 m), and the risk of piling causing other forms of physical impacts cannot be ruled out, and has been assessed as being of major significance for all marine mammal species. The natural curiosity of seals may increase the risk of exposing both grey and common seals to sound levels capable of causing adverse physical effects.

Impact of Noise: Cumulative Exposure Impacts

32 The cumulative noise dose modelling indicate that unless a cetacean is within the immediate vicinity of piling operations (<1.35 km) or a seal is situated within 3.6 km, the only possibility for an auditory injury to occur is during the initial piling period. It is expected that the perceived loudness of the piling activity would cause the marine mammal to exhibit an aversive behavioural

reaction, with the animal moving from the area before the onset of any auditory injury can occur.

33 The marine mammals which are most likely to be exposed are the more commonly sighted species within Aberdeen Bay, with the harbour porpoise, bottlenose dolphins and grey and common seals being the species most at risk from physical impacts. Given that the relatively small Moray Firth bottlenose dolphin population has been increasing its range expansion in a southerly direction, and that Aberdeen Bay frequently has bottlenose dolphins, especially during the winter and spring months, the potential impact both to the individual and population is considered to be of high magnitude and potentially of major significance. It should be considered that the majority of bottlenose dolphins sightings have been observed frequenting the harbour mouth area and that the mitigation measures mentioned below they should be sufficient to ensure that no bottlenose dolphins are situated within 820 m prior to piling activities. If such measures are put in place the anticipated magnitude of the effects is expected to be negligible and thus be of minor significance to the bottlenose dolphin populations.

Impact of Noise: Behaviour Disturbance and Displacement

34 The range at which behavioural responses are considered potential adverse is up to 22 km for harbour porpoise and 16 km for common and grey seals. For harbour porpoises the results of post-monitoring studies suggest that after piling stops the animals have been found to return to the area within a few hours. The haul out locations of seals could be affected by the piling operations, which could cause temporary displacement of seals from such areas. Therefore, behavioural disturbance, which would lead to displacement of marine mammals from the piling activities, is only expected to occur for the duration of piling activities.

35 The potential exclusion of bottlenose dolphins through behavioural displacement for the duration of the piling activity and out to an extent of 16 km has been assessed as being of high magnitude, and therefore of potentially of major significance to the bottlenose dolphin. As bottlenose dolphins are present along the east coast of Scotland, it has been predicted that the temporary displacement of animals from the Aberdeen Bay area would be mitigated by animals moving into other areas within their natural range. This is a hypothetical assessment and is based on the available habitat range for bottlenose dolphins being extensive and covering the coastal waters along the Scottish east coast.

36 The other species of cetacean present in Aberdeen Bay are not restricted to coastal areas and are present throughout a far wider area. Aberdeen Bay has not been recognised as being of particular importance for breeding or calving purposes for other cetacean species. The possible exception is that in that shallower coastal water of the east coast of Scotland other cetacean species have been speculated to have a role in breeding or calving for the white beaked dolphin during the summer period.

37 If piling occurs during summer months (July/August) the significance of the behavioural disturbance could be major for the white beaked dolphins and the bottlenose dolphin, but of minor significance impact for all other cetacean species. Any temporary exclusion of the cetacean species (except bottlenose) from Aberdeen Bay is considered to be of moderate significance, given that there is likely to be adequate areas for foraging relatively nearby.

38 The vessels used in the construction of Aberdeen Bay may locally increase the ambient sound levels, cause disturbance and may temporarily contribute to the displacement marine mammal from the vicinity of construction activities. However, the significance of this local displacement of marine mammals is minor.

Impact of Noise: Interference with the use of Sound

39 During the pile driving construction activities there is the potential for the sound to mask any seal vocalisations, potentially out to a distance of 80 km. The spatial scale of the potential masking would be dependent upon prevailing ambient sound levels and 80 km is a theoretical maximum. The actual significance of this potential impact is expected to be low given that there are no notable haul out locations in close proximity to Aberdeen Bay and that any potential masking would be temporary.

40 Masking of biologically relevant sounds produced by high frequency cetaceans, such as the harbour porpoise, and possibly mid-frequency cetaceans, such as the bottlenose dolphin, is unlikely as the piling pulses have little high frequency energy (Thomsen et al., 2006). Pile driving pulses are of short duration, and are therefore likely to be below the time where full detection of signals is possible in cetaceans (Thomsen et al., 2006). The magnitude of the impact on marine mammal vocalisations is considered to be low for seal and negligible for other cetacean species. The overall significance is considered to be moderate for seals and minor for cetaceans. After completion of the construction works there are not anticipated to be any residual impacts.

41 Vessel sounds are likely to be audible to marine mammals, they are not considered to be capable of permanently masking the sounds produced by cetacean species that are most commonly present in Aberdeen Bay.

Impact of Elevated Suspended Sediments

42 No impacts to marine mammals are anticipated from an increase in suspended sediments levels as the increases are still within the ranges of naturally occurring levels.

Impact of Displacement of Prey Species

43 Marine mammals are highly mobile and are expected to follow their prey should they be displaced from the area during construction activities. Piling would be infrequent and temporary so that any disturbance to prey species would be intermittent and not consecutive. Therefore any foraging impacts are unlikely to be of sufficient magnitude or duration to adversely affect any life history traits of marine mammals. The marine mammals present in Aberdeen have been known to feed on varied prey species and should be adaptable if one of the more sensitive species to sound is temporarily displaced from the local area.

Impact of Increased Vessel Activity

44 Increased shipping levels could be considered to increase the risk of collisions with marine mammals. Construction vessels would be transiting at slow speeds within Aberdeen Bay and are typically slow moving and generate low frequencies. It is considered that any marine mammals would be able to avoid approaching vessels. There have never been any reports of ship strikes from stranding records along the Grampian coast, which suggests the magnitude of the effect to marine mammals is negligible.

12.3.2.2 Operation Phase

Impact of Underwater Sound

45 The noise from the operational wind farm is not considered to be capable of causing disturbance or displacement to marine mammals. There has been considerable variation in the reported underwater noise measurement from operational wind farms, yet all the sound levels reported thus far are relatively low.

46 Aberdeen Bay is already very busy with a wide range of human activities and the small increase in vessel activity associated with the maintenance of the EOWDC proposed wind farm is unlikely to cause any notable increase disturbance to marine mammals.

Impact of Loss of Habitat

47 The worst case scenario in terms of seabed habitat lost would be through the use of gravity based structures for all 11 wind turbines, this would result in the loss of 0.03 km^2 of seabed habitat. As the turbines are separated by a considerable distance, the movement of marine mammals should not be restricted through the EOWDC. This loss of seabed habitat, in terms of similar available habitat within Aberdeen Bay is of negligible magnitude, with the significance of the impact being minor.

Impact of Electromagnetic Fields generated from cables

48 From the monitoring studies of constructed wind farms there is no evidence of any increases or decreases in marine mammal activity that would suggest attraction or avoidance related to magnetic fields. The information on the potential effects of EMF on marine mammals is largely unknown and further research is required to determine the potential risks this may pose to these species. The ecological significance of EMFs is an area of research which requires further study and is discussed further in Chapter 13.

TABLE 12.2
Summary of Impact Assessment

Impact	Environmental effect	Probability of effect occurring	Magnitude	Duration	Spatial extent	Significance level*	Mitigation	Residual impacts	Monitoring
Construction									
Sound	Physiological damage (death) marine mammals	Negligible	High	Temporary	Site specific 3 m from piling	Major	Marine Mammal Protection Plan (MMPP) Including piling mitigation measures; soft – start Marine Mammal Observers, Passive Acoustic Monitoring (PAM).	None	MMPP
	Physiological damage (non-auditory) injury	Very Low			Local (injury possible to 60 m and cumulative dosage impacts upto 3.6 km)				
	Physiological damage (auditory damage) to marine mammals	Very Low	High	Temporary	Local (species specific ranges)	Major	MMPP	None	MMPP

TABLE 12.2
Summary of Impact Assessment

Impact	Environmental effect	Probability of effect occurring	Magnitude	Duration	Spatial extent	Significance level*	Mitigation	Residual impacts	Monitoring
	Behavioural disturbance and displacement	High*(seasonally variable for white beaked dolphins)	High (bottlenose dolphins, White beaked dolphins	Temporary	Regional	Major (piling sound)	MMPP	None	MMPP
			Low (other species marine mammals)			Minor (piling and construction sound)			
Sound (piling)	Interference of sound produced by seals	Low	Low / Negligible	Temporary	Local	Moderate / Minor	MMPP	None	None
	Interference of sound produced by cetaceans	Very low	Negligible	Temporary	Local	Minor	MMPP	None	None
Sound (all other construction sounds)	Interference sound marine produced by mammals	Very low	Negligible	Temporary	Local	Minor	MMPP	None	None
Suspended sediment levels	Impact to marine	Negligible	Negligible	Temporary	Local	Minor	None	None	None

TABLE 12.2
Summary of Impact Assessment

Impact	**Environmental effect**	**Probability of effect occurring**	**Magnitude**	**Duration**	**Spatial extent**	**Significance level***	**Mitigation**	**Residual impacts**	**Monitoring**
	mammals (foraging etc)								
Disturbance to prey species	In-direct impact upon marine mammals	Low	Low	Temporary	Regional	Moderate	None	None	None
Construction vessels and infrastructure	Disturbance to marine mammals	Negligible	Negligible	Temporary	Local	Minor	MMPP	None	MMPP
Operation									
Operational noise turbines	Disturbance to cetaceans	Low	Negligible	Long term	Site specific	Minor	None	None	None
	Disturbance to seals and baleen whales	Medium	Low	Long term	Local	Moderate	None	None	None
Maintenance vessels	Disturbance marine mammals	Negligible	Negligible	Long term	Local	Minor	None	None	None
Turbine foundations	Habitat loss	High	Low	Long term	Local	Moderate	None	None	None
Electromagnetic Fields	Disturbance to marine mammals	Negligible	Negligible	Long term	Local	Minor	None	None	None

TABLE 12.2
Summary of Impact Assessment

Impact	Environmental effect	Probability of effect occurring	Magnitude	Duration	Spatial extent	Significance level*	Mitigation	Residual impacts	Monitoring
Decommissioning									
Cutting of foundations	Disturbance to marine mammals	Low / Medium	Moderate	Temporary	Local	Moderate / Major	Decommissioning Plan recommended mitigation	None	None

12.3.2.3 Mitigation and Monitoring

49 The Marine Mammal Protection Plan would be developed to address and mitigate any of the impacts identified as being of concern to marine mammals. The MMPP would outline the mitigation procedures to be used during construction activities to minimise the risk of impacts to marine mammals, the final MMPP would be developed in consultation with advice from statutory consultees.

50 The programme of boat based surveys and acoustic monitoring using both towed and stationary devices (C-Pods) would continue throughout the development and construction of the EOWDC to enable the identification of marine mammals in the lead up to construction and also to identify potential impacts upon marine mammals

12.4 Summary

51 The environmental baseline identified the distribution and abundances of the marine mammal species in the developmental area that could be potentially impacted. The impacts assessment process considered the worst case developmental scenario and applied this to potential impacts during the construction, operation and subsequent decommissioning of the EOWDC.

52 Underwater sound, principally generated during the piling activities, was assessed as being of potential concern with a number of potentially significant impacts identified (physical damage, behavioural disturbance and in-direct impacts on prey species). The underwater sound generated from the operation and the losses of seabed habitat from the placement of the foundations were both assessed as being impacts of moderate significance. The removal of the foundation by cutting techniques could be an activity that is of major / moderate significance of causing disturbance to marine mammals. Providing the appropriate mitigation measures are followed during construction, operation and decommissioning activities there are not anticipated to be any long lasting residual impacts upon marine mammals.

53 Information to Inform a Habitats Regulations Appraisal (HRA) with respect to marine mammals can be found in Appendix 29.1.

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 13: Electromagnetic Fields

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

13 ELECTROMAGNETIC FIELDS

13.1 Background Introduction

1 The transportation of electricity within cables can cause electric and magnetic fields (EMF) to be generated. This has been a cause of concern amongst stakeholders regarding potential impacts upon marine life. These concerns relate to the behaviour of animals found near the source of the EMFs, specifically whether the fields result in the attraction or repulsion of animals from areas around cables and whether the fields influence migration behaviour of certain commercially important or protected fish species.

2 The purpose of this section is to explain the types of EMF that can be generated within subsea cables associated with offshore wind farms and to summarise the potential environmental impacts of EMFs. This section is not an impact assessment, the impacts of EMFs are considered in more detail in the impact assessments for Marine Ecology (Chapter 9) and Marine Mammals (Chapter 12) and Salmon and Sea Trout (Chapter 22). This section has been prepared by Genesis Oil and Gas Consultants.

13.2 Data information and Sources

3 The subject of EMFs has received much attention from the renewable energy industry and Collaborative Offshore Wind Research in the Environment (COWRIE) has commissioned several reports on the subject. The first of these reports provided a review of the potential for electromagnetic fields generated by the offshore wind energy industry (CMACS, 2003; Gill et al., 2005). A second COWRIE report tested fish responses to EMFs from the sub-sea cables (Gill et al., 2009). Both reports are discussed within this chapter.

4 Additional information considered in this report includes an internal report produced by Vattenfall on the impact of EMF from submarine cables on marine organisms (Olsson and Larsson 2010) and a literature review produced by Scottish Natural Heritage (SNH) on the potential effects of electromagnetic fields on protected species (Gill et al., 2010).

13.3 Introduction to EMF Fields

5 EMFs are generated every time electricity is produced, transported or used, with all electric equipment including power cables having the potential to produce EMFs.

6 The principal source of EMFs in offshore wind farm developments are the subsea cables. There are three components to the EMFs from the Alternating Current (AC) submarine power cables considered for the proposed EOWDC (Gill *et al*., 2010). These are:

- an electric field that is contained within an insulated conductor and earthed metallic screen
- a magnetic field which radiates into the surrounding medium
- an induced electric field (iE). This can be generated by water and/or fish movement through the magnetic field. Induced iE fields have also been

shown to arise from the fluctuating magnetic fields produced by AC cables (Gill et al., 2010)

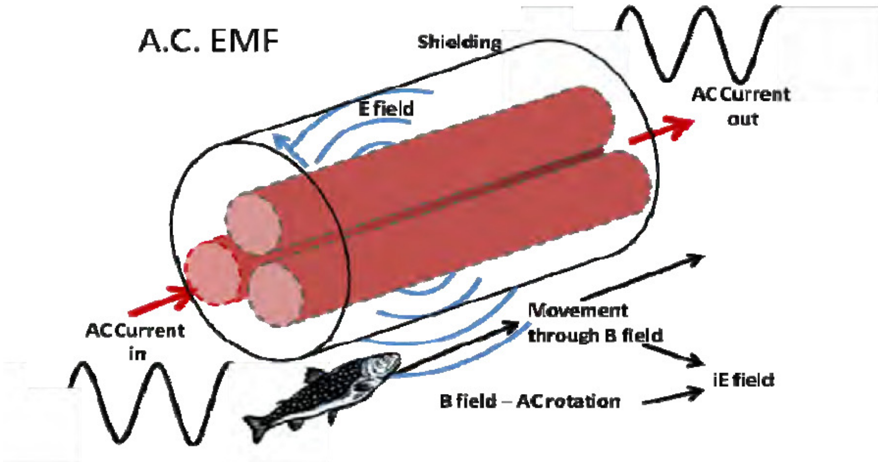

Figure 13.1 Subsea AC cable showing the three cores with the alternating current following a typical oscillating sine wave pattern through each core. (Reproduced from Gill et al., 2010)

7 Electric field strength is measured in volts per meter (V/m). The magnetic filed can be described in terms of the the B-field or the H-field. ‘B’ fields describe the magnetic flux density (T), whilst ‘H’ fields describe the magnetic field strength in amperes per metre (A/m), referenced to a particular point (Table 13.1). B fields are generally used to describe the magnetic field generated within a medium as they are more easily measured than H fields.

TABLE 13.1 Components of the electric and magnetic field			
Field	**Denotation**	**Unit**	**Proportional to**
Electric	E-field	Volt / meter (V/m)	Voltage (V)
Magnetic	Flux density (B-field)	Telsa (T)	Current (I)
Magnetic	Intensity (H-field)	Ampere / meter (A/m)	Current (I)

8 The coating of electric subsea cables ensures that electric fields are contained within the cable, however magnetic fields can radiate from the cable. Whilst it is theoretically possible to contain the magnetic fields through cable burial, it is likely that burial to depths realistically achievable offshore makes no significant difference to the resultant magnetic fields or the distance over which they propagate (CMACS, 2008). The decay in the resultant magnetic fields occurs over a very short scale, at a distance of 10 m they will be undetectable.

13.4 Cable Configuration and Potential for EMFs at the Proposed EOWDC

9 The final cable design and route corridors for the proposed EOWDC have yet to be determined, however it is expected that there would be a maximum of 4 export power cables required, with a total maximum length of 26 km. The precise power requirements of the cables have yet to be established, although it is expected that they would be 33 kV AC cables.

10 The AC cables are three-phase such that there would be three separate cores each of which would be shielded by an insulation screen. As mentioned previously, the use of insulation screens confines any electric fields produced within the cable and reduces the risk of causing electric shocks.

11 There would also be inter-array cables connecting the wind turbines which would have the same power requirements as the export cables. It is expected the inter-array cabling arrangements and associated electrical infrastructure would be comparable to other existing wind farms.

12 A study employing modelling of EMFs from cables with contrasting conductor sizes and current loads at the Kentish Flats Offshore Wind Farm site was undertaken by the University of Liverpool, the results of which are applicable to the proposed EOWDC (Gill et al., 2002). Table 13.2 provides the estimated output parameters for industry standard cables buried 1.5 m in the seabed. These models predicted that the B field on both the surface of a 33 kV cable (millimetres from the source) and the seabed directly above the cable was of the order of 40 µA m-2 or 1.5 µT. Assuming the seabed has a conductivity of 1 S m-1 the resultant electric field would have a probable strength of 40 µVm-1. The electric field within the seabed was modelled to dissipate rapidly to only 1 or 2 µV m-1 within a distance of approximately 10 m from the cable.

13 The magnetic fields produced by the cables would be 1.5 µT which is the equivalent of less than 15 % of the Earth's magnetic field (ie 10 µT).

TABLE 13.1
EMF Output Parameters for Industry Standard Cables Buried 1.5 m in the Seabed (Gill *et al.*, 2002)

Conductor size (mm2)	500
Maximum voltage (kV)	33
Maximum current (A)	530
Maximum B field in seabed (µT)	1.5
Maximum B field in sea (µT)	0.03
Maximum current density in seabed above cable (µA m-2)	40
Maximum current density in sea at seabed surface (µA m-2)	10
Maximum iE field in seabed (µVm-1)	40
Maximum iE field in sea (µVm-1)	2.5
Estimated normal iE field in seabed (µV m-1)	20
Estimated normal B field in sea (µT)	0.015

14 The magnetic and induced electric fields generated by the cables are expected to naturally decay to the extent that electrical fields above 0.5 μVm^{-1} will not be detectable beyond 10 m in any direction from the cable (ie in the water column or the seabed).

15 Each cable is expected to generate similar magnetic and electric fields. Modelling of magnetic and induced electrical fields undertaken for other windfarm developments has identified that broadly comparable fields would be generated by a range of cabling scenarios. The effects of the electric and magnetic fields are expected to become additive when the separation distance between the cables is less than 10 m.

16 The export and inter-array cables would be buried. The burial of the cables increases the separation distance between the cable and any swimming

animals and thereby reduces the magnitude of potential EMF effects. The cable would need to be buried approximately 10 m to avoid the potential for any magnetic fields to be detectable on the surface, which as mentioned previously is uneconomical for an offshore cable installations.

13.5 Existing Anthropogenic Sources of EMF in the Vicinity of the Proposed EOWDC

17 A review of Kingfisher cable awareness charts, SeaZone and Admiralty chart data, shows that there are no other cables in Aberdeen Bay that may produce EMFs. Two telecommunications cables near to The Crown Estate EOWDC lease area were identified however these do not generate EMFs.

18 Gas pipelines can be heated electrically in order to minimise the potentially of hydrates forming, and this can produce EMFs. The St. Fergus gas terminal situated 35 km north of Aberdeen processes 20 % of the UK's gas supply from 8 main pipelines delivering gas from fields across the North Sea. None of the gas pipelines are known to be electrically heated and hence are not expected to act as EMF sources.

19 For the purposes of the environmental assessment of the proposed EOWDC, the effects of EMFs have been considered in isolation from any potential effects from other planned offshore wind farms in the Moray Firth or the Firth of Forth area.

13.6 Use of EMFs by Marine Biological Receptors and Potential Sensitivity of These Receptors to EMFs

20 Naturally occurring EMFs in the form of geomagnetic fields are the predominant EMF that occurs in the marine environment. In addition electric fields are also naturally emitted as a result of biochemical, physiological and/or neurological processes that can occur within an organism, these are known as bioelectric fields. Induced Electric fields can also occur as a result of the animal itself or oceanic waters interacting with the geomagnetic field.

21 A number of biological mechanisms are known by which marine organisms are able to detect an electric and/or magnetic field. Species can be broadly separated into those that are either electroreceptive and / or those that are magneotoreceptive.

22 Electroreception is believed to be closely linked to the mechanisms involved in finding prey, locating conspecifics (other individuals), finding mates and in some instance for navigation, while magnetoreception is believed to primarily be linked to navigation and homing behaviours.

23 The available information on animals detection mechanisms for EMFs is limited, however three possibilities have been proposed:

- electromagnetic induction
- magnetic field dependent chemical reactions, and
- magnetite based magnetoreception

24 Magnetite is a magnetically sensitive material that occurs within the skeletal structure of a large variety of marine organisms and is commonly considered

to have a role in the direction finding using the Earth's geomagnetic field (Kirshvink, 1997).

25 Behavioural experiments have demonstrated that diverse animals, including representatives from all five vertebrate classes, can sense the Earth's magnetic field and use it as an orientation cue (Lohman and Johnsen 2000). The list of animals that is known to possess magnetic compasses includes isopods, sea turtles, spiny lobsters, rays, eel and salmon (Lomann et al., 2008; Westerberg and Lagenfelt, 2008).

26 An unproven hypothesis that some animals possess an additional mapping sense that allows them to determine their position relative to their destination has been proposed. The use of magnetic positional information has been demonstrated in several diverse animals which suggest that such systems are widespread amongst the animal kingdom and have functional abilities across a range of scales (Lohmann, 2007).

27 Responses to induced electric (iE) fields are generally assumed to aid navigation and may either be passive or active on the part of the animal. In active navigation the organism generates its own EMF to interact with the horizontal component of the Earth's magnetic field, whereas passive detection is derived from the interaction of the tide or wind driven currents and the vertical component of the Earth's geomagnetic field (Von der Emde, 1998). Species such as eels and salmonids are able to detect voltage gradients associated with water movement through the geomagnetic field. This mechanism is not fully understood but it is believed that species can detect fields in the range of 8-25 µV/m associated with peak tidal flows.

28 Cartilaginous fish are the major group of organisms that are known to be electroreceptive, this group includes the sharks, skates and rays, collectively known as elasmobranchs. Elasmobranchs register electric fields through a series of pores in the surface skin connected to electroreceptors which enable them to detect small voltage gradients in the environment (CMACS, 2003). The paddlefish, bichirs, lungfish and catfish are also electroreceptive but are not known to be present in the developmental area. There are a number of mostly tropical species that are electrogenic in that they can actively produce electricity, an example being the electric eel.

29 In terms of other groups of marine mammals being electroreceptive, there has been no evidence of any marine mammals species or of any invertebrates using electroreception, but this could be attributed to a lack of research targeting this area as noted for the invertebrates by Bullock (1999).

30 For most magnetoreceptive or electroreceptive species there is little or no information present on how, or if, submarine AC cables affect their behaviour. To date, research has focused on effects of submarine cables on migrating eels and elasmobranchs.

31 In the UK, research has been conducted on elasmobranchs in various controlled environments. The fish are exposed to EMFs which replicate EMFs from subsea cables. Results show that the emitted EMFs may be detectable by the fish, although the response is categorised as a behavioural change that varied between species and between individuals within the same species. No conclusions as to whether the behavioural changes of the elasmobranchs are positive, negative, or have no environmental impact have been drawn (Gill *et al.*, 2009).

13.7 Potential Impact of EMFs Generated from Anthropogenic Sources

32 Any potential impacts of EMFs are restricted to the operational phase when the cables would be transporting electricity, with no impacts being anticipated during either the construction or decommissioning phases. The impacts can be summarised as follows:

- animals may confuse EMF signals with those of potential prey species and may hence waste energy hunting in areas containing prey, or be attracted to areas where they believe conspecifics are present
- repulsion of animals would result in the reduction of available habitat or disrupt the movement or migration of animals throughout Aberdeen Bay creating barrier effects to the natural movement of animals
- disruption to the navigation or orientation may arise for those species using the Earth's geomagnetic field to orientate or time behavioural movements in response to daily events such as tidal cycles. Depending on the magnitude and persistence of the magnetic field, the impact could be a relatively minor temporary change in swimming direction or a more serious impact on migration
- the potential physiological effects on marine organisms may include impacts on cellular development

13.8 Summary

33 The potential EMF generated from the proposed EOWDC submarine cables has been presented, with the marine groups sensitive to the electric and magnetic fields being identified. The detailed impact assessments of the marine species potentially sensitive to EMF has been provided in the impact assessments for Chapter 9 Marine Ecology, Intertidal Ecology, Sediment and Water Quality and Chapter 12 Marine Mammals and Chapter 22 Salmon and Sea Trout.

34 The ecological significance of EMFs is the subject of ongoing research. To date, studies have shown that there is potential for impacts on marine species, however field tests have been inconclusive and both the offshore wind industry and regulators recognise the need for improved understanding in this area.

13.9 References

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European Offshore Wind Deployment Centre

Environmental Statement

Chapter 14: Statutory Designations and Conservation

14 STATUTORY DESIGNATIONS AND CONSERVATION

1 This section of the ES is for information and is not an assessment chapter. Although the proposed site does not lie within a designated area, the north-east coast of Scotland does support many sites of national and international importance for wildlife. Table 14.1 presents the designated sites that may be affected by the proposed EOWDC. These sites are identified on Figure 14.1. Any effects on designations have been considered in the individual impact assessments.

TABLE 14.1 Designated Sites Potentially Impacted By the Proposed EOWDC		
Designation	**Approximate distance from proposed EOWDC (km)**	**Citation Information**
Special Areas of Conservation (SACs)	*Convention of Natural Habitats and of Wild Fauna and Flora Directive (92/43/EEC) transposed in the UK through the Conservation (Natural Habitats) Regulations 1994.*	
River Dee SAC	7.5	Annex II species, Freshwater Pearl Mussel, Atlantic Salmon, Otter
Sands of Forvie SAC	7.2	Annex I habitats, Embryonic shifting dunes, shifting dunes along the shoreline with *Ammophila arenaria*, decalcified fixed dunes with *Empetrum nigrum*, humid dune slacks
Buchan Ness to Collieston SAC	12.2	Annex 1 habitats, vegetated sea cliffs
River South Esk SAC	63	Annex II species: Atlantic salmon, Freshwater pearl mussel
Firth of Tay and Eden Estuary SAC	96	Annex II species: Common seal Annex I habitats: Estuaries, Intertidal mudflats and sandflats, Subtidal sandbanks
Isle of May SAC	119	Annex II species: Grey seal Annex I habitats: Reefs
Moray Firth SAC	150	Annex II species: Bottlenose dolphin Annex I habitats: Sandbanks which at all times are covered by seawater
Berwickshire and North Northumberland Coast SAC	150	Annex II species: Grey seal Annex I habitats: Large shallow inlets and bays' Mudflats and sandflats not covered by seawater at low tide, Reefs, Submerged or partially submerged sea caves
Special Protection Areas (SPAs) and Ramsar Sites	*Council Directive 79/409/EEC on the Conservation of Wild Birds*	
Ythan Estuary, Sands of Forvie and Meikle Loch SPA & Ramsar	7.2	Qualifying species, Article 4.2 pink-footed goose, Article 4.1 Sandwich tern, common tern, little tern Article 4.2 eider, redshank and lapwing, pink-footed goose
Buchan Ness to Collieston SPA	9.5	Article 4.2: holding in excess of 20,000 seabirds: fulmar, shag, kittiwake, herring gull and guillemot.
Loch of Skene SPA & Ramsar	21	Qualifying species: Article 4.1: whooper swan, greylag goose.
Fowlsheugh SPA	31.1	Qualifying species: kittiwake, guillemot, Article 4.2 seabird assemblages: fulmar, herring gull and razorbill
Loch of Strathbeg SPA & Ramsar	47.6	Qualifying species: Sandwich tern. Article 4.2 waterfowl assemblages: whooper swan, pink-footed goose, barnacle goose, greylag goose, teal
Montrose Basin SPA & Ramsar	63	Article 4.2 over winter, graylag goose, knot, pink-footed goose, redshank Article 4.2 waterfowl assemblage: dunlin, oystercatcher, eider, wigeon, shelduck, redshank, knot, graylag goose, pink-footed goose.
Troup, Pennan and Lion's Heads SPA	74.3	Article 4.2 seabird assemblages: fulmar, kittiwake, guillemot, herring gull and razorbill.

TABLE 14.1 Designated Sites Potentially Impacted By the Proposed EOWDC		
Designation	**Approximate distance from proposed EOWDC (km)**	**Citation Information**
Firth of Tay & Eden Estuary SPA & Ramsar	96	Qualifying species Article 4.1 breeding: marsh harrier, little tern Article 4.2 wintering redshank Article 4.2 waterfowl assemblage, pink-footed goose, greylag goose, cormorant, shelduck, eider, long-tailed duck, common scoter, velvet scoter, goldeneye, red-breasted merganser, goosander oystercatcher, grey plover, sanderling, dunlin, black-tailed godwit
Forth Islands SPA	124.4	Qualifying species: Article 4.1 Annex 1 species: Arctic tern, roseate tern, common tern, Sandwich tern. Article 4.2 migratory species; Northern gannet, European shag, lesser black-backed gull, Atlantic puffin Article 4.2 Seabird assemblage: razorbill, common guillemot, black-legged kittiwake, herring gull, great cormorant, northern gannet, lesser black-backed gull, European shag, Atlantic puffin, northern fulmar, Arctic tern, common tern, roseate tern, Sandwich tern
Firth of Forth SPA	134	Article 4.1 wintering populations: red-throated diver, Slavonian grebe, golden plover, bar-tailed godwit Article 4.1 post-breeding: Sandwich tern Article 4.2 wintering populations pink-footed goose, shelduck, knot, redshank, turnstone. Article 4.2 wintering waterfowl assemblage: great crested grebe, cormorant, scaup, eider, long-tailed duck, common scoter, velvet scoter, goldeneye, red-breasted merganser, oystercatcher, ringed plover, grey plover, dunlin, curlew, wigeon, mallard, lapwing
Fair Isle SPA	298	Qualifying species: Arctic skua, Arctic tern, Fair Isle wren, fulmar, gannet, great skua, guillemot, kittiwake, puffin, razorbill, shag, Seabird assemblage
National Nature Reserves (NNRs)	*National Parks and Access to the Countryside Act (1949)*	
Forvie NNR	7.2	Sand dune, foreshore, estuarine, spit, dune heath, slacks, rough pasture and cliffs habitat
St Cyrus NNR	53	Sand dune, heathland and cliffs
Sites of Special Scientific Interest (SSSIs)	*Wildlife and Countryside Act (1981/1985)*	
Corby, Lily and Bishops Lochs SSSI	6.7	Wetland sites, aquatic vegetation, wildfowl roost
Foveran Links SSSI	4.8	Mobile foreshore and dunes, interesting vegetation assemblages, migrating birds, moulting

TABLE 14.1 Designated Sites Potentially Impacted By the Proposed EOWDC		
Designation	**Approximate distance from proposed EOWDC (km)**	**Citation Information**
		and passage sea ducks and divers, and coastal geomorphology
Sands of Forvie and Ythan Estuary SSSI	7.2	Sandwich tern, common tern and little tern
Meikle Loch and Kippet Hills SSSI	11	Pink-footed goose, greylag goose, teal, pochard, wigeon, tufted duck.
Collieston to Whinnyfold SSSI	15	Breeding seabirds, guillemot, kittiwake, shag, razorbill, fulmar
Loch of Skene SSSI	21	Breeding tufted duck, Non-breeding, goosander, goldeneye, mallard, pochard, teal, wigeon, common gull, greylag goose.
Bullers of Buchan Coast SSSI	22	Maritime cliff habitat. Breeding bird assemblage: guillemot, shag, kittiwake, herring razorbill, puffin
Fowlsheugh SSSI	31.1	Breeding seabirds, kittiwake, guillemot, razorbill, puffin, fulmar shag
Loch of Strathbeg SSSI	47.6	Wildfowl: pochard, tufted duck, wigeon, goldeneye, goosander, mute swan, pink-footed goose, greylag goose, Seaduck, Divers
St Cyrus and Kinnaber Links SSSI	53	Sand dunes, salt marsh, grassland, breeding birds: fulmar, shelduck, eider, curlew, redshank, ringed plover, oystercatcher, sedge warbler, grasshopper warbler, wheatear, stonechat, whinchat, kestrel, buzzard, sparrowhawk and peregrine.
Other Designations	*Ministerial Conference on the Environment (1973); Countryside Act 1968; National Parks and Access to the Countryside Act (1949)*	
Donmouth Local Nature Reserve	5.0	Birds that feed and roost, Grey seals
Balmedie Country Park	2.7	Recreation and leisure interests
Forvie Biogenetic Reserve	7.2	Heathland Interest.

2 There are no other national or local landscape designations such as national scenic areas within the vicinity of the proposal that have the potential to be affected by the proposed project.

3 In pre-scoping consultation, SNH highlighted, in conjunction with the JNCC that they are in the process of identifying possible marine SPAs. Currently, there have been no sites identified within Aberdeen Bay.

14.1 Conservation Designations

4 A number of protected sites and species in the vicinity of the proposed EOWDC site are designated both internationally and nationally (Table 14.1). The following section provides details of these designations and sites identified of relevance to the proposed project.

14.1.1 Requirement for a Habitats Regulation Appraisal (HRA)

5 Under the Conservation (Natural Habitats, & c.) Regulations (as amended), the relevant Competent Authority (in this case the Scottish Government) must consider the effect of a development on the integrity of a European site. If the development is considered likely to have a significant effect on that site, the competent authority would undertake a Habitats Regulation Appraisal using information supplied as part of the EIA process to accurately determine risk to site integrity. Special Areas of Conservation (SACs) or Special Protection Areas (SPAs) constitute a European site.

6 Initial consultation with statutory bodies has indicated that the interaction between the proposed EOWDC and European sites in the wider area would need to be considered as part of the EIA process and that Habitats Regulation Appraisal may be required.

14.1.1.1 International Sites

Ramsar Sites

7 These sites are internationally important wetland sites protecting wildfowl habitat. Ramsar sites are designated under the Convention of Wetlands of International Importance. The Convention was adopted in Ramsar, Iran, in 1971 and ratified by the UK Government in 1976.

Natura 2000 Sites

8 The two most influential pieces of European legislation relating to nature conservation are the “Habitats” Directive and the “Birds” Directive. The ‘Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora’, commonly known as the Habitats Directive, adopted in 1992, complements and amends the 1979 ‘Council Directive 79/409/EEC on the conservation of wild birds’, commonly known as the Birds Directive. A further Directive *On The Conservation of Wild Birds* (Directive 2009/147/EC) is a codified version of the 1979 Directive.

9 The Birds Directive protects all wild birds, their nests, eggs and habitats within the European Community. It gives EU member states the power and responsibility to classify Special Protection Areas (SPAs) to protect birds, which are rare or vulnerable in Europe as well as all migratory birds that are regular visitors.

10 The Habitats Directive builds on the Birds Directive by protecting natural habitats and other species of wild plants and animals. Together with the Birds Directive, it underpins a European network of protected areas known as Natura 2000. This network includes SPAs classified under the Birds Directive and Special Areas of Conservation (SAC) under the Habitats Directive.

11 Annexes I and II of the Habitats Directive identify a set of habitats (Annex I) and species (Annex II), which require special conservation measures to be taken by Member States. These lists of habitats and species have been used to define the ‘features’ of a site which form the basis for designating the site as a SAC. Marine SACs may be put forward for habitats of conservation importance (listed in Annex I to the Habitats Directive) or for species of conservation importance (listed in Annex II) (Table 14.2).

TABLE 14.2 Marine Habitats on Annex I and Species on Annex II of the Habitats Directive Found in UK waters	
Annex I Habitats Considered for SAC Selection in UK Offshore Waters	**Species Listed in Annex II Know to Occur in UK Offshore Waters**
Sandbanks which are slightly covered by seawater all the time Reefs (bedrock, biogenic and stony) – Bedrock reefs – made from continuous outcroppings of bedrock which may be of various topographical shape (eeg pinnacles, offshore banks) – Stony reefs – these consist of aggregations of boulders and cobbles which may have some finer sediments in interstitial spaces (eg cobble and boulder reefs, iceberg ploughmarks) – Biogenic reefs – formed by cold water corals (eg *Lophelia pertusa*) and the polychaete worm *Sabellaria spinulosa* Submarine structure made by leaking gases Submerged or partially submerged sea caves	Grey seal (*Halichoerus grypus*) Harbour or common seal (*Phoca vitulina*) Bottlenose dolphin (*Tursiops truncatus*) Harbour porpoise (*Phocoena phocoena*) Salmon (*Salmo salar*) Otter (*Lutra lutra*) Freshwater pearl mussel (*Margaritifera margaritifera*)

Source: JNCC (2002, 2010)

Special Protection Areas (SPAs)

Buchan Ness to Collieston SPA

12 Buchan Ness to Collieston Coast SPA is located on the coast of Aberdeenshire in North-east Scotland, approximately 9.5 km from the EOWDC site. It is a 15 km stretch of south-east facing cliff formed of granite, quartzite and other rocks running to the south of Peterhead, interrupted only by the sandy beach of Cruden Bay. The low, broken cliffs (generally less than 50 m high) show many erosion features such as stacks, arches, caves and blowholes. The varied coastal vegetation on the ledges and cliff tops includes maritime heath, grassland and brackish flushes.

13 The site is of importance as a nesting area for a number of seabird species (Gulls and Auks). These birds feed outside the SPA in the nearby waters as well as more distantly. It is the sea bird assemblage of international importance that qualifies Buchan Ness to Collieston as a SPA. The area qualifies under Article 4.2 of the Habitats Directive (79/409/EEC) by regularly supporting at least 20,000 seabirds.

14 During the breeding season, the area regularly supports 95,000 individual seabirds (Count, as at mid-1980s) including: Guillemot (*Uria aalge*), Kittiwake (*Rissa tridactyla*), Herring Gull (*Larus argentatus*), Shag (*Phalacrocorax aristotelis*), Fulmar (*Fulmarus glacialis*).

Ythan Estuary, Sands of Forvie and Meikle Loch SPA

15 The Ythan Estuary, Sands of Forvie and Meikle Loch make up an area of 1016.24 ha. The site comprises the long, narrow estuary of the River Ythan and eutrophic Meikle Loch. At its mouth, the river splits an extensive area of sand dunes with the Forveran Links on the west bank and the Sands of Forvie dune system on the east bank. Extensive mud-flats in the upper reaches of the estuary are replaced by coarser gravels with mussel (*Mytilus edulis*) beds closer to the sea (JNCC, 2010).

16 These varying habitats give rise to a varied substrate including clay, sands and gravel, extensive areas of bare mud, small areas of salt marsh with representative northern salt marsh flora. Small areas of club-rush swamp are associated with the salt marsh. In the upper parts of the estuary there is a reed bed and near the mouth of the estuary there are shifting sand dunes and areas of bare shingle. To the west of the estuary there is a large area of improved grassland.

17 The margins of the estuary are varied with areas of salt marsh, reed bed and poor fen, heath and scrub, coniferous woodland and grassland. Meikle Loch is an important roost site for geese, which feed away from the SPA on surrounding farmland in winter. It is a eutrophic loch supporting limited aquatic vegetation. In summer, the coastal habitats of the dunes and estuary provide an important breeding site for three species of tern, whilst in winter the estuary holds large numbers of waders, ducks and geese.

18 The site qualifies under a number of articles of the European Directive. Firstly, the site qualifies under Article 4.1 of the Habitats Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive. During the breeding season it supports common tern (*Sterna hirundo),* 265 pairs representing up to 2.2 % of the breeding population in Great Britain, little tern (*Sterna albifrons*), 41 pairs representing up to 1.7 % of the breeding population in Great Britain and Sandwich tern (*Sterna sandvicensis*), 600 pairs representing up to 4.3 % of the breeding population in Great Britain (Seabird Census Register).

19 This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of migratory species. Over-winter pink-footed goose (*Anser brachyrhynchus*), 17,213 individuals representing up to 7.7 % of the wintering Eastern Greenland/Iceland/UK population (winter peak means).

20 The site also qualifies under Article 4.2 of the Directive by regularly supporting at least 20,000 waterfowl. Over winter, the area regularly supports 51,265 individual waterfowl including: redshank *Tringa totanus*, lapwing *Vanellus vanellus*, eider *Somateria mollissima*, and pink-footed goose *Anser brachyrhynchus*.

21 The Ythan Estuary and Meikle Loch sites are also designated as a Ramsar wetland site. The justification for this designation is the assemblages of internationally important waterfowl and the species/populations occurring at levels of international importance.

Loch of Strathbeg SPA

22 The Loch of Strathbeg is located in north-eastern lowland coats of Scotland, in Aberdeenshire, inland from Rattray Head and covers an area of 615.93 ha.

23 The SPA provides wintering habitat for a number of important wetland bird species, particularly wildfowl (swans, geese and ducks), and is also an important staging area for migratory wildfowl from Scandinavia and Iceland/Greenland. In summer, coastal parts of the site are an important breeding area for Sandwich tern (*Sterna sandvicensis*), which feed outside the SPA in adjacent marine areas.

24 The site qualifies under Article 4.1 of the Habitats Directive (79/409/EEC) by supporting populations of European importance of species listed on Annex I of the Directive. During the breeding season it supports Sandwich tern (*Sterna sandvicensis*), 530 pairs representing up to 3.8 % of the breeding population in Great Britain. Over winter it supports barnacle goose (*Branta leucopsis*), 226 individuals representing up to 1.9 % of the wintering population in Great Britain and whooper swan (*Cygnus cygnus*), 183 individuals representing up to 3.3 % of the wintering population in Great Britain.

25 This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of migratory species. Over winter it supports greylag goose (*Anser anser*), 3,325 individuals representing up to 3.3 % of the wintering Iceland/UK/Ireland population, pink-footed goose, (*Anser brachyrhynchus*), 39,924 individuals representing up to 17.7 % of the wintering Eastern Greenland/Iceland/UK population.

26 In addition area qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl and being a wetland of international importance. Over winter, the area regularly supports 49,452 individual waterfowl including: teal (*Anas crecca*), greylag goose, (*Anser anser*), pink-footed goose, (*Anser brachyrhynchus*), barnacle goose, (*Branta leucopsis*), and whooper swan, (*Cygnus Cygnus*).

27 The majority of the site is managed by the Royal Society for the Protection of Birds (RSPB) for conservation and primarily for the SPA interest. Scottish Natural Heritage (SNH) has piloted a Strathbeg Goose Management Scheme to alleviate the conflict between the geese, which roost on the loch, and the surrounding farms where they feed.

28 The Loch of Strathbeg site is also a designated Ramsar site as the loch constitutes the largest dune slack pool in the UK and the largest water body in the north-east Scottish lowlands, one of the very few naturally eutrophic lochs of the size in the region. The site also qualifies under criterion 5 and 6 with assemblages of international importance, especially peaks in winter, and species/populations occurring at levels of international importance.

Loch of Skene SPA

29 Loch of Skene lies approximately 21 km from the proposed EOWDC location.

30 The qualifying species is greylag goose, which roost on the loch during the winter. The population of wintering greylag geese on the Loch has declined in recent years as increasing numbers of greylag geese now winter in Orkney.

31 In addition to greylag geese the loch also holds nationally important numbers of goldeneye (*Bucephala clangula*) and goosander (*Mergus merganser*) during the winter and a large roost of common gulls occurs during the winter. During the summer the loch holds 50 to 100 pairs of tufted duck.

Fowlsheugh SPA

32 Fowlsheugh is a 10.15 ha stretch of cliffs to approximately 31.1 km south of the proposed EOWDC location. It is an important site for breeding seabirds with up to 145,000 birds present including guillemot, razorbill, kittiwake, fulmar and herring gull. The site is also part of an RSPB reserve.

Troup, Pennan and Lion's Heads SPA

33 The sea cliffs along Troup, Pennan and Lion's Head SPA hold internationally and nationally important numbers of seabirds, notably kittiwake, guillemot, fulmar, herring gull and razorbill. There is a seaward extension out to 2 km from the cliffs, which are approximately 74.3 km from the project location.

Montrose Basin SPA

34 The Montrose Basin lies approximately 63 km to the south of the proposed EWODC and comprises of a large tidal basin containing mud flats and marsh.

35 The area is important for wintering and migrating wildfowl and waders, particularly pink-footed and graylag geese. Other species of importance include: eider, wigeon, shelduck and waders such as knot, oystercatcher and dunlin.

Fair Isle SPA

36 Fair Isle lies halfway between Mainland Shetland and Orkney. It has a rocky, cliff coastline with adjacent coastal waters, heather moorland, acidic grassland, maritime grassland and crofting in-bye. There is a seaward extension out to 2 km from the island.

37 The island lies nearly 300 km from the proposed EWODC site and contains a large assemblage of breeding seabirds the most relevant of which is the gannet that has a foraging range during the breeding season in excess of 300 km. Other species present includes Auks, Skua and Terns as well as fulmars and shags.

Firth of Tay and Eden Estuary SPA

38 The Firth of Tay & Eden Estuary SPA is a complex of estuarine and coastal site in eastern Scotland stretching from the mouth of the River Earn in the inner Firth of Tay east to Barry Sands on the Angus coast and St Andrews on the Fife Coast. The site lies approximately 96 km to the south of the proposed development.

39 It holds a nationally important breeding population of marsh harrier and little tern. It also holds nationally important wintering and migrating populations of a variety of wildfowl and waders including pink-footed goose, graylag goose, eider, scoters and waders such as bar-tailed godwit and oystercatcher.

Firth of Forth SPA

40 The Firth of Forth SPA is a complex of estuarine and coastal habitats in south-east Scotland stretching east from Alloa to the coasts of Fife and East Lothian. The site lies approximately 134 km to the south of the proposed EOWDC. It contains nationally important wintering populations of wildfowl and waders including pink-footed goose, red-throated diver, Slavonian grebe, golden plover and bar-tailed godwit and ducks including goldeneye, eider and long-tailed duck.

Forth Islands SPA

41 The Forth Islands SPA comprises a series of islands situated in the Firth Forth and includes the Bass Rock and the Isle of May. It is a site holding internationally and nationally important seabirds including gannet, fulmar, shag, cormorant, common tern, Sandwich tern, Arctic tern and roseate tern. Three species of auk: puffin, razorbill and guillemot, and three species of gull: herring, lesser black-backed and kittiwake are found there.

Special Ares of Conservation (SACs)

Buchan Ness to Collieston Coast SAC

42 Buchan Ness to Collieston Coast, an area of 207.52 ha, is a designated special area of conservation (SAC). The site includes shingle sea cliffs and islets, bogs marshes, water fringed vegetation and fens as well as heath, scrub, maquis, garrigue, phygrana, humid grassland, and mesophile grassland. Such habitat qualifies the site as an Annex I Habitat, 1230 Vegetated Sea Cliff of the Atlantic and Baltic Coasts.

43 The vegetated cliff slopes support a wide range of coastal vegetation types with an abundance of such local species as Scots lovage (*Ligusticum scoticum*) and roseroot (*Sedum rosea*). In several places the cliff edge retains semi-natural plant communities such as maritime heath, acid peatland and brackish flushes. All these are now rare on the coast of North-east Scotland and this section of coastline contains some of the best remaining examples. Possibly due to the local microclimate and the presence of lime-rich soils, these communities contain several plants, which are associated with dry, calcareous grassland, including carline thistle (*Carlina vulgaris*) and cowslip (*Primula veris*). Sea wormwood (*Seriphidium maritimum*) also occurs. The cliffs and offshore stacks support a scattered but considerable colony of cliff-nesting seabirds with bird-influenced vegetation.

Sands of Forvie SAC

44 The Sands of Forvie SAC includes an area of coastal sand dunes, beaches, machair, inland water bodies, sea cliffs, bogs, marshes, water fringed vegetation, fens, heath, scrub, marquis and garrigue, phygrana, humid grassland and mesophile grassland covering an area of approximately 734.05 ha. There are three primary reasons for selecting Sands of Forvie as an SAC. These include the embryonic shifting dunes, shifting dunes along the shoreline with *Ammophila arenaria* (white dunes), decalcified fixed dunes with *Empetrum nigrum* and humid dune slacks.

45 Sands of Forvie is one of only three sites on the east coat of Scotland which represent the northern part of the UK range of embryonic shifting dunes. Sands of Forvie is one of the most geomorphically active dune systems in the UK and as a result the site contains significant representation of dune types associated with shifting sands. Present throughout the site are identifiable zones of lyme-grass (*Leymus arenarius*) and sand couch (*Elytrigia juncea*).

46 In recent years, Terns have bred in much lower numbers owing to predation and the periodic overtopping of the favoured shingle beds by sand. There is growing concern about the effects of eutrophication on the estuary and its flora and fauna. The continuing build up of algal mats has apparently led to a reduction in the populations of invertebrates, which are the prey of waterfowl such as redshank and shelduck.

47 The site forms the Forvie National Nature Reserve, which is managed for its nature conservation interest under an agreed management plan. The site is also 100 % covered by SSSI designation.

Moray Firth Marine SAC

48 The Moray Firth was designated by Scottish Ministers as a Special Area of Conservation (SAC) on 17 March 2005. The Moray Firth marine SAC has been designated for the species bottlenose dolphin (*Tursiops truncatu*), which is, listed on Annex II of the Habitats Directive, as well as for the Annex I habitat 'Sandbanks which are slightly covered by sea water all the time'.

49 The conservation objectives for the Moray Firth marine SAC with regards to bottlenose dolphins are:

- to avoid deterioration of the habitats of the qualifying species (bottlenose dolphin *Tursiops truncatus*) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest
- to ensure for the qualifying species that the following are established then maintained in the long-term:
  - population of the species as a viable component of the site
  - distribution of the species within the site
  - distribution and extent of habitats supporting the species
  - structure, function and supporting processes of habitats supporting the species
- no significant disturbance of the species.

50 The conservation objectives ensure that the obligations of the Habitats Directive are met; that is, there should not be deterioration or significant disturbance of the qualifying interest. This will also ensure that the integrity of the site is maintained and that it makes a full contribution to achieving favourable conservation status for its qualifying interests (SNH, 2006).

River Dee SAC

51 The River Dee SAC lies inland from the proposed project and enters the sea at Aberdeen. The river contains three qualifying species otter (*Lutra lutra*), freshwater pearl mussel (*Margaritifera margaritifera*) and Atlantic salmon (*Salmo salar*). The salmon enter the river throughout the year and the freshwater pearl mussel relies upon the salmon for part of its life cycle when it uses the salmon as a host species. Otters are infrequent on the coast and the majority of the otter population found along the Dee is upstream from the river mouth.

River South Esk SAC

52 The River South Esk SAC is adjacent to the Montrose Basin SAC as the river runs into the basin. The river is nationally important for salmon and freshwater pearl mussel.

Firth of Tay and Eden Estuary SAC

53 The Firth of Tay and Eden Estuary SAC lies approximately 96 km to the south of the proposed EOWDC. The sites comprise of coastal habitats including, estuaries, sand banks, sand flats and mud flats and holds a population of common seal.

Isle of May SAC

54 The Isle of May SAC covers an area of 357 ha and lies 119 km to the south of the proposed development. Grey seal is a qualifying species present and the population has increased significantly since the 1980's when approximately 500 pups were born each year to 2,100 pups in 2,000. The population has since levelled off.

Berwickshire and North Northumberland Coast SAC

55 This large SAC comprising of large variety of habitats including large shallow inlets and bays, mudflats, reefs and sea caves covers an area of 60,545 ha. The site holds a population of grey seals. The site lies approximately 150 km to the south of the proposed development.

14.1.1.2 National Sites

Sites of Special Scientific Interest (SSSI)

Corby, Lilly and Bishops Lochs SSSI

56 Corby, Lilly and Bishops Lochs are designated as Sights of Special Scientific Interest under the Wildlife & Countryside Act (1981). The Lochs lie approximately 6.7 km inland from the proposed EOWDC location. The lochs contain locally important vegetation and invertebrate populations. The Lochs also use to hold roosting greylag geese but the numbers roosting on the Lochs has reduced in recent years.

Foveran Links SSSI

57 Extensive sand dune systems lie to the north of the proposed development. Up to the Ythan Estuary. The 205 ha Foveran Links SSSI contains plant communities not found elsewhere along the coast and a variety of habitats including, fixed dunes, dune pastures, marshes and heaths.

Sands of Forvie and Ythan Estuary SSSI

58 The Sands of Forvie lie approximately 7.2 km to the north of the proposed EOWDC location. The site is also covered by the SAC.

59 It is an extensive area of sand dunes containing a wide range of typical dune habitats and very diverse range of flora. The site holds the UKs largest breeding colony of eider ducks and nationally and internationally important populations of pink-footed geese and other wildfowl and waders.

Meikle Loch and Kippet Hills SSSI

60 Meikle Loch and Kippet Hills SSSI lies approximately 11 km to the north-west of the proposed development. The Loch is freshwater Loch and holds internationally important number so f geese, particularly pink-footed geese

which roost on the Loch and feed in the neighboring area. Other wildfowl species present include graylag goose and teal, wigeon and tufted duck

Collieston to Whinnyfold SSSI

61 This coastal SSSI holds nationally important populations of breeding seabirds including kittiwake, guillemot, razorbill and shag. The site lies approximately 15 km to the north of the proposed development.

Bullers of Buchan SSSI

62 The rocky maritime cliffs at the Bullers of Buchan contain breeding seabirds including guillemots, razorbills, puffins, fulmars and shags.

Fowlsheugh SSSI

63 The cliffs at Fowlsheugh hold the largest breeding seabird colony in the North-east with national important numbers of kittiwakes, guillemots, razorbills as well as puffins, fulmar and shag.

Loch of Skene SSSI

64 The Loch of Skene is approximately 21 km inland from the proposed EOWDC. The site holds nationally important numbers of breeding tufted duck and during the winter goldeneye, goosander, pochard, teal and wigeon. The Loch use to hold nationally important numbers of geese and swans but numbers present on the loch have decreased in recent years. During the winter there is a large common gull roost on the loch.

Loch of Strathbeg SSSI

65 The Loch of Strathbeg is a large shallow freshwater loch on the coast to the north of the proposed development. It is of international importance for its wildfowl, particularly passage and wintering pink-footed geese. It also holds nationally important numbers of whooper swan, graylag goose and important concentrations of pochard, tufted duck, wigeon, goldeneye, goosander and mute swans.

St Cyrus and Kinnaber Links SSSI

66 St Cyrus and Kinnaber Links SSSI is a coastal SSSI located approximately 53 km to the south of the proposed development. It comprises of a wide range of habitats including sand dunes, shingle, slat marsh and grassland. It has diverse range of breeding birds including waders: curlew, redshank, ringed plover and oystercatcher. Breeding passerines include sedge warbler, grasshopper warbler and whinchat and stonechat.

14.1.1.3 <u>Local Sites</u>

Biodiversity

67 Following the 1992 Rio Earth Summit, the UK Biodiversity Action Plan was published in 1994. At the local level, this is implemented through the North East Scotland Local Biodiversity Action Plan (LBAP). LBAP is a partnership of local authorities, environmental, forestry, farming, land and education agencies, businesses and many individuals involved in biodiversity across North East Scotland (Aberdeen, Aberdeenshire and Moray)

68 Most of the North East action for biodiversity is addressed through Habitat Action Plans (HAPs), which incorporate action for associated priority species. These HAPs are grouped under the broader habitat headings of Coastal & Marine; Farmland & Grassland; Woodland; Montane, Heath & Bog; Wetland & Freshwater; and Urban (NESBiodiversity, 2007).

69 The Coastal and Marine Habitat Action Plans (HAPs) are the most relevant for the proposed development. The protection of these coastal and marine habitats is a top priority for North East LBAP and several specific action plans have been developed, including:

- Coastal Sand Dunes and Shingle
- Coastal Cliffs and Heaths [action plan development in progress]
- Marine Habitats [action plan development in progress]
- Estuarine and Intertidal Habitats

70 A number of species has been identified with dedicated North East Action Plans (NESBiodiversity, 2007).

14.1.2 Marine (Scotland) Act 2010

71 The Marine (Scotland) Act (which applies to Scottish territorial waters) introduces new powers relating to functions and activities in the Scottish marine area, including provisions concerning marine plans, licensing of marine activities, the protection of the area and its wildlife including seals, and regulation of sea fisheries. The Act comprises six key elements: the formation of Marine Scotland, a strategic marine planning system, a streamlined marine licensing system, improved marine nature conservation measures, improved measures for the protection of seals and improved enforcement measures (JNCC, 2010).

72 Marine Scotland will deliver integrated marine management functions relating to marine science and data, planning, policy development and delivery, compliance, monitoring and enforcement, whether fully or executively devolved to Scottish Ministers out to 200 nautical miles; and will work closely with the UK Marine Management Organisation (MMO) established under the UK Marine and Coastal Access Act 2009 (JNCC, 2010).

73 Scottish Marine Protection Areas (MPAs) are a new national designation under the **Marine (Scotland) Act** for inshore waters and the **Marine and Coastal Access Act 2009** for offshore waters. Scottish Ministers have executive devolution of authority for the designation of MPAs for the conservation of important marine biodiversity and geodiversity out to 200 nm.

74 Within the Marine Nature Conservation element, powers in the **Marine (Scotland) Act** enable Scottish Ministers to designate three types of Marine Protected Area (MPA) across Scottish territorial waters: Nature Conservation MPAs; Historic MPAs; and Research/Demonstration MPAs (JNCC, 2010).

75 The Scottish MPA project has been established by Marine Scotland (Scottish Government), Scottish Natural Heritage and the Joint Nature Conservation Committee (JNCC) to identify and recommend MPAs for the conservation of nationally important features of marine biodiversity and geodiversity to Government. Scottish MPAs will be identified using science-based selection criteria, but socio-economic information may be taken into account when

selecting between sites of equal scientific merit and to identify likely management issues (Natural England, 2010).

76 The new MPA powers allow Scotland to contribute to the UK's European and International marine conservation commitments, such as those laid out under the Marine Strategy Framework Directive, the OSPAR Convention and the Convention on Biological Diversity (JNCC, 2010) and the government is required by European law to introduce a network of MPAs by the end of 2012 (Natural England, 2010).

14.2 References

JNCC (Joint Nature Conservation Committee) (2010) http://www.jncc.gov.uk [Date accessed –June 2011]

Natural England (2010) http://www.naturalengland.org.uk/about_us/news/2010/230210.aspx [Date accessed - June 2011]

NESBiodiversity (2007) www.nesbiodiversity.org.uk North East Scotland Local Biodiversity Action Plan (LBAP) website.

SNH (2006) Moray Firth Special Area of Conservation, Advice under Regulation 33(2) of The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). http://www.snh.org.uk/pdfs/about/directives/Moray_Firth.pdf. [Date accessed June 2011]

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 15: Shipping and Navigation

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

15 SHIPPING AND NAVIGATION

15.1 Introduction

1 This section summarises the work undertaken as part of the Navigation Risk Assessment (NRA) by Anatec UK Ltd to identify the baseline vessel activity and navigational features in the vicinity of the proposed European Offshore Wind Deployment Centre (EOWDC) and to assess the potential impacts associated with the different phases of the development. Planned mitigation measures to manage the impacts, which have been identified in consultation with maritime stakeholders, are also documented.

2 The following technical reports support this chapter and can be found as:

- Navigational Risk Assessment (Appendix 15.1)

15.1.1 Methodology Consultation

3 The methodology applied was based on the DECC Guidelines "Methodology for Assessing the Marine Navigational Safety Risks of Offshore Windfarms, Version Date: 7th September 2005".

4 Extensive consultation on navigational issues has been carried out with stakeholders during the evolution of the proposed development. This following list section briefly summarises the key consultees:

- Aberdeen Harbour
- Marine Safety Forum
- NorthLink ferries
- Craig Group
- Gulf Offshore
- Trico
- Shell Marine
- Scottish Fishermen's Federation
- Other Marine Stakeholders

5 A hazard review workshop was held in Aberdeen on the 25 August 2010, hosted by Aberdeen Harbour. The purpose of the workshop was to identify and review the potential navigational hazards associated with the proposed development of the EOWDC.

6 Various consultation exercises have also been carried out by the project over a number of years including several public events which allowed all stakeholders to contribute opinions on the proposals.

15.1.2 Key Guidance Documents

7 The following key guidance documents have been referred to:

- MCA Marine Guidance Notice 371, Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues MCA Wind Farm: "Shipping Route" Template

- DECC, U.K. Government, Methodology for Assessing the Marine Navigational Safety Risks of Offshore Windfarms, Version Date: 7th September 2005
- IMO, Guidelines for Formal Safety Assessment (FSA) for use in the IMO rule Making Process, 5th April 2002
- MCA Marine Guidance Notice 372 (M+F), Guidance to Mariners Operating in the Vicinity of UK OREIs, August 2008
- IALA Recommendation O-139 On The Marking of Man-Made Offshore Structures, Edition 1, Dec 2008

15.1.3 Data Information and Sources

8 The following data sources have been used within this assessment:

- AIS and Radar Survey 1 (Anatec, 24 March – 7 April 2009)
- AIS and Radar Survey 2 (Anatec, 21 September – 5 October 2009)
- AIS and Radar Survey 3 (Anatec, 9 April – 23 April 2010)
- AIS and Radar Survey 4 (Anatec, 1 November – 15 November 2010)
- AIS and Radar Survey 5 (Anatec, 18 February – 4 March 2011)
- RYA, UK Coastal Atlas
- EOWDC Commercial Fisheries Assessment (Chapter 21 of this ES)

15.2 Baseline Assessment

9 A baseline assessment gives account to:

- shipping and navigational practices
- Aberdeen Harbour
- oil and gas infrastructure
- MoD Exercise Areas
- metocean data
- hydrographic data

10 Due to the proximity of the site to Aberdeen Harbour particular attention was placed on detailing information on this port.

11 Aberdeen Harbour is the principal commercial port serving the northeast of Scotland with approximately 16,000 ship movements in 2009 handling approximately 4.5 million tonnes of import and export goods. The port is the main marine support centre for the North Sea oil and gas industry. In addition to the oil and gas support services there are regular shipping services to Orkney, Shetland and Scandinavia via Ro-Ro services for passengers and cargo, with 142,468 passengers passing through the port in 2009.

12 The port also has a large modern fish market and although there are no commercial fisheries within the area of jurisdiction of Aberdeen Harbour or proximity, deep-sea fishing vessels and a number of locally registered potters land their catches at the Aberdeen fish market.

13 The nearest proposed turbine within the EOWDC site would be located over 2 nautical miles (nm) from the northern limits of Aberdeen Harbour.

14 There is a designated anchorage area just to the north of the Aberdeen Harbour boundary, which was established in 2010 (see Figure 2.2).

15 Figure 15.1 presents details on shipping as gathered in the AIS and radar during a two week survey in November 2010.

15.3 Impact Assessment

15.3.1 Impact Assessment Methodology

16 The AIS and radar survey data were analysed and further consultation was carried out to assess the potential impacts of the proposed development on shipping and navigation. Through this process, the main shipping and navigation hazard scenarios identified were as follows:

- commercial shipping impact within EOWDC site
- not under command vessel collision
- dragging anchor event
- ship-to-ship collisions
- recreational vessel collisions
- fishing vessel collisions
- fishing vessel gear snagging

17 Further assessment of these scenarios was carried out using qualitative and quantitative techniques. A number of consultation meetings were held with key stakeholders and a Hazard Workshop was carried out in August 2010 in-line with the DECC Guidelines.

18 In addition to the above scenarios, the NRA also assessed the potential impact of the development on a number of factors as outlined in the DECC Guidelines, including:

- visual navigation
- marine radar systems
- communications and position fixing
- search and rescue
- aids to navigation
- anchoring (sea room availability and the potential of cable interaction)

19 The main conclusions of this work are as follows:

- the proposed EOWDC site has been relocated and reduced in size such that it would not affect the main navigation routes in the area, including the bulk of shipping heading to/from Aberdeen Harbour
- moving the site to the north has provided a 0.25 nm separation between the nearest wind turbine and the designated anchorage area in Aberdeen Bay
- consultation with Aberdeen Harbour Board and other users of the area, such as NorthLink Ferries, indicated the site is acceptable in terms of navigational safety
- there is limited fishing and recreational vessel activity in the area
- in the hazard review workshop involving local navigational stakeholders, all hazards were identified to be low

- following identification of the key navigational hazards, risk analyses were carried out to investigate selected hazards in more detail. The overall annual level of risk due to the presence of the proposed EOWDC was estimated to increase by approximately 1 in 404 years (base case) and 1 in 367 years (future case based on traffic growth estimates over the life of the development). The majority of this risk is from passing powered ship collisions with the wind turbines, followed by fishing vessel collisions
- the risks associated with recreational craft interaction with the proposed EOWDC structures (blade/mast and vessel/structure collisions) were qualitatively assessed and concluded to be as low as reasonably practicable given the mitigation measures planned
- a quantitative assessment estimated that, compared to the background marine accident risk levels in the UK, the increase in risk to both people and the environment caused by the proposed EOWDC is low

20 It was concluded that with the correct mitigation measures in place (see Table 15.1) the shipping and navigational impact of the EOWDC development is Low.

21 This outcome was found to be the same for all phases of the development; during construction, operation and decommissioning, although it was noted that the mitigation measures may vary for each phase.

22 No cumulative and in-combination effects were identified throughout the process.

23 The following table summarises the main mitigation measures identified during the NRA.

TABLE 15.1 Mitigation Measures Identified during the NRA	
Mitigation	**Description**
Site selection	Site selected to avoid significant navigational impacts, eg, located away from main anchorage area and navigation lanes to/from Aberdeen following consultation with Aberdeen Harbour, etc.
Marked on Admiralty Charts	EOWDC would be charted by the UK Hydrographic Office using the magenta turbine tower chart symbol found in publication “NP 5011 - Symbols and Abbreviations used in Admiralty Charts”. Submarine cables associated with the project would also be charted on the appropriate scale charts.
Information Circulation	Appropriate liaison to ensure information on the wind farm and special activities is circulated in Notices to Mariners, Navigation Information Broadcasts and other appropriate media.
Marking and Lighting	Structures to be marked and lit in-line with Northern Lighthouse Board and International Association of Marine Aids to Navigation and Lighthouses (IALA) guidance.
Turbine Air Draught	Lowest point of rotor sweep at least 22 m above Mean High Water Springs as per RYA and MCA recommendations.
Cable Protection	Cables to be buried to suitable depth based on cable protection study taking into account fishing and anchoring practices in Aberdeen Bay. Periodic inspection of the cable to ensure it remains buried. Positions of cable routes notified to Kingfisher Information Services (KIS) for inclusion in cable awareness charts and plotters for the fishing industry.
Compliance with MCA’s Marine Guidance Notice (MGN) 371 including Annex 5	Annex 5 specifies “Standards and procedures for generator shutdown and other operational requirements in the event of a search and rescue, counter pollution or salvage incident in or around an OREI.”
Formulation of an Emergency Response Cooperation Plan (ERCoP) as per MCA template	The Applicant would use the draft template created by the MCA to formulate an emergency response plan and site Safety Management Systems, in consultation with the MCA.

15.4 Summary

24 The Shipping and Navigation Assessment was carried out in accordance with the regulations and guidance.

25 Throughout the project marine navigational marking would be provided in accordance and consultation with the NLB requirements, which would comply with IALA and the additional requirements of MCA. It is also noted that there is a requirement to mark selected structures with lights for aviation as per Civil Aviation Authority (CAA) requirements.

26 One of the main elements of the process has been extensive consultation with the key navigation stakeholders to ensure the site design is optimised. Having achieved this, it was identified that the shipping and navigation impacts associated with the development would be Low, provided the correct mitigation measures are implemented.

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 16: Aviation

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

16 AVIATION

16.1 Introduction

1 This chapter considers the potential implications of the European Offshore Wind Deployment Centre (EOWDC) in relation to potential aviation issues.

2 Aberdeen airport serves more than three million travellers a year and is the world's busiest commercial heliport, transporting more than 500,000 passengers in support of the North Sea oil and gas industry.

3 The presence of helicopter traffic is the most significant aviation issue for the site. Following early consultation with the relevant authorities it was identified that in certain weather conditions the helicopters may descend to 1,000 feet (or lower), while the tip height of the wind turbines could be in the region of 640feet. This would breach the minimum clearance limit required for helicopter safety and consequently the wind farm layout has been amended to account for the helicopter corridors. This was a major revision to earlier wind farm layouts, and has dominated all subsequent layout considerations.

16.1.1 Methodology Consultation

4 In order to address any potential aviation issues that could arise from the proposed development an Aviation Working Group was established as early as 2005.

5 Although there have been periods of lesser activity the group were active during 2010, with over four meetings discussing a range of issues.

6 The Civil Aviation Authority (CAA) was an early attendee at these meetings, but in recent years they have been content to allow aviation issues – largely operational in nature – to be discussed by National Air Traffic Services (NATS) (Aberdeen) and BAA (Aberdeen). These meetings have also been attended by the three helicopter companies operating out of Aberdeen airport – Bond, Bristows and CHC Scotia. Also in attendance has been Oil and Gas UK, the main client for their helicopter operations.

16.1.2 Key Guidance Documents

7 NATS studies have taken due account of all relevant aviation guidance documents.

16.1.3 Data Information

8 The data used for these studies has come from existing NATS operational data. The following reports have been prepared/ are underway:

- Aberdeen Wind Farm Analysis, April 2011, produced by NATS Procedure Design Group at Heathrow House, Bath Road, Cranford, TW5 9AT
- Aberdeen Wind Farm Radar study - report in preparation by NATS technical specialists
- Assessing the Impact of the Proposed Vattenfall/AREG Wind Farm on Perwinnes MSSR, QinetiQ, March 2010

16.2 Baseline Assessment

16.2.1 Helicopter Routeing

9 As part of the agreement on the final layout of the wind farm, it has been agreed that the northern helicopter route into Aberdeen could be moved to the north, thereby allowing greater clearance between the wind farm and Aberdeen Harbour entrance. The change would be brought about by applying for an Air Space Change, the project has entered into a contract with NATS to bring this into effect.

10 The presence of the EOWDC would also require some minor changes to helicopter procedures in the event of encountering problems during take-off and landing phases at Aberdeen which may be exacerbated in icy conditions.

16.2.2 Primary and Secondary Radar Facilities

11 The proposed layout is within 10 km of the secondary radar facility at Aberdeen airport and as such it has been necessary to assess the potential impacts of the project on this function. The Applicant has commissioned a study from QinetiQ and the report has been passed to NATS. The report shows that although there may be potentially significant effects there are a number of technical solutions available to solve them. The project is currently negotiating a contract with NATS to determine the most efficient and effective technical solution to this issue. The project has also requested that this work include a confirmation that the project does not cause difficulties for the primary radar at Aberdeen airport.

16.3 Impact Assessment

16.3.1 Change to Air Route Maps

12 The project has entered a contract with NATS in order to apply for an Air Space Change. This would be implemented by NATS, in consultation with the Aviation Working Group.

16.3.2 Primary and Secondary Radar Facilities

13 The project is currently negotiating a contract with NATS to determine the most efficient and effective technical solution to this issue.

16.3.3 Mitigation and Monitoring

14 Through the creation of the Aviation Working Group early consultation has ensured that mitigation has been built in to the development process. As a result it is not anticipated that any further mitigation would be required.

15 The implementation of these measures would be the subject of ongoing monitoring by the Aviation Working Group, thereby ensuring that the objectives of minimal impact are sustained.

16 Details of the development would be provided to the Defence Geographic Agency as required.

16.4 Summary

17 Close liaison with key consultees and the formulation of the Aviation Working Group has ensured that there are not likely to be any detrimental effects upon aviation as a result of the EOWDC proposal. Ongoing monitoring during construction, operation and decommissioning would ensure that if any unforeseen issues arise they can be dealt with promptly.

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 17: Ministry of Defence

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

17 MINISTRY OF DEFENCE

17.1 Introduction

1 This chapter considers the potential implications of the European Offshore Wind Deployment Centre (EOWDC) in relation to any impacts upon the Ministry of Defence (MoD).

2 The proposed EOWDC is in close proximity to military facilities such as the Black Dog firing range, therefore the MoD interests and potential conflicts with other activities has been a key consideration for the project.

17.1.1 Methodology Consultation

3 Consultation with the MoD has been ongoing since 2005. Liaison with MoD has been constructive, with several meetings being held at Defence Estates, and one at a Royal Air Force (RAF) base in the north of England to discuss the radar interference issue.

17.1.2 Key Guidance Documents

4 Development of any issues will comply with all relevant MoD guidance documents in this area.

17.1.3 Data Information and Sources

5 In matters of national security, the MoD is the sole holder of the relevant detail to make the assessment of the impact of the project upon their activities

17.2 Baseline Assessment

6 Consultation with the MoD has raised two key issues relating to the proposed EOWDC, these are:

- any effect of the project on the operability of the defence radar installation at Buchan (Peterhead)
- any effect of the project on the Black Dog firing range – a small-arms firing range on the coast nearby, but with an associated exclusion zone at sea during firing

17.3 Impact Assessment

17.3.1 Effect of the EOWDC on the Operability of the Defence Radar Installation at Buchan (Peterhead)

7 The MoD undertook an assessment on the current layout 39 (LABER039) in September 2010 as a response to a Request for Scoping Opinion (see Appendix 4.2). They responded that 'the wind turbines will be 26 km from; in line of sight to; and will cause unacceptable interference to the Air Defence (AD) radar at Buchan'.

8 Further correspondence revealed that the MoD was of the opinion that the current 11 wind turbine layout was additional to a 10 wind turbine layout (Layout 12, LABER 012, see Site Selection Chapter 2) assessed in 2008 by the MoD and confirmed by the MoD as raising no concerns. This misunderstanding was recently clarified with the MoD, however, the MoD has maintained their objection to the current 11 wind turbine layout.

9 Given the response to the assessment of layout 12 (LABER012) the Applicant did not anticipate the change in the outcome of the assessment between layouts 12 and 39 leading to a change in position of the MoD from no concern to now a concern of unacceptable interference.

10 At a meeting in June 2011 the MoD confirmed that their advice in response to Scoping 2010 and their current position to a single project of 11 wind turbines remained only if no suitable mitigation could be agreed.

11 The Applicant working in conjunction with the MoD therefore needs to develop technical mitigation measures to accommodate these concerns, and plan to do so during the period of consultation on the project.

17.3.2 Effect of the EOWDC on the Black Dog Firing Range

12 Regarding the Black Dog Firing range, the MoD has consistently stated that no wind turbines should be placed within the safety exclusion zone at sea.

13 While there would be no wind turbines within the firing range exclusion zone, there would be a need for project vessels to enter the area for the purposes of surveying, construction, operations and maintenance. It would therefore be necessary to agree access provisions with the MoD.

14 Operational procedures would be agreed with MoD to allow vessel access to the firing range exclusion zone for project activities during the lifetime of the project.

15 Once operational procedures have been established with the MoD it is not envisaged that there would be any further impact, therefore any potential impacts upon the firing range are considered to be negligible.

17.4 Summary

16 The project has had a long-term relationship with the MoD during its development, through the MoD Defence Estates department in Birmingham. The Applicant understands that plans for the area of the Black Dog Firing Range are acceptable, although further discussions will be needed on operational aspects. There will now need to be an intensive period of work to address MoD concerns regarding the Buchan (Peterhead) radar issue.

European Offshore Wind Deployment Centre
Environmental Statement

Chapter 18: Marine and Maritime Archaeology

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

18 MARINE AND MARITIME ARCHAEOLOGY

18.1 Introduction

1 An Environmental Impact Assessment (EIA) has been undertaken for the proposed European Offshore Wind Deployment Centre (EOWDC) by Wessex Archaeology, to support this Environmental Statement (ES). The impact of eleven wind turbines with inter-array cabling and export cabling to the coast (to the mean high-water mark) upon cultural heritage receptors in marine contexts was assessed. The EIA is underpinned by a baseline technical report which incorporates information from documentary sources and from a geophysical assessment of the seabed and sub-seabed sediments to identify cultural heritage assets within the marine study area (MSA).

2 The following technical reports support this chapter and can be found as:

- Marine and Maritime Archaeology Baseline Technical Report (Appendix 18.1)
- Marine and Maritime Archaeology Environmental Impact Assessment Technical Report (Appendix 18.2)

18.1.1 Methodology Consultation

3 During the preparation of this baseline report organisations were consulted. These are listed below:

- UK Hydrographic Office (UKHO) (101201), documentary sources of wrecks and seabed obstructions
- Royal Commission on the Ancient and Historic Monuments of Scotland (RCAHMS) (101201), documentary sources of wrecks, recorded losses
- Ministry of Defence, Third Sector Heritage (110128), supplementary background source for protected places and control sites

18.1.2 Key Guidance Documents

4 The following guidance documents have been utilised:

- The Code of Practice for Seabed Developers, Joint Nautical Archaeology Policy Committee 2006 (JNAPC 2006)
- Historic Environment Guidance for the Offshore Renewable Energy Sector, COWRIE 2007 (Wessex Archaeology 2007)
- Guidance for Assessment of Cumulative Impacts on the Historic Environment; from Offshore Renewable Energy, COWRIE 2008 (Oxford Archaeology & George Lambrick Archaeology and Heritage, 2008)
- Protocol for Archaeological Discoveries: Offshore Renewables Projects, The Crown Estate, 2010 (Wessex Archaeology, 2010)
- Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector (Gribble & Leather/COWRIE 2011)

18.1.3 Data Information and Sources

- Archaeological records for the MSA available in the maritime section of the CANMORE database held by the RCAHMS which constitute the National Monuments Record for Scotland (NMRS), also interrogated via a map interface, CANMAP
- Archaeological records for the MSA held locally in the Aberdeenshire, Moray and Angus Sites and Monuments Record (SMR)
- Records of wrecks and obstructions collated by the UK Hydrographic Office (UKHO)
- Records of Protected Places and Controlled Sites provided by the Ministry of Defence
- SeaZone datasets including basemapping and wreck information (derived from UKHO records)
- British Geological Service (BGS) mapping and UKHO charts
- Various secondary sources relating to the palaeo-environment of the area and to the Palaeolithic and Mesolithic archaeology of Northern Europe
- Secondary sources relating to wrecks and the maritime environment and the history and archaeology of Aberdeen and its surrounding area

5 Geophysical data that have been archaeologically assessed as part of this report is associated with the following reports:

- Emu Ltd (2008) Geophysical and Seabed Habitat Assessment of the Proposed Aberdeen Offshore Wind Farm for Aberdeen Offshore Wind Farm Ltd. Report No. 07/J/1/02/1136/0716
- Osiris Projects (2010) Aberdeen Offshore Wind farm Geophysical Survey. Volume 1: Operations Report. No. C10023

18.2 Baseline Assessment

18.2.1 Maritime Cultural Heritage Assets

6 A total of two sites designated as of anthropogenic origin and of archaeological interest (WA 7071 and WA 7072) have been identified during the assessment of geophysical survey data within the MSA, located approximately 40 m apart. Of these, one is a previously uncharted wreck site (WA 7071) and the other is possibly a large piece of debris relating to a wreck (WA 7072).

7 It is not currently possible to define the type, identity and archaeological importance of the unidentified wreck (WA 7071). The sonar dimensions of the vessel are 25 m long by 6.5 m wide and it is partially buried by seabed sediment from the east. The wreck is associated with a small magnetic anomaly suggesting it could be of partly metal construction.

8 Both cultural heritage assets are in close proximity to the proposed location of Wind Turbine 8 (maximum distance around 60 m not including foundation dimensions) and the possible inter-array cable routes between Wind Turbines 8 - 9, 8 – 11 and 8 – 5 (around 30 m at nearest points not including trenching dimensions).

9 No other specific wreck sites have been identified in the MSA through geophysical survey interpretation. A magnetic anomaly WA 7070 (potentially an unknown wreck/aircraft crash site) is situated close to the proposed location of Wind Turbine 3 (maximum distance around 40 m not including foundation dimensions).

18.2.2 Submerged Prehistory & Palaeo-landscape Potential

10 The shallow geological sequence underlying much of the survey area represents a prograding shoreline sequence and records changes in sea level in the area since the Last Glacial Maximum. This, makes it a potentially important palaeogeographical and palaeoenvironmental sequence in relation to local and regional patterns of early prehistoric coastal activity and now-submerged archaeological landscapes.

11 The sandy sediment type suggests that potentially important organic palaeoenvironmental indicators may not have been preserved and that prehistoric archaeological material if present and preserved could mainly be lithic in nature.

12 The nature of the local Mesolithic records of lithic scatters associated with coastal sand dunes directly adjacent to the MSA suggests there may be potential for encountering early prehistoric lithic finds in offshore sediments of Holocene age.

18.3 Impact Assessment

18.3.1 Impact Assessment Methodology

13 Cultural heritage receptors are a finite resource, they cannot recover following physical impacts upon them and the security of the context in which they are found is critical to their value and importance. A summary of the nature and type of impacts is given in Table 18.1.

14 The adverse and beneficial impacts affecting cultural heritage receptors can be seen to derive from three main activities during the lifetime of the proposed project. Primary impacts are products of the main activities occurring within the project and would derive from:

- installation of inter-array and export cabling and
- installation of wind turbine foundations

15 Secondary impacts are produced as a consequence of other impacts such as primary impacts and would derive from:

- the seabed footprint of attending vessels which may also cause impacts during construction, operation and decommissioning of the project

16 Both primary and secondary impacts can be direct or indirect. Direct impacts, as the name suggests, directly affect cultural heritage assets, eg excavation or compression of the seabed.. Indirect impacts, via an additional process or processes, affect cultural heritage assets, eg erosion of the seabed by turbulence induced by a seabed structure..

18.3.1.1 Impacts

TABLE 18.1 Summary of the Nature and Type of Impacts		
Impact	**Nature of Impact**	**Type of Impact**
Direct damage to both *in situ* cultural heritage assets and assets in secondary contexts	Adverse	Direct
Disturbance of relationships between structures, artefacts and their surroundings or contexts	Adverse	Direct
Destabilisation and erosion of sites through changes to seabed characteristics	Adverse	Indirect
Burial of sites due to re-deposited sediment, potentially protecting and promoting the favourable preservation of cultural heritage receptors	Positive	Indirect

18.3.1.2 Cultural Heritage Receptors

17 The Cultural Heritage Receptors examined in this study are presented in Table 18.2. Baseline conditions highlight the presence or potential of prehistoric, maritime and aviation archaeology

TABLE 18.2 Cultural Heritage Receptors defined for MSA by Theme		
Prehistoric Archaeology	**Maritime Archaeology**	**Aviation Archaeology**
Post-glacial submerged landscape features & fills	Known wreck sites	Unknown aircraft crash sites
Isolated prehistoric finds	Unknown wreck sites	

18.3.1.3 Sensitivity of the Receptor

18 The security of the context in which cultural heritage receptors are found is a key factor in assessing their value and importance. Generally impacts have adverse effects upon archaeological materials but some effects can be positive.

19 The sensitivity of the cultural heritage receptors is based on the definitions in Table 18.3. Cultural heritage receptors may be important for other reasons such as wartime significance (eg protected under the Protection of Military Remains Act 1986).

20 The terms used in the impact assessment are defined in Table 18.3. Where the importance or significance is unknown or cannot be clearly defined (eg for unknown distributions of prehistoric archaeological materials or unidentified wrecks), a precautionary approach is taken and receptors' archaeological potential, if adversely directly impacted, is assessed.

TABLE 18.3 Definition of Terms Associated with the 'Sensitivity of Receptor'	
Sensitivity	**Definition**
Very High	Feature of International Importance OR best known example and/or significant potential to contribute to knowledge and understanding and/or outreach.
High	Feature of National Importance OR above average example and/or high potential to contribute to knowledge and understanding and/or outreach.
Medium	Feature of Regional Importance OR average example and/or moderate potential to contribute to knowledge and understanding and/or outreach.
Low	Feature of Local Importance OR below average example and/or low potential to contribute to knowledge and understanding and/or outreach.

21 For some cases, a negligible significance of impact may be surmised in association with Table 18.5. In relation to cultural heritage assets this would be defined as a "poor example and/or little or no potential to contribute to knowledge and understanding and/or outreach".

18.3.1.4 Magnitude of Effect

22 The magnitude of effect is assessed relative to the worst realistic case and the impact of development upon specific or regional cultural heritage assets relative to baseline conditions. The terms are defined as shown in Table 18.4:

TABLE 18.4 Definition of Terms Associated with the 'Magnitude of Effect'	
Magnitude	**Definition**
Very High	Total loss or very major alteration to key elements/features of the baseline conditions such that post development character/composition/attributes would be fundamentally changed and may be lost from the site altogether.
High	Major alteration to key elements/features of the baseline (pre-development) conditions such that post development character/composition/attributes would be fundamentally changed.
Medium	Loss or alteration to one of more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline would be partially changed.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration would be discernible but underlying character/composition/attributes of baseline condition would be similar to pre-development circumstances/patterns.
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the 'no change' situation.

18.3.1.5 Assessment of Significance

23 Based upon these criteria a judgement on receptor's sensitivity and the magnitude of effect is made. The significance of impact is then derived from Table 18.3 and Table 18.4 and guided by the matrix shown in Table 18.5.

TABLE 18.5 Matrix for Significance of Impact					
	Sensitivity of Receptor				
Magnitude of Effect based on spatial, duration and scale of effect		**Very High**	**High**	**Medium**	**Low**
	Very High	Major	Major	Major	Moderate
	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

18.4 Impact Assessment

24 During construction, without mitigation there may be adverse impacts of moderate significance to currently unknown/unidentified prehistoric cultural heritage receptors - submerged landscape features and fills, and potentially to isolated prehistoric finds within the MSA from development activities associated with cable trenching and wind turbine foundations.

25 Without mitigation there may be impacts of major significance to maritime archaeology receptors, in particular known wreck sites.

26 In addition, secondary impacts to known wreck sites of potentially major significance may also occur during operation and decommissioning phases of the project. This is due to the close proximity of known wreck site WA 7071 to the proposed position of Wind Turbine 8 and inter-array cable routes.

27 Using a worst case approach there may be several direct effects upon cultural heritage assets WA 7071 (unidentified wreck) and WA 7072 (possible debris) of anthropogenic origin of archaeological interest by a gravity base structure, skirting and scour protection at the Wind Turbine 8 position and cable trenching between Wind Turbines 8 and 9 (maximum 10.38 m width x 3 m deep).

28 There may be several direct effects in particular locations within the MSA from multiple export cable routes (up to a maximum of four 10.38 m width x 3 m deep trenches). The exact location of these is currently not fixed within the indicative export cable corridor. In the seabed area between the MCA designated anchorage abutting the south of the MSA and the exclusion zone around the Black Dog rifle range to the north, the concentration of trenching would be greater, increasing the spatial extent of adverse effects upon cultural heritage receptors that may be present in a localised area.

29 As a precautionary mitigation strategy, 50 m exclusion zones (buffered around the visible extents of each cultural heritage asset) have been recommended for WA 7071 and WA 7072 (see Appendix 18.2 Figure 1). WA 7070 cannot currently be identified as an anthropogenic feature and therefore has not been given a precautionary exclusion zone. Avoidance, or further site examination to identify the archaeological importance of WA 7070, 7071 and 7072, is proposed.

18.4.1 Cumulative and In-combination Effects

30 There may also be cumulative effects upon cultural heritage assets within the MSA in association with the following activities:

- a potential Ocean Laboratory to the south of Wind Turbine 1
- Maritime and Coastguard Agency (MCA) designated anchorage area
- commercial fisheries activity
- subsea cables within the Blackdog Rifle Range exclusion zone
- port/harbour dredging operations

31 In-combination effects, in this case, are not applicable to cultural heritage assets only to European sites associated with the EU Habitats Directive.

32 Recent and future developments are subject to EIA and mitigation strategies derived during this process should effectively manage impacts to cultural heritage receptors.

33 Table 18.6 presents a summary of the assessment for adverse impacts and positive impacts, as outlined in Table 18.1.

TABLE 18.6 Impact Assessment				
Potential Impact / Receptors	**Significance Level**	**Mitigation**	**Residual Significance**	**Monitoring**
Construction – Cable Trenching, Wind Turbine Foundations & Secondary Impacts from Vessel Seabed Footprints – ADVERSE IMPACTS				
Post-glacial submerged landscape features & fills	Moderate	Avoidance, Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol
Isolated prehistoric finds	Moderate	Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol
Known wreck sites	Major	Avoidance, Research, reporting protocol	Minor / Negligible	Geophysical survey, ROV, finds reporting protocol
Unknown wreck sites	Minor	Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol
Unknown aircraft crash sites	Minor	Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol
Operation – Secondary Impacts from Vessel Seabed Footprints – ADVERSE IMPACTS				
Known wreck sites	Major	Avoidance, Research, reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol
Decommissioning – Secondary Impacts from Vessel Seabed Footprints – ADVERSE IMPACTS				
Known wreck sites	Major	Avoidance, Research, reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol
Construction – Cable Trenching & Wind Turbine Foundations – POSITIVE IMPACTS				
All receptors	Negligible	-	-	Geophysical survey, ROV, finds reporting protocol

18.5 Summary

34 Impacts to cultural heritage receptors have been assessed for the proposed EOWDC. The significance of adverse impacts to potential prehistoric archaeology receptors, isolated prehistoric sites and finds and submerged landscape features, are assessed to be moderate. Following mitigation the significance of impacts is likely to be minor.

35 Adverse impacts relating to the damage and disturbance of known cultural heritage assets have been identified primarily with respect to the unidentified wreck (WA 7071) in close proximity to Wind Turbine 8 and associated inter-array cable routes between Wind Turbines 8 and 9, 8 and 11 and 8 and 5 (Figure 18.1). Without mitigation adverse impacts to this heritage asset are likely to be major. With mitigation, impacts may be avoided or significantly reduced.

36 Further research and site inspection of this feature may be an effective method for ascertaining the archaeological importance of this unidentified wreck and ultimately the most appropriate methods for impact mitigation.

37 The significance of adverse impacts to potential maritime archaeology and aviation archaeology receptors – unknown wreck sites and unknown aircraft

crash sites – are assessed to be moderate. Following mitigation the significance of impacts is likely to be minor.

38 Avoidance, where practicable, is the preferred mitigation strategy for known cultural heritage assets. Minor amendments to the position of cable trenching and the configuration or placement of the foundation of Wind Turbine 8 have been outlined.

39 There is potential for encountering previously unknown archaeology in the. Strategies have been proposed to mitigate adverse impacts to these receptors.

40 Research, particularly the geoarchaeological examination of vibrocores and grab samples from sub-seabed sediments, taken for engineering or other development purposes provides a cost-effective mitigation strategy to directly investigate the age and archaeological potential of sub-seabed sediments of potential prehistoric archaeological importance. The integration of this kind of geoarchaeological analysis early in the sequence of development activities is advisable to provide the most effective mitigation strategy (Gribble and Leather 2011).

41 Monitoring may be achieved through remote means such as geophysical or ROV survey. In addition, The Crown Estate has recently published a reporting protocol for finds from offshore developments (The Crown Estate/Wessex Archaeology 2010). Best-practice and effective monitoring may be partly achieved by implementing this protocol. Added value would also be provided to the National Monuments Record.

18.6 References

COWRIE, 2008, '*Guidance for Assessment of Cumulative Impacts on the Historic Environment; from Offshore Renewable Energy*', Commissioned by COWRIE ltd project reference CIARCH-11-2006). Project contractors: Oxford Archaeology with George Lambrick Archaeology and Heritage.

Gribble, J., and Leather, S., for EMU ltd, '*Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector'*, Commissioned by COWRIE ltd (project reference GEOARCH-09).

JNAPC, 2006. *Code of Practice for Seabed Developers*. Joint Nautical Archaeology Policy Committee.

The Crown Estate/Wessex Archaeology, 2010, *'Protocol for Archaeological Discoveries: Offshore Renewables Projects*', The Crown Estate.

Wessex Archaeology Ltd, 2007, '*Historic Environment Guidance for the Offshore Renewable Energy Sector*', Commissioned by COWRIE ltd (project reference ARCH-11-05).

European Offshore Wind Deployment Centre
Environmental Statement

Chapter 19: Seascape, Landscape and Visual

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

19 SEASCAPE, LANDSCAPE AND VISUAL

19.1 Introduction

1 The Seascape, Landscape and Visual Impact Assessment (SLVIA) considered the potential effects that the European Offshore Wind Deployment Centre (EOWDC) would have on the existing seascape, landscape, and visual environment. This assessment was conducted by LDA Design. The purpose of the assessment was to determine the sensitivity, magnitude, and therefore significance of any change to the character of the regional seascape, landscape, and any areas of designated landscapes. The potential effect upon views, visual amenity and receptor groups within the overall Zone of Theoretical Visibility (ZTV) was also assessed. The cumulative seascape, landscape, and visual effects of the proposed development with the existing, consented and in-planning wind farms were also assessed for the study area.

2 The following technical reports support this chapter and can be found as:

- SLVIA Baseline Technical Report (Appendix 19.1)
- SLVIA Environmental Impact Assessment Technical Report (Appendix 19.2)
- SLVIA Figures and Visualisations (Appendix 19.3)

19.1.1 Methodology Consultation

3 Consultation to agree upon the assessment methodology and a number of other important parameters regarding the scope of the SLVIA took place with Scottish Natural Heritage, Aberdeen City Council, and Aberdeenshire Council. The Baseline Report (Appendix 19.1) provides a summary of the key stages of consultation and also provides a detailed record of all consultation which took place on the SLVIA throughout the project.

19.1.2 Key Guidance Documents

4 Key guidance documents that have informed the SLVIA include:

- Maritime Ireland/Wales Interreg 1994 – 1999 Guidance ‘Guide to Best Practice in Seascape Assessment’ (GSA), published in March 2001
- ‘An assessment of the sensitivity and capacity of the Scottish Seascape in relation to wind farms’, (SNH commissioned Report 103, 2005)
- Guidance on the Assessment of Effect of Offshore Wind Farms: Seascape and Visual Effect Report (DTI – November 2005)
- Guidelines for Landscape and Visual Effect Assessment (Institute of Environmental Management and Assessment (IEMA) and the Landscape Institute’s (LI), second edition 2002)
- Visual Representation of Windfarms Best Practice Guidance (SNH 2006, albeit published in 2007)
- Cumulative Effects on Windfarms, (SNH, 2005)
- Siting and Designing Windfarms in the Landscape (SNH, December 2009)

19.1.3 Data Information and Sources

5 The list below records the main survey information that was used in this assessment. Site visits in April 2010 and October 2010 were also undertaken to establish the baseline and assessment work was carried out on site in February 2011.

- SNH (1977) Beaches of Northeast Scotland
- SNH (1994) Banff and Buchan Landscape Assessment
- SNH (1996) Landscape Character Assessment of Aberdeen
- SNH (1998) South and Central Aberdeenshire Landscape Character Assessment

19.2 Baseline Assessment

6 A 40 km radius study area was agreed with the consultees. This area includes a large part of Aberdeenshire which extends along the coast from Kinneff, south of Stonehaven to Crimond, near Peterhead in the north, and inland to the Grampian Mountains (see Figure 19.1). The city of Aberdeen is the main settlement within the study area on the North Sea coast approximately 5 km south-west at its closest point to the proposed EOWDC wind turbines. Stonehaven and Peterhead are the main coastal towns within the study area and Ellon, Inverurie and Banchory are the main inland towns.

7 The baseline landscape, seascape and visual environments within the 40 km radius study area have been defined and sensitivity to the type of development proposed assessed. Sensitivity to change is assessed for seascape/landscape receptors such as regional seascape units, designated areas and landscape character areas, and for visual receptors (people) at agreed viewpoints. It provides an indication of the sensitivity of those receptors to the development proposed.

8 Sensitivity is assessed for each receptor type on the following scale. A full description of the sensitivity methodology can be found in the Baseline Technical Report (Appendix 19.1).

- high – material effects are likely to arise from a development of this nature
- medium – material effects may arise from a development of this nature
- low - material effects are unlikely to arise from a development of this nature

9 Within the study area there are no national designated landscapes except for a number of Gardens and Designed Landscapes (GDLs). Please refer to the Chapter 20 Cultural Heritage for discussion on these and other historical landscape features. Local landscape designations include Areas of Landscape Significance (ALS) which cover a large proportion of the coast line and inland areas adjacent to the Cairngorms (see Figure 19.2). The closest of these to the EOWDC lies between Balmedie and Longhaven and has a high sensitivity to the type of proposed development.

10 Six seascape units were defined from Inverbervie to Fraserburgh with varying sensitivities towards the proposed development (see Figure 19.3). The north part of Aberdeen Bay at Forvie Sands has the highest sensitivity, assessed at

High to Medium, due principally to the remote and unspoilt dune landscape. This sensitivity is reduced to some degree by the presence of nearby existing wind turbines, and views of the developed seafront at Aberdeen.

11 The sensitivity of the landscape character areas within the 40 km radius study area was also assessed. The landscape character types and areas are identified on Figures 19.4 and 19.5. Those character areas from which views out to the sea and coastline are a key characteristic have the highest sensitivity. This includes the higher Moorland Plateau character types at the furthermost extents of the study area, Hills surrounding Aberdeen, and the Open Farmland and Agricultural Heartlands adjacent to the coastline.

12 The visual baseline identified key receptors of residents, travelling public (including sea travel), and visitors and tourists. Twenty representative viewpoints were selected through the consultation process from which the effects upon visual receptors was assessed (please see Figure 19.6 for viewpoint locations). The sensitivity to the proposed development of the main identified visual receptor group at each viewpoint is described in the Baseline Report (Appendix 19.1). Fifteen of the viewpoints are located within 15 km of the site, with seven of these in and around Aberdeen. Those with highest sensitivity to the proposed development are those viewpoints where residents or visitors are the key visual receptors. This includes viewpoints at Balmedie Beach, Aberdeen Beach, Forvie Nature Reserve, Udny Station, near Netherley, and near Slains Castle. Photographic panoramas of each viewpoint are presented in Appendix 19.3.

19.3 Impact Assessment

19.3.1 Impact Assessment Methodology

13 The full assessment methodology is set out in the Baseline Technical Report (Appendix 19.1) and a brief summary of the methodology used to assess impacts is discussed below.

14 The magnitude of effect is assessed for all seascape, landscape and visual receptors and identifies the degree of change arising as a result of the proposed development. It is rated on the following scale:

- high – total or major alteration to key elements, features or characteristics, such that post development the baseline situation would be fundamentally changed
- medium - partial alteration to key elements, features or characteristics, such that post development the baseline situation would be noticeably changed
- low – minor alteration to key elements, features or characteristics, such that post development the baseline situation would be largely unchanged despite discernable differences; and
- negligible – very minor alteration to key elements, features or characteristics, such that post development the baseline situation would be fundamentally unchanged with barely perceptible differences

15 The process of forming a judgment regarding the significance of any potential effect is based upon the site assessment of magnitude of effect which is then correlated with the sensitivity of the receptor to come to a professional

judgment as to how important this effect is in enabling others to come to a decision as to whether consent should be granted. This judgment is illustrated in Table 19.1:

Table 19.1 Matrix for Significance of Impact				
	Magnitude of Effect			
Sensitivity of Receptor	Negligible	Low	Medium	High
High	Negligible	Moderate	Major-Moderate	Major
Medium	Negligible	Moderate-Minor	Moderate	Major-Moderate
Low	Negligible	Minor	Moderate-Minor	Moderate

19.3.2 Seascape and Landscape Effects

16 The scale and extent of the proposed EOWDC, located just over 2 km east off the Aberdeenshire coast, would inevitably affect the surrounding seascape and landscape environments. The primary source point of the effects would be the 11 wind turbines. Whilst the assessment also considered construction and decommissioning effects, the SLVIA is primarily concerned with the operational effects as these have the most potentially significant effects due to the duration of this stage.

17 The proposed EOWDC site would be located within the Aberdeen Bay regional seascape unit which would thus carry the greatest effect arising from the EOWDC development. The EOWDC would be a prominent feature within the seascape unit and would become a defining characteristic. However, the scale of the seascape unit and the presence of existing prominent man made elements would assist to some extent with containing the overall extent of the effect locally to major to major-moderate in the north to major-moderate in the south of the seascape unit.

18 Given the distance between the proposed site and the coastline, the wind turbines would also be theoretically visible from five other regional seascape units and would thus have a degree of effect upon the visual attributes of their character. A combination of distance, the nature and scale of these units; and the fact that effects are confined to visual influence only, will, however, assist with limiting the overall extent of effect to major-moderate to moderate at Aberdeen Beach and no more than moderate in the remaining seascape units.

19 Whilst there would be no direct effects upon their physical character, the landscape character areas defined for the study area would also experience a range of effects on their visual characteristics. The most significant effects of major-moderate to moderate would be upon the Perwinnes Open Farmland and major-moderate to moderate to moderate-minor on the Formartine Lowlands which both lie adjacent to the coastline where views across the sea are a key characteristic. The more elevated inland character areas encompass far ranging and expansive views within which the EOWDC would be a noticeable, but not dominant, element and therefore would not result in any significant effects.

20 The EOWDC would have a major to negligible indirect effect on the Area of Landscape Significance which lies along the coast from Balmedie to Longhaven due to its proximity to the proposed wind turbines, which at its closest is 3 km. However, significant effects would reduce to negligible further north within this ALS.

19.3.3 Visual Effects

21 The proposed 11 wind turbines have a maximum nacelle height of 120 m above lowest astronomical tide (LAT), with a maximum height to blade tip of 195 m. They would be seen, both individually and collectively, as large visual elements set within a simple open setting comprised predominantly of sea, coastal edge and sky. As the wind turbines would be sited close to land, from within the wider study area, where visible, they would be seen both with and without the sea context, rising above the predominantly undulating landscape. The wind turbines would also be seen, admittedly by a far fewer number of visual receptor groups, in views from the sea where they would be seen against a backdrop of either the Aberdeenshire deposition coastline with farmland behind or against Aberdeen city and Girdle Ness headland.

22 The Zone of Theoretical Visibility (ZTV) (see Figure 19.7) illustrates that visual effects arising from the offshore wind turbines would be greatest when seen in views within an approximately 15 km radius of the site and for areas extending north along the coast from where clear views of the EOWDC are possible. This is also demonstrated by the assessment of significant effects at nine of the fifteen viewpoints which lie within 15 km of the EOWDC. Appendix 19. 3 provides wireframes and photomontages of each viewpoint. Inland, theoretical visibility is highest primarily to the north and north-west of the site in the more open gently undulating farmland. The city and its suburbs, combined with the more pronounced landform to the south and west limit views of the EOWDC within these areas of Aberdeenshire.

23 The visual effects would ease considerably with distance from the site. However, given the size of the wind turbines, they would still be a noticeable, but not significant, feature from the northern coastline at distances of over 20 km away. The landform and components of the landscape at this distance obscure or reduce the prominence of the wind turbines so that they become a minor element in the view. The magnitude and extent of visual effects is also reduced by distance as the proposed development would be seen to shift from being the main focus of view to occupying a more peripheral or oblique position within the field of view.

24 The visual impact on Aberdeen is limited by the densely built up nature of a city. Only in the more open elevated areas of the city are the wind turbines likely to be clearly visible, and then they would be seen within a busy and dynamic cityscape.

25 The significance of effect for Local Residents within close proximity to the EOWDC (approximately 3 km) is judged as major where properties are orientated towards the sea and direction of the proposed wind turbines.

26 Other land receptor groups include the visitors and walkers of the Coastal Path where the significance of effect would be major to major-moderate along those parts of the path in close proximity to the EOWDC, reducing to negligible with distance.

27 Any significant visual effects on receptors within the sea would be temporary due to the generally transient nature of views available from marine vessels making passage. There would, however, be overall moderate effects on those receptors out at sea, such as recreational sailors, who have an interest and enjoyment in the surrounding seascape.

19.3.4 Cumulative Effects

28 The assessment of cumulative effects found that, due to the offshore location of the EOWDC and the fact that the majority of the many wind farms within Aberdeenshire are beyond 20 km from the site, the combined and successional cumulative effects were mostly minor or negligible and no more than moderate in significance for visual, seascape and landscape cumulative effects. Appendix 19.3 provides cumulative ZTVs and cumulative wireframes from a selection of the viewpoints.

29 As a consequence of being the closest wind farm (11-19 km) to the EOWDC, the existing and consented Hill of Fiddes, Ardgrain, Tillymaud, and Mains of Bogfechel wind turbines and the in-planning Woodlands Farm and Hill of Fechel are the most frequent wind farms to be seen in theoretical views with the EOWDC. However, these wind farms are approximately half the height of EOWDC and with only between one and three wind turbines, they have a relatively confined visual envelope which reduces the cumulative effect.

30 Although there are no significant combined cumulative effects, the sequential cumulative effects (ie those seen by the travelling public) of EOWDC are potentially greater given the large number of wind farms within the study area.

31 The sequential cumulative assessment from the main roads within the study area showed that the EOWDC would potentially extend the visibility of turbines further than currently exists along the A90 and A96 thus creating localised moderate to moderate-minor sequential effects. Along the other roads studied, the EOWDC would become part of an existing sequential effect and not significantly add to it due to distance and angle of view.

19.3.5 Construction and Decommissioning Stages

32 During the construction phase the effect of increased activity of construction vessels travelling to the site, the presence of jack-up barges and the progressive construction of the wind turbines would constitute the main effect, albeit temporary. During this phase there would be some minor effects on the surrounding seascape. There would also be minor effects on the associated visual receptors and general visual amenity during construction operations which, although temporary, may be more significant than during the operational stages due to the increase in activity and vessel movements. The existing baseline of marine activity in the area helps to moderate impacts to some degree.

33 During the decommissioning phase, there would also be visual effects associated with the decommissioning activity. This would be similar to that of the construction phase and relatively insignificant as there is an existing baseline of marine activity in the area. As the anticipated length of decommissioning would be slightly less than for the construction phase, these impacts would be more temporary than for the construction period. Following

the decommissioning stage there would be no residual effects on the seascape, landscape or visual receptors.

19.3.6 Overview

34 Table 19.2 summarises the potential seascape, landscape and visual impacts which have been assessed as major or major-moderate, and also the associated cumulative impacts. The inherent characteristics of the EOWDC suggest that there are very limited opportunities for incorporation of mitigation measures although the scheme has been designed to minimise the risk of aesthetically visually uncomfortable arrangements.

TABLE 19.2 **Summary of Impacts**		
Receptor	**Significance of Effect**	**Significance of Cumulative Effect**
Regional Seascape Units		
Aberdeen Beach	**Major-Moderate to Moderate**	Moderate/Minor to Negligible
Aberdeen Bay	**Major-Moderate (south)** **Major to Major-Moderate (north)**	Moderate-Minor to Negligible (south) Moderate to Moderate-Minor to Negligible (north)
Aberdeenshire and Banff & Buchan LCA		
Formartine Lowlands	**Major-Moderate to Moderate to Moderate-Minor**	Moderate to Moderate-Minor
Aberdeen LCA		
Perwinnes	**Major-Moderate to Moderate**	Moderate-Minor
Areas of Landscape Significance		
Balmedie to Longhaven	**Major in close proximity to the site reducing to Negligible with distance.**	Moderate
Visual Effects		
Vpt 1 Balmedie Beach	**Major**	None
Vpt 2 A90 (Harehill)	**Major-Moderate to Moderate**	None
Vpt 4 B999 Whitecairns	**Major-Moderate (residents)**	None
Vpt 5 Aberdeen Beach	**Major to Major-Moderate**	None
Vpt 7 Torry Battery	**Major to Major-Moderate to Moderate**	Negligible
Vpt 9 Forvie Nature Reserve	**Major-Moderate**	None
Vpt 12 Kincorth Hill	**Major-Moderate to Moderate**	Negligible
Vpt 13 Udny Station	**Major-Moderate to Moderate**	Moderate
Vpt 15 Brimmond Hill	**Major-Moderate to Moderate**	Moderate to Moderate-Minor
Visual Receptor Groups		
Local Residents	**Major (within close proximity to the site)**	None
Travelling Public – Coastal Path	**Major to Major-Moderate reducing to Moderate-Minor to Negligible with distance**	Negligible
Travelling Public - Ferry	Moderate/Minor to Minor (overall) **Major-Moderate to Moderate (only when passing in close proximity)**	Negligible
Recreational Sailing	Moderate (overall) **Major-Moderate (only when passing in close proximity)**	Negligible
Sequential Effects on Roads		
A90	**Major-Moderate to**	Moderate to Moderate/Minor

TABLE 19.2 Summary of Impacts		
Receptor	**Significance of Effect**	**Significance of Cumulative Effect**
	Moderate within approximately 5 km	

19.4 Summary

35 Upon evaluation, the seascape, landscape, visual, and cumulative effects arising from the proposed EOWDC development have not been found to be inappropriate, although they would fundamentally change the character of the Aberdeen Bay seascape and views from the nearby coastline within approximately 15 km. Where visibility permits beyond this distance, the EOWDC wind turbines would be a noticeable but increasingly minor feature in views. Offshore, the EOWDC would be a visible feature for a considerable distance across the expansive open sea and would thus provide an identifiable focal point and visual reference within the maritime setting. It should also be considered that the nearby city and harbour, designated anchorage area, airport and heliport, and oil industry related activities such as the demonstration drilling platform, provide an environment where the EOWDC would not be an incongruous addition ie vessels are a common feature on the Aberdeen Bay seascape.

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 2: Site Selection

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

2 SITE SELECTION

2.1 Site Selection

1 The European Offshore Wind Deployment Centre (EOWDC) site location has been determined through a long process of examining the constraints, undertaking consultations, and conducting surveys, studies and assessments.

2 The concept of an offshore wind farm in Aberdeen originated in 2002 following approach by AREG to AMEC Wind Energy. The concept of a Renewable Energy Centre in Aberdeen was discussed and included an onshore wind turbine and a number of offshore wind turbines. AMEC Wind Energy began to look at an offshore layout stretching up the coastline and initial visualisations were carried out by the Macaulay Institute.

3 Aberdeen Bay was considered suitable for development as it is capable of providing ideal conditions, for example:

- wind speeds likely to be in excess of 8 metres per second (m/s) at 60 m
- water depth consistent with commercial offshore developments
- not directly inside any area designated for nature conservation (see Figure 2.1) although consideration given to areas nearby
- not within a major international shipping route but consideration given to the maritime industry in the area (see Figure 2.2)
- proximity to electricity transmission network

4 A joint venture was formed in 2005 in the proportions AMEC 75 % and AREG 25 %. With the sale of AMEC Wind Energy to Vattenfall, the joint venture now comprises Vattenfall Wind Power Ltd 75 % and AREG 25 %. The company AOWFL has a board of directors drawn from the two constituent organisations.

5 The wind farm layout has undergone a number of alternative iterations from 2004 to 2010 which are described in Table 2.1 and shown on Figure 2.3 and Figure 2.4. These alternative layouts have primarily been a result of consultation with Aberdeen Harbour Board, the aviation industry, the Ministry of Defence and key environmental stakeholders.

6 In 2005, a Scoping Opinion was sought on a wind farm development layout which was located approximately 1 km from the Aberdeenshire coast (See LABER007 Figure 2.3, Frame 2). This site comprised an area following the coastline between Girdle Ness and Newburgh, with the study area for development covering approximately 26 km^2. It was proposed that the wind turbines would be aligned in two rows either side of the 10 m water depth contour. The wind farm at that time comprised approximately 33, three-bladed wind turbines, with an individual wind turbine capacity of up to 5 MW.

7 The current layout (LABER039) comprises 11 wind turbines located approximately between 2 and 4.5 km offshore, see Figure 1.2. This layout has been driven by both biological and human constraints as identified on Figures 2.1 and 2.2 these are primarily:

- proximity to designated sites
- helicopter routes to the north
- coastal bird populations to the west

- shipping to the east
- proximity to Aberdeen Harbour to the south

8 Aberdeen is ideally placed, both in terms of location and supply chain expertise, to drive offshore renewable technologies forward and the EOWDC would be the focal point for the next phase of development for this world-renowned energy industry hub.

TABLE 2.1 Site Layout Iterations			
Internal Layout Reference	**Number of Wind Turbines**	**Date**	**Wind Turbine Layout Description**
LABER002	18	October 2004	Initial layout (based on 10 m water depth constraint) extended north to Newburgh Bar and increased indicative rotor diameter to 120 m and separation between wind turbines to suit.
LABER007	33	February 2005	Layout followed the coastline between Girdle Ness and Newburgh. Two rows of wind turbines were designed to be aligned either side of the 10 m water depth contour. This is the layout included in the previous Scoping Report 2005.
LABER008	24	September 2005	Similar to LABER007, this layout follows the coastline between Girdle Ness and Newburgh. There are two distinct groups, a northern one and a southern one, with a gap in the middle to accommodate a 4 nm helicopter corridor (Shrub – Balis). Both groups have three columns of wind turbines. Outer wind turbines now in water depths up to 20 m. Layout created for discussion.
LABER011	23	January 2006	Updated aviation constraints (including Bridge of Don alternative route) were used to create this layout along with a water depth limit of 25 m. Layout wind turbines have a 120 m rotor diameter. Layout created for discussion.
LABER012	10	September 2008	From the previous layout, the columns closest and furthest from the shore were both removed (for bird and shipping interests) along with the two northern most wind turbines of the remaining 12 (for Black Dog Firing Range impact), leaving 10 wind turbines. Layout submitted to the Ministry Of Defence for re-assessment.
LABER015	10	March 2009	Wind turbine locations similar to subset of LABER011. Wind turbine locations differ slightly due to increased separation to accommodate a 126 m rotor diameter. Created with the intention of a 10 wind turbine layout not extending as far south as LABER012, in order to avoid Bridge of Don alternative helicopter corridor constraint.
LABER021	15	September 2009	Layout created based on LABER015. Five wind turbines added in total. Two coastal wind turbines removed, extra row added to south (but outside helicopter constraint) and three wind turbines added as eastern column. One wind turbine added into the Black Dog Firing Range giving a total of two in this area.
LABER027	12	October 2009	Layout based on new internal agreed list of constraints: - outside existing northern and alternative southern helicopter constraints - within geophysical survey area

TABLE 2.1
Site Layout Iterations

Internal Layout Reference	Number of Wind Turbines	Date	Wind Turbine Layout Description
			- outside of MoD Black Dog Firing Range - no closer to coast than layout LABER021. Layout designed to consider multiple rotor diameters of 90 m, 126 m and 150 m so that outer row accommodates largest rotor diameter. The layout was limited by the necessary spacing between wind turbines. Layouts LABER022 to 026 informed this layout through several variations for discussion.
LABER028	11	November 2009	Following a response from the MoD the wind turbine which was located within the MoD Black Dog Firing Range was removed.
LABER032	16	April 2010	Following further consultation with NATS, it became apparent that there is a possibility of moving the northern helicopter route further north allowing room for two more wind turbines at the north of the site. Also three wind turbines were added to the east of the site as the geophysical survey boundary constraint was relaxed due to this expansion to the north. The decision to have wind turbines beyond the geophysical survey boundary was driven by desire to increase distance from Aberdeen Harbour.
LABER033	11	April 2010	The six southernmost wind turbines were removed to increase distance from the harbour and shipping. The entire site was slightly shifted down to accommodate an extra wind turbine to the north of the site such that it doesn't lie within the helicopter constraint.
LABER034	11	April 2010	Entire layout was rotated using northernmost wind turbine as a turning point to align the rows of wind turbines to the proposed realigned helicopter constraint. Layout created for discussion.
LABER037	12	April 2010	New layout based on latest constraints of revised northern helicopter route, MoD Black Dog Firing Range and maintaining a distance from the harbour similar to LABER036. Layout is a regular grid of 3 rows and 4 columns of wind turbines.
LABER039	11	April 2010	Removed the easternmost wind turbine of LABER037 to increase distance from shipping routes.

European Offshore Wind Deployment Centre
Environmental Statement

Chapter 20: Cultural Heritage

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

20 CULTURAL HERITAGE

20.1 Introduction

1 This chapter of the Environmental Statement (ES) considers the potential impact of the EOWDC upon the setting of nationally important onshore cultural heritage assets. The assessment was undertaken by Headland Archaeology. The cultural significance of cultural heritage assets is often tied to their relationship with their surroundings; consequently development may affect the significance of an asset without affecting its physical fabric by degrading the contribution of setting. This chapter assesses the potential for setting impacts to occur as a result of the EOWDC.

2 The following technical reports support this chapter and can be found as:

- Cultural Heritage Baseline Technical Report (Appendix 20.1)
- Cultural Heritage Environmental Impact Assessment Technical Report (Appendix 20.2)

20.1.1 Methodology Consultation

3 The following consultation was undertaken

- Aberdeen City Council
  Aberdeen City Council was approached in order to establish whether they had specific concerns or requirements for data to be provided, in particular visualisations. Comments were also invited upon the proposed scope of the assessment.

  Robert Forbes, The Planning Officer, indicated that he did have some concern regarding potential impacts upon the setting of Girdle Ness Lighthouse, and requested that visualisations from elevated points to the south and south-west of the lighthouse should be provided in order to help assess the potential impact upon views of the lighthouse.

  The potential impact upon the setting of the lighthouse has been assessed using wireframes and a site visit. The wireframes presented with this report are photographs illustrating various views of the lighthouse. However, photomontages have not been prepared. The wireframes give an adequate demonstration of the scale of the wind turbines in relation to the lighthouse in views from the south, whilst the photomontages for the Torry Battery and Kincorth Hill viewpoints (SLVIA Viewpoints 07 & 12 respectively) provide an indication of the EOWDC's appearance from the vicinity of the lighthouse and from high ground to its southwest. The inclusion of photomontages for Nigg Bay would not afford any substantive information that is not available from that presented here.

  The Archaeology Unit indicated that all consultation was to be undertaken through the Planning Officer.

- Aberdeenshire Council Archaeology Service
  Aberdeenshire Council Archaeology Service was approached in order to establish whether they had specific concerns or requirements for data to

be provided, in particular visualisations. Comments were also invited upon the proposed scope of the assessment.

The Archaeology Service indicated that it had no concerns regarding potential setting impacts.

- Historic Scotland
  Historic Scotland was approached in order to establish whether they had specific concerns or requirements for data to be provided, in particular visualisations. Comments were also invited upon the proposed scope of the assessment.

  No specific concerns were noted. However, it was suggested that the assessment be accompanied by visualisations to illustrate the potential impact upon the setting of Straloch Garden and Designed Landscape (GDL), Hare Cairn and Forvie Chruch and deserted village, as well as those proposed for the Seascape, Landscape and Visual Impact Assessment (SLVIA) for Dunnottar Castle and Torry Battery. It was suggested that assets in the vicinity of Straloch GDL, such as Tillygreig hut-circles (SM2450) be considered.

  Visualisations have been included for Torry Battery (Viewpoint 07 of SLVIA) and from near Forvie Church (Viewpoint 09 of SLVIA). No visualisations have been presented for Straloch GDL or Dunnottar Castle, as there is no intervisibility, or Hare Cairn or Tillygrieg hut-circles, as there is no potential for a significant impact upon its setting from the EOWDC.

- Scottish Natural Heritage (SNH)
  SNH was approached in order to establish whether they had specific concerns or requirements for data to be provided, in particular visualisations. Comments were also invited upon the proposed scope of the assessment (e-mail dated 1st March 2011). SNH had indicated early in the project's lifespan that impacts upon the setting of cultural heritage assets should be considered by the Environmental Statement (ES).

  SNH indicated that the proposed scope of the study was acceptable (e-mail dated 25th March 2011) and did not require any further visualisations.

20.1.2 Key Guidance Documents

4 The following guidance documents have been referred to:

- COWRIE (2007a) Historic Environment Guidance for the Offshore Renewable Energy Sector
- COWRIE (2007b) Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy
- Historic Scotland (2008) Scottish Historic Environment Policy (SHEP)
- Historic Scotland (2009) Assessment of Impact upon the setting of the Historic Environment Resource
- Historic Scotland (2010) Managing Change in the Historic Environment: Setting

20.1.3 Data Information and Sources

5 Two concentric study areas have been used to gather and present the baseline data:

- Inner study area (Figures 20.1, 20.2, and 20.3): This extends 10 km from the outermost proposed wind turbines. Within it data have been gathered for all designated nationally important assets (scheduled monuments, Category A listed buildings and Inventory Gardens and Designed Landscapes (GDL)) and conservation areas; and
- Outer study area: this extends 40 km from the proposed wind turbines to take in the area for which the Zone of Theoretical Visibility (ZTV) has been prepared for the Seascape, Landscape and Visual Impact Assessment (SLVIA). Within it assets specifically identified by consultees as being of concern have been considered.

6 There is no guidance regarding appropriate study areas for cultural heritage setting impact assessments. The study area has been defined in order to take in those assets that are most likely to be affected by the proposed development. Assets further inshore are less likely to be affected as their setting is less likely to relate to the sea.

7 Data were gathered from the following data sources:

- Databases of designated assets held by Historic Scotland
- National Monuments Record of Scotland (NMRS)
- Aberdeen City Council Sites and Monuments Record (SMR); and
- Aberdeenshire Council Historic Environment Record (HER)

8 The results of the desk-based study were augmented by site visits undertaken on 8th and 9th March 2011.

20.2 Baseline Assessment

9 The baseline assessment considered all nationally important cultural heritage assets within the inner study area. Assets in the outer study area were considered where raised by consultees.

10 It was established that there are 18 scheduled monuments (Figure 20.1), 86 Category A-listed buildings (though there are only 62 individual listings (Figures 20.2 & 20.3) and ten conservation areas within the inner study area (Figure 20.4). In the outer study area Straloch Inventory Garden Designed Landscape (GDL) (Figure 20.4), Dunnottar Castle, Tillygrieg hut-circles, Baron's Cairn, Cat Cairn and Loirston cairn (Figure 20.1) were considered.

11 The baseline assessment established that there is no potential for impacts upon the setting of all but two of the listed buildings: Orrok House and Girdle Ness Lighthouse. There is no potential for impacts upon nine of the scheduled monuments in the inner study area. Also there is no potential for impacts upon the setting of the ten conservation areas, Straloch or Dunnottar Castle. Fourteen assets have been taken through to the assessment phase. Assets not taken through to assessment are listed in Appendix 20.1.

20.3 Impact Assessment

12 The impact assessment methodology is detailed in Appendix 20.2.

13 Potential impacts of greater than negligible significance have been identified in five cases. Potential impacts upon Hare Cairn, the Peaterseat cairns, Torry Battery and Orrok House have been assessed as being of minor significance and those upon Girdle Ness Lighthouse as being of minor to moderate significance. The assessment is detailed in Appendix 20.2. For the remaining 8 assets, it was concluded that the EOWDC would have negligible impact on their setting.

14 The impacts would commence during the construction phase and would persist through the lifetime of the EOWDC, ceasing upon decommissioning.

15 The potential for cumulative impacts has been considered resulting from the Ocean Laboratory being added to the EOWDC. No potential cumulative impacts have been identified.

TABLE 20.1
Summary of Impact Assessment

Potential Impact	Significance Level	Mitigation	Residual Significance	Monitoring
Impact upon the setting of Torry Battery	Minor	None proposed	Minor	None proposed
Impact upon the setting of Orrok House	Minor	None proposed	Minor	None proposed
Impact upon the setting of Girdle Ness Lighthouse	Minor to Moderate	None proposed	Minor to Moderate	None proposed
Impact upon setting of Peterseat cairns	Minor	None proposed	Minor	None proposed
Impact upon setting of Hare Cairn	Minor	None proposed	Minor	None proposed

20.4 Summary

16 The cultural heritage impact assessment has identified potential impacts upon the setting of five nationally important cultural heritage assets: the scheduled Torry Battery, Peterseat cairns and Hare Cairn and the A-listed Orrok House and Girdleness Lighthouse. The impacts upon Torry Battery, the Peterseat cairns, Hare Cairn and Orrok House have been assessed as being of minor significance and those upon Girdle Ness Lighthouse as being of minor to moderate significance. No mitigation is proposed in relation to these impacts and they would persist throughout the lifetime of the EOWDC and cease upon decommissioning.

European Offshore Wind Deployment Centre
Environmental Statement

Chapter 21: Commercial Fisheries

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

21 COMMERCIAL FISHERIES

21.1 Introduction

1 This section of the Environmental Statement (ES) summarises the assessment of the potential impacts on commercial fishing from construction, operation and decommissioning of the proposed European Offshore Wind Deployment Centre (EOWDC). For the purpose of this study, commercial fishing is defined as any legal fishing activity undertaken for declared taxable profit. Brown and May Marine have undertaken this commercial fisheries assessment.

2 The following technical reports support this chapter and can be found as:

- Commercial Fisheries Baseline Technical Report (Appendix 21.1)
- Environmental Impact Assessment Technical Report (Appendix 21.2)

21.1.1 Methodology Consultation

3 Consultation with local stakeholders was undertaken by the Scottish Fishermen's Federation (SFF) between 2008 and 2010, particularly with the skippers of the vessels which were identified to fish in the area of the development. In addition, the local District Fisheries Officer provided valuable information for this assessment.

4 The individuals and organisations consulted were:

- Aberdeen District Fisheries Office (281010)
- Fisheries Research Services (211107)
- Scottish Fishermen's Federation (211107)
- Sid McLean – Boy Paul – Peterhead (170111)
- Ricky Greenhowe – Skua II- Aberdeen (170111)
- John Anderson – Tern – Aberdeen (170111)
- Stuart Willox – Maddie Marie – Peterhead (170111)
- Scottish Inshore Fish Producers Association (December 2007 &150211)

21.1.2 Key Guidance Documents

5 The key guidance documents used for both the baseline and impact assessment are as follows:

- Offshore Wind Farms, Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements - Version 2; Cefas, MCUE, Defra, DTI, June 2004
- Strategic Environmental Assessment (SEA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Volume 1: Environmental Report; Marine Scotland 2010
- UK Offshore Energy – Strategic Environmental Assessment; DECC, January 2009
- Recommendations for Fisheries Liaison; FLOW, May 2008
- Fisheries Liaison Guidelines – Issue 5; UK Oil & Gas, 2008
- Guidelines to Improve Relations between Oil & Gas Industries and Near-shore Fishermen, UKOOA (renamed UK Oil & Gas), August 2006

- Fishing & Submarine Cables – Working Together, International Cable Protection Committee (CPC), February 2009
- Options and Opportunities for Marine Fisheries Mitigation Associated with Wind farms, COWRIE 2010; and
- Scoping Response - Marine Scotland (2011)

21.1.3 Data Information and Sources

6 The principal data and information sources used were:

- International Council for the Exploration of the Sea (ICES)
- Marine Management Organisation (MMO)
- Marine Scotland, Marine Science (MS)
- European Commission- Fisheries (Europa)
- Scottish Fisheries Protection Agency (SFPA)
- Brown & May Marine in-house databases

21.2 Baseline Assessment

7 This section provides a brief description of the current commercial fisheries baseline for the EOWDC (salmon and sea trout fisheries have been assessed separately).

8 There is currently no single data source or recognised model for establishing commercial fisheries baselines within small discrete sea areas such as wind farms. The following description has, therefore, been derived using data and information from a number of sources:

- ICES statistical rectangles
- daily log sheets of vessels over 10 m in length
- surveillance sightings recorded by fishery protection aircraft and surface craft as a means of policing fisheries legislation in UK territorial waters and
- satellite tracking of all EU registered fishing vessels 15 m and over in length which are monitored approximately every 2 hours

9 The average landing values (2000-2009) of fish caught in ICES rectangles 43E7 and 43E8 are £89,468 and £1,125,276 respectively. Within 43E7, the main target species is crab using creels, whilst in 43E8 scallops and haddock are the main targets using dredges and otter trawls. Both ICES rectangles are large in relation to the area of sea occupied by the proposed development, as illustrated in Figure 21.1. The majority of landing values (approximately 80%) in ICES rectangle 43E7 are recorded as landed in Aberdeen, for ICES rectangle 43E8 approximately 40 % of the landing values are recorded as being landed in Aberdeen.

10 To date, there have been only low levels of fishing activity within the boundaries of the proposed EOWDC site, largely as a result of the poor productivity of the area. Four local vessels were identified as operating within the general area of the site, all of which are inshore demersal trawlers. These vessels are 11 m and under in length, with two registering their home port as Aberdeen and two Peterhead. The fishing grounds of these vessels were stated to be between Aberdeen Harbour Fairway Buoy and the buoys off the

Black Dog Firing Range, with the main target species being plaice. In addition to trawling, three of the vessels have the capacity to deploy creel gear.

11 From the consultation undertaken and the evidence obtained, it is apparent that the area of the proposed EOWDC constitutes only a small proportion of the fishing grounds of the identified vessels.

12 Analysis of Vessel Monitoring System (VMS) data for over 15 m vessels indicates that vessels with plots recorded within the site are steaming through it to more productive fishing grounds further afield rather than actually fishing within it. The nearest scallop dredging areas are on the Bennachie ground, which lies in the deeper offshore waters beyond Aberdeen Bay. The nearest nephrops grounds are identified well to the south of the site, off the coast of Montrose. Potting, largely by virtue of the habitat requirements of the main target species, is concentrated in areas to the south and the north of the site.

21.3 Impact Assessment

13 The assessment aims to describe the magnitude of effect of each potential impact and the sensitivity of each environmental receptor based on importance and recoverability.

14 The criteria used in the assessment are as follows:

- spatial extent of the effect (national, regional, local and site-specific)
- duration of effect (long term/ permanent (>10 years), medium(5-10 years), short term(1-5 years) or temporary(<1 year))
- scale of effect
- recoverability of the receptor (high, medium, low or none); and
- importance of the receptor (high, medium, low or none)

15 The impact significance is then given as major, moderate, minor or negligible guided by the matrix in Table 21.1.

TABLE 21.1
Matrix for Significance of Impact

	Sensitivity of Receptor				
Magnitude of Effect based on spatial, duration and scale of effect		**Very High**	**High**	**Medium**	**Low**
	Very High	Major	Major	Major	Moderate
	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

16 Some of the potential impacts described within this report are based upon incomplete knowledge and data gaps. In such instances, the assessment may be based upon a number of assumptions and, therefore, a degree of uncertainty will exist.

17 Where the significance of a potential impact is classified as moderate or major, it is considered to be a potentially significant effect. Impacts that were classified as moderate or major during construction, decommissioning and operation of EOWDC are listed in Table 21.2 below.

TABLE 21.2 Impact Assessment				
Construction and Decommissioning				
Potential Impact	**Significance Level**	**Mitigation**	**Residual Significance**	**Monitoring**
Damage to fishing gears by presence of seabed obstacles and obstructions	Negligible to Major if damage occurred	Contractors' obligations and standard offshore practices would prevent , or in case of accidental incidents, remove dropped objects	Negligible	None proposed
Safety issues for fishing vessels (collision with construction vessels)	Negligible to Major if damage occurred	Implementation and adherence to standard offshore safety procedures. Involvement of the SSF for liaison and information distribution	Negligible	None proposed
Operational				
Potential Impact	**Significance Level**	**Mitigation**	**Residual Significance**	Monitoring
Complete loss of, or restricted access to traditional fishing grounds	Negligible (for larger vessels) Moderate (for local vessels)	Certain fishing practices may resume within the operational site with some modification to operating practices	Negligible to beneficial (for larger vessels) Minor (for local vessels)	None proposed
Damage to fishing gears by presence of seabed obstacles and obstructions	Minor to Major if damage occurred	Contractors' obligations and standard offshore practices should ensure objects are removed. Any scour protection rock placement would be adjacent to wind turbines	Negligible	None proposed
Safety issues for fishing vessels (collision with wind turbines)	Minor to Major if collision occurred	Implementation and adherence to standard offshore safety procedures	Negligible	None proposed
Damage to fishing gear/vessels from exposed cables	Minor to Major	Cable burial to 0.6 m depth. Implementation and adherence to standard offshore procedures. Cable route surveys	Negligible to Minor	None proposed

18 Cumulative impact assessments used the same methodology and potential impacts for the standard impact assessment. Cumulative impact assessments have been undertaken on all existing and any reasonably foreseeable project/development activities. The elements that are considered to have the potential to contribute to cumulative impacts are:

- commercial shipping movements (discussed in Chapter 15 Shipping and Navigation)
- other offshore wind farms. As the closest wind farms are 58 km and 117 km from the EOWDC site, it is considered to be of negligible significance

- potential Ocean Laboratory. It is proposed that an Ocean Laboratory may be installed within the site and would be subject and separate application and EIA. As such, at this stage it is only assessed in terms of its cumulative effect

19 Cumulative impacts are, for the most part, expected to be of negligible significance. This is a consequence of the little offshore development, either existing or planned, in the vicinity of the site. Furthermore, as the EOWDC is expected to result in very few impacts above minor significance and those which do occur would be temporary and localised, the contribution of the development to cumulative impacts is expected to be minimal.

20 In-combination impacts, for the purposes of this assessment, describe impacts in relation to the Habitats Directive and have therefore been scoped out of the assessment. Any impacts relating to salmon are dealt with in the Chapter 22 Salmon and Seat Trout Impact Assessment.

21 It should be noted that current trends in fishing activity indicates that levels are unlikely to increase over the lifetime of the project. The current baseline is therefore taken as the worst realistic case in terms of the types and levels of fishing activity. The realistic worst case site layout is assumed to be the highest density of wind turbines within the site ie 11 wind turbines.

21.4 Summary

22 To date, there have been very low levels of fishing activity within the boundaries of the proposed EOWDC site. Four inshore demersal trawlers were identified as operating in the general area, ranging in length between 8 and 11 m. The main activity for these vessels is trawling for plaice, although the vessels also have the capacity to deploy other methods such as creeling for crabs and lobster. From the consultation undertaken it was apparent that the EOWDC site represents only a small proportion of the vessels' fishing grounds.

23 Taking the low levels of fishing activity, the small area of the site and the limited number of wind turbines to be installed, the potential impacts on commercial fishing of the proposed EOWDC are, for the most part, predicted to be of negligible significance.

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 22: Salmon and Sea Trout

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

22 SALMON AND SEA TROUT

22.1 Introduction

1 This section of the Environmental Statement (ES) summarises the assessment of the potential impacts on salmon and sea trout derived from the construction, operational and decommissioning phases of the proposed European Offshore Wind Deployment Centre (EOWDC). This assessment has been undertaken by Brown and May Marine.

2 The following technical reports support this chapter and can be found as:

- Salmon and Sea Trout Ecology and Fisheries Baseline Technical Report (Appendix 22.1)
- Salmon and Sea Trout Environmental Impact Assessment Technical Report (Appendix 22.2)

22.1.1 Methodology Consultation

3 Consultation meetings were held with all the salmon fishery boards located within the North East region and with representatives of the netting fishery in the North East.

4 These were as follows:

- Ugie District Salmon Fishery Board (26th October 2010)
- Ythan District Salmon Fishery Board (26th October 2010)
- Don District Salmon Fishery Board (27th October 2010)
- Dee District Salmon Fishery Board (17th January 2011)
- Esk District Salmon Fishery Board (27th October 2010)
- Usan Fisheries (Montrose) (17th Fenruary 2011)

5 In addition to the above meetings, questionnaires were circulated to all the District Salmon Fishery Boards in Scotland, through the Association of Salmon Fishery Boards (ASFB), and to netsmen, through the Salmon Net Fishing Association of Scotland. This process was aimed at gathering information at a national level and to note the main concerns of the boards and the netsmen with regards to wind farm developments in Scotland.

22.1.2 Key Guidance Documents

6 The key guidance documents used for the undertaking of the baseline and impact assessment technical reports are as follows:

- Strategic Environmental Assessment (SEA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Volume 1: Environmental Report; Marine Scotland 2010
- Offshore Wind Farms, Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements - Version 2; Cefas, MCUE, DTI, June 2004
- Marine Scotland Scoping Response (December 2010 and January 2011 update)
- Scottish Natural Heritage Scoping Response (29th September 2010)

- Habitats Regulations Appraisal Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Appropriate Assessment Information Review. Marine Scotland (2011)

22.1.3 Data Information and Sources

- Marine Scotland Review of Migratory routes and behaviour of Atlantic salmon, sea trout and European Eel in Scotland's coastal environment: Implications for the development of marine renewables (Malcolm *et al*., 2010)
- Scottish Natural Heritage Literature review on the potential effect of electromagnetic fields and subsea noise from marine renewable energy developments on Atlantic salmon, sea trout and European eel (Gill and Barlett, 2010)
- Consultation with District Salmon Fishery Boards
- Collaborative Offshore Wind Research Into the Environment (COWRIE) Publications
- Monitoring Surveys undertaken in Operational Wind Farms
- Marine Scotland Science (MSS)
- Association of Salmon Fishery Boards (ASFB)
- Salmon Net Fishing Association of Scotland
- North East Region District Salmon Fishery Boards and Fisheries Trusts
- Atlantic Salmon Trust
- Monitoring Surveys undertaken in Operational Wind Farms
- Other publically available research literature

22.2 Baseline Assessment

7 This section provides a brief description of the salmon and sea trout ecology and fisheries baseline for the EOWDC.

8 The study areas used for the undertaking of the baseline assessment are shown in Figure 22.1. The local area includes the salmon fishery district located in the immediate vicinity of the EOWDC, the Don, whilst the regional area includes all the salmon fishery districts within the North East region: Ugie, Ythan, Don, Dee and Esk. Given the migratory behaviour of salmon and sea trout and the relative importance of the fishery across the country, the baseline also includes a national focus.

9 The behaviour of salmon and sea trout in the marine environment, particularly on the Scottish east coast, is not fully known and a degree of uncertainty exists regarding salmon and sea trout migratory routes, their behaviour in coastal waters and navigation mechanisms.

10 Salmon and sea trout smolts migrate seawards in the spring, generally from April to June. The seaward migration in both species is thought to be an active process with fish swimming close to the surface and these does not appear to be a period of acclimation when moving from fresh to salt water.

11 Salmon post-smolts make limited use of the estuarine environment moving quickly to the open sea towards their feeding grounds. Limited research carried out to date suggests post-smolts may travel relatively close to the coast in the initial phases of their migration.

12 Salmon originating in rivers from Aberdeenshire southwards are thought to migrate back from their feeding grounds through the North Sea, approaching the coast as far south as Northumberland and then starting a northerly coastal migration towards their home rivers. Grilse (one sea winter salmon) enter the rivers from early summer until shortly before spawning in autumn, whilst multi sea winter salmon are those fish that enter the rivers over a greater period of time.

13 Unlike salmon, sea trout post-smolts are not believed to travel to distant waters to feed; instead they generally remain in coastal waters. In the North East region sea trout generally enter the rivers from June to September with peak runs varying between rivers.

14 The right to fish for salmon in Scotland is a heritable right, whether in inland waters or at sea. The fisheries are managed by their owner or leaseholder under a framework of regulations laid down by central government. Under Scottish legislation the term salmon applies to both salmon and sea trout.

15 In the salmon fishery districts located in close proximity to the proposed EOWDC, the Ythan, Don and Dee, the majority of the total salmon and sea trout catch comes from the rod-and-line fishery with some fixed engine (bag and stake) fisheries. Fixed engine fisheries are of greater relative importance in other districts within the regional area, such as the Ugie and more significantly the Esk.

16 The Don is the salmon fishery district located in the immediate vicinity of the proposed EOWDC. The majority of the reported catch in the district is by rod-and-line, a high percentage of which is by catch and release. Reported catches by the net fishery are comparatively low, with no net-and-coble currently taking place in the district and fixed engines recording very low reported catches in recent years.

22.3 Impact Assessment

22.3.1 Impact Assessment Methodology

17 The assessment aims to describe the magnitude of effect of each potential impact and the sensitivity of each environmental receptor based on importance and recoverability. The impact assessment has been carried out taking the installation of eleven 8.5 m diameter monopiles as the worst case scenario. In reality, however, as the EOWDC is an experimental development to trial various foundations types, it is expected that less than eleven monopiles would be installed.

18 As stated above data gaps exist with respect to the salmon and sea trout baseline and therefore for the purposes of the impact assessment certain assumptions have had to have been made.

19 The Rivers Dee, Don and Ythan are closest to the development and the assumption has been made that fish from these rivers are more likely to transit the site. It is also recognised however that fish from other rivers, both within the region (eg North Esk, South Esk, Ugie) and from other Scottish areas (eg Moray Firth, North, etc) may on occasions also be present in the vicinity of the development.

20 The following assumptions based on the behavioural patterns of salmon and sea trout taking a precautionary approach have been made for fish originating in the Dee, Don and Ythan Salmon Fishery Districts:

- juvenile salmon and sea trout transit through, or in close proximity to, the site on their seaward migration
- adult salmon (grilse and MSW) and sea trout transit through, or in close proximity to, the site on their return migration
- sea trout are present in the vicinity of EOWDC and transit the site as part of their foraging activity

21 The criteria used in the assessment are as follows:

- spatial extent of the effect (national, regional, local and site-specific)
- duration of effect (Long term/ permanent (>10 years), medium (5-10 years) short term (1-5 years) or temporary (<1 year))
- scale of effect
- recoverability of the receptor (high, medium, low or none); and
- importance of the Receptor (high, medium, low or none)

22 The impact significance is then given as major, moderate, minor or negligible guided by the matrix in Table 22.1.

TABLE 22.1
Matrix for Significance of Impact

		Sensitivity of Receptor			
Magnitude of Effect based on spatial, duration and scale of effect		**Very High**	**High**	**Medium**	**Low**
	Very High	Major	Major	Major	Moderate
	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

23 Where the significance of a potential impact is classified as moderate or major, it is considered to be a potentially significant effect.

24 The same methodology used for the assessment of potential impacts has been used in the cumulative impact assessment. The other developments and activities considered to have potential to result in a cumulative impact are as follows:

- other offshore wind farm developments
- offshore oil and gas developments
- introduction of Marine Protected Areas (MPAs)
- aggregate dredging
- potential Ocean Laboratory
- other offshore works

25 A summary of the significance of the impacts derived from the construction, decommissioning and operational phase of the EOWDC, including cumulative impacts is given in Table 22.2 below.

TABLE 22.2
Impact Assessment

Construction and Decommissioning

Source of Potential Impact	**Potential Impact**	**Receptor**	**Significance Level**	**Mitigation**	**Residual Significance**	**Cumulative Impact**	**Monitoring**
Noise	Direct Impact: Lethal effects and hearing damage	Adult and juvenile salmon and sea trout	Negligible	Soft-start piling	Negligible	None expected	Appropriate and relevant monitoring would be assessed through discussion with relevant stakeholders and regulators
	Disturbance/ Delay/Barrier to Migration	Salmon and sea trout juveniles	Minor to Moderate	Installation schedule to be discussed with relevant stakeholders and regulators	Negligible to Minor	Negligible	
		Salmon and sea trout adults	Minor	Installation schedule to be discussed with relevant stakeholders and regulators	Negligible to Minor	Negligible	
	Key prey species	Adult sea trout	Negligible	None required	Negligible	None expected	
Increased sediment concentrations	Direct effects/ Disturbance/ Delay/Barrier to Migration	Juvenile and adult salmon and sea trout	Negligible to Minor	None required	Negligible to Minor	None expected	None planned
Operational							
Source of Potential Impact	Potential Impact	Receptor	Significance Level	Mitigation	Residual Significance	Cumulative Impact	Monitoring

TABLE 22.2
Impact Assessment

Noise	Disturbance/ Delay/Barrier to Migration	Adult and juvenile salmon and sea trout	Negligible	None required	Negligible	None expected	None planned
	Feeding						
EMFs	Disturbance/ Delay/Barrier to Migration	Adult and juvenile salmon and sea trout	Negligible to minor	None other than cable burial	Negligible to minor	Negligible	None planned
Presence of Wind Turbines	Disturbance/ Delay/Barrier to Migration	Adult and juvenile salmon and sea trout	Negligible	None required	Negligible	None expected	None planned

26 As stated, the impact assessment has been based on the installation of 11 monopiles. As EOWDC is a test site, the exact type of foundations and installation schedules have yet to be decided. Once the information is available on actual foundation types, any mitigation and monitoring that may be deemed appropriate or necessary would be assessed through discussion with the relevant stakeholders and regulators at the appropriate time.

27 Given the socio-economic importance of the salmon and sea trout fishery in Scottish rivers and coastal waters, the potential for the fishery to be impacted directly through loss of fishing area, restricted access or interference with fishing activities, and indirectly as a result of the ecology of salmon and sea trout being impacted, have been evaluated. A summary of the potential impacts on the salmon and sea trout fishery is given in Table 22.3 below.

TABLE 22.3
Salmon and Sea Trout Fishery Impact Assessment

Construction and Decommissioning				
Potential Impact	**Receptor**	**Potential Impact**	**Mitigation**	**Residual Impact**
Loss of or Restricted Access to Fishing Areas	Coastal netting during cable installation	Moderate	Liaison and consultation with relevant stakeholders	Negligible
	Coastal netting during other construction activities	Negligible		
	Rod and line fisheries			
Interference with fishing activities	Coastal netting during cable installation	Negligible		Negligible
	Coastal netting during other construction activities			
	Rod-and-line fisheries			
Loss or reduction of catch	Netting and rod-and-line fisheries	Negligible to minor		Negligible to minor
Operation				
Potential Impact	Receptor	Potential Impact	Mitigation	Residual Impact
Loss or reduction of catch	Netting and rod-and-line fisheries	Negligible	Liaison and consultation with relevant stakeholders	Negligible

22.4 Summary

28 Scottish salmon populations are recognised as being of national and international importance. In addition to their ecological value, salmon and sea trout are species of importance from a socioeconomic perspective on a local, regional and national level in Scotland.

29 The significance of the impact derived from the construction, operational and decommissioning phases of the proposed EOWDC on salmon and sea trout is not expected to be above minor, provided adequate mitigation measures and consultation with relevant stakeholders are carried out, especially during

construction. It is accepted that there is uncertainty regarding the behaviour of salmon and sea trout and the implications of responses to factors such as noise and EMFs. For this reason, once detailed construction information is available, appropriate and robust mitigation and monitoring would be discussed with the relevant stakeholders and regulators.

30 Similarly, provided that adequate liaison with stakeholders and fishing interest is carried out, it is not expected that the construction/decommissioning and operational phase of the proposed EOWDC would result in direct impacts on salmon and sea trout fisheries (eg loss of fishing area, restricted access, interference with fishing activities).

31 Indirect impacts on the fishery through loss or reduction of salmon and sea trout catches, would in effect, be directly related to the effects on the ecology of the two species as assessed above. As given in Table 22.2 above, the significance of the residual impacts on salmon and sea trout is predicted to range from negligible to minor. It is however recognised that the scale and magnitude of the potential impacts would vary between districts and would be primarily related to the relative value of the rod and line fisheries within individual districts and the timing and importance of runs within specific rivers.

32 The Atlantic Salmon (*Salmo salar*) is a qualifying species for the River Dee SAC and River South Esk SAC. Atlantic salmon from the relevant SACs may also occur in either the proposed developments in the Moray Firth or the Firth of Forth.

33 Assuming mitigation, in-combination impacts ie cumulative impacts of plans or projects on a European site, are not anticipated (see Appendix 29.1 Information to Inform the HRA).

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 23: Socioeconomics, Recreation and Tourism

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

23 SOCIOECONIMICS, RECREATION AND TOURISM

23.1 Introduction

1 The purpose of this chapter is to assess the socio-economic impacts associated with the European Offshore Wind Deployment Centre (EOWDC), including direct employment and supply chain effects, impacts on tourism and recreation, and impacts on the offshore wind energy sector as a whole, due to the opportunity for research and development. This assessment has been carried out by DTZ Consulting. The assessment has been achieved through reference to secondary literature, consultation with relevant stakeholders, and economic modelling of impacts. The scope of the assessment is the Inner Study Area (Aberdeen and Aberdeenshire), Wider Study Area (Scotland), and the UK.

2 The following technical reports support this chapter and can be found as:

- Socioeconomic, Recreation and Tourism Baseline Technical Report (Appendix 23.1)
- Socioeconomic, Recreation and Tourism Environmental Impact Assessment (EIA)Technical Report (Appendix 23.2)

23.1.1 Methodology Consultation

3 DTZ consulted with the following individuals in April 2011 (all by telephone) to inform the Baseline Assessment and Impact Assessment:

- Colin Parker, Chief Executive, Aberdeen Harbour
- Matt North, Port Manager for the Port of Dundee, Forth Ports
- Steven Paterson, Chief Financial Officer, Peterhead Port Authority
- Eric May, Marine Renewable Section Leader, Marine Scotland
- Robert Forbes, Aberdeen City Council
- Eric Wells, Aberdeenshire Council
- Roddy Mathieson, Aberdeenshire Council
- Alistair Reid, Aberdeenshire Council and Energetica Project
- Paul Reynolds, Offshore Wind Development Manager, RenewableUK
- Sara Budge, Project Director, Energetica
- Dr Graham Russell, RYA Scotland

23.1.2 Key Guidance Documents

4 This assessment has been undertaken in accordance with the following guidance on economic assessment:

- HM Treasury (2003) Green Book
- BIS (2010) Impact Assessment Guidance
- English Partnerships (2008) Additionality Guide: Third Edition
- BIS (2009) Guidance for Using Additionality Benchmarks in Appraisal
- Surfers Against Sewage (2009) Guidance on Environmental Impact Assessment of Offshore Renewable Energy Development on Surfing Resources and Recreation

23.1.3 Data Information and Sources

5 The following key sources of data were used to inform the baseline assessment and EIA technical reports:

- BWEA (2009) UK Offshore Wind: Charting the Right Course
- Ernst & Young (2009) Cost of and financial support for offshore wind
- Marine Scotland (2011) Economic Assessment of Short Term Options for Offshore Wind Energy in Scottish Territorial Waters: Costs and Benefits to Other Marine Users and Interests
- Office of National Statistics (2003-2009) Mid Year Population Estimates
- Office of National Statistics (2009) Annual Population Survey
- Office of National Statistics (2009) Claimant Count
- Office of National Statistics (2009) Annual Business Inquiry / Business Register and Employment Survey
- Scottish Enterprise (2010) National Renewables Infrastructure Plan
- Scottish Government (2010) Scottish Sea Fisheries Statistics 2009
- Scottish Government (2010) Scotland's Marine Atlas - Information for the National Marine Plan
- Scottish Renewables (2010) Scottish Offshore Wind: Creating an Industry
- The Crown Estate / BVG Associates (2010) Guide to an Offshore Wind Farm
- Visit Scotland (2009) Visit Scotland Tourism Statistics

23.2 Baseline Assessment

6 There is a significant renewable energy resource in Scotland, coupled with a high level of government commitment to renewable energy generation. The Scottish Government is committed to achieving a headline target of 20 % of total Scottish energy use from renewable sources by 2020. Scotland has a quarter of Europe's offshore wind potential. The Crown Estate has granted exclusive development rights for 11 offshore wind zones in Scotland. Offshore wind is in its infancy and there is a clear need for demonstration and deployment centres such as the EOWDC. The project, therefore, has an excellent fit with policy.

7 The project has been successful in gaining EU funding of up to €40m from the European Economic Recovery Plan. This award is in recognition of the project's potential role in supporting development of the European offshore wind industry by proving technologies and techniques.

8 At a local level, Aberdeen City and Aberdeenshire recognise the importance of the energy sector to the local economy. The 'Energetica' project has been developed which sets out a vision as to how the Inner Study Area can see energy, tourism, other industries and quality of life factors combine to raise the profile and economic performance of the region.

9 The Inner Study Area can be characterised as follows in terms of socio-economics, tourism and recreation:

- apopulation of 457,300 people in 2009, which has grown by 4.8 % since 2003 (a faster rate than the UK or Scotland)
- high levels of employment in the working age population (79.4 % of the working age population are employed, compared to 71.9 % in Scotland)

- low level of unemployment (2.8 % in the Inner Study Area compared to 7.1% in Scotland)
- a highly qualified workforce (24 % of the workforce is degree qualified, compared to 20.5 % in Scotland)
- the Inner Study Area is less dependent on public sector employment than other parts of Scotland
- the Inner Study Area has a significant Oil and Gas sector – comprising 25,700 workers, and accounting for over 60 % of UK employment in the oil and gas industry. This provides a firm foundation for development of new energy sources such as offshore wind, given the complementarity of skills required.
- the three principle ports within the Inner Study Area are Aberdeen, Peterhead, and Fraserburgh. Aberdeen Port is the major supply base for the North Sea oil industry employing around 11,000 people and Peterhead is the UK's biggest fishing port, landing 149,200 tonnes of fish in 2009 valued at £118 million (27 % of the total Scottish market)
- 1.5 million tourist trips were made to Aberdeen and Grampian in 2009, contributing £344 million of expenditure to the local economy. The region attracts a high number of Scottish and UK tourists. A relatively high proportion of tourist trips into the region relate to business tourism – almost three quarters of visitors to Aberdeen City are business-related. The most significant tourism investment in the inner study area is the Trump Corporation's investment at Menie Estate which will increase tourist income in coming years
- the coastline of the Inner Study Area is used for a variety of recreational activities including sailing (although only to a moderate extent relative to other parts of Scotland), sea angling, surfing, canoeing, kayaking, windsurfing and kitesurfing. Fraserburgh is a particularly popular surfing location and regularly holds surf competitions and events, such as the UK Surf Tour and Fraserburgh Surf Festival

10 Looking forward, the Inner Study Area is expected to experience a weak recovery from the recession. Forecasts show that the economy is expected to grow by an average of 2.7 % per annum in the period 2011-2015 in the Inner Study Area, compared to 2.9 % in Scotland, and 3.4 % in the UK. Employment in the Inner Study Area is expected to decline by 12,100 jobs from 2008 to 2011; after which it is expected that there will be a gradual recovery, with job numbers increasing by 6,000 in the period 2011 to 2018. Over the period 2008-2018 as a whole, the worst affected industries in terms of job losses are expected to be Manufacturing and Oil and Gas industries.

23.3 Impact Assessment

23.3.1 Impact Assessment Methodology

11 The scope of this assessment is to consider the impacts of the development across the areas listed below.

- socioeconomic – employment and economic impacts associated with the construction, operation and decommissioning of the project, including supply chain and income effects
- tourism – considering the impact on tourism in the local area
- recreation – considering the impact on coastal recreational activities

- research and development – considering the possible impact of the deployment centre on the UK offshore wind industry as a whole, due to the opportunity for research, development and testing of equipment

12 The impact methodology is primarily based on a quantitative assessment of the economic impacts in terms of job and Gross Value Added (GVA). The level of significance is assessed as follows:

TABLE 23.1 Impact Methodology		
Magnitude of the Effect (based on spatial extent, duration, and scale)		
Spatial Extent of Effect assessed at the level of • Inner Study Area (Aberdeen & Aberdeenshire) • Wider Study Area (Scotland) • UK	**Duration of Effect** • Long-term/ permanent (more than 10 years) • Medium-term (existing for 5 to 10 years) • Short-term (existing for 1 to 5 years) • Temporary effect (existing for less than a year)	**Scale of Effect:** •As there are no specific standards or guidelines, the impacts are assessed relative to baseline conditions, or a 'No Development' scenario.
Sensitivity of the Receptor		
The sensitivity of the receptor (which in this case is assumed to be the economy, population, businesses and workforce in the study area) has been judged in terms of the level of unemployment in the area.		

13 Impacts are assigned a rating of major, moderate, minor or negligible; based on the magnitude of the effect and sensitivity of the receptor as follows:

TABLE 23.2 Matrix for Significance of Impact					
	Sensitivity of Receptor				
Magnitude of Effect based on spatial, duration and scale of effect		**Very High**	**High**	**Medium**	**Low**
	Very High	Major	Major	Major	Moderate
	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

14 For the purposes of this assessment, only the offshore works associated with the EOWDC have been considered. The onshore works will be subject to a separate EIA, but have been considered briefly within this assessment as a cumulative development. The cumulative impact assessment has also considered the interaction with other planned offshore wind developments on the East coast of Scotland, totalling around 7.5 GW of capacity.

15 In conducting this assessment, consideration has been given to the possible range of impact scenarios, based around the following key aspects of the project:

- scale – it has been assumed that 84MW of capacity (comprising 11 wind turbines) would be deployed within the EOWDC, with an estimated total capital cost of £260.4 million
- timing – construction would take place from 2013-2014 and the EOWDC would be operational for a period of up to 22 years. Following which, there would be a decommissioning period of up to 5 months

- sourcing of components – based on analysis of project expenditure, it has been estimated that a total of around 38 % of capital expenditure would be retained within the Wider Study Area (Scotland), of which around 18 % would be retained within the Inner Study Area
- usage of local ports – It has been assumed that the construction and operational ports would both be within the Inner Study Area (ie Peterhead and Aberdeen)

23.4 Summary

16 Total capital expenditure during the two-year construction phase has been estimated at £260.4 million. It has been estimated that this would support 738 job-years worth of employment, and £40 m of Gross Value Added (GVA) in Scotland; of which 296 job-years and £16 million of GVA would be in the Inner Study Area (Aberdeen and Aberdeenshire). The impact related to the Inner Study Area would relate mainly to the construction and assembly of turbines and foundations. The additional impact in the rest of Scotland relates to the supply chain activity such as the manufacture of foundations and potentially also wind turbines.

TABLE 23.3
Summary of Impact: Construction Phase (2 years)

Total Employment (job-years)	**Direct & Indirect**	**Induced**	**Total**
Inner Study Area	248	48	296
Wider Study Area (Scotland)	531	207	738
UK	955	n/a	n/a
Gross Value Added (£ million, discounted)	**Direct & Indirect**	**Induced**	**Total**
Inner Study Area	£13.8	£2.3	£16.1
Wider Study Area (Scotland)	£29.5	£10.0	£39.6
UK	£53.1	n/a	n/a

17 In terms of the operational phase of the project – this is anticipated to be 22 years in duration, and therefore is judged to have a 'Long-term' effect. Once fully deployed, it is anticipated that the EOWDC would require a local team of around 25 jobs for operational and maintenance activities within the inner and wider study area. Over the 22 year operational life of the development, this would support 768 job-years worth of employment and £23 million of GVA at the Scotland level as summarised below.

TABLE 23.4 Summary Operational Impacts over lifetime of project (22 years)			
Total Employment (job-years)	**Direct & Indirect**	**Induced**	**Total**
Inner Study Area	553	108	661
Wider Study Area (Scotland)	553	216	768
UK	693	n/a	n/a
Gross Value Added (£ million, discounted)	**Direct & Indirect**	**Induced**	**Total**
Inner Study Area	£17.4	£3.0	£20.4
Wider Study Area (Scotland)	£17.4	£5.9	£23.4
UK	£21.9	n/a	n/a

18 The decommissioning phase is expected to be temporary, lasting for up to five months. It has been estimated that the total expenditure on decommissioning would be £33.3 million, and this would support 248 job-years of employment and £7.7m of GVA at the Scotland level.

TABLE 23.5 Summary of Impacts from Decommissioning Phase (up to 5 months)			
Total Employment (job-years)	**Direct & Indirect**	**Induced**	**Total**
Inner Study Area	178	35	213
Wider Study Area (Scotland)	178	69	248
UK	178	n/a	n/a
NPV of GVA	**Direct & Indirect**	**Induced**	**Total**
Inner Study Area	£5.8	£1.0	£6.8
Wider Study Area (Scotland)	£5.8	£2.0	£7.7
UK	£5.8	n/a	n/a

19 The impact of the proposed development on tourism is considered to be of negligible significance.

20 The impact of the proposed development on recreational activities is considered to be of negligible significance.

21 The impact of the proposed development on research and development and the offshore wind industry has also been considered at both a local and national level. The view of consultations was that the proposed deployment centre would have a positive impact on the offshore wind sector. The following quotations highlight the significance of that impact:

'The development of offshore wind still faces many challenges to commercial deployment. The operation of the EOWDC will make a strong contribution to knowledge sharing for new components, designs and access methodologies for construction, operations and maintenance to be executed in the marine environment.' ***Chris Bronsdon, Chief Executive, Scottish European Green Energy Centre (SEGEC)***

'The European Offshore Wind Deployment Centre will provide invaluable opportunities for R&D, helping the industry to grow with real confidence. Innovative projects such as this will help the UK to maintain its position as the

world leader in offshore wind. This will in turn encourage more investors to come forward, creating thousands of jobs in the rapidly-expanding offshore wind sector.' ***Maria McCaffery, Chief Executive of RenewableUK***

'This is potentially a great opportunity for Scotland's research community to actively engage in the development of an important means to generate low carbon electricity. Particularly important will be the deployment of the Ocean Laboratory, a wide range of turbines and support structures as possible and access to these for independent evaluation in order to aid future developments.' ***Professor Paul Mitchell of the University of Aberdeen's School of Engineering***

'The EOWDC is a major component of ACSEF's flagship project, Energetica. As a pioneering offshore wind project, it will be at the cutting edge of the development of new technologies and presents significant opportunities for Aberdeen City and Shire to build a viable, robust supply chain around offshore wind, particularly in the areas of development, operation and maintenance' ***Sara Budge, project manager for Energetica, Aberdeen City and Shire Economic Future (ACSEF)***

'This is a real opportunity for Aberdeen and the North-east [of Scotland] to place itself at the forefront of this aspect of the renewables industry. There is fierce completion not just in Scotland but across the rest of Europe to gain recognition as a leader in the field and this project will provide an extremely valuable testing site for manufacturers to demonstrate their products and to gather vital data on performance.' ***Bob Collier, Chief Executive of Aberdeen & Grampian Chamber of Commerce***

22 Overall, the assessment demonstrates that the project would have a significant positive impact on the economy of the Inner Study Area, Scotland and the UK. Over the lifetime of the project, it is estimated that it would support over 1,750 job-years worth of employment in Scotland, supporting over £70 million of Gross Value Added. It would also provide benefits to the wider offshore wind energy sector by providing opportunities for testing, research and development, and training. This would accelerate the deployment of offshore wind projects progressing through The Crown Estate's 'Round 3' and Scottish Territorial Waters licensing processes by providing the opportunity to demonstrate new equipment in the marine environment. The impacts on tourism and recreational activities are considered to be of negligible significance.

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 24: In Air Noise

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

24 IN AIR NOISE

1 This chapter describes the effects of noise from the proposed European Offshore Wind Deployment Centre (EOWDC) due to the construction and operation of the wind turbines at onshore locations along the shoreline to the north of Aberdeen. The assessment has been undertaken by Hayes McKenzie Partnership Ltd.

24.1 Introduction

2 A baseline noise survey was carried out to establish the existing background noise at the four closest residential properties to the proposed EOWDC. An additional two locations were also surveyed, which are representative of properties further inland where the influence of noise from the sea will be lower. The noise impact on residential properties during the operation and construction phases of the proposed EOWDC has been assessed.

3 The following technical reports support this chapter and can be found as:

- In Air Noise Baseline Technical Report (Appendix 24.1)
- In Air Noise Environmental Impact Assessment Technical Report (Appendix 24.2)

24.1.1 Methodology Consultation

4 A Request for an Environmental Impact Assessment (EIA) Scoping Opinion was made to Marine Scotland in August 2010. None of the responses received identified specific requirements for in-air noise assessment for residential properties onshore.

5 The Environmental Health Officers of Aberdeen City Council and Aberdeenshire Council have been consulted regarding the assessment methodology and the choice of measurement locations for the baseline noise survey:

- Andrew Gilchrist, Aberdeen City Council (6th January 2011)
- John Dawson, Aberdeenshire Council (6th January 2011)

24.1.2 Key Guidance Documents

6 The following documents have been used in the assessment:

- Scottish Executive (2011). Planning Advice Note PAN 1/2011: Planning and Noise
- Scottish Executive (2010). Web based ‘renewables advice’
- DTI Working Group on Noise from Wind Turbines (1996). The Assessment and Rating of Noise from Wind Farms ETSU-R-97
- Aberdeenshire Council (2005). Use of Wind Energy in Aberdeenshire: Guidance for Developers – Supplementary Planning Guidance Part 1
- Institute of Acoustics Bulletin Vol 34 no 2, March/April 2009 Prediction and Assessment of Wind Turbine Noise
- British Standards (2009). BS 5228:2009 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise

- The Scottish Government (2011). Technical Advice Note – Assessment of Noise

7 The documents listed above have all been written for the purpose of assessing onshore developments but have been adopted for this project as providing suitable guidance on assessing background noise and deriving noise limits for the onshore residential properties.

8 Advice on long-range sound propagation over sea has been taken from:

- Mathieu Boué (2007). Report for Swedish Energy Agency: Long-range sound propagation over the sea with application to wind turbine noise.

24.1.3 Data Information and Sources

- Oldbaum Services Limited (2011a). Wind speed data spatial translation – Method Statement for Aberdeen Offshore Wind Farm Limited
- Hayes McKenzie Partnership Ltd. (2011). Measurement of background noise data and rainfall
- Oldbaum Services Limited (2011b). Wind speed data spatial translation – Wind data analysis for Aberdeen Offshore Wind Farm Limited
- Menck: Noise Reduction Skirt, Product sheet, accessed online: http://www.menck.com/products/noise-reduction/
- World Health Organisation (2000): Guidelines for Community Noise
- World Health Organisation (2009): Night Noise Guidelines for Europe

24.2 Baseline Assessment

9 An assessment has been carried out for the existing noise environment at six locations along the shoreline closest to the proposed development to the north of Aberdeen.

10 Noise monitoring equipment was left at the measurement positions for a period of 21 days from 15th February to 8th March 2011. The locations are shown on Figure 24.1. The meters were programmed to measure a number of statistical noise indices, including the LA90, together with the maximum and minimum levels and the LAeq (the Equivalent Continuous A-Weighted Sound Pressure Level) over consecutive 10-minute periods. Results were automatically stored at 10-minute intervals and synchronised to wind speed measurements to allow for later correlation between the two.

11 The baseline survey has been carried out to derive noise limits for the proposed development according to guidance normally used for onshore wind farms. This guidance has been used as there is currently a lack of Planning Policy Guidance for offshore wind farms with respect to noise impact on onshore residential properties.

24.3 Impact Assessment

24.3.1 Impact Assessment Methodology

12 For the impact assessment of noise from the construction and the operational phase of the EOWDC, following table has been used.

TABLE 24.1
Magnitude of Impact

Descriptor for Magnitude of Impact	Generic Criteria of Descriptor
Major adverse	Loss of resource and/or quality of resource; severe damage to key characteristics, features or elements
Moderate adverse	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements
Minor adverse	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements
Negligible adverse	Very minor loss or detrimental alteration to one or more characteristics, features or elements
No change	No loss or alteration of characteristics, features or elements; no observable impact

13 Noise levels at properties onshore have been calculated and compared with noise limits derived from the ETSU guideline for wind farms and the British Standard BS5228:2009 Part 1 for construction noise. Based on the potential exceedance of the noise limits, the magnitude of the impact has been allocated.

14 The predicted levels and measured background noise levels indicate that for all dwellings located onshore, wind turbine noise would meet the amenity and night-time noise criteria proposed within ETSU-R-97. In terms of this guideline for wind farm noise, no significant impact is expected. The noise contours are shown on Figure 24.1.

15 Prediction of the pile driving noise during the construction phase shows exceedance of the night-time noise limits adopted from BS5228:2009 Part 1 (BSI, 2009) at all properties. This is based on a worst case scenario of a monopile of 8.5 m diameter. It has therefore been proposed that for monopiles construction times should be limited to daytime hours unless suitable noise mitigation can be found and verified by measurements. The restrictions for smaller piles at night time may not be required and would be evaluated when the final pile sizes are known against the same criteria.

16 Prediction of the pile driving noise during daytime show exceedance of the LAeq daytime noise limits adopted from BS5228:2009 Part 1 (BSI, 2009) at three assessed properties by 1 decibels (dB). With a suitable noise management policy it is expected that the impact during daytime hours would be minor adverse. As the construction period with high noise levels is only for a limited time and as methods to screen the sound at source could potentially be employed this impact could be reduced even further.

17 The decommissioning phase is not expected to cause any significant effect as noise levels from shipping and taking down the wind turbine parts would be significantly lower than the piling noise from the construction phase.

18 The cumulative assessment of potentially constructing and operating the potential ocean laboratory has shown no increase to the current impacts of constructing and operating the wind farm on its own.

TABLE 24.2
Summary of Impact Assessment

Potential Impact	Significance Level	Mitigation	Residual Significance	Monitoring
Sleep disturbance during piling at night	Major	No piling during night	Negligible	No
Stress, annoyance during piling daytime	Minor to Moderate	Screens and good information policy	Minor	Determine real sound levels and check efficiency of potential mitigation measures
Exceedance of noise limits during operation day	Negligible	Not required	Negligible	No
Exceedance noise limits operation night,	Negligible	Not required	Negligible	No
Construction noise from other machinery	Negligible	Not required	Negligible	No
Operational noise from diesel generator	Negligible	Not required	Negligible	No

24.4 Summary

19 Analysis of the measured background noise data has been performed in accordance with ETSU-R-97 to determine the pre-existing background noise environment at six residential properties. Predictions of wind turbine noise have been made, based upon a generic sound power level typical for an up to 10 MW generating capacity wind turbine. The calculation procedure adopted is considered to be worst-case. The predicted levels and measured background noise levels indicate that for all dwellings located onshore, wind turbine noise would meet the amenity and night-time noise criteria proposed within ETSU R 97. Prediction of the pile driving noise during the construction phase shows exceedance of the night-time noise limits proposed in BS5228:2009 Part 1 at all properties. It has therefore been proposed that construction times should be limited to daytime hours unless suitable noise mitigation can be found and verified by measurements.

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 25: Energy Use and Emissions

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

25 ENERGY USE AND EMISSIONS

25.1 Introduction

1 This chapter reports on the energy use and emissions that are expected to be generated during the lifecycle of the European Offshore Wind Deployment Centre (EOWDC) project and puts these into the context of reductions in greenhouse gas emissions that offshore wind power deliver in comparison to conventional gas and coal based power generation. This chapter has been prepared in conjunction with Genesis Oil and Gas Consultants.

2 The First Minister for Scotland wants renewable sources to generate the equivalent of 100 % of Scotland's gross annual electricity consumption by 2020. Similarly, a target has been set for renewables sources to provide the equivalent of 11 per cent of Scotland's heat demand by 2020.

3 The Scottish Government's Climate Change Act, sets a target of reducing emissions by 80 % by 2050, including emissions from international aviation and shipping. It also sets a world-leading interim target for a 42 % cut in emissions by 2020.

4 In their annual energy statement the Department of Energy and Climate Change (DECC) report that it is likely that demand for electricity will double over the coming 40 years, as a result of the need to electrify large parts of the heat and transport sectors (DECC, 2010). Furthermore, for the UK to meet its obligations on reducing emissions of greenhouse gases, the electricity being consumed will need to be almost exclusively from low carbon sources. In the first quarter of 2010 nearly 80 % of the UK's electricity was generated by burning gas and coal. This needs to change and offshore wind will be crucial to delivering the UK's renewable and low carbon targets.

25.1.1 Methodology and Data Information and Sources

5 The following information sources have been used:

- DECC (2010) Annual Energy Statement, Departmental Memorandum. The Department of Energy and Climate Change (DECC), 27th July 2010
- Defra (2002) Guidelines for the measurement and reporting of emissions by Direct Participants in UK Emissions Trading Scheme. UKETS(01)05rev2.
- DBERR (2007) Digest of UK Energy Statistics. Department for Business, Enterprise and Regulatory Reform.
- Dft (2008) Department for Transport, Energy Statistics: http://www.dft.gov.uk/pgr/statistics/datatablespublications/energyenvironment/
- EEMS (2008) Atmospheric Emissions Calculations. Environmental Emissions Monitoring System (EEMS), November 2008
- The Institute of Petroleum (2000) Vessels Energy Use and Emissions. The Institute of Petroleum (2000) "Guidelines for the Calculation of Estimates of Energy Use and Gaseous Emissions in the Decommissioning of Offshore Structures)
- Scottish Government (2010) Renewables Action Plan, Renewable Energy Division
- Scottish Government (2011) Carbon Payback Calculator Guidance

- Parliamentary Office of Science and Technology, October 2006, post note 268, Carbon footprint of electricity generation
- Renewable UK (2011) (formerly BWEA) http://www.bwea.com/

25.2 Impact Assessment

25.2.1 Construction Emissions

6 The EOWDC is likely to be installed offshore in stages, with the foundation section installed first, then the tower, the nacelle and finally the rotor.

7 For estimating emissions, it has been assumed that the foundations and transition pieces would be transported to site by a specially built installation vessel or barge. The barge may be self propelled or towed onto station using a tug vessel. Once *in situ*, the foundation structure would be up-ended by crane and installed onto the seabed. The transition piece would be installed by crane. A dive support vessel, and/or speciality rock placement vessel may be used to provide protection to seabed infrastructure. The export cables and inter-array cables would be installed using a cable lay vessel. Throughout the operations support vessels would be needed to transfer personnel and to act as guard vessels, to maintain the navigational safety distances, during construction.

8 Once the EOWDC is operational small maintenance vessels are expected to be needed on a daily basis to service the wind turbines, with larger vessels needed for any major repairs.

9 In order to determine emissions the activities were broken down into construction and operational phases. The expected duration of construction activities were calculated to provide the number of vessel days expected to install the foundations, wind turbine and cables (Table 25.1). The development scenarios with the highest number of days and vessels were chosen in the calculation of construction emissions to illustrate the worst case scenario.

Table 25.1
Vessel Fuel Use during Construction Activities (11 wind turbines)

Vessel type	Duration (days)	Working Consumption * (tonnes/day)	Total fuel use (tonnes)
Barge	132	18	2,376
Tug	20	50	1,000
Jack-up crane vessel	182	20	3,640
Dive support vessel	20	18	360
Standby vessel	207	0.7	145
Total	561	-	7,521

*Fuel use consumption taken from Institute of Petroleum (2000)

Table 25.2 Vessel Fuel Use during Operation (1 year of operation)			
Vessel type	**Duration (days)**	**Working Consumption * (tonnes/day)**	**Total fuel use (tonnes)**
Maintenance vessel* (Based on maximum 12 hour working day)	150	0.7	105
Jack-up crane vessel	20	20	400
Total	170	-	505

*Fuel use consumption taken from Institute of Petroleum (2000)

10 Information on vessel days was combined with emission factors for diesel consumption by engines to estimate emissions from both the construction and operational phases of the EOWDC (Table 25.3). It has been assumed that all the construction hours arise in a single year and that emissions from maintenance activities would be annual from year 2 onwards.

Table 25.3 Total Emissions from Construction and Maintenance Activities								
Vessel	**Tonnes Diesel Consumed (tonnes)**	**Emissions (tonnes)**						
		CO_2	**NO_x**	**N_2O**	**SO_2**	**CO**	**CH_4**	**VOC**
Emissions Factors (EEMS, 2008)	-	3.2	0.059	0.0002	0.004	0.0157	0.00018	0.002
Construction (Year 1)	7,521	20,416	447	2	30	118	1	15
Maintenance (annual)	505	1,371	30	0.1	2	8	0.1	1
Maintenance (22 years)	1,1110	30,162	660	2.2	44	176	2.2	22
Total construction and maintenance	18,631	50,578	1107	4.2	74	294	3.2	37

11 Operational emissions would arise principally from the activities associated with maintaining the vessels, and are significantly lower than the construction activities. The vessels used in the decommissioning activities are not yet known, however it is expected that vessels similar to that used for the construction activities would be used in a decommissioning capacity. Hence, the installation emissions can be seen to represent the worst case decommissioning emissions.

25.2.2 Emission Reductions Achieved from Wind Energy

12 A comparison of the lifecycle of different electricity generation systems currently used in the UK was undertaken by the Parliamentary Office of Science and Technology in 2006, this report concludes that while all electricity generation technologies emit CO_2 during their lifecycle, and that no CO_2 is actually generated from the wind turbines themselves during the operational stage, offshore wind power ranks as one of the lowest carbon footprints generating 5.25 g CO_2 equivalents/kWh. The only operational CO_2 emissions as part of the EOWDC are activities associated with maintenance of the wind turbines.

13 Electricity generated from offshore wind turbines is able to replace the output of coal and gas fired power stations as these are the most flexible plants on the grid and can relatively easily increase and decrease production capability to meet demand. Wind energy does not replace electricity from nuclear power stations because these operate at 'base load', that is they would be working for the whole time that they are available. The energy savings in tCO_2 have been presented in relation to a variety of conventional energy sources including coal fired plant, grid mix and fossil fuel mix, the savings of tCO_2 per year and over the course of the 22 years of operation are presented along with the associated emission factors are presented in Table 25.4.

14 The emissions reductions in tonnes has been calculated using the following formulae:

CO_2 = (A*0.35*8,760*Emission factor)

Where:

- A = the rated capacity of the wind energy development in MW (the EOWDC would include 11 three bladed wind turbines with a maximum power generation of up to 100 MW)
- 0.35 is a constant, assumed capacity factor for offshore, which takes into account the intermittent nature of the wind, the availability of the wind turbines and array losses
- 8,760 is the number of hours in a year

Table 25.4
Emission Factors for Coal Fired Plant, Grid Mix, and Fossil Fuel Mix Emissions

Source	Emission factor tCO_2 MWh^{-1}	Emission reductions per year tCO_2	Emission reductions 22 years tCO_2
Grid mix	0.43*	131,838	2,900,436
Fossil fuel mix	0.607**	186,106	4,094,336
Coal fired plant	0.86*	263,676	5,800,872

*Defra (2002)
**(DECC, 2007; DBERR, 2007)

15 This would lead to emission reductions that are between 131,838 – 236,676 tCO_2 per year and 2,900,436 – 5,800,872 tCO_2 for the up to 22 years that the EOWDC may be operational.

25.2.3 Energy Balance and Pay Back Time for the EOWDC

16 The comparison of energy used in the manufacture with the energy produced by a power station is known as the energy balance. One of the measures of this is the 'pay back' time that is, the time taken for the EOWDC to generate the equivalent amount of energy as used in its manufacture. At this stage in the process the energy costs associated with the wind turbine manufacture are not known so a full lifecycle carbon analysis or calculation of the pay back time is not possible. In carrying out overall system calculations there may be a requirement for a backup figure to be included in line with Scottish guidance, this figure would be 15 % installed capacity or 5 % of the actual output (Scottish Government, 2011 Carbon Payback Calculator).

17 A comparison of the lifecycle emissions saved by the generation of the electricity at the EOWDC, using the lowest emissions reductions of the grid mix (2,900,436 tCO_2), against the emissions generated during the installation

and maintenance over the lifecycle of the project (50,578 tCO_2). The atmospheric emissions generated by installation and maintenance represent only 1.74 % of the emissions that are saved, which is a small proportion of the total savings.

18 Although the emissions associated with the manufacture are not known at present it is expected that the payback of electricity would be accomplished within 10 months, as Renewable UK state "the average wind farm in the UK will pay back the energy used in its manufacture within three to ten months, and over its lifetime the wind turbine will produce over 30 times more energy than was used in its manufacture" (Renewable UK, 2011).

25.3 Summary

19 The main atmospheric emissions would be generated during the manufacture, construction and maintenance of the EOWDC. Once the wind farm is operational the only emissions would be as a result of the regular maintenance trips. The EOWDC is expected to pay back the energy required within a maximum of 10 months. The generation of renewable energy from wind power is expected to result in a significant saving of greenhouse gas emissions in comparison to generating electricity produced from conventional coal and gas power stations.

European Offshore Wind Deployment Centre

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Chapter 26: Electromagnetic Interference

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

26 ELECTROMAGNETIC INTERFERENCE

26.1 Introduction

1 This chapter considers the potential implications of the European Offshore Wind Deployment Centre (EOWDC) in relation to the potential for electromagnetic interference.

2 The following technical reports have been used when completing this chapter and can be found as:

- Navigational Risk Assessment (Appendix 15.1)

3 Wind turbines can cause electromagnetic interference (EMI) by two means:

- physical interference – caused by the wind turbine providing a second path between the transmitter and receiver of the signal causing "scattering" of the signals. This can lead to a phenomenon called "ghosting" on television screens
- electrical interference – caused by electrical signals generated within the wind farm infrastructure, principally the wind turbine. Modern wind turbines are designed to minimise the emission of such interference

4 Wind farms have the potential to cause adverse effects on communication systems, which use electromagnetic waves as the transmission medium (for example, television, radio or microwave links). The nature of the interference depends on the size of the structure relative to the wavelength of the radiation. Provided careful attention is paid to siting, wind turbines should not cause any significant problems of electromagnetic interference.

5 In the unlikely event of the EOWDC causing television interference the developer would agree to rectify any problems associated with the project.

26.1.1 Methodology Consultation

6 In order to assess the potential impact of EMI by the proposed development consultations were undertaken with the following stakeholders:

- Joint Radio Company (JRC) (8th July 2010 4th April)
- Atkins Ltd (21st June 2010 and 4th April 2011)
- OFCOM (15th June 2010 and 4th April 2011)

7 An on-line tool to estimate potential television interference provided by the BBC was also used as a source of information about the potential impact from the project on 16 June 2011.

8 In August 2010 the Scoping Report for the EOWDC project was sent out to the following stakeholders for comment:

- British Telecom (Radio Network Protection Team)
- Joint Radio Company (JRC)
- Atkins Ltd
- OFCOM

26.1.2 Data Information and Sources

9 The Office of Communications (OFCOM) holds a central register of all civil and radio communications operators in the UK and acts as a central point of contact for identifying specific consultees relevant to site.

26.2 Baseline Assessment

26.2.1 Television Reception

10 Television reception can be affected when viewers are within the shadow of a wind farm. This is a problem more closely associated with onshore wind farm developments where signals from the main masts could be influenced by the installation of wind turbines.

11 An on-line tool to estimate potential television interference provided by the BBC indicates that no households would be affected by the development of the EOWDC.

26.2.2 Microwave and Other Telecommunications

12 Contact was made with OFCOM regarding the proposal. Information on the site centre and the radius of the development was submitted.

13 OFCOM responded that there are currently no fixed link ends within or fixed paths that cross the site in respect of microwaves.

14 For scanning telemetry the information was passed to both the Joint Radio Company (JRC) and Atkins Ltd both of whom responded with no objection to the proposal.

26.2.3 Maritime Communication and Navigation

15 The Navigational Risk Assessment (NRA) (Appendix 15.1) carried out in 2011 highlighted that there are no anticipated impacts upon maritime communication and navigation devices as a result of electromagnetic interference associated with the development of the EOWDC.

26.3 Impact Assessment

26.3.1 Television Reception

16 The BBC assessment tool highlighted that there is no possible interference predicted for any households, the impact is therefore considered to be negligible.

26.3.2 Microwave and Other Telecommunications

16 None of the consultees mentioned in Section 26.1.1 raised objections to the proposal and no impacts were predicted. Therefore the impact is considered to be negligible.

26.3.3 Maritime Communication and Navigation

17 The NRA indicates that there are no anticipated impacts upon maritime communication and navigation, therefore possible impacts are considered to be negligible.

26.3.4 Mitigation and Monitoring

18 No specific mitigation of monitoring is envisaged. In the event of an impact the situation would be analysed and suitable mitigation measures would be taken so that there are no residual impacts as a result of this development.

26.4 Summary

20 There are not likely to be any detrimental effects from EMI as a result of the EOWDC proposal. If any problems are identified during construction, operation or decommissioning, it is likely that these could be resolved quickly and satisfactory.

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Chapter 27: Other Marine Users

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

27 OTHER MARINE USERS

27.1 Introduction

1 This section of the Environmental Statement (ES) considers other marine users in the EOWDC development area that could be potentially impacted by the development. This assessment was undertaken by Genesis Oil and Gas Consultants. The following activities were considered for assessment:

- oil and gas industry
- pipelines, cables and telecommunications
- other wind power resources
- dredging and disposal sites
- commercial shipping and navigation
- salmon net fisheries and recreational fishing
- Ministry of Defence firing range
- Drums Link firing range
- recreational sailing
- surfing
- kite surfing
- canoeing and sea kayaking

2 Figure 27.1 illustrates other marine users within the vicinity of the EOWDC.

3 A number of the other marine users are discussed in other sections of this ES (eg commercial shipping and navigation; and fisheries), such users will be discussed briefly here with further details provided in their appropriate sections.

27.1.1 Methodology Consultation

4 The following organisations and stakeholders were consulted during the assessment:

- RYA (14th February 2011)
- MoD (10th December 2009)

27.1.2 Key Guidance Documents

5 The assessment of other marine users was under taken based on the following guidance and literature:

- Aberdeen Harbour Board. (2005). Dredging Aberdeen Harbour: A Presentation to the Scottish Branch of the Hydrographic Society. Retrieved May 2011, from The Hydrographic Society: http://www.ths.org.uk/documents/ths.org.uk/downloads/dredging_aberdeen_harbour.pdf
- Marine Scotland. (2008). Scottish Salmon and Sea Trout Catches, 2008, Fisheries Series No. Fis/2009/1. Retrieved 2011 May from http://www.scotland.gov.uk/uploads/documents/SCSB08.pdf.

- RenewableUK. (2011). Operational wind farms. Retrieved May 2011, from RenewableUK - the voice of wind and marine energy: http://www.bwea.com/ukwed/operational.asp
- RYA. (2009). The RYA's position on offshore energy developments - December 2009. The Royal Yachting Association (RYA).
- The BMF. (2010). UK leisure, superyacht and small commercial marine industry - key performance indicators 2009-10. Surrey: The British Marine Federation (BMF).
- Visit Scotland. (2009). Visit Scotland Tourism Statistics.
- RYA Personal Communication 14 February 2011

27.2 Impact Assessment Methodology

6 The structure of this assessment is as follows:

- a summary of the baseline data related to other users of the sea
- an assessment of the impact of the project on other users of the sea
- a summary of findings from the above for this ES

7 As a number of the other marine users have been dealt with in other parts of this ES, the baseline data will be included in this chapter as opposed to in a separate baseline report.

8 Potential impacts of the development on other marine users were identified and assessed. Potential impacts were assessed in terms of their magnitude (based on spatial duration and scale of effect) and the sensitivity of the receptor to the impact. A combination of the sensitivity of the receptor and the magnitude of effect was used to determine the significance of the impact Table 27.1. From this impacts were deemed either; major, moderate, minor or negligible. For those impacts that were considered to be significant (moderate or major) additional mitigation measures were considered to demonstrate that the risk was as low as reasonably practicable (ALARP).

TABLE 27.1
Matrix Used to Assign Level of Significance of Impact

Magnitude of Effect (spatial extent, duration of effect and scale)	**Sensitivity of Receptor (based on importance and recoverability)**			
	Very High	**High**	**Medium**	**Low**
Very High	Major	Major	Major	Moderate
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Moderate	Minor
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

27.3 Baseline and Impact Assessment

9 This section presents a description of each of the marine users identified above and an assessment of the potential impacts caused by the proposed EOWDC. Additional mitigation measures for impacts that were deemed significant are discussed also, and impacts that are deemed negligible, or discussed in other sections of this ES, were not explored further.

27.3.1 Offshore Oil and Gas Industry

10 As discussed in the socioeconomic assessment (Chapter 23), oil and gas exploration and production is a significant contributor to employment within Aberdeen and Aberdeenshire (ie the development area).

11 There are currently no oil and gas fields within the EOWDC nor is there any related infrastructure. The closest pipelines are gas pipelines entering into the St Fergus Gas Terminal, which is north of Peterhead. Therefore there would be no impact on oil and gas installations from the wind farm development.

12 Although no oil and gas infrastructure exists within the development area, Aberdeen harbour is an important communications link for the industry. The wind farm's impacts on shipping and navigation are detailed in Chapter 15 Shipping and Navigation.

13 Due to the location of the development and the measures in place to mitigate impacts on shipping and navigation it is anticipated that the impacts on the oil and gas industry would be negligible.

27.3.2 Pipelines, Cables and Telecommunications

14 There are two abandoned telecommunications cables within the vicinity of the EOWDC (Figure 27.1), there are no other cables within development area.

15 It is possible, depending upon the chosen subsea cable route that the abandoned telecommunications cables may have to be crossed. The design of any crossing would be agreed with the owner of the cable to ensure that the integrity of all the assets is maintained. Thus, impacts on pipelines and cables are anticipated to be negligible.

27.3.3 Other Wind Farms

16 A number of onshore wind farms are located within the Aberdeen area however, there are no offshore developments within the wider Aberdeen area (RenewableUK, 2011).

27.3.4 Dredging and Disposal Sites

17 There are currently only two licensed dredging areas in Scotland, neither of which is located within the development area. However, occasional maintenance dredging activities occur in Aberdeen Harbour.

18 Maintenance dredging is required to widen the Harbour after sediment build up. Current proposals for Aberdeen harbour are for the mouth to be dredged by 8 m and dredging further in port to reach 7 m, this is scheduled for 2012. Previous dredging of the Harbour took place in 2005 with a total of 190,000 m^3 of material dredged and deposited approximately 90 km from the Harbour (57o07 N, 02o00 W)(Aberdeen Harbour Board, 2005). As this dredging is occasional and assuming a similar disposal site would be used, the impacts of the EOWDC on maintenance dredging are anticipated to be negligible.

19 There is a disused explosive dumping ground approximately 6.4 km from the EOWDC site. As this is no longer in use, and no activities associated with the development of the EOWDC would disturb this ordnance deposit, the impacts are considered to be negligible.

27.3.5 Shipping

20 The navigational impacts are assessed in more detail in the ES chapter on navigation (Chapter 15).

27.3.6 Fishing

21 There are 11 salmon fisheries along the coastline of the Aberdeen and Aberdeenshire area spanning across two fisheries districts, the Don and Ythan (see Figure 27.1).

22 The impact assessment Salmon and Sea Trout (Chapter 22) and Commercial Fisheries (Chapter 21) consider impacts to fisheries in more detail.

27.3.7 Ministry of Defence Operations

23 A firing range is situated to the north of the EOWDC, the Black Dog Firing Range (Figure 27.1). The Black Dog Firing Range is a small arms firing range on the coast with an associated exclusion zone at sea.

24 Following consultation with the Ministry of Defence (MoD) the layout of the wind farm was altered. Along with the wind turbines closest from shore being removed for shipping interests, the two northern most wind turbines were removed due to potential impacts on the Black Dog Firing Range, one of which was within the boundaries of the firing range's safety exclusion zone. . Other MoD operationsare discussed in Chapter 17.

27.3.8 Drums Link Firing Range

25 The Drums Link Firing Range is situated to the north of the EOWDC. The Aberdeen Full Bore Gun Club owns this private range and uses it for small bore and low power rifles as well as muzzle loading pistol shooting. The exclusion zone extends 2 km offshore. No modifications to the gun clubs activity are required as part of the development of the EOWDC and the impact upon this user group is expected to be negligible.

27.3.9 Surfing, Kite-surfing, Windsurfing and Canoeing

26 There are a number of other widespread water-borne recreational activities of importance. The British Marine Federation (BMF) estimated that in 2009 across Scotland 52,869 adults participated in surfing, 23,952 in windsurfing and 37,416 in canoeing. Fraserburgh, which is located within the development area, is a particularly popular surfing location and regularly holds surf competitions and events such as the UK Surf Tour and Fraserburgh Surf Festival. There are a number of popular surfing and windsurfing sites along the coast of the development area including:

Lossiemouth, Spey Bay, Sandend Bay, Cullen, Banff, Pennan, Stonehaven and St Combs.

27 The principal surfing area within Aberdeen Bay is the beach, where depending upon the prevailing swell conditions surfers are either located at the northern area of the beach; south of the mouth of the Don, or to the north of the entrance to Aberdeen Harbour.

28 Kite surfing has become increasingly popular in recent years. The kite surfing areas are different from those chosen by surfers. The presence of groynes along Aberdeen beach creates suboptimal conditions for kite surfers. The main kite surfing locations are Cruden Bay, Fraserbough and Balmedie, with Balmedie being the most popular destination for kite surfing.

29 Kite surfers tend to surf within the immediate proximity from the shoreline where the waves are largest for performing aerial tricks. Kite surfers tend to transit back and forth along the shoreline area, and rarely venture more than 2 km offshore.

30 Windsurfing is lower in popularity than either surfing and kite surfing in Aberdeen. Windsurfers can be seen infrequently during all times of the year throughout Aberdeen Bay.

31 Surf kayakers can occasionally be seen amongst the surfers at Aberdeen beach and they utilise the same areas. The area south of Aberdeen along the sea cliffs is routinely used for sea kayaking, and this sport is typically done during the calmer summer moths.

32 The EOWDC is located approximately 2 to 4.5 km from shore and north of the main surfing areas, but close to Balmedie which is used for kite surfing. There is not expected to be any detrimental effect upon the wave period, wind quality, as a result of the development of the EOWDC and the impacts upon these water sports is anticipated to be negligible.

27.3.10 Recreational Sailing

33 This section explores potential impacts of the wind farm on recreational sailing.

34 According to the Royal Yachting Association (RYA), recreational boating and sailing tourism contributes approximately £300 million to the Scottish economy. Sailing activity in the east of Scotland occurs mainly in the Firth of Tay and Firth of Forth and along the southern section of coastline in this region. The RYA (2009) highlights two potential impacts on recreational boating as a result of offshore wind farms:

- navigational safety
- loss of routes and sailing and racing areas

27.3.11 Navigational Safety

35 This is covered within Chapter 15 Shipping and Navigation.

27.3.12 Loss of Routes and Sailing and Racing Areas

36 The main concern associated with an offshore wind farm and recreational sailing routes is "squeezing." Recreational routes differ from commercial routes as recreational crafts are essentially aiming to avoid major commercial routes by travelling in shallower adjacent waters or taking other routes entirely (RYA, 2009). The approaches to the port of Aberdeen harbour can be very busy with vessels entering and leaving. Many recreational vessels follow an inshore route from the Forth of Peterhead and vice versa, often at night to take advantage of favourable tidal flow. Only some recreational vessels are equipped with radar and AID and great care is needed to avoid commercial vessels entering or leaving Aberdeen. Therefore, there is the danger of "squeezing" recreational crafts between the commercial shipping routes and the development (RYA, Pers Comm., 14th February 2011).

37 The layout of the wind farm has been designed to minimise impacts on other users of the sea, including the removal of the eastern most wind turbine to increase distance from commercial shipping routes. This will, in turn, reduce the risk of squeezing recreational users between the development area and commercial shipping routes. Furthermore, due to small crafts being excluded from safety zones they can navigate within the EOWDC.

38 Some recreational vessels within the development area would choose to sail further offshore to avoid the development, therefore effective marking and lighting would be essential and needs to be considered from the point of view of recreational craft as well as much larger commercial vessels. (RYA, Personal Communication, 14th February 2011).

39 Wind farms can have significant negative impacts on an event site (eg racing areas) through interference with wind speed and / or turbulence. However, most general day sailing and racing areas are close to the shore and in more sheltered waters, thus the development is unlikely to impact such activities (RYA, 2009).

27.4 Summary of Impacts

40 As discussed above the proposed development has the potential to impact a variety of other marine users, however, most impacts are anticipated to be negligible.

27.4.1 Mitigation and Monitoring

41 Mitigation measures to control impacts on MoD operations, fishing, shipping and navigation and tourism are discussed in their own sections within this ES.

27.5 Summary

42 There are a number of other marine users that could be potentially affected by the development, however, as this impact assessment has shown the impacts are anticipated to be negligible for all other marine users. With the appropriate mitigation measures in place, including all wind turbines being appropriately lit and marked, along with the layout of the development, it is

not anticipated that other marine users would be significantly impacted by the proposed development.

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Chapter 28: Mitigation, Management and Monitoring

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

28 MITIGATION, MANAGEMENT AND MONITORING

28.1 Introduction

1 Information on mitigation, management and monitoring proposals are presented in the individual impact assessment chapters within this Environmental Statement and are detailed further in the draft Environmental Management Plan (EMP), which has been prepared and is presented in Appendix 28.1. This chapter explains the purpose behind the EMP and presents an outline of the draft EMP structure.

2 The EMP document will undergo several revisions. The version presented here in order to accompany the submission is the draft EMP. Upon receiving consent approval for the proposed European Offshore Wind Deployment Centre (EOWDC, this would be finalised).

3 The aim of the EMP is to ensure that all aspects of environmental management are carried out in accordance with relevant legislation and best practice guidelines.

4 This is to be achieved by taking a fully integrated approach to project management through the complete cycle of preparation, planning, action, monitoring, checking and review.

5 The EMP would be implemented prior to construction in consultation with statutory authorities, with a suite of complementary management plans corresponding to different aspects of the construction activity. The documents would be tailored specifically to ensure compliance with the consent conditions for the project and current environmental best practice. The following documents would be incorporated:

- Commitments Register
- Monitoring Protocol (as per statutory consents)
- Incident Reporting and Non Conformance Procedure
- Emergency Response Plan
- Collision Risk Management Plan
- Marine Pollution Contingency Plan
- Dropped Objects and Materials Recovery Plan
- Archaeology Plan
- Noise, Dust and Vibration Management Plan
- Waste Management Plan

6 The final EMP would be in place well before construction begins to take full account of all pre-construction monitoring requirements.

28.2 Structure of this Document

7 This EMP is divided in to three sections:

- Part 1 provides background and supporting information for the EMP
- Part 2 details in a series of Summary Briefing Notes, the environmental impacts identified to date and the associated commitments made with regard to environmental management, impact mitigation measures and

consent conditions, all of which the Applicant is obliged to carry out. These commitments derive from this ES
- Part 3 provides an introduction to outline construction method statements

8 It should be noted that further commitments could be contained in any consent granted to the project. At such time these commitments would be fully incorporated in to the EMP.

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Chapter 29: Information to Inform a Habitats Regulations Appraisal

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

29 INFORMATION TO INFORM A HABITATS REGULATIONS APPRAISAL

29.1 Introduction

1 The purpose of this document is to provide a summary of the information required to inform any possible Habitats Regulations Appraisal that may be required to be undertaken by the competent authority with respect to the proposed European Offshore Wind Deployment Centre (EOWDC) as required under the EU Habitats and Birds Directives. The Information to Inform the Habitats Regulation Appraisal can be found as Appendix 29.1.

2 The document aims to identify all qualifying species or habitats that, based on data collected at the proposed development site, have the potential to be impacted. A high level assessment on the risk of a possible adverse effect has been undertaken and a conclusion made on the level of risk to a qualifying species or habitat.

3 This assessment is based on site specific data collected from the surveys undertaken so far and, where appropriate, relevant data from other offshore wind farms. The aim of this assessment is to identify species or habitats that may be required to be assessed by the competent authority as part of a Habitats Regulations Assessment and if required an Appropriate Assessment.

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Chapter 3: Description of the Proposed Project

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

3 DESCRIPTION OF THE PROPOSED PROJECT

3.1 Introduction

1 The European Offshore Wind Deployment Centre (EOWDC) is an innovative offshore wind turbine deployment facility proposed off the Aberdeenshire coast close to Blackdog.

2 The vision of the project is:

"To deploy new equipment, systems, processes, and initiate R&D to improve the competitiveness of offshore wind energy production, whilst generating environmentally sound, marketable electricity and to increase the supply chain capabilities in Scotland, the wider UK and Europe."

3 The EOWDC would include 11 three bladed wind turbines with a maximum power generation of up to 100 MW. It is more likely that the power generation would be around 84 MW which is based on the following assumption:

- 4 x 6 MW wind turbines
- 4 x 7.5 MW wind turbines
- 3 x 10 MW wind turbines

4 The wind turbines connected by inter-array cabling would export the electricity onshore to a new substation and then to the National Grid. Additional onshore facilities may include a deployment centre with a research and development centre.

5 This section of the Environmental Statement (ES) describes the details for the proposed offshore elements of the EOWDC, together with a description of the construction, operation, maintenance, decommissioning and their associated timescales.

6 Brief details of the onshore elements are also included for information only as the onshore elements would be included in a separate application as discussed in Chapter 1 Introduction. The exact construction process would depend upon the final details of the equipment to be installed, preferences of the construction contractor, availability of installation plant and, most notably, developments in technology in the near future. In addition, as many of the wind turbines and supporting equipment are still under development, only high level details and envelopes are available at present and are presented within this chapter.

7 The description provided here is based on current best practice, as employed recently on sites both in the UK and across Europe. Where possible, the impact of alternative foundation design or new technologies, practices, and their associated construction techniques are considered.

8 Should additional technologies or methodologies become available these would be considered against this Environmental Impact Assessment (EIA).

3.2 Objectives of the Development

9 As well as delivering renewable electricity to the National Grid, the EOWDC would encourage research, development, knowledge sharing, industry competition and competitiveness by allowing developers and supply chain companies to test a variety of products and applications, including reliability and capacity, in a real time offshore environment prior to commercial deployment. Environmental Management System

10 The successful contractors would need to take into account:

- the requirements of third parties
- the potential impacts and effects outlined in this ES
- the requirements for any mitigation measures and monitoring
- the results of site investigation surveys; and
- any conditions in the consents

11 The Contractors would be required to implement their own Environmental Management System (EMS). The contractors would produce detailed Method Statements and Risk Assessments covering construction activities, such as piling, in accordance with the requirements of this ES and any measures agreed with the statutory authorities. These Method Statements would be subject to approval by the design engineers and in accordance with the approved method statements and standards. Throughout the construction phase, contractors would be audited against their method statements and risk assessments, company policies (including this ES), and UK statutory health, safety and environmental requirements. Health and Safety Management

12 All construction activities shall comply with UK health and safety legislation, in particular the Construction (Design and Management) Regulations 2007, and be conducted in accordance with industry best practice as developed by the UK Health and Safety Executive and RenewableUK. Additionally, all contractors shall be required to comply with the Project's Health and Safety Policy and procedures.

3.3 Site Location and Physical Characteristics

3.3.1 Site Location

13 The EOWDC is located approximately 2.4 km from the coastline of Aberdeenshire at Blackdog. The total area of the wind turbine layout is approximately 4.3 km^2 which is situated within a 20 km^2 lease boundary awarded by The Crown Estate. Water depth on the wind turbine locations ranges from 20 m to 30 m below Lowest Astronomical Tide (LAT). Figure 3.1 shows The Crown Estate Lease Boundary. The wind turbine location coordinates are shown in Table 3.1 and The Crown Estate lease boundary coordinates are shown in Table 3.2.

14 The optimum site layout for offshore structures including the wind turbines is based on several conditions including:

- optimum wind capture
- ground geology conditions
- seabed obstructions including munitions and wrecks

- water depth
- foundation choice
- construction limitations
- scour potential
- operation and maintenance requirements
- electrical layout (array cables, etc.) and
- stakeholder considerations

15 It is proposed that the project may be constructed in two phases. The actual deployment of wind turbines is at this stage not known and the numbers deployed in 2013 and 2014 are variable but for the purposes of the EOWDC assessment, the following has been assumed for the phasing:

- 2013 - 4 wind turbines installed
- 2014 - 7 wind turbines installed

16 It should be noted that this is indicative (ie there could be six wind turbines installed in 2013 and five wind turbines installed in 2014) or all 11 wind turbines could potentially be installed in 2013. Each individual impact assessment has considered which is worst case, a phased deployment over two consecutive years or a full deployment within one phase.

3.3.2 Physical Characteristics

17 The EOWDC project would comprise of various components and construction activities as listed below:

- 11 wind turbines with a total rating of up to 100 MW
- potential for an Ocean Laboratory with meteorological mast (which would be subject to a separate application)
- foundations (gravity, monopile, tripod, suction caisson/bucket, jacket) and scour protection on seabed if required
- transition pieces including access ladders/fenders and landing platforms depending on the foundation
- marine lights/foghorns/or other buoys and markings to the requirements of the Northern Lighthouse Board, International Association of Marine Aids to Navigation and Lighthouses (IALA) and Marine Coastguard Agency (MCA)
- aviation lights to the requirements of Civil Aviation Authority (CAA)
- inter-array cables
- export cables to shore
- onshore cables
- miscellaneous cable joints/cable protection and cable/pipeline crossings
- temporary pre-assembly construction facilities onshore
- onshore substation
- boat landing (quay site in the harbour)
- operation and maintenance facilities depending on wind turbine selection

3.4 Site Layout

18 The wind turbine layout is illustrated in Figure 3.2. The figure shows the locations of wind turbines and an indicative position for the potential Ocean Laboratory.

19 The figure also illustrates the export cable corridor and inter-array cable options.

20 Table 3.1 lists the proposed wind turbine locations, however the exact position of the wind turbine may move slightly due to local seabed restrictions such as archaeology, seabed obstructions or pile refusal. It has been assumed that this move would be no more than 100 m. Figure 3.3 shows the indicative wind turbine spacing for the site.

TABLE 3.1
Wind Turbine Coordinates (UTM30N (WGS84 Datum))

Turbine ID	Easting (m)	Northing (m)
1	559820	6340967
2	559719	6341842
3	559619	6342717
4	560481	6341400
5	560374	6342325
6	560269	6343249
7	561224	6341887
8	561111	6342868
9	560999	6343849
10	561931	6343472
11	561811	6344515

21 The 22 year lease agreement with The Crown Estate includes an area of 20 km^2 and the installed nominal power must not exceed 100 MW. As this is a deployment centre to test first of run wind turbines there may be a requirement to change out the machines at an earlier date than the full potential operating life of the wind turbine.

Table 3.2
Coordinates of Crown Estate Lease Boundary (UTM30N (WGS84 Datum))

Lease Boundary Node (as shown on Figure 3.2)	Easting (m)	Northing (m)
1	559430	6345131
2	563485	6346152
3	561740	6340780
4	557684	6339759

22 Wind turbine technology is developing at a fast pace, so to ensure the project is adequately future proof, wind turbines in the range of 4 MW to 10 MW have been proposed for the purpose of this EIA, even though 10 MW is currently not available. With a maximum installed capacity of 100 MW, the project may contain a range of wind turbines ranging from 4 MW to 10 MW and the mix may also vary over time. Table 3.3 lists some maximum parameters of the 4 MW and 10 MW machines

TABLE 3.3 Wind Turbine Parameters		
Parameter	**4 MW**	**10 MW**
Maximum Height of Nacelle (above LAT)	100 m	120 m
Maximum Rotor Diameter	120 m	150 m
Maximum Tip Height (above LAT)	160 m	195 m

3.4.1 Construction Laydown Areas

23 At the port of shipping, during the construction period, space on the quay would be required for mounting and temporary storage of foundations, pre-assembly of the wind turbines, cables and other components of the project. It may be the case that several mobilisation ports may be utilised for different activities depending on vessel transits and restrictions. In addition, space at the quayside would be required for the vessels used for the establishment of the project (jack-up platforms, barges, tugs, cable vessels etc.) to anchor during downtime periods. Table 3.4 shows typical anticipated laydown areas associated with the construction of a typical wind farm.

TABLE 3.4 Typical Laydown Areas	
Activity	**Construction Area (m^2)**
Storage of piles and assembly of transition pieces	100,000
Storage are for cable contractor (cable drums)	10,000
Pre-assembly of wind turbines	40,000 + offices and storehouse for components
Storage area for towers at paint shop	27,000
Storage area for bays at factory	27,000

3.5 Access Arrangements to the Site

3.5.1 During Construction

24 During the construction period, the crews/workers are most likely to reside in either onshore accommodation or accommodation on board the work vessel (depending on work hours and availability). If necessary, the daily transport between local port and the site would take place by transfer vessels.

3.5.2 During Operation

25 When operational, the wind turbines would be monitored remotely from an onshore operational/storage base. Service personnel would travel to the site as required for planned and unplanned maintenance work. The wind turbines would be accessed by transfer vessels. There would be at least one boat landing arrangement on the foundations. There are no plans to use helicopters for maintenance of the wind turbines, but the wind turbines may be equipped with a heli-hoist platform for possible future maintenance and Health and Safety activities.

3.5.3 Exclusion Zones

26 For health and safety reasons, exclusion zones would be sought during the construction operational and decommissioning phases. These are discussed further below.

3.5.3.1 During Construction

27 In the construction phase, advisory zones or safety (exclusion) zones of 500 m around the construction works would be sought to keep construction and non-construction vessels separate. These safety zones would be reviewed monthly and clearly marked using buoys. Notifications would be issued in accordance with statutory procedures. The vessels laying the cables to shore would have their own advisory or safety (exclusion) zone extending up to 500 m in addition to a 250 m safety zone either side of the cable corridor. There would be close liaison with port authorities and Maritime Coastguard Agency (MCA) particularly when working in close proximity to marked navigation channels and other anchorage areas. Where necessary guard vessels may also be employed should operations be phased/broken.

3.5.3.2 During Operation

28 It is thought likely operational safety (exclusion) zones would be sought for and should if granted take effect when construction exclusions finish. A navigational safety (exclusion) zone would then likely apply between 50 m and 100 m around each wind turbine foundation tower. The potential impact of these safety (exclusion) zones on navigational interest and fishing interest are discussed in Chapters 15 Shipping and Navigation and 21 Commercial Fisheries. Potential exclusion zones are shown in Figure 3.4.

3.6 Wind Turbines

29 The Applicant is proposing to install 11 three bladed horizontal axis wind turbines. As this is a deployment centre the exact models and types of wind turbine would only be chosen through assessment of wind turbines during detailed engineering and chosen on the basis of various selection criterias, including testing, operational and commercial aspects. The wind turbines may be replaced in the future life of the project to allow testing of newer wind turbines. An in-principle design of a wind turbine is shown in Plate 3.1. A mixture of wind turbines are expected on the site as these are pre-commercial deployments and therefore there are likely to be two to four of each type of wind turbine, not all 11 would be is the same.

Plate 3.1 3 MW Wind Turbines Installed at the Kentish Flats Offshore Wind Farm (Photographer Chris Laurens)

30 The wind turbines would likely begin generating electricity at 3 m/s hub height, achieving their maximum power output in winds greater than approximately 13-14 m/s hub height. They would continue generating up to wind speeds of 25 to 30 m/s where they would be designed to automatically shut down.

31 The blades would most likely be made of fibre-reinforced epoxy. The towers would be made in sections of tubular steel with an approximate diameter ranging from 5 m to 8.5 m at the foundations tapering to 3.5 to 5 m at the top.

32 On top of the tower the nacelle is placed containing among others the generator and controls.

33 The transformer would be placed in either the nacelle or in the tower. It transforms the electricity to minimise the loss through the cable to the substation.

3.6.1 Colour Scheme

34 Colour scheme of the turbine tower, nacelle and blades is likely to be light grey RAL 7035, white RAL 9010 or equivalent.

3.6.2 Dimensions and Airdraft

35 A schematic drawing of a wind turbine with maximum dimensions is shown in Figure 3.5. Minimum blade tip clearances of the wind turbines being considered for EOWDC is 22 m above MHWS.

3.6.3 Oils and Fluids

36 The wind turbine would contain the following approximate quantities of mineral lubricating and hydraulic oils:

- Gear box oil: Approximately 0–1,000 litres of mineral oil
- Hydraulic oil: Approximately 200–300 litres
- Yaw/pitch motor oil: Approximately 20 -100 litres
- Transformer oil: Approximately 0-3,000 litres
- Cooling fluids: Approximately 0-1,000 litres

37 The nacelle, tower and rotor would be constructed to accumulate any leaks from the construction and operation. Thereby leaks to the environment would be minimised.

3.6.4 Noise and Vibration from Operating Wind Turbines

38 Noise emissions from wind turbines could be separated into two categories: aerodynamic and mechanical noise. Aerodynamic noise occurs when the wind is passing the blades and mechanical noise is emitted from the engineering components of the wind turbine such as gearbox and generator. Although the larger wind turbines that are being considered for EOWDC site are not yet under production and therefore the noise characteristics have not been measured, the wind turbine manufacturers predict that the wind turbines would have a noise output of no greater than 110 dB(A) at hub height measured according to the IEC 61400-11 standard.

3.6.5 Installation of Wind Turbines

3.6.5.1 Base Case Method

39 The wind turbines are expected to be installed using an crane of suitable size located on a jack-up vessel. A jack-up vessel is a barge or ship that once in position lowers its legs onto the seabed and when the legs are sufficiently stable the vessel then jacks itself up out of the water. Jack-up vessels come in a range of specifications and can either be self propelled or require the assistance of tugs and anchor handling vessels to locate.

40 The wind turbines would be transported to site either on the jack-up vessel or to the jack-up on a barge or another jack-up. The installation crane lifts the wind turbine parts from the jack-up/barge onto the foundation, see Plate 3.2.

Plate 3.2 Jack Up Installation Barge at Ormonde Offshore Wind Farm

41 Experience has shown that it normally takes 24 hours to position the jack-up and erect a wind turbine requiring a total of 4–5 lifts per wind turbine to complete installation. Normal procedure would be that the bottom tower is mounted first followed by the top section. Following the top section the nacelle and the rotor/blades are mounted.

3.6.5.2 Alternative Methods

42 As part of the Deployment Centre aspect of the project, the Applicant would look for alternative methods for wind turbine installation. This may include installation of the wind turbine and foundation as a single operation or utilising dynamically positioned vessels rather than jack-up vessels.

43 Should alternative methods be utilised the impact on the marine environment would be the same or less than that described and evaluated above.

3.6.6 Material Requirement

44 Typical weights for EOWDC wind turbine (10 MW):

- rotor including blades: 120 tonnes fibreglass (three blades) and 150 tonnes steel
- nacelle: 70–600 tonnes mainly steel
- tower: 700 tonnes steel

3.6.7 Control Functions and Safety Features

45 All wind turbines would be designed to allow for the following safety features:

- manual yawing of the wind turbines shall be possible via the remote control
- remote parking of the wind turbines in an oriented stop, to allow for heli-hoist operation

3.6.8 Emergency Provisions

46 The wind turbines would be equipped with emergency provisions for personnel of the service team. The personnel of the service teams would be trained to work with these emergency provisions.

47 Emergency escape and access hatches to the wind turbine nacelle would be designed as far as practical to be capable of being opened from the outside in order to allow rescuers (eg helicopter winch-man) to gain access through the nacelle to the tower if personnel of the service team are unable to assist and when a sea-borne approach is not possible.

48 Ladders for access to the foundation platform for use in emergency or refuge would be placed in the optimum position taking into account the prevailing wind, wave and tidal conditions.

3.6.9 Wind Farm Marking and Lighting

49 All wind turbines would be marked with clearly visible unique identification characters. Characters would be visible from all sides of the wind turbine and would comply with requirement in MCA Marine Guidance Notice MGN 275 (M) (MGN 275) that they should be visible from at least 150 m from the structure and be permanently lit by down-lights to minimize light pollution. As an alternative to permanent down-lights the option of Light Emitting Diodes (LEDs) to mark the identification characters is included.

50 Logos and identification would be included on the offshore structures including Vattenfall, the European Union (EU) Flag and other manufacturer requirements.

51 The wind farm would be designed and constructed to satisfy the requirements of the Civil Aviation Authority (CAA) and the Northern Lighthouse Board (NLB) in respect of marking, lighting and fog horn specifications. The typical arrangement using the Navigation Risk Assessment layout (see Chapter 15) is shown in Figure 3.6. This arrangement would be adjusted in consultation with CAA and NLB, MCA and IALA.

52 The CAA has issued “Lighting of Wind Turbine Generators in United Kingdom Territorial Waters” in accordance with Annex A to 8AP/51/06/19 dated September 2003. The guidelines have been applied to the typical arrangement as follows.

53 For aviation purposes, wind turbines would be marked with aviation lighting in line with the following:

- each wind turbine located at the corner would be fitted with aviation lighting
- in addition, aviation lighting would be installed along perimeter wind turbines so a maximum gap of 3.5 km between lighting

54 Lights would be fitted to be visible in all directions without interruption (the shadowing effect of passing blades is not considered to be an interruption in this context):

- the angle of the plane of peak intensity shall be elevated to between 3 and 4 degrees above the horizontal plane
- not more than 45 % or less than 20 % of the minimum permitted peak intensity shall be visible at the horizontal plane
- not more than 10 % of the minimum peak intensity shall be visible at a depression of 1.5 degrees or more below the horizontal plane

55 The navigational marking specifications for the typical arrangement would be agreed with the Northern Lighthouse Board (NLB). The Applicant proposes the following in accordance with IALA Recommendation 0-139 (see Figure 3.6):

- wind turbines foundations and towers would be painted yellow from highest astronomical tide (HAT) to 12 m above Highest Astronomical Tide (HAT)
- the wind turbines in the periphery of the wind farm would be marked with yellow flashing lights and potential fog horns as shown in Figure 3.6
- navigation lights would only be installed at the correct elevation on outer boundary wind turbines
- an uninterruptible power supply would be installed

3.7 Foundations

56 This section is applicable for all offshore wind farm structures requiring foundations including:

- wind turbines
- potential Ocean Laboratory including meteorological mast

3.7.1 Foundation Concepts

57 Foundation selection for an offshore wind farm development is generally influenced by the following factors:

- type of wind turbine/hub height that would be mounted onto the foundation
- wind turbine dynamic loads
- wind turbine access and maintenance requirements
- Mean Sea Level (MSL) and variations in water depth due to tide and meteorological conditions
- dynamic wind and wave loading especially with respect to fatigue
- extent of local scour and global seabed movements ie seabed stability
- soil conditions on which foundation would bear including drivability/drill ability

- transportation/logistics
- material costs/manufacturing costs and limits
- installation limits with respect to crane capacities, piling, drilling equipment, etc
- cable entry to foundation base

58 The Front End Engineering Design (FEED) studies and tendering process would establish, within the limits of this EIA, which types of foundations are the most cost effective and innovative for the EOWDC project. The following foundation concepts may be considered:

- gravity foundation
- monopile in steel
- steel tripod or piled concrete tripod
- jacket structure
- suction bucket

59 As part of this process, the installation of the foundation and the equipment requirements would also be considered. In addition, wind turbine and foundation manufacturers would also be involved to ensure all optimisation and innovation is considered.

60 There is likely to be a mix of foundations deployed on the site ie not all 11 foundations would be of one type, ie there would not be 11 monopiles installed on the proposed EOWDC site.

3.7.1.1 Gravity Foundation

61 The gravity foundation concept is typically installed in water depths from 0 to 30 m. Most are concrete based but steel based concepts are being developed. A concrete gravity foundation may be manufactured completely from reinforced concrete or a mixture of concrete and steel sections to provide an optimised design.

62 The gravity foundation is constructed such that the base structure has sufficient ballast and surface area to stay in place even at extremely high loading, ie a 50 or 100 year storm.

63 The concept can have slightly different designs in terms of shape and structure ie could be circular in plan or square. The concept and requirements may contain sufficient weight in the design itself for operation or ballast may be added once the structure is located in place. Ballast may be sand, stone or seawater.

64 Dimensions of the gravity base foundation are likely to vary across the site depending mainly on wind turbine size and water depth and seabed geology.

65 Future detailed geophysical and geotechnical investigations would determine locations where the seabed conditions are suitable for gravity foundations. The gravity foundation may be equipped with a 0.5 to 2 m high steel skirt penetrating into the seabed below the bottom plate. This skirt would protect the foundation against scour in the period until scour-protection is in place, if required.

Dimensions

66 The gravity foundation with hollow shaft for a typical wind turbine has the following dimensions as presented in Diagram 3.1:

- maximum outer shaft diameter: 6.5 m
- shaft wall thickness: 0.6 m
- base plate diameter: 20 – 40 m
- base plate thickness: 3 – 9 m
- weight (dry): 2,500 – 9,000 tonne

Manufacturing and Transportation

67 The foundations would be pre-manufactured onshore. Either directly on barges in a harbour, on the quayside or in the case of a towed foundation within a slipway. For the purposes of the ES the fabrication of gravity foundations could be either overseas or in the UK. If manufactured in the UK then the consideration would be given to the provision of a temporary concrete casting facility at a local port with adequate space, draft and facilities (Dundee, Aberdeen or Invergordon).

68 The gravity bases would be shipped directly to the offshore site.

Material Requirement

69 Amounts of material per concrete gravity foundation:

- concrete: 2,000–8,000 tonnes
- steel-reinforcement: 200–1,000 tonnes
- ballast: 0–4,000 m^3 based on sand
- stones for scour protection: up to 2,000 m^3

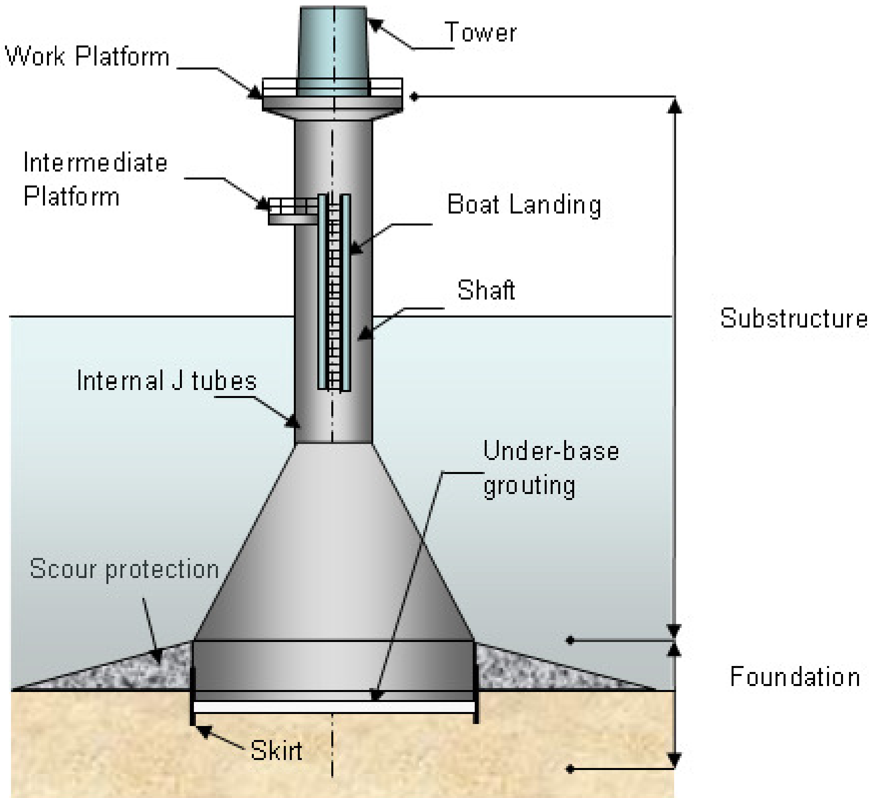

Diagram 3.1 Gravity Base Foundation (Courtesy of GL Garrad Hassan)

3.7.1.2 Steel Monopile

70 In the UK and most other countries (except Denmark) the steel monopile is the most common foundation type used for offshore wind turbines mainly due to suitable ground conditions for the monopile installation.

71 Usually steel monopiles are driven into the seabed from a jack-up barge using a hydraulic hammer which is available in various capacities for either operation above or below the water surface.

72 An alternative installation method includes drilling to assist piling operations ('drive, drill and drive'). Drilling may be applied where ground conditions make driving more difficult.

73 The ability to fully drive piles to a required depth may be limited in the EOWDC site by:

- layers of consolidated glacial material
- Old Devonian sandstone at 25-35 m depth below seabed

74 The drive, drill and drive methodology has been used successfully at other wind farm sites with soil conditions similar to EOWDC. The basic steps of the drive, drill and drive methodology includes:

- driving the monopile down to the obstruction layer
- drill out pile internals (diameter of drill is approx 10–20 % less than internal of monopile) to final pile depth
- drive monopile to final depth

Dimensions

75 Example dimensions of the steel monopile foundations for the EOWDC are given below and the arrangement is shown in Diagram 3.2:

- outer shaft diameter: 4 – 8.5 m
- shaft wall thickness: 0.06 – 0.15 m
- overall length: 50-75 m
- seabed penetration: 30 m +
- weight (dry): 300–1500 tonnes depending on depth

Manufacturing and Transportation

76 The foundations are pre-fabricated onshore. Steel plates are delivered from steel mills to fabricators who roll and weld the plates together into a monopile structure. Once fabricated the monopiles are transported to site either directly or through an interim port.

77 An approximately 10 m long transition piece consisting of a piece of steel pile equipped with a flange in the top may be grouted on the outside of the top of the driven steel pile-fixing the top flange perfectly horizontal. Alternatively a heavy flange might be in place already during the driving sequence.

Material Requirement

78 Typical material amounts per foundation:

- steel: 300 – 1,000 tonnes
- concrete for fixing of transition piece: 25–100 tonnes
- gravel/rock for scour protection: 150–1,250 m^3

79 The volumes do not include for additional volumes of grout or concrete that may be used to secure the monopile in rock.

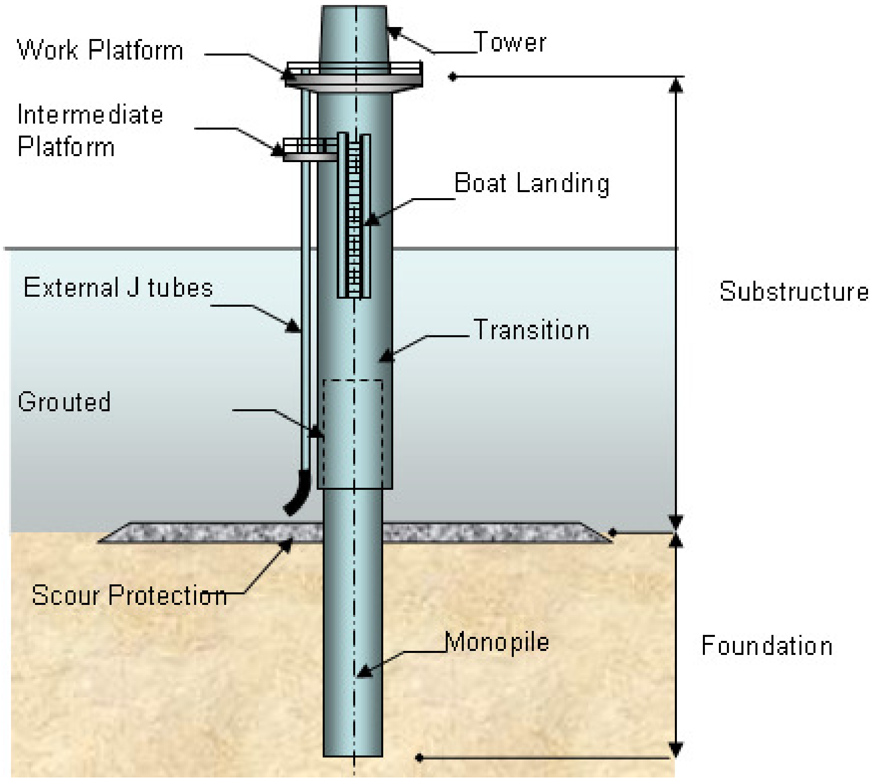

Diagram 3.2 Monopile Foundation (Courtesy of GL Garrad Hassan)

3.7.1.3 Steel Tripod / Piled Concrete Tripod

80 The steel tripod has been extensively used in the oil and gas industry for small, generally unmanned offshore platforms. The concept consists of a steel tube construction above seabed, and of three steel piles driven into the seabed.

81 The concept has only been used a few times for wind turbines, but may be an option for EOWDC for use in areas of greater water depths. Example dimensions are provided below and the arrangement is shown in Diagram 3.3:

- main shaft diameter: 5.5 m
- base footprint width: up to 25 m diameter
- seabed penetration (securing piles): 25 – 35 m
- securing pile diameter: 2.5 m
- overall height: 15 – 35 m (15 m above mean sea level)
- weight: 400 – 1,200 (excluding securing piles) tonnes
- number of piles: 3 (total up to 500 tonnes)

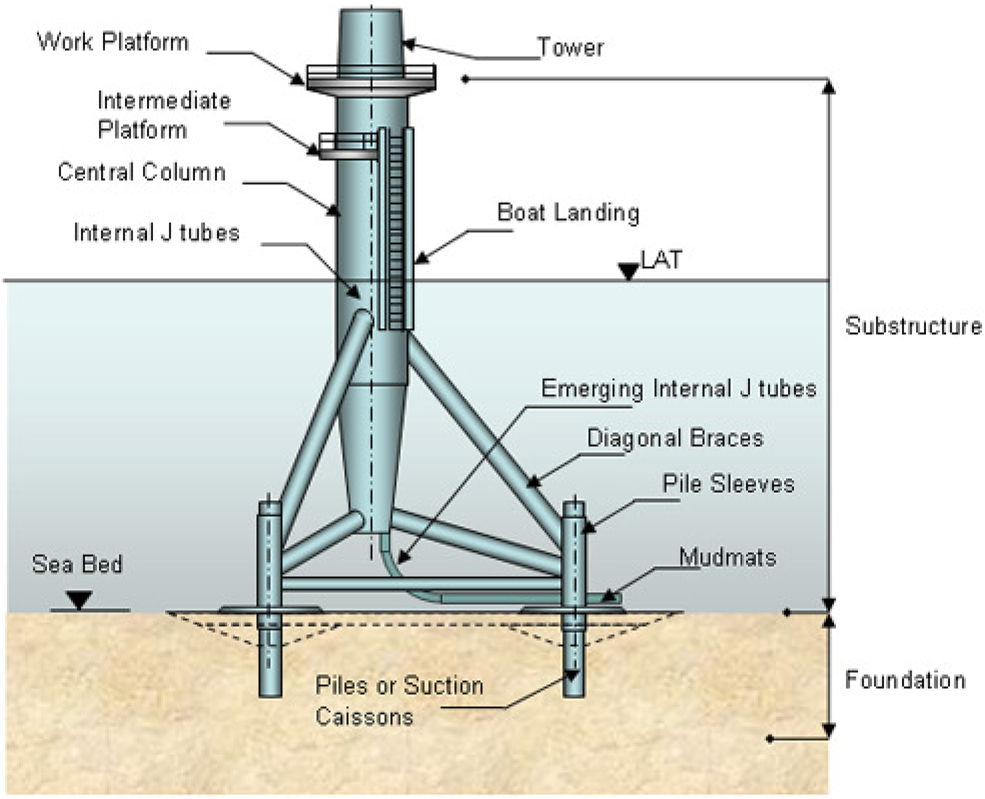

Diagram 3.3 Steel Tripod Foundation (Courtesy of GL Garrad Hassan)

Transportation

82 Transportation methods are similar to that of monopiles, including transporting out on barge and lifting off on-site by crane from a separate installation vessel. A disadvantage is that good weather conditions are required to allow pickup and transfer. Transportation directly on a jack-up or floating crane vessel is also possible.

Material Requirement

83 Typical amounts per foundation:

- steel: 400 – 1,200 tonnes
- concrete for fixing of transition piece: 25 – 100 tonnes
- grout for fixing of piles: 25 – 100 tonnes

Piled Concrete Tripod

84 The piled concrete tripod is a composite construction using steel piles and a concrete and steel construction above the seabed. An additional strength of the concept is a possibility to use the high stiffness of the concrete shaft to replace flexible steel-tower to heights up to 20 – 30 m above mean sea level. While the split of concrete and steel is not fixed a typical split would be steel piles, concrete base and a concrete shaft/tower. The parts are connected with grouted joints. Manufacturing, material requirement, seabed preparation, scour protection and installation methods for this option are similar to those of the gravity foundation.

3.7.1.4 Steel Jacket

85 The steel jacket has been extensively used in the oil and gas industry for small as well as large platforms. The concept consists of a steel tube construction above seabed, and of four steel piles driven into the seabed.

86 The concept has recently been used on the Ormonde Offshore Wind Farm, and may be an option for EOWDC. Example dimensions are provided below and the arrangement is shown in the Diagram 3.4:

- base footprint width: up to 25 m square
- seabed penetration (securing piles): 25 – 35 m
- securing pile diameter: up to 2.5 m
- overall height: 15–35 m (15 m above mean sea level)
- weight: 400–1200 (excluding securing piles) tonnes
- number of piles: 4 (total up to 600 tonnes)
- maximum width of structure above LAT: 21 m

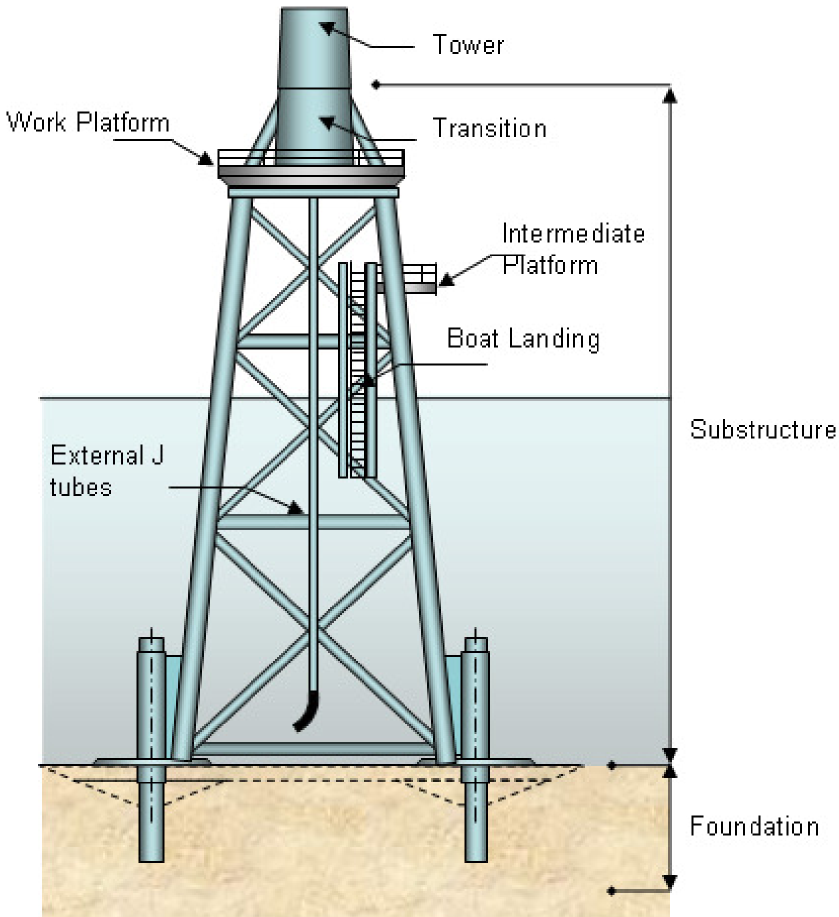

Diagram 3.4 Steel Tripod Foundation (Courtesy of GL Garrad Hassan)

Transportation

87 Transportation methods are similar to that of monopiles, including transporting out on barge and lifting off on site by crane from a separate installation vessel. An advantage of this method is that the installation vessel can remain on site. A disadvantage is that good weather conditions are required to allow pickup and transfer. Transportation directly on a jack-up or floating crane vessel is also possible.

Material Requirement

88 Typical amounts per foundation:

- steel: 400–1200 tonnes
- grout for fixing of piles: 25–100 tonnes

3.7.1.5 Suction Caisson / Bucket

89 The suction caisson/bucket foundation concept is typically installed in water depths from 20 – 50 m. The foundation is generally manufactured completely from steel.

90 The suction caisson is designed so a vacuum can be formed once in contact with the seabed which would then allow the pile to suck into and embed to the required depth. Overturning and gravity loads are resisted by a combination of skin friction around the skirt and to a lesser extent the bearing pressure on the top of the bucket.

91 The concept can have different designs parameters in terms of number of suction buckets and size and shape of buckets. This is a function of install ability and soil and load problems.

92 Dimensions of the suction caisson foundation are likely to vary across the site depending mainly on wind turbine size and water depth and seabed geology.

93 At the site of EOWDC future detailed geotechnical investigations would determine locations where the seabed conditions are suitable. Suction buckets are generally suitable for clay conditions without gravel or boulders and may have limited application at EOWDC, however they could provide a new concept that could be applicable to other sites in the UK.

Dimensions

94 Suction caisson foundations vary greatly depending on design and location and may be a shallow bucket of 20 m diameter or a cluster of deep cans penetrating 18 m deep.

- maximum outer shaft diameter: 6.5 m
- shaft wall thickness: 0.1 m
- maximum base diameter: 20 m
- penetration: up to 18 m
- weight (dry): 600–1,500 tonnes

Manufacturing and Transportation

95 The foundations would be pre-manufactured onshore in a similar manner to monopiles and tripods. For the purposes of the ES the fabrication of foundations could be either overseas or in the UK. If manufactured in the UK then consideration would be given to the provision adequate quayside draft and lifting at the manufacturing facility.

96 The foundations would be shipped directly to the offshore site.

3.7.2 Foundation Installation

3.7.2.1 Gravity Base

Soil Disposal

97 The worst case volume of sediment per gravity foundation has been calculated assuming preparation over a circle with a diameter of 40 m and down to a depth of 1 m.

98 The volume of sediment = $(40\ m/2)^2$ * pi * 0.5 m =628 m^3 of sediment (sand) per gravity foundation.

Expected Noise levels

99 There is expected to be no major noise generation during the installation operations other than general noise from vessels, lifting operation and ballasting which would all be significantly less than monopile piling operations (see section 3.7.2.2).

Seabed Preparation

100 At the EOWDC site the seabed generally consists of sand overlying clay, with the thickness of the top layer of sand varying across the site. In some instances, some levelling or soil removal may be necessary across the base of the foundation. The amount of soil removal or replacement would be evaluated during detailed engineering, however it is expected to be less than the height of local sand waves which are up to 1 m in places. Levelling would be done by using either local sand or a gravel bed. Preparation of the seabed is expected to last 1 – 4 per foundation. It is expected that the seabed may be prepared for one foundation at a time immediately prior to foundation installation.

Installation

101 Installation is likely to be carried out from a floating vessel, either a shear-leg barge or a purpose made barge. The gravity based foundations may be floated using a tug prior to ballasting operations when at location.

Scour Protection

102 Subject to soil conditions a gravity foundation may require scour protection. The basic method of protection is use of gravel and possibly boulders at the periphery of the base plate. A 1 – 1.5 m thick layer of gravel 10 – 15 m extending from the outer edge of base plate perimeter is typical. This might be assisted by a skirt penetrating 0.5 – 2 m into the seabed in the periphery of the base, as presented in Diagram 3.1. Across the site, the seabed appears to be sand overlying clay of varying depths. If the sand is a sufficiently thin veneer, some small amount of scour of the overlying sand may be tolerated in the design.

3.7.2.2 Monopile

Seabed Preparation

103 Generally, seabed preparation is not required although some removal of obstructions may be required but is unlikely.

Installation

104 Monopiles could be transported to site by:

- sealing ends and floating out to the installation vessel
- transporting out on a transportation barge and lifted off on site by crane from a separate installation vessel
- transported out directly on crane vessel (either jack-up type or floating)

105 Once on site the piles are lifted up by a crane on the installation vessel and held in place until driven to final depth.

106 Pile driving of a single monopile could take from less than 2 hours to up to 24 hours if the geology and pilling operation proves to be difficult. It is estimated that on average it would take 4 – 6 hours to drive a single monopile. The overall installation time would however be longer as the pile must first be lifted, stabbed and the hammer located on top of the pile. The total length of operation may be up to 5 days as the worst case.

107 Generally installation of only one monopile at a time occurs as mobilising multiple vessels for a development the size of EOWDC would not be feasible.

Soil Disposal

108 Driving of monopiles is not expected to create any sediment spill of significance. However should ground conditions require some drilling this may cause sediment spill. Detailed assessment of this impact is detailed in the coastal processes study as presented in Chapter 8 Costal Processes.

109 The drilled hole would be slightly less than the inside diameter of the monopile but for the purpose of this description the outside diameter of the monopile would be used (slightly conservative assumption).

110 Total volume of sediment in this case would therefore be = $(8.5\ m/2)^2 * pi * 37m = 2,100\ m^3$ of sediment

111 The sediment that would be disturbed would consist of sand in the upper layers with clay and sandstone in the lower layers. The drilling activity, if required, could last from one day to five days depending on the ground conditions.

Expected Underwater Noise Levels during Installation of Monopiles

112 Pile driving using an impact hammer is potentially the greatest noise concern with this type of foundation system. High noise levels are produced by the repeated striking of the hammer to drive the pile to depth.

113 However as monopiles are the most common type of foundation system used for wind farms, the factors affecting the noise level are documented and the expected noise level at EOWDC has been assessed.

114 Factors that are affecting the noise levels include:

- seabed substrate
- bathymetry
- pile diameter
- piling equipment

115 No piles of 8.5 m diameter have previously been installed. An assessment of the underwater noise level produced by piling these monopiles has been made and is included as Appendix 3.1. Should noise mitigation measures be required, this would be addressed in the construction procedures.

3.7.2.3 Steel Tripod/ Piled Concrete Tripod

Steel Tripod Soil Disposal

116 Generally, no seabed preparation would be required for the tripod structure other than levelling to position the mud mats. Worst case seabed preparation would involve sediment removal for drilled piles.

117 Volume of sediment = 2.5 m x 2.5 m x Pi/4 x 3 x 35m = 515 m^3 per tripod foundation.

Piled Concrete Tripod Soil Disposal

118 Soil disposal and seabed preparation for a piled concrete tripod is expected to be similar to steel tripod. It is therefore referred to the soil disposal section for steel tripod for sediment volumes.

Expected Noise levels

119 The noise levels during installation of a piled steel or concrete tripod foundation is expected to be less than for monopile installation due to the decrease in pile diameter and therefore piling force which has been found to result in lower levels of underwater sound, however the number of piles increases to three (Nedwell, et al. 2007).

3.7.2.4 Jacket

Installation

120 At site the jacket structure is lifted into position by the installation vessel crane. The jacket is then fixed to the seabed by driving piles through the feet by use of hydraulic hammer. An alternative would be to install a guide frame and pre-install the piles prior to jacket installation. Once driven the piles are fixed to the piled sockets by grouting or swaging. Prior to lifting the jacket into position, seabed preparation may be required to ensure the jacket is level prior to piling. The jacket would be temporarily supported on mudmats prior to piling.

Soil Disposal

121 Generally, no seabed preparation would be required for the tripod structure other than levelling to position the mud mats. Worst case seabed preparation would involve sediment removal for drilled piles.

122 Volume of sediment = 2.5 m x 2.5 m x Pi/4 x 4 x 35mm = 687 m^3 per foundation.

Expected Noise Levels

123 The noise levels during installation of a steel jacket foundation are likely to be less than that for monopile installation due to the decrease in pile diameter and therefore piling force required.

3.7.2.5 Suction Caisson/ Bucket

Seabed Preparation

124 It is not anticipated any seabed preparation would be necessary.

Installation

125 Installation is likely to be carried out from a floating vessel, either a shear-leg barge or a purpose made barge. Floating to site of the suction caisson foundations with tug control may also be an option with ballasting operations when in place.

Scour Protection

126 Subject to soil conditions the foundation may require scour protection. The basic method of protection is use of gravel and possibly boulders at the periphery of the base plate. A 1 – 1.5 m thick layer of gravel 10 – 15 m extending from the outer edge of base plate perimeter is typical.

Expected Noise Levels

127 The noise level during installation of a suction pile type foundation is expected to be small in comparison to monopile installation and likely to be comparable to gravity based installation with the principal noise sources being the installation vessels.

128 There is expected to be no major noise generation during the installation operations other than general noise from vessels, lifting operation and subsea pumping.

3.7.3 Levelling of the Foundation

129 Transition pieces could be used to connect the wind turbine tower to the foundation. The transition piece provides a means to adjusting non-verticality tolerances of installed foundations, and makes the pile design very simple, basically only a straight tube, with only minor attachments for fixing of anodes or cable ducts.

130 There have been a number of issues with failure of grouting of transition pieces. An aim of this project would be to investigate and possibly trial alternative connection and levelling methods. Alternative methods may include use of a jacking mechanism on the platform or foundation to level the connection flange for wind turbine installation.

131 Some types of foundation, such as suction caisson could be levelled by controlling the level of seabed penetration.

132 A second alternative to using a transition piece is the use of a flange welded directly onto the monopile. Welding *in-situ* requires that the upper piece of around 1 m is cut off the monopile after hammering.

133 Specific flange geometry is required to optimise the flow of the shock waves from the hammer impact through the pil*e.* Any inclination of the pile has to be compensated by shim plates or an inclined adapter piece. This option has the potential of a reduction of offshore vessel time as well as saving on grout curing time. However, damage of the flange or high fatigue of the flange is a risk.

134 The transition piece, which does not undergo significant loading during installation, could be fully equipped with all electrical or electronic components prior to installation.

135 Traditionally, the transition piece is joined to the pile with a radial connection of high performance grout. The tower itself is mounted on an internal L-flange on top of the transition piece however alternatives would also be investigated.

3.7.4 Scour Protection

136 There are two main design options to address seabed erosion, either allow for scour in the design or install scour protection such as rock dumping.

137 The amount of local scour around a monopile without scour protection is expected to be less than 2 times the monopile diameter. Allowance for scour in the design would lead to increases in penetration depths and potentially wall thickness of monopiles, and therefore additional fabrication and handling weights both leading to increases in the cost.

138 For other foundation designs such as gravity based, skirts may be added around the perimeter of the foundation to penetrate the seabed and provide a hard barrier for undermining of the foundation.

139 Scour protection of loose rock, rough gravel or mats around the base of the pile to a diameter of 2 – 3 times the pile is the most likely solution, though the choice of solution can only be made after detailed design of foundation, taking into account a range of aspects including soil data, tidal, depth of water, foundation option, maintenance strategy, cost of options.

140 Installation may involve a specialised rock placement vessel. Once the vessel has positioned itself alongside the specified rock dump location the hydraulically operated dozer blades pushes the rock material over the ships side or bags with boulders are lifted into location. Alternatively rock is transported to site by barge where it is then grabbed and dropped onto location by excavating bucket (either positioned on same barge or separate installation vessel). The final option involves mats being transported to site on the installation vessel, whereby they are picked up and lowered onto location around the base of the foundation.

3.7.5 Sediment Spill during Installation

141 Table 3.5 summarises the sediment volumes that may be excavated or released during the installation process. The sediment can either be cast-aside or disposed on a licensed disposal ground. Disposal licenses would be applied for from Marine Scotland as appropriate prior to any disposal activities taking place. For the sediment spill modelling it is considered a worst case assumption that the sediment is cast-aside next to the foundations.

TABLE 3.5 Sediment Spill during Installation			
Foundation Type	**Volume of Sediment**	**Sediment Composition**	**Comments**
Gravity Base	628 m^3	Sand/some glacial till possible	Assumes average 0.5 m excavation of 40 m diameter circle
Monopile Driven	Negligible	N/A	-
Monopile Drilled	2,100 m^3	Sand/some glacial till/some sandstone	Assumes average inner pile diameter of 8.5 and length if 37 m.
Tripod	Negligible	N/A	Assumes driven piles
Suction Caisson/Bucket	Negligible	N/A	Assumes driven piles

3.7.6 J-tubes

142 The j-tubes hold and protect the cables to and from the structure. They could be attached to the inside or outside the foundation structure. If the j-tubes are run on the inside they would penetrate the structure near the seabed. If run on the outside the j-tubes would be supported on a number of supports connected to the main structure. The j-tubes could be made of steel or thick walled plastic type tubes.

3.7.7 Corrosion Protection

143 In the aggressive offshore environment, steel foundations have to be protected against the corrosion. In principle there are several options - Surface protection in the form of painting and /or metallic coating. Treatment of the surface is particularly relevant for the part of the structure above water and in the splash zone. Another alternative include an allowance for corrosion (designing the structure with sufficient steel to allow waste due to corrosion).

144 Below the splash zone (permanently submerged structure) corrosion protection would be administered by paint and cathodic protection. This may be in the form of an impressed current system or anodes which corrode in preference to the structure.

3.8 Meteorological Masts

145 One anemometer mast may be required for EOWDC to monitor wind over the project life, however this could be integrated with the Ocean Laboratory which would be the subject of a separate planning application.

146 A potential location is shown on Figure 3.2.

147 The combined Ocean Laboratory and anemometer mast would consist of a platform mounted on a foundation, which depending on the loading would be smaller than wind turbine foundations, but follow a similar design. The platform, located approximately 20 m from LAT may be up to 20 m square and house various measuring, survey and research apparatus. Should an anemometer mast be required, the mast would be installed on the platform and extend to the hub height of the largest wind turbine. The Ocean

Laboratory may be powered by a separate cable from shore or by diesel and electrical generators located on the platform.

148 The combined Ocean Laboratory and anemometer mast would include all required navigation and aviation warning requirements in accordance with other aspects of the project.

149 The source noise level of 90 dB(A) at 1 m distance for the diesel generator has been estimated.

150 Outline parameters for the Ocean Laboratory are shown in Table 3.6.

TABLE 3.6
Ocean Laboratory Parameters used in Cumulative Assessment

Maximum Height above LAT (m)	120 m
Platform size	20 m x 20 m
Height of platform above LAT	18-20 m
Depth of Platform	Maximum 4 m including containers and ancillary equipment
Foundation Type/Size	As wind turbines
Maximum Noise Output at source	90dBA at 1m (Diesel generators)

3.9 Cables

3.9.1 Introduction

151 The wind turbines would be electrically connected by inter-array cables. Indicative options for the layout of the inter-array cables are shown on Figure 3.7. The final positions of the cables would be determined once the wind turbine types and locations are finalised and following the detailed site investigation which would establish in more detail the positions of any seabed obstructions that would need to be avoided. It is likely that the final inter-array cable layout would be a mix of more than one of the options presented in Figure 3.7 determined by slot allocation for the wind turbines.

152 It is expected there may be up to four export cables installed on the site. The export cables would collect the power from the wind turbines on the west or south edge of the site and export it to shore. It is expected that the maximum power would be in the region of 35 MW per cable with a 33 kV operating voltage.

153 Subject to further detailed electrical engineering studies, the array and export cables are likely to be 33 kV three-core cables with optical fibres incorporated for communications. Three-core designs are better than single-core designs in the marine environment as losses in the cable armour wires, and a resulting derating of the cables, are considerably less along with a single installation and therefore less disturbance. The external magnetic and secondary electric fields outside three-core designs of cables are also considerably less than those for single-core cables. Single-core subsea cable designs have not been considered within this ES.

154 Assuming the use of currently available models, each wind turbine would generate electricity at 690 V or higher and would have its own transformer

and switchgear within the tower or nacelle to step-up the voltage to the inter-array and export cable circuits collection voltage of likely 33 kV.

155 The total length of inter-array and export cable would be approximately 39 km. This is based on the following:

- up to 13 km for the inter-array cables
- up to 26 km for the export cables (1 x 5 km, 1 x 6 km, 1 x 7 km, 1 x 8 km)

156 This actual lengths would be depndent on the number of wind turbines and the electrical design employed.

3.9.2 Cable Protection

157 Cables would be buried in the seabed to a sufficient depth, which would be determined by a burial protection study. In determining the burial depth, consideration must be given to potential threats such as fishing gear and small anchors (larger anchors are excluded by an exclusion zone) and seabed movement. Consideration would also be taken of long-term seabed movement. Based on the surveys undertaken, seabed mobility would be restricted to the top layer of sand. Typical burial depths would be in the range of 0.6 m – 3 m.

158 It is possible that the export cables could cross redundant telecom lines. As the cables are redundant, permission may be provided to cut through the cables prior to installation. A second crossing philosophy would be to provide a surface crossing of the cables. In this case, the EOWDC cables would be laid on the seabed and protected on the exposed section by concrete mattresses.

3.9.3 Cables Design

159 The inter-array and export cables are likely to use a voltage of 33 kV and be a sea-armoured three-core cable, with copper conductors. A typical cable is shown in Plate 3.3. Table 3.6 shows the size and weight of three typical cables and it is expected that up to 800 mm^2 cable would be used for the export cable. A smaller size may be used for cables serving fewer turbines and for inter-array cables. The cables may also contain a fibre optic, for communication purposes.

TABLE 3.6
Example of 33 kV Cable Sizes

Conductor cross section	**Diameter**	**Weight in air**	**Weight in sea water**
120 mm^2	110	18 kg m^{-1}	10 kg m^{-1}
240 mm^2	120	24 kg m^{-1}	14 kg m^{-1}
300 mm^2	125	28 kg m^{-1}	16 kg m^{-1}
400 mm^2	130 mm	32 kg m^{-1}	20 kg m^{-1}
500 mm^2	150 mm	36 kg m^{-1}	22 kg m^{-1}
630 mm^2	160 mm	42 kg m^{-1}	24 kg m^{-1}
800 mm^2	170mm	52 kg m^{-1}	30 kg m^{-1}

Plate 3.3 Cut Away Image Showing a Typical Undersea Cable (Courtesy of DUCO)

Table 3.7
Typical Cable Corridor

Section	Water Depth	Approx Corridor Width	Temp Construction Corridor
Landfall	5 m	10 – 150 m	650 m
Approach to wind turbines	15 m	150 – 1,000 m	1,500 m
Inter-array Cables	15 – 30 m	10 m	510 m

3.9.4 Cable Landfall

160 There are potentially up to four cables to make landfall along the coastline. The landfall location has not been confirmed at present as is subject to many factors including detailed investigation of potential routes, substation locations and consideration of the potential environmental impacts of the chosen location.

161 It is understood that the shoreline is similar throughout the corridor location, therefore the proposed methods may be employed at any location. Methods under consideration include:

- horizontal directional drilling (HDD)
- dredged cofferdam
- plough pulled off the beach

162 It should be noted that only the works that are below Mean High Water Mark are assessed in this ES.

3.9.4.1 Horizontal Directional Drilling

163 Horizontal directional drilling may offer a solution with lower environmental impacts to the intertidal area, however is more suited to harder seabed materials and may have a limited application on the EOWDC. Softer seabed materials may require the use of drilling muds to support the hole on a temporary basis.

164 The hole would be drilled from behind the dune area under the tidal zone to exit the seabed a suitable distance from the shore. Each hole would be supported either temporarily with drilling mud or a steel liner to allow the cable to be pulled through.

3.9.4.2 Dredged Cofferdam

165 An alternative solution is to provide an open trench temporarily supported by coffer dams in which the cables are laid. This solution involves removing soils to the required burial depth over a width of approximately 10 m between high water mark and location where subsea trenching can commence. The trenching walls would be supported by sheet pile driven into the beach and seabed, which would also keep the trench dry for work.

166 Following completion, the beach would be reinstated with original materials.

167 This method could require removal of 12,000 m^2 of material for a 400 m long excavation which would be locally stored and reinstated after cable installation.

3.9.4.3 Plough Pulled off the Beach

168 The third solution generally utilised for single cables is to pull the plough up the beach beyond the high water mark and then commence trenching of the cable down the beach using a vessel to pull the plough over the cable into the sea. For this project, this operation would need to be repeated three up to four times.

169 As the chosen method depend on many factors including soil conditions, number of cables and availability of equipment and access, this would be assessed further during detailed engineering and procurement phases.

3.9.5 Onshore Cabling (Information Only)

170 Should the substation not be located behind the cable landfall, onshore cabling would be required to connect the cable jointing bays to the onshore electrical substation. The trench per circuit is approximately 0.75 m wide by 1.2 m deep, with 2 m distance between circuits. Therefore a maximum cable route width of 12 m would be appropriate for four circuits.

3.9.6 Cable Jointing (Information Only)

171 The offshore cables would be jointed to the onshore cables inside pre-cast concrete enclosures located close to the landing area. This would be behind the beach if required and would therefore form part of the onshore planning

application. Each of the four sunken enclosures, one for each export cable, is approximately 7 m long x 2 m wide and 1.5 m deep, with the top surface below ground level. Following installation, these enclosures would be covered with a layer of topsoil. Access to these enclosures would only be required during the operations phase of the wind farm for emergency purposes and they do not need be maintained.

3.10 Substation (Information only)

172 The proposed onshore substation location has not been finalised and is expected to be in one of three locations between Blackdog and the Aberdeen Exhibition and Conference Centre in land that is designated for industrial development or future development. Details are included for information only but would be subject to a separate planning application.

173 In addition the substation location would also include the following facilities:

- site control room
- office and amenities
- facilities relating to the development centre, which may include additional office and training facilities and a permanent exhibition
- possible energy storage and or Flexible Alternating Current Transmission Systems(FACTS) devices

3.10.1 Transmission Cables (Information Only)

174 The transmission infrastructure to the National Grid network would be part of the scope of work undertaken by Scottish and Southern Energy (SSE) and National Grid and therefore does not form part of this EIA.

3.11 Construction

3.11.1 Offshore Construction

3.11.1.1 Introduction

175 This section presents an overview of the proposed methods of construction for the project. While as much care as possible has been taken to explore and document the most suitable construction methods, it must be noted that construction contractors have not been appointed and the Applicant would also look towards innovative methods for construction which may be more efficient or cost effective. Options for this may include:

- use of larger vessels which would require less trips
- use of smaller vessels / different vessels suited for the specific water depths at different parts of the site
- installation of wind turbine and foundation in one operation

176 As such, this should be considered provisional and would be updated for each phase prior to construction.

3.11.1.2 Access to Site

177 Construction in the marine environment is potentially hazardous, and in the interests of safe working the project should be permitted to take advantage of as much construction time in favourable conditions as is possible. Construction activity is expected to continue, subject to site weather conditions, for 24 hours per day until construction is complete and may take place at all times of the year.

3.11.1.3 Safety Zones

178 The Applicant will request advisory safety zones or apply to the Secretary of State for Trade and Industry for a temporary offshore construction safety zone under Section 95 of the Energy Act 2004. The purpose of this zone is to protect the safety of project plant and personnel, and the safety of third parties during the construction and commissioning phases of the wind farm.

179 Although the stated safety zone encompasses the entire wind turbine area, the extent of the safety zone at any one time would be dependent on the locations of construction activity, and a rolling safety zone may therefore be proposed.

180 It is intended that third parties would be excluded from any safety zone during the construction period, and that the zone(s) would be marked in accordance with Trinity House Lighthouse Service recommendations. Regular Notice to Mariners would be issued as construction progresses.

181 For the export cables, an advisory safety zone would be implemented to the extent permitted by legislation and by the relevant regulatory authorities.

3.11.1.4 Construction Vessels

182 The types of construction vessels to be used would be selected post-consent, however the main types of vessels for each tasks are presented in Table 3.8.

TABLE 3.8 Likely Types of Construction Vessels		
Task Likely	**Type of Construction Vessel**	**Comments**
Pile Installation	Jack-up barge Dynamic Positioning (DP) vessel	Potential for support barge, tug(s) and work boats as support craft
Gravity Base Installation	Floating Barge (eg Shear Leg) DP vessel	Potential for support barge, tug(s) and work boats as support craft
Tripod	Floating Barge (eg Shear Leg) DP vessel	Potential for support barge, tug(s) and work boats as support craft
Wind Turbines	Jack-up barge	Such vessels now able to carry multiple units in one trip
Scour Protection	Construction barge or dedicated rock dumping vessel	
Cable Installation	Dedicated cable lay vessel (anchored barge or Dynamic Positioned vessel)	
Crew transfer, wind farm commissioning	Workboat	To conform to the MCA Workboat Code

183 The predicted number of movements (between port and the site) relating to the construction phase are shown in Table 3.9 and Table 3.10:

TABLE 3.9 Phase 1 Construction Vessel Movements		
Activity	**Frequency**	**Total Vessel Movements (approx)**
Pile Installation	One visit per two piles	2
Gravity Base Installation Crane barge on site at all times	One support barge visit per base	4
Wind Turbines	Two visit per turbines	8
Scour Protection	One visit per turbine	4
Cable Installation	One visit per five inter-connecting cables and one trip/export	5
Crew transfer, wind farm commissioning	Six visits per turbine	24
		TOTAL 45

TABLE 3.10 Phase 2 Construction Vessel Movements		
		Total Vessel Movements (approx)
Pile Installation	One visit per two piles	4
Gravity Base Installation Crane barge on site at all times	One support barge visit per base	7
Wind Turbines	Two visits per turbine	14
Scour Protection	One visit per turbine	7
Cable Installation	One visit per five inter-connecting cables	2
Commissioning	Six visits per turbine	42
		TOTAL 72

184 To optimise the construction programme, it is likely that installation of wind turbines, foundations and cables would be undertaken on the site at the same time, although not necessarily in the same part of the site. Therefore it is likely that 1 - 5 vessels (including support craft) may be on site at any one time.

3.11.1.5 Lighting and Marking

185 The construction area would be depicted on Admiralty Charts by the UK Hydrographic Office, and information pertaining to construction would be disseminated through the Notice to Mariners procedure together with regular communication with local and regional stakeholders.

186 The construction area and incomplete structures would be lit and marked in accordance with the protocol recommended by THLS.

3.11.1.6 Construction Programme

187 An indicative construction programme is presented below, based upon two construction seasons:

- Phase 1 2013
  - 4 x 6.5 MW wind turbines installed
- Phase 2 2014
  - 4 x 7.5 MW wind turbines installed
  - 3 x 10 MW wind turbines installed

188 To optimise the construction programme, it is likely that installation of wind turbines, foundations and cables would be undertaken on the site at the same time, although not necessarily in the same part of the site.

3.11.1.7 Construction Management (Environmental)

189 During construction (and decommissioning) some discharges to the atmosphere would arise from the marine vessels required to undertake these stages of the development.

190 There are no anticipated solid discharges into the marine environment during the construction phase.

191 A comprehensive Environmental Management System would be implemented prior to construction in consultation with statutory authorities, with a suite of complementary management plans corresponding to different aspects of the construction activity. The Environmental Management System would form a component part of the construction contract for the development. The documents, which would be tailored specifically to ensure compliance with the consent conditions for the project and current environmental best practice, include the following:

- Environmental Management System
- Environmental Management Plan including Commitments Register
- Monitoring Protocol (as per statutory consents)
- Incident Reporting and Non Conformance Procedure
- Emergency Response Plan

- Collision Risk Management Plan
- Marine Pollution Contingency Plan
- Dropped Objects and Materials Recovery Plan
- Archaeology Plan
- Noise, Dust and Vibration Management Plan
- Waste Management Plan
- Health and Safety Plan

3.11.1.8 Foundation Installation Vessels

192 The different types of foundations would be installed using different methodologies, however fall into the following main categories:

- float to location and ballast
- lift to location and ballast
- lift to location and secure to seabed

Float to Location and Ballast

193 This is restricted to gravity base foundations that could be towed to site by tugs and once in the final location, ballasted to secure to the seabed. Typically the foundation may require 2 - 3 tugs for the tow and positioning operation. Additional vessels (such as rockdumpers) may be necessary for the ballasting operations and scour protection. Seabed preparation may be required prior to installation.

Float to Location and Lift

194 This method could be utilised for some foundation types including monopiles. With this method the foundation would be towed to location by tugs (in the case of a monopile, the ends would be sealed). Once on location a crane vessel (either jack-up or Dynamically Positioned (DP) vessel) lifts the foundation and control location and orientation as the foundation approached the seabed.

195 For this installation method, 1 – 2 tugs would be utilised for the tow and the crane vessel for the lift operation. Additional vessels may be required for seabed preparation prior to installation and scour protection following installation.

Lift to Location and Secure on Seabed

196 Using this method, the foundations are transported to site utilising either a barge or the installation vessel. The foundation would generally be seafastened to the deck of the vessel. Once at location the seafastening would be removed and the foundation lifted to location and secured to the seabed by ballasting or pilling. This method would be suitable for all foundation types.

197 Additional vessels would also be required for seabed preparation prior to installation and scour protection after.

3.11.1.9 Wind Turbine Installation Vessels

198 Although offshore contractors have varying construction techniques, the installation of the wind turbines would likely require one or more jack-up barges, possibly one of the vessels currently in the market and/or a purpose-

built wind turbine installation vessel. Most of these large vessels stand on the seabed and create a stable lifting platform by lifting themselves out of the water. The area of seabed taken by the vessel feet varies between vessels and maybe up to 800 m^2 (in total), or with leg penetrations of up to 6 m to 8 m for leg designs reliant on leg wall friction (dependant on seabed properties). These holes would be left to in-fill naturally. Based on a worst case scenario and taking into account multiple operations (including barge jack-up for wind turbine and foundation installation), this could entail an area of impact of up to 4200 m^2 per wind turbine/ foundation. Alternatively, a DP vessel may be used for the installation work, which does not leave footprints. The wind turbine components would either be stored at an adjacent port and transported to site by support barge or the installation vessel itself, or transported directly from the manufacturer to the wind farm site by barge or by the installation vessel. The wind turbine would typically be installed using multiple lifts – the tower (1-2 lifts), nacelle (1 lift), hub/blades (1- 4 lifts). A support jack-up barge, support barge, tug, safety vessel and personnel transfer vessel may also be required.

200 It is expected that wind turbines would be installed on the foundation at a rate of one every one to two days.

201 As an alternative the project would investigate other options for innovative installation which would reduce the number of lifts, installation time and impact.

202 The works would be planned for 24 hours per day, with lighting of each barge or vessel (if using multiple barges) at night, and accommodation for crew on board.

3.11.1.10 Cable Installation

203 The installation of the inter-array and export cables is likely to be carried out by a specialist cable lay vessel, with the cables stored either on reels or a carousel designed to carry the necessary lengths and maintain the minimum bend radius.

204 The vessel is likely to be fully equipped with specialised cable lay equipment, including cable tensioners and a full survey suite to provide details of the final cable positions. The vessel would follow the cable route either through use of a four or eight point moving system or a fully DP (Dynamically Positioned) or a DP assisted operation. The vessel is likely to be specifically mobilised to undertake the work and would be selected for the ability to work in the shallow water and tidal conditions that prevail on site. A typical DP vessel is shown in Plate 3.4, however barge based vessels may also be utilised.

205 Depending on the vessels used for the installation, for the shallow water sections beyond the landfall it may be necessary to use additional barges or anchored platforms to allow for the cable installation.

Plate 3.4 Dynamically Positioned Cable Lay Vessel (Courtesy of Technip)

206 All the subsea cables would be buried in order to provide protection from all forms of hostile seabed intervention, such as fishing activity (trawler and otter boards), dragging of anchors and the minor risk of dropped objects. The subsea cables are also buried to ensure stability in the tidal conditions and eliminate the risk of free-spans causing cable fatigue.

207 The degree of cable burial proposed relates to a combination of the anticipated ground conditions as well as the perceived threat, and as such it is not proposed to bury deeper than is considered necessary.

208 The final method of cable installation and depth of burial would be determined at a later date and would vary depending on more detailed soil condition surveys and equipment selected.

209 The cables are likely to be buried using a combination of two or three techniques. Typical tools from each are shown in plates 3.5, 3.6 and 3.7.

Ploughing

210 Ploughing would be carried out using an underwater cable plough that executes a simultaneous lay and burial technique by lifting a wedge of sediment, allowing the cable to fall into this trench. A separate operation may be necessary to fold the sediment back on top of the cable. Such an operation mobilises very little sediment. The trench could typically be controlled to match the burial depth requirement which maybe between 0.6 m and 3 m deep. The trench width for the greatest depth maybe up to 10 m wide depending on soil conditions and would displace 405, 000m^3 over the 26 km cable length, with a potential for a loss of 10.38 m^2 of habitat per metre of cable laid.

Jetting

211 Cable burial from a ROV (Remote Operated Vehicle) that utilise high-pressure water jets to fluidise a narrow trench into which the cable is located. A working assumption for the trench dimension is 0.5 m wide and up to 2 m

deep. The jetted sediments settle back into the trench and with typical tidal conditions the trench coverage is reinstated over several tidal cycles. This could be undertaken in a single operation or multiple operations.

Mass Flow Excavation

212 Cable burial using mass flow excavation where a propeller is placed above the target and a jet of water is directed to the target to wash the seabed away in a specific location. The cable is then laid into the open trench. The propeller can then be reused to provide infill or allow natural backfill.

213 As the export cables are relatively short, it is proposed to install the export cables in the same way as the inter-array cables, should conditions allow.

214 The seabed in the proposed export corridor and inter-array area consists of sand overlaying glacial clays. The method chosen would depend on the depth of overlaying sand and detailed analysis of the soils along the proposed route.

Plate 3.5 ROV Jet Trenching Tool (Courtesy of Technip)

Plate 3.6 Subsea Plough (Courtesy of Technip)

Plate 3.7 Mass Flow Excavation Tool (Courtesy of RoTech)

215 Depending upon installation method chosen, the cable approaches to each wind turbine j-tube (the cable "bight") would not be buried in the final few metres. It is proposed that these cable sections would be subsequently buried using appropriate techniques to be agreed prior to construction (mattress installation, diver air lifting etc).

216 Alternatively, a shallow rock, grout bag berm, or cast iron casing may have to be installed where other burial techniques are unsuccessful.

3.12 Wind Farm Operations and Maintenance

3.12.1 Access to the Site and Safety Zones

217 Operation and maintenance of the offshore wind farm would continue 24 hours per day, 365 days per year, and therefore the Applicant would require access to site at any time.

3.12.1.1 Safety Zones

218 The Applicant would likely apply for safety zones under Section 95 of the Energy Act 2004 for the following safety zones during wind farm operation:

- each structure including (wind turbine) structure would there under have a safety zone of 50-100 m radius prohibiting entry for non-project vessels

3.12.2 Wind Farm Control

219 The wind turbines are configured so that they operate with a minimum of supervisory input. The wind turbines are monitored and controlled by micro-processors installed within the wind turbine tower. Should a wind turbine develop a fault, the status of the fault is diagnosed, and if necessary the turbine is automatically shut down for safety purposes a fault signal is sent to the onshore operator. The wind turbine operation is based upon a "fail-safe" philosophy.

220 All information relating to on-site conditions (wind speed, direction, etc), wind turbine status and generated output is held within a central Supervisory Control and Data Acquisition (SCADA) system linked to each individual turbine micro-processor. The SCADA system is controlled from an operations base ashore, and allows for the remote control and shutting down of any individual wind turbine (or a number of wind turbines) should circumstances dictate.

3.12.3 Wind Farm Inspection and Maintenance

221 The EOWDC would be serviced and maintained throughout the life from a local port, possibly Aberdeen or Peterhead. Following the commissioning period of a commercial wind farm scheduled servicing interval for the wind turbines would usually be every twelve months. As this project is a test centre it is expected that there may be more visits for data gathering etc.

222 Maintenance of the wind farm is normally separated into three different categories:

- physical periodic inspections
- scheduled maintenance
- un-scheduled maintenance

223 The integrity of the installation needs to be checked on a regular basis by remote monitoring and physical inspections of foundations, sea cables and scour protection which is likely to be undertaken at a frequency of 1–5 years.

Maintenance of scour protection may require periodic installation of additional scour protection material.

3.12.4 Physical Periodic Inspections

224 Periodic inspections would be carried out to determine the technical condition of the offshore installation. These inspection campaigns take half a day for the wind turbine and the top part of the foundation and half a day for the underwater inspections. The execution of these inspections would be planned in the periods of the year with the best access conditions, preferably in summer.

225 The periodic inspections would be carried out according to the supplier's and project specifications. The work scope typically includes function and safety tests, visual inspections, analysis of oil samples, inspection of subsea cables and scour protection.

3.12.5 Scheduled Maintenance

226 Scheduled maintenance applies primarily to inspections and work on wear parts like replacement of brake pads and filters, check of bolts, lubrication, oil change on gear box or hydraulic systems susceptible to failure or deterioration in between the periodic overhauls. A scheduled maintenance of each turbine is likely to take place every twelve months.

227 Scheduled maintenance would be performed using relatively small crew vessels from the local harbour.

3.12.6 Unscheduled Maintenance

228 Unscheduled maintenance applies to any sudden defects. The scope of such maintenance would range from small defects easy to solve with the crew vessels used for the scheduled maintenance to complete failure or breakdown of main components. For the replacement of main components like gearboxes, generators or blades bigger jack-up barges would be needed. The replacement of main components is not to be expected in the first fiver operational years.

3.12.7 Operation Management (Environmental)

229 There are no anticipated direct discharges to the atmosphere during normal operation of the wind turbines.

230 There are no anticipated solid discharges into the marine environment during normal operation of the wind turbines. All waste generated during operation, for example associated with maintenance, would be collected and disposed of by licensed waste management contractors to licensed waste management facilities onshore.

231 There are no anticipated direct aqueous discharges to the marine environment during normal operation of the wind turbines However, there is a small risk of accidental discharges from the wind turbines array or marine vessels associated with operations and maintenance.

232 During the operations phase of the wind farm an Environmental Management System, based upon the system implemented for the construction phase, would be in place. The system would ensure that the environmental monitoring, as specified in the statutory consents, is undertaken and reported, and that the wind farm is operated and maintained in an environmentally responsible manner.

233 It is anticipated that the following aspects would be featured in the Environmental Management System during the operational phase:

- Environmental Management System
- Environmental Management Plan
- Environmental Monitoring Protocol
- Emergency Response Plan
- Incident Reporting and Non Conformance Procedure
- Collision Risk Management Plan
- Marine Pollution Contingency Plan
- Waste Management Plan
- Dropped Objects and Materials Recovery Plan

234 The plans would generally be shorter versions of the corresponding construction plan – however, if major unscheduled maintenance works are required the construction plans may need to be invoked if larger construction vessels are required.

3.13 Wind Farm Decommissioning

3.13.1 Introduction

235 The Applicant recognises the importance of considering the decommissioning process at an early stage, and is committed to decommissioning the wind farm to the standard wind industry protocol at the agreed time. The implementation of the Energy Act 2004 includes an outline protocol for decommissioning. The following sections provide a description of the current intentions with respect to decommissioning, with the intention to review the statements over time as industry practices and regulatory controls evolve.

3.13.2 Programme for Decommissioning

236 As part of the implementation of the Energy Act 2004, some provisions relating to decommissioning are to be proposed. The anticipated sequence of events at present is as follows:

237 The developer submits a decommissioning plan at the time of gaining consent (precise timings to be refined). This plan would be costed and would have an outline schedule attached. Over the lifetime of the project, the plan would be reviewed and updated if necessary. When the wind farm is ready to be decommissioned, the operations take place in accordance with the agreed documentation

238 Post decommissioning monitoring would be performed in accordance with the approved decommissioning plan.

3.13.3 Facilities to be Decommissioned

239 The key offshore components of the proposed EOWDC to be decommissioned are:

- 11 wind turbines and their associated foundations
- inter-array cables between the wind turbines
- export cables for connection to the electricity transmission network
- scour protection around foundations

240 At the end of the operational life of the project (approximately 22 years) it is anticipated that all structures above the seabed would be completely removed by reverse lay, that is, the reverse construction sequence.

3.13.3.1 Wind Turbines

241 The structures above the seabed would be removed piecemeal in the reverse order of the construction procedure, using offshore cranes or, alternatively, the entire structure could be removed in a single activity using a heavy lift vessel. At the end of their individual life, the offshore wind turbines would be removed and either refurbished or recycled. The wind turbines are designed to allow removal. A typical decommissioning process for a wind turbine is set out below:

- de-energize and isolate from Grid (may be undertaken in phases)
- mobilise suitable heavy lift vessel(s) to the wind farm location
- remove rotor component parts
- cut wind turbine inter-array cables adjacent to the substructures
- remove nacelle including generator
- remove wind turbine tower
- transport all components to an onshore site at which they would be processed for reuse, recycling or safe disposal

3.13.3.2 Foundations

242 For steel foundations, piles would be cut to a sufficient target depth below the seabed to ensure that they do not become exposed. All salvaged steel to be lifted on a barge and transported to land. A jack-up type vessel would typically be used for this operation.

243 Reinforced concrete or steel gravity based structures, would be demolished by the use of demolition tools, jackhammers, diamond saw, or hydraulic splitting with the resultant material recovered for reuse.

244 The exact method of removal would be in line with regulations in place at the time of decommissioning.

3.13.3.3 Cables

245 With respect to subsea cables, it is likely that these would be removed unless it can be demonstrated that they do not pose a risk to other users of the sea and removing them leads to a greater impact on the environment than leaving *in situ*.

246 The export cables and inter-array cables would be buried to a depth ranging between at least 0.6 and 3 m below seabed. Further studies would examine if the proposed burial depths of these cables are likely to be sufficient to leave in situ. If the option to leave *in situ* is proposed then contingency plans would be put in place to ensure appropriate actions are carried out if the cables do become exposed.

European Offshore Wind Deployment Centre
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Chapter 30: Summary

30 SUMMARY

1 This document and supporting volumes have assessed the potential effects of the construction, operation and decommissioning of the proposed European Offshore Wind Deployment Centre (EOWDC).

2 The assessments presented have used detailed, site specific, baseline information gathered over a number of years, through: desk study, site surveys and consultation with both statutory and non statutory organisations.

3 Assessments have made using Environmental Impact Assessment criteria, guidance and best practice (where relevant), and are presented in relation to the following topics:

- seascape, landscape and visual impact
- ornithology
- marine ecology, intertidal, sediment and water
- geology and bathymetry
- offshore ordnance
- coastal processes
- bats
- cultural heritage
- offshore archaeology
- marine mammals
- electromagnetic interference
- statutory designations and conservation
- shipping and navigation
- aviation
- Ministry of Defence
- commercial fisheries
- salmon and sea trout
- socio-economics, recreation and tourism
- in-air noise
- energy and emissions
- other marine users

4 The design of the project has been sensitive to many environmental (physical, biological and human) and technical issues, many potential impacts have been removed or reduced.

5 Environmental Impact Assessments have been carried out assuming a worst case scenario. This ensures that any possible negative impacts upon the environment resulting from the development of the EOWDC would never be more than, and are likely to be less than, the findings of the EIA.

6 As a result of the worst case scenario being modelled the potential for a major significant impact has been identified within the seascape, landscape and visual assessment and in some instances behavioural disturbance and displacement during possible construction activities is considered to be of moderate to potentially major significance for marine mammals. A number of mitigation strategies have been suggested in order to minimize any impacts upon marine mammals.

7 Where assessments have identified the potential for significant effects, possible mitigation measures have been proposed. These measures include the provision of a draft Environmental Management Plan (EMP) that accompanies this document and an obligation to produce a Marine Mammal Protection Plan.

8 It should be noted that significant effects can be reversible. When the proposed EOWDC is decommissioned at the end of the 22 year Crown Estate Lease period the wind turbines would be dismantled and removed.

www.vattenfall.co.uk/en/aberdeen-bay.htm

VATTENFALL Technip areg Aberdeen Renewable Energy Group

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 4: EIA Methodology, Scoping and Consultation

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4 ENVIRONMENTAL IMPACT ASSESSMENT (EIA), SCOPING AND CONSULTATION

4.1 Scoping

1 Regulation 7 of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations Scotland 2000 makes provision for developers to seek a formal opinion on the scope of what should be included in the ES.

2 In August 2010, a 'Request for an Environmental Impact Assessment Scoping Opinion' was made to Marine Scotland for a proposed deployment centre in Aberdeen Bay (see Appendix 4.1). In October 2010 two figures were updated within the Request for Scoping Opinion document to show the Maritime and Coastguard Agency (MCA) designated anchorage area (2a and 12a) and these were sent to Marine Scotland (see Appendix 4.1).

3 The request contained information on the proposal, the proposed content of this Environmental Statement (ES) and the proposed desk and study methods which would be used to collect information for the studies presented in the ES.

4 The request was circulated to a large number of statutory and non-statutory consultees. Copies of scoping responses from these consultees are presented in Appendix 4.2. Table 4.1 below provides a summary of the main responses received during this scoping process and where in the ES they are addressed. The issues highlighted in the table are arranged in order of topic and are not attributed to individual consultees.

TABLE 4.1
Summary of Scoping Responses Received

Topic	Issues	Relevant Section
Shipping and Navigation	Location of EOWDC should not change and no additional wind turbines added. Proximity of Maritime and Coastguard Agency Designated Anchorage Area. Notice to Mariners, Radio Navigation Warning and publication in appropriate bulletins will be required stating nature and timescale of works. NRA to be carried out in accordance with MCA MGN 271. Recreational sailing should be considered.	EOWDC remains as Layout 039. Export cable corridor is outwith the designated anchorage area. Chapter 15
Ornithology	Appropriate duration of survey data at the time of ES submission. Impacts to red-throated diver and common scoter, does the methodology allow sufficient data to assess these species. Consideration of migrant waterfowl.	Chapter 10
Marine Mammals	Ensure mitigation and monitoring of impacts is robust.	Chapter 12
Seascape, Landscape and Visual	Flexible approach of study area. Consideration of effects as result of differing wind turbines.	Chapter 19
Cultural Heritage	Potential impacts on the setting of assets should be considered.	Chapter 20
Aviation	Potential impact upon operations with Aberdeen Airport. Significant helicopter operations in the area. EOWDC to be charted on aviation maps. If development progresses need to provide details to Defence Geographic Agency. Requirement for a coordinated regional wind turbine development plan, aimed at meeting renewable energy priorities whilst addressing aviation concerns and minimising proliferation issues.	Chapter 16
Ministry of Defence	Unacceptable interference to the Air Defence radar at Buchan.	Chapter 17
Coastal Processes	Highly mobile seabed. Dynamic seabed leading to possible scour and erosion around base of turbines leading to increase in material in suspension which	Chapter 8

TABLE 4.1 Summary of Scoping Responses Received		
Topic	**Issues**	**Relevant Section**
	could impact dredging regime at Aberdeen. EOWDC could impact harbour and beach profile of Aberdeen beach. Need to address cumulative effects of devices on coastal processes upon density and location with respect to existing renewable and coastal developments. The baseline assessment should identify the following features and processes in the environment: • sediments (eg composition, contaminants and particle size) • hydrodynamics (waves and tidal flows) • sedimentary environment (eg sediment re-suspension, sediment transport pathways, patterns and rates and sediment deposition) • sedimentary structures (eg protected banks) • typical suspended sediment concentrations With regards to hydrodynamic modelling, model performance should be checked in order to demonstrate accuracy and should include sensitivity analysis or estimate of errors in order to enable confidence levels to be applied to model results. It would be helpful to see a series of contour plots showing the magnitude and spatial extent of +(ve) and –(ve) changes in current velocities between the 'pre development' and 'post development' scenarios. The assessment should also identify and quantify the relative importance of high energy low frequency events eg storm events, versus low energy high frequency processes. Ythan estuary is not in area considered for far-field effects. Significant changes in sediment mobility should be considered here. Esnure development is unlikely to have adverse effects on erosion on adjacent coast. Ensure no obstructions to net northerly sediment movement in the Bay.	
Marking of Turbines	Aviation Warning Lighting - project will fall under requirements of Air Navigation Order 2009 Article 220.	Chapter 3

TABLE 4.1
Summary of Scoping Responses Received

Topic	Issues	Relevant Section
	Rotor blades, nacelle and upper 2/3 of supporting mast of wind turbines should be painted white. Final marking and lighting recommendations to be made in a formal response through CPA consultation process and will be based on IALA Recommendation O-139 with statutory sanction from the Northern Lighthouse Board prior to deployment. Marking needs to be considered for recreational craft as well as much larger commercial vessels.	
Socioeconomics, Recreation and Tourism	Relevant economic information connected with the project to be supplied Recreational sailing should be considered. Danger of squeezing recreational craft between commercial shipping routes and the development should be considered.	Chapter 15, Chapter 23 and Chapter 27
Planning	Onshore elements and offshore elements should be separated.	Chapter 1
Marine Ecology	As single grabs are now being collected does this mean that the sampling strategy is randomly stratified? Sampling should take into account pollution around Balckdog. River basins comprise all surface waters (including transitional (estuaries) and coastal waters) extending to 3 nautical miles seaward from the Scottish territorial baseline. Any proposed development within these waters must have regard to the requirements of the Water Framework Directive to ensure that all surface water bodies achieve 'Good Ecological Status' and that there is no deterioration in status. The Water Framework Directive requires the consideration of chemical, ecological and hydromorpholgical status. The data held on 'Cruden Bay to Don Estuary' coastal water body should also be included in the baseline dataset. This water body is currently classified at high ecological status. Any proposed development within these waters must have regard to the requirements of the Water Framework Directive (WFD) to ensure that all surface water bodies achieve 'Good Ecological Status (GES)' and that there is no deterioration in status.	Chapter 9 and Chapter 8

TABLE 4.1 Summary of Scoping Responses Received		
Topic	**Issues**	**Relevant Section**
	The WFD requires the consideration of chemical, ecological and hydromorpholgical status. A baseline assessment of existing intertidal and subtidal habitats and species should be submitted. This should include any UK Biodiversity Action Plan habitats and species (eg maerl, sea pens, eel grass, horse mussels). Ensure references for biotope names is inserted (Marine Scotland response) Collieston beach is bounded by a breakwater/pier and the meiofaunal distributions may reflect this artificial situation. Therefore the sediment and the fauna distributions are localised for this area and may not represent soft sediment shores from the area of interest. Beach profiling to quantify erosion / modification, and the outcome discussed with Marine Scotland prior to any action being taken.	
Salmon and Freshwater Pearl Mussel	The ecological status of surface water bodies which may be affected by the proposal should also be considered alongside the discussion of protected areas for salmon and freshwater pearl mussel.	Chapter 9 and Chapter 22
Migratory Fish/ diadromous fish	The proposed development will need to consider, in the first instance through a desk study, potential impacts on migratory fish including salmon (*Salmo salar*), sea trout (Salmo trutta), sea lamprey (*Petromyzon marinus*), river lamprey (*Hyperoplus lanceolatus*)and sandeels (*Ammodytes marinus*) during all phases of the project. The potential for offshore renewable projects to impact on migratory fish will vary depending on the design and location of the development in relation to the migration routes of adults and juveniles. Specific questions raised by Marine Scotland to be discussed in the assessment.	Chapter 9 and Chapter 22
Commercial Fishing	Ongoing discussion with fishing stakeholders required. Cumulative impacts of fishing with other marine activities should be addressed. Fishing baseline information to be	Chapter 21

TABLE 4.1 Summary of Scoping Responses Received		
Topic	**Issues**	**Relevant Section**
	updated.	
Site Information	Maps should be included in the ES showing the areas of seabed likely to be affected by the footprint of the turbine bases and cabling, and the area of intertidal zone that is likely to be affected by shoreline infrastructure development.	See Figures (Volume 3)
Timing of Works	The Schedule of Mitigation should include a timetable of works that takes into account all environmental sensitivities, such as fish spawning, which have been raised by SEPA, SNH or other stakeholders.	Chapter 28
Environmental Management	A Construction Environmental Management Document (CEMD) is a key management tool to implement the Schedule of Mitigation. Recommend that the principles of the CEMD are set out in the ES drawing together and outlining all the environmental constraints and commitments, proposed pollution prevention measures and mitigation as identified in the ES.	Chapter 28
Waste Management	Details of how waste will be minimised at the construction stage should be included in the ES, demonstrating that: • construction practices minimise the use of raw materials and maximise the use of secondary aggregates and recycled or renewable materials • waste material generated by the proposal is reduced and re-used or recycled where appropriate on site	Chapter 28
Conservation	Advice on designated sites and European Protected Species should be sought from SNH. For marine and transitional Special Areas of Conservation (SAC) and Special Protected Areas (SPA), these are Water Framework Directive Protected Areas. Therefore, their objectives are also River Basin Management Plan objectives. A Report to Inform the Habitats Regulation Appraisal should be included in the Application.	Chapter 14 and Chapter 29
Assessment methodology	If one or more type of foundation is to be deployed then the Rochdale approach should be applied differently ie cumulative impacts between each different type of foundation. Assessment to be carried out on the worst case scenario for wind turbines eg maximum rotor diameter Approach to assessment to be based on	All

TABLE 4.1 Summary of Scoping Responses Received		
Topic	**Issues**	**Relevant Section**
	rigorous professional judgement. Cumulative and in combination impact assessment to consider other east coast wind farm sites.	
Operation and Maintenance	Gearbox oil changes method statements and contingency plans required Major turbine service every 12 months – is this based on historic info?	Chapter 3 To be provided at appropriate time. Text based on Vattenfall O&M current experience.
Safety Zones	Section 36A does not apply in Scottish Waters. Situation may have changed.	Chapter 3 and Chapter 15
Research and Development	ES to include an outline of construction and post construction monitoring plan including research proposals.	Potential future research opportunities are covered in relevant chapters.

4.2 The Environmental Impact Assessment Regulations

5 The EIA for this project comprises the following sections:

- Non-Technical Summary
- Introduction including Legislative Framework
- Site Selection
- Project Description
- Physical Environment Baseline Description and Impact Assessment
  - Meteorological Conditions
  - Geology and Bathymetry
  - Offshore Ordnance
  - Coastal Processes
- Biological Environment Baseline Description and Impact Assessment
  - Marine Ecology to include Intertidal Ecology, Sediment and Water Quality
  - Ornithology
  - Bats
  - Marine Mammals to include Underwater Noise
  - Electromagnetic Fields
  - Conservation
- Human Environment Baseline Description and Impact Assessment
  - Shipping and Navigation
  - Aviation
  - Ministry of Defence
  - Archaeology
  - Seascape, Landscape and Visual
  - Cultural Heritage
  - Commercial Fisheries
  - Salmon and Sea Trout
  - Socioeconomics, Recreation and Tourism
  - In-Air Noise
  - Energy Use and Emissions
  - Electromagnetic Interference

    - Other Marine Users
- Draft Environmental Management Plan
- Information to Inform a Habitats Regulation Appraisal
- Summary of Environmental Impact Assessment and Mitigation Measures
- Supporting Technical Appendices

6 Each Environmental Impact Assessment section aims to comprise the following information:

- Introduction
- Methodology and Guidance
- Baseline Methodology
- Impact Assessment Methodology
- Description of the Baseline Environment
- Impact Assessment – Construction, Operation and Decommissioning
    - Potential Impact
    - Mitigation
    - Residual Impact
    - Monitoring
- Cumulative Impact Assessment
- In-combination Impact Assessment

4.2.1 Impact Assessment Methodology

7 In the case of each impact, the assessment aims to describe the magnitude of effect (ie the change created by an activity in terms of spatial extent, duration and scale) and the sensitivity of each receptor. The combination of the effect and the sensitivity of the receptor are then used to derive the significance of the impact. The criteria that have been are given below:

4.2.1.1 Spatial Extent of Effect

- a national/international effect
- a regional effect
- a local effect (within 5 km of the site)
- a site-specific effect

4.2.1.2 Duration of Effect

- a long-term/permanent effect (more than 10 years)
- a medium-term effect (existing for 5 to 10 years)
- a short-term effect (existing for 1 to 5 years)
- a temporary effect (existing for less than a year)

4.2.1.3 Scale of Effect

- above accepted standards/guidelines
- within accepted standards/guidelines
- where there are no standards/guidelines available, the impact relative to background conditions

4.2.1.4 *Recoverability of the Receptor*

- high
- medium
- low or none

4.2.1.5 *Importance of the Receptor*

- high
- medium
- low

8 The impact significance is then given as *major*, *moderate*, *minor* or *negligible*, using the matrix in Table 4.2 as a guide in the assessment process. Not all assessments directly follow this but have used this as a guide.

TABLE 4.2
Matrix for Significance of Impact

	Sensitivity of Receptor				
Magnitude of Effect based on spatial, duration and scale of effect		Very High	High	Medium	Low
	Very High	Major	Major	Major	Moderate
	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

4.2.2 Cumulative and In-combination Impact

9 An important part of the EIA process is to consider cumulative and in-combination impacts.

4.2.2.1 *Cumulative Impact*

10 Schedule 3 of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations Scotland 2000 requires that the potential for *cumulative impact* should be considered and where appropriate, assessed.

11 Cumulative impacts include, but may not be limited to, impacts that arise from the following existing and reasonably foreseeable development activities:

- other wind farms
- aggregate extraction and dredging
- navigation and shipping
- established fishing activities
- existing and planned construction subsea cables and pipelines
- potential port / harbour development
- oil and gas installations

12 The cumulative assessment addresses where predicted how impacts of the EOWDC construction and operation could interact with impacts from other industry sectors within the same region and impact sensitive receptors. This

may be through direct effects or spatially/temporally separated impacts on the same population of a receptor.

4.2.2.2 In-combination Impacts

13 The Conservation (Natural Habitats, & c.) Regulations 1994 (as amended) require that a Habitats Regulations Appraisal (HRA) must be conducted by a competent authority. The HRA considers the implications for European sites in view of the European sites conservation objectives, in respect of any plan or project which is not directly connected with or necessary to the management of the European site for conservation purposes and which is likely to have a significant effect on the European site either alone or *in-combination* with other plans or projects.

14 Therefore the term 'in-combination' is used when considering the impacts of the proposals with other plans or projects on European sites.

4.3 Consultation

15 As the proposal for the EOWDC has evolved over a number of years, there have been many individual stakeholder meetings involving a wide range of environmental, marine and aviation interests and over 24 public exhibition events. These discussions and events have allowed consultation with key interests and the general public on their views and comments regarding the proposal. The project has held extensive consultation with various statutory and non statutory bodies which have been useful in identifying issues which have been addressed through the EIA process and also in determining the location of the current application (see Chapter 2 Site Selection).

4.3.1 Public Exhibitions

16 Following an initial stakeholder workshop which took place in July 2005, a series of local consultation public exhibitions were publicised. These were held from 31st October to 10th November 2005 in Aberdeen and six other coastal North East communities. The exhibitions were organised to coincide with the ongoing feasibility study for the proposed development by Aberdeen Offshore Wind Farm Limited. Response sheets were collected and display materials were made available for inspection with representatives of the project team present to answer questions. The 2005 public exhibitions were held at:

- The Palace Hotel, Peterhead 31 Oct, 2-8 pm
- The Kilmarnock Arms Hotel, Cruden Bay 1 Nov, 2-8 pm
- Oceanlab, Newburgh 2 Nov, 2-8 pm
- Kirk Centre, Ellon 3 Nov, 2-8 pm
- Collieston Community Centre 4 Nov, 2-8 pm
- White Horse Inn, Balmedie 7 Nov, 2-8 pm
- Aberdeen Exhibition and Conference Centre, 8 Nov, 2-8 pm
- Tullos Primary School foyer, Aberdeen 9 Nov, 3-8 pm
- Beach Ballroom, Aberdeen 10 Nov, 2-8 pm

17 Following the 2005 consultation and ongoing stakeholder dialogue, a further series of public exhibitions was publicised and held in June 2006. The events

explained the proposed layout changes of the scheme following feedback received on environmental issues surrounding the Ythan Estuary and operational issues faced by local helicopter operators. Response sheets were collected and display materials were made available for inspection with representatives of the project team present to answer questions. The Public Consultation Exhibitions displayed a revised 23 wind turbine scheme and took place during the last two weeks in June at:

- The Palace Hotel, Peterhead 19 June, 2-8 pm
- The Kilmarnock Arms Hotel, Cruden Bay 20 June, 2-8 pm
- Oceanlab, Newburgh 21 June, 2-8 pm
- Kirk Centre, Ellon 22 June, 2-8 pm
- Collieston Community Centre, 23 June, 2-8 pm
- White Horse Inn, Balmedie 26 June, 2-8 pm
- Aberdeen Exhibition and Conference Centre, 27 June, 2-8 pm
- Tullos Primary School foyer, Aberdeen 28 June, 3-8 pm
- Patio Hotel , Aberdeen 29 June, 2-8 pm

18 These early periods of consultation helped to identify new stakeholders and interest groups in proximity to the proposal. Feedback from these stakeholders helped shape the final project design. Dialogue with stakeholders has continued as the project has moved towards the development of the EOWDC concept and the Vattenfall, Technip and Aberdeen Renewable Energy Group partnership.

19 In November 2010 briefing events for Aberdeen City and Shire councillors were held at the Town House in Aberdeen. Public exhibition events were publicised and run in November 2010 which outlined the European Offshore Wind Deployment Centre proposal and the revised 11 wind turbine layout. Response sheets were collected and display materials were made available for inspection with representatives of the project team present to answer questions. The events took place at :

- The Palace Hotel, Peterhead 22 November, 2-8 pm
- Udny Arms Hotel, Newburgh 23 November, 2-8 pm
- Kirk Centre, Ellon 24 November, 1-7pm
- Beach Ballroom, Aberdeen 25 November, 2-8 pm
- White Horse Inn, Balmedie 26 November, 2-8 pm

4.3.2 Additional Consultation

20 On the 18th February 2011 a briefing event was held for Energy Communications contacts at Aberdeen Town House. In March 2011 a project briefing session was run at the Scottish Parliament in Edinburgh for MSPs.

21 Since 2005 the project team has also presented the proposals to local community council meetings, and also responded to other ad-hoc requests for presentations / display stands including the Aberdeen Highland Games 2006.

22 The project has been a key focus of the All-Energy show over the last six years, and updates on progress were delivered at the opening business breakfast and during the main session presentations. In addition to press and media coverage, Councillor, MP & MSP briefings were given during the two day shows.

23 At the 2011 show a call was made to European Innovators. Wind turbine manufacturers, supply chain companies, universities and research establishments were all briefed in the project to identify possible involvement.

24 Information & briefings regarding the project were also available at the Aberdeen City and Shire stand at Offshore Europe 2005/2007/2009.

25 The project has featured in regular updates at meetings of the Aberdeen Renewable Energy Group.

European Offshore Wind Deployment Centre

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Chapter 5: Meteorological Conditions

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

5 METEOROLOGICAL CONDITIONS

5.1 Introduction

1 Information on the meteorological conditions is required to inform the design of wind farm projects. This section outlines the baseline data collected to date.

5.1.1 Key Guidance Documents

2 This study uses existing data from Dyce airport and the Met Office, and therefore follows their existing protocols. The guidelines for wind measurements to calculate power performance for turbines (IEC 61400-12-1) is currently being revised to cover remote measuring techniques (such as Light Detection and Ranging device (LIDAR) and Sound (or Sonic) Detection And Ranging (SoDAR). As these guidelines have not been completed the LIDAR measurements followed accepted principles as stated in the installation manual.

5.1.2 Data Information and Sources

3 In 2008a LIDAR was deployed by Natural Power, east of the Bridge of Don, to the north of Aberdeen. This instrument transmits a beam of light upwards, and measures the return signal (reflected from particles in the air) to assess the wind speed and direction at different heights above the sensor. It is therefore a remote sensing device for measuring wind parameters.

4 Wind data were recorded from 31 October 2008 to 22 January 2009, and the results have been reported in the following report:

- Prevailing (2009) Aberdeen Offshore Wind Farm: Analysis of LIDAR Data (00028-001-R: 7 October 2009)

5 A description of the data collection is given in Table 5.1

TABLE 5.1
Summary of LIDAR Measurements

Measurement device	Natural Power ZephIR
Location	OS Grid Reference 395024 810254
Monitoring period	31 October 2008 to 22 January 2009
Wind speed measurement heights*	27 m, 70 m, 90 m, 125 m, 153 m
Data recorded	Horizontal and vertical wind speed, wind direction, turbulence, temperature, pressure, humidity
Configuration	Cloud correction turned on

* Note: 1 m added to the LIDAR measurement heights to account for height of device

6 In addition to the LIDAR data, the following data from the Dyce Meteorological Station were also considered:

- hourly data from 1 November 2008 to 31 January 2009
- wind speed and direction data collected from January 2001 to January 2009

5.2 Baseline Assessment

7 The climate along the east coast of Scotland is heavily influenced by the weather systems and large scale currents in the North Atlantic. Weather patterns are particularly governed by variation in the North Atlantic Oscillation (a difference in pressure between the Icelandic Low and the Azores High). Large scale westerly circulation dominates, bringing frequent depressions across Scotland (DTI, 2004).

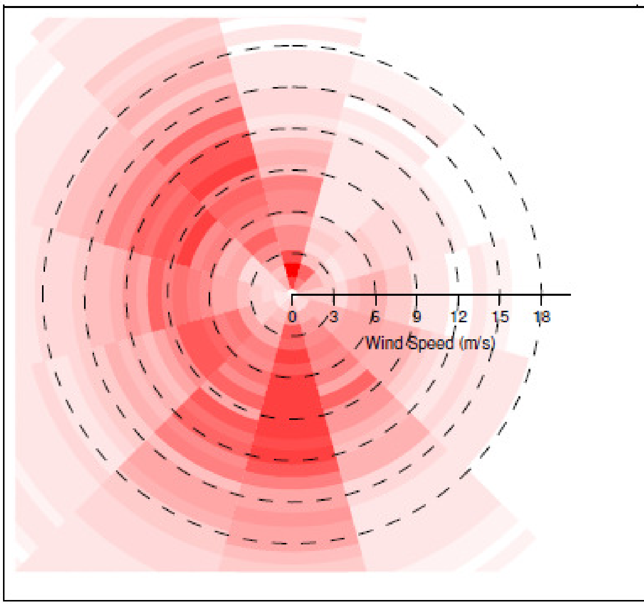
8 The North Sea climate is characterised by large variations in wind direction and speed, a high level of cloud cover and relatively high precipitation (OSPAR, 2000; DTI, 2004). The local climate along the north-east coast is dependent to a large extent on the shelter from winds from the north and west. Predominant winds are from the south and west. Wind strengths along this stretch of coast are variable and generally affected by local topography.

9 Mean annual rainfall in the central North Sea is 400 – 600 mm (OSPAR, 2000; DTI, 2004).

10 Coastal fog (“haar”) is common during spring and summer along the east coast of Scotland, with up to 14 days per month recorded in exceptional years (North Sea Pilot, 1997; DTI, 2004). Visibility statistics show that fog (visibility less than 1000 m) is most common in July and August. June to August is also when thunderstorms occur (MetOffice, 2011a).

11 Correlations of the concurrent wind speed at Dyce and the LIDAR using hourly, daily and weekly averaging periods were conducted and the daily correlation used to derive the long-term mean wind speed of 8.74 ms^{-1} at a height of 90 m (Prevailing, 2009).

12 Data from the Dyce site have been used to derive the long-term site wind rose using a Measure-Correlate-Predict methodology. The Dyce wind rose was scaled to the predicted long-term mean wind speed of 8.74 ms^{-1} at 90 m at the LIDAR location. The resultant wind rose is shown in Diagram 5.1.2 (source: Prevailing, 2009). This shows that the predominant wind directions are from the south (17.9 %) and north-north-west (13.4 %).



Sector	Probability
0	9.1%
30	2.8%
60	2.0%
90	2.4%
120	4.4%
150	8.4%
180	17.9%
210	12.2%
240	8.8%
270	7.9%
300	10.6%
330	13.4%

Diagram 5.1 Estimated Long-term Wind Rose at the LIDAR Llocation at 90 m

13 The meteorological conditions for the EOWDC area are summarised in Table 5. 2.

TABLE 5. 2 Meteorological Conditions at EOWDC Area	
Long-term wind speed*	8.7 ms^{-1}
Predominant wind speed – summer**	4.6 ms^{-1}
Predominant wind speed – winter**	5.2 ms^{-1}
Prevailing wind direction – summer**	South
Prevailing wind direction – winter*	South
Air temperature – annual average+	4.6 – 11.2 °C
Days of air frost – annual average+	53.6
Hours of sunshine – annual average+	1409
Rainfall – annual average+	816.3 mm
Days of rainfall ≥1mm – annual average+	134.2

*Long-term wind speed predicted at 90 m above ground level for LIDAR location (Prevailing report). Further offshore data collection would clarify this figure
**Dyce Station; summer (June, July & August), winter (December, January & February) measured at 10 m above ground level
+Craibstone 1971-2000 averages
Sources: *DTI (2004); +MetOffice Website (2011b)

5.3 Impact Assessment

14 The meteorological data are presented for information only, and an analysis of the wake effects is not required within the Environmental Statement (ES).

5.4 Summary

15 Short-term wind data were collected onshore adjacent to the EOWDC site and correlated with long-term data from Dyce Meteorological Station. These showed the average wind speed to be 8.7 ms^{-1} at 90 m height, and the predominant wind direction to be from the south.

16 Haar fog is common in the summer months, with July and August having the highest duration of low visibility.

5.5 References

DTI (2004) SEA 5: Strategic Environmental Assessment of Parts of the Northern and Central North Sea to the East of the Scottish Mainland, Orkney and Shetland. Department of Trade and Industry.

International Electrotechnical Commission (2005) International Standard: Wind Turbines – Part 12-1: Power performance measurements of electricity producing wind turbines. IEC 61400-12-1

MetOffice Website (2011a) Climatological statistics for British Isles airfields http://secure.metoffice.gov.uk/aviation/climatestats/region1.jsp#image [Date accessed: May, 2011]

MetOffice Website (2011b) http://www.metoffice.gov.uk/climate/uk/averages/19712000/sites/craibstone.html [Date accessed: May, 2011]

OSPAR Commission (2000) Quality Status Report 2000. Region II – Greater North Sea. OSPAR Commission, London, 136 +xiii pp.

Prevailing (2009) Aberdeen Offshore Wind Farm: Analysis of LIDAR Data. 00028-001-R: 7 October 2009

UKHO (1997) North Sea (West) Pilot – Admiralty Sailing Directions NP54

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Environmental Statement

Chapter 6: Geology and Bathymetry

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

6 GEOLOGY AND BATHYMETRY

6.1 Introduction

1 A review of the offshore sediments and geology in Aberdeen Bay indicates that the seabed sediments are defined as non-solid sediments laid down by the actions of the sea during the early Holocene. The sediments in this region reflect its glacial history and hydrodynamic regime. There is little input of sediment from land with most inputs being derived from peat deposits. The sediments off Aberdeen consist predominantly of sand and slightly gravelly sand (DTI, 2004).

2 Below the seabed, Pleistocene deposits off the Aberdeenshire coast vary from soft red-brown, grey-brown and pink-grey muds to compact grey clays with scattered pebbles that are interpreted as glacial till. The soft muds probably date from late Devensian to Early Flandrian, being deposited during the retreat of the last ice sheet. The underlying bedrock along the coast between Aberdeen and Stonehaven comprises sandstones, conglomerates, mudstones and cherts.

3 Forvie is designated as a geological conservation statutory review site. This is a non statutory designation which reflects the area's earth science interest in relation to coastal geomorphology.

4 Surveys that obtained bathymetric, seabed and sub-bottom data are critical to the project, providing a basis for the foundation design work, and informing the coastal process modelling and marine ecological and archaeological impact assessments.

6.1.1 Key Guidance Documents

5 There are no formal guidance documents to inform the geology assessment, but several project reports have been used to provide baseline information.

6.1.2 Data Information and Sources

6.1.2.1 Surveys

6 Site specific studies were undertaken that collected on-site survey data and also incorporated more general information from background literature such as British Geological Survey charts.

7 In 2007, EMU Ltd. was commissioned to undertake a geophysical and seabed habitat survey of the site as proposed at that time (Layout 011, see Frame 4, Figure 2.3). The survey included swath bathymetry data, sidescan sonar imaging, shallow seismic profiling, magnetometer readings and use of an Acoustic Ground Discrimination System (AGDS) with video ground-truthing (EMU Ltd, 2008). The survey was completed using the vessel *FPV Morven* between 12th and 18th September 2007.

8 Following a change in site location as outlined in Chapter 3 Site Selection, Osiris Hydrographic & Geophysical Projects Ltd (Osiris Projects) was commissioned to undertake a geophysical and benthic sampling survey of the current site (Layout 039, see Figure 3.2) and potential cable corridor area.

9 This second survey area slightly overlapped with the previous survey area to enable comparison between the two surveys and ensure consistency of data. The survey was completed using the vessel *MV Lia* between 3rd September and 26th October 2010.

10 The areas of both surveys can be seen on Figure 6.1.

6.1.2.2 *Project Reports*

11 In addition to the surveys, a geotechnical desk study was undertaken to determine the soil properties within the site.

12 These studies are reported in the following documents:

- EMU Ltd (2008b) Geophysical and Seabed Habitat Assessment of the Proposed Aberdeen Offshore Wind Farm
- Osiris Ltd (2011) Aberdeen Offshore Wind Farm Geophysical Survey Report – Volumes 2a and 2b
- Setech Ltd (2009) Geotechnical Desktop Study

6.2 Baseline Assessment

6.2.1 General Description

13 The geological succession in the area has been charted as:

- Superficial sediments
- Quaternary sediments
  - Forth Formation – St Andrews Bay Member
  - Forth Formation – Largo Bay Member
  - Wee Bankie Formation
- Bedrock
  - Devonian Sandstone
  - Ultrabasic and other coarse grained igneous rocks related to the Belhelvie gabbro mass

14 BGS described the superficial sediments as gravelly shelly sands ranging in thickness from less than 0.5 m to 2.0 m in thickness.

15 Underlying these are the Quaternary sediments. The fine to coarse sands (St Andrews Bay Member) are anticipated to be up to 20 m thick, underlain by silty clays and gravelly clays (Largo Bay Member). Beneath these is the glacial till deposit of the Wee Bankie Formation. This comprises sandy gravelly clays with frequent cobbles, occasional boulders and thin layers of sand and silty clay, together with coarser sand and gravel deposits.

16 The bedrock beneath the Quaternary deposits consists of Upper Devonian sandstones and conglomerates. However, the BGS data indicate that ultrabasic rocks are present at the central inshore section of the site (Osiris, 2010). These are rich in ferromagnesian minerals.

17 There is no evidence at this stage to suggest that shallow gas will be present at the proposed site.

18 The UK is an area of low seismicity and the risk to offshore structures is considered to be correspondingly low. The Dee Valley Fault strikes

diagonally across Aberdeen Harbour, however it is unlikely to affect ground conditions below the project area (Setech, 2009).

6.2.2 Geophysical and Seabed Habitat Survey Results

19 The survey reports include presentations of the data for:

- depth: swath bathymetry
- seabed features: AGDS, drop-down video, sidescan data and magnetometer contacts
- sub-seabed geology: sediment isopach charts and geological cross sections

20 **Bathymetry:** The seabed slopes consistently offshore, deepening to the east-north-east. This even increase in water depth was apparent in both geophysical surveys. The depths within the 2010 survey area range from 0.8 m to 35.1 m below Lowest Astronomical Tide (LAT) (Osiris, 2011).

21 In the shallow inshore section, depths increase from 0.8 m to 6 m in an irregular channel. To the east of this channel, there is a series of linked narrow bank features running parallel to the shore. In places, the depth decreases to 2m below LAT. These banks are asymmetrical, with the steeper side facing west. The seabed then slopes east-south-east with decreasing gradient between 1 in 110 and 1 in 140 to the 25 m contour, continuing to decrease further offshore at a gradient of 1 in 300.

22 The depths within The Crown Estate lease boundary range from 11 m to 35 m below Chart Datum (CD). The data from both surveys are shown in Figure 6.2.

23 **Seadbed features:** The sidescan sonar showed the sediments over most of the survey area were predominantly slightly silty sands, which are frequently shelly (see Figure 6.3). Along the western border of the survey areas there are outcrops of glacial (clayey) till. There are also patches of gravel to the north. The till and gravel are exposed due to erosional forces of the tides and waves preventing net deposition. This means the gravels are reworked during storm periods changing the nature of the sediment morphology (Osiris, 2011).

24 Depositional ripple features are apparent towards the intertidal area (Emu, 2008), with megaripples within the gravel areas and other features in the silty sand up to 1,500 m from the shoreline (Osiris, 2011).

25 Several trawl scars were visible in the sonar data, plus numerous targets, most of which are interpreted as boulders. A wreck and possible area of associated debris have been identified near the proposed site of Wind Turbine 8 (see Chapter 18 Archaeology for more details).

26 The 2007 data identified 59 magnetic targets, being dominated by several large readings in the north-west of the survey area. These were the result of submerged geological features.

27 In the 2010 data, there was a total of 262 anomalies in the magnetometer readings. These included three outfall pipes running out from shore and the route of a disused telecoms cable. There was also an area of high magnetic readings in the west of the site, associated with submerged geology as described in the 2007 data. An igneous intrusion probably related to the Belhelvie gabbro mass was highlighted.

28 Only one medium-sized magnetic anomaly was considered to be of anthropogenic origin and of concern; this is located adjacent to Wind Turbine 3 and could be the remains of an unknown wreck or aircraft crash."

29 There were numerous small magnetic anomalies across the site. Given the possibility of ordnance in the area these may indicate small metallic objects such as unexploded ordnance (UXO).

30 The drop-down video confirmed that silty sand was common across the area, with ripple marks of 20-40 cm wavelength. Inshore, there was a lower mud content than offshore. There were occasional patches of shelly fragments.

31 **Sub-seabed geology:** The surveys confirmed a surface veneer of sandy sediments, which is absent in some locations nearshore (where the till outcrops at the surface) increasing to over 10 m thickness offshore. Nearshore, this is thickest in the sand bar features described above. In the north-west there may also be layers of peat near the surface.

32 These surficial sediments overlie a sequence of glacial (Quaternary) sediments with evidence of erosional surfaces and variable lithology (Emu, 2008). At the top of this sequence is the fine to coarse shelly sand of the Forth Formation. This is not present across the whole site, as patches of till outcrop at the surface; its deepest extent is 36 m below seabed in the north-west corner of the survey area (Osiris, 2011). Beneath this is the glacial till of the Wee Bankie Formation. There is a ridge feature extending west-north-west/east-south-east across the central eastern section of the proposed site. This is approximately 2 km long and 150 m wide, possibly representing a terminal or recessional moraine (Osiris, 2011). In the west, distinct lenses of sediment are apparent lying directly on the rockhead. These coincide with the high magnetometer readings and are interpreted as reworked local igneous material contained within the till deposit. This means the geology will be of variable engineering strength (Emu, 2008).

33 The rockhead is expected to be Devonian Old Red Sandstone which occurs at a depth of 5-10 m below the seabed in the west, deepening to over 30 m below seabed at the eastern boundary.

34 Further information on the habitat can be found in Chapter 9 Marine Ecology, Intertidal Ecology, Sediment and Water Quality.

6.2.3 Geotechnical Study Results

35 Setech (Geotechnical Engineers) Ltd. conducted a geotechnical desk study in early 2009. This used the Emu survey data plus existing borehole information from the BGS. The comparison of these datasets confirmed that the presence of Holocene sediments underlain by glacial Wee Bankie Formation, which rests directly on the Devonian Old Red Sandstone.

36 There is limited geotechnical information available, and therefore only general assumptions can be made regarding strength. The Wee Bankie Formation is described as soft to very stiff clay (increasing with depth), with borehole logs indicating C_u (undrained shear strength) values of 30 to >150 Kn/m^2. However, verification of the strength of both this and the bedrock is needed to determine engineering parameters for foundations.

6.3 Impact Assessment

6.3.1 Impact Assessment Methodology

37 From the geophysical and geotechnical studies undertaken, the only environmental impact anticipated on the geology and bathymetry is potential scour, which is considered in Chapter 8 Coastal Processes, or removal of material directly where the foundations are installed. Consequently, a formal impact assessment is not considered appropriate here.

6.3.2 Impact Assessment

38 Construction would not alter the geology of the site other than in localised areas directly impacted by the installation of wind turbine foundations. This is dependent upon the size of the foundation used, but is not considered to be significant for any of the options under consideration. It is anticipated that during decommissioning, foundations would be removed to below the seabed surface.

6.3.3 Summary

39 The geology of the site comprises silty sand at the surface, lying above glacial till, which in turn lies on Devonian Old Red Sandstone.

40 The only anticipated impacts would be potential scour due to the turbine foundations, which is considered in Chapter 8 Coastal Processes and direct loss of sediment where the foundations are installed. This would be dependent on the type and size of foundations used but is not considered to be significant.

41 However, to inform the engineering considerations, further geological work would be undertaken for the project. Following the recommendations by Setech (2009), a full site investigation would be conducted to obtain site specific data on soil conditions. This would confirm the potential strength parameters of the Wee Bankie Formation, and would also verify the bedrock composition, competency and strength as an addition to the geophysical survey and the desktop study. This survey would be conducted as part of the pre-construction survey.

6.4 References

DTI (2004) SEA 5: Strategic Environmental Assessment of Parts of the Northern and Central North Sea to the East of the Scottish Mainland, Orkney and Shetland. Department of Trade and Industry.

EMU Ltd (2008) Geophysical and Seabed Habitat Assessment of the Proposed Aberdeen Offshore Wind Farm. Report No. 07/J/1/02/1136/0716. February 2008.

Osiris Ltd (2011) Aberdeen Offshore Wind Farm Geophysical Survey Report – Volumes 2a and 2b C10023. February 2011.

Setech Ltd (2009) Geotechnical Desktop Study. Report No. 8733-0-0. January 2009.

European Offshore Wind Deployment Centre

Environmental Statement

Chapter 7: Offshore Ordnance

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

7 ORDNANCE

7.1 Introduction

1 This section outlines the information available with respect to unexploded ordnance (UXO) across the proposed European Offshore Wind Deployment Centre (EOWDC) site. The Health & Safety at Work Act and the construction (Design & Management) Regulations (1994) do not require UXO studies to be undertaken. In light of history of ordnance in Aberdeen Bay area, the Applicant commissioned UXO threat assessments and developed mitigation strategies to ensure the safety of those working on the project.

7.1.1 Key Guidance Documents

2 In 2009, CIRIA (the construction industry research and information association) produced a holistic UXO risk management framework for onshore UXO: "Unexploded ordnance (UXO) A guide for the construction industry". While not directly applicable to offshore UXO, the same principles apply in the marine environment (where no formal guidance exists at this time).

3 This has therefore been applied to the studies undertaken in 2010 in conjunction with marine and renewable experience (6 Alpha, 2010).

4 Other sources of guidance included:

- Maritime Coastguard Agency (MCA)
- British Marine Aggregate Producers Association (BMAPA)
- Health & Safety Executive (HSE)

7.1.2 Data Information and Sources

5 Three studies have been undertaken to inform the project on the risk of UXO across the site. The first was undertaken in 2007 by BACTEC International Limited, and was a risk assessment for the area around Layout 011 (see Frame 4, Figure 2.3).

6 The second and third were completed in 2010 by 6 Alpha Associates, describing the UXO risk and then proposing possible mitigation methods.

7 These used the following data sources (6 Alpha, 2010):

- Royal Navy (Northern Diving Unit), Scotland
- The National Archives, Kew
- Naval Historical Centre, Portsmouth
- UK Hydrographic Office, Taunton
- 6 Alpha database

7.1.2.1 Project Reports

8 The reports written specifically for this project were:

- BACTEC International Limited (2007) Explosive Ordnance Threat Assessment of the Aberdeen Offshore Wind Farm
- 6 Alpha Associates (2010) Unexploded Ordnance (UXO) Risk Situation Report and Risk Assessment/Method Statement Review
- 6 Alpha Associates (2010) Unexploded Ordnance (UXO) Threat & Risk Assessment with Mitigation Strategy. Project: Aberdeen Offshore Wind Farm. This is also included as Appendix 7.1.

7.2 Baseline Assessment

9 Initially, the risk of encountering UXO was considered to be high (BACTEC, 2007). However, with the change in location, the majority of the site is now considered to be low risk, with a medium risk only occurring in a buffer around Black Dog Rifle Range.

10 There are a number of potential sources for UXO (BACTEC, 2007; 6 Alpha, 2010):

- military ranges (Royal Navy and British Army)
- munitions dumping grounds
- sea mines (British and German)
- anti-aircraft artillery (AAA) projectiles
- coastal gun batteries
- unexploded bombs
- wrecks
- convoy routes

11 While most of the ordnance is from World Wars (WW) I and II, it rarely becomes inert or loses effectiveness with age.

12 There are four firing ranges in the area (Figure 7.1), but only Black Dog Rifle Range is close enough to affect the proposed EOWDC (and two are beyond the extent of the figure). This facility was a WWII military land service ammunition site, and is now a small arms range.

13 There is one munitions dumping ground in the area, but this is directly east of Aberdeen (Figure 7.1) and considered too far south for munitions to have migrated to the proposed site.

14 There was a defensive mine field off the east coast of Scotland that was cleared after WWII, although clearance methods are not considered 100 % effective. However, this is 18 km from the proposed development and therefore too far away to be impacted.

15 Aberdeen was regularly bombed throughout WWII, and an AAA battery was deployed at Black Dog. However, the locations of any unexploded shells cannot be determined through desk study, and therefore must be acknowledged as a background risk across the whole area. The SS Archangel was sunk by bombs to the north of the proposed site (Figure 7.1) which confirms bombing activity in the area.

16 There have been no munitions wrecks identified in the area.

7.3 Impact Assessment

17 The 6 Alpha report presents a semi-quantitative risk assessment for the project. This classifies areas as Low (Tolerable or Partly Tolerable risk), Medium (Intolerable risk) and High (Highly Intolerable risk).

18 In the areas classed as Low, there is a “remote to possible” chance of encountering UXO, mainly from the background risk of unexploded bombs or AAA.

19 In areas classed as Medium, it is “likely to very likely” that ordnance would be encountered. These areas should be avoided if possible. If not, then a full UXO survey should be undertaken, including diver or ROV (remote operated vehicle) inspection of any finds. Two of the wind turbines are located within an area classed as medium.

20 In areas classed as High, it is “almost certain” that ordnance will be encountered, and these should be avoided.

21 Figure 7.1 shows the classification across the EOWDC site. The majority of the site is classed as Low, ie only a remote chance of encountering UXO. However, there is Medium risk in a buffer around the Black Dog Rifle Range, so it is considered highly likely that there is a chance of encountering UXO. This buffer encompasses Wind Turbines 2 and 3, which means that further UXO specific investigation would be required at these sites before installation begins. This could be a UXO geophysical survey with a diver or ROV inspection of any possible finds.

7.4 Summary

22 A risk assessment for encountering UXO was undertaken for the proposed EOWDC site (6 Alpha, 2010). This concluded that the main ordnance threat was due to the Black Dog Firing Range, extending beyond the range itself and specifically affecting Wind Turbines 2 and 3, where further investigation would be required. Outside this area, there is a low UXO risk to this project, which is considered to be the “background residual risk”.

7.5 References

BACTEC International Limited (2007) Explosive Ordnance Threat Assessment of the Aberdeen Offshore Wind Farm, Report Number 9253TA April 2007

6 Alpha Associates (2010) Unexploded Ordnance (UXO) Risk Situation Report and Risk Assessment/Method Statement Review, Report Number P2219 August 2010

6 Alpha Associates (2010) Unexploded Ordnance (UXO) Threat & Risk Assessment with Mitigation Strategy. Project: Aberdeen Offshore Wind Farm, Report Number P2219 TRA September 2010.

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Chapter 8: Coastal Processes

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8 COASTAL PROCESSES

8.1 Introduction

1 ABPmer was commissioned by the Applicant to undertake an assessment on coastal processes. This section defines the baseline (existing) coastal processes within the study area and presents the potential impacts of the development relative to this baseline regime. In order to assess the potential effects of EOWDC relative to the baseline (existing) coastal environment, a combination of qualitative assessment of site data, empirical evaluation and detailed numerical modelling has been used to establish the potential magnitude and significance of the predicted changes. These effects have been assessed using the 'worst case' characteristics of the proposed development, as provided by the project. Considerations of the proposed effects upon the tide and wave regimes have been made and the subsequent impacts upon a series of receptors determined, including the offshore seabed morphology and littoral sediment regime. Comment has also been made to address relevant concerns raised by consultees, as fully presented in Appendix 4.2.

2 The following technical reports support this chapter and can be found as:

- European Offshore Wind Deployment Centre: Coastal Processes Baseline Report (Appendix 8.1) and
- European Offshore Wind Deployment Centre: Coastal Processes Assessment Report (Appendix 8.2)

8.1.1 Methodology Consultation

3 The scope of present considerations undertaken for coastal processes considers the specific issues raised through project consultation in combination with the generic project requirements, as detailed in present guidance.

4 A series of coastal process topics were raised as a result of the consultation of the Environmental Impact Assessment (EIA) Scoping Report (Appendix 4.1). Responses from four organisations were provided which have concerns relevant to coastal process issues. The full list of organisations whom submitted responses relevant to coastal processes at the current development are:

- Aberdeen Harbour Board Scottish Natural Heritage (SNH) Scottish Environmental Protection Agency (SEPA) and
- Marine Scotland

8.1.2 Key Guidance Documents

5 Guidance on the generic requirements, including spatial and temporal scales for coastal process studies is provided in six main documents:

- 'Offshore wind farms: guidance note for Environmental Impact Assessment in respect of Food and Environmental Protection Act (FEPA) and Coast Protection Act (CPA) requirements: Version 2' (Department for

Environment, Food and Rural Affairs (Defra), Centre for Environment, Fisheries and Aquaculture Science (Cefas) and Department for Transport (DfT), 2004)
- ‘Guidance on Environmental Impact Assessment in Relation to Dredging Applications’ (Office of the Deputy Prime Minister, 2001);
- ‘Nature Conservation Guidance on Offshore Wind Farm Development’ (Defra, 2005)
- ‘Marine Renewable Energy and the Natural Heritage: An Overview and Policy Statement’ (Scottish Natural Heritage, 2003)
- ‘Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment’ (COWRIE, 2009); and
- Consenting, EIA and HRA Guidance for Marine Renewable Energy Deployments in Scotland’ (EMEC & Xodus AURORA, 2010)

8.1.3 Data Information and Sources

6 The main data and information sources are summarised as follows, for further details on these data sources the reader is referred to Appendix 8.1.

- Five months of metocean survey between 12th September and 13th February 2008 (Emu, 2008a)
- Geophysical surveys covering the original study area (Emu, 2008b) and the EOWDC site (Osiris, 2010)
- Geotechnical review of existing borehole information (Setech, 2009)
- Grab samples covering the previous site collected by the Fisheries Research Services (FRS) (Titan, 2008), covering the EOWDC site collected in 2010 by the Centre for Marine and Coastal Studies (CMACS Ltd) and covering the intertidal are adjacent to the EOWDC (Appendix 8.1) Beach profiles collected by ABPmer(Appendix 8.1); and
- Water level data collected in Aberdeen Harbour by the British Oceanographic Data Centre’s (BODC) National Tide and Sea Level Facility (NTSLF) between 1980 and 2005

7 Reports from other previous work have also been compiled that describe various aspects of the study area, the principal studies are summarised below:

- Aberdeen Bay Coastal Protection Study (Halcrow Crouch Ltd, 1999)
- Coastal Cells in Scotland, Cell 2 (HR Wallingford, 2000)
- Coastal processes and management of Scottish estuaries, The Dee, Don and Ythan Estuaries (Stapleton and Pethick, 1996)
- Beaches of Northeast Scotland (Ritchie et al, 1977); and
- SEA 5 (DTI, 2005)

8.2 Baseline Assessment

8 The baseline, or pre-construction, phase considers the coastal processes prior to any wind farm works. The investigation of this phase is relevant as it provides a condition to which the coastal processes during all other phases can be compared. It should be noted that any changes to the coastal processes within the lifetime of the array due to natural variability will also be compared to this phase.

9 The pre-construction phase forms the baseline which has been discussed within the preceding report (Appendix 8.1).The proposed development is located between 2 and 4.5 km offshore in water depths ranging from 10 to 30 mCD (below Chart Datum). The seabed has a gentle gradient from the offshore to the shoreline, which increases in a shoreward direction. There is no evidence of large-scale bedform features within the proposed EOWDC site (Emu, 2008a; Osiris, 2010). In the shallower areas west of the site some seabed features are present including wave-induced ripples, areas of exposed glacial material and a shore parallel ridge (Figure 8.1).

10 Tidal range within the proposed site is 3.4 m and 1.7 m under mean spring and neap tidal conditions, respectively. Peak tidal currents have been measured at less than 1.1 m/s (near-surface) within the proposed EOWDC site, decreasing in magnitude towards the shore. Average near-bed and surface speeds recorded are approximately 0.22 m/s and 0.33 m/s, respectively. The peak flow occurs at approximately the times of high and low water, with slack water occurring mid-tide. The tidal axis is orientated approximately shore parallel, flooding towards the south-southwest and ebbing towards the north-northeast (Figure 8.2). Flood currents are slightly stronger than those of the ebb tide. The rectilinear nature of the tide increases from near-surface to the mid-water column.

11 The most frequently occurring waves within the proposed EOWDC site (based on observations made during a 5 month winter survey) are between 0.5 and 1.0 m significant wave height and originate from the southeast. The largest wave heights recorded within this period are of the order of 5.5 m and originate from the east (Figure 8.3). Further offshore, due to the absence of coastal sheltering, northerly wave directions predominate.

12 Analysis of the exposure conditions (tides, waves) in view of the surficial seabed sediments experienced within the array has been undertaken to assess the potential mobility of the seabed. Within the proposed EOWDC site, the seabed material has been observed to be predominantly sand (grain diameter 150 micrometre (µm)) with some mud and gravel in places. The presence of different size fractions acts to provide some armouring to the seabed. It is shown that both tidal and wave processes influence sediment mobility, with tides having a greater influence in the offshore. Analysis of tidal currents measured near the seabed shows that tidal asymmetry within the lower water column results in a net northerly transport of the typically present sand sized sediment. However, the seabed sediment transport regime within the wind farm boundary is not particularly active with respect to these size fractions.

13 The net direction of longshore transport has been shown to be in a northerly direction and under the control of waves (the more frequent waves originate from the southeast). This is evidenced by the rivers that have typically been deflected to the north due to the sediment deposition at the mouths. However, the southerly orientation of a spit across the mouth of the River Ythan at the northerly end of the bay indicates the potential for net southerly directed littoral transport in this part of the bay. Wave refraction causes some southerly directed transport in the far southern part of the bay adjacent to the mouth of the Dee. The rate of littoral transport decreases towards the north of Aberdeen Bay as a consequence of its changing alignment, an observation which is supported by the fining of beach sediment towards the north.

However, under extreme storm events, the potential alongshore transport potential is much greater in the north of the Bay than the south.

14 Aberdeen Bay is characterised by dune backed sandy beaches. Some aeolian exchange of dry sediment occurs between the dunes and the beach, with the beach supplying sediment to the dunes under ‘normal’ wind and wave activity. Some sediment may also be released back onto the beach during storm events through wind erosion and wave erosion in conjunction with high water levels. The overall erosion of the beach indicates that current sediment sources are not adequate to maintain the beach profile. This is probably due to the limited transfer of sediment from offshore.

8.3 Impact Assessment

8.3.1 Impact Assessment Methodology

15 A combination of qualitative assessment of site data, empirical evaluation and detailed numerical modelling has been used to establish the potential magnitude and significance of the predicted changes. These effects have been assessed using the ‘worst-case’ characteristics of the proposed development, as provided by the project. These are presented in Table 8.1.

TABLE 8.1 **Scenarios Assessed for Coastal Processes**	
Potential Impact	**Likely scenario assessed**
Phase: Construction and decommissioning	
Increase in suspended sediment concentrations as a result of installation / removal activities	Foundation Installation: 2,100 m^3 of sediment disturbed for the installation of each monopile foundation. Total of 11 structures with an installation period of 5 days per wind turbine/foundation. Monopile with diameter of 8.5 m and maximum burial depth of 37 m. Sediment disturbed includes combination of mud and fine sand, released in-situ next to structures. Cable Installation: 405,000 m^3 of sediment disturbed for 26 km of cable installation using mass excavation methods. Installed at rate of 500 m/hr and 5 m/hr in water depths greater and less than 2 m, respectively. Maximum depth and width of trench 3 m and 10.38 m, respectively. Sediment disturbed includes combination of mud and medium sands.
Phase: Operational	
Changes to processes acting within Aberdeen Bay. Including: (i) Changes to the tidal and wave regimes as a result of the presence of the turbine foundations. (ii) Changes to the seabed form receptor	Array consisting of 11 Gravity Base Structures with base diameter 40 m, tapering to 6.5 m at 10 m below Lowest Astronomical Tide (LAT). Cumulative effect allows for the addition of Ocean Laboratory located approximately 300 m from the nearest turbine. Represented as a Gravity Base Structure with dimensions as per the array structures.
Introduction of seabed scour as a result of the presence of construction equipment and turbine foundations.	Includes monopile, jacket, tripod, gravity base and suction caisson/bucket structures. Cumulative effect allows for the addition of Ocean Laboratory located approximately 300 m from the nearest wind turbine. Represented as a Gravity Base Structure with dimensions as per the array structures.
Changes to processes acting to maintain the Aberdeen Bay coastline	Array consisting of 11 Gravity Base Structures with base diameter 40 m, tapering to 6.5 m at 10 m below LAT.

16 Numerical models from the Danish Hydraulics Institute (DHI) have been applied to assess the effects of the potential development upon the existing coastal processes within the site and the wider sub-tidal area. Another numerical model ‘XBeach’ has also been used to determine potential changes to the beach morphology and nearshore (littoral) regime. The potential for localised scour around the turbine foundations has been assessed using empirical methods on the basis of foundation design information and the baseline understanding of tidal, wave and sedimentary environments.

17 When assigning significance to an impact, the methodology can be summarised as follows:

- the magnitude of the effect (Table 8.2) is determined based on a combination of the spatial extent, the duration and the scale of the effect; and

- the sensitivity of the receptor is determined by considering the recoverability and the importance of the receptor and assigning a value of very high, high, medium or low

18 Using a combination of these criteria, impacts are assigned an impact significance rating of major, moderate, minor or negligible (Table 8.3).

19 This approach to impact assessment is based on matrix as supplied by the Applicant (See Table 4.2). It is important to note that this approach assumes that all impacts are adverse or detrimental in nature, however, some impacts might actually have beneficial implications for the receptor concerned.

TABLE 8.2
Outline Criteria for Assessing the Magnitude of the Effect (adapted from AOWFL, 2010a)

Rating	Spatial extent criteria	Duration criteria	Scale criteria
Very High	National/ International	>10 years	Very high level of change compared to background
High	Regional	5 – 10 years	High level of change compared to background
Medium	Local (<5km)	1 – 5 years	Medium level of change compared to background
Low	Site specific	<1 year	Low level of change compared to background
Negligible	Restricted to the immediate vicinity	Negligible	Negligible level of change compared to background

TABLE 8.3
Matrix Used to Assign Level of Significance (Adapted from AOWFL, 2010a)

Magnitude of effect (based on combination of criteria in Table 1)	Sensitivity of Receptor			
	Very High	High	Medium	Low
Very High	Major	Major	Major	Moderate
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Moderate	Minor
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

8.3.2 Potential Impacts: Construction and Decommissioning Phases

8.3.2.1 Changes to Processes Acting within Aberdeen Bay as a Result of the Presence of Construction Equipment

20 The temporary presence of construction equipment is not considered to affect the tide and wave regimes. Consequently any impacts upon seabed morphology would be small in magnitude, temporary and localised.

21 In terms of coastal processes, the offshore seabed form is considered to be of low importance as it does not have any designated features and is considered to be of medium recoverability (due to the weak tidal conditions limiting the frequency and magnitude of sediment mobility).

22 The potential impact has been assessed of negligible magnitude, low sensitivity and therefore of negligible significance.

8.3.2.2 Seabed Changes as a Result of the Presence of Construction Equipment and Wind Turbine Foundations eg Scour

23 Construction vessels may use jack-up legs or a number of large anchors to hold station during construction operations. These (in conjunction with an additional limited amount of sediment scouring) may leave indentations on the seabed, post construction. The maximum footprint of the construction equipment would result from the use of one 6-legged jack and one 6-legged barge per wind turbine installation, with a total footprint per wind turbine of 4,200 m^2. This amounts to 0.021 % of the EOWDC lease area per wind turbine location.

24 The relative seabed immobility may mean that the indentations persist over the short-term. However, due to the small area of the potential indentations, this impact is considered to be of negligible magnitude.

25 The potential impact has been assessed of negligible magnitude, low sensitivity and therefore of negligible significance.

8.3.2.3 Potential Impact: Increase in suspended sediment concentrations as a result of installation / removal activities

26 During the installation of the foundation structures and cables, there is the potential for sediment re-suspension and subsequent dispersal. The scoping exercise identified sensitive receptors within nearby European designated sites and also concerns regarding sediment deposition within Aberdeen Harbour.

27 Sediment re-suspension and dispersal has been considered using numerical modelling techniques. Sediment resuspension rates vary between operations and are dependent upon the duration of works and the sediment volume released. The scenarios tested are provided in Table 8.1.

28 The localised resuspension of material by construction equipment during both foundation installation and cable burial leads to sediment dispersal in suspension both within the site and the wider area. Whilst sediment is being actively released, material in suspension initially accumulates within Aberdeen Bay. Once installation activities cease, the remaining suspended sediment is more widely dispersed, reverting to ambient background levels.

29 Results indicate that suspended sediment concentration levels are typically <8 mg/l and <40 mg/l, above natural background levels, for the foundation and cable works, respectively. Localised maximum concentrations of 100 mg/l and 90 mg/l, above natural background levels, also occur for the foundation and cable works, respectively but these are shown to be short-lived. Measured suspended sediment concentrations within the EOWDC array are shown to a maximum of 43 mg/l (Emu, 2008). The results are illustrated in Figures 8.4 and 8.5. Concentrations are given as depth-averaged values and as such may be slightly higher towards the bed and lower towards the water surface. Cable burial using mass excavation tools is

shown to produce a greater increase in suspended sediment concentration levels relative to the foundation installation works.

30 Due to the fine nature of the sediments suspended by the construction activities (Table 8.1), there was found to be little potential for measurable deposition of material within Aberdeen Bay and so upon sensitive receptors. It was found to be more likely that the material would become widely dispersed in the offshore environment.

31 A very small proportion of the total volume of sediments suspended may be entrained into Aberdeen Harbour by normal tidal exchange. The largest total volume of silt sized sediment potentially resuspended by the installation of foundations would result from 11 gravity bases and is equivalent to a maximum of 0.2 m unconsolidated sediment thickness, if deposited directly and evenly over an area equivalent to that of Aberdeen Harbour. Naturally occurring processes of advection, dispersion and sediment settlement in the coastal environment make it highly unlikely that any significant proportion of the total sediment volume disturbed would actually enter and subsequently settle inside the harbour. It is also unlikely that all foundations would be gravity bases, given the nature of the EOWDC development, further reducing the total sediment volume and the potential for its accumulation elsewhere.

32 A very small proportion of the total volume of sediments suspended may be entrained into Aberdeen Harbour by normal tidal exchange and as a consequence of the one-off short-term (52 hour) cable installation activity. It is, however, considered that, given the short-term duration of the installation works combined with the naturally occurring processes of advection, dispersion and sediment settlement in the coastal environment, it is highly unlikely that any significant proportion of the total sediment volume disturbed would actually enter and subsequently settle inside the harbour. Should the mass excavator tool not be used, the total sediment volume would be further reduced as would the potential for its accumulation elsewhere.

33 The potential impact within the Aberdeen Harbour has been assessed of low magnitude, medium sensitivity and therefore of minor significance.

34 Localised, temporary increases in sediment concentrations are shown to occur into areas designated for conservation at a European level. Some of the designations are for the onshore dune and coastal habitat features which would not be affected by temporary increases in marine suspended sediment levels. The marine exposed area affected by localised changes in suspended sediment concentration changes is along the Buchan Ness to Collieston coast. The temporary, localised concentration elevations above natural background levels, which may occur here are less than 8 mg/l.

35 The potential impact within designated sites has been assessed of low magnitude, high sensitivity and therefore of minor significance.

8.3.3 Potential Impacts: Operational Phase

8.3.3.1 <u>Changes to Processes acting within Aberdeen Bay</u>

36 Sediment transport within Aberdeen Bay is controlled by both the tidal and wave regimes, with the latter shown to exert a sizeable, relative, contribution

to the mobilisation of seabed sediments. The wave regime is shown to have a predominant influence upon the littoral sediment transport (Section 8.3.3.3). The absence of significantly large bedforms within the offshore area is probably due to a combination of weak tidal currents not creating bedforms and wave events further flattening the seabed during storm events.

37 The analyses of impacts on both the tidal and wave regime have demonstrated no significant impacts; whilst tidal currents may be slightly modified (<0.05 m/s) this does not occur at the time of peak flow and so the naturally occurring range of speeds remains unaffected (Figure 8.6). With respect to water levels, the analysis showed no measurable increases or decreases in this parameter. Significant wave heights (Hs) are reduced in the lee of the wind turbines by a small amount (< 0.1 m) for frequent, low energy wave conditions. For the most frequently occurring wave conditions (Hs 0.5 to 1.0 m from the south-east), wave height changes of less than 0.05 m are more common (Figure 8.7). As expected, it is under the larger wave heights that the largest absolute differences and spatial extents of effect are observed. The largest reported reduction in wave height is localised to within the immediate lee of individual wind turbines and is markedly less elsewhere (< 0.01 m at the shoreline) (Figure 8.7).

38 The combined changes to the tidal and wave regimes are not expected to have any significant impacts on the offshore sediment regime.

39 In terms of coastal processes, the offshore seabed form is considered to be of low importance as it does not have any designated features and is of medium recoverability due to the weak tidal conditions.

40 The potential impact has been assessed of negligible magnitude, low sensitivity and therefore of negligible significance.

8.3.3.2 Introduction of seabed scour as a result of the presence of turbine foundations

41 Currents and wave induced flow would interact with the foundations, resulting in accelerated flow and elevated turbulence at the seabed adjacent to the structure's edge. The resulting increase in bed shear stress and potential for sediment mobilisation results in sediment scour whereby a depression is formed in the seabed around the base of the foundation. The rate of scour development is generally rapid enough for the equilibrium scour depth (for the given flow conditions in unconsolidated non-cohesive sediments) to be achieved over a period of a few tides. Using empirical relationships, the equilibrium scour depth for each foundation type resulting from a combination of both waves and currents was calculated and summarised in Table 8.4.

TABLE 8.4
Summary of Scour Characteristics Assuming a Uniform Erodible Sediment

Parameter	**Foundation Option**				
	Monopile	**Jacket***	**Tripod**	**Gravity Base**	**Suction Caisson**
Equilibrium Scour Depth (m)					
Steady Current	11.05	3.25	3.25	7.2	3.6
Waves	Negligible	0.5	2.2	1.6	0.8
Waves and current	≤ 11.05	≤ 3.25	≤ 3.25	18	9
Group Scour	N/A	~1	~1	N/A	N/A
Scour Extent					
Scour extent from foundation ** (m)	18	5	5	12	6
Scour footprint ** (m^2)	1,445	1,472	1,101	1,865	466
Foundation footprint (m^2)	57	20	15	1,257	314
Scour Volume**					
Scour volume (m^3)	6,228	749	884	6,214	777

* Bed prep volume negligible if corner piles are inserted without drilling
** Extent and area excluding the foundation. Values based upon the scour depth for steady currents. Footprint and volume values per foundation.
Whilst these calculations assume an uniform erodible sediment, the presence of the Wee Bankie formation at, approximately, 10m to 20m below the seabed is likely to restrict the scour depth.

42 In terms of scour depth, the gravity base structure has the potential to cause the largest impact due to its large dimensions. However, the estimated maximum depth (18 m) is unlikely to be attained due to the potential constraints arising from the sub-surface geology with a till surface (termed the Wee Bankie Formation) at, approximately, 10 m to 20 m below the present seabed level (Osiris, 2010). This layer is described as a soft to very stiff clay with occasional sand and gravel lenses (SEtech, 2009). Group scour is expected to be minimal and the risk for global scour is considered to be negligible.

43 The extent of scour from the edge of each foundation is also shown in Table 8.4. This is calculated assuming the profile of the scour pit is an inverted cone with slopes at the angle of repose for sand (32°). The footprint or area of the scour pit (excluding the foundation footprint) is also provided, together with the footprint of the foundation for comparison. The gravity base foundation would result in the greatest total scour footprint; the suction caisson would produce the least. Table 8.5 summarises the total foundation and scour footprints and as a proportion of the lease area.

44 The time required for the majority of scour pit development around each foundation within the EOWDC is estimated to be within the order of 6 to 12 hours (under flow conditions sufficient to induce scour). This makes the assumption of a mobile uniform non-cohesive sediment substrate. Symmetrical scour would only develop following exposure to both flood and ebb tidal directions. Waves do not typically cause rapid initial scour directly, but can increase the rate of initial scour development.

45 The potential impact has been assessed of medium magnitude, low sensitivity and therefore of minor significance.

TABLE 8.5 Summary of Predicted Scour as a Proportion of the Lease Area					
Parameter	**Foundation Option**				
	Monopile	**Jacket***	**Tripod**	**Gravity Base**	**Suction Caisson**
Number of devices	11	11	11	11	11
Seabed footprint of all devices (m^2)	624	216	162	13,823	3,456
Proportion of total site area (%)	0.003	0.001	0.001	0.069	0.017
Seabed footprint of all devices + scour (m^2)	16,625	7,354	12,269	34,339	8,585
Proportion of total site area (%)	0.083	0.037	0.061	0.172	0.043

8.3.3.3 Changes to Processes Acting to Maintain the Aberdeen Bay Coastline

46 The main control on the nearshore sediment transport (littoral) regime is wave processes and therefore the impact assessment is focussed upon this aspect.

47 Potential impacts on the littoral regime were assessed for both frequent, low energy and infrequent, high energy wave events and directions experienced within the study area. Therefore the climate assessed was that resulting from winds (and waves) coming from, at the offshore boundary northeast (60 °N); east (90 °N); southeast (120 °N); and south-southeast (150 °N) at speeds of 8, 12 or 16 m/s. These wave conditions were suitably transformed in the model by processes of refraction and shoaling across the study area and the nearshore bathymetry, simulating naturally occurring modification to wave height, period and direction in the area. The relative difference in the morphological response of 3 km of shoreline in the developments lee was calculated by comparing pre- and post-construction scenarios.

48 'Natural' cross-shore profile changes occur in response to different (naturally occurring) wave conditions. The beach response is also spatially variable and ultimately dependent upon the initial local morphology. As would be expected, the magnitude of the beach response increases with increasing wave height. Absolute beach elevation changes are less than 0.2 m when significant wave height (Hs) is less than 1 m; conversely, to induce a beach elevation change greater than 0.5 m requires a wave height, Hs of larger than 3 m, with an associated peak wave period (Tp) greater than 10 s. For context, more than 45 % of wave heights recorded by the project specific, 5 month, metocean campaign (EMU, 2008) are less than 1 m and the 10 in 1 year return period wave condition, as derived from a longer (30 years) data set, at the AWAC site is 2.1 m (Hs) and 7.3 s (Tp) (Appendix 8.1). The metocean survey therefore shows that the conditions required to result in a +0.5 m beach profile change can be considered as infrequent events.

49 The additional presence of the EOWDC is shown to result in small additional changes (+0.05 m) under everyday events and slightly larger (+0.2 m) under the less frequent events (Figure 8.8). The development has been shown to slightly reduce significant wave height at the adjacent shoreline and so is most likely to result in a reduced variability in beach elevations. Changes to the frequency or magnitude of beach level change attributable to the EOWDC are within the range of those occurring naturally and as such would likely be indistinguishable from the natural variability. Therefore, the changes that may be induced by the EOWDC are considered to be of low magnitude.

50 The potential impact has been assessed of low magnitude, medium sensitivity and therefore of minor significance.

8.3.4 Potential Impacts: Cumulative Effects

8.3.4.1 Changes to Processes Acting within Aberdeen Bay as a Result of the Cumulative Presence of Wind Turbine Foundations and the Ocean Laboratory

51 As with the wind farm array, the presence of the Ocean Laboratory has the potential to impact on the local tidal and wave regimes as they interact with the structure. Any changes to these regimes may have a resultant impact on the sediment regime (both offshore and coastal) and therefore requires consideration.

52 A comparison of Figures 8.6 and 8.9 indicates that the cumulative impacts of the Ocean Laboratory and the EOWDC does not induce a greater magnitude of change to the tidal regime beyond that predicted by the EOWDC alone. Flow speed changes are predicted in the immediate vicinity of the Ocean Laboratory structure, but these are no greater than those predicted in the immediate vicinity of each of the wind turbines. A comparison of Figures 8.7 and 8.10 indicates that the cumulative impacts of the Ocean Laboratory and the EOWDC does not induce a greater magnitude of change to the wave regime beyond that predicted by the EOWDC alone.

8.3.4.2 Introduction of seabed scour as a result of the cumulative presence of turbine foundations and the Ocean Laboratory

53 As with the wind turbine foundations, the Ocean Laboratory has the potential to create scour around its base. The scour extents calculated for the range of substructures considered in Section 8.3.3.2 indicates that scour is unlikely to extend more than 30 m from the centroid location of any structure. It is therefore not anticipated that there would be any interaction of scour between the foundations of the Ocean Laboratory and other wind turbines.

54 Additionally, the foundations are located within a staggered grid such that the rows are not tidally aligned, making it unlikely that there would be any interaction between the tidal wake of one foundation and another one downstream.

TABLE 8.5
Summary of Impact Assessment

Potential Impact	Significance Level	Mitigation	Residual Impacts	Monitoring
Phase: Construction and decommissioning				
Changes to processes acting within Aberdeen Bay as a result of the presence of construction equipment.	negligible	not required	not relevant	not required
Introduction of seabed scour as a result of the presence of construction equipment.	negligible	not required	not relevant	not required
Increase in suspended sediment concentrations as a result of foundation installation / removal activities	minor	not required	not relevant	optional
Increase in suspended sediment concentrations as a result of cable installation / removal activities	minor	not required	not relevant	optional
Phase: Operation				
Changes to processes acting within Aberdeen Bay.	negligible	not required	not relevant	not required
Changes to processes acting within Aberdeen Bay as a result of the cumulative presence of turbine foundations and the Ocean Laboratory.	negligible	not required	not relevant	not required
Introduction of seabed scour as a result of the presence of turbine foundations.	minor	recommended	negligible	optional
Introduction of seabed scour as a result of the cumulative presence of turbine foundations and the Ocean Laboratory	negligible	not required	not relevant	not required
Changes to processes acting to maintain the Aberdeen Bay coastline	minor	not required	not relevant	not required

8.4 Summary

55 Considerations of the proposed impacts upon the tide and wave regimes have been made and the subsequent effects upon a series of receptors determined. These receptors include the offshore sediment transport pathways, offshore seabed morphology and littoral sediment transport pathways. Comment has also been made to address relevant concerns raised by consultees. The assessment was undertaken using 'worst case' characteristics of the proposed development, as provided by the project. It is shown that the majority of potential impacts are considered to be of negligible significance. Exceptions are scour development, short term changes to suspended sediment concentrations and subsequent localised deposition, and slight changes in the coastal response to naturally occurring storm events, which are all considered to be of minor significance

8.5 References

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European Offshore Wind Deployment Centre
Environmental Statement

Chapter 9: Marine Ecology, Intertidal Ecology, Sediment and Water Quality

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

9 MARINE ECOLOGY, INTERTIDAL ECOLOGY AND SEDIMENT AND WATER QUALITY

9.1 Introduction

1 The construction, operation and decommissioning of an offshore wind farm will inevitably have some impact upon the physical properties of the seabed in the near vicinity of the wind turbines and cables, as well as on the nature of the overlying water. Consequently, this could have impacts upon the benthic communities, fish and, ultimately, on their predators (marine mammals and birds). The Institute of Estuarine and Coastal Studies (IECS) at the University of Hull was commissioned by the Applicant to assess the impact of the proposed European Offshore Wind Deployment Centre (EOWDC) in Aberdeen Bay on the marine ecology of the area. The assessment was carried out using a combination of knowledge of the existing environment (baseline conditions), the proposed project design (worst case) and the likely response of the environment to any potential changes (impacts) from the development (construction, operation and decommissioning).

2 The assessment covers all the aspects of the EOWDC development (wind turbines, foundations, cabling). The potential Ocean Laboratory would be subject to a separate consent application and is therefore considered within the assessment of cumulative impacts only.

3 The following technical reports support this chapter:

- Marine Ecology, Intertidal Ecology and Sediment and Water Quality Baseline Technical Report (Appendix 9.1)
- Marine Ecology, Intertidal Ecology and Sediment and Water Quality Environmental Impact Assessment Technical Report (Appendix 9.2)

9.1.1 Methodology Consultation

4 In order to investigate the potential effects on benthic, fish and shellfish communities in the proposed development area, consultation with appropriate regulatory and other key institutes and organisations was undertaken. Consultees included Scottish Natural Heritage (SNH), Marine Scotland, Scottish Environmental Protection Agency (SEPA) and Aberdeen City Council. A detailed list of consultees is reported in the EIA Technical Report (Appendix 9.2).

9.1.2 Key Guidance Documents

5 The key guidance documents used for the baseline and impact assessment are as follows:

- IEEM, 2010. Guidelines for Ecological Impact Assessment in the United Kingdom. Final document.
- Environmental impact assessment: guide to procedures http://www.communities.gov.uk/documents/planningandbuilding/pdf/157989.pdf
- CEFAS, 2004. Offshore wind farms: Guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements. Version

2. Prepared by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) on behalf of the Marine Consents Unit (MCEU). 45pp.
- SNH, 2010. Renewable energy and the natural environment. SNH.

6 Further key guidance documents are indicated in Appendix 9.2.

9.1.3 Data Information and Sources

7 The principal data information and sources were:

- EOWDC Baseline Technical Report for the European Offshore Wind Development Centre (Appendix 9.1)
- OSPAR, 2006. Review of the Current State of Knowledge on the Environmental Impacts of the Location, Operation and Removal/Disposal of Offshore Wind-Farms. Publication Number: 278/2006
- OSPAR, 2008. Assessment of the environmental impact of offshore wind-farms. Publication Number: 385/2008

8 The EOWDC Baseline Technical Report includes the results of site specific surveys undertaken. These include:

- EMU Ltd (2007) Geophysical and seabed habitat assessment of the then Aberdeen Offshore Wind Farm
- OSIRIS Projects Ltd (2010) Geophysical survey of the EOWDC
- Centre for Marine and Coastal Studies Ltd (CMACS Ltd) (2011) Benthic survey of the EOWDC

9 Further baseline data sources are indicated in the EIA Technical Report (Appendix 9.2).

9.2 Baseline Assessment

10 The seabed sediments in the proposed EOWDC are largely homogeneous, with a gradation related to depth and distance from the shore. At inshore stations, medium-fine well-sorted sands dominate, whereas sediments further offshore and at deeper sites are dominated be fine-very fine muddy sands.

11 Overall, sediment contamination in the area is in line with the background contamination levels reported for the North East Atlantic Sea. The concentrations of all contaminants measured during the site specific survey were below the Probable Effects Level (PEL) throughout the area. All hydrocarbons, organotin and polychlorinated biphenyls (PCB) concentrations were below the limit of detection.

12 The intertidal substratum is mainly comprised of sandy shores with an intertidal fauna dominated by mobile crustaceans (such as haustorid amphipods). Sedentary species are less abundant as would be expected given the moderate exposure of the shores in this area.

13 The sublittoral benthic community changes mainly along the gradient of depth/distance offshore. Lower numbers of species and abundance are found in the infaunal community of the inshore shallower stations, where the polychaetes *Nephtys cirrosa* and amphipods dominate. Higher numbers of species and abundance are present further offshore, where the polychaetes

Notomastus latericeus, the bivalves *Nucula nitidosa* and *Tellina fabula* and brittle stars *Ophiura* spp. dominate. These two communities are described by the two biotopes: SS.SSA.IFiSa.NcirBat (inshore) and SS.SSA.CMuSa.AalbNuc (offshore).

14 The invertebrate epifaunal community present in the proposed project area is sparse and composed mainly of brittle stars, brown shrimp (*Crangon crangon*) and swimming crab (*Liocarcinus holsatus*). The most common and abundant fish species are dab (*Limanda limanda*) and plaice (*Pleuronectes platessa*). These species are more abundant as juveniles at shallower inshore stations suggesting the possible presence of nursery grounds in the area. Other common fish species in the area are whiting (*Merlangius merlangus*) and hooknose (*Agonus cataphractus*), these more abundant offshore. Commercially important species (e.g. whiting, cod *Gadus morhua*, Norway pout *Trisopterus esmarki*), although present in the proposed development area, are associated mainly with deeper waters.

15 No known spawning grounds are present in the proposed development area. Spawning grounds do occur: further offshore (for herring (*Clupea harengus*)), on coarser sediments (for sandeel (*Ammodytes marinus*)) or on muddier sediments (for *Nephrops*) than those present in the proposed development site.

16 No statutory designated marine protected areas have been identified within the proposed development area. There are however several protected species that are known to use the area. These include Atlantic Salmon (*Salmo salar*) which is a Annex II species listed on the Habitats Directive and which requires the establishment of Special Areas of Conservation (SACs). Atlantic Salmon have been addressed further within Chapter 22 Salmon and Sea Trout. The River Dee SAC also contains populations of the freshwater pearl mussel (*Margaritifera margaritifera*). This is a rare and threatened species, being one of the primary reasons for the selection of the River Dee SAC. It is highly dependent on the presence on Atlantic salmon and sea trout (*Salmo trutta*) as hosts for their larvae and therefore has the potential to be affected by the EOWDC.

9.3 Impact Assessment

9.3.1 Impact Assessment Methodology

17 The assessment has used the combination of development options which is considered to have the greatest potential for detrimental impact on the marine ecology of the area. The impacts assessed are therefore considered to be the worst case and assume that the development would comprise 11 wind turbines of 10 MW capacity constructed over a single phase. The foundation and scour protection options have been assessed using a worst case for each receptor group.

18 The various receptors that may be affected by the development (namely intertidal benthos, subtidal benthos, epibenthos, shellfish and fish) have been considered in relation to the phases of the EOWDC lifecycle, ie construction, operation and decommissioning. Impacts arising from decommissioning activities have been assumed to be similar to those generated from

construction works, although in most cases the magnitude of potential impact would be considerably lower.

19 In order to assess the magnitude of an effect, its spatial extent, duration and scale have been taken into account by gathering this information from available literature and previous assessments of similar effects. The assessment of the sensitivity of a receptor has been based on its importance and recoverability, as gathered from the baseline technical report, and, where available, from additional assessments of impacts on the same or similar receptor.

20 The evaluation of the magnitude of effect and of the sensitivity of receptor has then been combined in a final assessment of the impact significance, following the matrix in Table 9.1.

TABLE 9.1
Matrix for Significance of Impact

		Sensitivity of Receptor			
Magnitude of Effect based on spatial, duration and scale of effect		**Very High**	**High**	**Medium**	**Low**
	Very High	Major	Major	Major	Moderate
	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

9.3.2 Impact Assessment

21 Impacts on intertidal and subtidal benthic assemblages have been assessed in relation to: the release of toxic material, sediment disturbance, re-suspension and re-deposition, underwater noise, vibrations and Electromagnetic Field (EMF) emissions, hydrographic modifications, temperature increase (around the cable routes) and habitat loss (either temporary and permanent) and gain (introduction of artificial habitats). For benthic and epibenthic communities, these impacts have been assessed as being of negligible to minor significance, due to their general low to medium magnitude and to the high recoverability of the receptors.

22 Impacts on fish from piling noise during construction/decommissioning have been assessed as of minor to potentially moderate significance (Table 9.2). This is based on the precautionary approach adopted in the assessment of the possible effect on herring spawning grounds, given the lack of specific data on their local distribution within the area of influence of the impact.

23 Potential impacts on the River Dee SAC populations of freshwater pearl mussel (*Margaritifera margaritifera*) are directly related to impacts on salmon and sea trout which are discussed in Chapter 22 Salmon and Sea Trout. Impacts on salmon and sea trout are not expected to be above minor provided adequate mitigation measures and consultation with relevant stakeholders is carried out, particularly for the construction phases of the project.

TABLE 9.2 Summary of Impact Assessment				
Potential Impact	**Significance Level**	**Mitigation**	**Residual Significance**	**Monitoring**
Construction / Decommissioning				
Underwater noise and vibration on Fish	Minor to Moderate	Noise mitigation at source (eg soft-start procedure)	Minor to Moderate	Monitoring would be agreed with the relevant statutory authorities

9.3.3 Cumulative and In-Combination Impact Assessment

24 The only foreseeable development in Aberdeen Bay that has been considered in the context of cumulative assessment is the potential Ocean Laboratory, which is anticipated to result in a negligible/minor adverse impact. The impacts arising from the construction, operation and decommissioning of this structure are likely to be broadly similar (in type) to those assessed for the proposed EOWDC. However, given the smaller scale of the potential Ocean Laboratory, these impacts are likely to be of lower magnitude compared to those from the proposed EOWDC. Any additive effects are considered to be minimal in the context of existing predicted impacts. There are no other activities or developments that are in close proximity to the development that are anticipated to result in any adverse cumulative or in-combination impacts.

9.4 Summary

25 The proposed site contains physical, chemical and biological characteristics which resemble those of much of the surrounding area of Aberdeen Bay. No important sensitivities have been identified, except for the possible presence of salmonid migration routes and associated freshwater pearl mussel populations, addressed within Chapter 22 Salmon and Sea Trout, and of herring spawning grounds (which occur within the influence of piling noise during the construction of the proposed development).

26 Potential impacts on the marine ecology of the area arising from the construction, operation and decommissioning of the proposed development are generally considered to be of negligible to minor significance, and no significant cumulative impacts have been identified. Although the potential for moderate impacts on sensitive fish has been identified from the piling noise generated during construction, the basis for this assessment level is largely precautionary due to information paucity on the actual distribution of specific herring spawning grounds in the area.

27 The possibility of cumulative impacts arising from the installation of the proposed Ocean Laboratory on the proposed EOWDC site has been considered, but is expected to be minimal.

28 The assessment has not identified any potential adverse impacts on protected species or habitats when the development has been considered in context of other plans or projects.

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Figures
Aberdeen Offshore Wind Farm Limited

Volume 3 of 4

July 2011

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Figure List - Volume 3

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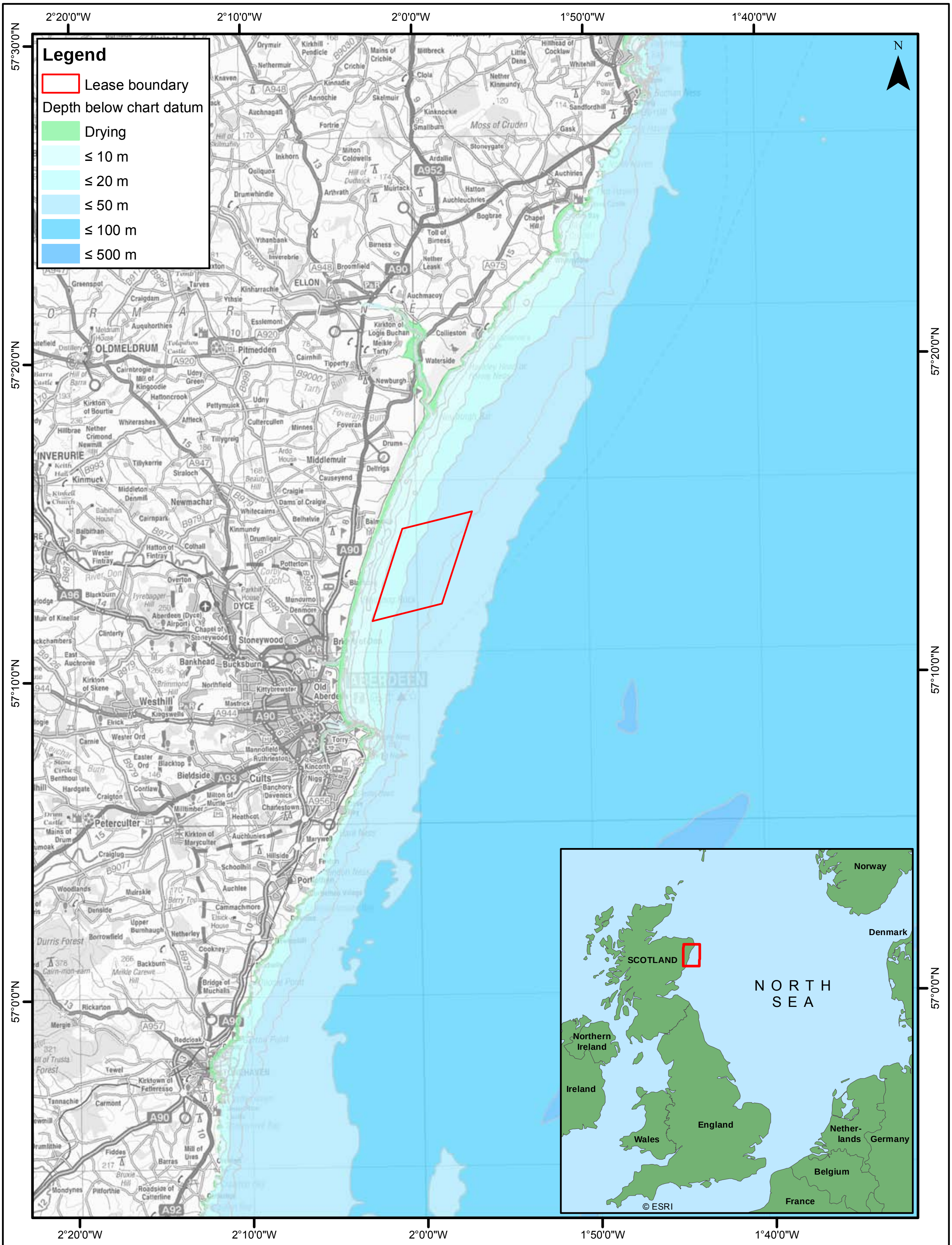


0 2 4 6 8 km

0 2 4 nm

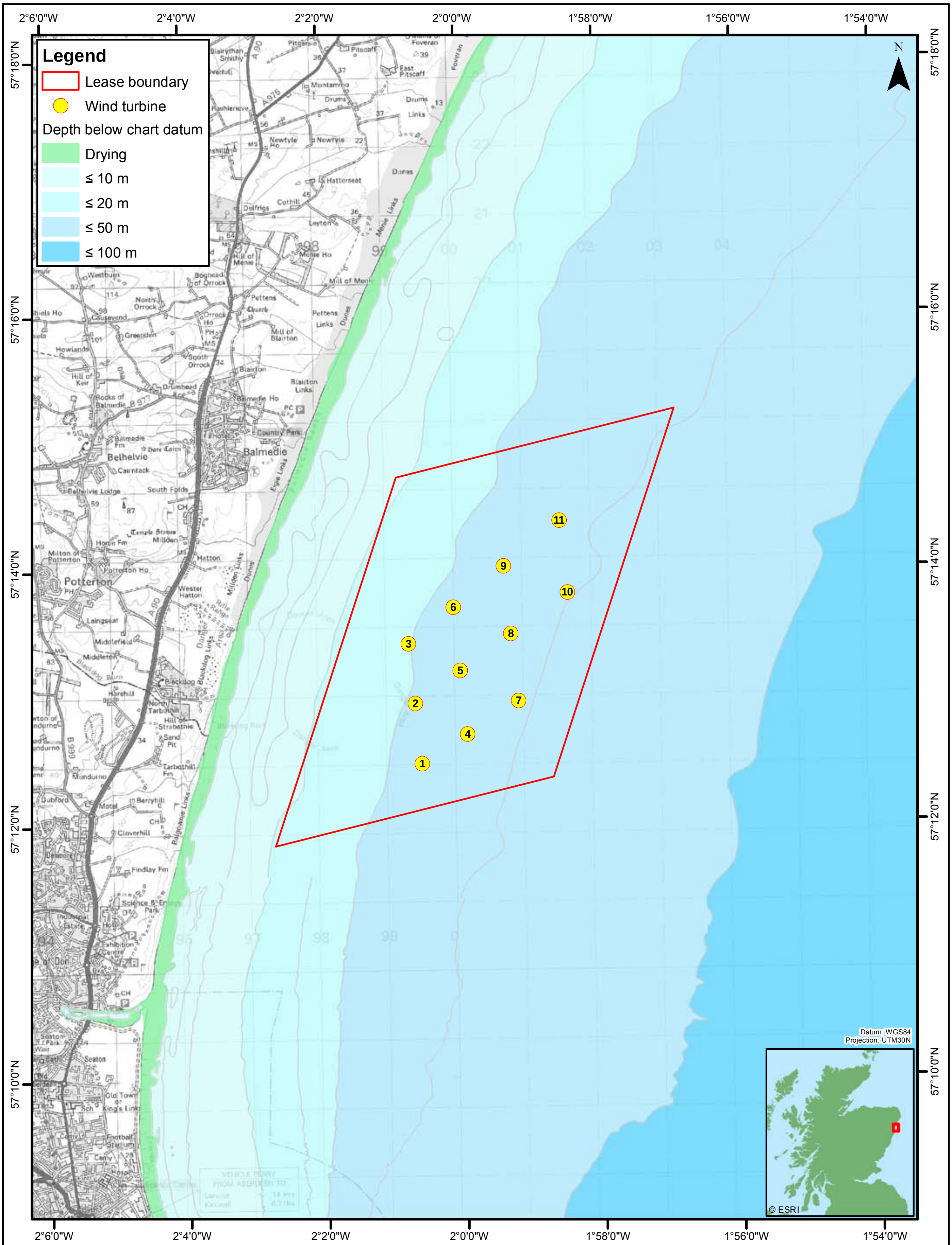
Original A4 Plot Scale 1:300,000

European Offshore Wind Deployment Centre

Site Location

Layout	By	Date	Rev	Dwg No.
NA	LH	21/06/2011	A	6129-530-PA-009

Figure 1.1



VATTENFALL

areg Aberdeen Renewable Energy Group

Technip

0 0.5 1 1.5 2 km

0 0.25 0.5 0.75 1 nm

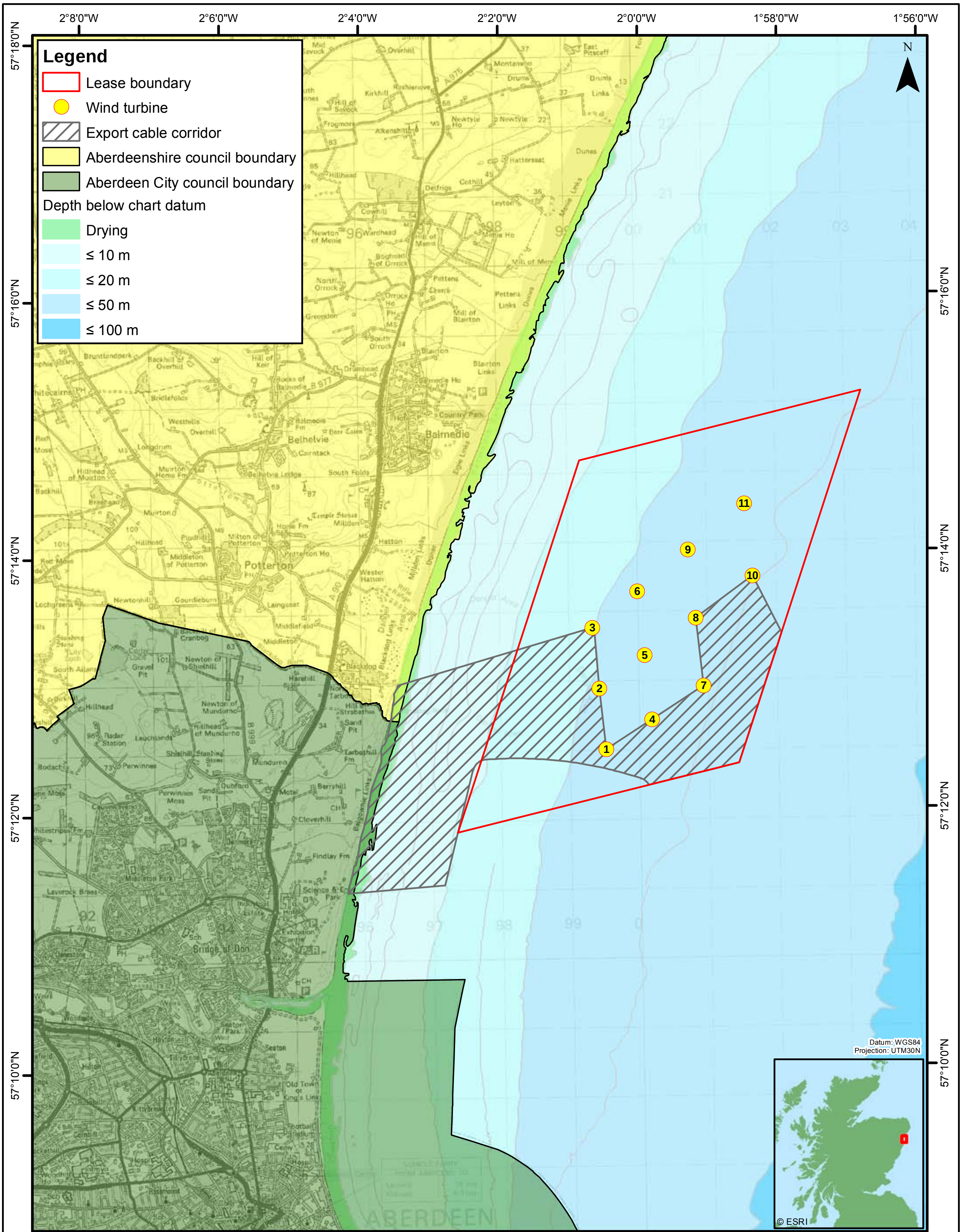
Original A4 Plot Scale 1:75,000

European Offshore Wind Deployment Centre

The Proposed European Offshore Wind Deployment Centre Site

Layout	By	Date	Rev	Dwg No.
LABER039	LH	21/06/2011	A	6129-530-PA-003

Figure 1.2



VATTENFALL

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Technip

0 0.5 1 1.5 2 km

0 0.25 0.5 0.75 1 nm

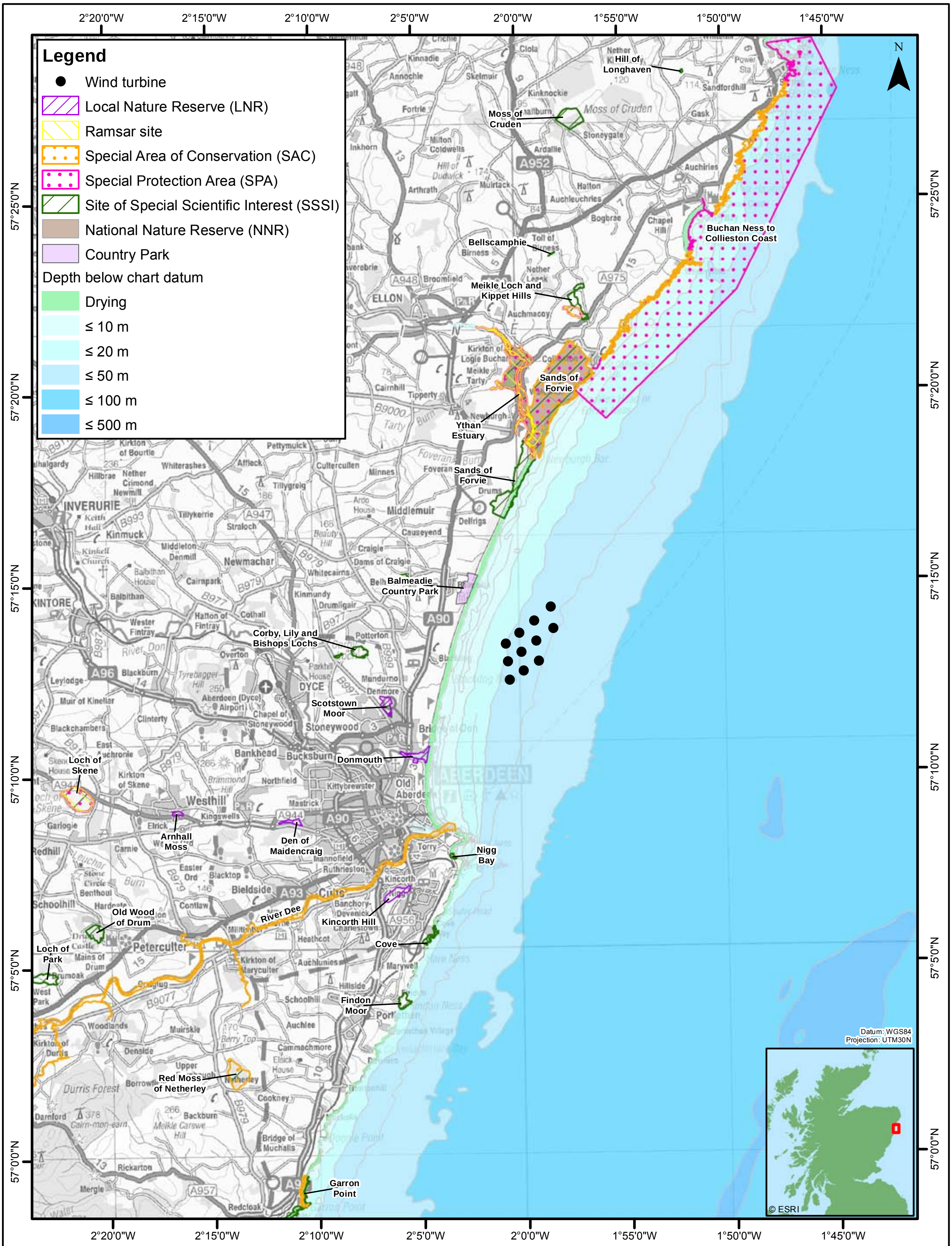
Original A4 Plot Scale 1:75,000

European Offshore Wind Deployment Centre

Key Jurisdiction Boundaries

Layout	By	Date	Rev	Dwg No.
LABER039	LH	21/06/2011	A	6129-530-PA-010

Figure 1.3



0	2	4	6 km
0	1	2	3 nm

Original A4 Plot Scale 1:250,000

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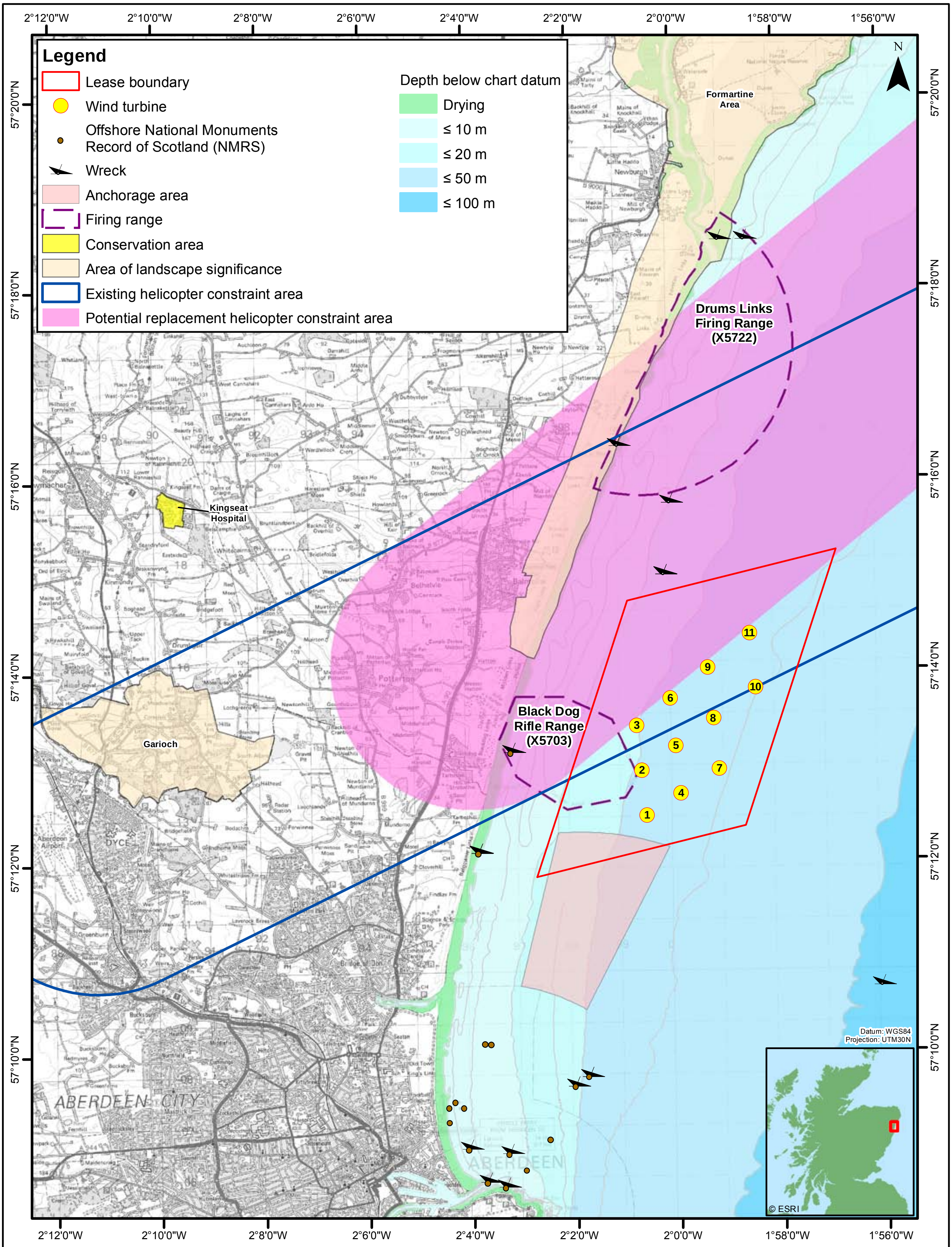
European Offshore Wind Deployment Centre

Designations and Constraints

Layout	By	Date	Rev	Dwg No.
LABER039	LH	23/06/2011	A	6129-530-PA-002

Figure 2.1



VATTENFALL

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Technip

0 1 2 km

0 0.5 1 nm

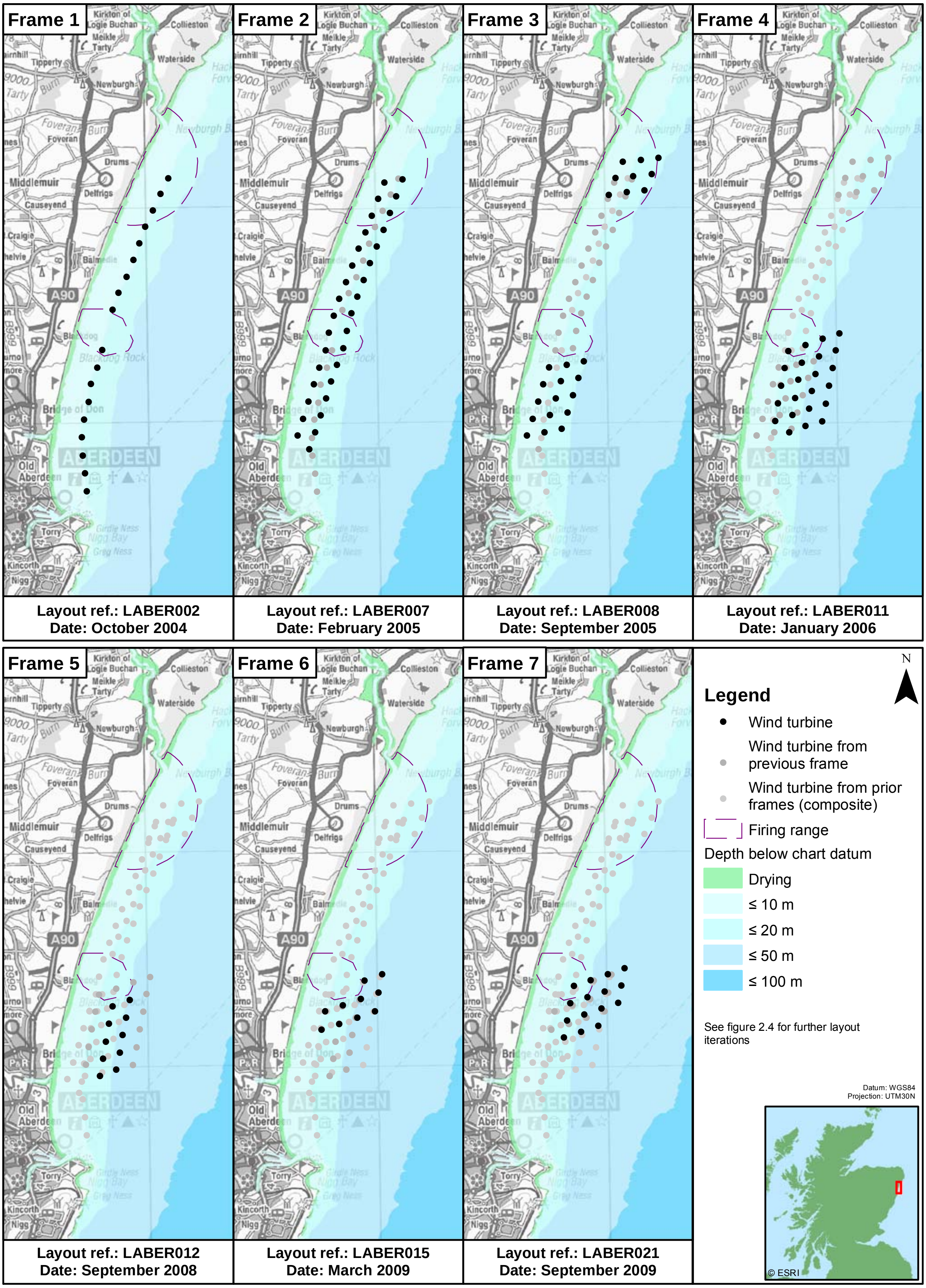
Original A4 Plot Scale 1:100,000

European Offshore Wind Deployment Centre

Human Constraints

Layout	By	Date	Rev	Dwg No.
LABER039	LH	23/06/2011	A	6129-530-PA-007

Figure 2.2



VATTENFALL

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Technip

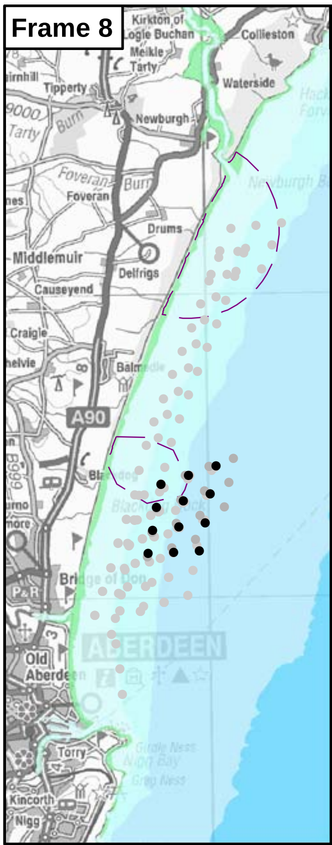
Original A4 Plot Scale 1:250,000

European Offshore Wind Deployment Centre

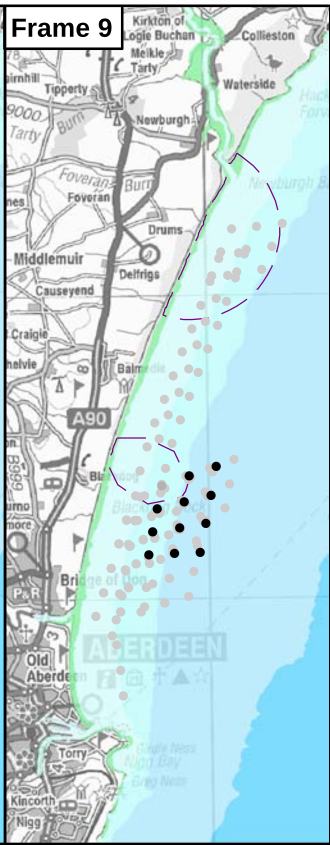
Site Iterations 2002 - 2009

Layout	By	Date	Rev	Dwg No.
Multiple	LH	21/06/2011	A	6129-530-PA-004

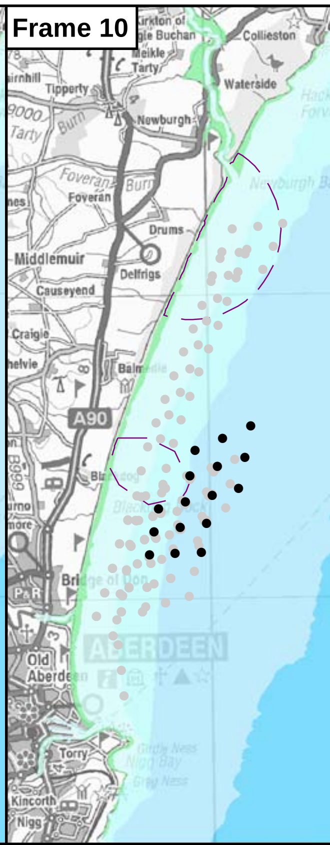
Figure 2.3



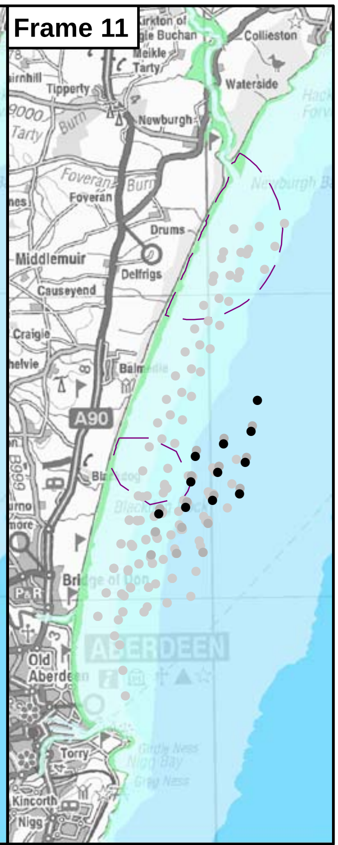
Layout ref.: LABER027
Date: October 2009



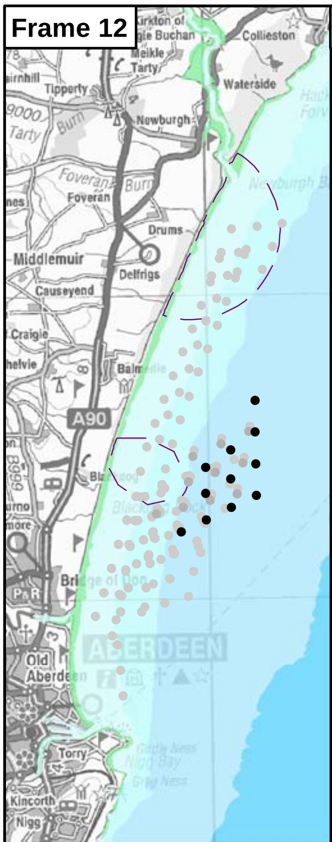
Layout ref.: LABER028
Date: November 2009



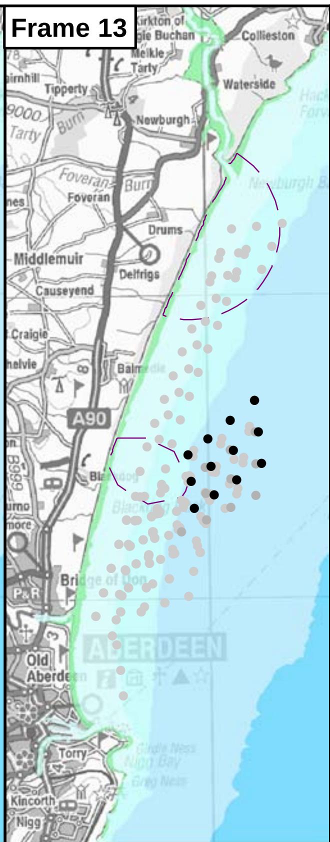
Layout ref.: LABER032
Date: April 2010



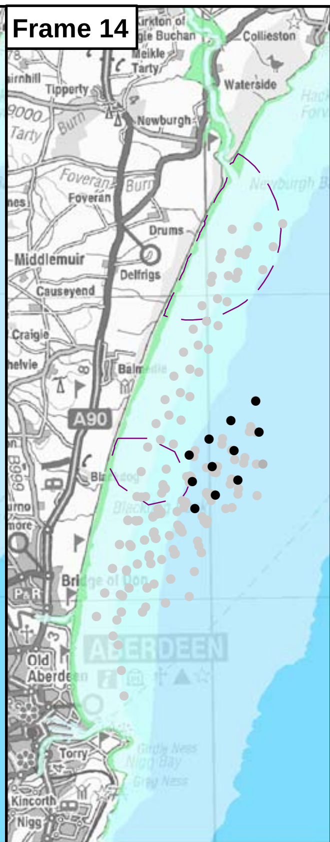
Layout ref.: LABER033
Date: April 2010



Layout ref.: LABER034
Date: April 2010



Layout ref.: LABER037
Date: April 2010



Layout ref.: LABER039
Date: April 2010

N

Legend

- Wind turbine
- Wind turbine from previous frame
- Wind turbine from prior frames (composite)
- Firing range

Depth below chart datum

- Drying
- ≤ 10 m
- ≤ 20 m
- ≤ 50 m
- ≤ 100 m

See figure 2.3 for further layout iterations

Datum: WGS84
Projection: UTM30N

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0 2 4 6 km

0 1 2 3 nm

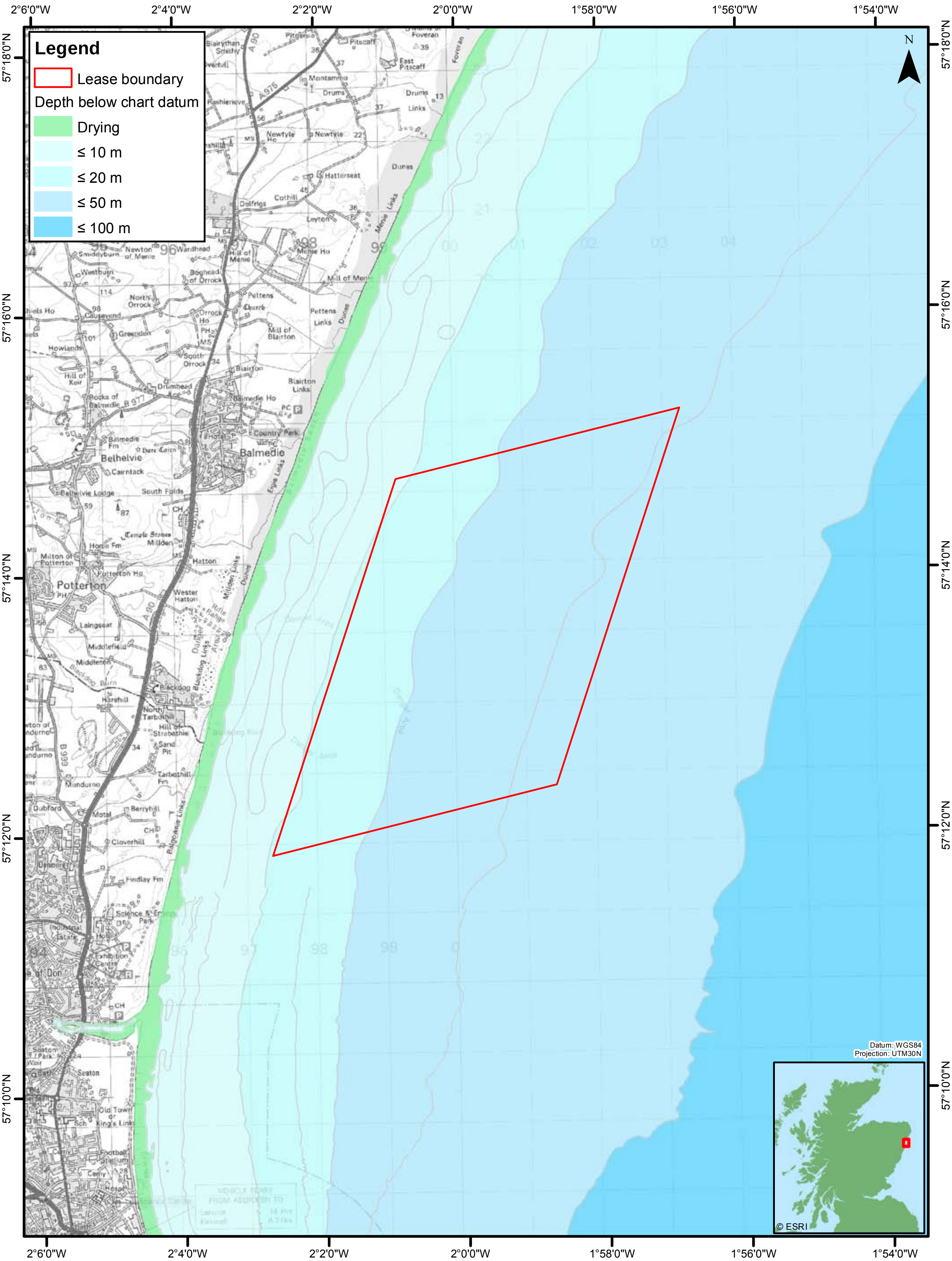
Original A4 Plot Scale
1:250,000

European Offshore Wind Deployment Centre

Site Iterations 2009 - 2010

Layout	By	Date	Rev	Dwg No.
Multiple	LH	21/06/2011	A	6129-530-PA-005

Figure 2.4



0 0.5 1 1.5 2 km

0 0.25 0.5 0.75 1 nm

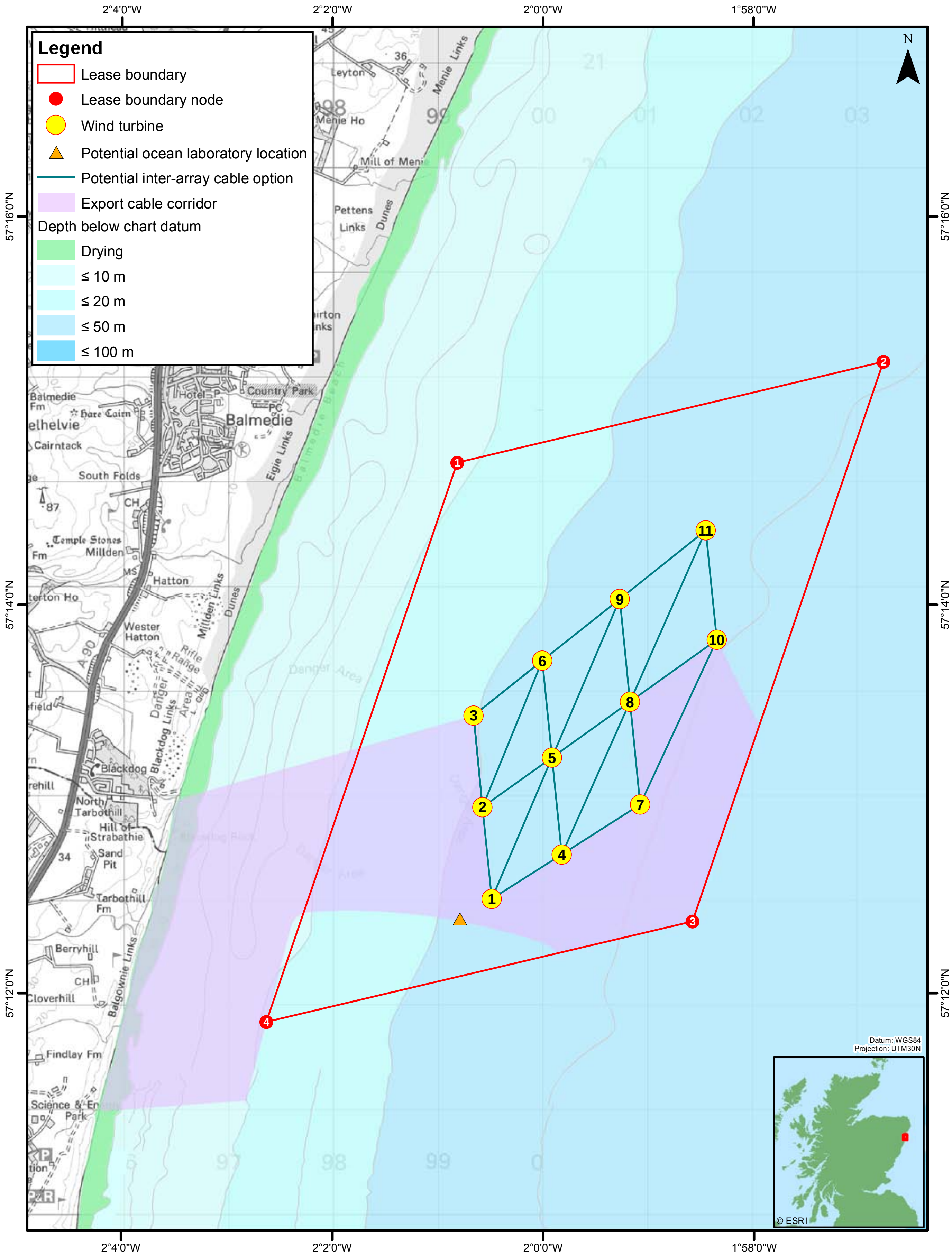
Original A4 Plot Scale 1:75,000

European Offshore Wind Deployment Centre

Lease Boundary

Layout	By	Date	Rev	Dwg No.
NA	LH	21/06/2011	A	6129-530-PA-001

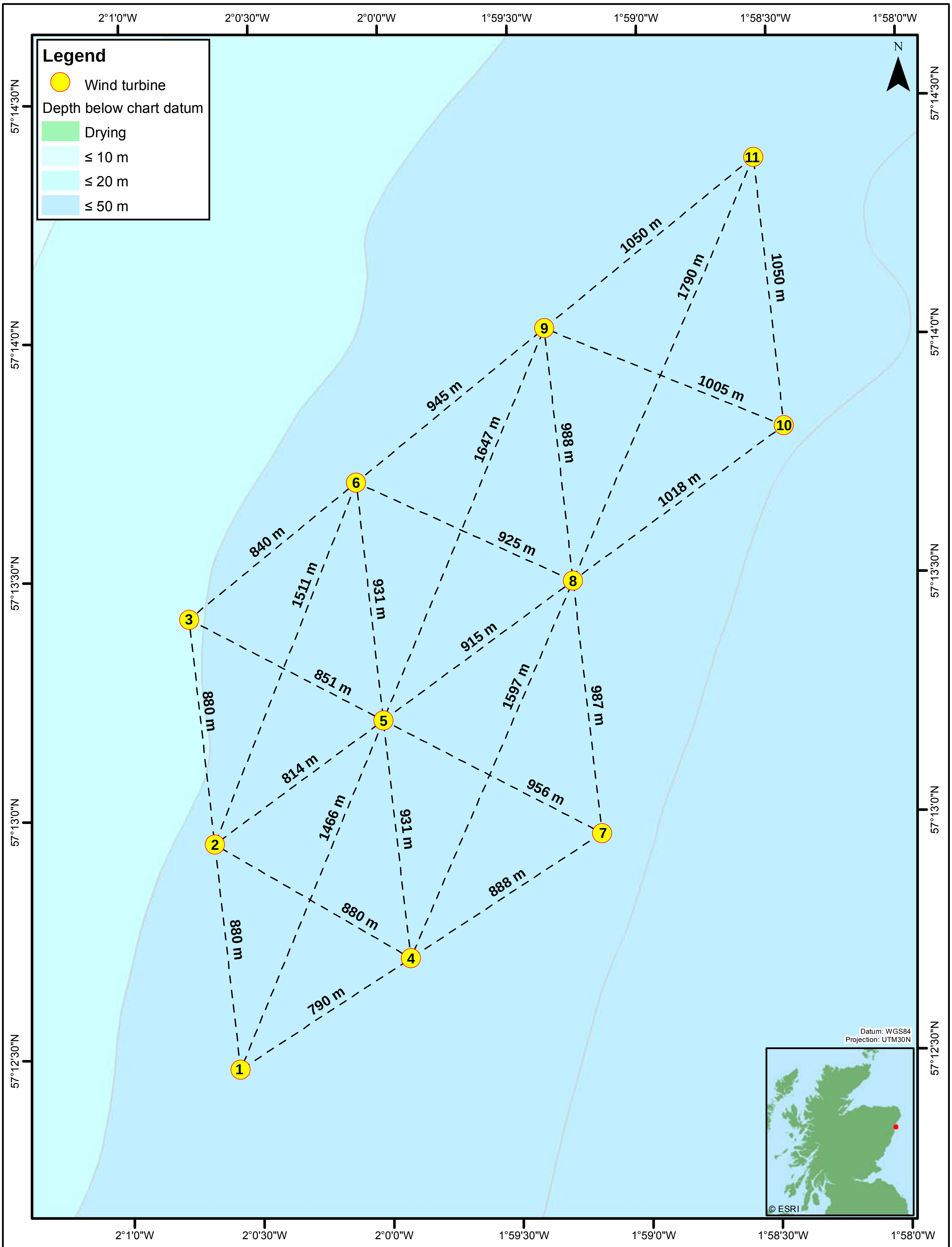
Figure 3.1



VATTENFALL areg Aberdeen Renewable Energy Group Technip	0 0.5 1 km 0 0.25 0.5 nm Original A4 Plot Scale 1:50,000	**European Offshore Wind Deployment Centre** Site Layout

Layout	By	Date	Rev	Dwg No.
LABER039	LH	14/06/2011	C	6129-530-PA-020

Figure 3.2



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0 0.1 0.2 0.3 0.4 0.5 km

0 0.1 0.2 0.3 nm

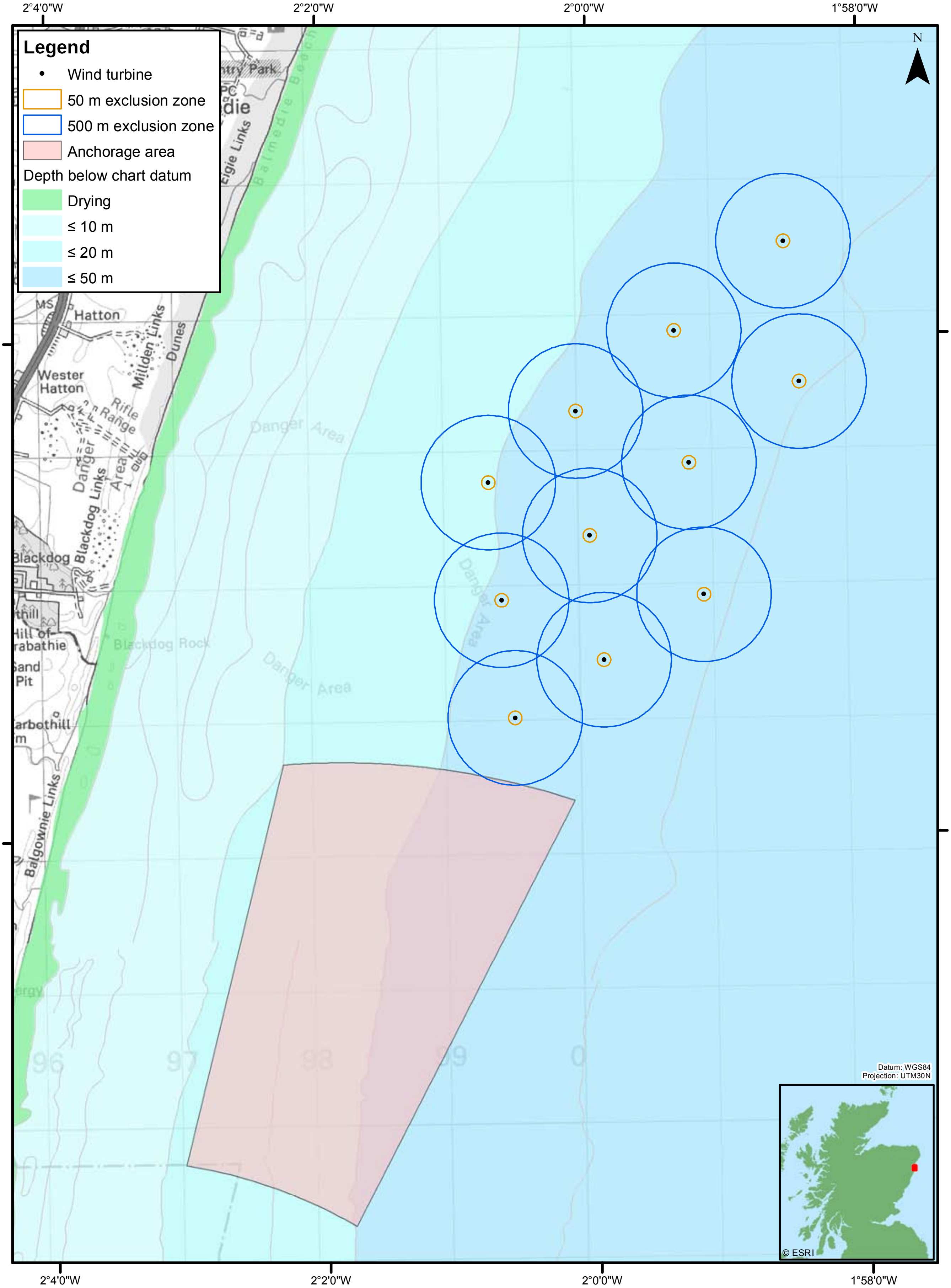
Original A4 Plot Scale 1:20,000

European Offshore Wind Deployment Centre

Wind Turbine Spacing

Layout	By	Date	Rev	Dwg No.
LABER039	LH	21/06/2011	A	6129-530-PA-019

Figure 3.3



VATTENFALL

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Technip

0 0.5 1 km

0 0.25 0.5 nm

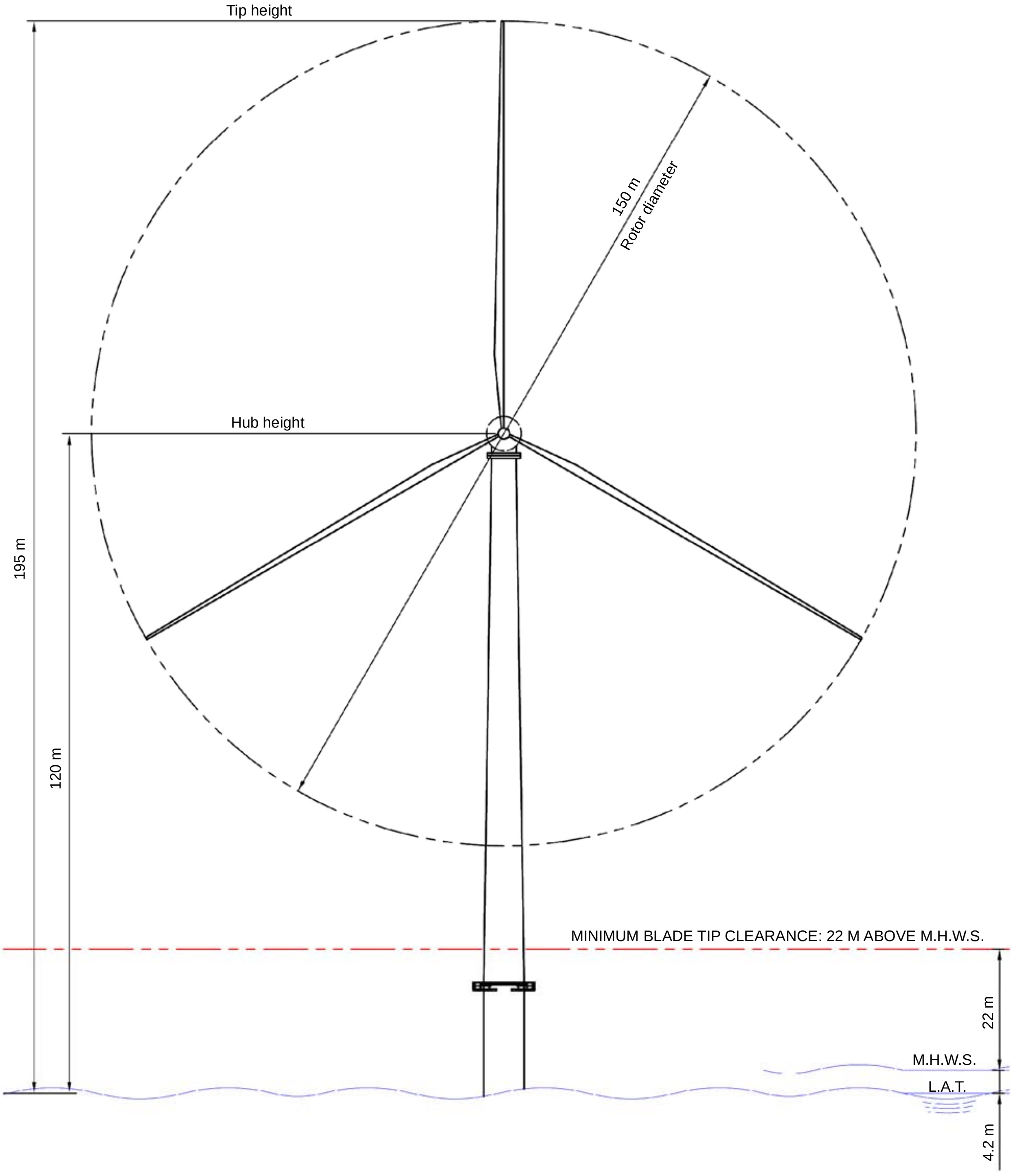
Original A4 Plot Scale 1:40,000

European Offshore Wind Deployment Centre

Wind Turbine Exclusion Zones

Layout	By	Date	Rev	Dwg No.
LABER039	LH	21/06/2011	A	6129-530-PA-025

Figure 3.4



M.H.W.S. = Mean High Water Spring
L.A.T. = Lowest Astronomical Tide

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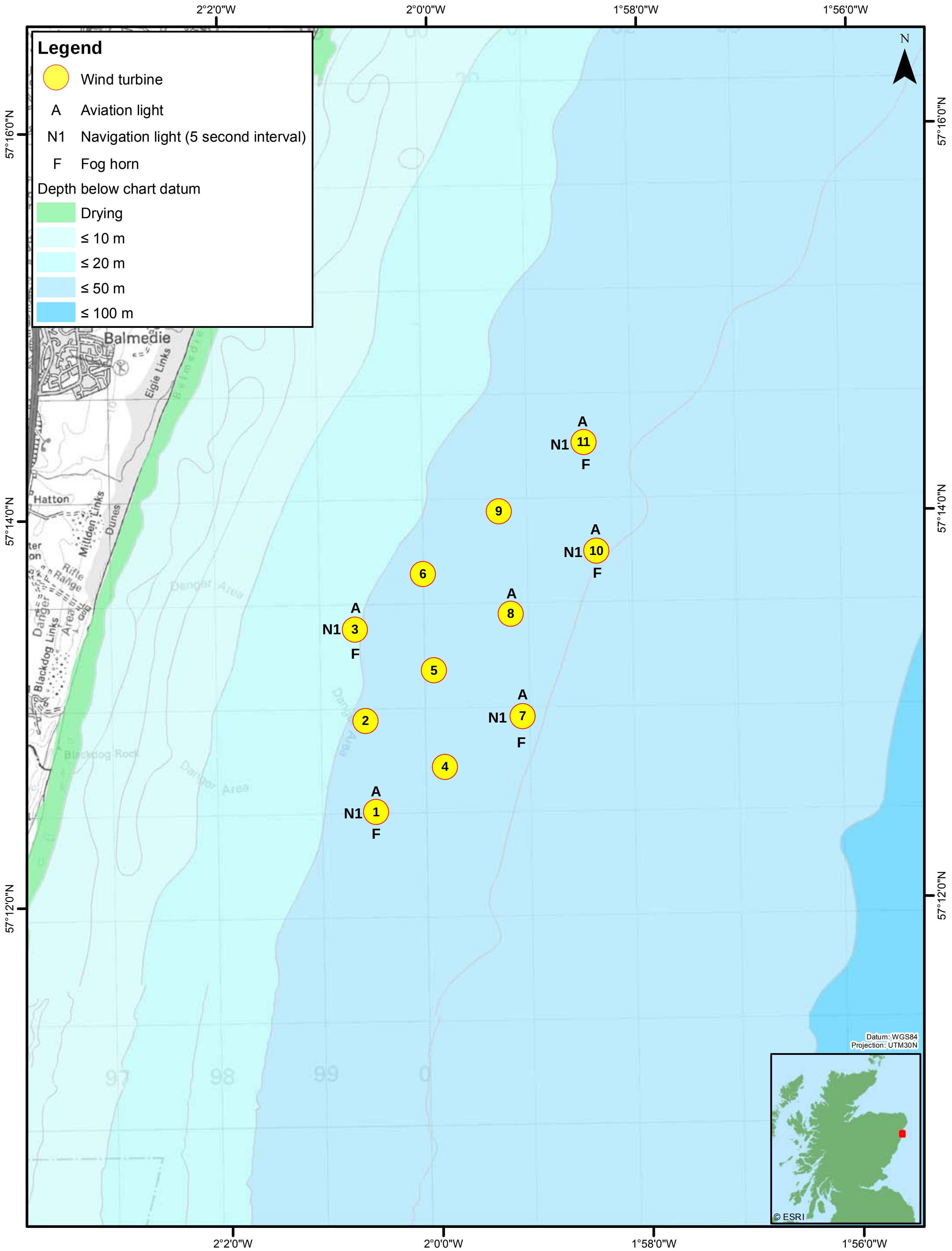
Technip

European Offshore Wind Deployment Centre

Maximum Wind Turbine Dimensions

Layout	By	Date	Rev	Dwg No.
NA	LH	24/06/2011	B	6129-530-PA-086

Figure 3.5



VATTENFALL

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Technip

0 0.25 0.5 0.75 1 1.25 km

0 0.2 0.4 0.6 nm

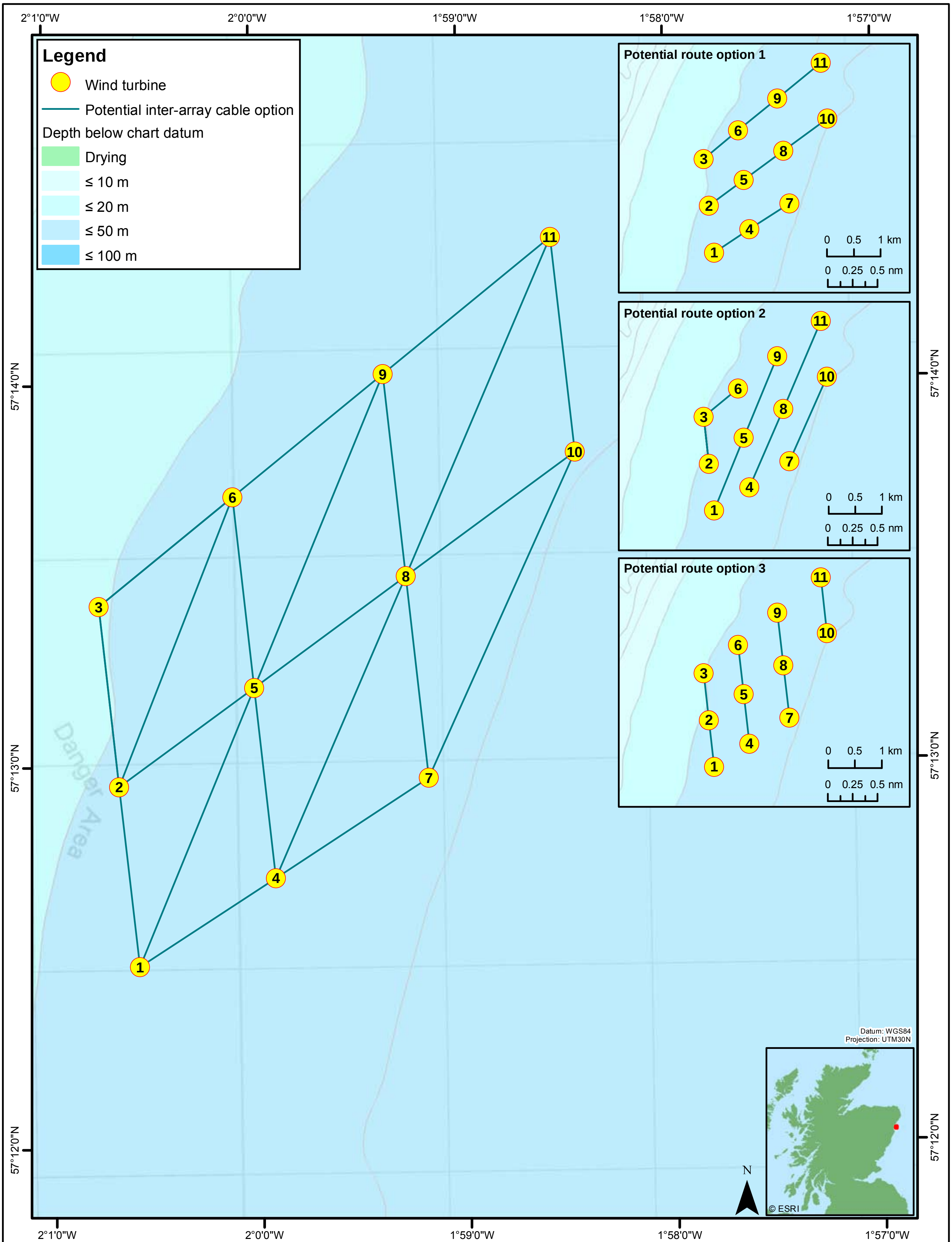
Original A4 Plot Scale 1:50,000

European Offshore Wind Deployment Centre

Aviation and Warning Lights

Layout	By	Date	Rev	Dwg No.
LABER039	LH	21/06/2011	A	6129-530-PA-026

Figure 3.6



VATTENFALL

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Technip

0 0.25 0.5 km

0 0.1 0.2 0.3 nm

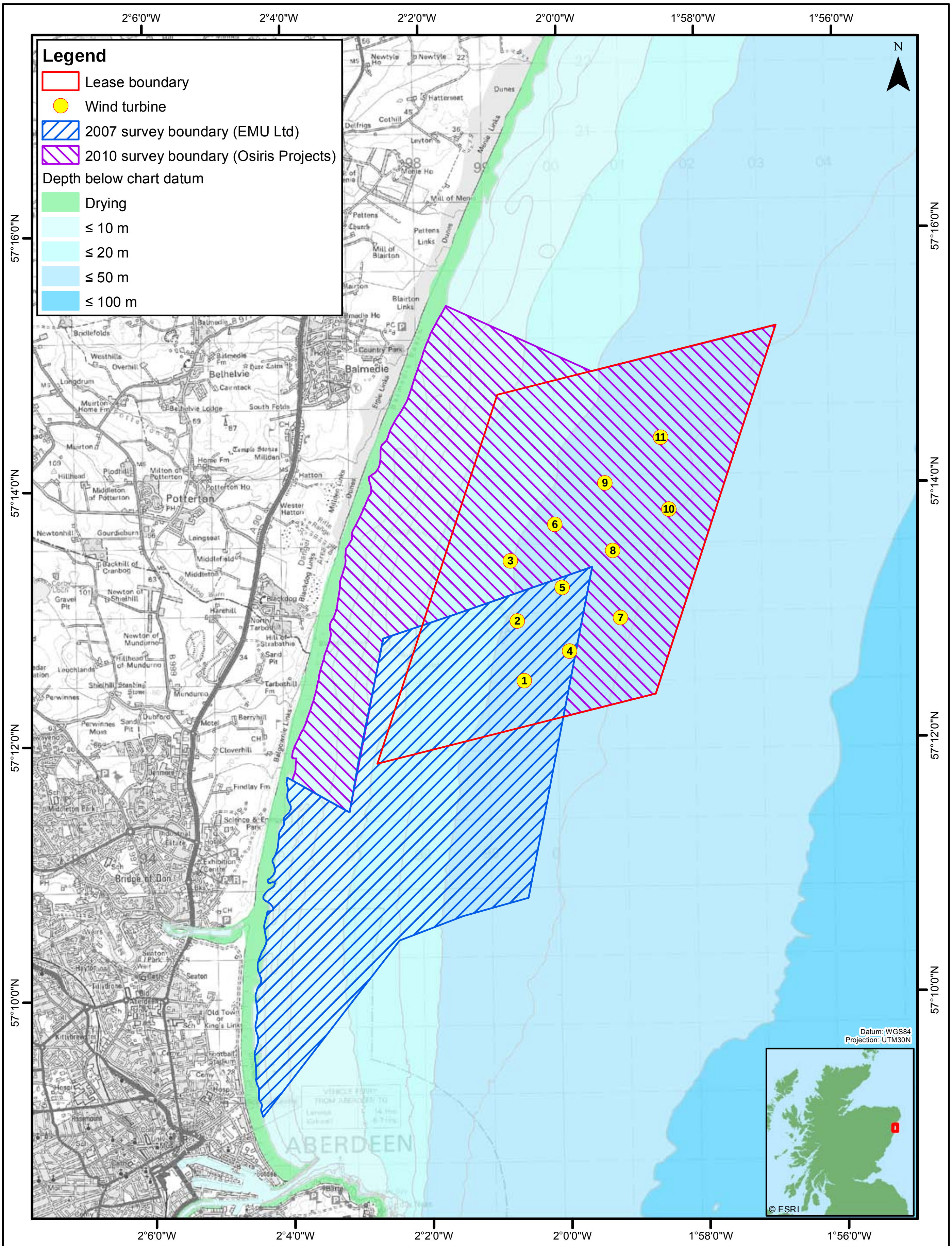
Original A4 Plot Scale 1:25,000

European Offshore Wind Deployment Centre

Indicative Inter-Array Cable Layout

Layout	By	Date	Rev	Dwg No.
LABER039	LH	23/06/2011	A	6129-530-PA-021

Figure 3.7



VATTENFALL

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Technip

0 1 2 km

0 0.5 1 nm

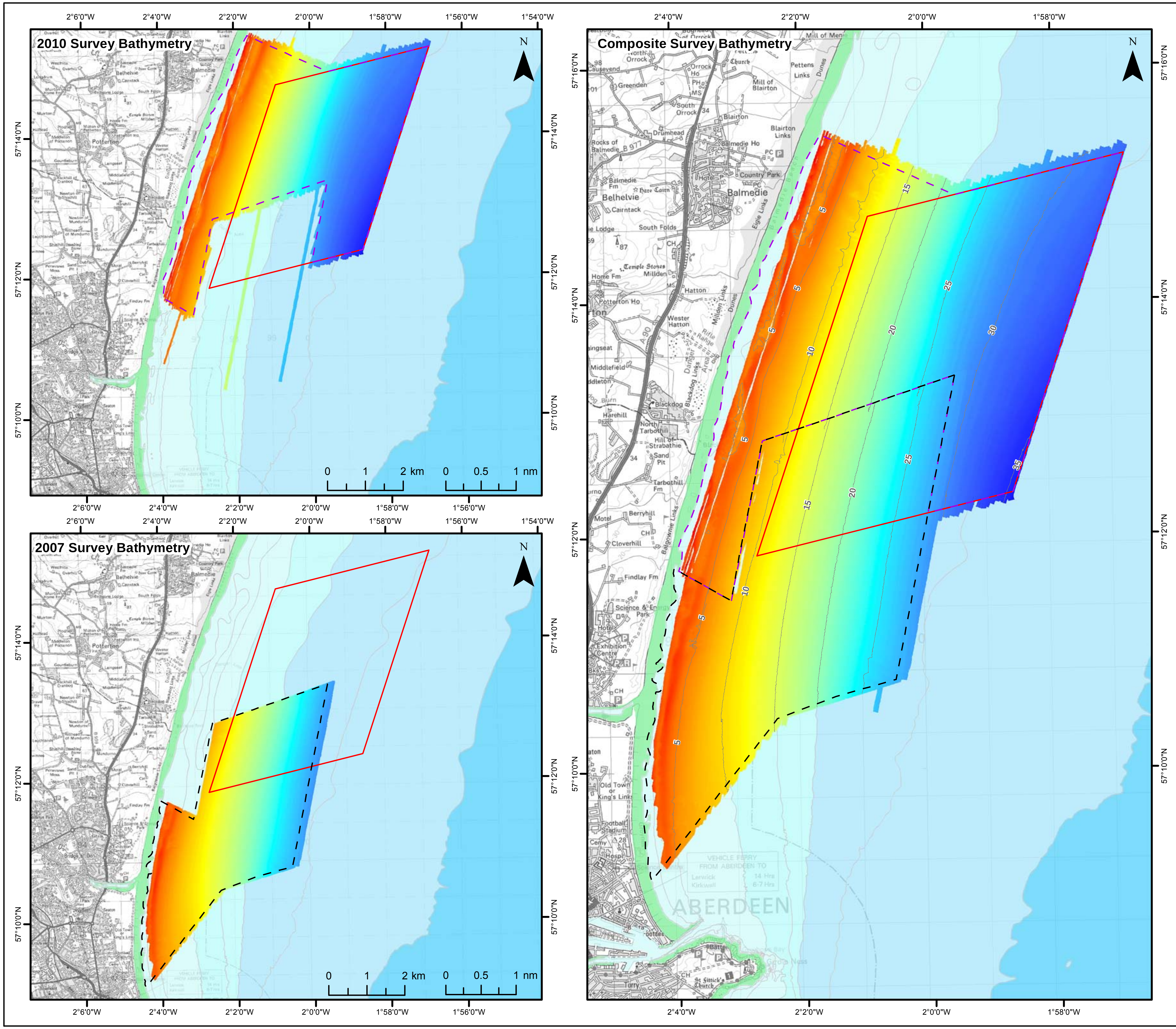
Original A4 Plot Scale 1:75,000

European Offshore Wind Deployment Centre

Geophysical Survey Boundaries

Layout	By	Date	Rev	Dwg No.
LABER039	LH	21/06/2011	A	6129-530-PA-008

Figure 6.1



Technip areg VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 6.2

Bathymetry Surveyed During 2007 and 2010 Geophysical Surveys

Legend

- Lease boundary
- 2010 survey boundary (Osiris Projects)
- 2007 survey boundary (EMU Ltd)
- Survey derived contour (below chart datum)[2]

Surveyed depth (below chart datum)[2]

- High : 0 m
- Low : 36 m

Depth below chart datum - UKHO

- Drying
- ≤ 10 m
- ≤ 20 m
- ≤ 50 m
- ≤ 100 m

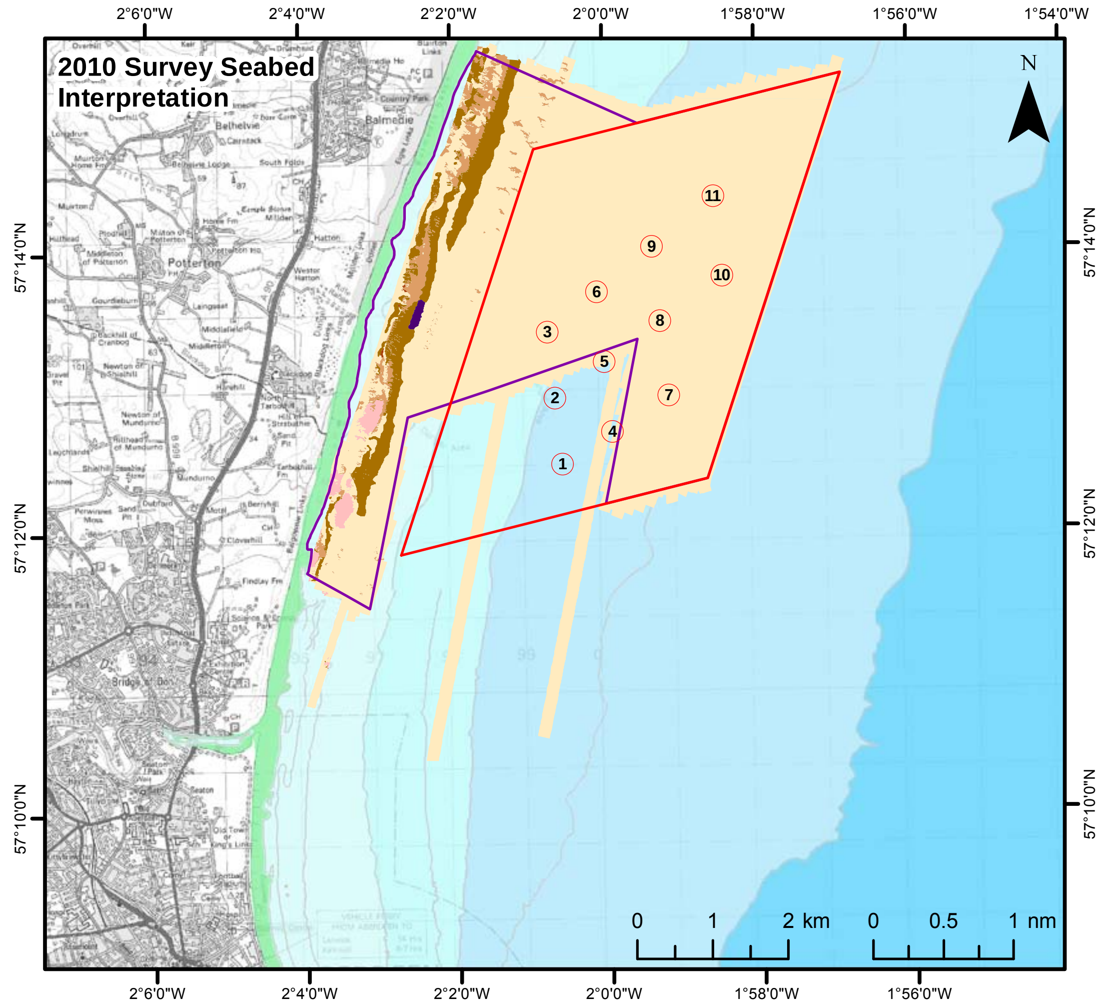
Notes
1 Do not scale
2 Surveyed depths and derived contours show the results of the 2007 and 2010 bathymetry surveys combined

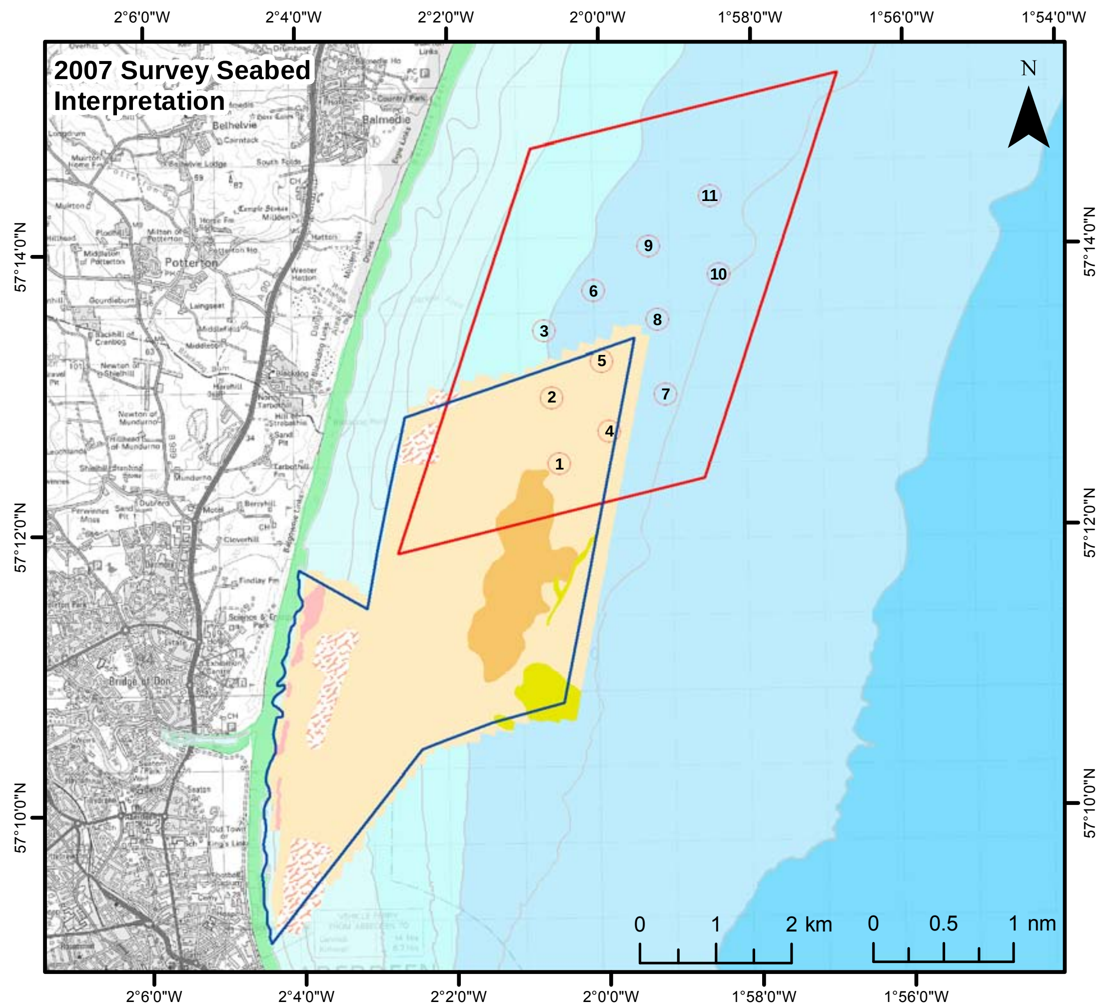
0 0.5 1 km 0 0.5 nm

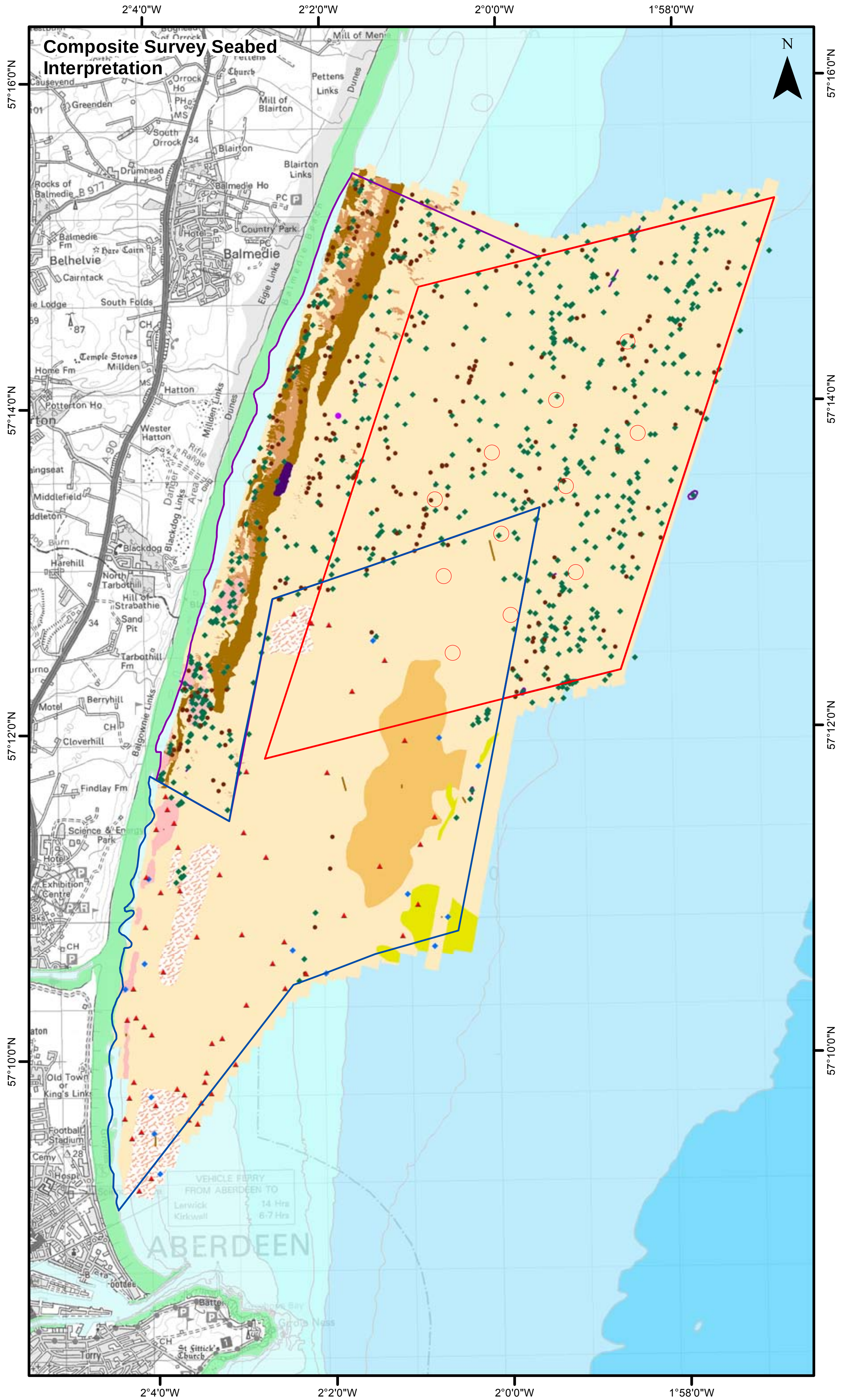
Original A3 Plot Scale 1:60,000

Drg No	6129-530-PA-080		
Rev	A	Date	23/06/2011
By	LH	Layout	NA

Figure 6.2







Technip areg VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 6.3

Seabed Features

Legend

- Lease boundary
- Wind turbine

2010 survey results (Osiris Project)

- 2010 survey boundary
- Sidescan sonar target
- Magnetic target
- Grab sample
- Linear sonar target

2010 survey seabed interpretation

- Fine silty sand
- Silty sand
- Consolidated glacial material
- Coarse sands and gravels
- Silty sand with bedforms
- Silty sand with gravel ribbons

2007 survey results (EMU Ltd)

- 2007 survey boundary
- Sidescan sonar target
- Magnetometer target
- Video survey path

2007 survey seabed interpretation

- Silty sand
- Consolidated glacial material
- Patches of glacial material exposed within seabed depressions
- Silty sand with patches of finer sediment
- Linear ribbons of finer sediment within silty sand

Depth below chart datum

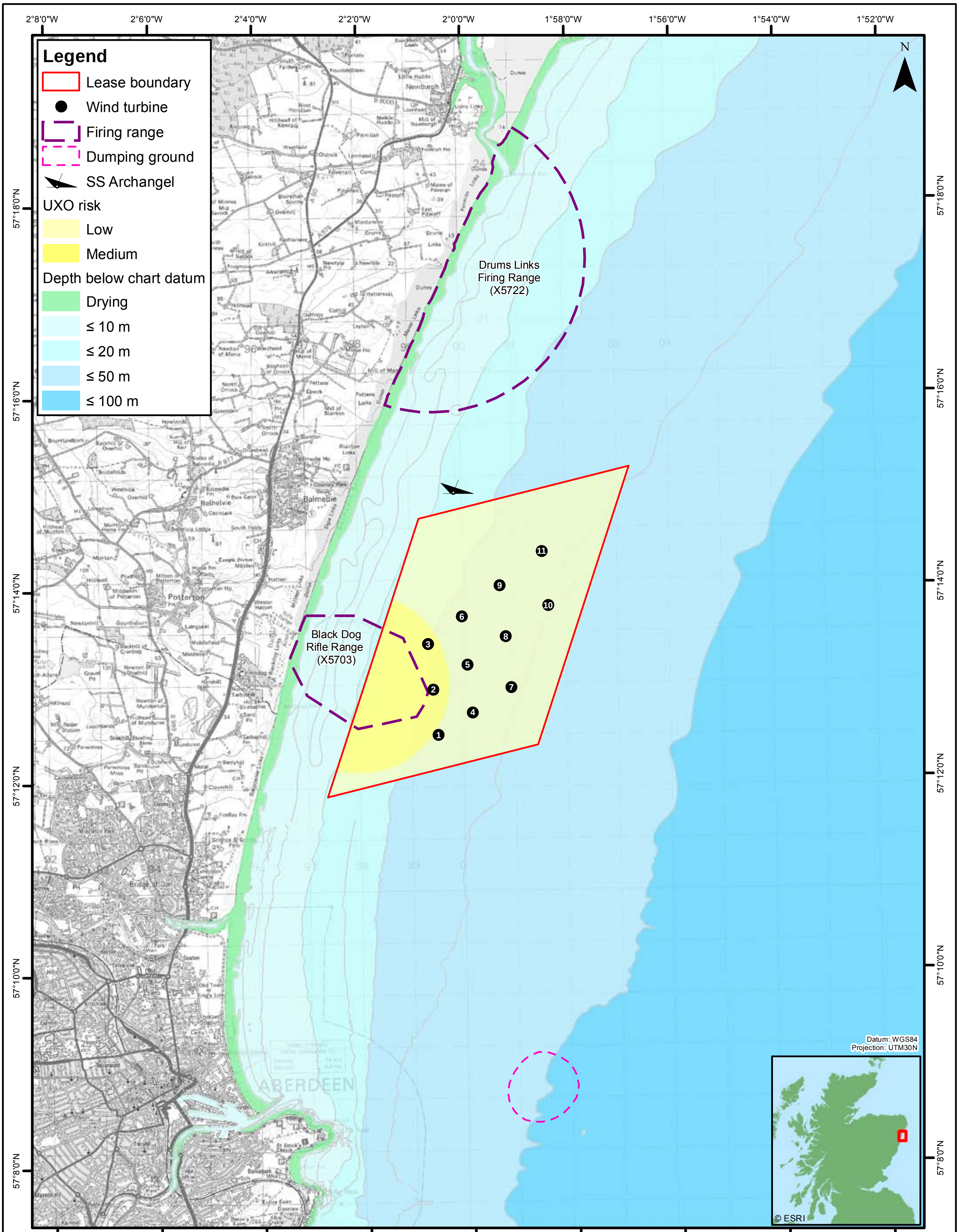
- Drying
- ≤ 10 m
- ≤ 20 m
- ≤ 50 m
- ≤ 100 m

Notes
1 Do not scale

0 0.5 1 km   0 0.5 nm

Original A3 Plot Scale 1:60,000

Drg No	6129-530-PA-081			Figure 6.3
Rev	B	Date	23/06/2011	
By	LH	Layout	LABER039	



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Technip

0 1 2 km

0 0.5 1 nm

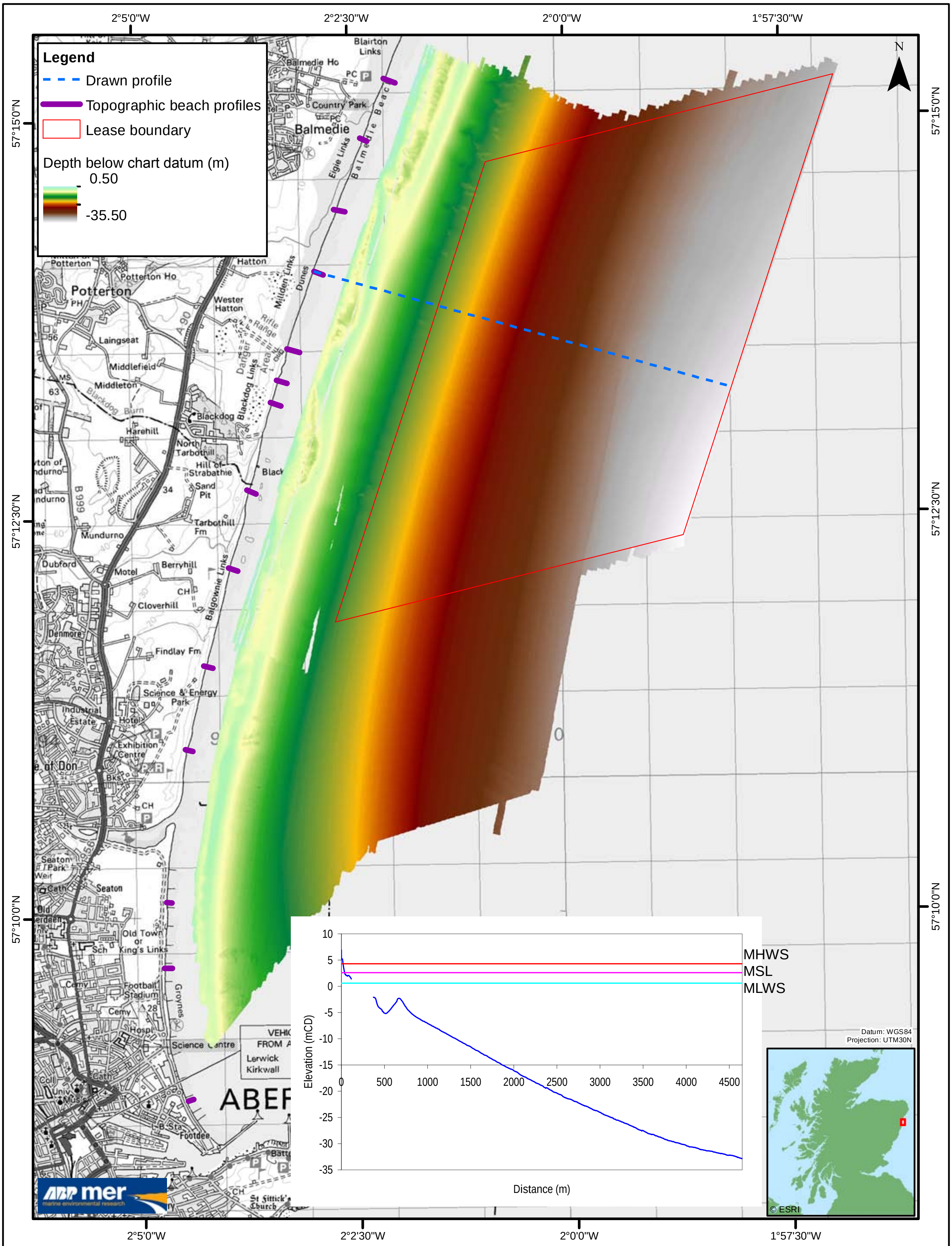
Original A4 Plot Scale 1:100,000

European Offshore Wind Deployment Centre

Potential Sources and Risk Classification of Unexploded Ordnance (UXO)

Layout	By	Date	Rev	Dwg No.
LABER039	LH	23/06/2011	A	6129-530-PA-082

Figure 7.1



VATTENFALL

areg

Technip

0 0.5 1 km

0 0.2 0.4 nm

Original A4 Plot Scale 1:60,000

European Offshore Wind Deployment Centre

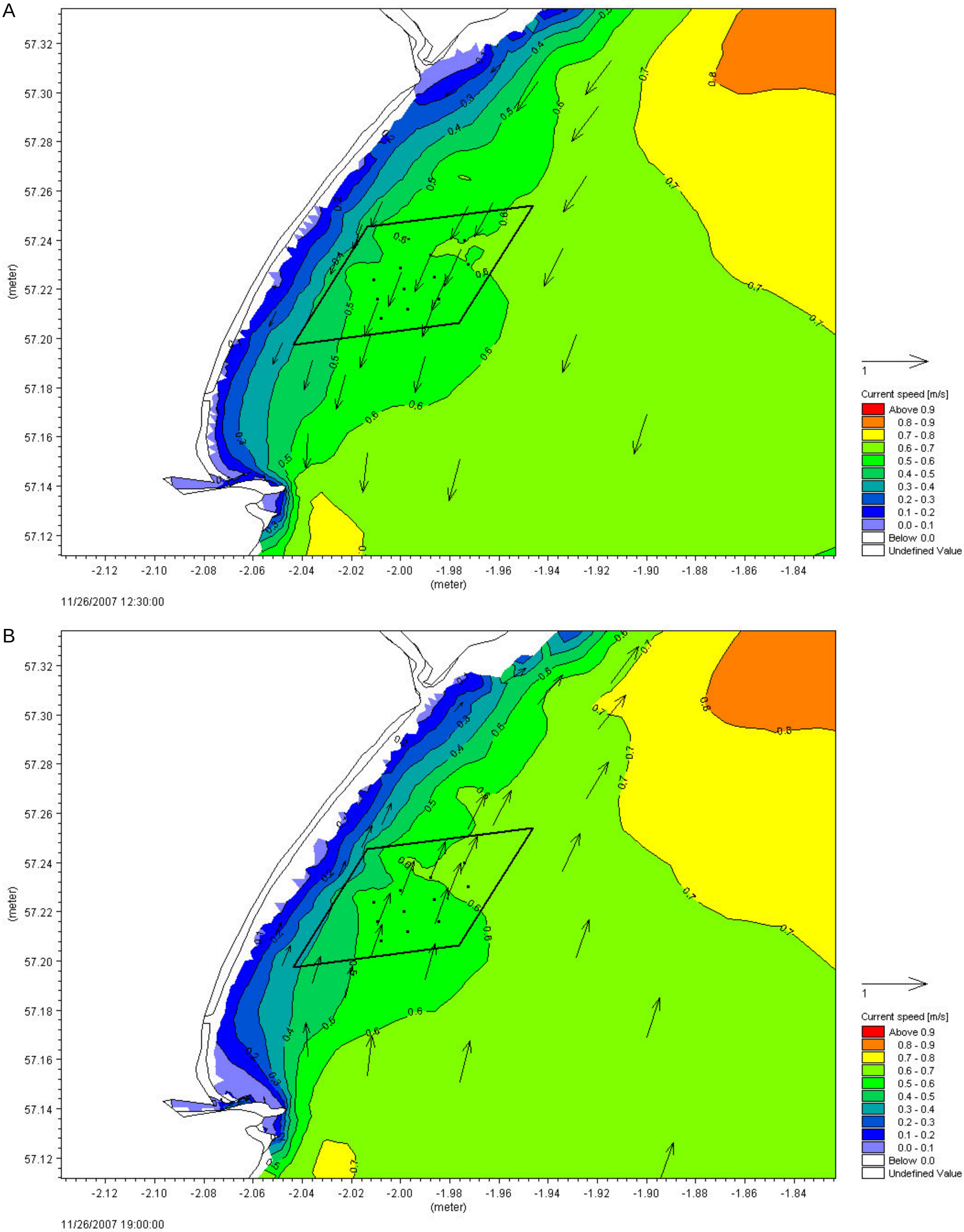
Bathymetry

Layout	By	Date	Rev	Dwg No.
NA	SNH	26/11/2010	C	6129-530-PM-004

Figure 8.1

A

B



ABPmer

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Technip

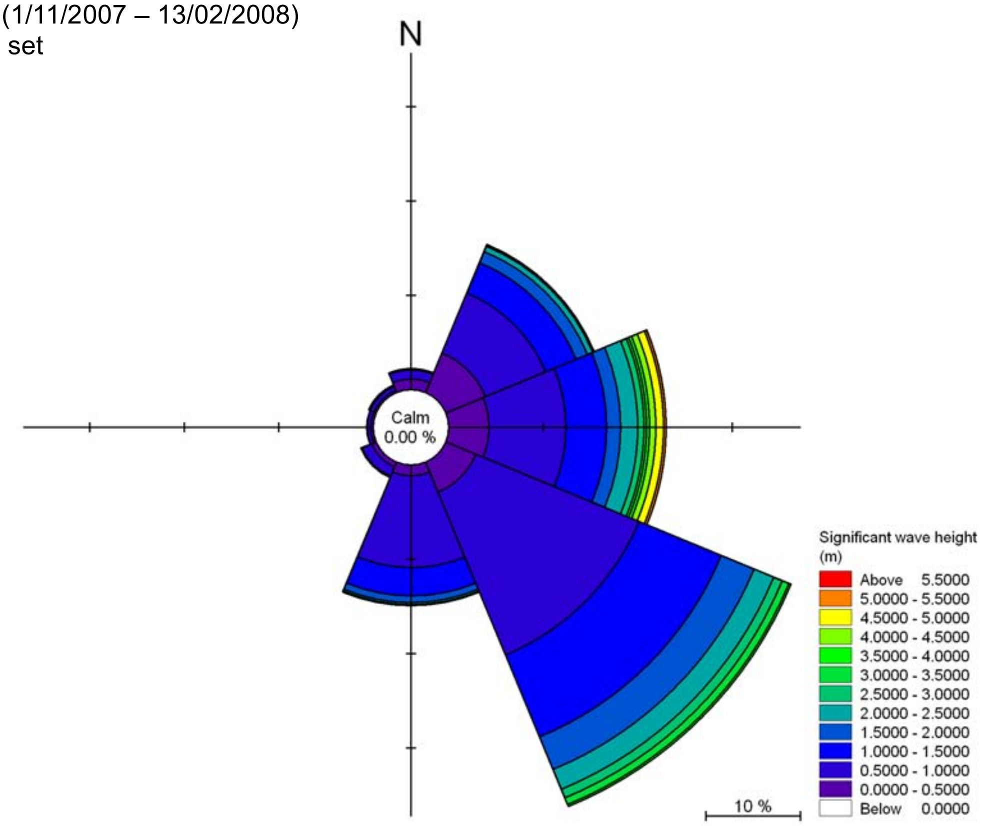
European Offshore Wind Deployment Centre

Modelled current speeds during peak flood (A) and peak ebb (B)

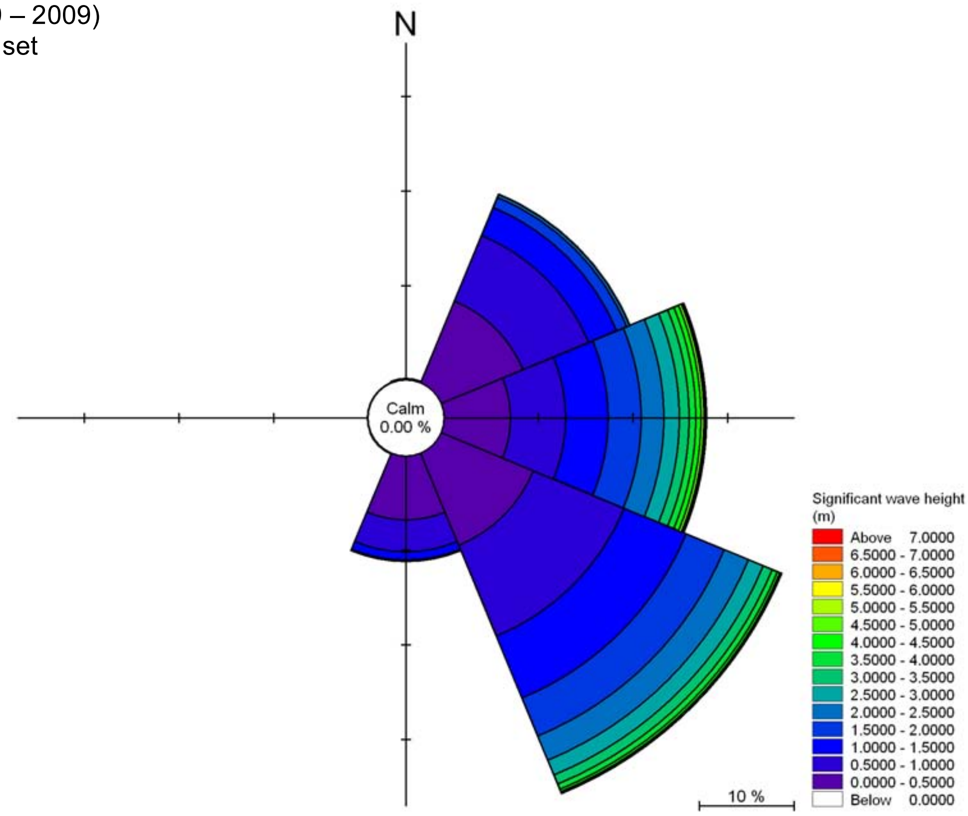
Layout	By	Date	Rev	Dwg No.
NA	SNH	26/11/2010	A	6129-530-PM-007

Figure 8.2

A: Emu AWAC (1/11/2007 – 13/02/2008)
Short-term data set



B: CFSR (1979 – 2009)
Long-term data set

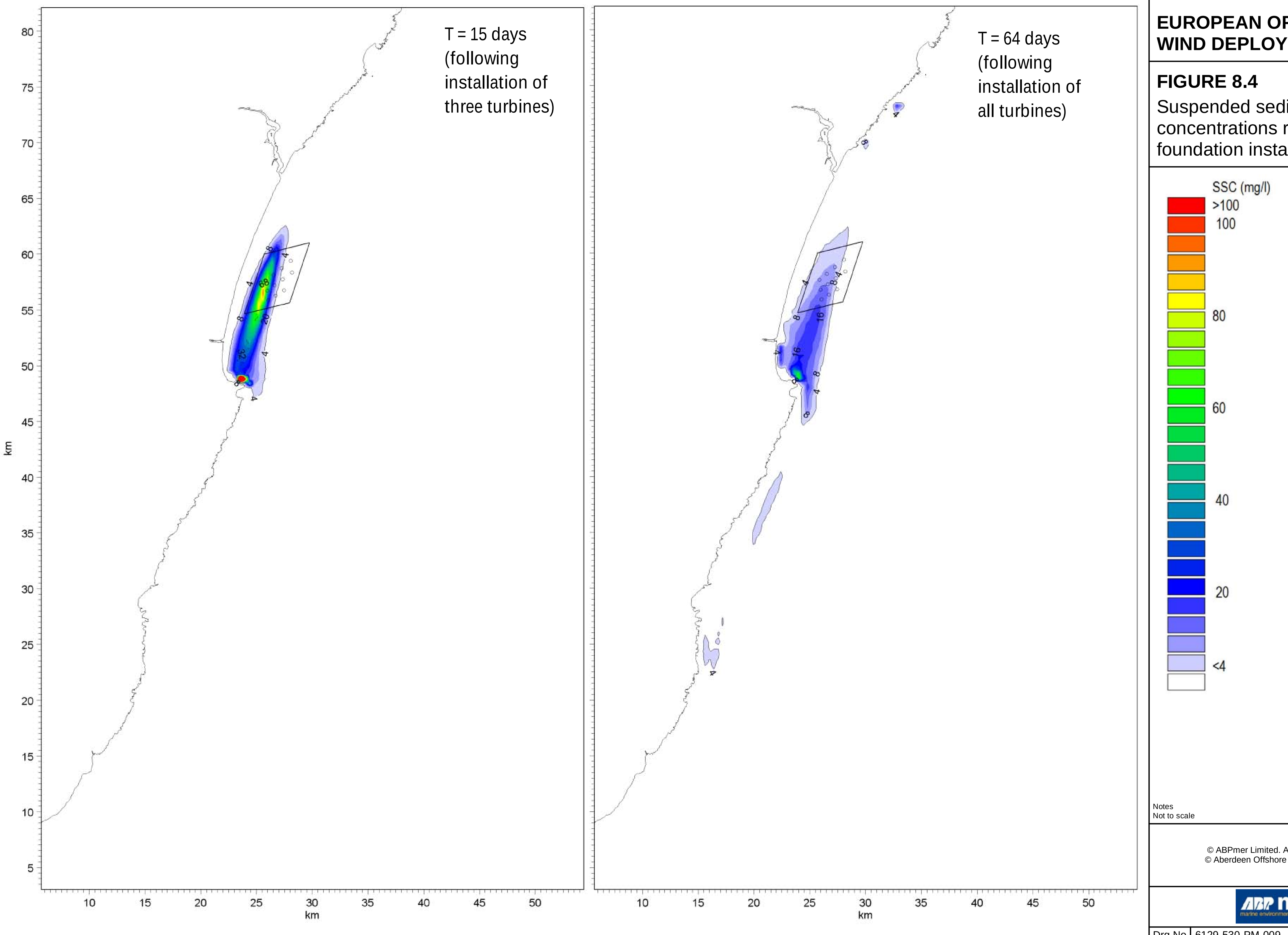


European Offshore Wind Deployment Centre

Wave roses showing significant wave height and peak wave direction from the AWAC and Seastates

Layout	By	Date	Rev	Dwg No.
NA	SNH	26/11/2010	A	6129-530-PM-008

Figure 8.3



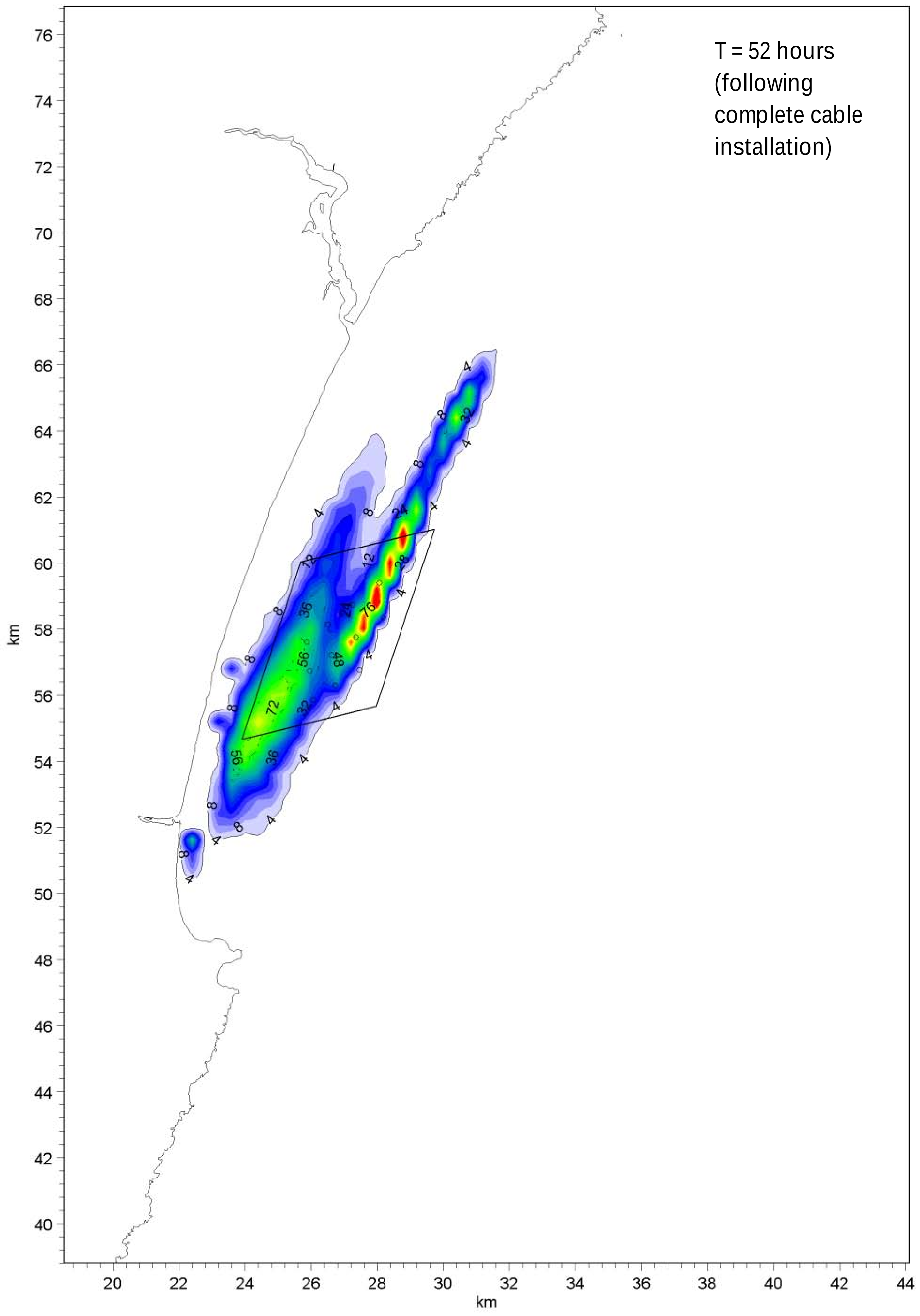
EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 8.4

Suspended sediment concentrations resulting from foundation installation works

Notes
Not to scale

Drg No	6129-530-PM-009			Figure 8.4
Rev	A	Date	04/05/11	
By	NW	Layout	LABER039	



EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 8.5

Suspended sediment concentrations resulting from cable installation works

SSC (mg/l)
- >100
- 100
- 80
- 60
- 40
- 20
- <4

Notes
Not to scale

ABP mer marine environmental research

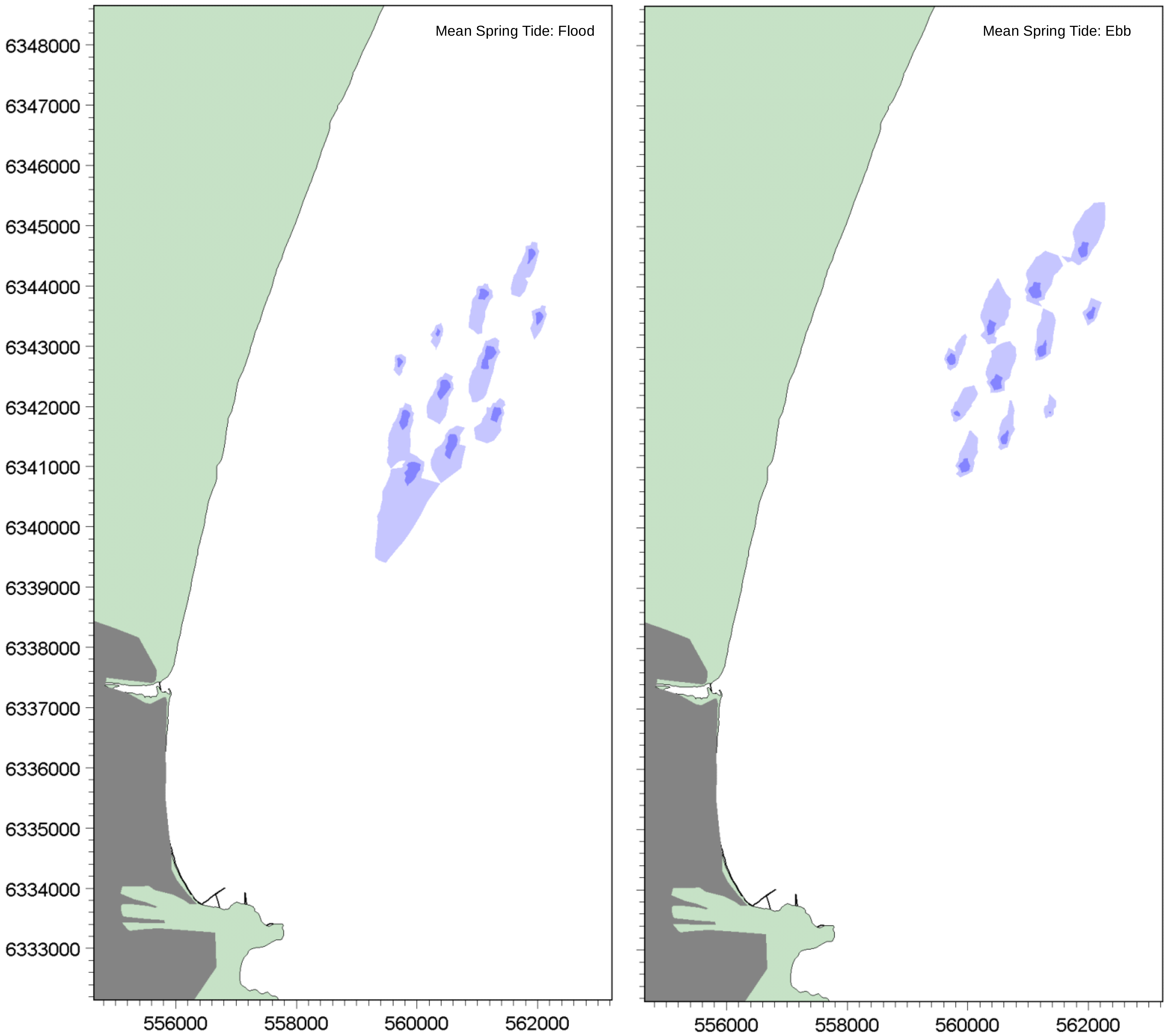
Drg No	6129-530-PM-010		
Rev	A	Date	03/05/11
By	NW	Layout	LABER039

Figure 8.5

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 8.6

Modelled changes to tidal currents

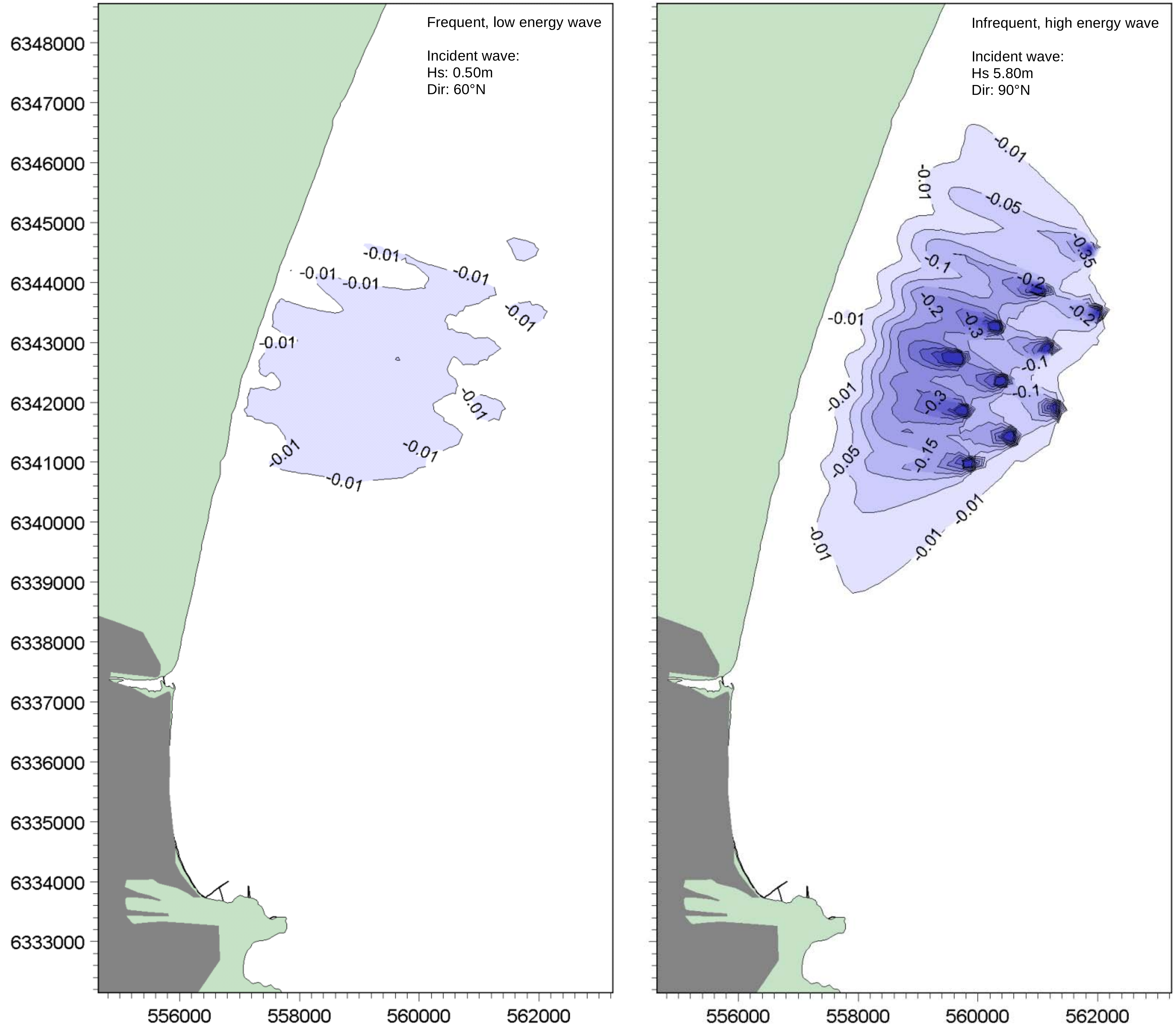


Current Speed difference (m/s)

- Above 0.10
- 0.05 - 0.10
- 0.02 - 0.05
- 0.01 - 0.02
- -0.01 - 0.01
- -0.02 - -0.01
- -0.05 - -0.02
- -0.10 - -0.05
- Below -0.10

Notes
Not to scale

Drg No	6129-530-PM-011			Figure 8.6
Rev	A	Date	28/04/11	
By	NW	Layout	LABER039	



Technip areg VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 8.7

Modelled changes to significant wave height

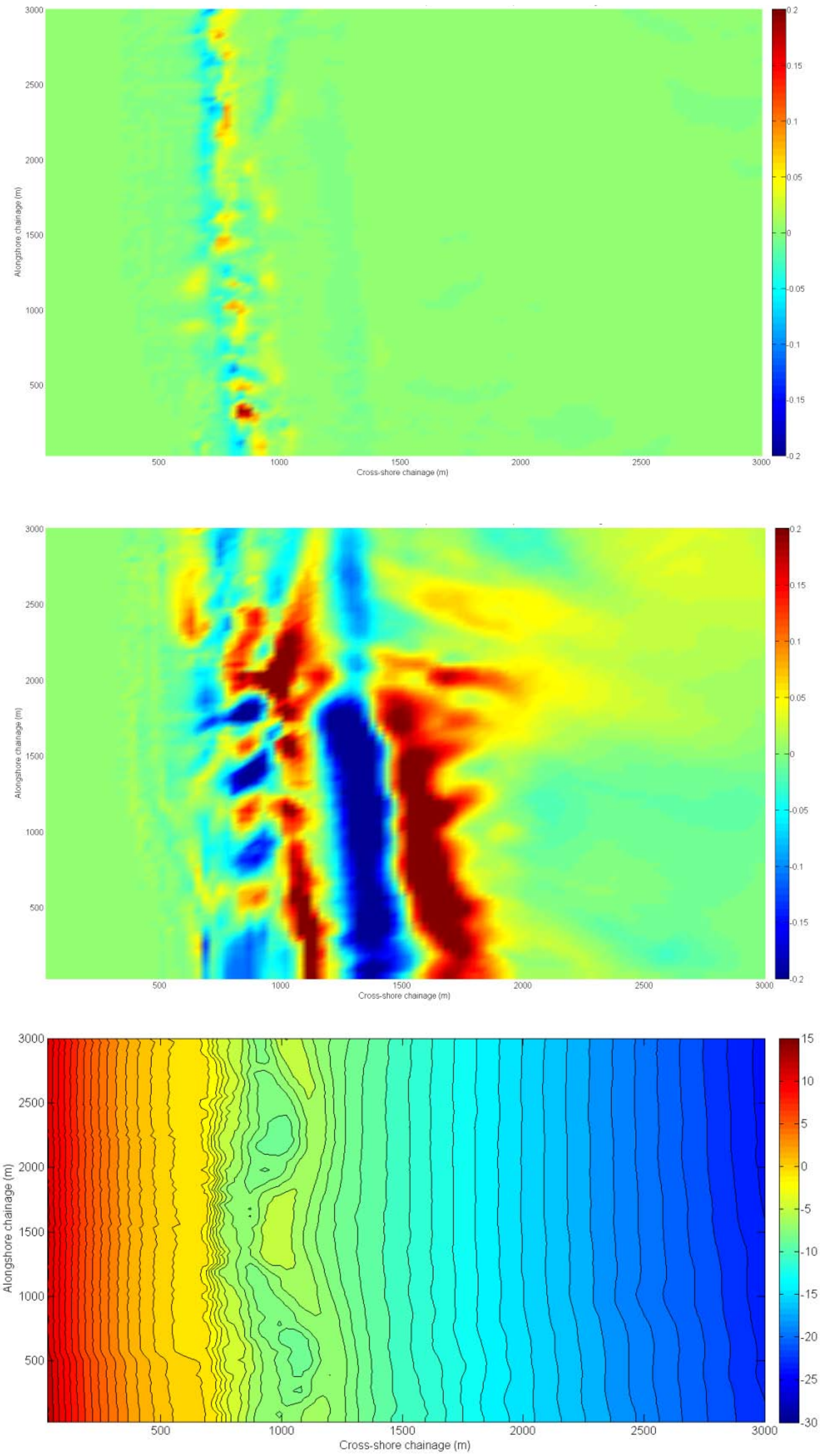
Hs difference (m)

	-0.01 - 0.01
	-0.05 - -0.01
	-0.10 - -0.05
	-0.15 - -0.10
	-0.20 - -0.15
	-0.25 - -0.20
	-0.30 - -0.25
	-0.35 - -0.30
	-0.40 - -0.35
	Below -0.40

Notes
Not to scale

ABP mer marine environmental research

Drg No	6129-530-PM-012			**Figure 8.7**
Rev	A	Date	28/04/11	
By	NW	Layout	LABER039	



Top: Baseline conditions: Ws = 8m/s, Hs = 1.8m, Tp = 7.6, Dir = 68.3°N;
Corresponding OWF scheme conditions: Ws = 8m/s, Hs = 1.66m, Tp = 7.56, Dir = 68.3°N;
Middle: Baseline conditions: Ws = 12m/s, Hs = 4.2m, Tp = 11.9, Dir = 68.3°N;
Corresponding OWF scheme conditions: Ws = 12m/s, Hs = 3.87m, Tp = 11.81, Dir = 68.3°N;
Bottom: Detail of initial nearshore bathymetry (mCD) used in the 2D XBeach simulations.

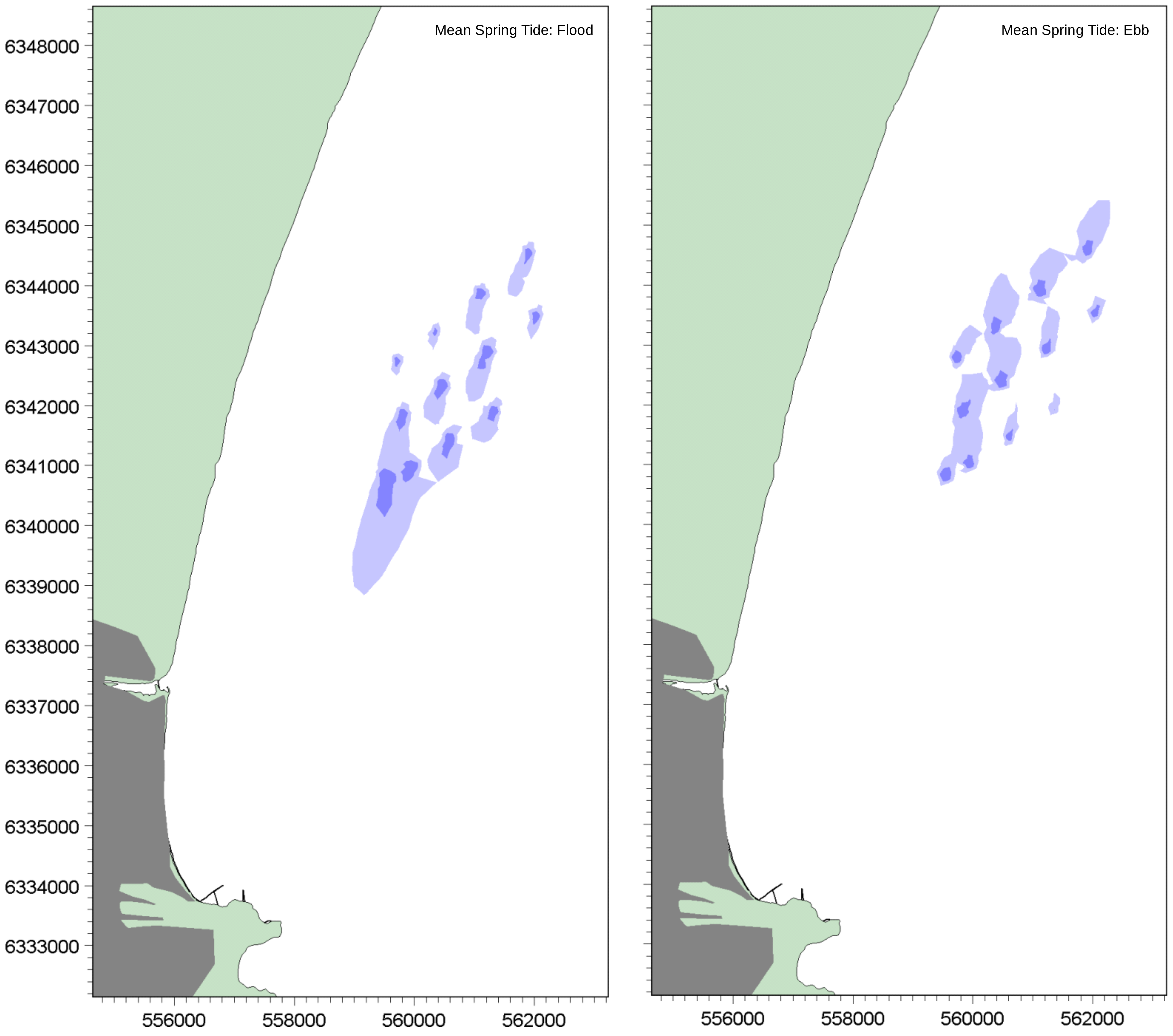
Ws = Wind speed; Hs = significant wave height; Tp = Peak wave period; Dir = incoming direction

European Offshore Wind Deployment Centre

Beach morphology changes in response to the installed EOWDC

Layout	By	Date	Rev	Dwg No.
NA	NW	28/04/2011	A	6129-530-PM-013

Figure 8.8



Technip areg VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 8.9

Modelled changes to tidal currents (+OceanLab)

Current Speed difference (m/s)

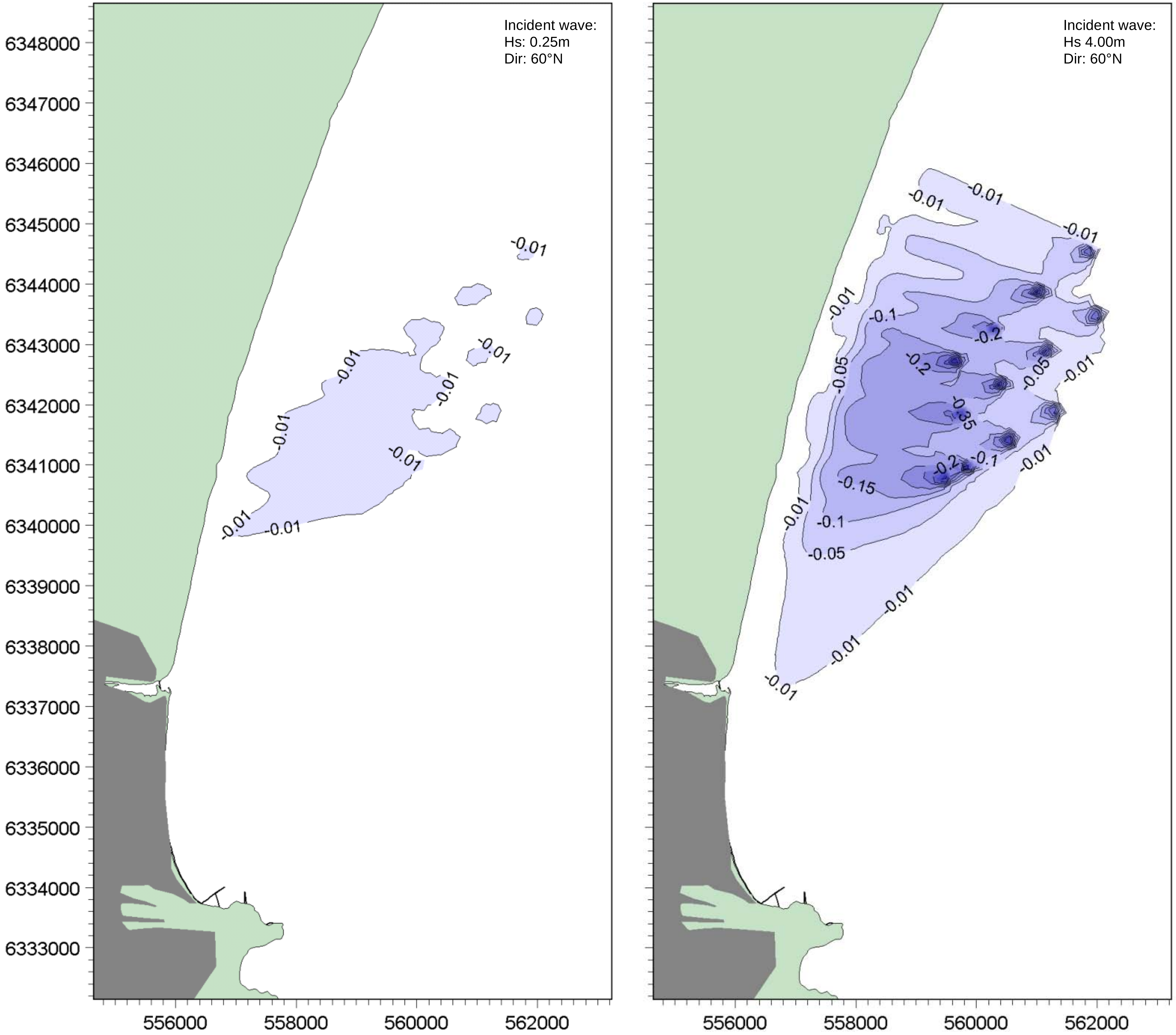
Above	0.10
0.05 -	0.10
0.02 -	0.05
0.01 -	0.02
-0.01 -	0.01
-0.02 -	-0.01
-0.05 -	-0.02
-0.10 -	-0.05
Below	-0.10

Notes
Not to scale

ABP mer marine environmental research

Drg No	6129-530-PM-014		
Rev	A	Date	28/04/11
By	NW	Layout	LABER039

Figure 8.9



EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 8.10

Modelled changes to significant wave height (+ OceanLab)

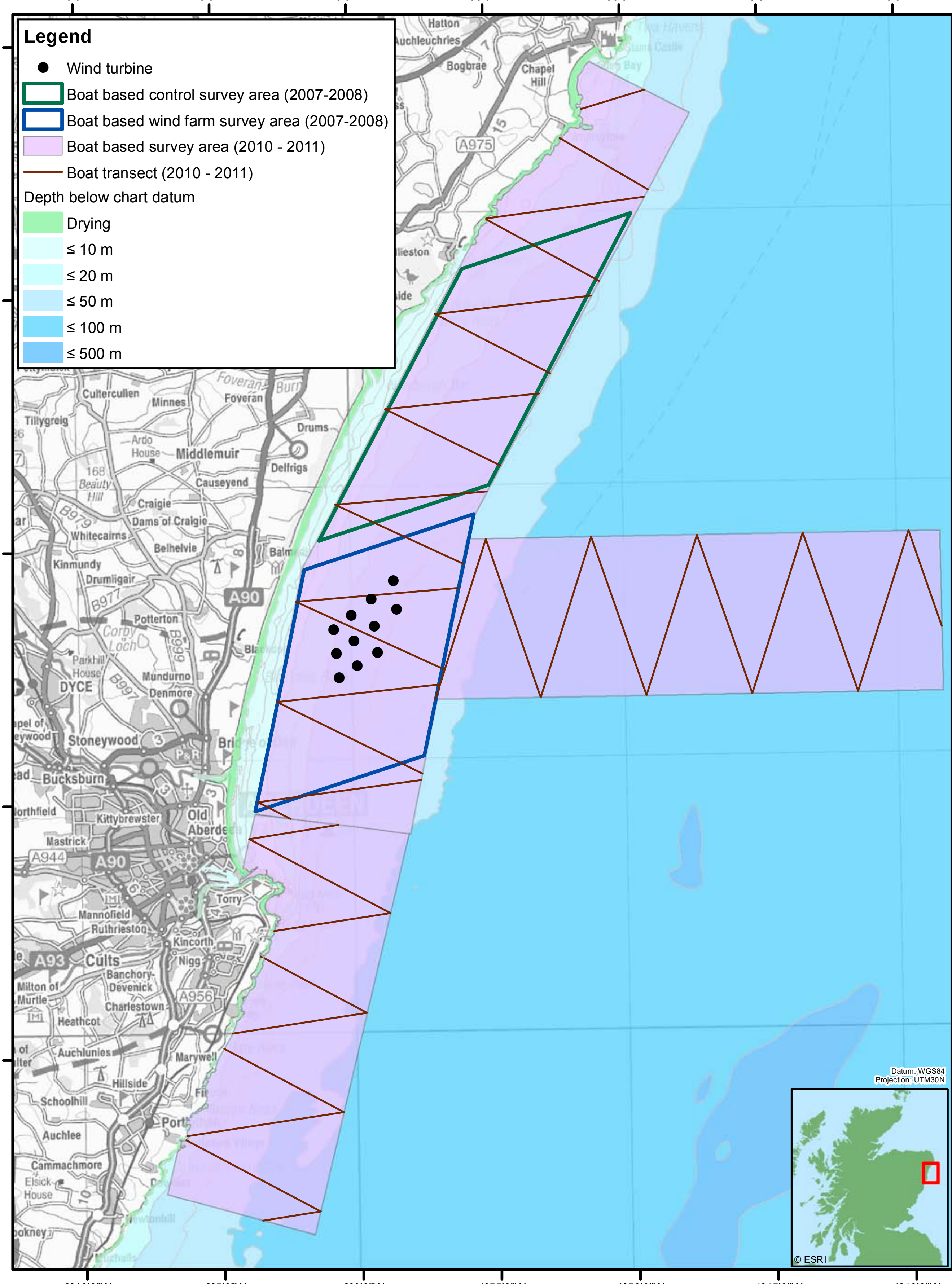
Hs difference (m)

- -0.01 - 0.01
- -0.05 - -0.01
- -0.10 - -0.05
- -0.15 - -0.10
- -0.20 - -0.15
- -0.25 - -0.20
- -0.30 - -0.25
- -0.35 - -0.30
- -0.40 - -0.35
- Below -0.40

Notes
Not to scale

Drg No	6129-530-PM-015		
Rev	A	Date	28/04/11
By	NW	Layout	LABER039

Figure 8.10



0 1 2 3 4 km 0 0.5 1 1.5 2 nm	Original A4 Plot Scale 1:200,000

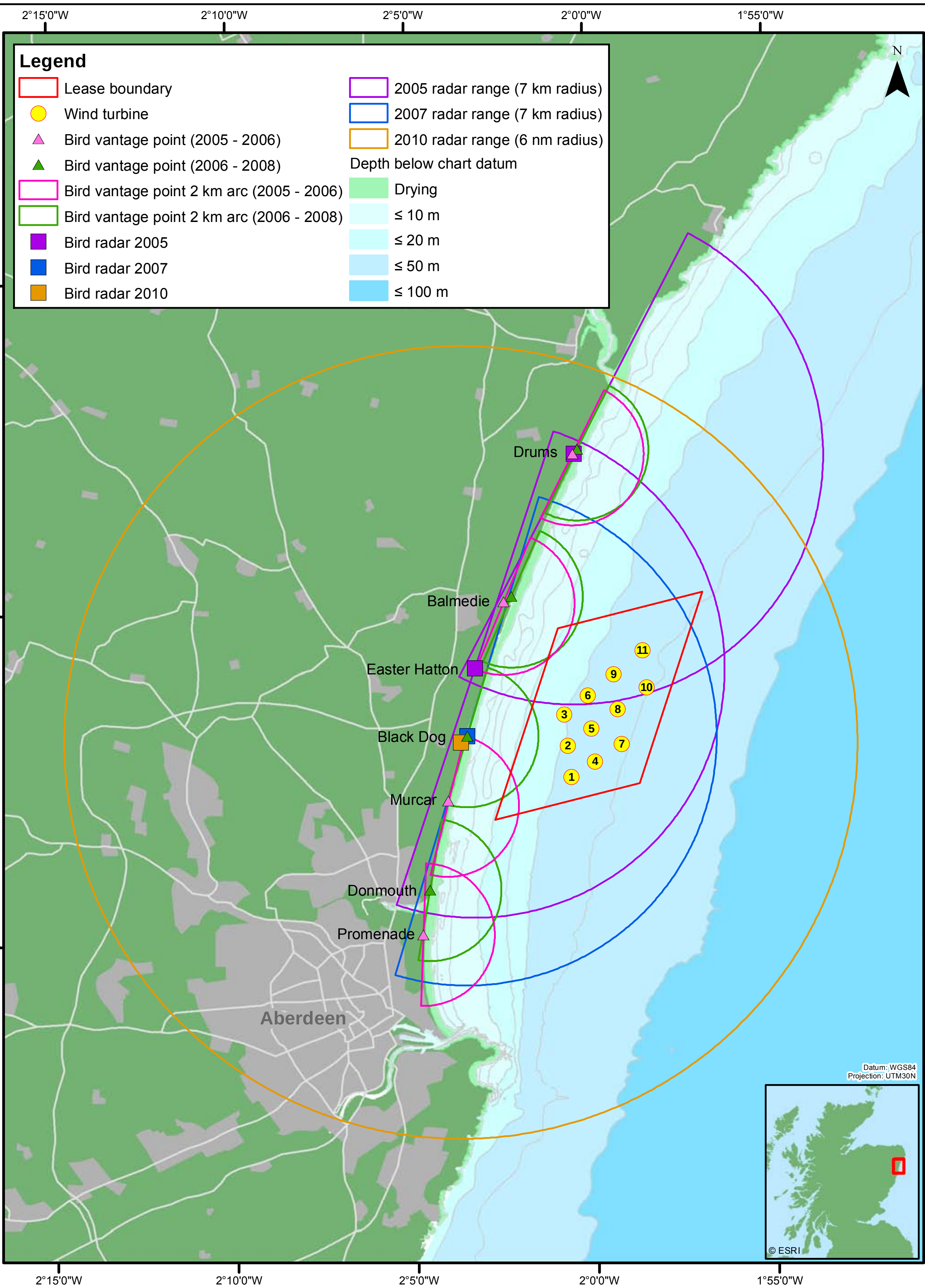
Contains Ordnance Survey data

European Offshore Wind Deployment Centre

Boat Based Survey Areas

Layout	By	Date	Rev	Dwg No.
LABER039	LH	22/06/2011	A	6129-530-PA-012

Figure 10.1



VATTENFALL

areg

Technip

0 1 2 3 4 km

0 0.5 1 1.5 2 nm

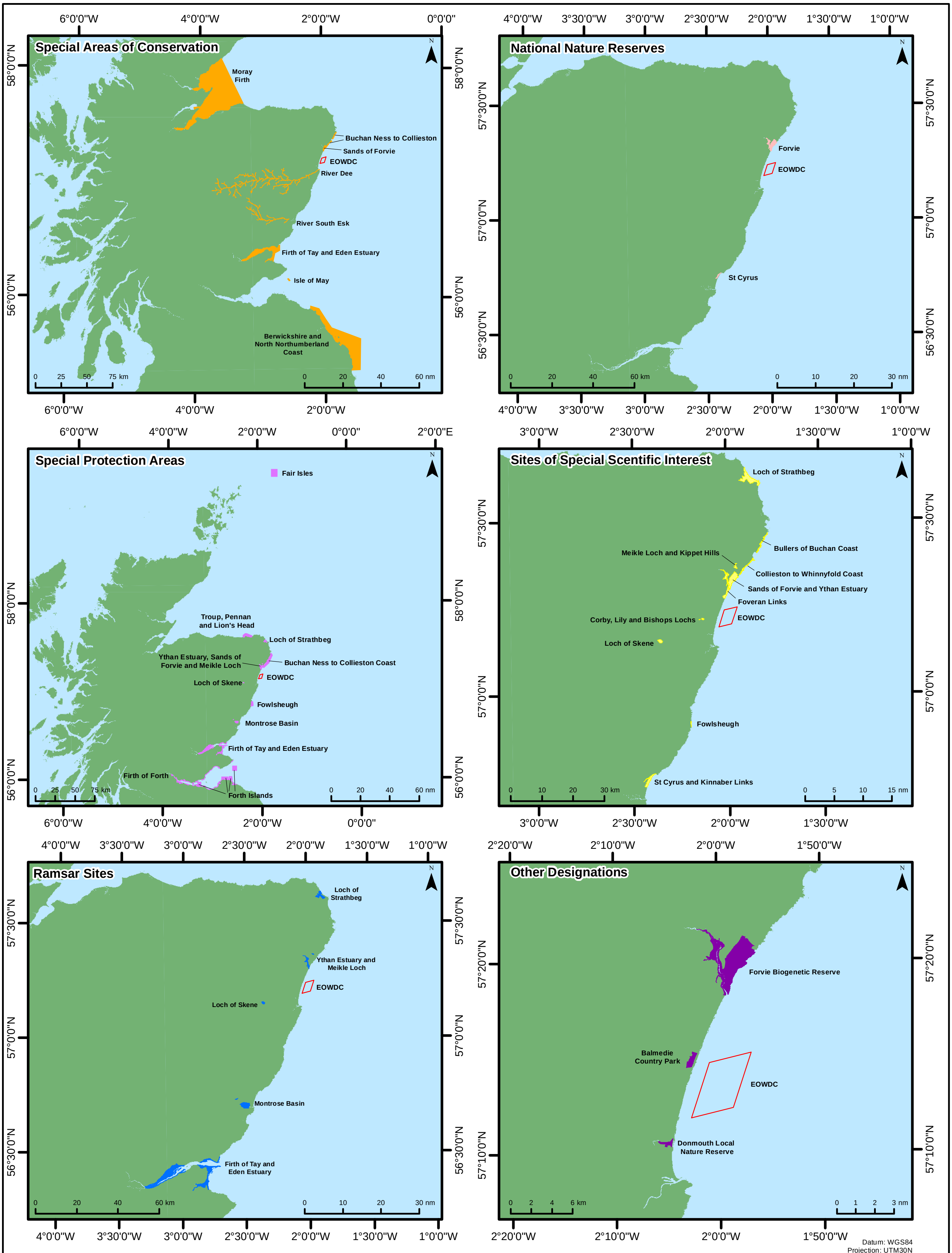
Original A4
Plot Scale
1:150,000

European Offshore Wind Deployment Centre

Bird Survey Areas

Layout	By	Date	Rev	Dwg No.
LABER039	LH	23/06/2011	B	6129-530-PA-022

Figure 10.2



VATTENFALL

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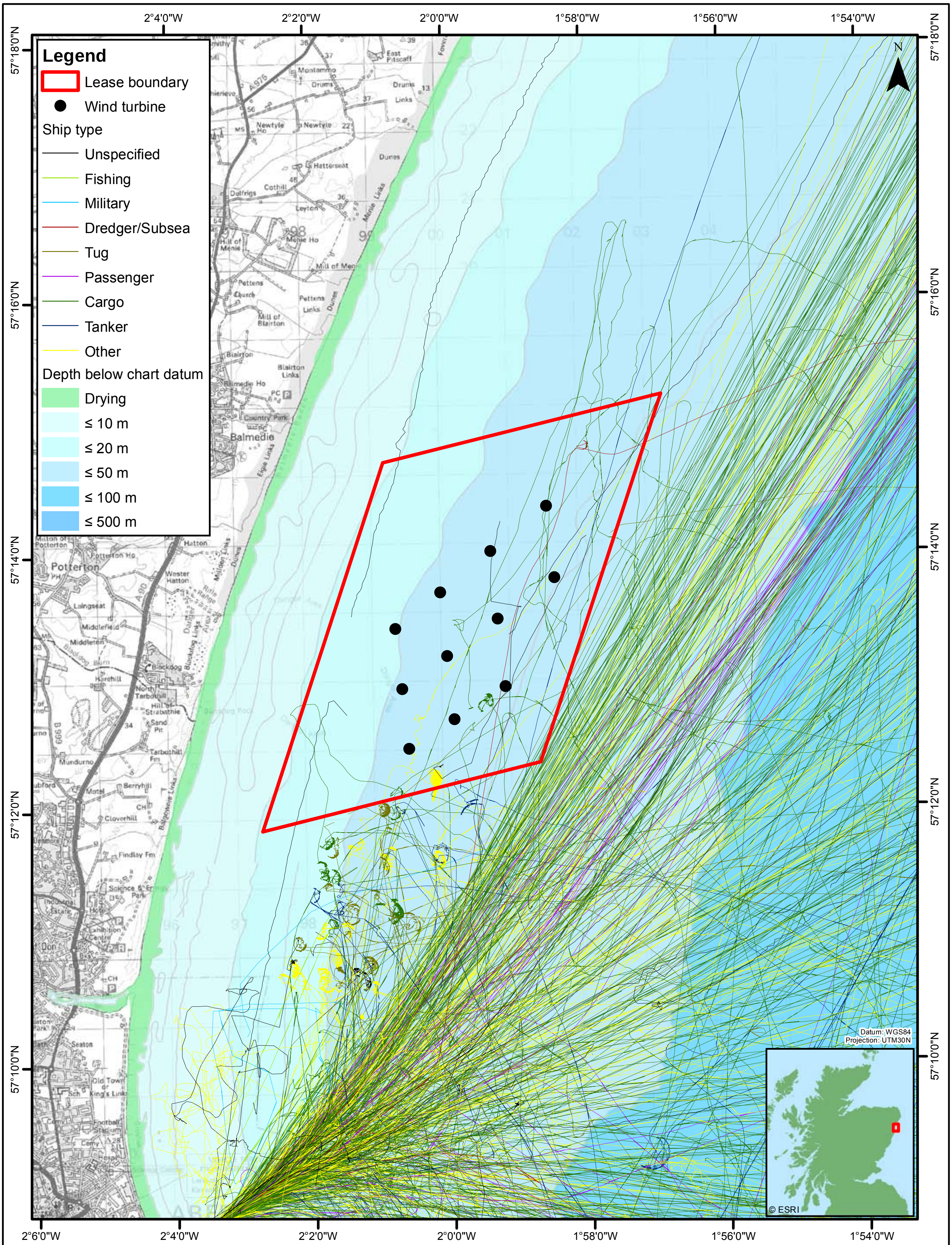
Technip

European Offshore Wind Deployment Centre

Designated Sites Potentially Impacted by the Proposed EOWDC

Layout	By	Date	Rev	Dwg No.
NA	LH	23/06/2011	A	6129-530-PA-011

Figure 14.1



VATTENFALL

areg Aberdeen Renewable Energy Group

Technip

0 0.5 1 1.5 km

0 0.25 0.5 0.75 nm

Original A4 Plot Scale 1:75,000

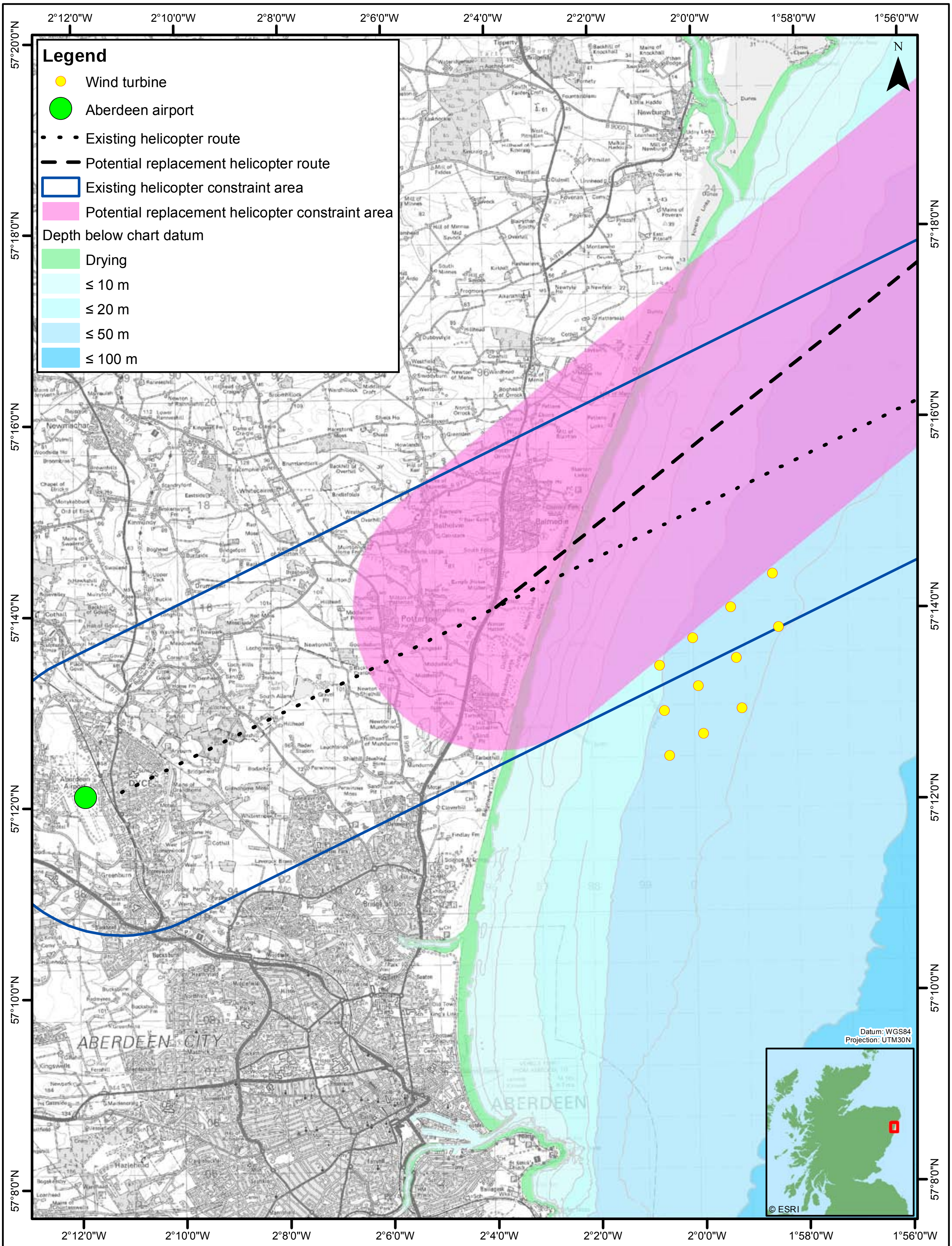
European Offshore Wind Deployment Centre

AIS and Radar Tracks

Survey 4 - 1st November - 15th November 2010

Layout	By	Date	Rev	Dwg No.
LABER039	LH	22/06/2011	A	6129-530-PA-090

Figure 15.1



VATTENFALL

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Technip

0 1 2 km

0 0.5 1 nm

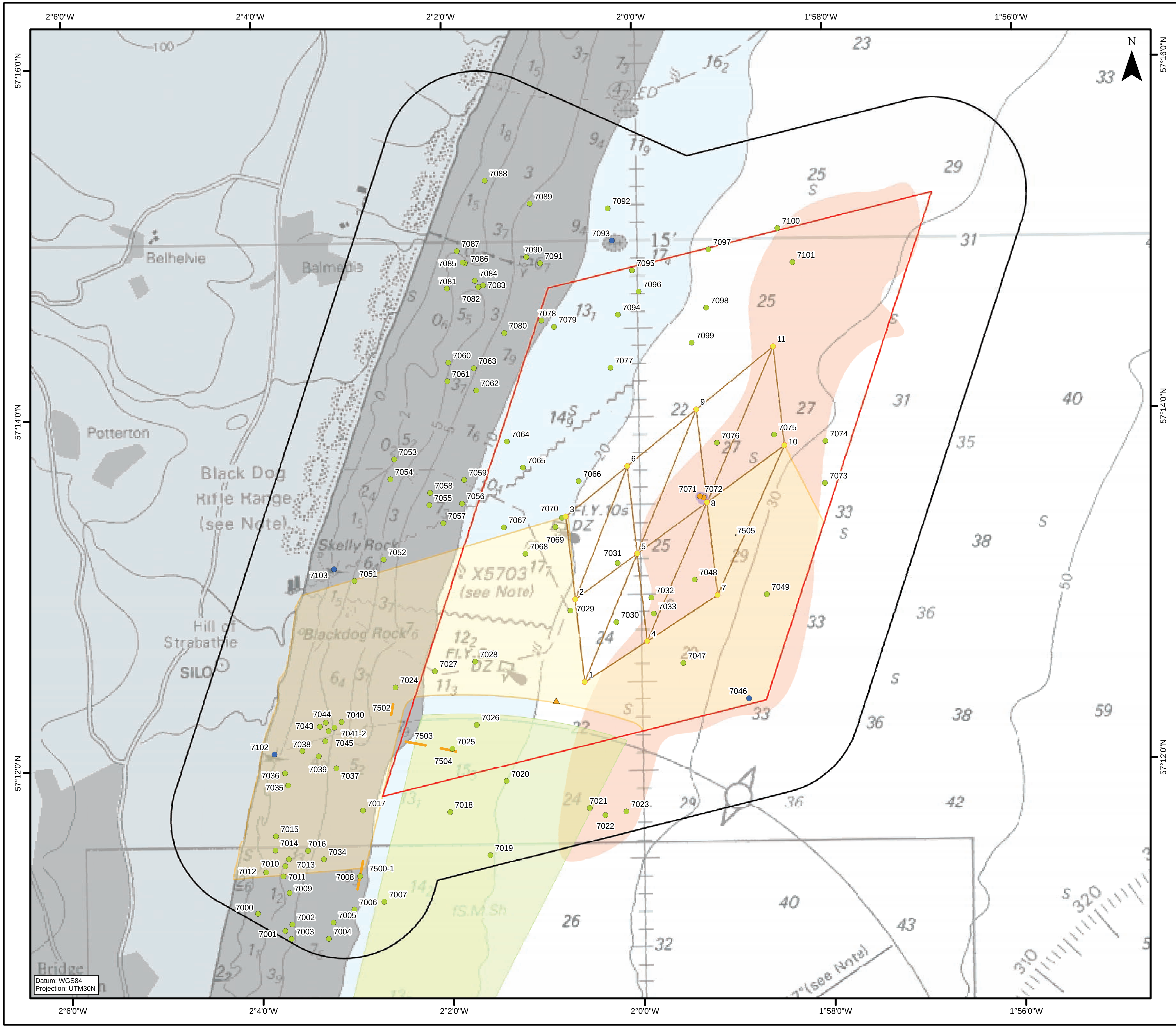
Original A4 Plot Scale 1:100,000

European Offshore Wind Deployment Centre

Helicopter Routes

Layout	By	Date	Rev	Dwg No.
LABER039	LH	22/06/2011	A	6129-530-PA-006

Figure 16.1



Technip areg VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 18.1

Seabed and sub-seabed gazetteers of Cultural Heritage Assets in the MSA in relation to Rochdale Envelope of the EOWDC

Legend

- Lease boundary
- Wind turbine
- Proposed ocean laboratory location
- Export cable corridor
- Proposed cable trench routes
- Anchorage Area
- Marine Study Area
- A1 - Anthropogenic origin of archaeological interest
- A2 - Uncertain origin of possible archaeological interest
- A3 - Historic record of possible archaeological interest
- Precautionary exclusion zones (50 m buffer)
- Possible prograding reflector within Forth Formation (WA 7505)
- Possible shallow cut and fills

Notes
1 Do not scale

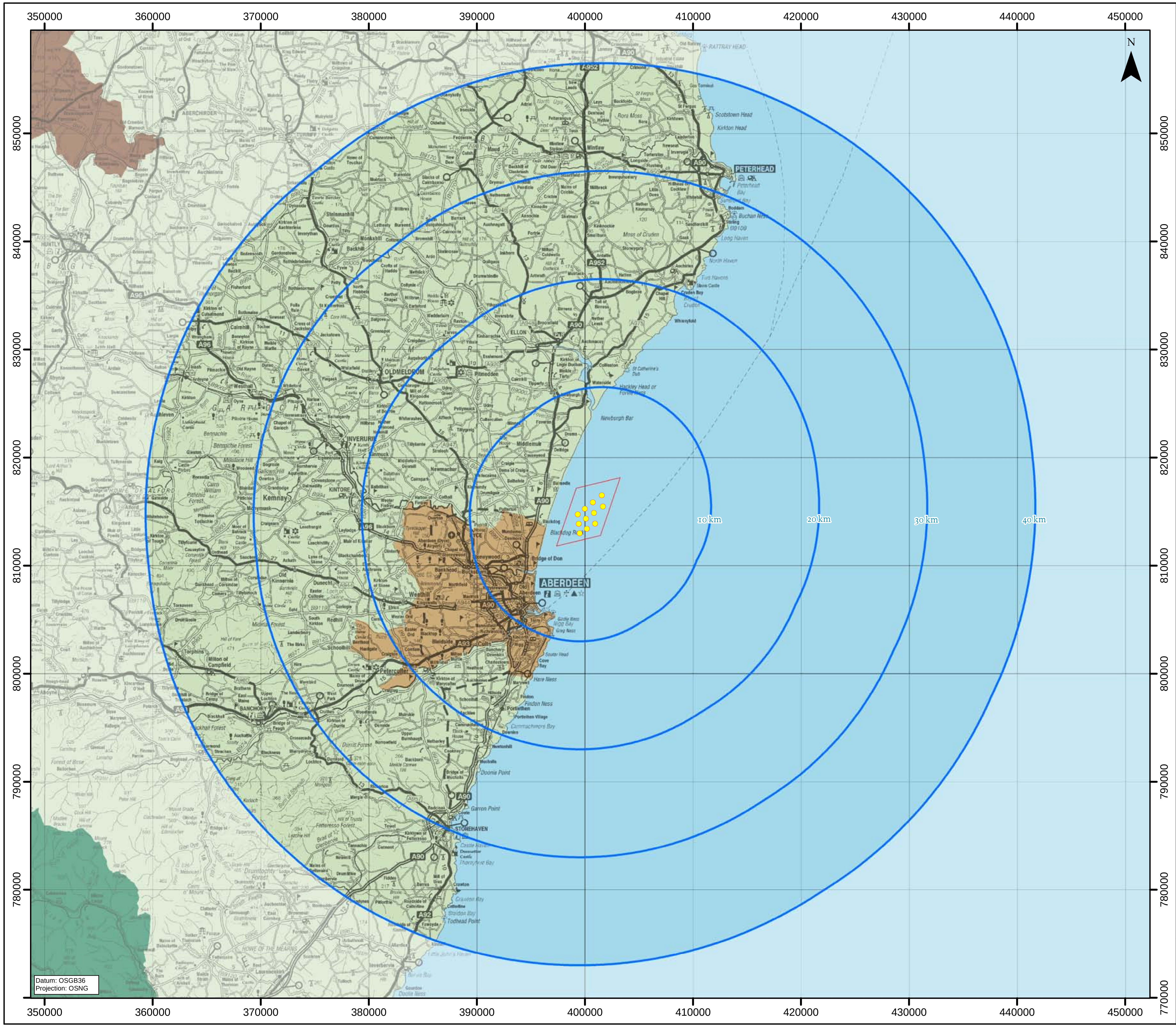
© ESRI

0 0.5 1 km 0 0.4 nm

Original A3 Plot Scale 1:40,000

Drg No	6129-530-PW-011		
Rev	D	Date	06/06/2011
By	KB	Layout	LABER039

Figure 18.1



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EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 19.1
Site Location

Legend

- Lease Boundary
- Wind turbine
- 10 km, 20 km, 30 km and 40 km radius bands around wind turbines

Districts

- Aberdeen City
- Aberdeenshire
- Angus
- Moray

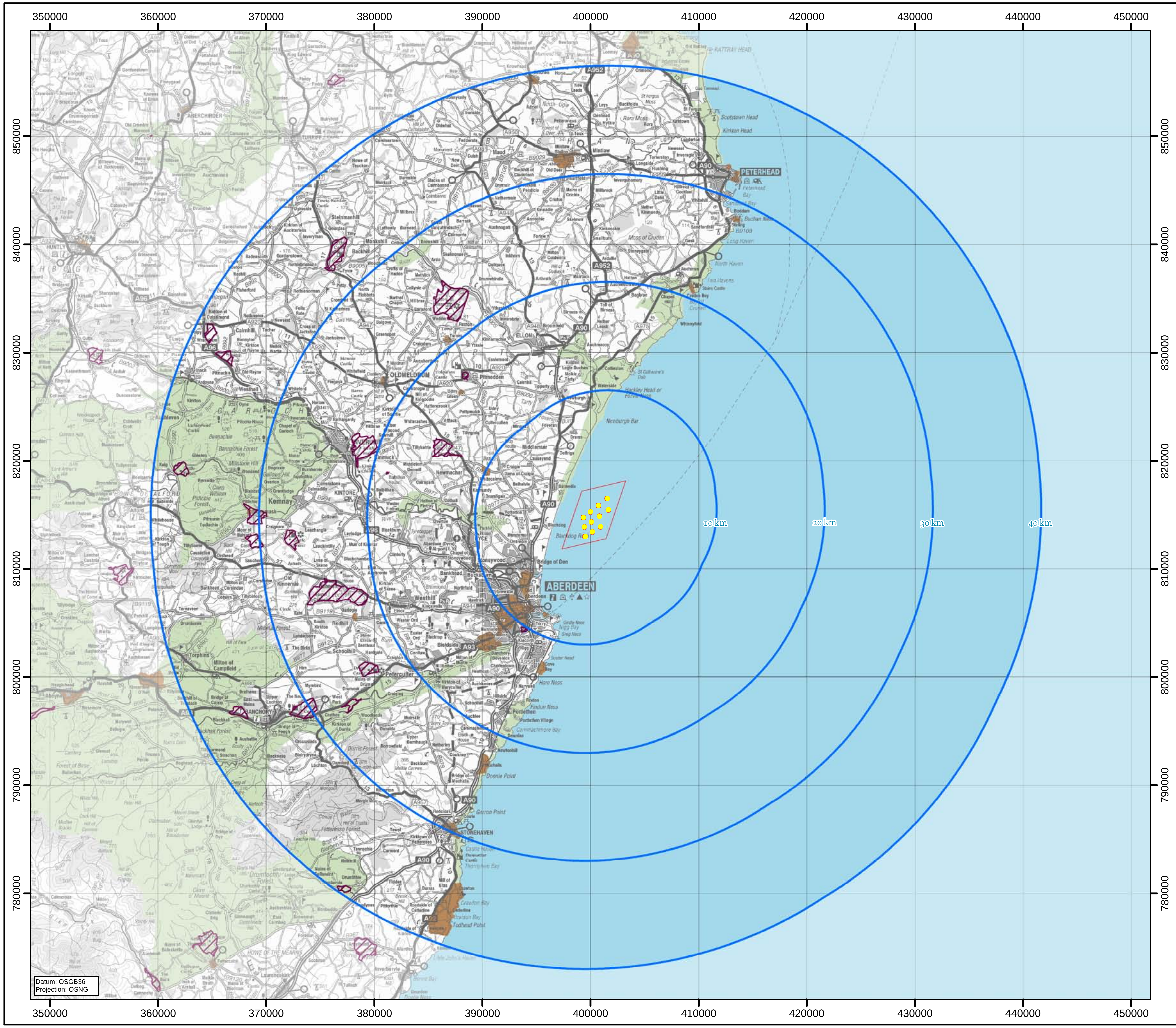
Notes
1 Do not scale

0 2.5 5 km   0 2 nm

Original A3
Plot Scale
1:350,000

Drg No	6129-530-PL-001		
Rev	B	Date	22/06/11
By	DL	Layout	LABER039

Figure
19.1



Technip areg Aberdeen Renewable Energy Group VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 19.2
Landscape Policy and Context

Legend

- Lease boundary
- Wind turbine
- 10 km, 20 km, 30 km and 40 km radius bands around wind turbines
- Gardens and Designed Landscapes
- Conservation Areas
- Area of Landscape Significance

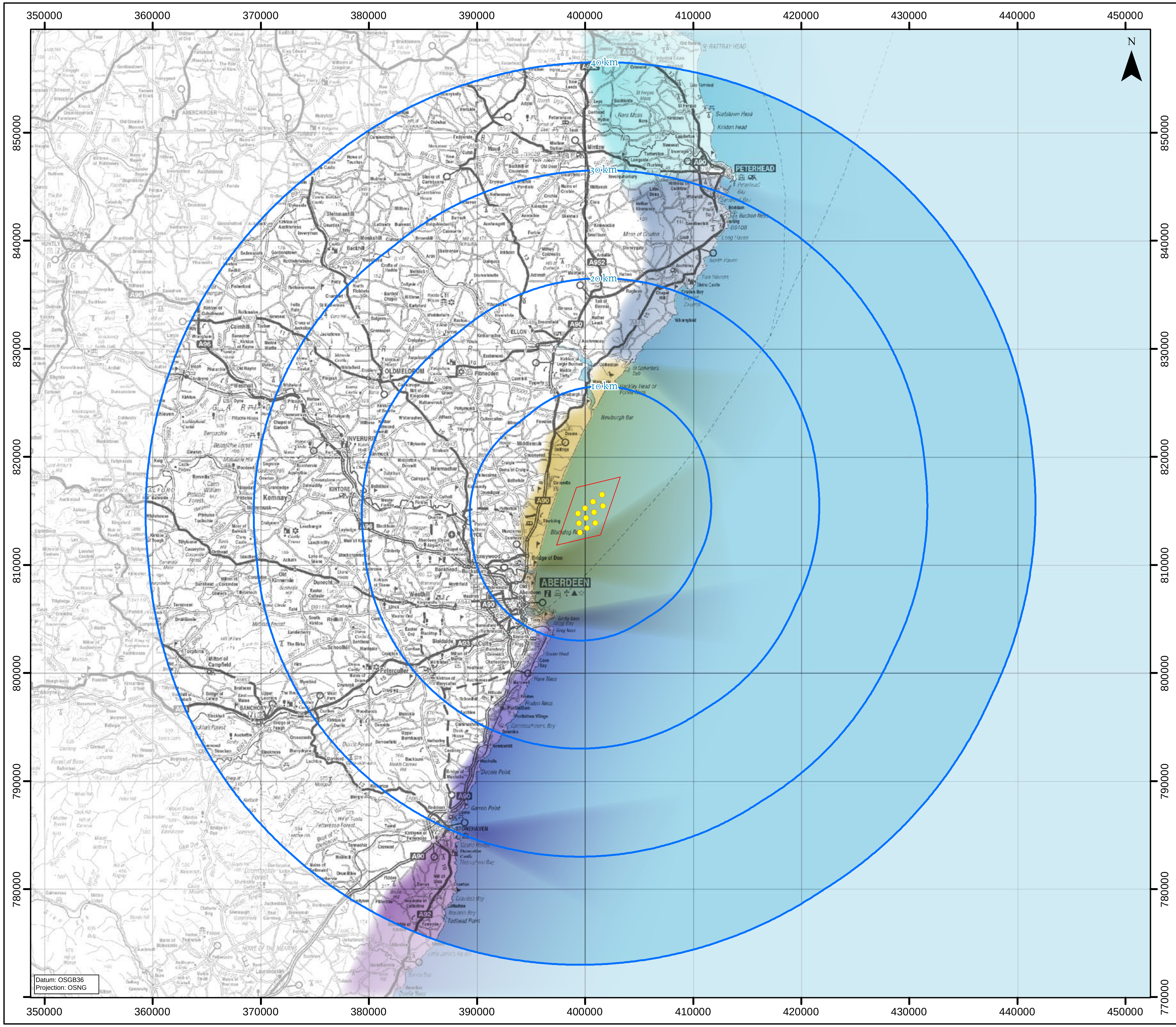
Notes
1 Do not scale
2 In Great Britain, AOD for the Ordnance Survey is ODN (Ordnance Datum Newlyn), defined as the Mean Sea Level at Newlyn in Cornwall between 1915 and 1921.

0 2.5 5 km 0 2 nm

Original A3 Plot Scale 1:350,000

Drg No	6129-530-PL-002		
Rev	B	Date	22/06/11
By	DL	Layout	LABER039

Figure 19.2



Technip areg VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 19.3
Regional Seascape Units

Legend

- Lease boundary
- Wind turbine
- 10 km, 20 km, 30 km and 40 km radius bands around wind turbines

Seascape Units

- Inverbervie to Stonehaven
- Stonehaven to Girdle Ness
- Aberdeen Beach
- Aberdeen Bay
- Collieston to Peterhead
- Peterhead to Fraserburgh

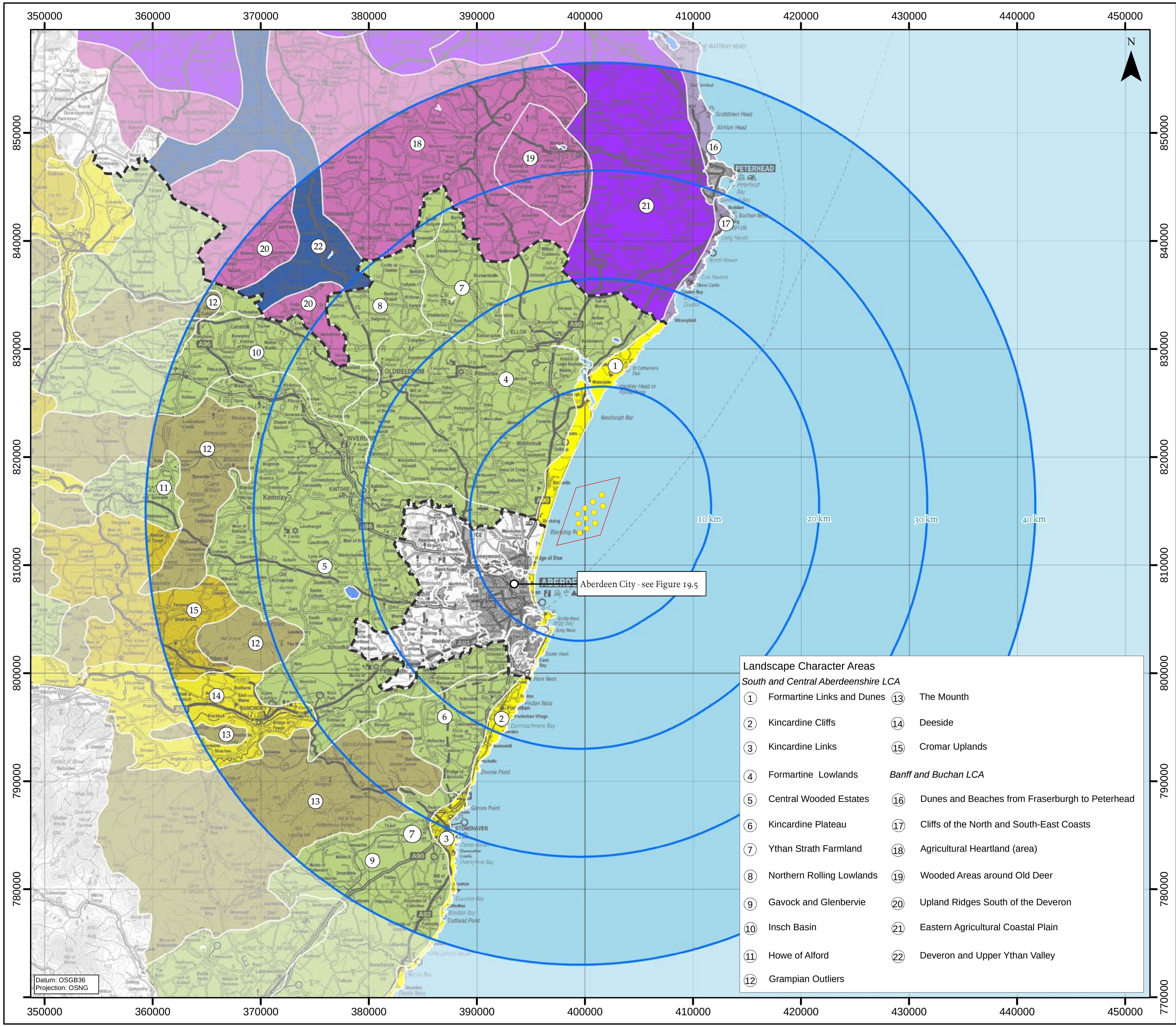
Notes
1 Do not scale

0 2.5 5 km   0 2 nm

Original A3 Plot Scale 1:350,000

Drg No	6129-530-PL-003		
Rev	B	Date	22/06/11
By	RL	Layout	LABER039

Figure 19.3



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EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 19.4
Regional Landscape Character Types and Areas

Legend
- Lease Boundary
- Wind turbine
- 10 km, 20 km, 30 km & 40 km radius bands around Wind turbines

Landscape Character Types
- Inland Loch
- Urban

South and Central Aberdeenshire LCA
- Agricultural Heartland
- Coast
- Farmed Moorland Edge
- Moorland Plateaux
- Straths and Valleys

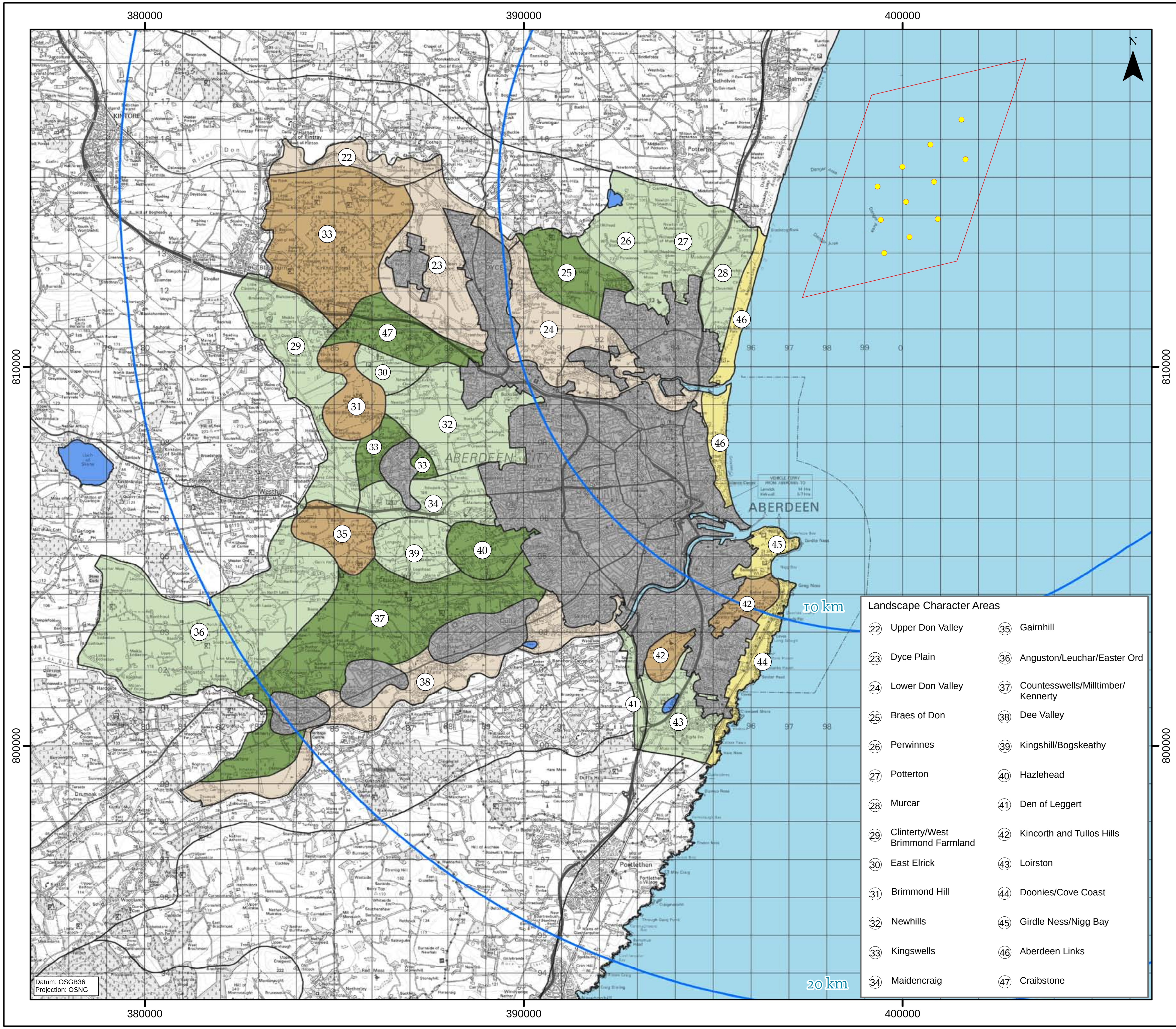
Banff and Buchan LCA
- Agricultural Heartland
- Coast
- Coastal Farmland
- River Valleys

Notes
1 Do not scale
2 Source: Scottish Natural Heritage

0 2.5 5 km | 0 2 nm | Original A3 Plot Scale 1:350,000

Drg No	6129-530-PL-004		
Rev	B	Date	22/06/11
By	DL	Layout	LABER039

Figure 19.4



Technip areg VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 19.5

Aberdeen City Landscape Character Types and Areas

Legend

- Lease Boundary
- Wind turbine
- 10 km and 20 km radius bands around wind turbines

Landscape Character Assessment

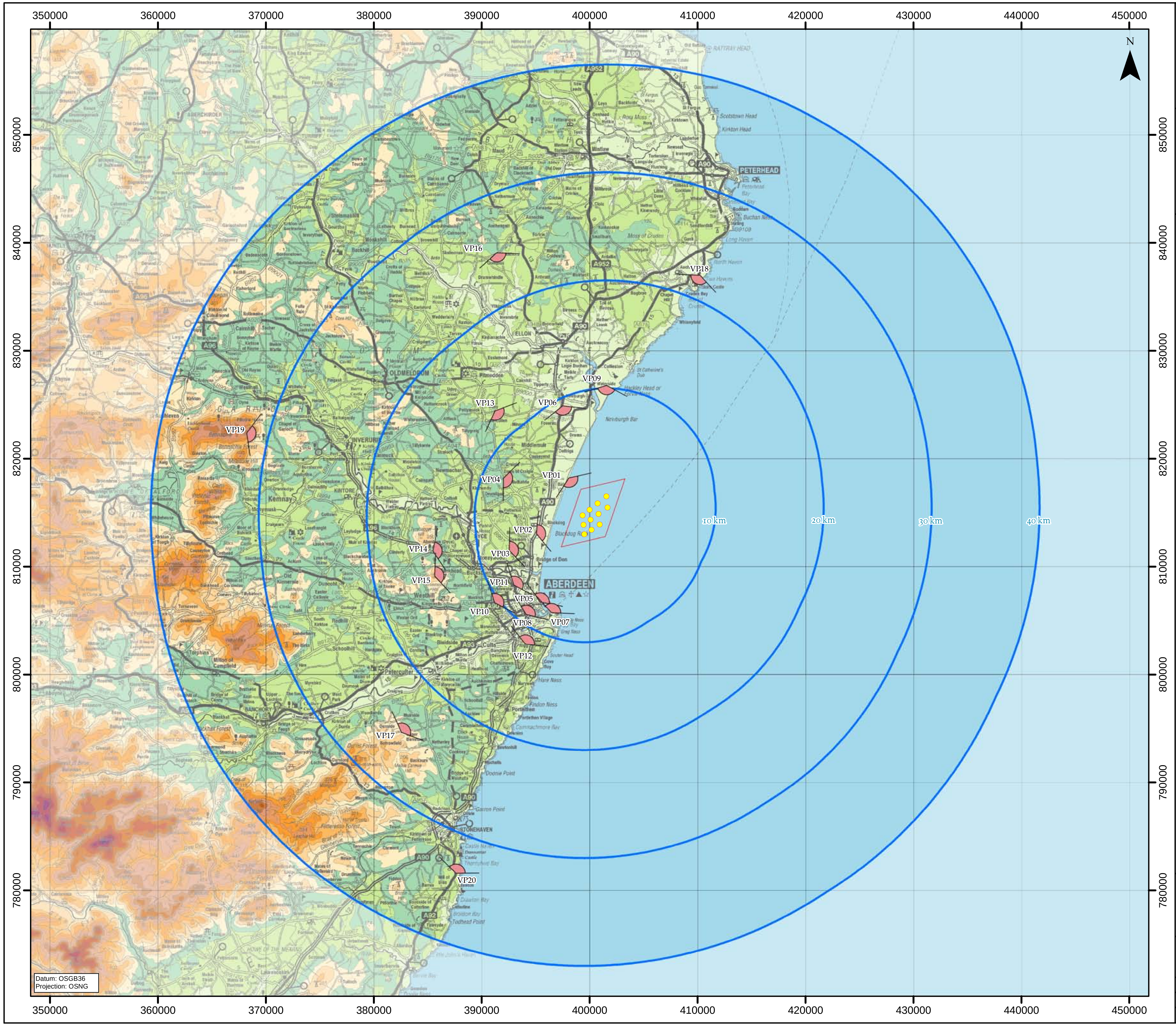
- Coast
- Hills
- Inland Loch
- Valleys
- Open Farmland
- Wooded Farmland
- Urban

Notes
1 Do not scale
2 Source: Scottish Natural Heritage

0 2 km 0 1 nm Original A3 Plot Scale 1:100,000

Drg No	6129-530-PL-005		
Rev	B	Date	22/06/11
By	RL	Layout	LABER039

Figure 19.5



Technip areg VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 19.6

Viewpoint Locations and Landform

Legend

- Lease Boundary
- Wind turbine
- 10 km, 20 km, 30 km & 40 km radius around wind turbine
- Viewpoint locations

Landform

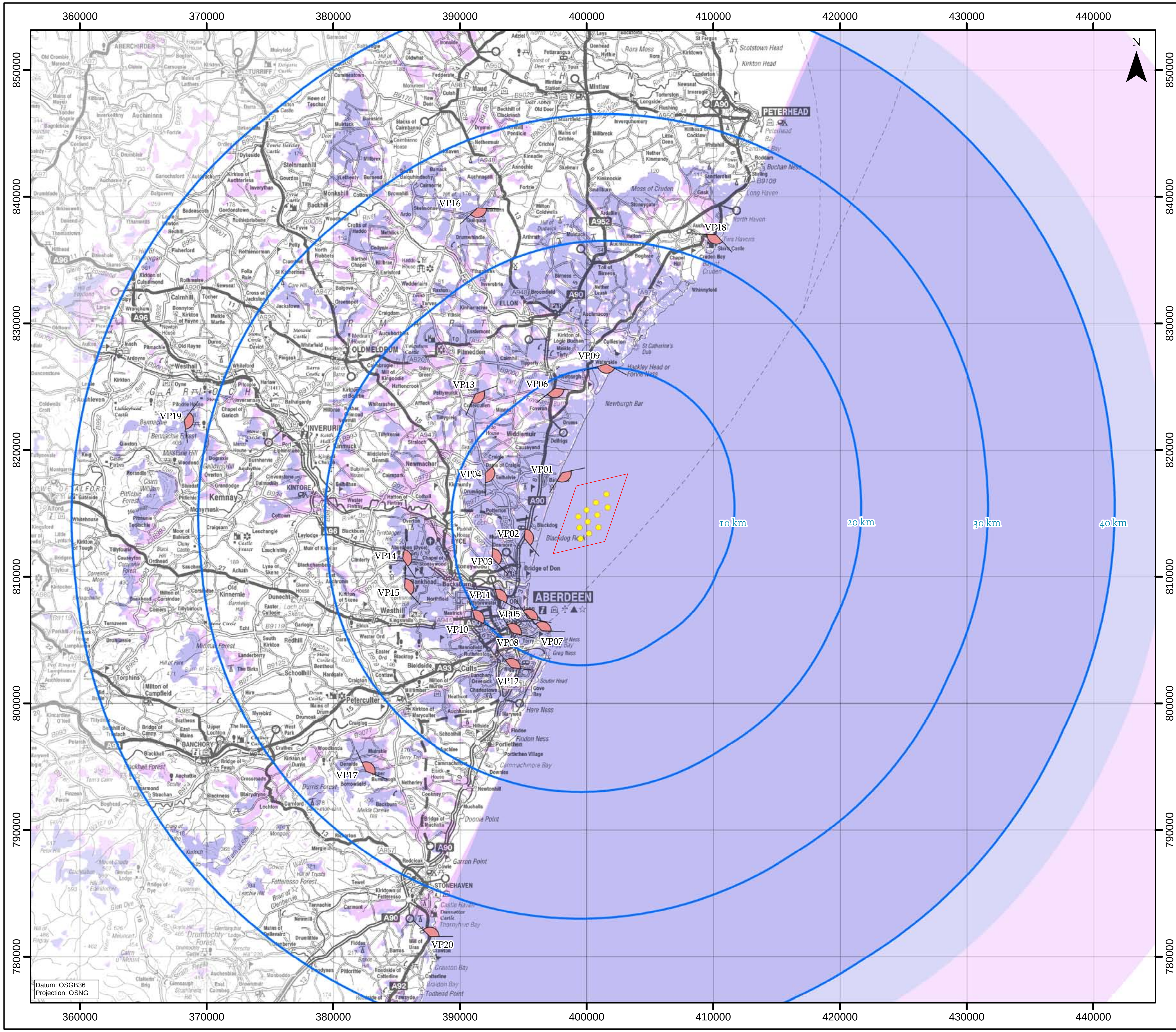
- 750 m - 800 m AOD
- 700 m - 750 m AOD
- 650 m - 700 m AOD
- 600 m - 650 m AOD
- 550 m - 600 m AOD
- 500 m - 550 m AOD
- 450 m - 500 m AOD
- 400 m - 450 m AOD
- 350 m - 400 m AOD
- 300 m - 350 m AOD
- 250 m - 300 m AOD
- 200 m - 250 m AOD
- 150 m - 200 m AOD
- 100 m - 150 m AOD
- 50 m - 100 m AOD
- 0 m - 50 m AOD

Notes
1 Do not scale
2 In Great Britain, AOD for the Ordnance Survey is ODN (Ordnance Datum Newlyn), defined as the Mean Sea Level at Newlyn in Cornwall between 1915 and 1921.

0 2.5 5 km   0 2 nm

Original A3 Plot Scale 1:350,000

Drg No	6129-530-PL-006			Figure 19.6
Rev	B	Date	22/06/11	
By	DL	Layout	LABER039	



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EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 19.7
Zone of Theoretical Visibility (ZTV) Bareground

Legend

- Lease Boundary
- Wind turbine
- 10 km, 20 km, 30 km and 40 km radius bands around wind turbines
- Viewpoint location
- Extent of Aberdeen Hub ZTV (120 m)
- Extent of Aberdeen Blade Tip ZTV (195 m)

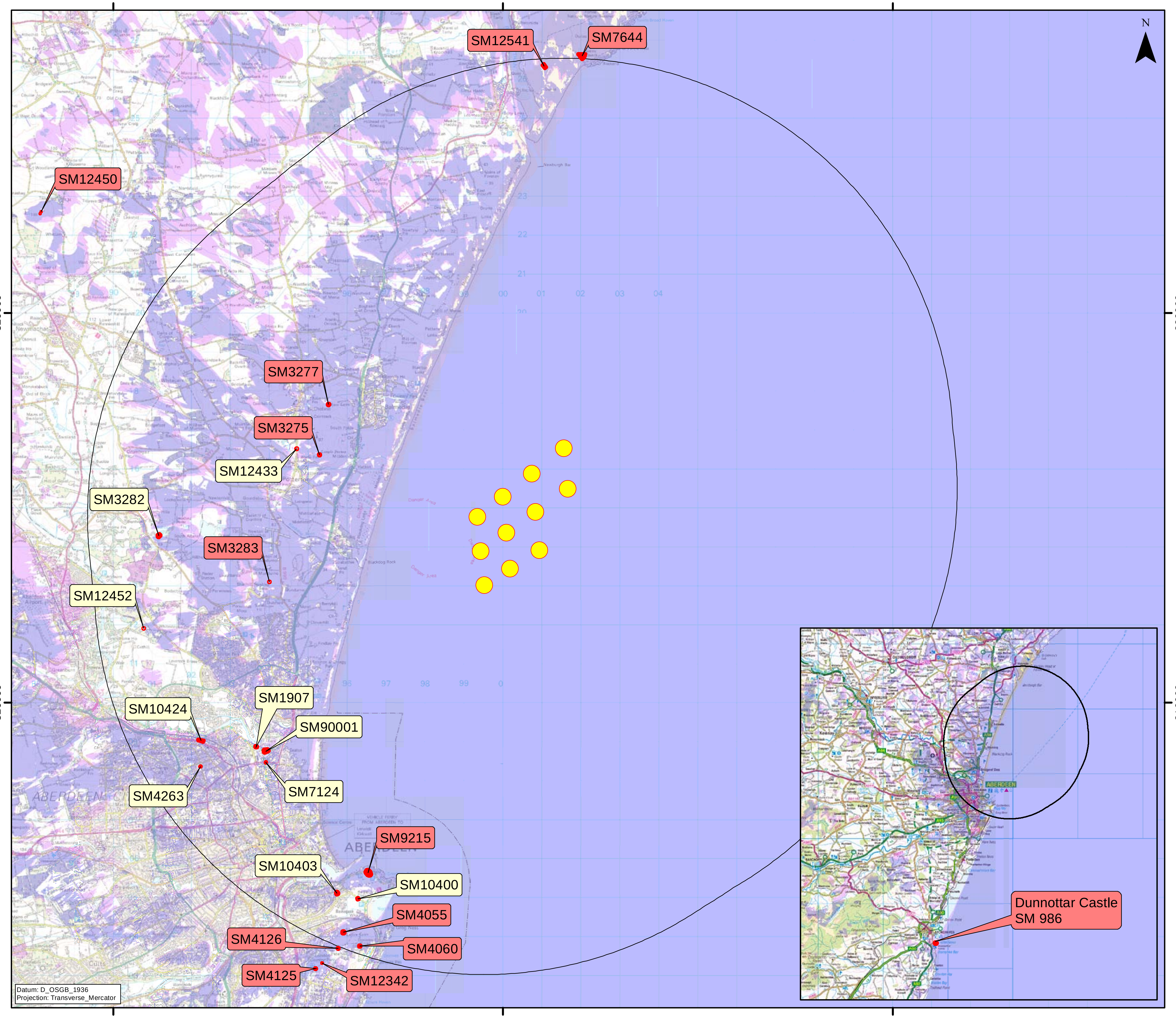
Notes
1 Do not scale

0 2.5 5 km 0 2 nm

Original A3
Plot Scale
1:300,000

Drg No	6129-530-PL-007		
Rev	B	Date	22/06/11
By	DL	Layout	LABER039

Figure 19.7



EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

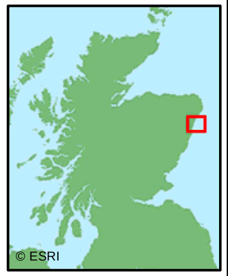
FIGURE 20.1

Scheduled Monuments Considered in Assessment

Legend

- Wind turbine
- SM100 Scheduled Monument (assessed in text)
- SM100 Scheduled Monument
- Hubs of 1-11 turbines visible (ZTV)
- Blade tips of 1-11 turbines visible (ZTV)
- Inner Study Area

Scheduled Monument information derived from Historic Scotland data dated 22.12.10 © Crown Copyright. All rights reserved 2011.

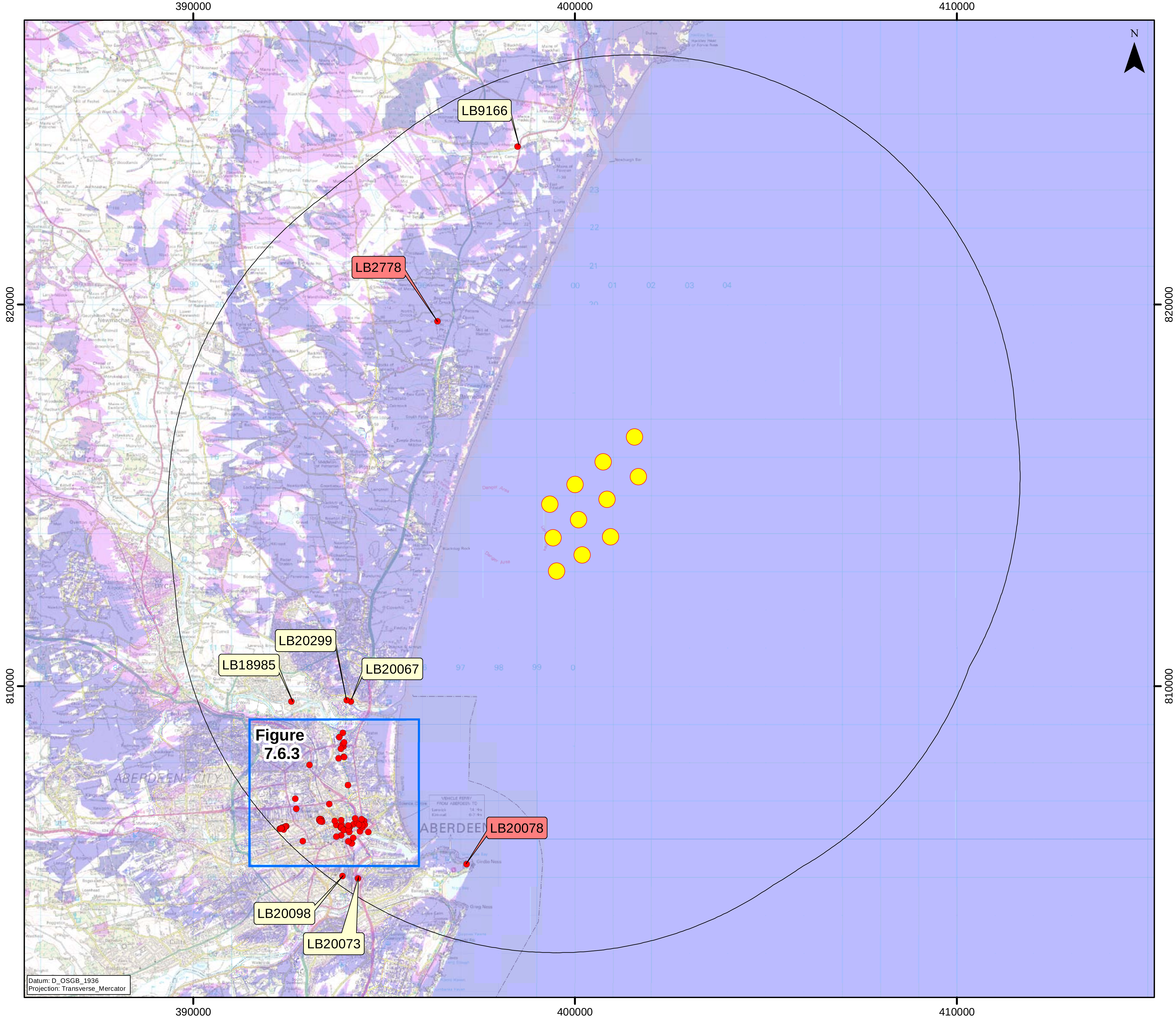


Notes
1 Do not scale

0 0.5 1 km 0 0.5 nm

Original A3 Plot Scale 1:100,000

Drg No	6129-530-PE-761			Figure 20.1
Rev	A	Date	20/05/11	
By	LB	Layout	LABER039	



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EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 20.2

Category A Listed Buildings Considered in Assessment

Legend

- Wind turbine
- LB100 Category A Listed Building (assessed in text)
- LB100 Category A Listed Building
- Hubs of 1-11 turbines visible (ZTV)
- Blade tips of 1-11 turbines visible (ZTV)
- Inner Study Area

Listed Building information derived from Historic Scotland data dated 22.12.10 © Crown Copyright. All rights reserved 2011.

© ESRI

Notes
1 Do not scale

0 0.5 1 km   0 0.5 nm

Original A3 Plot Scale 1:100,000

Drg No	6129-530-PE-762		
Rev	A	Date	20/05/11
By	LB	Layout	LABER039

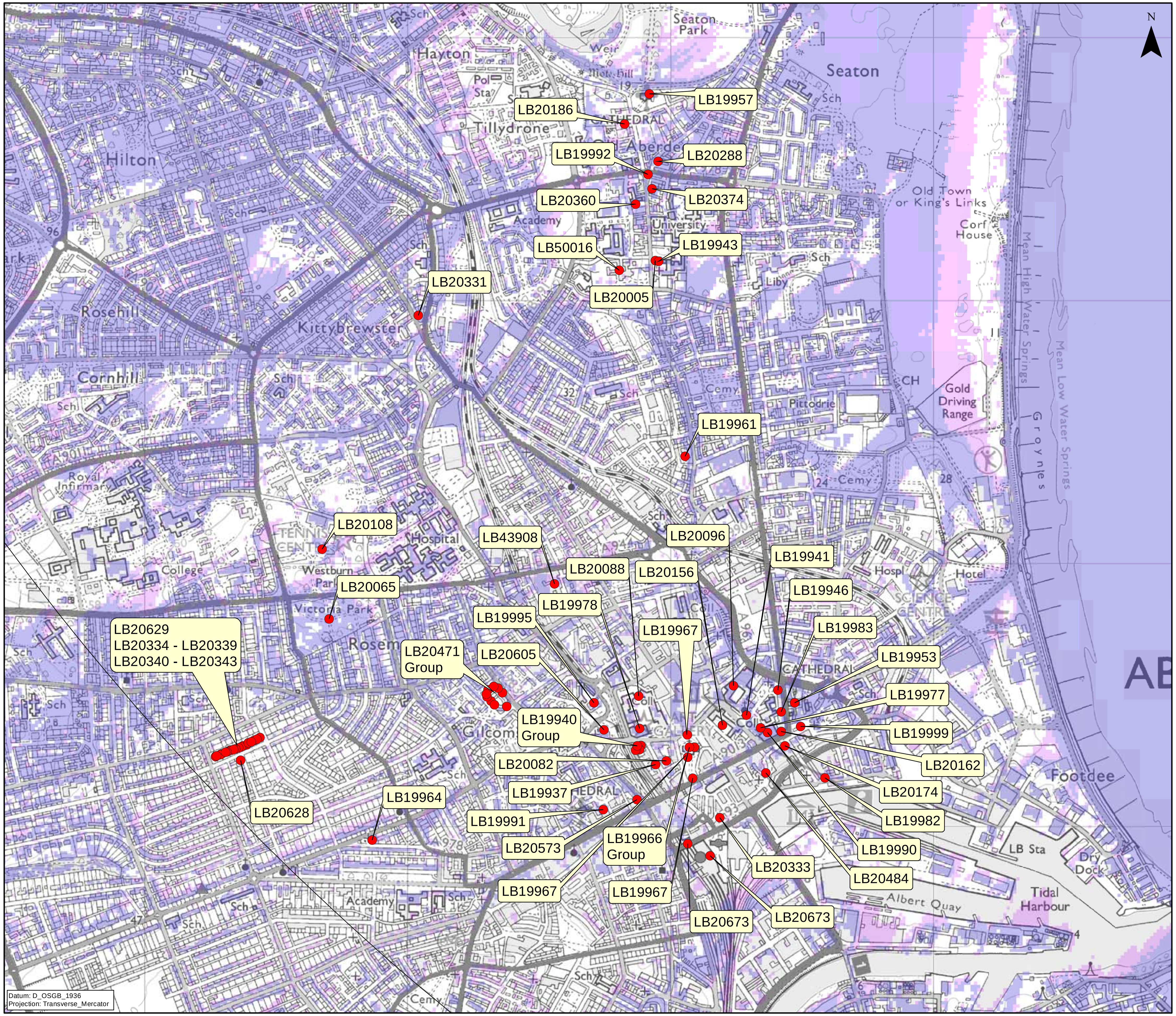
Figure 20.2

Technip areg VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 20.3

Category A Listed Buildings Within Aberdeen City



Legend

- LB100 Category A Listed Building
- Hubs of 1-11 turbines visible (ZTV)
- Blade tips of 1-11 turbines visible (ZTV)
- Inner Study Area

Listed Building information derived from Historic Scotland data dated 22.12.10 © Crown Copyright. All rights reserved 2011.

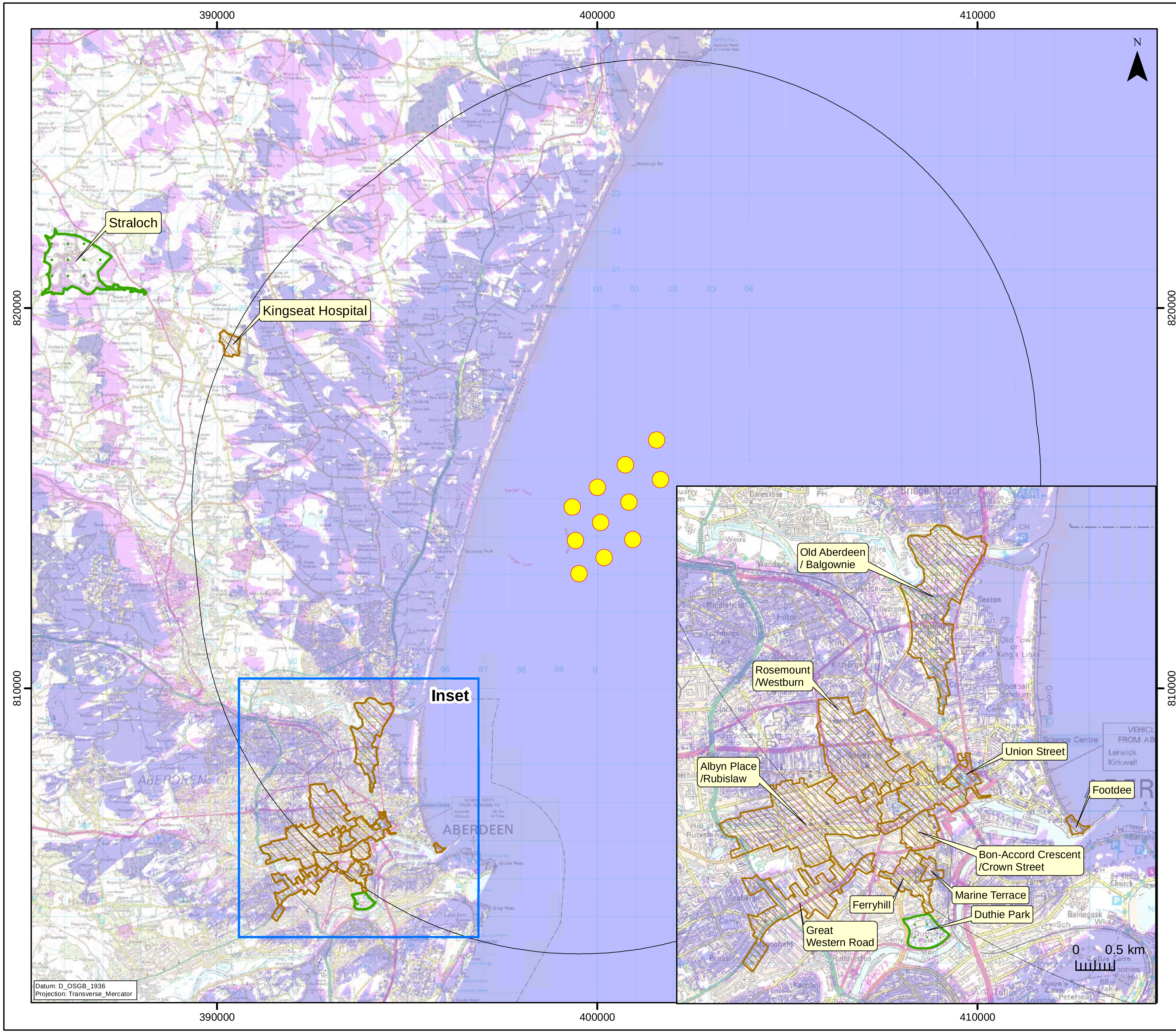
Notes
1 Do not scale

0 0.2 0.4 km

Original A3 Plot Scale 1:15,000

Drg No	6129-530-PE-763		
Rev	A	Date	20/05/11
By	LB	Layout	NA

Figure 20.3



Technip areg VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 20.4

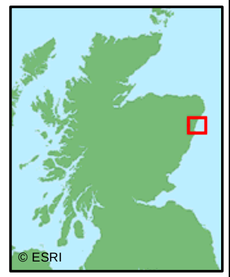
Conservation Areas and Gardens and Designed Landscapes Considered In the Assessment

Legend

- Wind turbine
- Conservation Area
- Gardens and Designed Landscape
- Hubs of 1-11 turbines visible (ZTV)
- Blade tips of 1-11 turbines visible (ZTV)
- Inner Study Area

Designed Landscape area information derived from Historic Scotland data dated 22.12.10 © Crown Copyright. All rights reserved 2011.

Conservation area information derived from Historic Scotland data dated 03.03.11 © Crown Copyright. All rights reserved 2011.



Notes
1 Do not scale

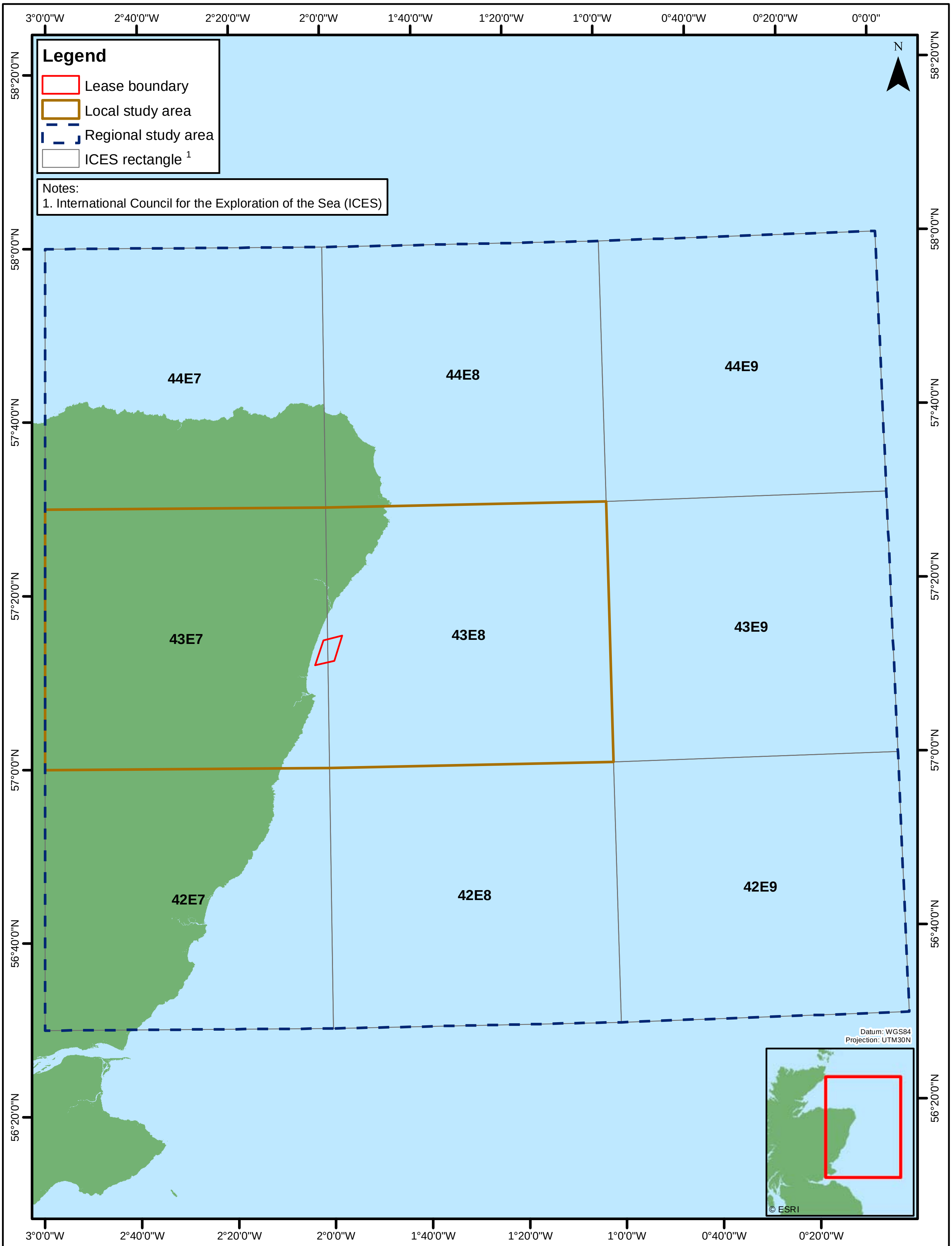
0 0.5 1 km

0 0.5 nm

Original A3 Plot Scale 1:100,000

Drg No	6129-530-PE-764		
Rev	A	Date	20/05/11
By	LB	Layout	LABER039

Figure 20.4



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Technip

0 10 20 30 km

0 5 10 15 nm

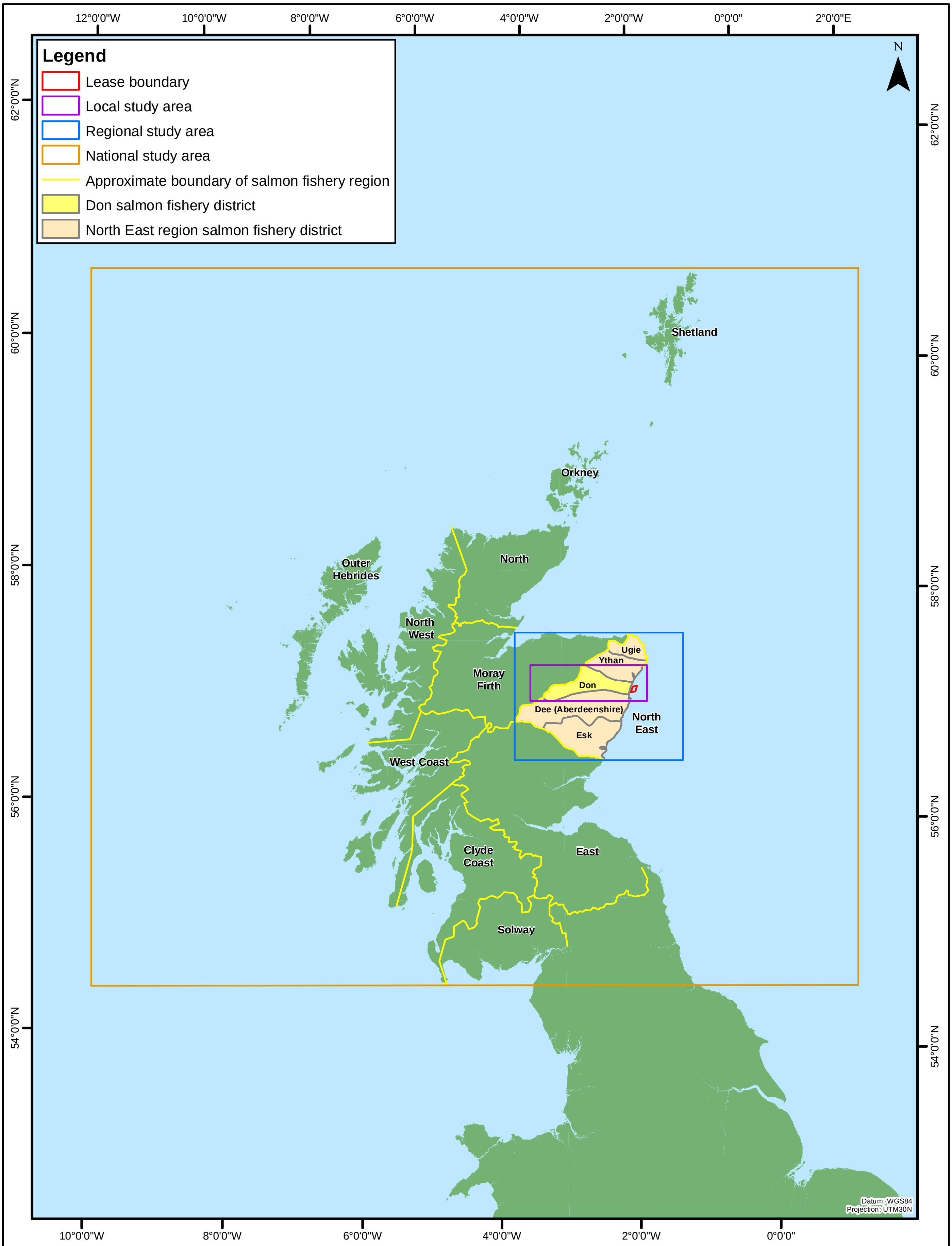
Original A4 Plot Scale 1:1,100,000

European Offshore Wind Deployment Centre

Commercial Fisheries Study Areas

Layout	By	Date	Rev	Dwg No.
NA	LH	22/06/2011	A	6129-530-PA-091

Figure 21.1



VATTENFALL

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Technip

0 25 50 75 100 km

0 20 40 60 nm

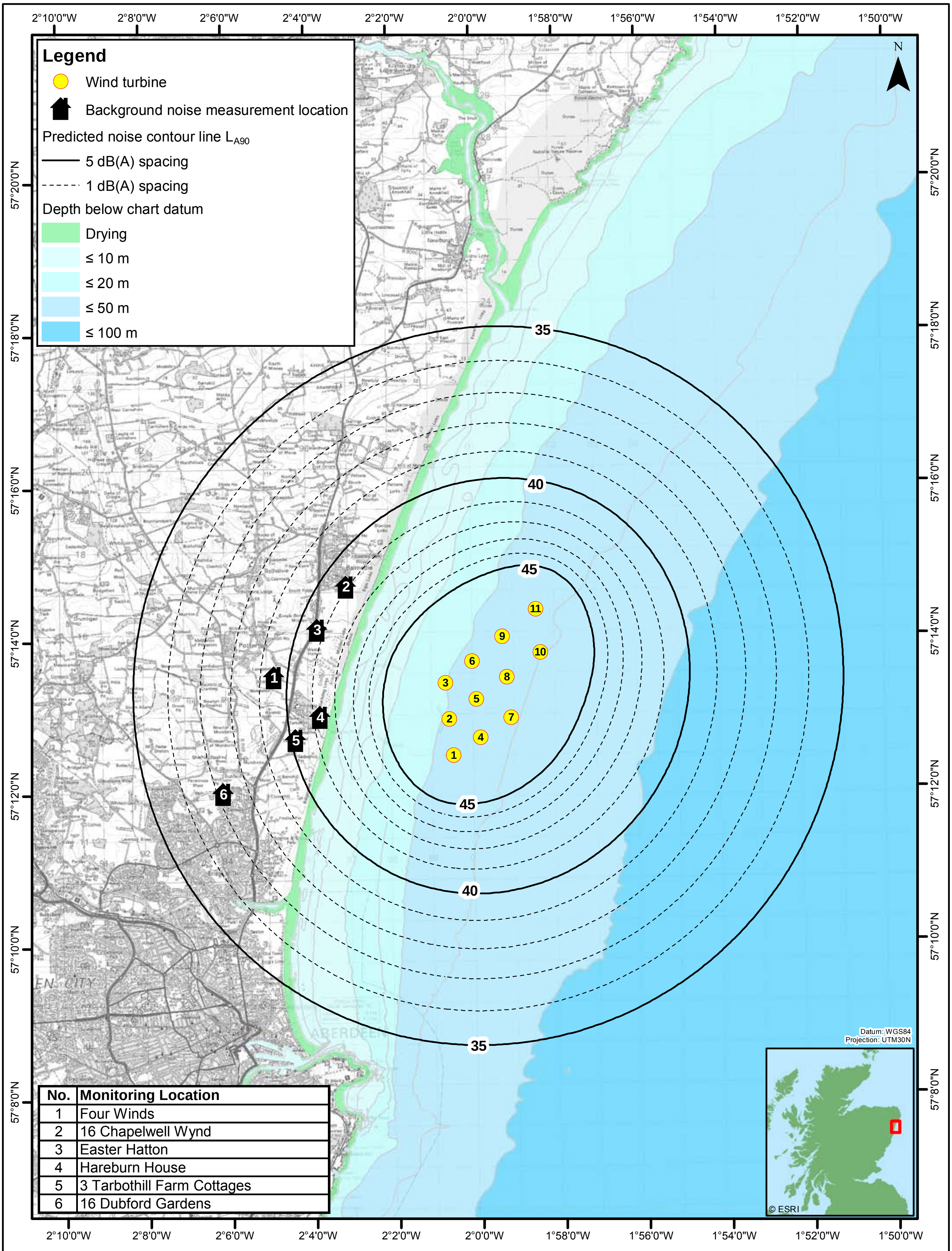
Original A4 Plot Scale 1:5,000,000

European Offshore Wind Deployment Centre

Salmon and Sea Trout Study Areas

Layout	By	Date	Rev	Dwg No.
NA	LH	23/06/2011	A	6129-530-PA-092

Figure 22.1



No.	Monitoring Location
1	Four Winds
2	16 Chapelwell Wynd
3	Easter Hatton
4	Hareburn House
5	3 Tarbothill Farm Cottages
6	16 Dubford Gardens

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Technip

0 1 2 3 km
0 0.5 1 1.5 2 nm

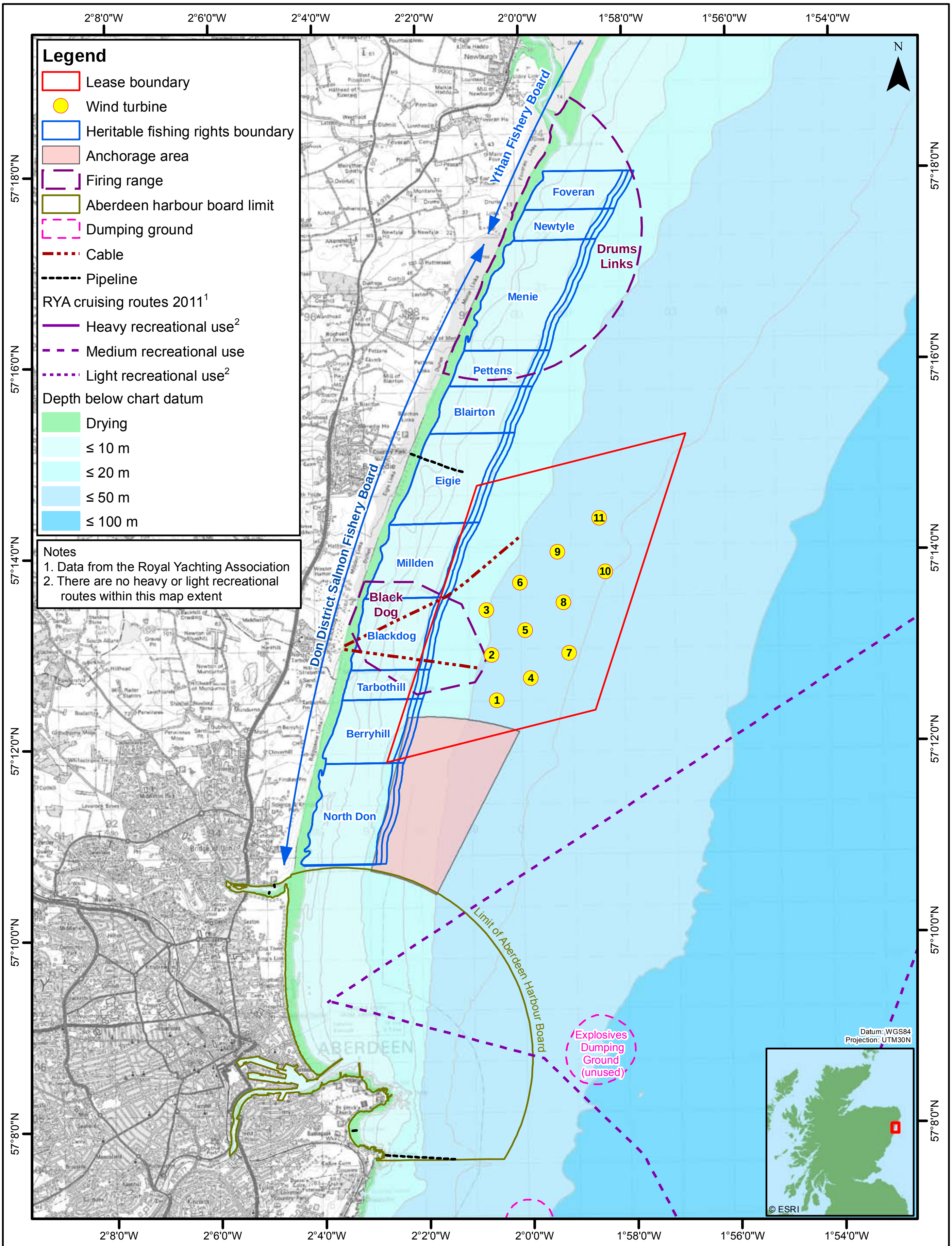
Original A4 Plot Scale 1:125,000

European Offshore Wind Deployment Centre

Background Noise Measurement Locations and Predicted Noise Contour Plot

Layout	By	Date	Rev	Dwg No.
LABER039	LH	22/06/2011	A	6129-530-PA-089

Figure 24.1



VATTENFALL

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Technip

0 0.5 1 1.5 2 2.5 km

0 0.25 0.5 0.75 1 1.25 nm

Original A4 Plot Scale 1:100,000

European Offshore Wind Deployment Centre

Other Marine Users

Layout	By	Date	Rev	Dwg No.
LABER039	LH	23/06/2011	A	6129-530-PA-017

Figure 27.1

www.vattenfall.co.uk/en/aberdeen-bay.htm

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Aberdeen Renewable Energy Group

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

European Offshore Wind Deployment Centre

Environmental Statement

Appendix 1.1: External Consultant Information

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

Company Experience
ABPmer is a specialist consultancy providing high quality scientific advice for interests relating to the marine environment. Major clients include ports, coastal authorities, nature conservation bodies, government departments, marine industries and other engineering and environmental consultancies.

Staff resources are managed and developed in four key areas:
•Coastal Processes;
•Data (including field survey and GIS);
•Modelling; and
•Environment.

In relation to the present study, ABPmer is recognised as a leading authority on coastal process investigations for offshore wind farms, both in terms of advancing generic science and offering project specific services. Our experience and expertise in relation to offshore wind developments includes:

•Oceanographic/metocean survey and survey design;
•Coastal process studies;
•Production of Environmental Impact Assessments and Environmental Statements; and
•Metocean analysis for operation, maintenance and design.

ABPmer is a longstanding member of Renewable UK, REA and is represented at the Offshore Renewable Energy Environmental Forum (OREEF).

Key Staff

Project Director:	Mr Bill Cooper
Project Manager:	Dr. Claire Hinton
Quality Manager:	Dr. David Lambkin
Numerical Modelling Lead:	Mr Nigel West
Data Manager:	Mrs Nicola Dewey

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Offshore Renewables (and related) Experience

Anatec's experience in relation to assessments for offshore renewables includes carrying out the following:

- Site Selection Screening (Rounds 1-3, Scottish Round, Pentland Firth Marine Round and other ad-hoc areas upon request)
- Provision of Shipping Data (merchant, fishing & recreational craft)
- Radar Surveys (covering sites in Scotland, England, Wales and Northern Ireland from onshore and offshore).
- Risk Modelling (meeting MCA and DECC Standards)
- Assessment of Mitigation Measures
- Consultation/Liaison
- Cumulative Assessment
- TWA & CPA application support
- Expert Witness for Robin Rigg Parliamentary Committee & Scarweather Sands Public Enquiry

In the past seven years, Anatec have completed navigational risk assessments for the majority of Round 1 and 2 Offshore Windfarm sites in the UK, including.

- Robin Rigg, Solway Firth (Consented)
- Rhyl Flats, Liverpool Bay (Consented)
- Burbo Bank, Liverpool Bay (Consented)
- Scarweather Sands, South Wales (Consented)
- Cromer, North East Norfolk (Consented)
- Inner Dowsing, Lincolnshire (Consented)
- Lynn, Lincolnshire (Consented)
- Walney Offshore Wind Farm (Consented)
- London Array (Consented)
- Ormonde (Consented)
- Greater Gabbard (Consented)
- West of Duddon Sands(Consented)
- Cirrus Shell Flat Array (Withdrawn)
- Lincs (Consented)
- Sheringham Shoal(Consented)
- Docking Shoal (In Progress)
- Race Bank (In Progress)
- Humber Gateway (Consented)
- Westermost Rough (In Progress)

We also performed the navigation risk assessments for the SW Wave Hub project off St Ives, the Wave Dragon project off Milford Haven and EMEC Fall of Warness Tidal Site in Orkney. Other wet renewables projects Anatec has been involved in include site assessment reviews for Trident Energy and Lunar Energy.

Named Consultants
Michael Cain M.Sc, PgD, B.Sc,
John Beattie M.Sc, B.Eng,
Robert Jones B.Sc.

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Aberdeen
AB10 1BA
01224 633711

www.anatec.com

Brown & May Marine Ltd

Summary of Experience

Brown and May Marine Ltd has been undertaking studies and services relating to various interfaces that occur between commercial fishing and, offshore renewable energy, offshore oil and gas developments and cable installations since 1982. Given below are examples of the work undertaken.

Commercial Fisheries Components of EIA's

The commercial fisheries components for the EIA's and ES's have been completed for the following offshore wind farm developments in the UKCS:

- Scarweather Sands - Green Energy, Swansea Bay 2004 – 2005
- Walney 1&2 - Dong Energy, Eastern Irish Sea, 2005 – 2008
- West of Duddon Sands - Scottish Power, Eastern Irish Sea 2005 – 2006
- Shell Flats 2 - Scottish Power, Eastern Irish Sea 2006 – 2007
- Lincs - Centrica, Wash 2006 – 2007
- Docking Shoal - Centrica, Wash 2007 – 2008
- Race Bank - Centrica, Wash 2007 – 2008
- Dudgeon - Warwick Energy, North Sea 2007 – 2008
- Gunfleet Sands 2 - Dong Energy, Thames Estuary 2007 – 2008
- Aberdeen Offshore Wind- Amec, Aberdeen Bay 2007 – 2008
- Westermost Rough - Dong Energy, North Sea 2008 – 2009

We are currently engaged in commercial fisheries works for ten Round 2 and 2.5 wind farms and six Round 3 wind farms.

Fisheries Liaison

Fisheries liaison work, public meeting attendance, and compensation assessment and advice provided for:

- Dong Energy
- Warwick Energy
- Centrica
- Scottish Power
- Vattenfall
- SSE Renewables
- EON
- Seagreen
- Sea Energy
- EDP Renovaveis

Experience in Scottish Waters

Brown and May Marine Ltd (BMM) have more than thirty years experience undertaking commercial fisheries assessments in Scottish waters.

In 1980 BMM staff undertook a Commercial Fishing Interaction Study for Shell Expro's Flags pipeline in the Northern North Sea, the first study specific to commercial fishing activities to be undertaken in the UK. This work contributed to the pipeline being awarded the first trenching dispensation in the UK Continental Shelf.

Over the past thirty years in excess of a hundred commercial fishing studies have been carried out in Scottish Waters for the offshore oil and gas and subsea cables industries.

BMM has established a strong working relationship with the Scottish Fishermen's Federation (SFF) for over twenty five years, working together on a range of projects not only in Scottish waters, but using their fishing experience to aid projects further afield.

BMM additionally has good working relationships with Marine Scotland, having worked closely with both the Science department (formerly Fisheries Research Services) and the formerly named Scottish Fisheries Protection Agency (SFPA), as well as with various district fisheries officers.

BMM has experience of the Scottish Atlantic salmon fisheries, and have liaised in the past with both commercial and recreational stakeholders and statutory consultees.

Examples of recent work undertaken in Scottish waters during the past 18 months are listed below:

- BP West of Shetland – Commercial Fishing Study and Interaction Frequency
- Conoco – Philips – Commercial Fishing Interaction Study for Jasmine pipeline
- Aberdeen Offshore Windfarm - Commercial Fishing Assessment and Impact Assessment
- Aberdeen Offshore Windfarm – Salmon and Sea trout Baseline Assessment
- Enagas: Experience sharing with the SFF. A series of visits organised by BMM subsequent to a Commercial Fishing Study undertaken in the Mediterranean to facilitate sharing the SFF experience of fishing in waters shared with the offshore oil and gas industry.
- Airtricity: FLO to the proposed Beatrice offshore wind farm development. FLO to the proposed Islay and Kintyre offshore wind farm developments. Contracted to undertake the commercial fishing aspect of the EIA (Ongoing).
- Scottish Power: FLO and EIA advice for Islay tidal energy project

The works we are currently undertaking are listed below:

- Beatrice Offshore Wind Farm- Commercial Fisheries EIA, Salmon & Trout EIA, and overall Fisheries Liaison Officer
- Moray Offshore Wind Farm- Commercial Fisheries EIA, Salmon & Trout EIA, Natural Fisheries EIA, and overall Fisheries Liaison Officer
- Aberdeen Offshore Wind Farm- Commercial Fisheries EIA, Salmon & Trout EIA, and overall Fisheries Liaison Officer
- Firth of Forth Offshore Wind Farm- Commercial Fisheries EIA and overall Fisheries Liaison Officer
- Inch Cape Offshore Wind Farm- Overall Fisheries Liaison Officer
- Neart Na Gaoithe Offshore Wind Farm- Commercial Fisheries EIA, Salmon & Trout EIA, and overall Fisheries Liaison Officer

- Islay & Kintyre Offshore Wind Farm- Commercial Fisheries EIA and overall Fisheries Liaison Officer

Named Consultants
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Summary of Experience
Policy and economics of energy, sustainability and climate change working for Research Councils, Governments, local authorities and corporates

Key Staff Involved
Donald Webb, Head of Energy & Sustainability, BSc Hons, MBA, Member of the Institute of Consulting
Richard Howard, BSc Hons, MSc

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Genesis Oil & Gas Consultants Ltd. was formed in 1988 and now employs over 700 engineers and scientists spread across main offices in Aberdeen, London, Paris, Perth (Australia); with smaller offices in Norway, Abu Dhabi and Brazil. We specialise in the energy industry with major projects world-wide. Our key skills are in offshore engineering, safety and the environment addressing all project phases from planning and concept design to operational support both for traditional oil & gas and the renewable energy sectors.

One of the challenges for offshore wind power is the difficulties in designing, installing, operating and maintaining rotating equipment in remote locations in the harsh North Sea environment. This challenge is dealt with on a daily basis by engineers in the oil and gas industry and the expertise possessed by Genesis is directly transferable into the renewable energy market. Our work on permitting (safety & environment) and foundation selection and design are areas where we have brought significant experience to the renewable market.

The key skills provided by Genesis are:

- Consents management and Environment Impact Assessment, onshore and offshore;
- Concept design;
- Foundation selection and design;
- Environmental studies including bird impact studies, underwater noise modelling, habitat assessments and marine mammal studies;
- Project execution and management services;
- Safety assessments;
- Rotating equipment design and support;
- Power system and network studies;
- Reliability and availability prediction for machinery and power output;
- Instrumentation and SCADA design; and
- Operational support

Examples of our client work has included environmental, safety and engineering support to the European Offshore Wind Deployment Centre where we have been responsible for engineering and environmental support to the project, safety support to the Beatrice wind farm and concept design for the Havsul offshore wind farm.

Major projects include:

- Environmental and engineering support to EOWDC with input to major sections of the Environmental Statement and the production of specialist studies on habitats, other users of the sea, marine mammals and noise. Genesis has also been involved in providing planning and engineering support including, structural and electrical studies.
- Engineering support to the Havsul offshore wind farm in Norwegian waters providing key advice on the selection and design of the foundations.
- Genesis provided technical safety support to the Beatrice Demonstrator project where our role included facilitating and participating in hazard identification sessions and writing the draft safety case for operation of the project as an appendix to the existing Beatrice Safety Case.
- Genesis provided advice to SeaEnergy Renewables on suitable HSE management system structure and the development of HSE plans.

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HarmonicQuay is the trading name for Dr Genevra Harker, and provides project management, environmental and oceanographic expertise to the energy sector, with the main focus on renewable energy projects. Building on initial experience in the offshore oil and gas industry Dr Harker has worked on numerous UK offshore wind farms including Neart na Gaoithe, Hornsea Zone, Dogger Bank Zone, Race Bank, Docking Shoal, Lincs, Lynn, Inner Dowsing, Gunfleet Sands, Scarweather and Shell Flats. She has also worked on desk studies for wind farms in France and the US.
For the EOWDC, her main role was technical reviewer.

Summary of Expertise

Hayes McKenzie Partnership Ltd (formerly Hayes McKenzie Partnership) have been specialising in the measurement, assessment and control of noise from wind farm sites for 20 years. During that time this has included work on over 600 proposed, consented or completed wind farm sites in the UK, Continental Europe, USA, Canada, Australia, New Zealand and Asia; source noise measurements on around 30 turbine types, measurements of residential noise levels at around 30 existing wind farms and provision of expert witness evidence for over 70 UK public inquiries. Our clients have included most of the major UK wind farm developers and have included many successful applications, including those gained at Public Inquiry.

All consulting staff are members or associate members of the Institute of Acoustics and Dr McKenzie sits on the joint Institute of Acoustics / Institute of Environmental Assessment Working Group on Environmental Noise Impact Assessment and BERR Working Group 3, Small and Micro Wind Turbines. They were invited contributors to the Australian Standard Acoustics – Measurement, prediction and assessment of noise and wind turbine generators. The company currently has 9 full time consultants and 3 administrative staff and sources all measurement equipment from its own stocks. It is a member of the Association of Noise Consultants.

Key Staff Involved

Dipl.-Ing. Sylvia Broneske MIOA

After graduating from the University of Applied Sciences, Hamburg, Germany with a degree in Environmental Engineering, Sylvia Broneske worked as an Engineer and Consultant in the Site Assessment department of the wind turbine manufacturer Enercon GmbH, Germany.

Her scope of duties included noise and shadow impact assessment for wind farm developments; supervising noise measurements of Enercon wind turbines; advising co-workers, authorities, clients/developers and wind farm neighbours on wind turbine noise-related issues; solving complaints about wind farm noise and optimisation of noise-critical Enercon wind farm sites; calculating periods of shadow flicker and programming the ENERCON shadow shutdown system to prevent shadow flicker at surrounding properties.

In 2007 she joined Hayes McKenzie Partnership Ltd. in Salisbury and is now an acoustic consultant responsible for the preparation of Environmental Impact Assessments for wind farm developments; other noise assessment work for planning

purposes; planning condition compliance tests and source noise measurements of wind turbines, recently in particular of several small wind turbines.
She has given lectures on noise from wind turbines on several occasions, including the 2007 UK Institute of Acoustics one-day meeting on Windfarm Noise and the Wind Turbine Noise Conference in Aalborg/Denmark in 2009. She has recently been invited to speak at a two day conference on wind farm noise in the UK at the KCE Akademie in Germany.

She is currently undertaking an MSc course in Sound and Vibration at the Institute of Sound and Vibration Research (ISVR) at the University of Southampton, continuing to work part-time at Hayes McKenzie Partnership. She is a member of the Institute of Acoustics and of the Verein Deutscher Ingenieure, the German equivalent of the Institute of Mechanical Engineers.

Robin Woodward BSc AMIO

Robin graduated from the ISVR/University of Southampton with a BSc in Acoustics and Music. He joined HMPL in 2010 and is currently carrying out the deployment of measurement equipment for environmental noise surveys in connection with wind farm developments in England and Scotland, the analysis of data and noise predictions and assists with the preparation of Environmental Impact Assessments.

Malcolm D Hayes BSc MIOA – Director of Hayes McKenzie Partnership Ltd

Member of DTI Working Group on Noise from Wind Turbines and of Eskdalemuir Seismic Array Working Group; Member of the Organising Committee for International Conference on wind turbine noise Berlin (2005), Lyon (2007), Aalborg (2009) and Rome (2011)

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HEADLAND
ARCHAEOLOGY Ltd

Headland Archaeology (UK) Ltd

Headland Archaeology (UK) was founded in 1996 and has since grown to become the largest archaeological company in Scotland, with offices in Edinburgh, Glasgow, Hereford and Leighton Buzzard, whilst the Irish arm has offices in Cork, Galway and Dublin. Headland offers a wide range of services and specialises in major projects such as the M74 Completion Project, Glasgow, A1 and A4 road schemes, Northern Ireland, Clyde Wind Farm, South Lanarkshire, and Upper Forth Crossing, Clackmannanshire.

Headland is a Registered Organisation of the IfA and abides by its Code of Conduct. The company is Achilles Category B2 accredited.

Headland has considerable experience of conducting EIAs throughout the UK, and has particularly extensive experience in relation to wind farms

Key Staff Involved
Richard Conolly MA(Hons) MIfA
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Company experience - projects, other companies work for etc:

UNIVERSITY OF Hull
Institute of Estuarine & Coastal Studies

Institute of Estuarine & Coastal Studies (IECS) at the University of Hull

Summary of Experience

The Institute of Estuarine and Coastal Studies (IECS) has been undertaking research and consultancy work in the estuarine and marine environment since 1982 and has both extensive survey and analysis facilities, together with a range of expertise within our professional staff and Associates. IECS is a multi-disciplinary research and consultancy organisation set up to utilise the facilities and expertise in coastal margin science and management within the University of Hull. IECS covers a wide range of specialisms within the coastal environment ranging from the biological and physical environments (topography, vegetation, ornithology, benthic and pelagic fauna) to coastal planning, environmental quality, marine law and environmental impact assessment.

Key Staff

Anita Franco, Nick Cutts, Katya Solyanko, Krysia Mazik, Shona Thomson, Professor Mike Elliott

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LDA DESIGN

Introducing LDA Design

Founded in 1979, LDA Design is a renowned independent design and environment business driven by a commitment to shape the world for the better. We provide tailormade solutions to every project. We help our clients regenerate communities, create special places, manage resources and realise their development and commercial goals.
LDA Design attracts people who are leaders in the planning, design, delivery and management of all types of change in the physical environment. We work on projects of all scales across the UK and internationally. Our talented and experienced team approaches each commission as a fresh, creative and practical challenge.
The special abilities of the practice include taking complex projects through an increasingly demanding planning system from concept to delivery. This collaborative and ideas-led approach to problem-solving, combined with the technical abilities we have cultivated over many years, uniquely positions us to meet the challenges arising from climate change and the need for development. Our strength lies in the way that we bring together the diverse skills and experience of our team in a working culture that combines creativity with pragmatism and commercial awareness.

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LDA Design brings together all the services necessary for the creative and technical leadership of complex development, regeneration and environmental projects. These skills can be brought into a multidisciplinary team as a specialist expertise if necessary.

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- Regeneration
- Landscape Architecture
- Ecology
- Architecture
- Development Planning
- Strategic Land Promotion
- Green Infrastructure
- Rural Consultancy
- Environmental Impact Assessment
- Historic Environments
- Environmental Planning
- Renewable Energy
- Community Asset Management

Support Services
To support our work and goals we have further complementary professional skills in-house, including:

- Expert Witness / Public Inquiry
- Event and Exhibition Organisation
- Graphic Design and Animation
- Public Consultation
- Public Relations
- Media Liaison

Our clients include developers, land-owners, regeneration agencies, government departments, local authorities, renewable energy firms and educational establishments.

For a full client list and further information about us visit our website www.lda-design.co.uk

Named Consultants

William Wheeler

POSITION IN PRACTICE:	Director
QUALIFICATIONS:	MPhilLD Landscape Architecture, 1986 MA (Hons) Geography, 1981
PROFESSIONAL STATUS:	Chartered Member of the Landscape Institute, 1989

Joanna Patton

POSITION IN PRACTICE:	Senior Consultant
QUALIFICATIONS:	MA (Hons) Landscape Architecture, 2003
PROFESSIONAL STATUS:	Chartered Member of the Landscape Institute, 2006

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Wessex Archaeology

Company Experience
Wessex Archaeology is a market leader working in the archaeological and broader heritage world: above ground, below ground and underwater. Established 25 years ago, and today employing a professional staff of over 200, Wessex offers an unrivalled range of archaeological services.

Wessex Archaeology has been involved in over 200 coastal and marine schemes, both development-led and strategic, including numerous schemes relating to the offshore renewables industry and has undertaken both offshore and onshore work, including programmes specifically designed to assess archaeology / cultural heritage and impact on setting.

Wessex Archaeology has a strong track record in providing the full range of archaeological services required to support development schemes in respect of renewable energy projects. Wessex Archaeology's Coastal and Marine service expertise encompasses desk-based cultural heritage assessments for EIAs, REAs, strategic assessments and industry guidance, and further work in support of these studies in the form of geophysical survey and geo-archaeological investigations.

Wessex Archaeology's experience in the area of renewables encompasses over 20 offshore wind farms, a wave power generator, a tidal power generator and Historic Environment guidance for the whole offshore renewables sector.

Key Staff Involved
Project Manager – Jonathan Benjamin
Archaeologist – Andrew Bickett
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European Offshore Wind Deployment Centre
Environmental Statement

Appendix 1.2: Household Calculations

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

Household Calculations

If consented and built it is expected that the EOWDC at 100 MW would generate up to 306,600 megawatt hours (MWh) of green electricity every year, which is equivalent to the total annual electricity needs of around 68,468 UK households*.

*This is calculated in the following way:

Number of hours in the year: 8760
Installed capacity: 100 MW
Assumed capacity factor for offshore wind: 35%
Average annual UK household electricity consumption: 4,478 kilowatt hours (kWh)

For example: (8760 x 100 x 0.35) x 1000 = 306,600,000 kWh divided by 4,478 = 68,468 homes.

Share of households that would have been provided with electricity from the EWODC in 2008: 68,468/102,900[1]= 66.5 %

Estimated share of households provided with electricity from the EOWDC in 2013: 68,468/108,150 = 63.3 %

[1] This assumes number of households in Aberdeen was 102,900 in 2008. This is based on the "Household Projections for Scotland 2008-based" from the General Register Office for Scotland (2010).

European Offshore Wind Deployment Centre
Environmental Statement

Appendix 1.3: Statutory and Regulatory Framework and Policies

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

STATUTORY AND REGULATORY FRAMEWORK

The construction and operation of the EOWDC will require a consent under Section 36 of the Electricity Act 1989 (as amended). The Electricity Act 1989 (Requirement of Consent for Offshore Generating Stations) (Scotland) Order 2002 requires Section 36 consent for the installation of any generating station with a permitted capacity of 1MW or above. Section 36A enables the Scottish Ministers when granting consent also to make declarations extinguishing rights of navigation.

Section 57(2) of the Town and Country Planning (Scotland) Act 1997 provides that the Scottish Ministers can direct that planning permission for development of the section 36 application or ancillary development can be deemed to be granted. The requirement for planning permission may apply to only a small portion of the export cable.

In formulating an application for a Section 36 consent the applicant is obliged to have regard to the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and in protecting sites, buildings and objects or architectural, historic or archaeological interest. Furthermore the applicant is obliged to do what he reasonably can to mitigate any effects which the proposal would have on such matters. In considering any proposals the Scottish Ministers are obliged to have regard to the desirability of preserving the list of assets and also the extent to which the applicant has complied with their duty reasonably to mitigate any effects. The applicant is also obliged to avoid so far as possible causing injury to fisheries or to the stock of fish in any waters.

In addition to a Section 36 Consent the EOWDC will also require a marine licence in terms of the Marine (Scotland) Act 2010. This Act imposes a number of duties upon the Scottish Ministers in respect of the grant of any marine licence. It includes an obligation under Section 3 to act in a way which is best calculated to further the achievement of sustainable development, including the protection or where appropriate the enhancement of the health of that area. Furthermore in terms of Section 4 the Scottish Ministers are obliged to act in a way best calculated to mitigate, and adapt to, climate change so far as consistent with the purpose of the function concerned. In terms of Section 15 all public authorities are obliged to take authorisation decisions in accordance with appropriate marine plans unless relevant considerations indicate otherwise. Furthermore, in the determination of a marine licence application, Section 27 implies certain statutory requirements on the determination process. The Scottish Ministers must have regard to the need to protect the environment, human health and prevent interference with legitimate uses of the sea and such other matters as the Scottish Ministers consider relevant. These are all matters which have been considered and assessed within the Environmental Statement. The construction of EOWDC will constitute the construction of works within the Scottish marine area both in and over the sea and on and under the seabed. The Scottish Ministers must have regard to the effects of any use intended to be made of the works after they have been constructed.

Decommissioning

The decommissioning of the EOWDC has been considered and assessed within the Environmental Statement. The Energy Act 2004 only applies to decommissioning the EOWDC beyond the mean low water mark. The marine licensing regime will therefore deal with the intertidal decommissioning issues.

ENERGY POLICY

European Policy

Renewable Energy Directive (Directive 2009/28/EC)

The Renewable Energy Directive (Directive 2009/28/EC) is the primary guidance in respect of European Union renewable energy policy. The Directive: (1) establishes a common framework for the promotion of renewable energy throughout the European Union; and (2) sets legally binding targets on member states for the use of renewable energy, in particular requiring 20% of the overall energy consumption in the European Union to come from renewable sources by 2020 (Article 3 and Annex I). Unsurprisingly, wind power is explicitly stated to be a renewable energy source (Article 2(a)).

The Directive's policy of setting legally binding targets means that the UK must achieve 15% of its energy needs by renewable sources by 2020, from a base level in 2005 of 1.3% (Annex I). This is an ambitious target which will require a broad spectrum of renewable technologies, including a significant contribution from offshore wind power. Indeed, a European Union communication[1] takes the view that, "while land-based wind energy will remain dominant in the immediate future, installations at sea will become increasingly important."

UK Government Policy

Climate Change Act 2008

The Climate Change Act 2008 is legislation which legally binds the UK Government to ensure that net emissions of greenhouse gases in the UK are reduced by at least 80% by 2050 (from 1990 emission levels). By 2020, the 2008 Act requires a reduction of at least 34% from 1990 emission levels.

National Renewable Energy Action Plan for the UK

In response to Article 4 of the Renewable Energy Directive, the UK Government produced the *National Renewable Energy Action Plan for the UK* ("Renewable Energy Action Plan"). The Renewable Energy Action Plan seeks to outline the UK Government's strategy to meet its legally binding target of 15% of total energy needs being met by renewables by 2020. At page 7, the Renewable Energy Action Plan states:

> "Offshore wind is a key area for development. We will work to develop an offshore electricity grid to support our continuing commitment to being world leaders in this technology. This new generation of offshore wind power will play a key role in meeting our 2020 target."

Further, at page 87, the Renewable Energy Action Plan states:

> "The scale of the offshore wind potential around the UK strengthens the economic, policy and security of supply arguments for working to maximise this offshore renewable potential…"

A Prevailing Wind: Advancing UK Offshore Wind Deployment

In June 2009, the UK Government published *A Prevailing Wind: Advancing UK Offshore Wind Deployment* ("A Prevailing Wind"). This policy document outlines the UK Government's policies in respect of offshore wind. The UK government expects an offshore contribution of some 25GW by 2020. A Prevailing Wind notes, however, that "there is a need for new renewable energy infrastructure to meet the [UK] Government's climate change mitigation and energy objectives. That need is sufficiently great and urgent that it should be given substantial weight in determining an application which contributes to meeting the [UK] Government's climate change mitigation and energy objectives."[2]

Further, A Prevailing Wind pragmatically adopts the policy that "[t]here will by their nature be significant impacts from offshore wind farms wherever they are located, but these may be positive impacts and, where they are adverse they may be acceptable when weighed against the national need for new energy infrastructure."[3]

Scottish Government Policy

Notwithstanding that energy policy is a matter reserved to the UK Government, the Scottish Government has brought forward ambitious legislation (Climate Change (Scotland) Act 2009) and policies to advance renewable energy in Scotland, working closely with the UK Government to do so.

Climate Change (Scotland) Act 2009

The Climate Change (Scotland) Act 2009 is legislation which legally binds the Scottish Ministers to ensure that net emissions of Scottish greenhouse gases are reduced by at least

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[1] Offshore Wind Energy: Action needed to deliver on the Energy Policy Objectives for 2020 and beyond, published 13 November 2008, COM (2008) 768 final

[2] *A Prevailing* Wind, ch 2.5

[3] *supra*, ch 2.7

80% by 2050 (from 1990 emission levels). By 2020, the 2009 Act requires a reduction of at least 42% from 1990 emission levels.

In addition to the targets set in the 2009 Act, on 18 May 2011 the First Minister announced a commitment to generating the equivalent of 100% of Scotland's own electricity demand from renewable resources by 2020, with offshore wind playing a key role in achieving this ambitious target.

Renewables Action Plan

In June 2009, the Scottish Government published its *Renewables Action Plan* ("RAP"), containing the Scottish Government's various policies towards renewable energy. According to the RAP, the Scottish Government expects offshore wind:

> "To make a significant contribution to 2020 renewables targets and beyond. To maximise economic benefits to the Scottish Economy, and enable a young industry to establish, whilst working in harmony with the marine environment."

Additionally, the RAP highlights the Scottish Government's ambition "to drive the success of the Scottish offshore wind industry, and facilitate the timely development and installation of offshore wind projects within the Scottish Territorial Waters…" and "to build Scotland's position as a key base for the offshore wind, innovation, manufacturing and installation, leveraging its oil and gas experience."

Blue Seas – Green Energy: A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters

Further to the RAP, in March 2011 the Scottish Government published its policy document aimed specifically at offshore wind energy, entitled *Blue Seas – Green Energy* ("Green Energy Plan"). The Green Energy Plan recognises offshore wind as an integral element in Scotland's contribution towards action on climate change and seeks to maximise the contribution that offshore wind energy makes to renewable energy generation in Scotland, whilst recognising that Scotland must compete with the rest of Europe and globally to maximise its share of the renewable energy market.

Green Energy Plan – Specific policies in/around North East waters

Policy recommendations of the Green Energy Plan for North East waters towards offshore wind energy development in the North East of Scotland include:

1. Recognition that the North East is a suitable location to progress the development of offshore wind; and
2. The development of the short term [offshore wind] option should be taken forward.

Renewables Road Map

On 2 June 2011, during a Scottish Government debate, Energy Minister Fergus Ewing announced to MSPs that the Scottish Government would publish a "renewables road map" in due course.

MARINE POLICY

UK Marine Policy Statement

The UK Marine Policy Statement (MPS) sets out the framework for preparing subsequent Marine Plans and taking decisions that will affect the marine environment. Consistent throughout the MPS is the intention that the marine planning system will help to promote the economic and social benefits intrinsically linked to proposed marine developments by placing a presumption in favour of sustainable development.[4]

Underlying the MPS are a number of key objectives, including a desire to "*achieve a sustainable marine economy and ensure a strong, healthy and just society*".[5] The policies can be read together, as by maximising sustainable marine economy, greater prosperity and opportunities will develop.

The MPS stipulates that any enforcement or authorisation decisions that directly, or which could potentially, affect the UK marine area must be made within the context of the relevant marine policy documents.[6] For the time being, this is limited predominantly to the MPS, as the national marine plans have still to be adopted.[7]

Continuing with the concurrent policies of economic and social prosperity, the MPS emphasises that a sustainable and affordable supply of energy is paramount to these key objectives and particularly that the marine environment will be at the forefront of sustainable solutions to the UK's energy supply and distribution.[8] Consequently, sustainable offshore development, whilst still considering relevant environmental protections, will be a priority for marine planning.[9] Offshore wind is noted as being integral to this strategy, as it is seen as currently the most mature of the offshore renewable energy technologies, and has the potential to have the most significant impact on security of energy supply, which in turn will mitigate the impact of climate change.[10]

Separately, the MPS draws attention to the potential impact of the ancillary electronic networks linked to offshore infrastructure and accepts that there is an inevitable environmental impact associated with underwater cables. However, the MPS notes that the impact from cable installations on the seabed is low and mainly a result of physical disturbance linked to their initial placement. As such, they tend to be of short duration with a relatively small area being affected.[11]

Draft Scotland National Marine Plan Statement

The draft National Marine Plan (NMP) sets out the policies for sustainable development of Scotland's seas and includes economic, social and marine ecosystems objectives. Included within the core objectives is the "*need to develop the marine sector to deliver both economic activity in Scotland and to assist the delivery of Scotland's climate change objectives*"[12]. As such, the Scottish Government's view is that there should be a presumption in favour of marine development.[13]

Particular to the offshore wind context, the NMP sets out that "*the continued exploitation of energy sectors will remain essential for the future growth of the Scottish economy and for our way of life*".[14] The Scottish Government intends to maximise the potential of the described benefits through exploitation of its marine energy resources, particularly though the development of onshore and offshore grid connection to both the UK and Europe. However, the draft also seeks to reach a balance by looking to limit as far as possible the

[4] MPS, para 2.5.2
[5] *supra*, Chapter 2, Box 1, pg 11
[6] s15 Marine (Scotland) Act 2010
[7] MPS, para 2.3.2.1
[8] *supra*, para 3.3.1
[9] *supra*
[10] *supra*, para, 3.3.16
[11] *supra*, para 3.3.30
[12] Draft NMP, pg 13
[13] Draft NMP, pg 26, para 9.2
[14] *supra*, pg 59

cost to the Scottish marine environment.[15] This balance will still enable Scotland to capitalise on its wind energy potential to assist with the climate change objectives, which will in turn generate new economic activity and consequently benefit Scotland socially.[16]

This referenced economic and social benefit underlies the NMP's declaration that the Scottish Government is committed to promoting the increased use of offshore renewable energy sources, with the expectation that the development of offshore wind (and marine and tidal energy) can trigger significant economic growth in Scotland, including the creation of 30,000 jobs by 2020.[17]

Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters

The Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters (the "Plan") is a strategic planning document for the development of offshore wind energy in Scottish Territorial Waters. It represents the vision for the delivery of energy from offshore wind resources, and contains proposals for offshore wind development at regional level up to 2020 and beyond. It is to be interpreted in the context of both the National and Regional Marine Plans, whilst being integrated into and used to advise the emerging marine planning framework.

Specific to the North East Region (Moray Firth), the Plan finds that there are favourable conditions and significant potential for the development of offshore wind both within Scottish Territorial Waters and beyond into Scottish Offshore Waters.[18] It highlights the significant issues relevant to offshore development in the Region as those relating to fishing and the environment, with shipping appearing to be less significant. However, it qualifies the findings by noting that on the current evidence available, those issues highlighted could be addressed and mitigated during project planning.[19]

No doubt referencing the MPS and NMP, the Plan notes that the scale of development of offshore wind represents one of the biggest opportunities for sustainable economic growth within Scotland for a generation, with potential investment of £7.1 billion over the next decade and the creation of upwards of 28,000 direct jobs in Scotland by 2020,[20] a figure consistent with the NMP. The Plan also recognises that the infrastructure in place through the available ports and harbours offer viable locations to service the associated construction and maintenance activities. It further highlights that appropriate marine development could lead to Scotland capturing one-third of the UK energy supply market, which would in turn potentially secure an additional £100bn of investment.[21]

As well as the potential stake in the UK market, the Plan also highlights that Scotland could realise up to 25% of Europe's wind potential, and from an environmental perspective, the Plan expressly refers to offshore wind as an integral element in Scotland's ambitious contribution towards climate change.[22]

[15] *supra*, pg 60
[16] *supra*, pg 61
[17] *supra*, pg 70
[18] Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters, pg 7
[19] *supra*, pg 7
[20] *supra*, pg 11
[21] UK Renewable Energy Strategy (2009)
[22] Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters, pg 10

PLANNING POLICY

NATIONAL POLICY

National Planning Framework for Scotland – NPF2

The NPF2 reinforces the need for a sustainable economic growth together with sustainable development and climate change. Energy forms a key focus of the document and that is reflected in paragraphs 144 to 165. Renewable energy and in particular offshore wind is specifically supported. In addition technical constraints, such as upgrades to the electricity grid, have been given priority in respect of delivery. Paragraphs 204 and 205 identify the specific challenges and opportunities facing Aberdeen and Aberdeenshire. The concept of a global energy hub is supported, including building existing offshore strengths into new renewable and clean energy technologies.

SCOTTISH PLANNING POLICY – FEBRUARY 2010

The SPP replaced all existing Scottish Planning Policy documents and provides a comprehensive national policy context. At the outset the SPP identifies that the central purpose of the planning system is to achieve increasing sustainable economic growth. It identifies the importance of development plans in delivering this objective. This is further explained in paragraph 33 which seeks to encourage the planning system to enable growth whilst at the same time protecting and enhancing the quality of the natural and built environment. The SPP also identifies the importance of sustainable development in formulating the National Planning Framework and Development Plans. Climate change is also specifically recognised as an issue in paragraphs 40 to 44. Coastal Planning is dealt with in paragraphs 98 to 103. Paragraph 101 explicitly identifies that one of the activities to be taken into account in coastal planning is land based development associated with offshore renewable energy generation. The paragraphs also recognise the importance of the coastal area for recreation and from a conservation perspective. The policy relating to the Historic Environment is contained in paragraphs 110 to 124. The importance of Landscape and Natural Heritage to Scotland is reflected in paragraphs 125 to 164. This provides National Policy in relation to both landscape and nature conservation. In terms of renewable energy paragraphs 182 to 195 provide policy guidance. Offshore renewable generation is specifically considered in paragraph 192. National Policy supports the development of renewable energy but the document pre-dates subsequent increases in the targets for electricity to be generated from renewable sources (see Energy Policy above).

DEVELOPMENT PLANS

The development plan for the area includes:-

- The Aberdeen City and Shire Structure Plan, approved on 14 August 2009.
- The Aberdeenshire Local Plan adopted in June 2006.
- The City of Aberdeen Local Plan adopted in June 2008.

The currently adopted Local Plans were both drafted to conform to the former Structure Plan, North East Scotland Together, which was approved in June 2002. There are currently two proposed Local Plans which will replace the currently adopted Local Plans. The Development Plan Policy will only be directly relevant in respect of a small element of the offshore proposal relating to the export cables between the mean low water mark up until the mean high water spring tide level. In that regard the most relevant policies in that respect are likely to be those relating to coastal zones and also those relating to landscape, visual, cultural heritage and access and leisure. In addition, a number of the effects of the EOWDC will occur onshore and planning policy has been referred to in assessing some of the receptors within the Environmental Statement. These are documented in the individual technical reports.

THE ABERDEEN CITY AND SHIRE STRUCTURE PLAN

The Aberdeen City and Shire Structure Plan was drafted to be a more strategic document than the traditional Structure Plan and reflected the approach being introduced through planning reform. It is, therefore a document which adopts a strategic approach and which seeks to guide development up to 2030.

The plan provides the vision and aims. The aims include:-

- To grow and diversify the regional economy.
- Take on the urgent challenges of sustainable development and climate change.
- To protect and improve valued assets and resources including the built and natural environment and cultural heritage.

The spatial strategy moves away from that formerly advocated in the previous Structure Plan and there is a new focus on three key growth areas. These include Aberdeen City and a strategic area from Aberdeen to Peterhead, along the A90. Within the Aberdeen to Peterhead growth area the value of the development of the Menie Estate is recognised. The area is also to host the "Energetica" initiative which seeks to develop and diversify the economy with a strong focus on energy.

After setting out the spatial strategy the Structure Plan goes on to provide objectives. Those of most relevance include economic growth, sustainable development and climate change and the quality of the environment. In terms of economic growth there is a strong desire to continue to grow the Aberdeen City and Shire economies. The Energetica initiative is again specifically referred to in paragraph 4.3.

In respect of sustainable development and climate change the Structure Plan incorporates a target:-

> "For the City region's electricity needs to be met from renewable resources by 2020".

There is strong support for the technology which can help to contribute to the supply of renewable energy. The quality of the environment objective identifies the importance of both built, natural and cultural heritage assets.

ADOPTED LOCAL PLANS

Both adopted Local Plans deploy strategies which were incorporated within the former Structure Plan and which have been altered by the new Structure Plan. The weight to the strategic context is therefore reduced. Both Local Plans however include development control policies which are potentially of relevance.

THE ABERDEENSHIRE LOCAL PLAN

In respect of the Aberdeenshire Local Plan the policies of most relevance are likely to include:-

- Policy Env 1, Env 2 and Env 3 provide applicable policies relating to Onshore Conservation Sites ranging from international to local sites.
- Policy Env 5A – the policy relevant to the protection of National Scenic Areas.
- Policy Env 5B – deals with areas of Landscape Significance (It should be noted that the coastal areas from the development plan boundary north of Aberdeen up to north of Collieston is designated as an area of landscape significance).
- Policy Env 6 deals with Coastal Development. This policy deals with specific criteria for considering proposals on the developed coast and also the undeveloped coast. This will potentially be relevant to certain of the onshore infrastructure associated with EOWDC.
- Policy Env 17 – Conservation Areas.
- Policy Env 18 – Listed Buildings.
- Policy Env 19 – Archaeological Sites and Ancient Monuments.
- Policy Env 20 – Historic Gardens and Design Landscapes.
- Policies Emp 9 and Emp 10 provide policies in relation to tourist facilities and accommodation and support leisure and recreation.

- Policy NF 7 provides policy relating to onshore renewable energy facilities for onshore wind. It adopts a tiered approach to identification of suitable locations. This is no longer consistent with national policy.
- The plan also includes general development policies which relate to all land based development. This includes policies such as Gen 1 and Gen 2 which are of general application.

CITY OF ABERDEEN LOCAL PLAN

The adopted Local Plan also adopts a strategic context from the former Structure Plan but at the same time also provides development control policies which would potentially be of relevance. These are as follows:-

- Policy 22 – Onshore Renewables. This adopts a similar tiered approach which is no longer consistent with national policy.
- Policy 26 – Coastal Management. This has specific policies on the developed coastal zone and applies specific criteria to the undeveloped zone.
- Policy 29 – provides a framework and Policy 31 provides a landscape protection policy.
- Policy 16 – Archaeology.
- Policy 32 – Historic Gardens.
- Policy 34 – Natural Heritage generally.
- Policy 35 – Access and Recreational Areas.
- Policy 81 – Aberdeen Harbour.

PROPOSED LOCAL PLANS

THE ABERDEENSHIRE PROPOSED LOCAL DEVELOPMENT PLAN

The Aberdeenshire Proposed Local Development Plan picks up the Structure Plan spatial strategy at Section 4 including the identification of the specific developments associated with the strategic growth area between Aberdeen and Peterhead. It includes a major extension to Ellon at Cromleybank, and other business land, a major extension to Peterhead and a major extension to the community of Blackdog. The plan thereafter sets out more general development control policies which are to be supplemented by supplemental planning guidance. The relevant policies are likely to include:-

  - Policy 1 – Business Development. This specifically identifies the "Energetica" initiative as a key development. The general policy is going to be supported by supplemental planning guidance on the development of employment land. (SGbus1)
  - Tourist Facilities and Accommodation. (SGbus4)
  - Policy 4 – Special Types of Rural Land. This policy heading also includes Aberdeenshire Coastal Zone and it is intended that there will be supplemental guidance dealing with development in the Coastal Zone. (SG STRL Type 1 Development on the Coastal Zone).
  - Policy 11 – Natural Heritage.
  - Policy 12 – Landscape Conservation.
  - Policy 13 – Protecting, Improving and Conserving the Historic Environment.

ABERDEEN PROPOSED LOCAL DEVELOPMENT PLAN

The Proposed Aberdeen Local Development Plan is primarily a map based one supporting the development strategy for the city. Within the draft Local Plan there is a substantial housing and longer term business proposal to the northeast of the city at Dubford & Murcar. Significant development is also proposed further up the Don Valley at Grandhome. The Local Plan also provides updated development control policies including:-

- D5 – Built Heritage.
- D6 – Landscape.

- B14 – Aberdeen Airport and Aberdeen Harbour.
- NE7 – Coastal Planning. This again draws the distinction between developed coastal areas and undeveloped coastal areas.
- NE8 – Natural Heritage. The River Dee is a Special Area of Conservation (SAC) is specifically referred to in the text above.
- NE9 – Access and Informal Recreation.
- R8 – Renewable and low carbon energy developments.

European Offshore Wind Deployment Centre
Environmental Statement

Appendix 3.1: Underwater Noise Modelling

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

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Subsea Noise Modelling in Support of the European Offshore Wind Deployment Centre Development

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Approved by Technical Director: Dr J R Nedwell

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1 UNDERWATER NOISE IMPACT ASSESSMENT

1.1 Introduction

1 Subacoustech Environmental has been contracted by Aberdeen Offshore Wind Farm Ltd to investigate the potential impacts that the noise generated by the construction of the European Offshore Wind Deployment Centre (EOWDC) off the coast of Aberdeen may have on marine fauna, by means of subsea noise propagation modelling. Of particular concern is the noise generated during impact piling operations to install the foundations of the wind turbines and it is this aspect that this report concentrates on.

2 The EOWDC will be located within an area approximately 2 km from the coast that extends eastwards to approximately 4.5 km offshore. The depth of the wind turbine positions range from approximately 19 m to 30 m. The proposed project will combine a small commercially operated wind farm with a test and research centre, allowing manufacturers to test “first of run” wind turbines and innovative foundation solutions along with related operation and maintenance access logistics. The project may also include an Ocean Laboratory which would allow environmental monitoring before, during and after deployments.

3 Aberdeen Bay is an important area for several species of marine mammal, most notably bottlenose dolphin (*Tursiops truncatus*) but also harbour porpoise (*Phocoena phocoena*), grey seals (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*). In summer months white-beaked dolphins (*Lagernorhynchus albirostris*), Minke whales (*Balaenoptera acutorostrata*) and Risso’s dolphins (*Grampus griseus*) have also been sighted.

4 The sections below initially provide some background to the metrics and accepted criteria for the assessment of underwater noise so providing some background to the subject. The report then presents the results of the modelling in which an estimation of the various impact ranges is given including the ranges for lethality, physical injury, auditory damage and behavioural avoidance.

1.2 Measurement of Underwater Noise

1.2.1 Introduction

5 Sound travels much faster in water (approximately 1,500 m/s) than in air (340 m/s). Since water is a relatively incompressible, dense medium, the pressures associated with underwater sound tend to be much higher than in air. As an example, background levels of sea noise of approximately 130 dB re 1 µPa (a definition of these units are covered in section 1.2.2) for UK coastal waters are not uncommon (Nedwell *et al*, 2003 and 2007). This level equates to about 100 dB re 20 µPa in the units that would be used to describe a sound level in air. Such levels in air would be considered to be hazardous. However, marine mammals and fish have evolved to live in this environment and are thus relatively insensitive to sound pressure compared with terrestrial mammals. The most sensitive thresholds are often not below 100 dB re 1 µPa and typically not below 70 dB re 1 µPa (44 dB re 20 µPa using the reference unit that would be used in air).

6 For this reason it is generally of little use and potentially misleading to directly compare sound sources underwater to those in air. Table 1.2-1 presents a summary of the typical levels of noise for various sound sources in air (HSE, 2005) and in water (Nedwell *et al*, 2003, Nedwell *et al,* 2007, Urick, 1983 and Parvin *et al,* 2007). From these data it is clearly evident that the typical levels of underwater noise are far higher than those found in air. This should be borne in mind when considering quoted levels of underwater noise.

Table 1.2-1 – Summary of typical levels of noise from various sources in air (all values referenced to 20 µPa) and in water (all values referenced to 1µPa)

Typical noise levels in air		Typical noise levels in water	
Sound Source	**Typical noise level (dB re 20 µPa)**	**Sound Source**	**Typical noise level (dB re. 1 µPa)**
Quiet office	~40 dB	Background noise	100 – 130 dB RMS
Conversation	~60 dB	Fishing trawler	168 dB RMS @ 1 m range
Pneumatic road drill	~100 dB	Impact piling	243 – 257 dB peak to peak @1 m
Jet aircraft taking off 25 m away	~140 dB	Underwater explosive blast	285 dB peak pressure @ 1 m

1.2.2 Units of Measurement

7 Measurements of underwater sound are usually expressed using the decibel (dB) scale, which is a logarithmic measure of sound. A logarithmic scale is used because rather than equal increments of sound having an equal increase in effect, typically a constant ratio is required for this to be the case, that is, each doubling of sound level will cause a roughly equal increase in "loudness".

8 Any quantity expressed in this scale is termed a "level". If the unit is sound pressure, as is the case with underwater noise, it will be termed a "Sound Pressure Level" (SPL). A refinement is that the scale such as when used with sound pressure is that the pressure squared is applied rather than the pressure. If this were not the case, if the acoustic power level of a source rose by 10 dB the Sound Pressure Level would rise by 20 dB.

9 As the dB scale represents a ratio (that is, the result of dividing one quantity by another base quantity), it is used with a reference unit which expresses the base from which the ratio is expressed. For underwater sound, typically a unit of one microPascal (µPa) is used as the reference unit; a Pascal is equal to the pressure exerted by one Newton over one square metre. One microPascal equals one millionth of this. It is important to state the reference unit when describing the level of a sound in decibels as the use of a different reference pressure for a given measured sound pressure will result in a different value. For underwater noise, therefore, a noise level would be expressed as "120 dB re 1 µPa", for example.

1.2.3 Quantities of Measurement

10 A sound level may be expressed in many different ways depending upon the particular type of noise that is being measured, and the parameters of the noise that allow it to be evaluated in terms of a biological effect. For example,

measurement of underwater noise following the detonation of explosives indicates a clear peak in positive (high) pressure and only a much smaller peak in negative (low) pressure. As the resulting impact on any surrounding objects is likely to be related to the positive peak, it is usually appropriate to quote the peak (sometimes also referred to as zero-peak) level of the sound.

11 For impact piling, however, where the pressure wave is roughly equal in positive and negative peaks, the resulting impact is likely to be related to both the positive and negative pressure peaks. It is therefore more appropriate to quote the level in terms of “peak to peak” levels which is the maximum variation between the positive and negative pressures in the sound wave. The zero-peak sound levels have also been included in this report for completeness.

12 When noise and vibration is of a continuous nature such as that associated with drilling, boring, continuous wave sonar, or background sea and river noise levels, it is more appropriate to characterise the noise level over a longer period of time. The variation in sound pressure is therefore measured over a specific time period to determine the Root Mean Square (RMS) level of sound that is varying with time. This is the RMS Sound Pressure Level (RMS SPL) which can be considered to be a measure of the average unweighted level of the sound over the measurement period.

13 Where a particular noise source is expressed in terms of RMS SPL it is necessary to quote the time period over which the RMS level is calculated. For instance, in the case of a transient noise source such as a pile strike lasting say a tenth of a second this is critically important as the mean taken over a tenth of a second will be ten times higher than the mean taken over one second.

14 Another way of expressing sound levels used in this study is the Sound Exposure Level (SEL), which sums the acoustic energy over a measurement period, and effectively takes account of both the SPL of the sound source and the duration the sound is present in the acoustic environment. Where the SPL is a measure of the average level of the broadband noise, the SEL sums the cumulative broadband noise energy. Therefore, for continuous sounds of duration less than one second, the SEL will be lower than the SPL. For periods of greater than one second the SEL will be numerically greater than the SPL (i.e. for a sound of ten seconds duration the SEL will be 10dB higher than the SPL, for a sound of 100 seconds duration the SEL will be 20 dB higher than the SPL and so on).

1.2.4 Source Level and Transmission Loss

15 As sound propagates through water it reduces in level as a result of losses relating to energy dissipation (absorption) and also due to the sound energy simply spreading over a wider area (geometric spreading). Typically, a source of underwater noise is quantified in terms of a Source Level, which is the level of sound energy released by the source, usually described as the level of underwater noise at a range of 1 m from the source. In order to characterise the rate at which energy is lost a value for the Transmission Loss is often given. The level at a particular point in the water space is therefore the Source Level minus the Transmission Loss.

16 Over short distances, absorption effects have little influence on the Transmission Loss and can often be ignored. The Source Level itself may be quoted in any physical quantity, for instance, a piling source may be expressed as having a "peak to peak Source Level of 200 dB re 1 μPa @ 1m".

17 This simple but convenient formulation ignores the practical difficulty of estimating the Source Level. Since the measurements are usually made at some distance from the source and extrapolated back to the source, the true level at 1 m may actually be very different from the Source Level used in these equations.

18 It is often not realised that, since the value of Source Level quoted for a particular source is obtained by extrapolation; the value will depend on the model that is used to perform the extrapolation. Figure 1.2-1 illustrates this point. The diagram illustrates a set of measurements made of the noise from piling. In the simplest case, in order to draw conclusions about the data, it may be fitted to a straight-line model; this is shown in the figure by the green line. Such a model effectively assumes that the noise level attenuates only as a result of geometric spreading. This however will generally over-estimate the level for low and high ranges, since it ignores the effects of absorption of the noise. An improved model, including absorption, is represented by the red line and gives a better fit to the data, and indeed this simple form is usually adequate for modelling sound propagation from a source in deep water of roughly constant depth. However, in the case of shallow coastal waters, where the proposed project is situated, the depth may rapidly fluctuate between shallow water of a few metres and deep water of tens of metres or more. In these circumstances, the Transmission Loss becomes a more complex function of depth that depends heavily on the local bathymetry and hence should ideally be calculated using a more sophisticated model, such as Impulse Noise Sound Propagation and Impact Range Estimator (INSPIRE). Where these effects are included, as illustrated by the blue line, yet another value of Source Level may result; typically lower levels of noise may be predicted near to the noise source.

19 The variation in estimates of Source Level for the same dataset, when analysed in different ways, indicates how Source Level will in general be a function of the model that is used to express the noise levels.

20 Where actual measured underwater noise data from a particular activity is not available, ideally the most sophisticated model for that noise will be used in all cases. These tend to require a very advanced level of knowledge of how a particular sound behaves in the underwater environment and/or a large amount of information on the conditions at the particular site such as temperature, salinity, etc and of the substrate conditions. Where actual measured data from a similar activity is available the introduction of the numerous variables used in sophisticated models is not required, hence reliance of measured data is generally preferable.

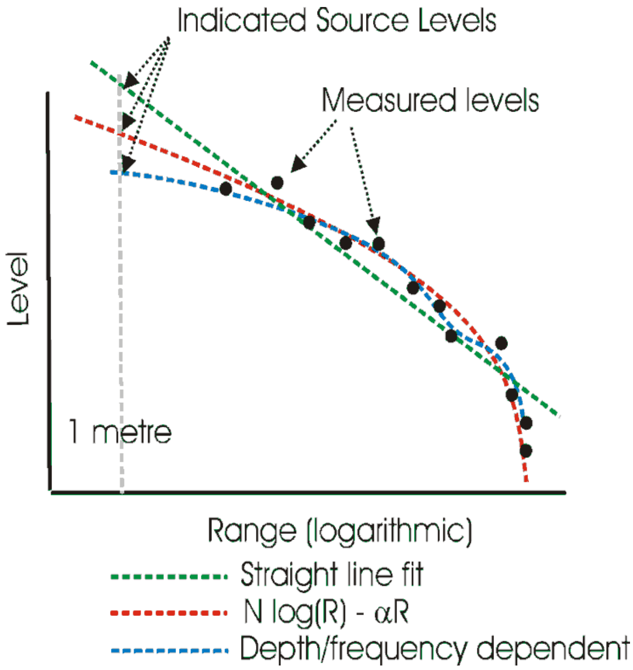

Figure 1.2-1 – Differences in Source Level estimation based on various models

1.3 Key Guidance Documents

21 The following documents have been used to inform this assessment:

- Nedwell J R, Turnpenny A W H, Lovell J, Parvin S J, Workman R, Spinks J A L and Howell D. (2007). *A validation of the dB_{ht} as a measure of the behavioural and auditory effects of underwater noise.* Subacoustech Report Reference: 534R1231, Published by Department for Business, Enterprise and Regulatory Reform.
- Southall B L, Bowles A E, Ellison W T, Finneran J J, Gentry R L, Greene C R, Kastak D, Ketten D R, Miller J H, Nachtigall P E, Richardson W J, Thomas J A and Tyack P L. (2007). *Marine Mammal Noise Exposure Criteria Aquatic Mammals*, Vol. 33 (4).
- Joint Nature Conservation Committee (JNCC), National England and Countryside Council for Wales. (2010). *The protection of marine European Protected Species from injury and disturbance;* Guidance for English and Welsh territorial waters and the UK offshore marine area. July 2009.

1.4 Data Information and Sources

22 The INSPIRE acoustic model is tested and validated against Subacoustech Environmental Ltd's extensive digital database of offshore noise measurements.

23 In addition, digital bathymetry supplied by SeaZone Solutions Ltd (License No. 052005.003) is used as an input to the INSPIRE noise propagation model.

1.5 Impact Methodology

1.5.1 Introduction

24 The methodology utilised in this impact assessment is similar to that used for numerous other studies carried out for the offshore wind industry. This approach utilises the proprietary Impulse Noise Sound Propagation and Impact Range Estimator (INSPIRE) model that has been specifically designed over five years to predict the likely level of underwater noise from impact piling operations. INSPIRE is a broadband model, that is, it does not calculate levels frequency by frequency, but in terms of the physics of the absorption of a pulse. INSPIRE uses a combination of loss caused by the spreading of the energy of the sound field (geometric loss) and loss caused by energy in the water column being absorbed in the underlying sea bed (absorption losses). This is used to estimate the likely transmission losses as the sound propagates away from the source; in this case impact piling. The model is therefore capable of estimating the effect of rapidly varying water depths that are commonly found in UK coastal waters. It has been validated against a wide range of actual measurements carried out by Subacoustech Environmental.

1.5.2 Pile Sizes

25 Currently available information suggests that the level of underwater noise from impact piling operations is closely related to both the pile size with sound levels increasing with pile size. The blow force applied to the pile also influences the noise levels produced; however, typically, blow forces also increase with pile size so these two factors are actually interdependent. The INSPIRE model also takes this into account via the inbuilt Source Level function.

26 Figure 1.5-1 shows a summary of Source Levels extrapolated from measured data on a number of impact piling operations using various pile sizes. It can be seen that as the diameter of the pile increases, the source level also increases. The estimated Source Level for an 8.5 m diameter pile is also plotted in Figure 1.5-1.

27 However, it should be noted that since the estimated Source Levels rely on extrapolation of data for other sizes of piles there is a degree of uncertainty associated with the estimate.

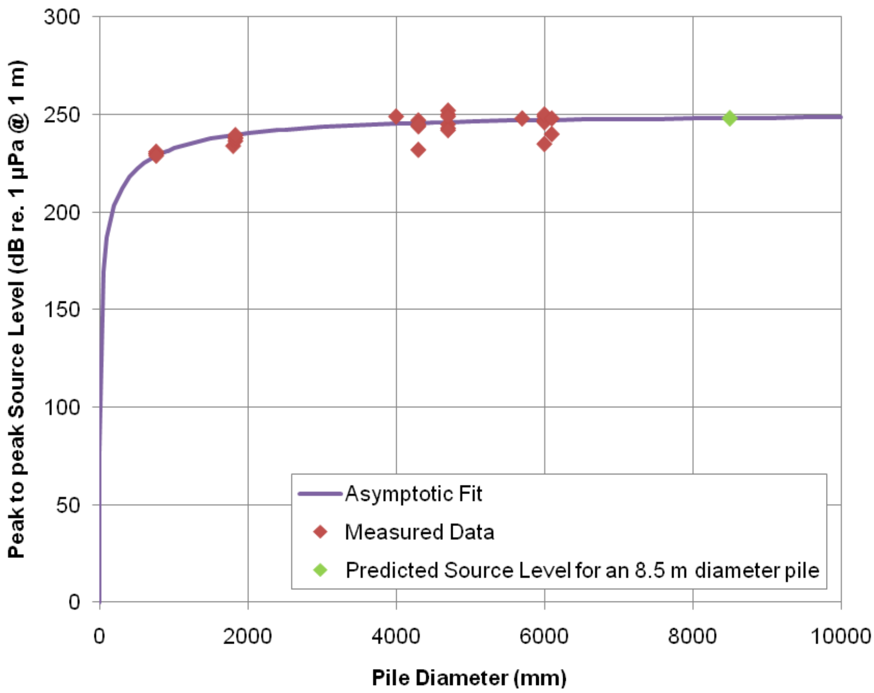

Figure 1.5-1 - Plot showing the asymptotic best fit to source level calculated from measured piling noise data for various pile sizes along with the predicted source level for an 8.5 m pile

1.5.3 Water Depths and Modelling Locations

28 The other main factor that affects the level of underwater noise is the local bathymetry, with sound attenuating at a faster rate over shallow water as opposed to deeper waters. The INSPIRE model uses digital bathymetric data provided by SeaZone Solutions Ltd, to input water depth data into the model.

29 Figure 1.5-2 shows a plan of the proposed EOWDC site along with the four wind turbine positions for which underwater noise modelling has been carried out. These are wind turbine positions 1, 3, 7 and 11. These four positions have been chosen to represent the greatest variation across the site in terms of location and to a lesser extent water depths, ranging from approximately 20 m LAT to the west to just under 30 m to LAT to the east.

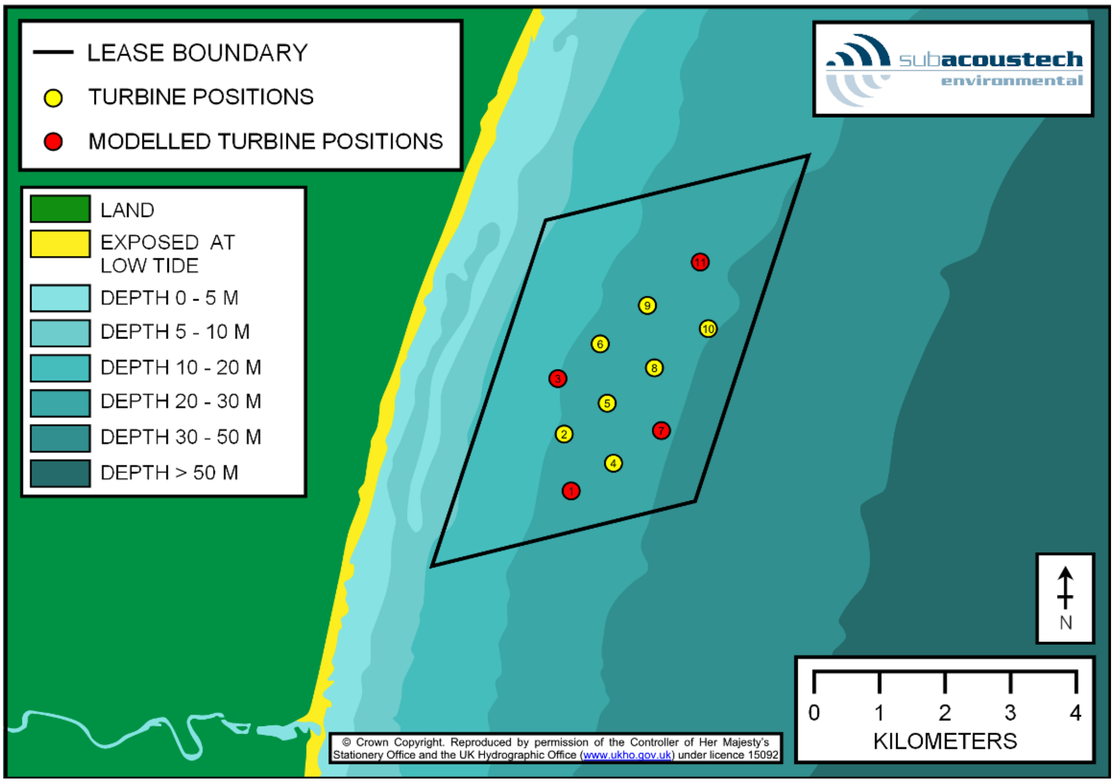

Figure 1.5-2 Map showing the four modelled wind turbine positions (Wind turbines 1, 3, 7 and 11) at the proposed EOWDC site

30 It should be noted that the INSPIRE acoustic model is not exact and does not use a Source Level / Transmission Loss (SL-TL) formulation; however, the testing and validation of the model against actual measured impact piling data confirms that the model accurately predicts the likely noise levels from impact piling operations.

1.6 Impact of Underwater Sound on Marine Species

1.6.1 Introduction

31 Over the past 20 years it has become increasingly evident that noise from human activities in and around underwater environments may have an impact on the marine species in the area. The extent to which intense underwater sound might cause an adverse environmental impact in a particular species is dependent upon the incident sound level, frequency content, duration and/or repetition rate of the sound wave (see, for example Hastings and Popper, 2005). As a result, scientific interest in the hearing abilities of aquatic animal species has increased.

32 Popper *et al* (2006) suggest the use of unweighted sound exposure metrics such as peak level of underwater noise and the SEL of the noise, to develop an interim guidance for estimating the injury range for fish from pile driving operations. Similarly, a review of underwater noise from offshore wind farms on marine mammals (Madsen *et al*, 2006) discusses the use of frequency weighting of the underwater noise. The authors' comment that the impact of underwater sound on the auditory system is frequency dependent and thus,

ideally, noise levels should (as for humans) be weighted using the defined frequency responses of the auditory system of the animal in question.

33 The approach that has been adopted in this study is to use unweighted sound level metrics to define the potential for gross damage such as fatality, swim bladder rupture or tissue damage, since hearing is not involved in this process. In addition, frequency weighted measures of the sound based on the hearing threshold of the affected species have been applied to assess the perceived loudness of the noise for representative marine species, and hence the range at which an aversive response to the piling may be expected.

34 In addition to this, a further set of criteria proposed by Southall *et al* (2007) and subsequently used as the basis for draft Joint Nature Conservation Committee (JNCC) guidance on protection of marine mammals from injury and disturbance (JNCC, draft 2010) have been used in this assessment to estimate the possibility of auditory injury and behavioural disturbance occurring.

1.6.2 Lethality and Injury Impacts and their Associated Sound Levels

35 At the highest level, typically during underwater blast from explosives, sound has the ability to cause injury and, in extreme cases, the death of exposed animals.

36 Due to the current lack of information on potential lethal and physical injury effects from impact piling, this study has used the data from blast exposures to estimate impact zones. The wave forms from these two noise sources are rather different; the transient pressure wave from an impact piling operation has roughly equal positive and negative pressure amplitude components and a relatively long duration of up to a few hundred milliseconds. By contrast, blast waves have a very high positive pressure peak followed by a much lower amplitude, negative wave due to the momentum imparted to the water surrounding the explosive gas bubble. The pressure of a blast wave is normally quantified therefore in terms of the peak level, due to the dominance of the positive peak of the waveform. There is, therefore, a level of uncertainty as to whether a blast wave criterion can be directly applied to a transient waveform arising from an impact piling operation.

1.6.3 Observations of Lethality and Physical Injury

37 Lethal and direct physical injury from an underwater transient pressure wave are related to the peak pressure level, rise time and duration that the peak pressure acts on the body (usually measured by the impulse of the blast wave). The criteria that have been developed for assessing gross injury of this type are based on data from blast injury, at close range, to explosives. Injury has been related both to the incident peak positive pressure of the wave and to the impulse. To obtain an effective measure of the impulse of the wave, an estimate of the effective duration must be made by integrating over the waveform. A number of different techniques for assessing the duration of an impulsive waveform are described by Hamernik and Hsueh (1991) based on the studies by Coles *et al* (1968), Pfander *et al* (1980) and Smoorenburg (1982). The measure of impulse will, therefore, depend upon which technique is applied.

38 There is currently very limited data relating to fish kill from piling (Hastings *et al*, 2005), although the study by Caltrans (2001) during impact piling operations on the San Francisco to Oakland Bay Bridge indicated fish kill to a range of approximately 50 m. By fitting the results of Abbot *et al* (2002) to a spreading model, it is possible to estimate the peak to peak Source Level (SL) of the piling to be about 242 dB re 1 µPa @ 1 m. This equates to fish being killed when the peak pressure level exceeds about 208 dB re 1 µPa, which corresponds to an interim criterion that has been proposed by Popper, discussed in the following section.

39 Studies carried out on the effects of blast on various species of fish by Yelverton *et al* (1975) (also reproduced in Richardson *et al*, 1995) demonstrated that mortality rates were related to body mass and magnitude of the impulsive wave. The results show that a 50% mortality rate would occur in fish weighing 1 kg when exposed to an impulse of about 340 Pa.s (Pascals per second). According to this model, to cause the same mortality rate in fish weighing 10 kg they would have to be exposed to an impulse of approximately 800 Pa.s. The work indicates that there are levels below which a sound would cease to be lethal to a fish of a certain weight. While this sound level may not cause the swim bladder to rupture or kidney and liver damage that may be seen after lethal doses of sound, there may still be considerable tissue damage to susceptible organs such as the lungs, gastro-intestinal tract or eyes and hence possible long term survival implications.

1.6.4 Observations of Auditory Damage

40 At lower received SPLs, temporary and permanent hearing loss has been demonstrated by constraining marine animals within a high level sound environment for prolonged periods. Temporary hearing loss usually presents as a temporary hearing threshold shift (TTS) which is recoverable over a period of time. However, following prolonged exposure at levels sufficient to cause TTS, a permanent threshold shift (PTS) or deafness, results from the death of the sensory hair cells of the ear. TTS is thus symptomatic of hearing damage. Some information is available concerning hearing damage in fish. Cox *et al* (1986, 1987) suggested that goldfish (*Cassius auratus*) exposed to pure tones at 250Hz at 204dB re 1µPa and 500Hz at 197dB re 1µPa for two hours developed hearing damage, corresponding to levels of 142 – 147 dB_{ht}(*Cassius auratus*). Enger (1981) also noted auditory damage in cod (*Gadus morhua*) exposed at frequencies from 50 – 400Hz at 180dB re 1µPa for one to five hours, corresponding to a level of about 100 dB_{ht}(*Gadus morhua*). The dB_{ht} metric is explained in section 1.11.1.8 in the appendix of this report

41 Hastings *et al* (1996) found damage to the sensory hair cells of the oscar fish (*Astronotus ocellatus*) caused by exposure to a pure 300Hz tone (sound generated at a single frequency) at 180dB re 1µPa for one hour. Comparing these results to the audiogram given by Kenyon *et al* (1998), this corresponds to a level of 74 dB_{ht}(*Astronotus ocellatus*).

42 Smith *et al* (2004) discovered that goldfish had a 5 dB TTS in hearing following a ten minute continuous exposure to noise in the frequency range from 100 Hz – 10 kHz at a level of 170 dB re 1 µPa. Popper *et al* (in Hastings and Popper, 2005) exposed rainbow trout (*Oncorhynchus mykiss*) and channel catfish (*Ictalurus punctatus*) to Low Frequency Active Sonar signals

(a submarine detection system deployed by the US Navy) for three periods of 108 seconds at a received level of 193 dB re 1µPa (RMS) over the frequency band 160 – 325 Hz. A goldfish with a 10dB TTS took 24 – 48 hours to recover. Popper *et al* (2005) exposed broad whitefish (*Coregonus nasus*), a salmonid, to five airgun emissions having a received peak sound level of 205 dB re 1µPa (corresponding to a received mean SEL of 175 dB re 1µPa^2-s). No TTS was observed in the whitefish, whereas northern pike (*Esox lucius*) and Lake Chub (*Couesius plumbeus*) demonstrated a 10 – 15 dB TTS from which the recovery time was around 24 hours.

43 The recent review by Madsen *et al* (2006) highlighted that experiments with marine mammals demonstrated a near inverse relationship between sound exposure level and duration of exposure (i.e. the same equal energy noise dose relationship). This was based on data from Schlundt *et al* (2000) which indicated that this effect translates to marine mammal exposure to underwater sound. In the study, short duration sound exposures (one second continuous wave) at levels of approximately 130 dB above hearing threshold caused a small TTS hearing injury in the bottlenose dolphin. Longer duration exposures at levels of 80 – 90 dB above hearing threshold have been shown to induce TTS after many hours of exposure (Nedwell *et al*, 2007).

44 The data reviewed above highlights typical levels of sound and the exposure durations at which audiological injury in fish and marine mammals have been measured. In the context of exposure of fish and marine mammal species to underwater sound it is very unlikely that fish or marine mammals would experience auditory injury unless constrained in a very high level continuous sound field for a prolonged period. Although it should be noted that physical injury and fatality, which is discussed in more detail below, can occur for very high level, short duration exposures such as those for underwater blast.

1.6.5 Criteria for Assessing Lethality and Physical Injury

45 The following criteria have been applied in this study for levels of noise likely to cause physical effects (Parvin *et al* (2007)), based on data in the studies of Yelverton *et al* (1975), Turnpenny *et al* (1994), Hastings and Popper (2005):

- Lethal effect may occur in marine species where peak to peak levels exceed 240 dB re 1 µPa; and
- Physical injury may occur in marine species where peak to peak levels exceed 220 dB re 1 µPa.

1.6.6 Criteria for Assessing Audiological Injury

46 The concept of auditory injury from exposure to noise is well established for airborne sound exposure of humans. At a high enough level of sound, traumatic hearing injury may occur even where the time of exposure is short. Injury also occurs at lower levels of noise where the period of exposure is long. In this case, the degree of hearing damage depends on both the level of the noise and the time of exposure to it. To estimate the effect of impact piling taking place over a long period of time this concept of cumulative “Noise Dose” relationship has been used.

47 For complex or time varying signals the degree of hearing damage has been related to the Noise Dose of the noise. The Noise Dose combines the continuous noise level containing the same sound energy as the time varying signal (the equivalent level of noise, or L_{eq}), and the duration of exposure. This is usually given in terms of $L_{EP, D}$, which is the daily personal noise exposure. This approach appears to translate to the underwater exposure of marine mammals, since for single exposure sounds Ward (1997) developed a level against exposure duration guide indicating that for sounds from 126 to 144 dB above hearing threshold (i.e. dB_{ht}), hearing injury can occur for exposure periods from 60 seconds to 1 second respectively. The data from Schlundt *et al* (2000) also indicates that this effect translates to marine mammal exposure to underwater sound. In the study, short duration sound exposures (one second continuous wave) at levels of approximately 130 dB above hearing threshold caused a small Temporary Threshold Shift (TTS) hearing injury in the bottlenose dolphin.

48 A review by Madsen *et al* (2006) highlighted that experiments with marine mammals demonstrate a near linear relationship between sound exposure level and duration of exposure (i.e. an equal energy Noise Dose relationship). In other words, each doubling of the noise energy (3 dB increase) results in a halving of the acceptable noise exposure period. The same Noise Dose (and therefore potential for auditory injury) occurs, for instance, following an exposure of 90 dB above threshold for a period of 8 hours, 93 dB above threshold for a period of 4 hours, or 130 dB above threshold for a few seconds as shown in Table 1.6-1 below. Hearing impairment in the form of a TTS in hearing may occur where an animal is exposed to a these levels, and Permanent Threshold Shift (PTS) will occur with repetitive exposure. The higher the Noise Dose above this limit, the more rapid will be the damage.

Table 1.6-1 – Comparison of noise exposure level and duration for the same cumulative 90 $L_{EP, D}$ Noise Dose

Exposure Level dB(A) (dB_{ht})	Exposure Duration
90	8 hours
93	4 hours
99	1 hour
110	Approx. 5 minutes
120	Approx. 30 seconds
130	Approx. 3 seconds

49 In summary, it is likely that hearing impairment will occur where fish or marine mammals are exposed to continuous or repeated high level underwater sound for relatively long periods of time; for impact piling the noise exposure can build up over many pile strikes. The Noise Dose that the animals will accumulate will depend on the received level of the underwater sound, which varies with range, and hence with the behaviour of the animal, and the time period and repetition rate of the pile strikes.

50 Nedwell *et al* (2007) has suggested that the use of a 130 dB_{ht} level, similar to that used for human exposure in air, provides a suitable criterion for predicting the onset of traumatic hearing damage (that is, where immediate traumatic and irreversible damage occurs), which recognises the varying hearing sensitivity of differing species.

51 Based on the evidence of auditory damage from numerous studies, Southall *et al* (2007) propose a set of auditory injury criteria based on peak pressure levels and M-weighted Sound Exposure Levels (dB re. 1 μPa^2-s (M)) for various groups of marine mammals. These criteria are presented in Table 1.6-2 and the results of this study have also been presented in terms of this metric. A detailed description of the M-weighting metric and the groups of marine mammals considered is presented in the Appendix to this report.

Table 1.6-2 – Proposed injury criteria for various marine mammal groups (Southall et al., 2007)

	Sound type	
Marine mammal group	**Single pulses**	**Multiple Pulses**
Low Frequency Cetaceans		
Sound Pressure Level	230 dB re 1 μPa (peak)	230 dB re 1 μPa (peak)
Sound Exposure Level	198 dB re 1 μPa^2/s (M_{lf})	198 dB re 1 μPa^2/s (M_{lf})
Mid Frequency Cetaceans		
Sound Pressure Level	230 dB re 1 μPa (peak)	230 dB re 1 μPa (peak)
Sound Exposure Level	198 dB re 1 μPa^2/s (M_{mf})	198 dB re 1 μPa^2/s (M_{mf})
High Frequency Cetaceans		
Sound Pressure Level	230 dB re 1 μPa (peak)	230 dB re 1 μPa (peak)
Sound Exposure Level	198 dB re 1 μPa^2/s (M_{hf})	198 dB re 1 μPa^2/s (M_{hf})
Pinnipeds (in water)		
Sound Pressure Level	218 dB re 1 μPa (peak)	218 dB re 1 μPa (peak)
Sound Exposure Level	186 dB re 1 μPa^2/s (M_{pw})	186 dB re 1 μPa^2/s (M_{pw})

52 The Southall study criteria can be used for both single pulse noise sources and multiple pulse sources. This report presents estimated impact ranges for both of these in terms of pile driving to provide impact ranges for exposure to a single pile strike and also the accumulated exposure to multiple pulses over a typical installation. The accumulated exposure is taken into account using the dB_{ht} metric by the noise dose modelling outlined above: This has also been carried out for the M-weighting metric. This modelling is carried out using a similar method to the noise dose modelling by assuming a swim speed and starting range for the animals and, hence calculating the accumulated exposure as the animal moves away from the noise source. The M-weighted Sound Exposure Level at each range is calculated based on analysis of previously measured data from numerous impact piling operations.

53 Predictive underwater noise modelling can be used to estimate the range at which a marine mammal can receive sound levels that could cause audiological impairment. By using the impact ranges and factoring a degree of precaution these can be used to help inform standoff ranges (exclusion zones) for use in the mitigation during piling activities. That is, the range at which the animal can be at the onset of piling to ensure it can flee the area before receiving an exposure level that is likely to damage hearing.

54 Once again, similarly to the dB_{ht} noise dose modelling, the M-weighted SEL modelling does not take into account the mitigating effects of a soft start procedure. The accumulated exposure is calculated assuming a high blow force at the onset of piling. Where a soft start procedure is used the effect is likely to be mitigated as the initial exposure is reduced.

1.6.7 Criteria for Assessing Behavioural Response

55 Measurements of underwater noise are frequently presented in terms of the overall linear level of that sound, such as its spectral level or peak pressure. This, however, does not provide an indication of the impact that the sound will have upon a particular fish or marine mammal species. This is of fundamental importance when considering the behavioural response of species to activities generating underwater noise, as avoidance is associated with the perceived level of loudness and vibration of the sound by the species. Therefore, the same underwater noise may have a different impact on different species with different hearing sensitivities.

56 The dB_{ht}(*Species*) metric (Nedwell *et al*, 2007) has been developed as a means for quantifying the potential for a behavioural impact on a species in the underwater environment. As any given sound will be perceived differently by different species (since they have differing hearing abilities) the species name must be appended when specifying a level. For instance, the same construction event for salmon (*Salmo salar*) might have a level of 70 dB_{ht}(*Salmo salar*) and for bottlenose dolphin a level of 110 dB_{ht}(*Tursiops truncatus*). Table 1.6-3 below summarises the assessment criteria for the dB_{ht}.

Table 1.6-3 – Assessment criteria proposed by Nedwell *et al* (2007) used in this study to assess the potential behavioural impact of underwater noise on marine species

Level in dB_{ht}(Species)	Effect
90 and above	Strong avoidance reaction by virtually all individuals.
Above 110	Tolerance limit of sound; unbearably loud.
Above 130	Possibility of traumatic hearing damage from single event.

57 In addition, a lower level of 75 dB_{ht} has been used for analysis as a level of "significant avoidance." At this level, about 85% of individuals will react to the noise, although the effect will probably be limited by habituation.

58 In Southall *et al* (2007), a further set of criteria are also suggested, again based on the M-weighted Sound Exposure Levels to assess the likelihood of behavioural disturbance. These criteria are presented in Table 1.6-4 below and, as with the criteria for auditory injury proposed by Southall, it has also been used in this study.

59 Southall suggests the onset of temporary Threshold Shift (TTS) as a criterion for a behavioural effect of single impulsive noises. No evidence is offered to substantiate this criterion. This approach is considered highly speculative; for instance, humans can tolerate substantial levels of noise, well above an aversive level, of up to 130 dB(A) re 20 μPa, for short periods of time without exhibiting a TTS. The authors are not aware of any equivalent criterion for human exposure, where aversion is generally specified in terms of the level of the noise in dB(A).

Table 1.6-4 – Proposed Behavioural response criteria in terms of single pulses for various marine mammal groups (Southall *et al*., 2007)

	Sound type
Marine mammal group	**Single pulses**
Low Frequency Cetaceans	
Sound Pressure Level	224 dB re 1 µPa (peak)
Sound Exposure Level	183 dB re 1 µPa^2/s (M_{lf})
Mid Frequency Cetaceans	
Sound Pressure Level	224 dB re 1 µPa (peak)
Sound Exposure Level	183 dB re 1 µPa^2/s (M_{mf})
High Frequency Cetaceans	
Sound Pressure Level	224 dB re 1 µPa (peak)
Sound Exposure Level	183 dB re 1 µPa^2/s (M_{hf})
Pinnipeds (in water)	
Sound Pressure Level	212 dB re 1 µPa (peak)
Sound Exposure Level	171 dB re 1 µPa^2/s (M_{pw})

1.7 Selection of Species

60 The species upon which the dB_{ht} analysis has been conducted in this study have been based upon regional significance and also crucially upon the availability of a good peer-reviewed audiogram data shown in Figures 1.7-1 to 1.7-3.

61 The species of marine mammal considered in this study are:

- **Bottlenose Dolphin** – (Johnson, 1967) A marine mammal (toothed whale) with good high frequency hearing sensitivity. It is also used in this report an indicative surrogate audiogram for **Risso's Dolphin**. Although some audiogram data are available for the Risso's dolphin, the authors consider that the quality of the data is not confirmed. Hence the bottlenose dolphin has been used to provide a conservative over-estimate of potential impacts.
- **Harbour Porpoise** – A marine mammal (toothed whale) that, based on current peer reviewed audiogram data (Kastelein, 2002), is the most sensitive marine mammal to high frequency underwater sound.
- **White-Beaked Dolphin** – a marine mammal (toothed whale) with similar high frequency hearing to the bottlenose dolphin, but lower sensitivity to lower frequency noise (using the Striped Dolphin (*Stenella coeruleoalba*) audiogram (Kastelein, 2003) as a surrogate as the White-Beaked Dolphin audiogram (Nachtigall *et al*, 2007) does not cover the entire audiometric range.
- **Harbour (Common) Seal** – a pinniped that based on current peer reviewed audiogram data (Mohl, 1968, Kastak and Schusterman, 1978) the most sensitive seal species to underwater sound. It is also used as a surrogate audiogram for **Grey Seal**.

62 As there is no single published dataset for seal species that covers the full audiometric range, the analysis undertaken in this report is based on a weighting filter for the harbour seal that is the locus of the minimum threshold (most sensitive) data from several audiogram sources for the harbour seal. The data of Kastak and Schusterman (1998) is used for the frequency range from 100 Hz to 6.4 kHz, and the data from Mohl (1968) over the higher frequency range from 8 to 128 kHz.

63 The species of fish considered in this study are:

- **Herring** (*Clupea Harengus*) – A fish hearing specialist that, based on current peer reviewed audiogram data (Enger, 1967) is the most sensitive marine fish to underwater sound.
- **Salmon** – A fish with relatively poor hearing sensitivity and therefore they may be classed as hearing generalists. For this study the audiogram produced by Hawkins and Johnstone (1978) has been used.
- **Dab** (*Limanda limanda*) – A flatfish species with generalist hearing capability but that based on current peer reviewed audiogram data (Chapman and Sand,1974) is the most sensitive flatfish to underwater sound. It is also sometimes used as a surrogate for sole (*Solea solea*).

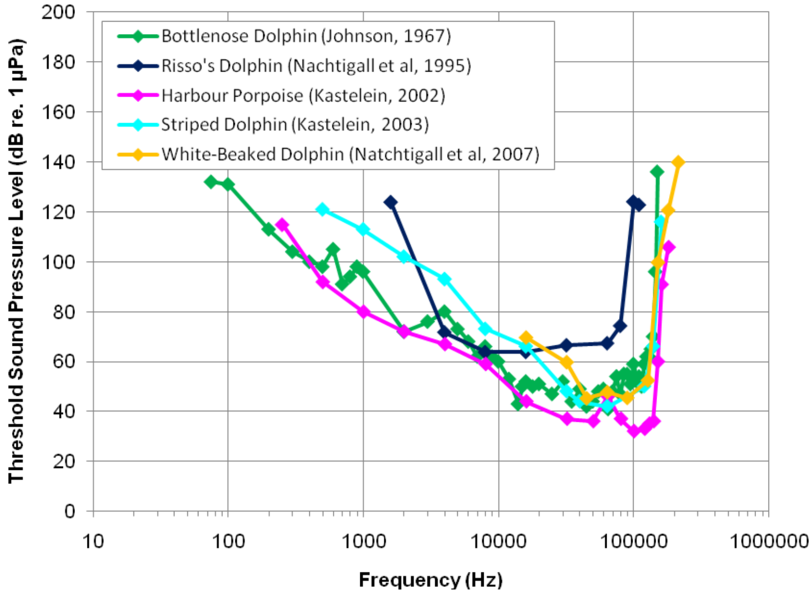

Figure 1.7-1 – Audiograms for the various species of cetacea interest in this study

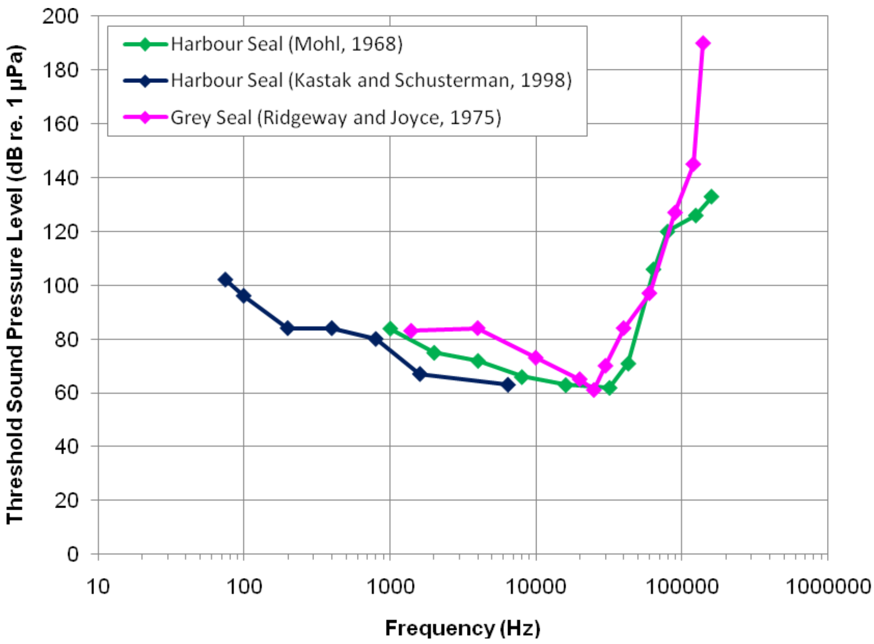

Figure 1.7-2 – Audiograms for the harbour seal and the grey seal

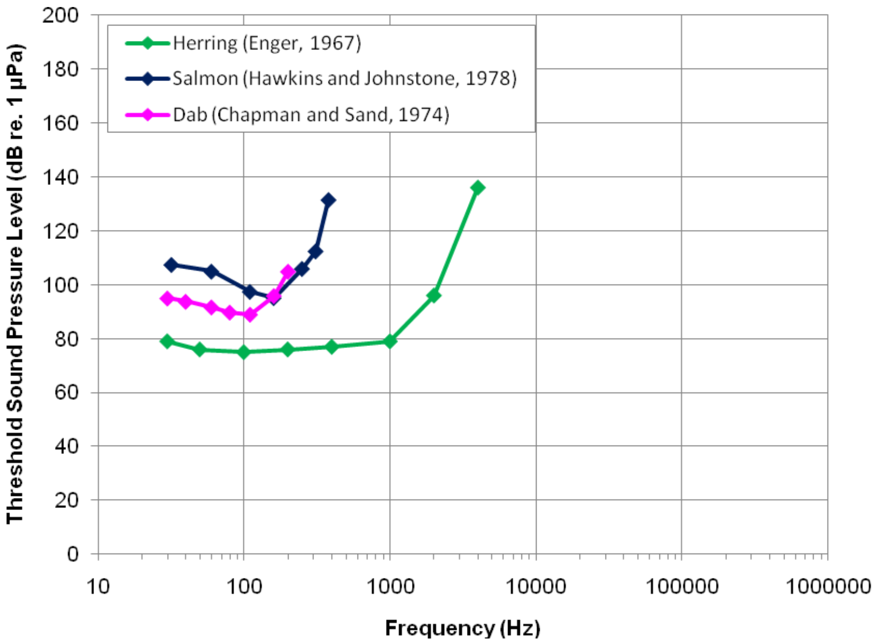

Figure 1.7-3 – Audiograms for the three fish species of interest in this study

1.8 Anticipated Worst Case Scenario for the Impacts of Underwater Noise during the EOWDC Construction

64 The two primary variables that are likely to affect the levels of underwater noise during impact piling operations are water depths and the diameter of the pile. To account for the worst case scenario in terms of water depths, an adjustment to the Lowest Astronomical Tide (LAT) depths provided by

Seazone to give high water conditions at the site (4.064 m above the lowest astronomical tide, taken from an Oceanographic survey undertaken for the AOWFL) has been made (EMU Ltd., 2008).

65 In order to inform discussions with the design engineers so that a realistic worst case scenario in terms of pile diameter could be determined preliminary modelling was carried out during the early stages of the project for various sizes of piles. From the consultations with the engineers using this modelling as a guide it was decided by the client that the modelling should be carried out assuming piles of 8.5 m in diameter at each location. This preliminary modelling report is included as an appendix to this report in section 1.11.2.

66 The simplest evaluation of the behavioural effects of noise considers the area of sea excluded to an animal by the noise. Where this is large or includes important areas, such as spawning grounds, the risk of an environmental effect of the noise may be significant. An alternative approach, which includes the significance of the period of exposure, is to consider the time for which the area is excluded, for instance by considering the impact in terms of kilometres squared of area and days of seabed excluded. On this basis, the influence of persistent lower level sources may dominate over intermittent high level sources, like piling. Thus, on this basis, it may be important to consider the changes in both duration and level of an activity when assessing the relative impact of two different methods of construction.

1.9 Impact Assessment: Impact Piling of 8.5 m Diameter Monopiles

1.9.1 Introduction

67 Presented in the following pages are the results of the modelling undertaken by Subacoustech Environmental Ltd using the underwater noise modelling software, INSPIRE (currently version 2.0), for the proposed piling operations for the installation of 8.5 m diameter piles at the EOWDC.

68 Figure 1.9-1 shows four representative example transects extending from wind turbine position 11 illustrating the varying bathymetry in the areas around the proposed EOWDC site. Comparison of the water depths at a bearing of 20° from WTG 11 which extends towards the shore with the transect at a bearing of 60° which extends directly out into the deeper water clearly shows a very large variation on water depths. For relatively shallow coastal waters, sound typically propagates with fewer losses in deeper water than for shallow water. It would therefore be expected that maximum impact ranges will be predicted for the deeper water transects.

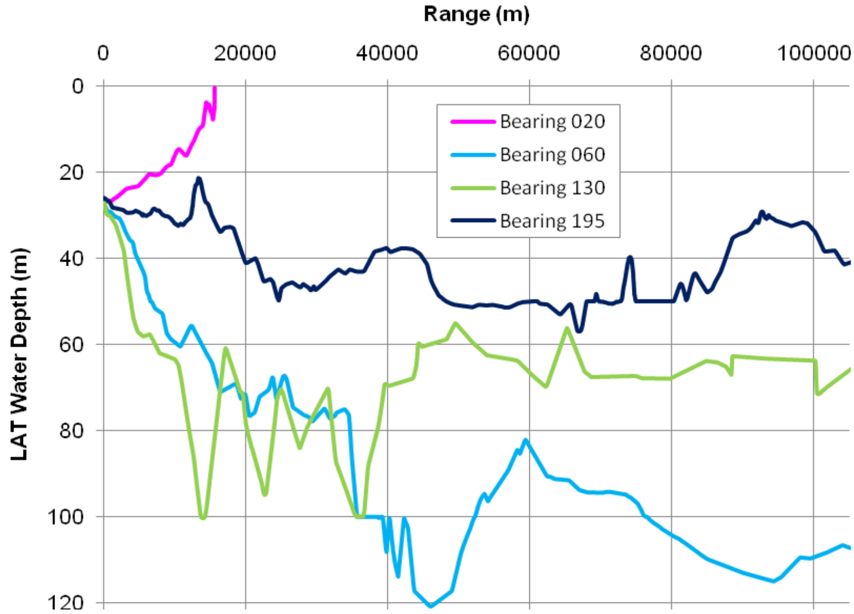

Figure 1.9-1 – Comparison of four representative depth profiles along transects from Wind turbine position 11, indicating the varying bathymetry around the proposed EOWDC site used for the INSPIRE modelling

69 Figure 1.9-2 shows the attenuation of unweighted peak to peak noise level against range for the four representative transects shown in Figure 3-1 for piling an 8.5 m diameter pile at wind turbine position 11. It can be seen that the shallower the water, such as for transects at bearings 020 and 195, the more rapidly the piling noise is likely to attenuate.

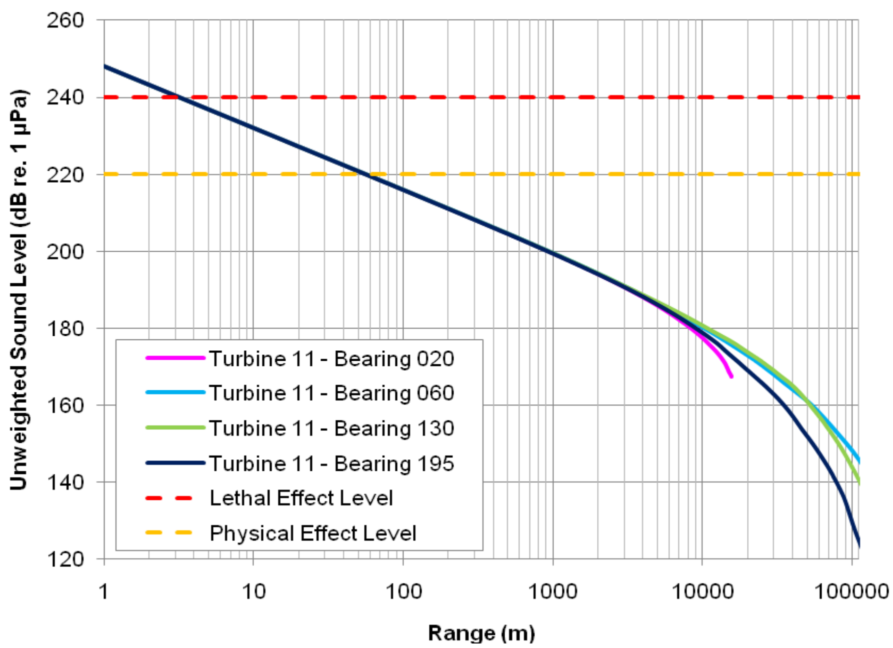

Figure 1.9-2 – Graph showing the unweighted peak to peak noise level with range for the four transects extending from wind turbine 11 shown in Figure 1.9-1

1.9.2 Unweighted Sound Levels; Potential for Lethality and Physical Injury to Marine Species

70 Table 1.9-1 shows the estimated ranges out to which lethal and physical injury may occur in marine species based on unweighted peak to peak sound levels and the criteria presented in section 1.6.5. The data indicate that marine species may suffer a lethal effect out to a range of approximately 3 m from the piling operation and that physical injury is likely to occur out to a range of 60 m. It should be noted that these impact ranges are based on the extrapolation of data from measurements taken at considerably greater ranges since it is generally not possible to carry out measurements this close to impact piling operations. “Near field” acoustic effects are likely to occur at close range to the piling operations so the levels of underwater noise maybe lower than those estimated by the INSPIRE model. It is therefore thought that lethality is therefore unlikely to occur in this case.

71 These impact ranges have been calculated using an estimated optimum blow force for installing an 8.5 m diameter pile. This is calculated using the piling logs from previous measurements undertaken by Subacoustech Environmental Ltd and extrapolating these figures to calculate an optimum blow force for a particular sized pile. In the case of an 8.5 m diameter pile it is estimated that a blow force of 1400 kJ (kilojoules) will be necessary to install the pile. However, this is dependent on the piling hammer used and ground type at the size.

72 Any residual risk of lethality and physical injury may be further mitigated by the use of a soft start procedure, or the use of acoustic mitigations devices such as seal scrammers or fish exclusion systems.

Table 1.9-1 – Summary of ranges out to which lethal effect and physical injury is expected to occur in marine species using the criteria proposed in Parvin *et al* (2007)

Peak to Peak Levels	Wind turbine 1	Wind turbine 3	Wind turbine 7	Wind turbine 11
Lethal Effect Range to 240 dB re. 1 µPa	3 m	3 m	3 m	3 m
Physical Injury Range to 220 dB re. 1 µPa	60 m	60 m	60 m	60 m

73 Figure 1.9-3 presents a contour plot of the estimated unweighted peak to peak levels of underwater noise from the four wind turbine positions, with each contour representing regions of the same unweighted sound level in 10 dB increments. It can be seen that the noise attenuates more rapidly in the slightly shallower waters directly to the east of the site, whereas the contours extend further to the north east where the water is deepest.

74 The figures indicate that there is likely to be relatively little variation in noise propagation for different wind turbine sites as the contours are all broadly similar in extent. This is likely due to the fact that the variation in water depths across the site is relatively small compared to the differences in water depths in the surrounding waters.

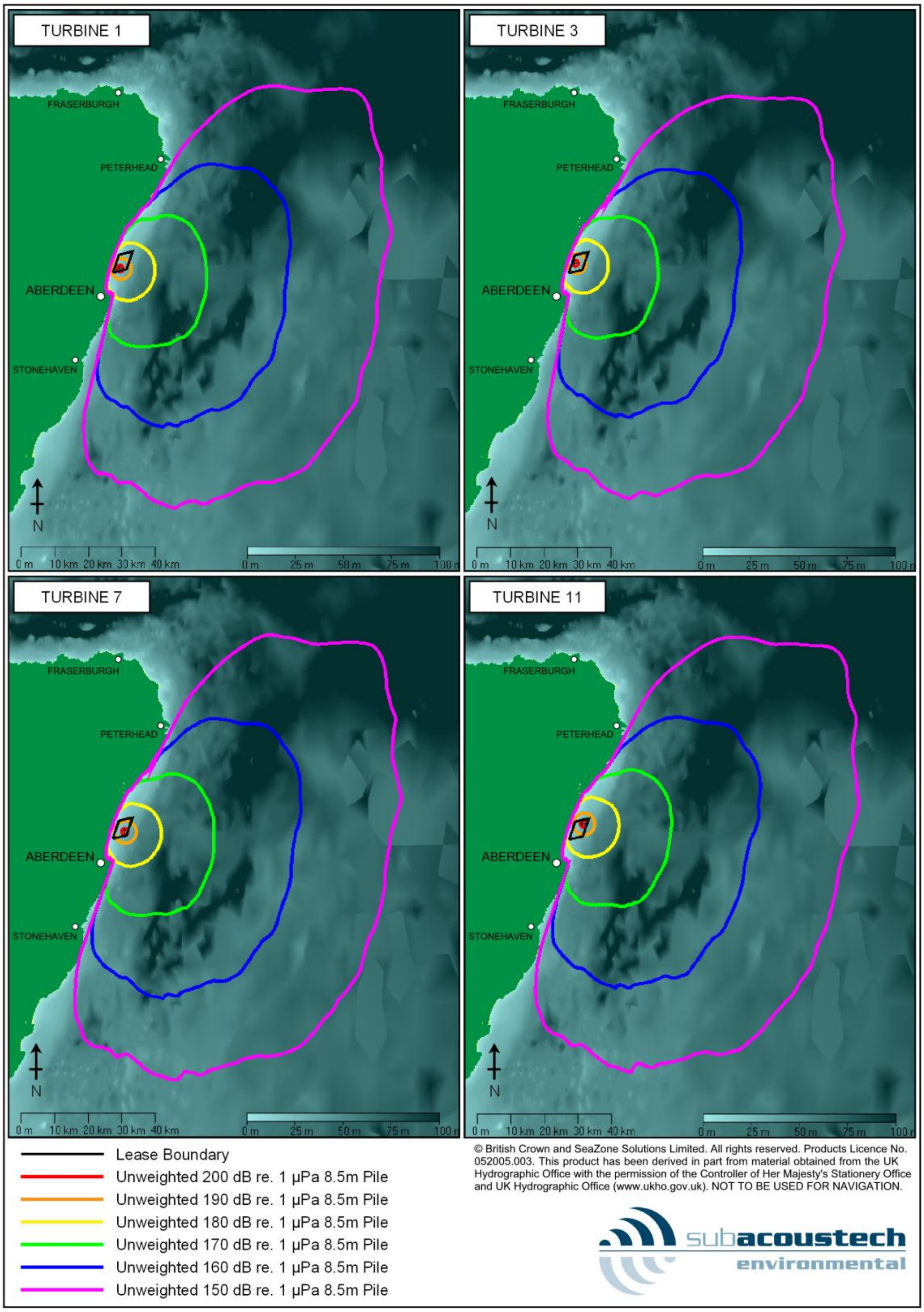

Figure 1.9-3 – Contour plots showing the estimated unweighted peak to peak noise levels from installing an 8.5 m diameter pile at the EOWDC site

75 Tables 1.9-2 to 1.9-4 summarise the estimated extent of underwater noise propagation in terms of three unweighted metrics, peak to peak level, peak level and sound exposure level calculated from single pile strikes analysed over a 0.5 second interval. It should be noted that the peak underwater noise levels, summarised in Table 1.9-3, have been calculated by reducing the

peak to peak noise levels predicted by the INSPIRE model by 6 dB. As the waveform of a pile strike is typically symmetrical about the ambient pressure level (equal high and low pressure excursions) it can be reasonably assumed that the peak pressure level is half of the peak to peak pressure level (a reduction of 6 dB). Also shown in Table 1.9-3 are the injury and behavioural avoidance impact ranges using the single pulse peak level criteria for species of cetacean and pinniped proposed by Southall *et al* (2007), outlined in tables 1.6-2 and 1.6-4.

76 Overall, the data indicate that the underwater noise is likely to propagate marginally further for wind turbine positions 7 and 11. This indicates the effect of wind turbines located to the east of the site, in close proximity to the deep water of the North Sea, as propagation losses are typically lower in deeper water.

Table 1.9-2 – Summary of the estimated mean ranges to various unweighted peak to peak noise levels during installation of 8.5 m diameter piles

Peak to Peak Levels	Wind turbine 1	Wind turbine 3	Wind turbine 7	Wind turbine 11
Range to 200 dB re. 1 µPa	920 m	890 m	960 m	940 m
Range to 190 dB re. 1 µPa	3.1 km	2.8 km	3.3 km	3.2 km
Range to 180 dB re. 1 µPa	7.2 km	6.5 km	8.1 km	7.8 km
Range to 170 dB re. 1 µPa	14 km	13 km	16 km	15 km
Range to 160 dB re. 1 µPa	25 km	24 km	27 km	27 km
Range to 150 dB re. 1 µPa	38 km	36 km	41 km	40 km

Table 1.9-3 – Summary of the estimated mean ranges to various unweighted peak noise levels during installation of 8.5 m diameter piles, including the PTS and TTS criteria shown in Tables 1.6-2 and 1.6-4

Peak Levels	Wind turbine 1	Wind turbine 3	Wind turbine 7	Wind turbine 11
Range to 230 dB re. 1 µPa (Cetacean Injury criteria, Southall *et al* 2007)	5 m	5 m	5 m	5 m
Range to 224 dB re. 1 µPa (Cetacean Behavioural avoidance criteria, Southall *et al* 2007)	15 m	15 m	15 m	15 m
Range to 218 dB re. 1 µPa (Pinniped Injury criteria, Southall *et al* 2007)	30 m	30 m	30 m	30 m
Range to 214 dB re. 1 µPa (Pinniped Behavioural avoidance criteria, Southall *et al* 2007)	60 m	60 m	60 m	60 m
Range to 200 dB re. 1 µPa	410 m	400 m	420 m	420 m
Range to 190 dB re. 1 µPa	1.5 km	1.5 km	1.6 km	1.6 km
Range to 180 dB re. 1 µPa	4.5 km	4.0 km	5.0 km	4.8 km
Range to 170 dB re. 1 µPa	9.6 km	11 km	11 km	10 km
Range to 160 dB re. 1 µPa	18 km	20 km	20 km	20 km
Range to 150 dB re. 1 µPa	30 km	33 km	33 km	32 km

Table 1.9-4 – Summary of the estimated mean ranges to various unweighted sound exposure levels (SELs) during installation of 8.5 m diameter piles

Sound Exposure Levels	Wind turbine 1	Wind turbine 3	Wind turbine 7	Wind turbine 11
Range to 200 dB re. 1 $\mu Pa^2/s$	20 m	20 m	20 m	20 m
Range to 190 dB re. 1 $\mu Pa^2/s$	100 m	100 m	100 m	100 m
Range to 180 dB re. 1 $\mu Pa^2/s$	510 m	500 m	520 m	520 m
Range to 170 dB re. 1 $\mu Pa^2/s$	2.2 km	2.1 km	2.4 km	2.3 km
Range to 160 dB re. 1 $\mu Pa^2/s$	6.8 km	6.1 km	7.6 km	7.3 km
Range to 150 dB re. 1 $\mu Pa^2/s$	16 km	14 km	17 km	17 km

1.9.3 *Estimates of Ranges at which Traumatic Hearing Damage may occur for Single Pulses*

1.9.3.1 The dB_{ht} metric

77 Table 1.9-5 shows the estimated impact ranges for traumatic hearing injury, using the dB_{ht} metric, for the marine species of interest, based on the 130 dB_{ht} criterion from Nedwell *et al* (2007). The results are given for each of the four locations modelled at the proposed EOWDC site. The 130dB_{ht} perceived level is used to indicate traumatic hearing damage over a very short exposure time of only a few pile strikes at most.

78 The largest estimated ranges out to which hearing damage may occur are for harbour porpoise with an estimated impact range of 570 m for impact piling an 8.5 m pile at both wind turbine positions 7 and 11. Of the marine mammals, the data indicate that the seal species are likely to suffer these effects out to the smallest ranges. The data indicate that salmon and dab are only likely to suffer traumatic hearing damage out to 20 – 30 m, however, it is estimated that herring are likely to suffer this effect out to considerably larger ranges of up to approximately 480 m.

79 It should be noted that, as with the lethality and physical injury criteria, and with all predicted behavioural avoidance criteria, the risk of hearing damage may be mitigated by the use of soft start for the piling operation, or the use of suitable acoustic mitigation devices such as seal scrammers or fish exclusion systems.

Table 1.9-5 – Summary of ranges out to which traumatic hearing injury is predicted to occur in various marine species using the 130 dB_{ht}(*Species*) criteria (Nedwell *et al, 2007)* while piling a 8.5 m diameter pile

Species	130 dB_{ht} Ranges			
	Wind turbine 1	Wind turbine 3	Wind turbine 7	Wind turbine 11
Bottlenose Dolphin Risso's Dolphin	290 m	290 m	290 m	290 m
Harbour Porpoise	560 m	550 m	570 m	570 m
White-Beaked Dolphin	240 m	240 m	250 m	240 m
Harbour Seal Grey Seal	120 m	120 m	120 m	120 m
Herring	470 m	460 m	480 m	480 m
Salmon	20 m	20 m	20 m	20 m
Dab	30 m	30 m	30 m	30 m

1.9.3.2 M-Weighted Sound Exposure Levels

80 Auditory injury criteria for marine mammals have been proposed by Southall *et al*. (2007) based on M-weighted SELs; SELs calculated from single pile strikes over a 0.5 second interval and then filtered using the M-weighting

criteria for low, mid and high cetacean groups as well as pinnipeds. This study has recently been used as the basis for draft guidance from the Joint Nature Conservation Committee (JNCC) on assessing the likelihood of a particular activity causing a disturbance to marine mammals. Modelling has therefore been carried out in order to provide the estimated mean impact ranges for the four groups of marine mammals specified in the Southall paper, in terms of these metrics. The results of this modelling assuming a single pulse (i.e. a single pile strike at the receiver) are summarised in Tables 1.9-6 to 1.9-9.

81 Tables 1.9-6 to 1.9-9 summarise the estimated impact ranges out to which auditory injury may occur, based on the single pulse Southall *et al* (2007) criteria. The largest estimated ranges are for the pinnipeds marine mammal group, with a mean range to likely auditory injury of between 120 and 130 m. For the three cetacean groups the largest impact ranges are predicted for the low frequency cetaceans followed by the mid frequency cetaceans with the smallest ranges predicted for the high frequency cetaceans. This is due to piling noise containing mainly low frequency components.

Table 1.9-6 – Summary of ranges out to which audiological injury to cetaceans in the low frequency cetaceans group may occur using the Southall *et al* (2007) criteria

Low Frequency Cetaceans	Auditory Injury Range 198 dB re. 1 μPa^2/s (M_{lf})
Wind turbine 1	20 m
Wind turbine 3	20 m
Wind turbine 7	20 m
Wind turbine 11	20 m

Table 1.9-7 – Summary of ranges out to which audiological injury to cetaceans in the mid frequency cetaceans group may occur using the Southall *et al* (2007) criteria

Mid Frequency Cetaceans	Auditory Injury Range 198 dB re. 1 μPa^2/s (M_{mf})
Wind turbine 1	10 m
Wind turbine 3	10 m
Wind turbine 7	10 m
Wind turbine 11	10 m

Table 1.9-8 – Summary of ranges out to which audiological injury to cetaceans in the high frequency cetaceans group may occur using the Southall *et al* (2007) criteria

High Frequency Cetaceans	Auditory Injury Range 198 dB re. 1 μPa^2/s (M_{hf})
Wind turbine 1	7 m
Wind turbine 3	7 m
Wind turbine 7	7 m
Wind turbine 11	7 m

Table 1.9-9 – Summary of ranges out to which audiological injury to pinnipeds (in water) may occur using the Southall *et al* (2007) criteria

Pinnipeds (in water)	Auditory Injury Range 186 dB re. 1 μPa^2/s (M_{pw})
Wind turbine 1	120 m
Wind turbine 3	120 m
Wind turbine 7	130 m
Wind turbine 11	130 m

1.9.3.3 dB_{ht}/M-weighting results comparison

82 It may be noted that these ranges disagree with those predicted using the dB_{ht} model, these M-weighted results are summarised for wind turbine position 1 alongside the equivalent dB_{ht} (*Species*) results for auditory injury in Table 1.9-10 shown below. The data indicate substantially lower ranges of effect for the species of cetacean when using the single pulse Southall *et al* (2007) criteria.

83 The recommendations of Southall are founded on re-interpretation of existing public-domain information, which the authors themselves note are “variable in quantity and quality.” Further, the recorded observations of the behavioural effects on marine animals caused by noise have been re-evaluated by Southall using SPL as a measure of level, and applying simple assumptions regarding transmission loss to estimate the received level of noise as an SEL. It should be noted however that the SEL of a noise source will very probably vary with range in a different way to that which has been assumed for its SPL; and this may account in part for the anomalous results.

Table 1.9-10 Summary of impact ranges comparing the single pulse auditory injury ranges predicted using the dB_{ht} criteria (Nedwell *et al*, 2007) and the M-weighted SEL (Southall *et al*, 2007) criteria

dB_{ht} (Nedwell *et al*, 2007)		M-weighted SELs (Southall *et al*, 2007)	
Species	**Single pulse auditory injury range (130 dB_{ht})**	**Equivalent M-weighting group**	**Single pulse auditory injury range**
Bottlenose Dolphin	290 m	Mid Frequency Cetacean	10 m
Harbour Porpoise	560 m	High Frequency Cetacean	7 m
Harbour Seal	120 m	Pinnipeds (in water)	130 m

1.9.4 Estimated Ranges at Which Traumatic Hearing Damage may Occur for Multiple Pulses

1.9.4.1 dB_{ht} Cumulative Noise Dose for Fleeing Animal Scenario

84 An estimate of the minimum safe standoff distances from the piling operation based on the INSPIRE fleeing animal noise dose algorithm have also been made. Each standoff range indicates that if a particular species is closer than that range at the onset of piling, then they are unlikely to be able to flee the area before suffering hearing damage. This is based on a conservative swim speed of 1 metre per second (m/s) and takes into account the accumulated noise dose over a typical piling operation.

85 Figure 1.9-4 shows a detailed plot of the results of this modelling that has been carried out for each of the key species, in this case the figure is shown for species of seal. It can be seen that the 90 dB_{ht} $L_{EP,\,D}$ criteria (illustrated by the dashed line) is met between the 100 and 200 m starting range datasets. This means that if the seal were to be closer to the piling operations than these ranges at the onset of piling it is unlikely to escape the area without receiving a damaging noise dose.

86 Table 1.9-11 below presents the results of this modelling for the other key species of fish and marine mammal. It can be seen from these data that herring and harbour porpoise will need to be at the greatest distance from the piling operation at its onset to avoid suffering hearing damage. If the fleeing animal is beyond the ranges presented in Table 1.9-11 that they are likely to be able to reach a safe distance before receiving an unacceptable noise dose.

Table 1.9-11 Summary of the maximum starting ranges for various marine species using the fleeing animal noise dose model

Marine Species	Maximum Starting Range for Fleeing Animal
Bottlenose Dolphin / Risso's Dolphin	120 m
Harbour Porpoise	1350 m
White-Beaked Dolphin	460 m
Harbour Seal / Grey Seal	190 m
Herring	1750 m
Salmon	1 m
Dab	20 m

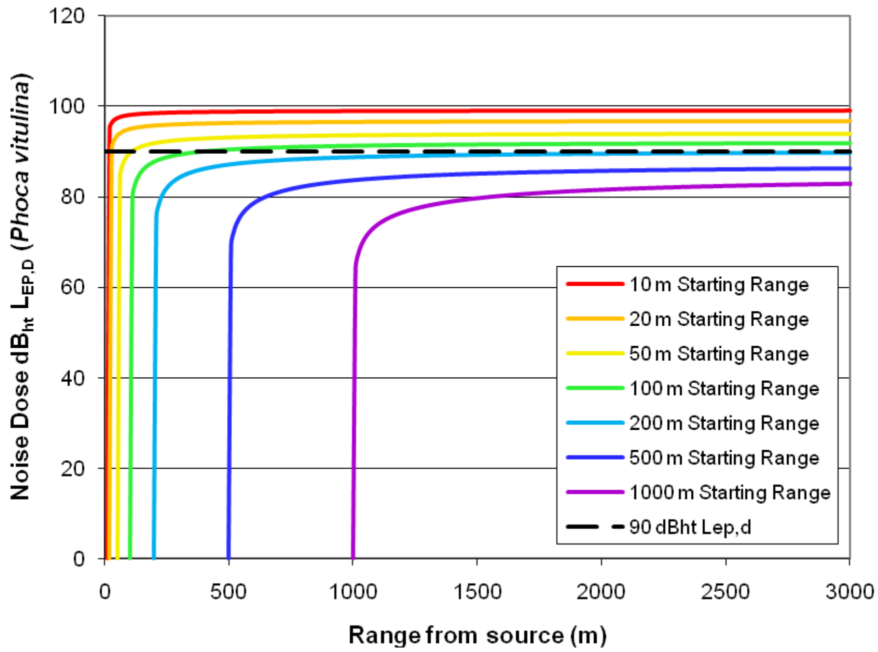

Figure 1.9-4 – Estimated noise dose for a fleeing Harbour Seal or Grey Seal for impact piling of an 8.5 m diameter pile

1.9.4.2 <u>dB$_{ht}$ Cumulative Noise Dose for Stationary Animal Scenario</u>

87 Noise dose modelling has also been carried out for a stationary animal during piling operations. It should be noted that this is considered an unlikely scenario as it implies that the animal makes no attempt to flee the high sound field area. This assessment has been carried out for the harbour seal, and the results can be seen in Figure 1.9-5.

88 It can be seen that the results for the stationary animal modelling give much higher starting ranges than for the fleeing animal modelling, with the starting range for the harbour seal rising from 190 m for a fleeing animal up to almost 1 km for a stationary animal.

89 Further modelling to estimate similar impact ranges for other species has not been carried out for the stationary animal scenario as it is not felt to represent a realistic case. The data presented for the seal is provided to indicate the potential differences in the two scenarios.

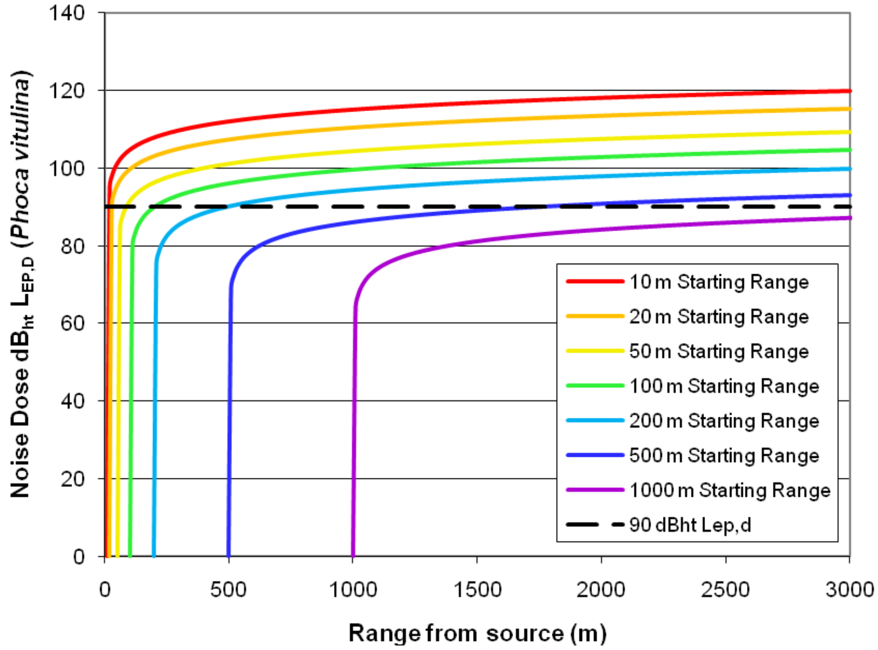

Figure 1.9-5 Estimated noise dose for a stationary Harbour Seal or Grey Seal for impact piling of an 8.5 m diameter pile

1.9.4.3 M-Weighting SEL Multiple Pulses

90 The accumulated exposure to sound for marine mammals has been assessed using the auditory injury criteria proposed by Southall *et al* (2007). This has been done by calculating a standoff range for each marine mammal group, whereby it would safely be able to escape the affected area without receiving a damaging exposure to the sound. Table 1.9-12 shows a summary of these standoff ranges for fleeing animals, assuming a swim speed of 1 m/s. The largest standoff ranges are calculated for the pinnipeds, which, based on the M-weighting criteria are likely to need to be at a range of at least 3.6 km at the onset of piling to avoid a damaging exposure to the sound. Lower standoff ranges are predicted for the three cetacean groups with low frequency cetaceans being the most sensitive to the sound and high frequency cetaceans being the least.

91 Once again, it should be noted that these results do not take into account the mitigating effects of a soft start procedure; these results assume a high blow force at the onset of piling. As long as a soft start procedure is used the effect is likely to be reduced.

92 Figure 1.9-6 shows the calculated multiple pulse M-weighted sound exposure levels for a fleeing high frequency cetacean at various starting ranges, from this it can be seen that if the animal was situated at a range of less than approximately 500 m from the piling operations at the onset of piling it is unlikely to escape the area without receiving a damaging exposure to noise according to the Southall *et al* (2007) criteria. Figure 1.9-7 shows similar data for the high frequency cetacean group; however, this is for a stationary animal during the piling operations. It can be seen that the animal would have to be between 1 and 1.5 km at the onset of piling to avoid a damaging sound exposure level, assuming that it stayed in the same position throughout the entire piling operation. It should be noted that this scenario is considered highly unlikely as marine species are likely to attempt to escape areas where injury is likely to be caused.

Table 1.9-12 Summary of the maximum starting ranges for marine mammal groups before receiving an exposure level that could cause auditory injury, using the multiple pulse criteria from Southall *et al* (2007).

Marine Mammal Group	Maximum Starting Range
Low Frequency Cetaceans	1350 m
Mid Frequency Cetaceans	820 m
High Frequency Cetaceans	650 m
Pinnipeds (in water)	3600 m

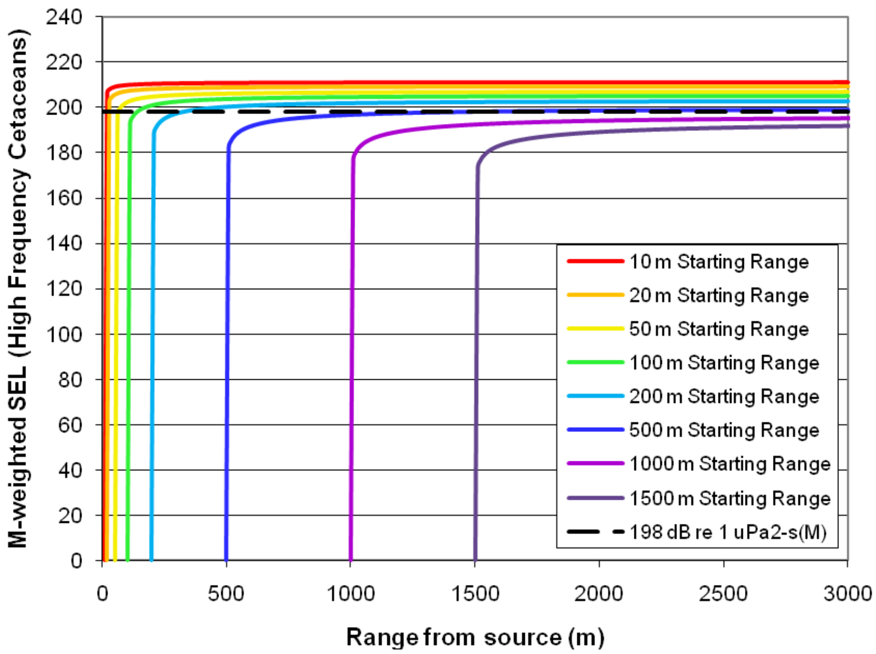

Figure 1.9-6 – Estimated M-weighted Sound Exposure levels from various starting ranges for High Frequency Cetaceans using the multiple pulse criteria from Southall *et al* (2007) for a fleeing animal

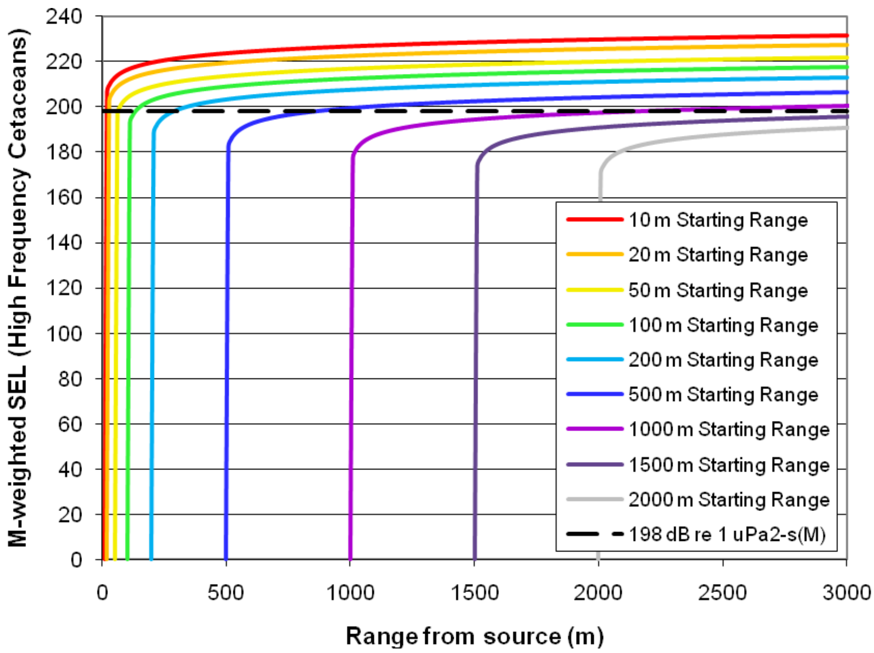

Figure 1.9-7 – Estimated M-weighted Sound Exposure levels from various starting ranges for High Frequency Cetaceans using the multiple pulse criteria from Southall *et al* (2007) for a stationary animal

93 Table 1.9-13 shows a comparison between multiple pulse auditory injury impact ranges for three marine mammals species calculated using the dB_{ht} criteria and the three equivalent M-weighted SEL marine mammal groups.

94 The data indicate that, unlike the single pulse exposure modelling, in some cases the dB_{ht} metric provides the largest estimated range of impact and in some cases the M-weighted SEL metric provides the largest impact range. This discrepancy is result of the different approaches adopted for the two metrics, however, the potential issues with the M-weighting metric have been discussed earlier in this report.

Table 1.9-13 Summary of impact ranges comparing the multiple pulse auditory injury ranges, using the fleeing animal model, predicted using the dB_{ht} criteria (Nedwell *et al*, 2007) and the M-weighted SEL (Southall *et al*, 2007) criteria

dB_{ht} (Nedwell *et al*, 2007)		M-weighted SELs (Southall *et al*, 2007)	
Species	**Multiple pulse auditory injury range (fleeing animal)**	**Equivalent M-weighting group**	**Multiple pulse auditory injury range (fleeing animal)**
Bottlenose Dolphin	120 m	Mid Frequency Cetacean	820 m
Harbour Porpoise	1350 m	High Frequency Cetacean	650 m
Harbour Seal	190 m	Pinnipeds	3600 m

1.9.5 Estimates of Behavioural Impact on Marine Species

1.9.5.1 Peak to Peak dB_{ht}

95 Figures 1.9-4 and 1.9-5 show the results for modelling 8.5 m diameter piles in terms of peak to peak dB_{ht} (*Species*) perceived sound levels for the marine species of interest for a deep water transect and a shallower water transect respectively. The depth profiles for these transects are shown in Figure 1.9-1.

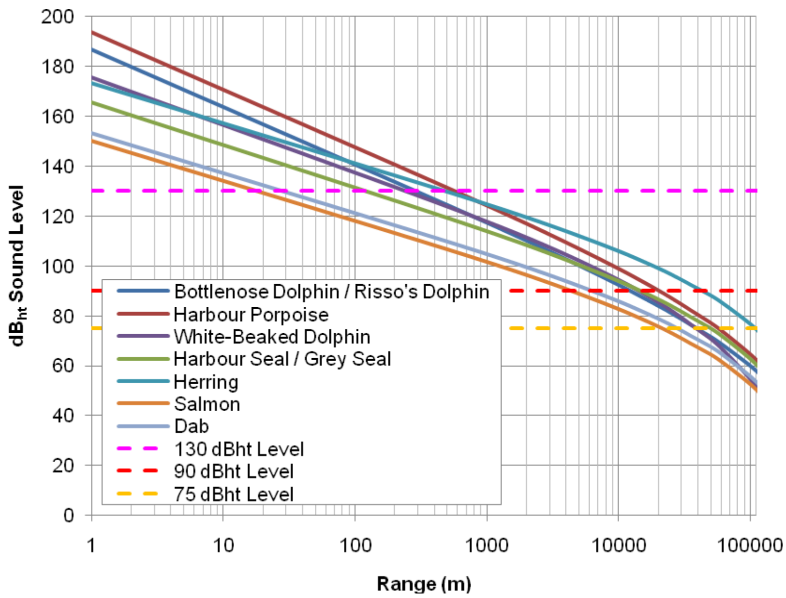

Figure 1.9-8 – Estimated peak to peak dB_{ht} level with range plot of various marine species along a deep water transect (Wind turbine 11, Bearing 060) during the installation of an 8.5 m diameter pile

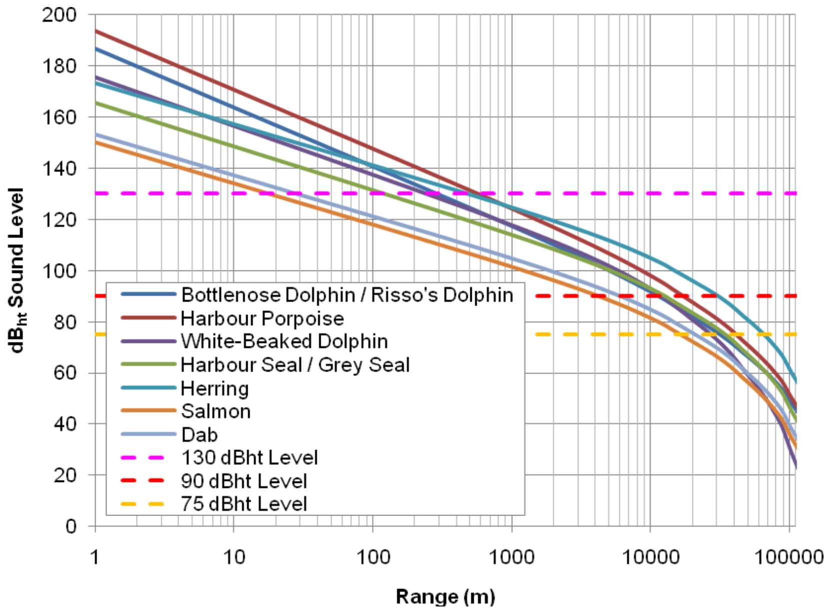

Figure 1.9-9 – Estimated peak to peak dB_{ht} level with range plot of various marine species along a shallow water transect (Wind turbine 11, Bearing 195) during the installation of an 8.5 m diameter pile

96 Table 1.9-14 to 1.9-17 present a comparison of estimated 90 dB_{ht} impact ranges for behavioural response for the species of interest at MHWS. Mean ranges along with the overall range of values are presented for all four wind turbine positions.

97 It can be seen that the largest impact ranges predicted are for herring, where maximum 90 dB_{ht} impact ranges of between 44 and 47 km are predicted. The other key fish species assessed in this study, salmon and dab, have much smaller impact ranges, from between 4.2 and 4.7 km for salmon and between 6.2 and 6.8 km for dab.

98 For species of marine mammal, the largest impact ranges are predicted for the harbour porpoise, which is likely to receive an underwater noise level of $90dB_{ht}$ out to maximum of 22 km from piling operations. The smallest 90 dB_{ht} impact ranges predicted for species of marine mammal is for bottlenose dolphin and Risso's dolphin, which are predicted maximum 90 dB_{ht} impact ranges of between 12 and 13 km.

99 The INSPIRE model calculates impact ranges along transect paths from a selected point, in this case the wind turbine positions, along 180 equally spaced transects (one every 2º). The maximum, minimum and mean ranges from all of these transects are collected in the tables below. It should be noted that the minimum ranges are for transects heading into shallow water, and in most cases, are reaching the coastline before the sound has attenuated to below 90 dB_{ht}. Hence why, for example, all the minimum ranges from Wind turbine 1 are calculated to be 3 km, as this is the minimum distance between the wind turbine position and the coastline. All the predicted received noise for all the key species is still above 90 dB_{ht} at this particular piece of coastline.

100 As the mean values quoted in the tables take into account all of the transects, these apparently shorter impact ranges are also used on the averaging. It is, therefore, suggested that the maximum values quoted and the contour plots presented later are also considered along with these results.

Table 1.9-14 – Summary of the estimated impact ranges for piling an 8.5 m diameter pile at wind turbine position 1 on various marine species

Species	90 dB_{ht} Range	
	Mean	Range of values
Bottlenose Dolphin Risso's Dolphin	8.5 km	3.0 – 13 km
Harbour Porpoise	12 km	3.0 – 21 km
White-Beaked Dolphin	9.3 km	3.0 – 15 km
Harbour Seal Grey Seal	9.6 km	3.0 – 16 km
Herring	22 km	3.0 – 45 km
Salmon	3.9 km	3.0 – 4.4 km
Dab	5.2 km	3.0 – 6.5 km

Table 1.9-15 – Summary of the estimated impact ranges for piling an 8.5 m diameter pile at wind turbine position 3 on various marine species

Species	90 dB_{ht} Range	
	Mean	Range of values
Bottlenose Dolphin Risso's Dolphin	7.9 km	2.3 – 12 km
Harbour Porpoise	11 km	2.3 – 20 km
White-Beaked Dolphin	8.4 km	2.3 – 14 km
Harbour Seal Grey Seal	8.7 km	2.3 – 15 km
Herring	20 km	2.3 – 44 km
Salmon	3.5 km	2.3 – 4.2 km
Dab	4.6 km	2.3 – 6.2 km

Table 1.9-16 – Summary of the estimated impact ranges for piling an 8.5 m diameter pile at wind turbine position 7 on various marine species

Species	90 dB_{ht} Range	
	Mean	Range of values
Bottlenose Dolphin Risso's Dolphin	9.5 km	4.1 – 13 km
Harbour Porpoise	13 km	4.1 – 22 km
White-Beaked Dolphin	10 km	4.1 – 16 km
Harbour Seal Grey Seal	11 km	4.1 – 16 km
Herring	24 km	4.1 – 47 km
Salmon	4.2 km	3.6 – 4.7 km
Dab	5.8 km	4.1 – 6.8 km

Table 1.9-17 – Summary of the estimated impact ranges for piling an 8.5 m diameter pile at wind turbine position 11 on various marine species

Species	90 dB_{ht} Range	
	Mean	Range of values
Bottlenose Dolphin Risso's Dolphin	9.2 km	3.8 – 13 km
Harbour Porpoise	13 km	3.8 – 21 km
White-Beaked Dolphin	10 km	3.8 – 16 km
Harbour Seal Grey Seal	10 km	3.8 – 16 km
Herring	23 km	3.8 – 47 km
Salmon	4.1 km	3.4 – 4.6 km
Dab	5.6 km	3.8 – 6.6 km

101 These results are also presented graphically as contour plots in Figures 1.9-10 to 1.9-16, with each group of images showing the 90 and 75 dB_{ht} impact ranges for each marine species of interest. The 75 dB_{ht} level is a lower behavioural avoidance level which has been used for analysis to show a level of "significant avoidance". At this level, about 85% of individuals will react to noise, although the effect will probably be limited in duration by habituation. In general, the 90dB_{ht} criteria level is thought to represent the most useful measure of behavioural disturbance in this case. It should be noted that the figures for dab and salmon are shown in a larger scale that the contours for the other species, this is so the extents of these smaller impact ranges can be seen in detail.

102 It can be seen from these figures that the maximum impact ranges stretch out to the east and north east of the proposed EOWDC into the deeper water of the North Sea, where, in some places, water depths are in excess of 100 m LAT. The data indicate that, in nearly all cases, the minimum 90 dB_{ht} contours are the same for each pile; this is due to sound levels being above 90 dB_{ht} for these species at the Scottish coastline. Salmon is the exception to this where, on two occasions, Turbine 7 and Turbine 11, noise levels during the

installation of 8.5m diameter piles have dropped below 90 dB_{ht}(*Salmo salar*) before reaching the Scottish coastline to the west.

103 As with the unweighted results it can be seen from these contour plots that the difference between the impact ranges at the four wind turbine sites are similar. The largest impact ranges are estimated for wind turbines 7 and 11; this is due to being situated on the east boundary of the proposed EOWDC, which is closer to the deep water of the North Sea.

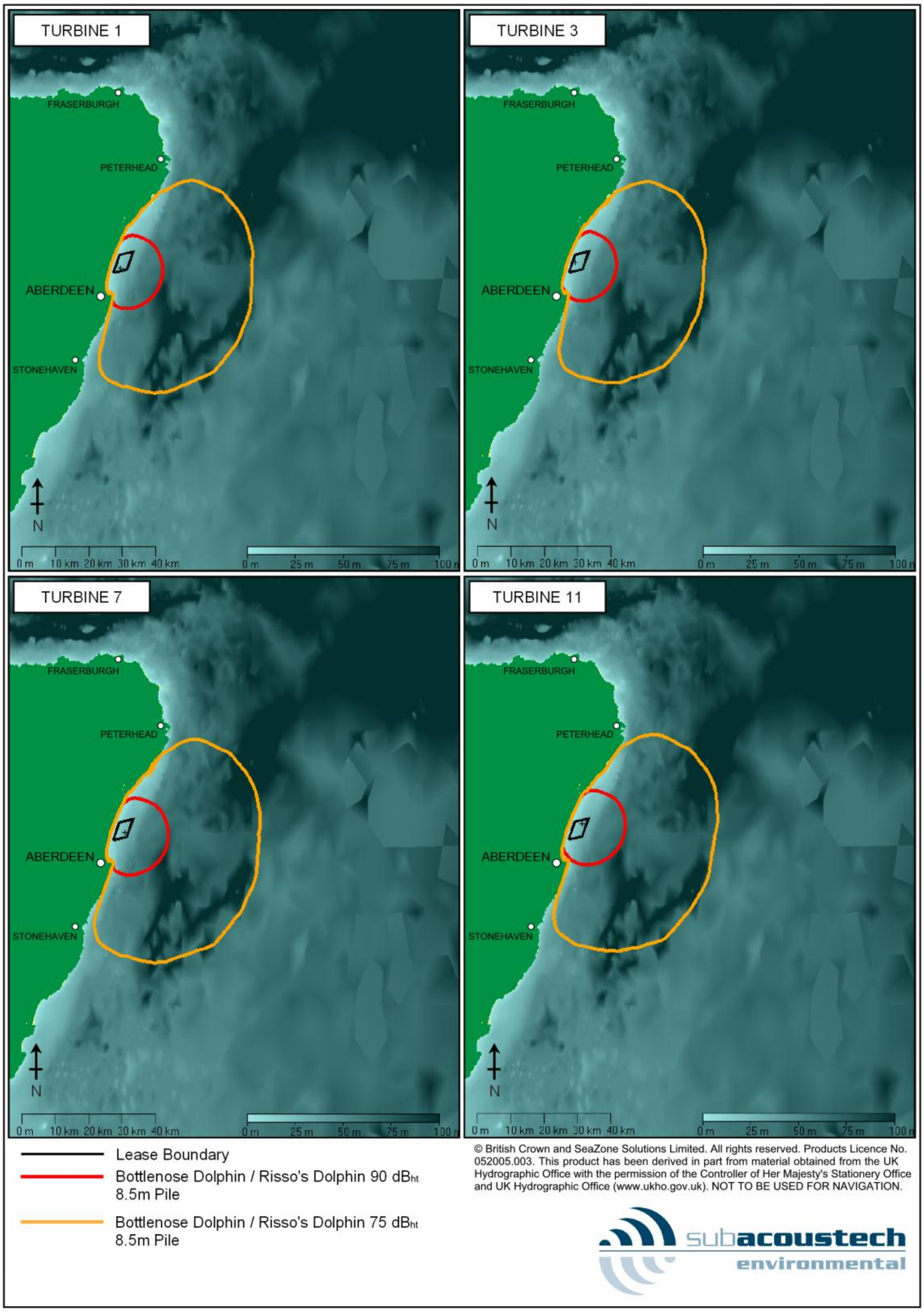

Figure 1.9-10 – Contour plots showing the estimated 90 and 75 dB$_{ht}$ peak impact ranges for Bottlenose Dolphin and Risso's Dolphin during installation of an 8.5 m diameter pile

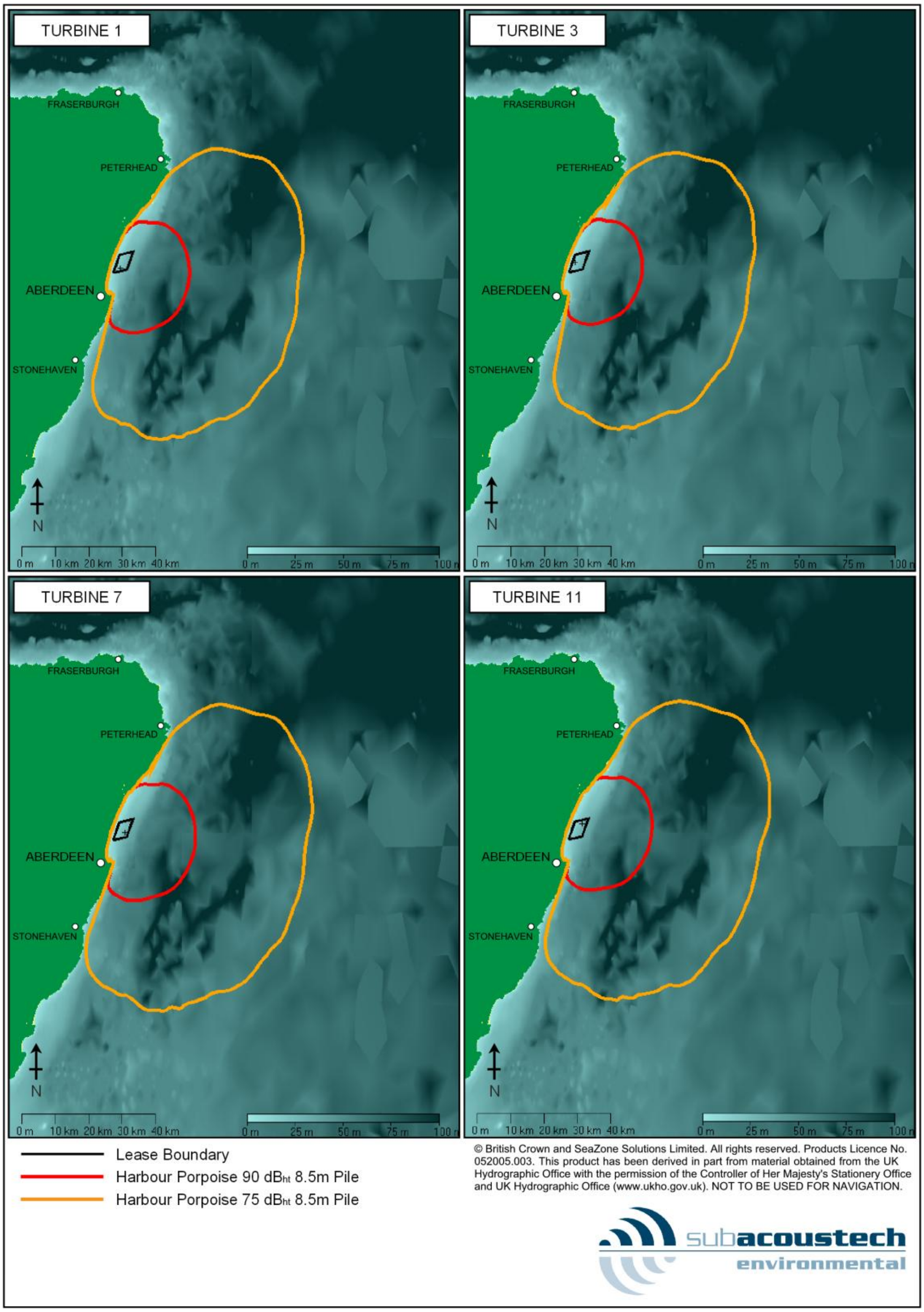

Figure 1.9-11 – Contour plots showing the estimated 90 and 75 dB_{ht} peak impact ranges for Harbour Porpoise during installation of an 8.5 m diameter pile

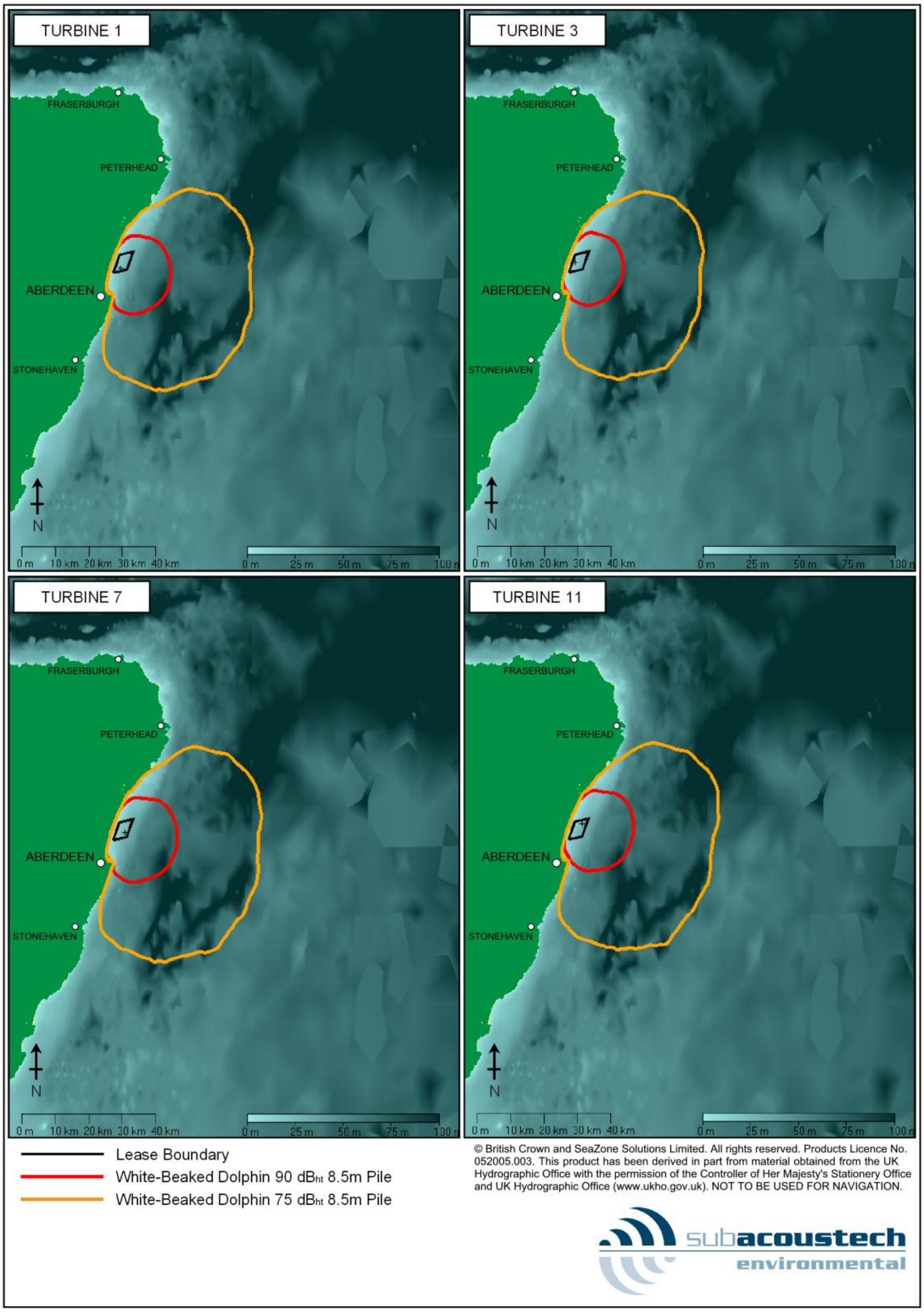

Figure 1.9-12 – Contour plots showing the estimated 90 and 75 dB_{ht} peak impact ranges for White-Beaked Dolphin during installation of an 8.5 m diameter pile

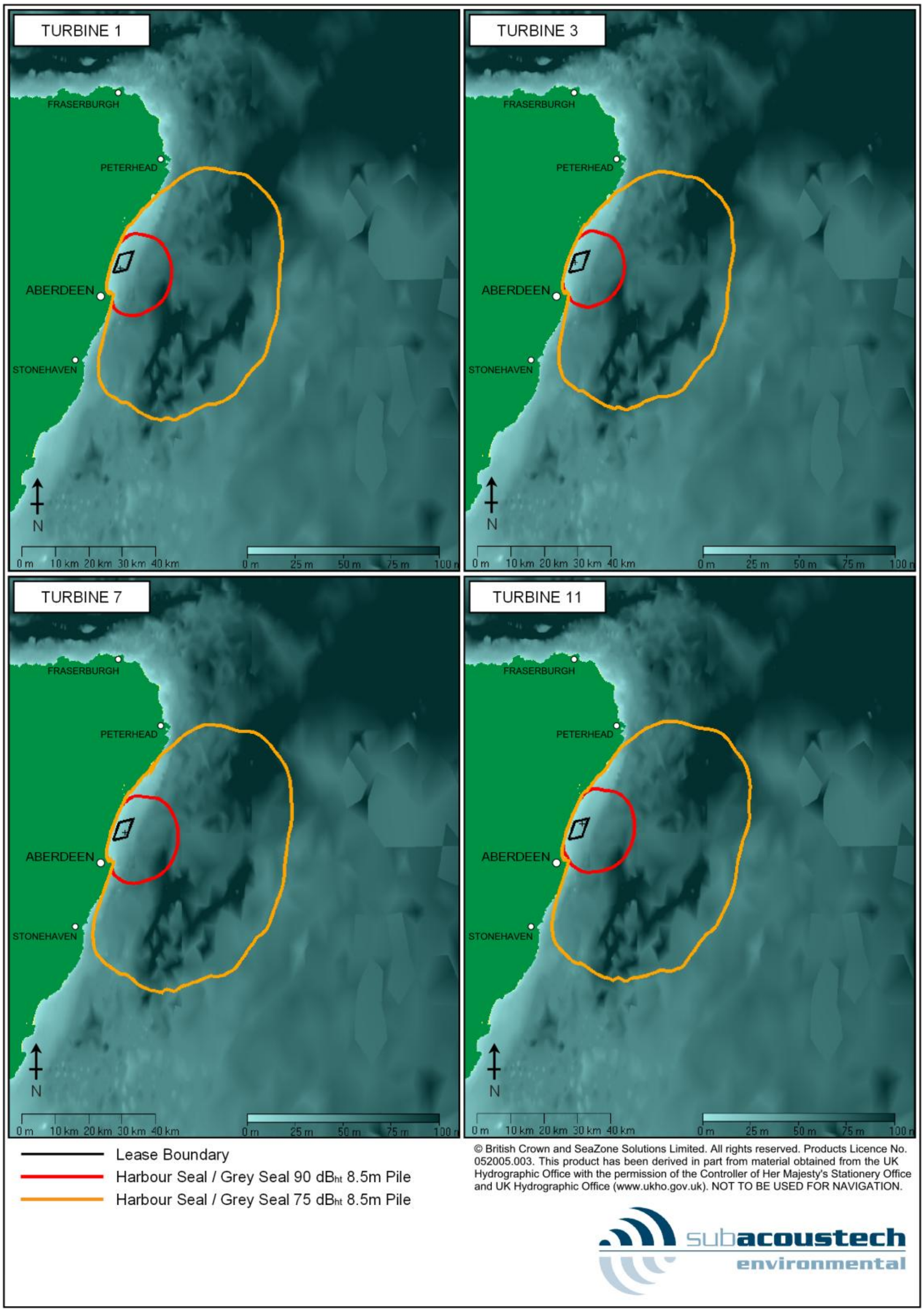

Figure 1.9-13 – Contour plots showing the estimated 90 and 75 dB$_{ht}$ peak impact ranges for Harbour Seal and Grey Seal during installation of an 8.5 m diameter pile

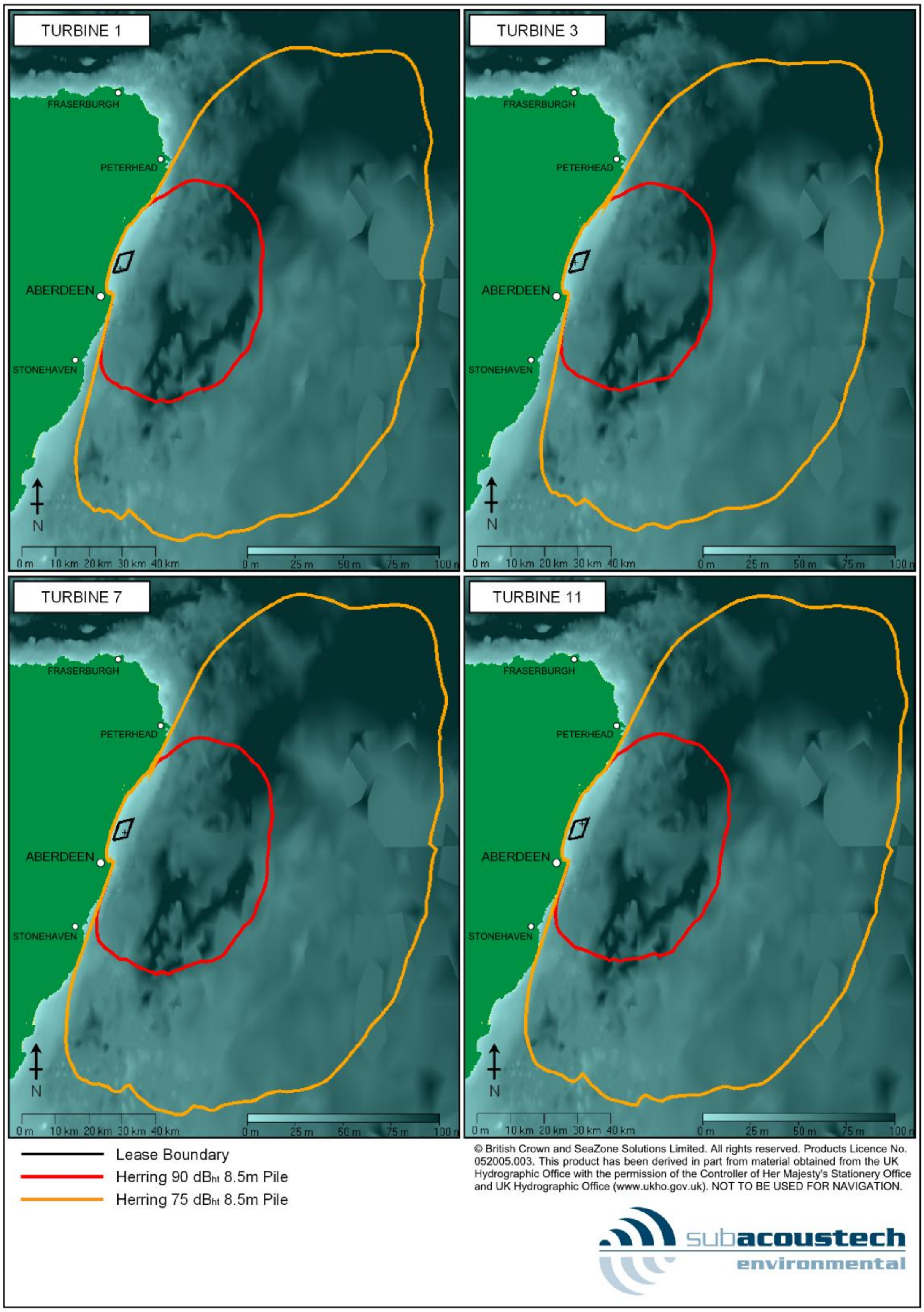

Figure 1.9-14 – Contour plots showing the estimated 90 and 75 dB_{ht} peak impact ranges for Herring during installation of an 8.5 m diameter pile

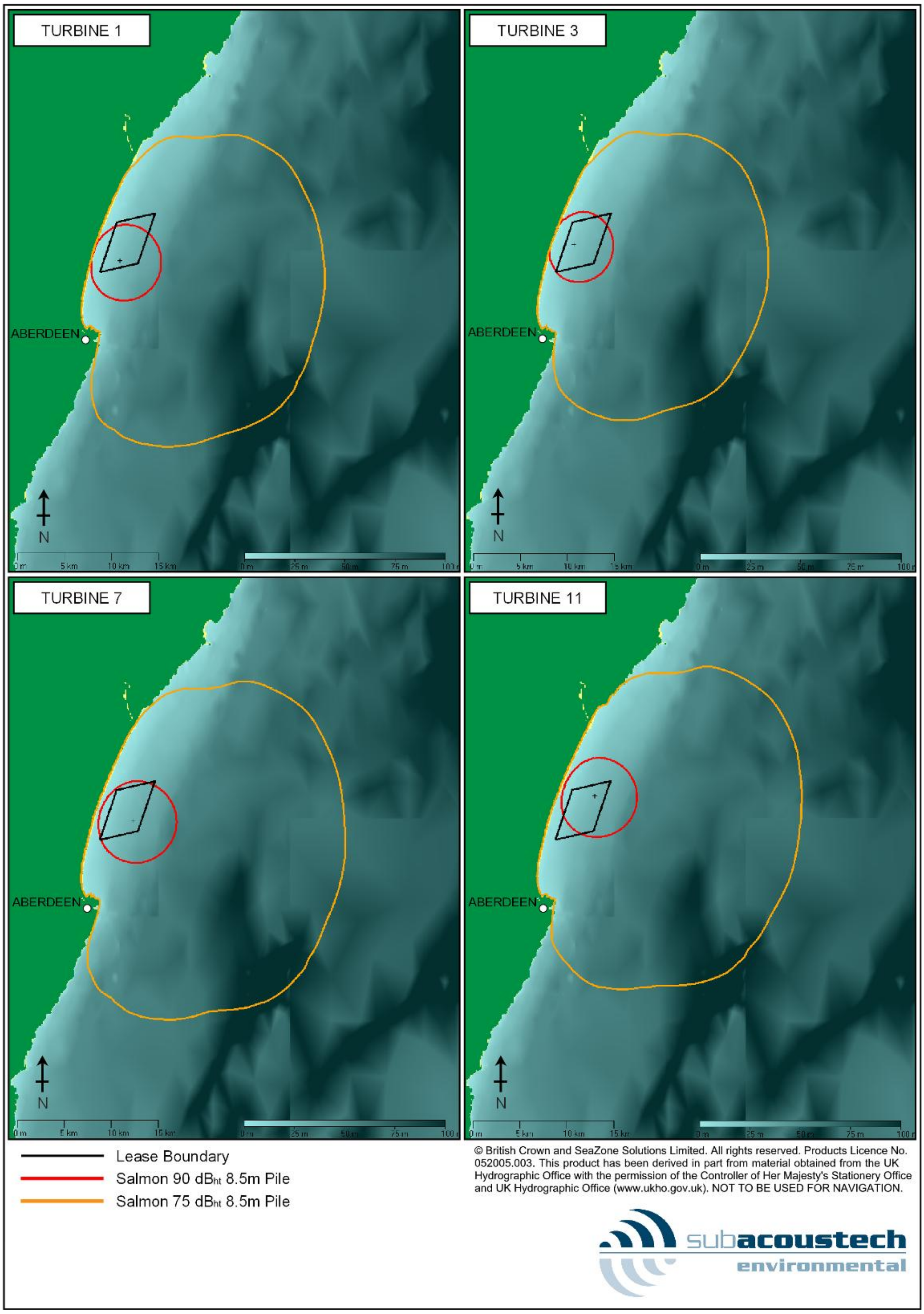

Figure 1.9-15 – Contour plots showing the estimated 90 and 75 dB_{ht} peak impact ranges for Salmon during installation of an 8.5 m diameter pile, please note the larger scale on these figures

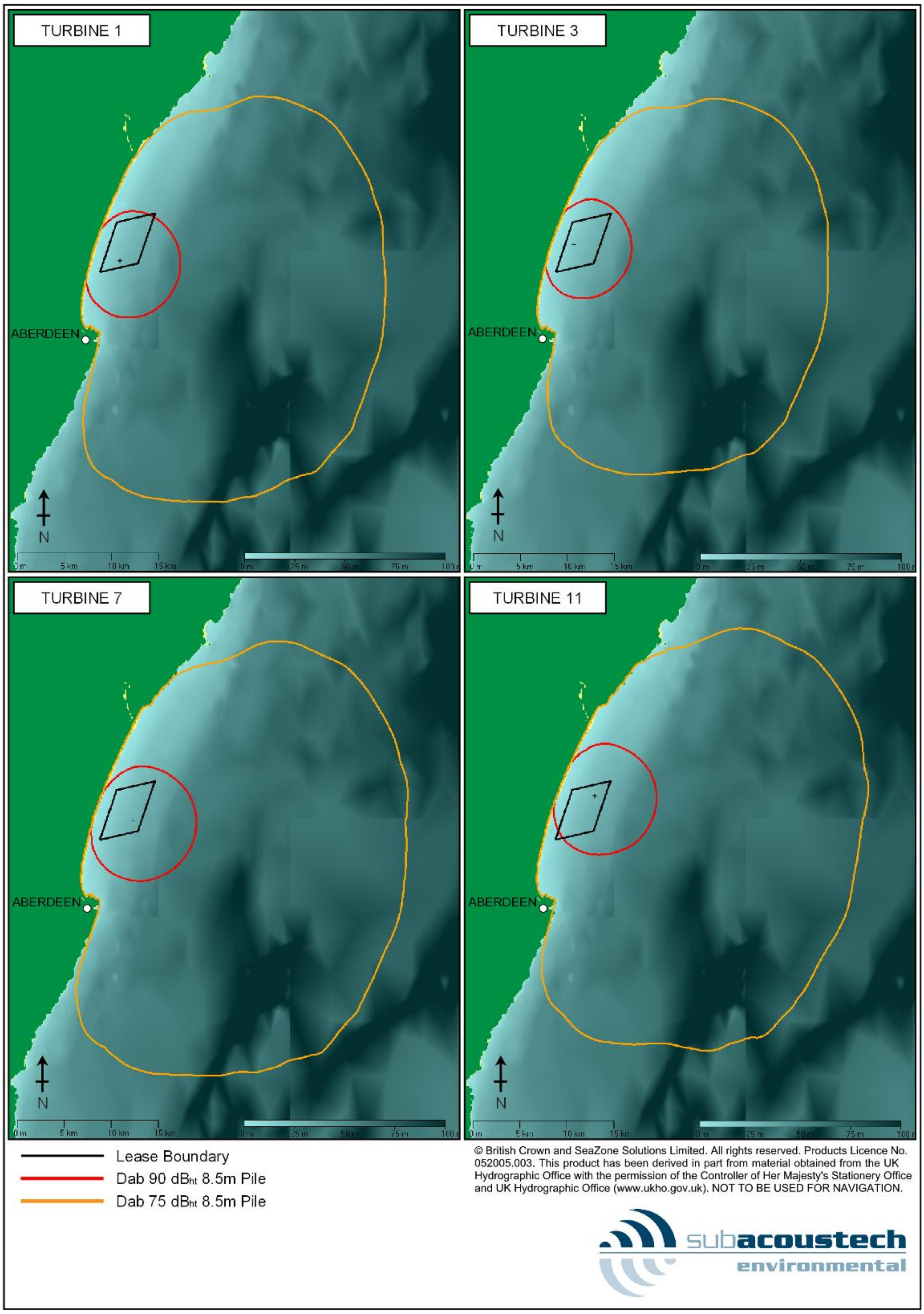

Figure 1.9-16 – Contour plots showing the estimated 90 and 75 dB_{ht} peak impact ranges for Dab during installation of an 8.5 m diameter pile, please note the larger scale on these figures.

1.9.6 Estimates of Behavioural Impact on Marine Species; M-weighted SELs

104 Tables 1.9-18 to 1.9-21 show summaries of the single pulse behavioural impact ranges predicted using the Southall *et al* (2007) criteria. It can be seen that the largest impact ranges are predicted for the Pinnipeds group with behavioural avoidance predicted out to a range of 1.6 km during the installation of an 8.5 m diameter pile. The three cetacean groups predict lower single pulse behavioural impact ranges, ranging from 280 m, for low frequency cetaceans, to 100 m, for high frequency cetaceans.

105 Due to these SEL levels predicting relatively low impact ranges, no maximum and minimum ranges have been included as, at these close ranges, changes in bathymetry do not affect the attenuation of sound significantly, resulting in relatively uniform results.

Table 1.9-18 – Summary of ranges out to which a behavioural avoidance reaction in cetaceans in the low frequency cetaceans group may occur using the Southall *et al* (2007) criteria

Low Frequency Cetaceans	Behavioural Avoidance Range 183 dB re. 1 μPa^2/s (M_{lf})
Wind turbine 1	270 m
Wind turbine 3	260 m
Wind turbine 7	280 m
Wind turbine 11	280 m

Table 1.9-19 – Summary of ranges out to which a behavioural avoidance reaction in cetaceans in the mid frequency cetaceans group may occur using the Southall *et al* (2007) criteria

Mid Frequency Cetaceans	Behavioural Avoidance Range 183 dB re. 1 μPa^2/s (M_{mf})
Wind turbine 1	120 m
Wind turbine 3	110 m
Wind turbine 7	120 m
Wind turbine 11	120 m

Table 1.9-20 – Summary of ranges out to which a behavioural avoidance reaction in cetaceans in the high frequency cetaceans group may occur using the Southall *et al* (2007) criteria

High Frequency Cetaceans	Behavioural Avoidance Range 183 dB re. 1 μPa^2/s (M_{hf})
Wind turbine 1	100 m
Wind turbine 3	100 m
Wind turbine 7	100 m
Wind turbine 11	100 m

Table 1.9-21 – Summary of ranges out to which a behavioural avoidance reaction in pinnipeds (in water) may occur using the Southall *et al* (2007) criteria

Pinnipeds (in water)	Behavioural Avoidance Range 171 dB re. 1 μPa^2/s (M_{pw})
Wind turbine 1	1.6 km
Wind turbine 3	1.5 km
Wind turbine 7	1.6 km
Wind turbine 11	1.6 km

106 Table 1.9-22 presents a comparison between the mean predicted dB_{ht} behavioural avoidance impact ranges and the mean M-weighted SEL behavioural avoidance impact ranges for the equivalent marine mammal groups for modelling undertaken for wind turbine position 1.

107 Once again it can be seen that the impact ranges for dB_{ht} differ substantially from those predicted using the M-weighted SEL criteria. The ranges using the M-weighted SEL criteria are thought to be highly optimistic, and are in conflict with the limited amount of published information currently available. For instance, harbour porpoise have been found to avoid an area around similar pile driving operations out to a distance of 15 km (Tougaard *et al*, 2006).

Table 1.9-22 – Summary of impact ranges comparing the single pulse behavioural avoidance ranges, at wind turbine position 1, predicted using the dB_{ht} criteria (Nedwell *et al*, 2007) and the M-weighted SEL (Southall *et al*, 2007) criteria

dB_{ht} (Nedwell *et al*, 2007)		M-weighted SELs (Southall *et al*, 2007)	
Species	**Mean behavioural avoidance range (90 dB_{ht})**	**Equivalent M-weighting group**	**Mean behavioural avoidance range**
Bottlenose Dolphin	8.5 km	Mid Frequency Cetacean	120 m
Harbour Porpoise	12 km	High Frequency Cetacean	100 m
Harbour Seal	9.6 km	Pinnipeds (in water)	1.6 km

1.10 Summary

108 Subsea noise modelling has been carried out by Subacoustech Environmental Ltd to estimate the potential impact on various species of marine mammal and fish during the installation of 8.5 m diameter piles at the proposed EOWDC. Four modelling locations were chosen to provide a representative overview of potential impact ranges from the impact piling; showing the greatest variation across the site in terms of locations. The modelling has been carried out using the latest version of the INSPIRE acoustic model (version 2.0).

- Data analysed in terms of unweighted levels of underwater noise have indicated that, for impact piling operations of 8.5 m diameter piles, the levels of underwater noise produced are predicted to be of a sufficient level to cause lethality out to a range of 3 m (using the 240 dB re. 1 μPa criteria) and physical injury out to a range of 60 m (using the 220 dB re.1 μPa criteria). Beyond these ranges severe physical effects are not expected to occur based on the assessment criteria used.
- The ranges at which traumatic hearing injury is likely to occur in the selected marine species have been estimated based on the 130 dB_{ht} (*Species*) perceived noise level. The modelled data have indicated that hearing damage may occur out to a maximum of 570 m for the harbour porpoise (the most sensitive marine mammal species to underwater noise) and 480 m for the herring (the most sensitive fish species in terms of sensitivity to underwater noise).
- Modelling to determine the potential ranges of behavioural impact for selected marine species has been carried out in terms of the dB_{ht} (*Species*) specific metric for key species of marine mammal and fish. The data have indicated that herring are likely to perceive levels of underwater noise above 90 dB_{ht} out to the greatest ranges. The maximum ranges out to which the noise is expected to remain above 90 dB_{ht} for this species is between 20 and 24 km during piling of an 8.5 m diameter pile.
- Of the marine mammals considered the perceived levels of underwater noise for harbour porpoise is estimated to remain above the behavioural impact criteria out to the greatest ranges. The maximum strong behavioural avoidance impact ranges for this species are estimated to be between 11 and 13 km for the 8.5 m diameter pile.
- The maximum ranges for all the key species are predicted to be out to the east of the site into the North Sea where the water depths are in excess of 100 m. There is not predicted to be great variation in impact ranges for the four modelling locations.
- Analysis of the modelled data has also been carried out so that an assessment can be made in terms of the M-weighted SEL criteria presented by Southall *et al* (2007). These data have indicated that, for an 8.5 m diameter pile, auditory injury from a single pulse is likely to occur out to a maximum range of 130 m for pinnipeds and 20 m for the most sensitive cetacean species.
- Using the same analytical approach for single pulses a behavioural avoidance response may be expected out to a maximum range of 1.6 km for pinnipeds and 280 m for the most sensitive cetacean species for the proposed piling operations. However, these M-weighted SEL ranges are

thought to be highly optimistic, and are in conflict with published information.

- Analysis for multiple pulses has also been carried out using the dB_{ht} Noise Dose metric and the M-Weighted SEL metric presented by Southall *et al* (2007). The dB_{ht} data indicate that the most sensitive marine mammal species, harbour porpoise, and the most sensitive fish species, herring, would have to be less than 1350 m and 1750 m away respectively from the piling operation respectively at the onset of piling to exceed the 90 dB_{ht} $L_{EP, D}$ criterion. Provided these animals were beyond these ranges at the onset of piling they would not be expected to suffer auditory damage as a result of cumulative noise dose.
- For the multiple pulse criteria for auditory injury proposed by Southall *et al* (2007). The data indicate that the pinnipeds group would have to start at a range of at least 3.6 km from the piling to avoid a damaging sound exposure from the piling noise. The cetacean group most sensitive to piling noise, the low frequency cetaceans, which includes Humpback whales (*Megaptera novaeangliae*) and Minke whale, are predicted to have to start at a range of at least 1350 m from the piling operations to escape the area without receiving a damaging exposure to the noise.
- It should be noted that these ranges for multiple pulses were calculated using the assumption that a high blow force is used at the onset of piling, this is an unlikely scenario and a soft start procedure is likely to result in a reduction to these standoff ranges.

1.11 Appendices

1.11.1 Underwater Sound Measurements

1.11.1.1 Units of Measure

109 The fundamental unit of sound pressure is the Newton per square metre, or Pascal. However, in quantifying underwater acoustic phenomena it is convenient to express the sound pressure (either peak, or Root Mean Square (RMS)) as a Sound Pressure Level (SPL) through the use of a logarithmic scale.

110 There are three reasons for this:

- there is a very wide range of sound pressures measured underwater, from around 0.0000001 Pascal in quiet sea to say 10000000 Pascal for an explosive blast. The use of a logarithmic scale compresses the range so that it can be easily described (in this example, from 0 dB to 260 dB re. 1 µPa (referenced to a sound level of 1 µPa)).
- many of the mechanisms affecting sound underwater cause loss of sound at a constant rate when it is expressed on the dB scale.
- the effects of noise tend to increase in proportion to the SPL rather than the linear level. For instance, a given increase in effect will occur each time the sound is doubled, rather than each time it increases by a given unit of pressure.

111 The Sound Pressure Level, or SPL, is defined as

$$SPL = 20\log\left(\frac{P}{P_{ref}}\right)$$

eqn. 1.11-1.

where P is the sound pressure to be expressed on the scale and P_{ref} is the reference pressure, which for underwater applications is 1 µPa.

1.11.1.2 Peak Level

112 The peak level of the noise is the maximum variation in the acoustic pressure from the ambient level within the measurement period. Peak pressures are often quoted for underwater blast measurements where there is a clear positive peak following detonation.

1.11.1.3 Peak-to-Peak Level

113 The peak-to-peak level is calculated using the maximum variation of the pressure from positive to negative within the wave. Where the wave is symmetrically distributed in positive and negative pressure, the peak-to-peak level will be twice the peak level, and hence 6 dB higher.

1.11.1.4 Root-Mean-Square (RMS) Level

114 For both continuous sound, or sound that varies in level, the RMS is used as an "average" value when calculating the level. The time period over which the averaging is conducted has to be quoted as this will influence the average level. For instance, in the case of a pile strike lasting say a tenth of a second, the mean taken over a tenth of a second will be ten times higher than the mean taken over one second.

1.11.1.5 Source Level

115 Where there is a single, well-defined source of noise, underwater sound pressure measurements may be expressed as dB re 1 µPa @ 1m, which represents the apparent level at a distance of one metre from the source. In fact, since the measurements are usually made at some distance from the source, and extrapolated back to the source, the true level at one metre may be very different from the Source Level. The Source Level may itself be quoted in any of the measures above, for instance, a piling source may be expressed as having a "peak-to-peak Source Level of 200 dB re 1 µPa @ 1 m".

1.11.1.6 Sound Exposure Level

116 The degree by which a noise source affects marine animals may depend on the duration the sound is present above background levels. Sound Exposure Level (SEL) takes into account both the SPL of the sound source and the duration the sound is present in the acoustic environment. Sound Exposure (SE) is defined by the equation:

$$SE = \int_0^T p^2(t)dt$$

eqn. 1.11-2.

where p is the acoustic pressure in pascals, T is the duration of the sound in seconds and t is time.

117 Equation A-2 gives units of pascal squared seconds (Pa^2-s).

118 The SE can be expressed as a deciBel level by using a reference pressure (P_{ref}) and a reference time (T_{ref}) on a logarithmic scale giving Sound Exposure Level (SEL):

$$SEL = 10\log_{10}\left(\frac{\int_0^T p^2(t)dt}{P_{ref}^2 T_{ref}}\right)$$

eqn. 1.11-3.

119 P_{ref} and T_{ref} are typically 1 µPa and 1 second respectively for underwater noise.

120 Equation 3 can also be expressed by:

$$SEL = SPL + 10\log_{10}(T)$$ **eqn. 1.11-4**

where T is the duration of the noise in seconds.

121 Using the reference pressures above Equation 1.11-4 shows that for a sound of 1 second duration the Sound Exposure Level is equal to the Sound Pressure Level as $10\log_{10}(1) = 0$. For a sound of 10 seconds duration the SEL will be 10 dB higher than the SPL, for a sound of 100 seconds duration the SEL will be 20 dB higher than the SPL and so on.

1.11.1.7 Frequency Content

122 To interpret an underwater sound signal for the manner in which it will be heard by an underwater animal, the sound signal in a time history format must be converted into its frequency components. This is because the response of marine species to underwater sound is frequency dependent (see the audiograms in Figures 1.7-1 to 1.7-3). This transformation of the sound is achieved by performing a Power Spectral Density (PSD) analysis of the signal. 'The PSD's (frequency spectra) presented in this report may therefore be regarded as dividing up the total power of the sound into its frequency components, and are presented in decibels (dB) referenced to 1 µPa.

1.11.1.8 The dB_{ht} (Species)

123 Measurement of sound using electronic recording equipment provides an overall linear level of that sound. The level that is obtained depends upon the recording bandwidth and sensitivity of the equipment used. This, however, does not provide an indication of the impact that the sound will have upon a particular fish or marine mammal species. This is of fundamental importance when considering the behavioural impact of underwater sound, as this is associated with the perceived loudness of the sound by the species. Therefore, the same underwater sound will affect marine species in a different manner depending upon the hearing sensitivity of that species.

124 The measurements of noise in this study have therefore also been presented in the form of a dB_{ht} level for the species. This scale incorporates the concept of "loudness" for a species. The metric incorporates hearing ability by referencing the sound to the species' hearing threshold, and hence evaluates the level of sound a species can perceive. In Figure 1.11-1, the same noise spectrum is perceived at a different loudness level depending upon the particular fish or marine mammal receptor. The aspect of the noise that can be heard is represented by the 'hatched' region in each case. The receptors also hear different parts (components) of the noise spectrum. In the case shown, Fish 1 has the poorest hearing (highest threshold) and only hears the noise over a limited low frequency range. Fish 2 has very much better hearing and hears the main dominant components of the noise. Although having the lowest threshold to the sound, the marine mammal only hears the very high components of the noise and so it may be perceived as relatively quiet.

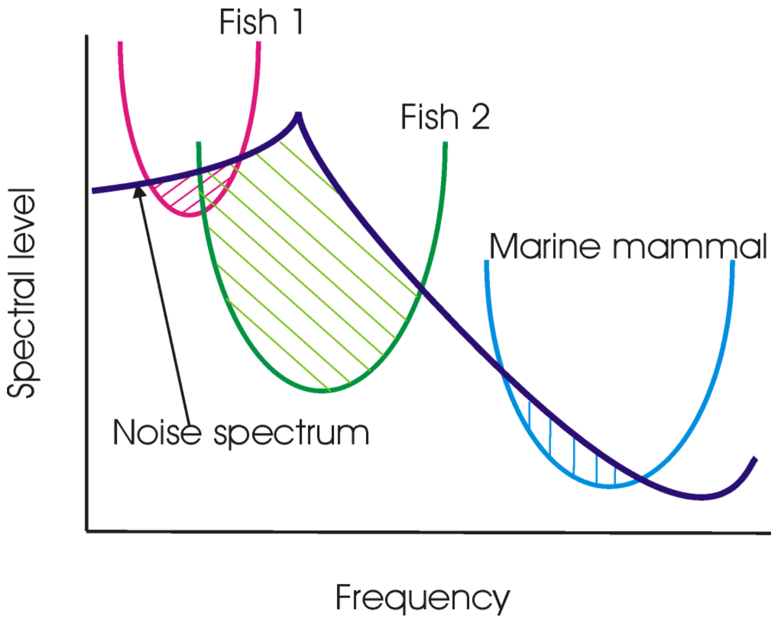

Figure 1.11-1. Illustration of perceived sound level (dBht) for representative fish and marine mammal species.

125 Since any given sound will be perceived differently by different species (since they have differing hearing abilities) the species name must be appended when specifying a level. For instance, the same sound might have a level of 70 dB_{ht} for a cod (*Gaddus morhua*) and 40 dB_{ht} for a salmon (*Salmo salar*).

126 The perceived noise levels of sources measured in dB_{ht} (*Species*) are usually much lower than the un-weighted (linear) levels, both because the sound will contain frequency components that the species cannot detect, and also because most aquatic and marine species have high thresholds of perception to (are relatively insensitive to) sound.

1.11.1.9 <u>M-weighted Sound Exposure Levels</u>

127 Southall *et al*., (2007) proposes the use of generalised frequency weighting functions to filter underwater sound exposure levels to better represent the levels of underwater noise various marine species are likely to be able to hear. The authors group marine mammals into 5 groups, 4 of which are relevant to underwater noise (the fifth is for pinnipeds in air). For each group an approximate frequency range of hearing is proposed based on known audiogram data, where available, or inferred from other information such as auditory morphology. These are summarised in Table 1.11-1 below.

Table 1.11-1 Functional marine mammal groups, their assumed auditory bandwidth of hearing and genera presented in each group (reproduced from Southall *et al* (2007))

Function hearing group	Estimated auditory bandwidth	Genera represented	Example species
Low frequency cetaceans	7 Hz to 22 kHz	*Balaena, Caperea, Eschrichtius, Megaptera, Balaenoptera* (13 species/subspecies)	Grey whale, Right whale, Humpback whale, Minke whale
Mid frequency cetaceans	150 Hz to 160 kHz	*Steno, Sousa, Sotalia, Tursiops, Stenella, Delphinus, Lagenodelphis, Lagenorhynchus, Lissodelphis, Grampus, Peponocephala, Feresa, Pseudorca, Orcinus, Globicephala, Orcaella, Physeter, Delphinapterus, Monodon, Ziphius, Berardius, Tasmacetus, Hyperoodon, Mesoplodon* (57 species/subspecies)	Bottlenose dolphin, striped dolphin, Killer whale, Sperm whale
High frequency cetaceans	200 Hz – 180 kHz	*Phocoena, Neophocaena, Phocoenoides, Platanista, Inia, Kogia, Lipotes, Pontoporia, Cephalorhynchus* (20 species/subspecies)	Harbour porpoise, River dolphins, Hector's dolphin
Pinnipeds (in water)	75 Hz to 75 kHz	*Arctocephalus, Callorhinus, Zalophus, Eumetopias, Neophoca, Phocarctos, Otaria, Erignathus, Phoca, Pusa, Halichoerus, Histriophoca, Pagophilus, Cystophora, Monachus, Mirounga, Leptonychotes, Ommatophoca, Lobodon, Hydrurga,* and *Odobenus* (41 species/subspecies)	Fur seal, Harbour (common) seal, Grey Seal

1.11.1.10 Background Levels

128 Of critical importance in assessing the impact of noise and vibration from an activity is a measure of the ambient noise environment. The pre-existing noise and vibration levels in fast flowing rivers, busy estuaries and coastal waters will be high compared to the levels that are associated with airborne perception by terrestrial animals. As an example, ambient underwater noise in coastal waters measured as a broadband level from 1 Hz to 100 kHz, typically varies from 100 to 130 dB re. 1 µPa.

1.11.1.11 Attenuation of Sound

129 To normalise underwater sound and vibration measurements to a common reference point, levels are normally quoted as Source Levels. As the sound propagates out from the source the level will reduce both as a result of geometric spreading and absorption in the propagation medium. These effects when combined provide a model for the Transmission Loss (TL) of the noise and vibration with range. This means that the received level at range is substantially lower than the Source Level in the immediate vicinity of the activity.

130 The sound level at range from an activity can be described by the expression;

$L(r) = SL – TL$ **eqn. 1.11-5.**

where L(r) is the Sound Pressure Level at distance r from a source (m), SL is the (notional) source level at 1 m from the source, and TL is the transmission loss.

131 The Transmission Loss is frequently described by the equation

$TL = N \log(r) + \alpha r$ **eqn. 1.11-6.**

where r is the distance from the source (m), N is a factor for attenuation due to geometric spreading, and α is a factor for the absorption of sound in water and boundaries (dB.m-1).

132 Using this form of sound transmission loss, the sound level with range L(r) can be described by the expression

$L(r) = SL – N \log(r) - \alpha r$ **eqn. 1.11-7.**

1.11.2 Preliminary subsea noise modelling at the proposed European Offshore Wind Deployment Centre

1.11.2.1 *Introduction*

133 Preliminary underwater noise modelling has been undertaken by Subacoustech Environmental to provide an indication of the likely differences in impact ranges between impact piling different size piles at the proposed EOWDC site.

134 Underwater noise levels have been estimated along one transect using the INSPIRE model (currently version 2.0), a proprietary acoustic propagation modelling program developed by Subacoustech Environmental. INSPIRE has been tested and validated against a large database of measured underwater noise data from previous impact piling operations and calculates absorption and depth-dependent transmission losses. These are used in conjunction with bathymetric data to calculate estimated impact ranges for the underwater noise produced during the proposed impact piling operations.

135 The two options being considered at proposed EOWDC are monopile foundations, using 8.5m diameter piles, and jacket foundations, using four 2.5 m diameter piles. To make this assessment a representative transect has been chosen from turbine position 11, which is in the deepest water (approximately
30 m deep at mean high water springs (MHWS)), at a bearing of 60º, which extends into water that is over 100 m in depth. This particular transect has been chosen to give a “worst case” estimate of the impact ranges for the proposed piling operations at the proposed EOWDC.

136 It should be noted that the INSPIRE model has been developed using the best available underwater noise data, however, the largest pile diameter for which reliable measured data is available is 6.1 m in diameter. Impact range estimates for pile sizes greater than this have been calculated by extrapolation and it is not yet possible to validate the results experimentally.

137 The results of the modelling have been presented here as linear (unweighted) peak to peak sound levels and weighted peak to peak dB_{ht}(*Species*) levels for four species of marine mammal that are of interest in the areas surrounding the proposed EOWDC site; bottlenose dolphin, harbour porpoise, harbour seal and white-beaked dolphin (using the striped dolphin as a surrogate, as currently available information suggests that both species have a similar sensitivity to sound).

1.11.2.2 *Unweighted Results*

138 Figure 1.11-2 illustrates the predicted unweighted peak to peak underwater noise levels, using the INSPIRE model, shown as level against range plots. The results were calculated along one deep water transect of bearing 60º from turbine position 11 estimating the impact of installing an 8.5 m diameter and a 2.5 m diameter pile, these impact ranges are also summarised in Table 1.11-2. It can be seen from these results that the sound is likely to remain at

high levels out to considerably larger distances for the 8.5 m pile when compared to the 2.5 m pile.

139 Table 1.11-3 summarises the unweighted impact ranges using predicted peak underwater noise levels. As the waveform of a pile strike is typically symmetrical about the ambient pressure level (equal high and low pressure excursions) it can be reasonably assumed that the peak pressure level is half of the peak to peak pressure level (a reduction of 6dB). The impact ranges in Table 2 have been calculated by reducing the peak to peak noise levels predicted by the INSPIRE model by 6dB.

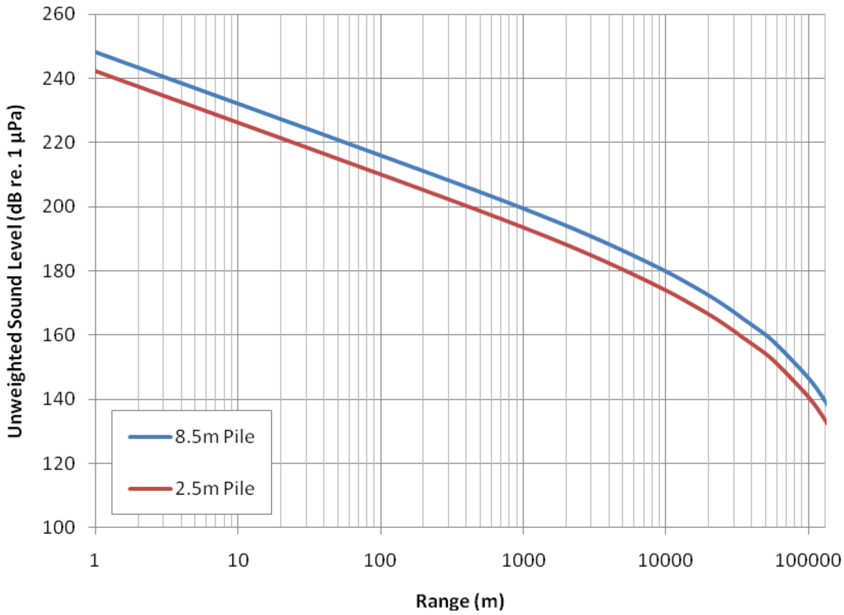

Figure 1.11-2 – Level with range plot for the estimated unweighted peak to peak underwater noise levels at Position 11 for 8.5m and 2.5m diameter piles.

Table 1.11-2 – Summary of the estimated ranges to various unweighted peak to peak underwater noise levels at Position 11 for 8.5 m and 2.5 m diameter piles.

Peak to peak	**8.5 m Diameter Pile**	**2.5 m Diameter Pile**
Range to 200 dB re. 1 µPa	960 m	420 m
Range to 190 dB re. 1 µPa	3.3 km	1.6 km
Range to 180 dB re. 1 µPa	9.9 km	5.3 km
Range to 170 dB re. 1 µPa	24 km	15 km
Range to 160 dB re. 1 µPa	51 km	33 km
Range to 150 dB re. 1 µPa	86 km	64 km

Table 1.11-3 – Summary of the estimated ranges to various unweighted peak underwater noise levels at Position 11 for 8.5 m and 2.5 m diameter piles.

Peak	**8.5 m Diameter Pile**	**2.5 m Diameter Pile**
Range to 200 dB re. 1 µPa	390 m	180 m
Range to 190 dB re. 1 µPa	1.6 km	720 m
Range to 180 dB re. 1 µPa	5.3 km	2.6 km
Range to 170 dB re. 1 µPa	15 km	8.2 km
Range to 160 dB re. 1 µPa	33 km	21 km
Range to 150 dB re. 1 µPa	64 km	44 km

1.11.2.3 dB$_{ht}$(Species) Results

140 The dB$_{ht}$(*Species*) metric (Nedwell *et al.*, 2007) has been developed as a means for quantifying the potential for a behavioural impact on a species in the underwater environment. Since any given sound will be perceived differently by different species (since they have differing hearing abilities) the species name must be appended when specifying a level. For instance, the same sound might have a level of 70 dB$_{ht}$(*Phocoena phocoena*) for harbour porpoise and 40 dB$_{ht}$(*Phoca vitulina*) for harbour seal.

141 Currently, on the basis of a large body of measurements of fish avoidance of noise (Maes *et al,* 2004), and from re-analysis of marine mammal behavioural response to underwater sound, the following assessment criteria was published by the Department of Business, Enterprise and Regulatory Reform (BERR) (Nedwell *et al,* 2007) to assess the potential impact of the underwater noise on marine species:

Table 1.11-4 – Assessment criteria used in this study to assess the potential impact of underwater noise on marine species.

Level in dB$_{ht}$(*Species*)	Effect
90 and above	Strong avoidance reaction by virtually all individuals.
Above 110	Tolerance limit of sound; unbearably loud.
Above 130	Possibility of traumatic hearing damage from single event.

142 In addition, a lower level of 75 dB$_{ht}$ has been used for analysis as a level of “significant avoidance”. At this level, about 85% of individuals will react to the noise, although the effect will probably be limited in duration by habituation.

143 Figures 11.1-3 and 11.1-4 show the results for modelling 8.5 m diameter piles and 2.5 m diameter piles respectively in terms of peak to peak dB$_{ht}$(*Species*) perceived sound levels for the four marine mammals as level with range plots. The levels where traumatic hearing injury (130 dB$_{ht}$), strong behavioural avoidance (90 dB$_{ht}$) and significant behavioural avoidance (75 dB$_{ht}$) may occur in species are also indicated in these figures. The modelling was carried out along the same transect as before at a bearing of 60º from turbine position 11. A summary of these impact ranges is presented in Tables 11.1-5 and 11.1-6.

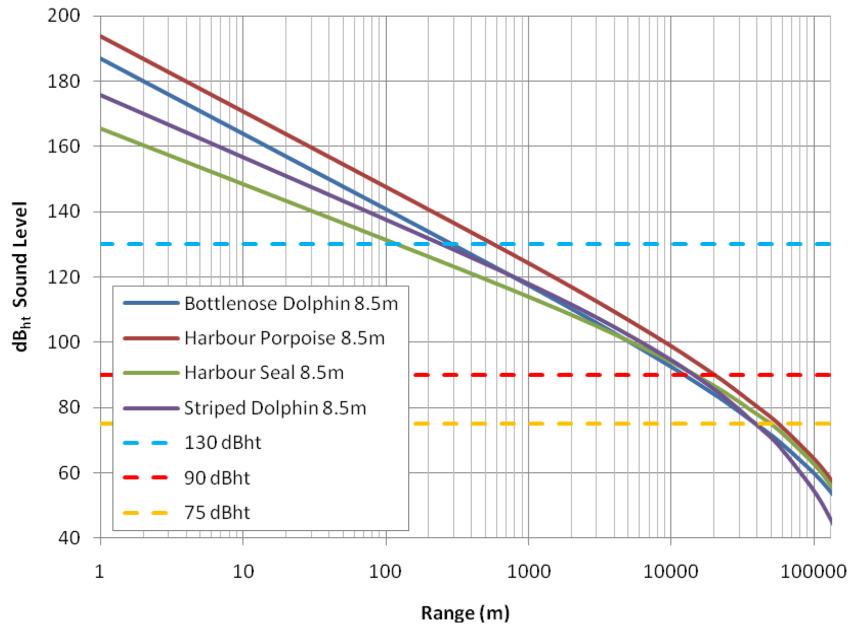

Figure 1.11-3 – Estimated peak to peak dB_{ht} level with range plot for four species of marine mammal during the installation of an 8.5 m diameter pile.

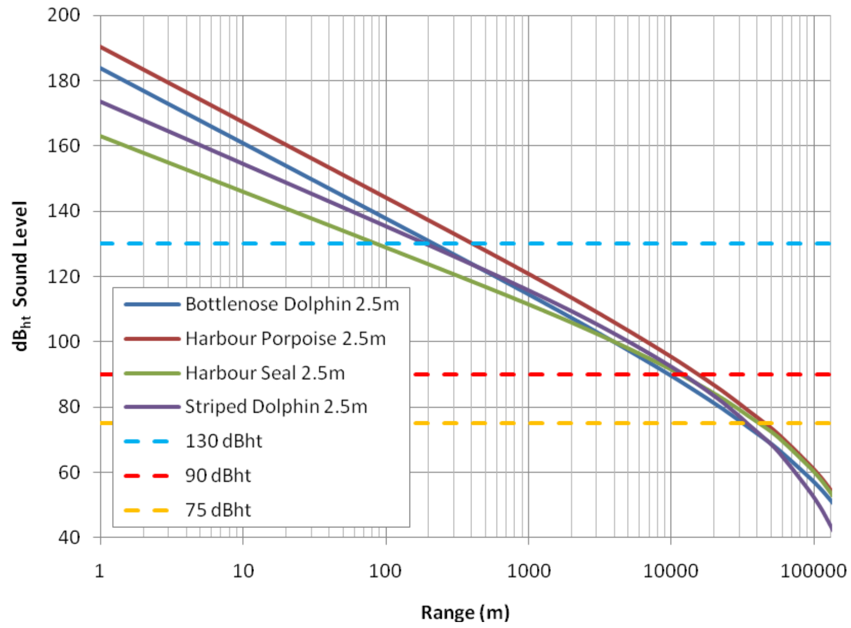

Figure 1.11-4 – Estimated peak to peak dB_{ht} level with range plto for four species of marine ammal during the installation of a 2.5m diameter pile.

Table 11.1-5 – Summary of the estimated impact ranges for piling an 8.5 m diameter pile on various species of marine mammals.

8.5 m Diameter Pile	Range to 130 dB_{ht}	Range to 90 dB_{ht}	Range to 75 dB_{ht}
Bottlenose Dolphin (dB_{ht}(*Tursiops truncatus*))	300 m	12 km	39 km
Harbour Porpoise (dB_{ht}(*Phocoena phocoena*))	570 m	20 km	57 km
Harbour Seal (dB_{ht}(*Phoca vitulina*))	150 m	15 km	50 km
Striped Dolphin (dB_{ht}(*Stenella coeruleoalba*))	270 m	14 km	39 km

Table 11.1-6 – Summary of the estimated impact ranges for piling a 2.5 m diameter pile on various species of marine mammals.

2.5 m Diameter Pile	Range to 130 dB_{ht}	Range to 90 dB_{ht}	Range to 75 dB_{ht}
Bottlenose Dolphin (dB_{ht}(*Tursiops truncatus*))	240 m	10 km	32 km
Harbour Porpoise (dB_{ht}(*Phocoena phocoena*))	420 m	16 km	46 km
Harbour Seal (dB_{ht}(*Phoca vitulina*))	90 m	12 km	42 km
Striped Dolphin (dB_{ht}(*Stenella coeruleoalba*))	210 m	12 km	35 km

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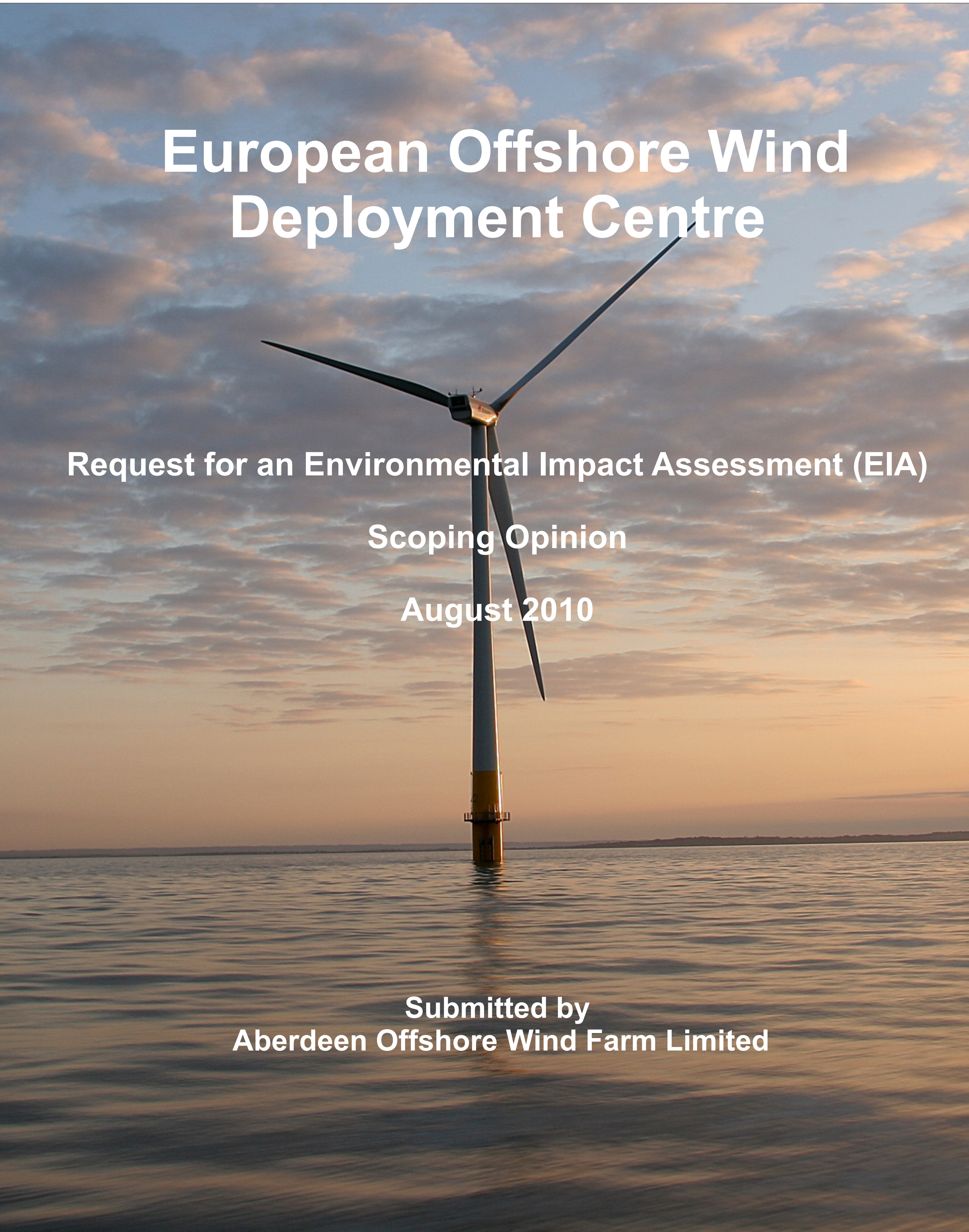
European Offshore Wind Deployment Centre
Environmental Statement

Appendix 4.1: Request for Scoping Opinion 2010

VATTENFALL Technip areg Aberdeen Renewable Energy Group

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy



European Offshore Wind Deployment Centre

Request for an Environmental Impact Assessment (EIA)

Scoping Opinion

August 2010

Submitted by
Aberdeen Offshore Wind Farm Limited

PREFACE

Aberdeen Offshore Wind Farm Limited (AOWFL) is proposing to develop an offshore wind farm and deployment centre off the coast of Aberdeen, known as the European Offshore Wind Deployment Centre (EOWDC).

The proposed project would combine a small commercially operated wind farm with a test and research centre, allowing manufacturers to test “first of run” wind turbines and innovative foundation solutions along with related operation and maintenance access logistics.

The project would also include an Ocean Laboratory which would allow environmental monitoring before, during and after deployments. Environmental data may also be collected through a series of planned surveys.

The site is considered ideal for this purpose as it is close to the city of Aberdeen, a recognised centre of excellence for offshore activities and easily accessible, being approximately 2 to 4.5 km from the shore, and in close proximity to Aberdeen Harbour.

The maximum output, as governed by The Crown Estate lease conditions, is 100 MW which would meet the demand of over 55,300 households, approximately 50 % of the domestic need of the Aberdeen City population.

An application for an agreement for lease from The Crown Estate was submitted as part of the ‘Demonstration Sites’ round in December 2009. In August 2010 AOWFL was awarded an exclusivity agreement for the Aberdeen site.

A Section 36 consent in relation to the European Offshore Wind Deployment Centre, will be applied for within the first quarter of 2011. This timeline is driven by securing and committing 40 million Euros from Europe under the European Energy Programme for Recovery (EEPR).

The project is also likely to require consent under Section 34 of the Coast Protection Act 1949, and a Marine Construction Licence under Section 5 of the Food and Environment Protection Act 1985.

A previous Scoping Report was submitted in 2005. Following detailed consultation the site layout for the project has altered significantly. This document aims to inform stakeholders about the current proposal, the consents required and the planned approach to the Environmental Impact Assessment.

AOWFL welcome your comments on this Scoping Report. Comments should be sent to:

David Rodger
Vattenfall Wind Power Ltd
The Tun Building
4 Jacksons Entry
Holyrood Road
Edinburgh
EH8 8AE

Alternatively please e-mail david.rodger@vattenfall.com.

1 INTRODUCTION

1.1 Background Information

1 In 2005 there was an intention to develop a project comprising 33 commercially operating wind turbines off the coast of Aberdeen. However, due to constraints on the layout which became apparent at an early stage, recent rapid developments in technology and the need for further research in key areas, in 2008 the project was developed into its current form and is now known as the European Offshore Wind Deployment Centre (EOWDC) – a small (11 wind turbine) commercially operated wind farm with a test and research facility, including an Ocean Laboratory.

1.2 Project Overview

2 The vision of the project is:

“To deploy new equipment, systems, processes and initiate R&D to improve the competitiveness of Offshore Wind Energy production, whilst generating environmentally sound marketable electricity and to increase the supply chain capabilities in Scotland, the wider UK and Europe.”

3 This project is targeted at both enabling and encouraging increased competition into the European wind turbine supply chain by providing sites for manufacturers both to prove new and innovative solutions and also to allow the acquisition of offshore “hands-on” design, build and operational and maintenance experience, in advance of Round 3.

4 This project will allow “first of run” production wind turbine systems to be operated in the marine environment so that developers, owners and financiers can gain confidence in wind turbine manufacturer’s new machine designs, allowing the development of the supply chain in this area.

5 The project will promote and enable the deployment of pre-production innovative foundations.

6 There will be an Ocean Laboratory that could hold meteorological masts, environmental monitoring equipment and be used for access training. The inclusion of an Ocean Laboratory would allow environmental monitoring before, during and after deployments. Environmental data may also be collected through a series of planned surveys. The environmental effects of the deployment centre could be closely monitored and data collected prior to Round 3 developments being installed.

7 Environmental monitoring would provide stakeholders with information on associated environmental impacts.

8 There is the possibility of novel electrical design through testing grid connection technologies.

1.3 The Developer

9 The project will be developed by Aberdeen Offshore Wind Farm Ltd (“AOWFL”). AOWFL will build, own and operate the project's permanent wind

farm assets. AOWFL is an established legal entity owned by Vattenfall Wind Power Ltd (75 %) and Aberdeen Renewable Energy Group (AREG) (25 %).

1.3.1 Vattenfall Wind Power Ltd (VWPL)

10 Vattenfall Wind Power Ltd's ultimate holding company is Vattenfall AB (publ.), a state owned Swedish energy utility company. It currently operates nearly 570 MW of offshore wind capacity around Europe and has a pipeline of 4,800 MW of offshore wind capacity at various stages of development. Vattenfall are currently constructing Thanet Offshore Wind Farm, located 12 km off the Kent coast. The project consists of 100 wind turbines of 3 MW installed capacity each. Vattenfall are also jointly developing with ScottishPower Renewables, the Round 3 East Anglia zone off the east coast of England which has the potential to provide a capacity of up to 7,200 MW.

1.3.2 Aberdeen Renewable Energy Group (AREG)

11 AREG is an incorporated company representing the interests of over 150 member organisations. Established in 2001, AREG aims to ensure that Aberdeen City and Shire and its businesses play a major role in the energy revolution. AREG has been supported by the Energising Aberdeen Fund of Aberdeen City Council. The Fund represents a £22.25 million investment in the future of Aberdeen over five years by the Scottish Government.

1.4 Aims of this Document

12 AOWFL requests a Scoping Opinion from the Scottish Ministers under Regulation 7 of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 specifying the information to be provided in the Environmental Statement (ES) which will accompany the application for a consent under Section 36 of the Electricity Act 1989.

13 A request for a Scoping Opinion was originally made for the scheme in 2005. However there have been considerable changes in both layout and information available on the site since that date so it was suggested and thought highly appropriate that a new Scoping Opinion be requested.

14 AOWFL also requests the Scottish Ministers to procure Scoping Opinions on the basis of the same information under Regulation 4 of the Harbour Works (Environmental Impact Assessment) Regulations 1999 in relation to the intended application for a consent under Section 34 of the Coast Protection Act 1949 and under the provisions of the Food and Environment Protection Act 1985 in relation to the intended application for one or more licences pursuant to Section 5 of that Act.

15 In addition, AOWFL formally notifies the Scottish Ministers under Regulation 8 of the 2000 Regulations described above, that it is intended to submit an application for consent under Section 36 of the 1989 Act for the Aberdeen Offshore Wind Farm and that it is intended to submit an Environmental Statement to accompany this application.

16 In accordance with the above Regulations, this scoping document includes:

- a plan to identify the proposed development site
- a brief description of the nature and purpose of the proposed development and of its possible effects on the environment
- further information as required

17 This document has been prepared with reference to the above Regulations and the Guidance Notes on the Offshore Wind Farm Consents Process issued by Scottish Executive Consents and Emergency Planning Unit.

18 Under Directive 2000/42/EU (the Strategic Environmental Assessment Directive) an environmental assessment is required for plans and programmes in specific sectors, including energy, that sets the framework for development consents for projects listed in the EIA Directive and for those requiring an appropriate assessment under the Habitats or Birds Directives. At present an SEA is being prepared by the Scottish Government in respect of Scottish Territorial Waters, which may impact upon this proposal. We welcome advice from the Scottish Executive on this subject. However we note that the Draft Plan for Offshore Wind Energy in Scottish Territorial Waters confirms "smaller areas that are suitable for test and demonstration sites, including existing sites have been scoped out of the Draft Plan and it's environmental assessment" (Marine Scotland, 2010 paragraph 2.5.3).

1.5 The Need for Offshore Wind Energy

19 Climate change represents one of the greatest environmental threats faced by the world today with far reaching implications for the global environment and economy. Renewable electricity generation is vital for decarbonising the global energy system and hence global climate change mitigation. Wind energy is one of the most competitive technologies in renewable energy. However, large scale implementation offshore, whilst offering potential for significant opportunity to develop vast wind resource capacity, also poses huge challenges, requiring technological innovation, industrial & market development and, in parallel, significant cost reduction to become cost competitive with other forms of energy sources.

20 The UK, and specifically Scotland, has some of the best wind resource in Europe.

21 The Scottish Government aims to achieve a target of 50 % of Scottish demand for electricity from renewable sources by 2020 with a milestone of 31 % by 2011. The Scottish Parliament passed the Scottish Climate Change Act in 2009. It demanded a 42 % cut in greenhouse gas emissions by 2020 and 80 % cuts by 2050, based on a 1990 baseline. The development of Scotland's offshore wind potential will be crucial to the delivery of Scotland's legal obligations on climate change.

22 The rapid development of offshore wind capacity is central to the delivery of the UK's share of the EU target of 20 per cent renewable energy by 2020. The Crown Estate, as the seabed owner, has recently announced proposals to deliver up to 25 GW of new offshore wind farm sites by 2020 through the Round 3 licensing. This is intended to provide a stimulus throughout the EU and to provide an important contribution to both reducing CO_2 emissions and improve security of energy supply to the wider EU. This builds on the 8 GW of offshore wind farm projects currently under development and to be

delivered by Rounds 1 and 2. If successful, the addition of the capacity from Round 3 and the Scottish Territorial Waters Round together with any additional smaller sites, could lead to a potential total of 39.5 GW of offshore wind energy.

23 The scale of the challenge in delivering such a large programme is such that the equipment and services supply chains need to be dramatically enhanced very quickly and efficiently. The central requirement is for live operational experience with validated data, together with an area to deploy novel technologies to gain actual operational hours offshore in a controlled, yet real, environment.

24 The EOWDC focus on proving new technology, processes and operations and improving existing technology, processes and operations. Key objectives will be increasing reliability, efficiency and reducing costs. As such, it will directly contribute to the delivery of not only the UK Round 3 and Scottish Territorial Water Rounds, but also the wider European programme of offshore development.

25 The maximum output, as governed by The Crown Estate lease conditions, is 100 MW, and with a 30 % capacity factor would provide enough capacity to meet the demand of over 55,300 homes, equating to a supply large enough to meet over 50 % of the domestic need of the Aberdeen City population[1]. The 2013 household estimate for Aberdeen is 108,150 (See Appendix 9.1).

1.5.1 Creation of Employment from Wind Energy

26 Estimates vary as to the global job creation potential for wind power (on and offshore). However a middle case scenario suggests 462,000 by 2010 and 1.3 million by 2020 with a potential maximum recognised as 572,000 by 2010 and 2.2 million by 2020 (GWEA, 2008). As Europe is a particularly intensive area for wind development, it is to be expected that the proportion of global employment secured could be significantly higher than implied by the population or land mass and sea area. The European Wind Energy Association estimates that European employment in wind power will increase to almost 330,000 in 2020 and to 375,000 by 2030, 57 % of the latter figure being accounted for by offshore wind (EWEA, 2008).

1.6 Approach to Environmental Impact Assessment

27 The EIA for this project will comprise the following sections:

- Non-Technical Summary
- Introduction
- Legislative Framework
- Project Description
- Physical Environment Baseline Description and Impact Assessment
    - Meteorological Conditions
    - Geology, Bathymetry and Topography

[1] This assumes number of households in Aberdeen was 102,900 in 2008. This is based on the “Household Projections for Scotland 2008-based” from the General Register Office for Scotland (2010).

  - Oceanographic Conditions
  - Sediment and Water Quality
  - Coastal Processes
- Biological Environment Baseline Description and Impact Assessment
  - Marine Ecology
  - Intertidal Ecology
  - Ornithology
  - Bats
  - Marine Mammals
  - Underwater Noise and Vibration
  - Electromagnetic Fields
  - Conservation - to include information to support an Appropriate Assessment if one is required
- Human Environment Baseline Description and Impact Assessment
  - Shipping and Navigation
  - Aviation
  - Ministry of Defence
  - Archaeology
  - Seascape, Landscape and Visual and Cultural Heritage
  - Commercial Fisheries
  - Socio-economics
  - Recreation and Tourism
  - In-Air Noise
  - Energy and Emissions
  - Electromagnetic Interference
  - Other Marine Users
- Summary of Environmental Impact Assessment and Mitigation Measures
- Glossary of Terms
- References
- Supporting Technical Appendices

28 Each Environmental section is likely to comprise the following information:

- Introduction
- Methodology and Guidance
- Baseline Methodology
- Impact Assessment Methodology
- Description of the Baseline Environment
- Impact Assessment – Construction, Operation and Decommissioning
  - Potential Impact
  - Mitigation
  - Residual Impact
  - Monitoring
- Cumulative Impact Assessment
- In-combination Impact Assessment

1.6.1 Impact Assessment Methodology

29 In the case of each impact, the assessment aims to describe the magnitude of effect (ie the change created by an activity in terms of spatial extent, duration and scale) and the sensitivity of each receptor. The combination of the effect and the sensitivity of the receptor are then used to derive the

significance of the impact. The criteria that will be used in general is given below:

1.6.1.1 <u>Spatial Extent of Effect</u>

- a national/international effect
- a regional effect
- a local effect (within 5 km of the site)
- a site-specific effect

1.6.1.2 <u>Duration of Effect</u>

- a long-term/permanent effect (more than 10 years)
- a medium-term effect (existing for 5 to 10 years)
- a short-term effect (existing for 1 to 5 years)
- a temporary effect (existing for less than a year)

1.6.1.3 <u>Scale of Effect</u>

- above accepted standards/guidelines
- within accepted standards/guidelines
- where there are no standards/guidelines available, the impact relative to background conditions

1.6.1.4 <u>Recoverability of the Receptor</u>

- high
- medium
- low or none

1.6.1.5 <u>Importance of the Receptor</u>

- high
- medium
- low

30 The impact significance is then given as *major*, *moderate*, *minor* or *negligible*, see Table 1.1.

TABLE 1.1 Matrix for significance of impact					
	Sensitivity of Receptor				
Magnitude of Effect based on spatial, duration and scale of effect		**Very High**	**High**	**Medium**	**Low**
	Very High	Major	Major	Major	Moderate
	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

1.6.2 Cumulative and In-combination Impact

31 An important part of the EIA process will be to consider cumulative and in-combination impacts.

1.6.2.1 Cumulative Impact

32 Schedule 3 of the Electricity Works EIA (Scotland) Regulations 2000 requires that the potential for *cumulative impact* should be considered and where appropriate, assessed.

33 Cumulative impacts will include, but may not be limited to, impacts that arise from the following existing and reasonably foreseeable development activities:

- other wind farms
- aggregate extraction and dredging
- navigation and shipping
- established fishing activities
- existing and planned construction subsea cables and pipelines
- potential port / harbour development
- oil and gas installations

34 The cumulative assessment will address where predicted impacts of the wind farm construction and operation could interact with impacts from other industry sectors within the same region and impact sensitive receptors. This may be through direct effects or spatially/temporally separated impacts on the same population of a receptor.

1.6.2.2 In-combination Impacts

35 The Conservation (Natural Habitats, & c.) Regulations 1994 (as amended) require that an Appropriate Assessment (AA) must be conducted by a competent authority of the implications for the European site in view of the European sites conservation objectives in respect of any plan or project which is not directly connected with or necessary to the management of the European site for conservation purposes and which is likely to have a significant effect on the European site either alone or *in-combination* with other plans or projects.

36 Therefore the term 'in-combination' will be used when considering the impacts of the proposals with other plans or projects on European sites.

2 PROJECT DESCRIPTION

2.1 Site Location

37 The EOWDC site is located approximately 2 km from the Aberdeenshire coast (see Figure 1). The proposed site comprises an area following the coastline between northern Aberdeen and Balmedie. The lease boundary for development would cover up to 20 km^2.

2.2 Site Selection

38 The EOWDC site location has been determined through a long process of examining the constraints, undertaking consultations, and conducting surveys, studies and assessments.

39 The concept of an offshore wind farm in Aberdeen originated in 2002 following approach by AREG to AMEC Wind Energy. The concept of a Renewable Energy Centre in Aberdeen was discussed and included an onshore wind turbine and a number of offshore wind turbines. AMEC Wind Energy began to look at a layout stretching up the coastline and initial visualisations were carried out by the Macaulay Institute.

40 The joint venture was formed in 2005 in the proportions AMEC 75 % and AREG 25 %. With the sale of AMEC Wind Energy to Vattenfall, the joint venture now comprises Vattenfall Wind Power Ltd 75 % and AREG 25 %. The company has a board of directors drawn from the two constituent organisations.

41 The wind farm layout has undergone a number of iterations from 2004 to 2010 which are described in Table 2.1 and shown on Figures 3, 4 and 5. These layout changes have primarily been a result of consultation with Aberdeen Harbour Board, the aviation industry, the Ministry of Defence and key environmental stakeholders.

42 In 2005, a Scoping Opinion was sought on a wind farm development layout which was located approximately 1 km from the Aberdeenshire coast (See LABER007 Figure 3). This site comprised an area following the coastline between Girdle Ness and Newburgh, with the study area for development covering approximately 26 km^2. It was proposed that the wind turbines would be aligned in two rows either side of the 10 m water depth contour. The wind farm at that time comprised approximately 33, three-bladed wind turbines, with an individual wind turbine capacity of up to 5 MW.

43 The project described in this Scoping Report now comprises 11 wind turbines and an Ocean Laboratory located approximately between 2 and 4.5 km offshore, see Figure 2.

Table 2.1
Site Layout Iterations

Internal Layout Reference	Number of Wind Turbines	Date	Wind Turbine Layout Description
LABER002	18	October 2004	Initial layout (based on 10 m water depth constraint) extended north to Newburgh Bar and increased indicative rotor diameter to 120 m and separation between wind turbines to suit.
LABER007	33	February 2005	Layout followed the coastline between Girdle Ness and Newburgh. Two rows of wind turbines were designed to be aligned either side of the 10 m water depth contour. This is the layout included in the previous Scoping Report 2005.
LABER008	24	September 2005	Similar to LABER007, this layout follows the coastline between Girdle Ness and Newburgh. There are two distinct groups, a northern one and a southern one, with a gap in the middle to accommodate a 4 nm helicopter corridor (Shrub – Balis). Both groups have three columns of wind turbines. Outer wind turbines now in water depths up to 20 m. Not a valid layout, created for discussion only.
LABER011	23	January 2006	Updated aviation constraints (including Bridge of Don alternative route) were used to create this layout along with a water depth limit of 25 m. Layout wind turbines have a 120 m rotor diameter. Not a valid layout, created for discussion only.
LABER012	10	September 2008	Site reduced to 10 wind turbines for MOD re-assessment. From the previous layout, the columns closest and furthest from the shore were both removed (for bird and shipping interests) along with the two northern most wind turbines of the remaining 12 (for Black Dog Rifle Range impact), leaving 10 wind turbines.
LABER015	10	March 2009	Wind turbine locations similar to subset of LABER011. Wind turbine locations differ slightly due to increased separation to accommodate a 126 m rotor diameter. Created with the intention of a 10 wind turbine layout not extending as far south as LABER012, in order to avoid Bridge of Don alternative helicopter corridor constraint.
LABER021	15	September 2009	Layout created based on LABER015. Five wind turbines added in total. Two coastal wind turbines removed, extra row added to south (but outside helicopter constraint) and three wind turbines added as eastern column. One wind turbine added into the Black Dog Rifle Range giving a total of two in this area.
LABER027	12	October 2009	Layout based on new internal agreed list of constraints: - outside existing northern and alternative southern helicopter constraints - within geophysical survey area

Table 2.1
Site Layout Iterations

Internal Layout Reference	**Number of Wind Turbines**	**Date**	**Wind Turbine Layout Description**
			- outside of MoD Black Dog Rifle Range - no closer to coast than layout LABER021. Layout designed to consider multiple rotor diameters of 90 m, 126 m and 150 m so that outer row accommodates largest rotor diameter. The layout was limited by the necessary spacing between wind turbines. Layouts LABER022 to 026 informed this layout through several variations for discussion.
LABER028	11	November 2009	Following a response from the MoD the wind turbine which was located within the MoD Black Dog Firing Range was removed.
LABER032	16	April 2010	Following further consultation with NATS, it became apparent that there is a possibility of moving the northern helicopter route further north allowing room for two more wind turbines at the north of the site. Also three wind turbines were added to the east of the site as the geophysical survey boundary constraint was relaxed due to this expansion to the north. The decision to have wind turbines beyond the geophysical survey boundary was driven by desire to increase distance from Aberdeen Harbour.
LABER033	11	April 2010	The six southernmost wind turbines were removed to increase distance from the harbour and shipping. The entire site was slightly shifted down to accommodate an extra wind turbine to the north of the site such that it doesn't lie within the helicopter constraint.
LABER034	11	April 2010	Entire layout was rotated using northernmost wind turbine as a turning point to align the rows of wind turbines to the proposed realigned helicopter constraint. Layout created for discussion.
LABER037	12	April 2010	New layout based on latest constraints of revised northern helicopter route, MoD Black Dog Rifle Range and maintaining a distance from the harbour similar to LABER036. Layout is a regular grid of 3 rows and 4 columns of wind turbines.
LABER039	11	April 2010	Removed the easternmost wind turbine of LABER037 to increase distance from shipping routes.

2.3 The Project Concept

44 The intent is to install a mix of "first run of production" wind turbines on a mix of conventional and novel foundations with monitoring and instrumentation, both for technical and environmental purposes.

45 By providing this infrastructure relatively close to shore, the EOWDC has a possibility for novel training, logistics and an accreditation centre to enable the efficient and timely deployment for European offshore wind turbines

46 Timely construction of the EOWDC will be conditional on successfully raising of all the funding requirements which include a €40m grant from the EU under the European Energy Programme for Recovery (EEPR).

47 At the heart of the project is the interaction between a research, test and training centre with a small, highly innovative, commercially operated and highly instrumented and monitored offshore wind farm. The technologies deployed on the wind farm will provide supporting income to the EOWDC and will offer potential opportunities for:

- the provision of renewable electricity
- technology “proving” through commercial development and deployment
- logistics and supply chain development and proving
- accreditation and training as commercial offerings, especially Health, Safety and Environmental protection (HS&E)
- commercial R&D, testing and dissemination including:
  - long-term environmental monitoring and improvement
  - University level research
  - community, regional, national and international education

2.4 Proposed Development

48 This section summarises the key aspects of the project design. It should be noted that, in defining the project that will be assessed during the EIA, the “Rochdale Envelope” approach (see section 3.4.1) will be adopted. By adopting this approach, it will be possible to conclude that the environmental impact of the proposed development will be no greater than set out in the Environmental Statement.

49 The key offshore components of the proposed EOWDC are:

- 11 offshore wind turbines and their associated foundations
- subsea cables between the wind turbines
- an export cable for connection to the electricity transmission network
- scour protection around foundations and on inter-array and export subsea cables as required and
- an Ocean Laboratory

50 The key onshore components of the wind farm are likely to be:

- onshore deployment facilities
- the landfall site with associated jointing between the offshore export cable and onshore cable to the onshore substation
- the onshore substation

51 This scoping report deals with the offshore components of the project only. The onshore cables and onshore components will be applied for under the Town and Country Planning Act and will be dealt with under a separate Scoping Report. The level of environmental information required to support

the planning application for the onshore works will be discussed with the relevant authorities.

2.4.1 Wind Turbines

52 The wind turbines will be between 4 and 10 MW. The 4 MW wind turbines will have a maximum hub height of 100 m above LAT and the 10 MW wind turbines will have a maximum hub height of 120 m above LAT. Maximum rotor diameter will be 120 m and 150 m respectively. It should be noted that the exact specifications for the project are yet to be determined as it is a test centre and it is not known yet exactly which wind turbines will be deployed on the site.

TABLE 2.2
Wind Turbine Dimensions for the Minimum and Maximum Size Machines

Wind Turbine Size	Maximum Hub Height above LAT (m)	Maximum Rotor Diameter (m)	Maximum Tip Height above LAT (m)
4 MW	100	120	160
10 MW	120	150	195

53 The Environmental Impact Assessment will be based on a hypothetical machine with a maximum height to tip of 195 m above LAT. The lifetime of the project is dependent upon seabed lease agreements and the current proposal for the length of the lease is 22 years.

2.4.2 Foundations

54 Potential foundation types which will be considered within the EIA are:

- steel monopile
- concrete monopile
- jacket on piles
- tripod on piles
- gravity base structure and
- suction caisson

55 A detailed description of the installation, and decommissioning methods for each foundation type considered will be included within the Environmental Statement.

56 Apart from the different foundation types stated in Table 2.3, the EOWDC may also be used to test new concepts.

57 It is expected that any new foundation concepts which may be proposed for the wind farm site would lie within the project envelope used for the purposes of the EIA.

58 More than one foundation type could be used within this project. For all the foundation options, the foundation structure will extend by approximately 15 to 20 m above mean sea level (MSL) such that the base of the wind turbine tower is clear of the most extreme design wave height.

59 Indicative dimensions, construction materials and a brief description of the expected installation methods for each of the foundation options are outlined in Table 2.3. The indicative dimensions are based on a 5 MW wind turbine size and mid-range water depth but will vary for larger wind turbine sizes.

2.4.3 Ocean Laboratory

60 It is the intention to install an Ocean Laboratory on the wind farm site. This is likely to comprise of meteorological monitoring and other environmental measuring equipment. The Ocean Laboratory structure could also be used for access training. Options for future research and monitoring of the site can be found within the relevant sections of this document. The Ocean Laboratory would be subject to a separate consent application which would be discussed with the relevant consenting authorities. Once the Ocean Laboratory is operational it could be used by research organisations to allow long-term environmental monitoring. Potential locations for the Ocean Laboratory can be seen on Figure 2 as an indicative monitoring location.

2.4.4 Export Cable

61 The potential location of the export cable route is dependent on the location of the onshore substation. An indicative onshore substation location and indicative cable route can also be seen on Figure 2.

Table 2.3
Basic Foundation Types and Information

Type	Indicative Dimensions[1]	Construction Material	Indicative Installation Method
Steel monopile[2]	Up to 7.5 m diameter Pile embedment 30 m plus	Steel pile and transition piece	Pile and transition piece transported to site by installation vessel or barge Pile up-ended by crane and lowered to seabed Pile driven by hammer (sometimes drilled) Transition piece installed by crane and connection grouted Rock dumping scour protection (if required)
Concrete monopile[2]	Up to 8.5 m diameter Pile embedment 30 m plus	Pre-cast reinforced concrete ring elements with steel post-tensioning	Pile and ice cone platform transported to site by installation vessel or barge Pile up-ended by crane and lowered to seabed Pile drilled from inside toe of pile Ice cone platform installed Rock dumping scour protection (if required)
Jacket on piles	Numerous variants are being considered. Typically, lattice structure comprising tubular sections of diameter 0.5 to 1.2 m Approx. 25 m x 25 m footprint at base Pile diameter approx. 1.8 to 2.5 m Pile embedment approx. 30 m – 35 m	Steel jacket and piles	Jacket and piles transported to site by barge Installation template set down on sea bed Piles stabbed and driven Survey of pile levels and adjustment of jacket leg positions Jacket lifted and set down on piles Jacket levelled and pile connections grouted

Table 2.3
Basic Foundation Types and Information

Type	Indicative Dimensions[1]	Construction Material	Indicative Installation Method
Tripod on piles	Typically main column approx. 5.5 m diameter, with 3 No. diagonal braces approx. 4 m diameter Approx. 25 m diameter footprint at base Pile diameter approx. 1.8 to 2.5 m Pile embedment approx. 30 m – 35 m	Steel tripod and piles Concrete tripod variants also being considered	Tripod and piles transported to site by barge Tripod lifted and set-down on mudmats on the seabed by crane Piles stabbed and driven Tripod levelled and pile connections grouted
Gravity base structure	Typically conical tower, approx. 6.5 m diameter at top Approx. 30-40 m diameter footprint at base	Reinforced concrete shell with pumped sand ballast fill	Seabed preparation as necessary GBS transported to site by barge or heavy lift vessel (or floated) GBS lifted by crane (or up-ended) and lowered to seabed Levelling and underbase grouting Ballasting (sand or similar) and further levelling as necessary Rock dumping scour protection (if required)
Suction caisson/bucket	Tower section 5.5 to 6.5 m diameter Approx. 18 m diameter footprint for bottom skirt Skirt embedment approx. 10 m depending of the soil conditions	Primary material is steel	Caisson transported to site by floating Up-ended by crane and lowered to seabed Air deflated in bucket skirt to sink caisson Scour protection (if required)

Notes
1 Initial estimate based on mid-range wind turbine size (5 MW) and mid-range water depth
2 These foundation types are limited to lower end of range of wind turbine sizes and water depths

2.5 Project Construction

2.5.1 Construction Timescales

62 The construction of the proposed project is planned in a phased approach and will be further described in the Environmental Statement but it is likely to be:

- four wind turbines installed in Year 1 (2012)
- seven wind turbines to be installed in Year 3 (2014)

63 Construction in the marine environment is potentially hazardous, and in the interests of safe working the project should be permitted to take advantage of as much construction time in favourable conditions as is possible. Construction activity is expected to continue, subject to site weather conditions, for 24 hours per day until construction is complete.

2.5.2 Construction Infrastructure

64 Key to defining the construction methodologies (and therefore the likely construction activities) will be choices on the following:

- wind turbine selection
- foundation types
- inter-array cables
- port(s) used as the base for the construction phase
- vessels to be used for the offshore construction works

65 Potential options would be addressed during the detailed design and EIA phase. However, as the project is being used to test first of run wind turbine and innovative foundation types, new concepts may become apparent throughout the project development. It is anticipated that these would lie within the project envelope used for the purposes of the EIA.

66 A number of ports exist on the east coast of Scotland and mainland Europe coast that may be suitable for much of the construction and operation activities required for the wind farm project. Part of the detailed project design and logistics planning for the project involves assessing a number of potentially suitable port facilities.

67 In addition to using ports for the construction of the wind farm, consideration will be given to the components of the wind farm being brought directly to the project site from their point of manufacture.

68 Construction compounds and storage facilities will be required at the ports used as the construction base(s).

69 It can be assumed that the key stages associated with the installation of the wind farm are likely to be as follows:

- detailed pre-construction site investigation (eg cone penetration tests, boreholes and high resolution geophysics), subject to a separate consent application process

- foundation installation and associated site preparation
- installation of tower, nacelle, hub and blades of the wind turbine generators
- installation of inter-array transmission cables
- installation of transmission cables to shore and
- construction of the required onshore electrical infrastructure (onshore substation) to link the development to the National Grid transmission system

2.5.2.1 *<u>Foundations</u>*

70 Foundation installation will be one of the first offshore construction activities to take place. Methods of installation for foundations vary significantly depending upon the foundation type selected. Techniques typically employed for foundation installation include:

- pile driving
- pile drilling
- seabed levelling (for gravity base structures)
- ballasting (for gravity base structures) and
- grouted connections (eg for connecting piles to jacket)

2.5.2.2 *<u>Wind Turbines</u>*

71 Following foundation installation, offshore wind turbines will be erected. Commonly, towers and nacelles are pre-erected or erected individually at the site using a crane barge. Blades are subsequently fitted to the tower/nacelle structure as individual components or in a part assembled state.

72 Aviation warning lighting to be fitted to some or all of the wind turbines, as required by the UK Air Navigation Order 2009 which will be designed in consultation with key stakeholders, such as the Civil Aviation Authority (CAA). Additionally, international aviation regulatory documentation requires that the rotor blades, nacelle and upper two thirds of the supporting mast that are deemed to be an aviation obstruction should be painted white, unless otherwise indicated by an aeronautical study.

2.5.2.3 *<u>Inter-Array Cables</u>*

73 The extent to which the various burial techniques are used will be dependent on the result of a detailed seabed survey of the final cable route and associated burial risk assessment process. It is likely that some form of ploughing or jetting, or combination of both, will be used.

74 Rock dumping, frond mats/ grout bags or concrete mattresses may be used to protect the cable ends where they enter wind turbine foundations and may be utilised when ground conditions result in the cable being laid near to or on the surface. It is conceivable that the laying of cable protection may also be necessary after burial, where sections of cables are too shallow or have otherwise become exposed as informed by the post installation inspection or periodic maintenance surveys.

2.5.2.4 Cable and Pipeline Crossings

75 There are two telecommunications cables west of and close to EOWDC and it is therefore possible that crossings may be required. The design of any crossing will be agreed with the cable/pipeline owner/operator to ensure that integrity of all the assets is maintained.

2.5.2.5 Scour Protection

76 Scour can occur around the base of a foundation when seabed sediment is worn away as a result of the flow of water around the structure. A number of options for scour protection could be considered for installation, depending on the final project design process, ground conditions and scour assessments. These could include:

- rock and gravel dumping
- protective aprons
- mattresses and
- flow energy dissipation (frond) devices

77 The installation of scour protection material would be carried out using a ship or barge, for example using an on-board fall pipe system. Alternatively, custom-built vessels equipped with side-dump facilities, grabs or fall pipe with a remotely operated vehicle can also be used.

2.6 Project Operation and Maintenance

78 The operation and control of the wind farm will be managed by a Supervisory Control and Data Acquisition (SCADA) system, connecting each wind turbine to a control room.

79 The current technology of wind turbines will require a major service every 12 months. Periodic visits will also be required in the event the wind turbines experience a fault which cannot be remotely reset. Gearbox oil changes are required every five years. Periodically, large components such as gearboxes and blades may need to be replaced.

80 It is not considered a requirement to have formal safety zones around the wind turbines during operation, but an area may be established around each wind turbine to regulate other users of the sea for safety reasons. The applicants understand that provisions within the Electricity Act 1989 could be revised to allow this. Any safety areas will be proposed only after full consultation with the Maritime and Coastguard Agency (MCA) and Aberdeen Harbour Board.

2.7 Project Decommissioning

81 The design life of the wind turbines and other components of the wind farm are likely to be in the order of 20 to 30 years. If the decision to refurbish or replace the wind turbines is made, then any relevant consents or licences required would be applied for at that time.

82 At the end of the operational life of the wind farm it is anticipated that all structures above the seabed will be completely removed by reverse lay, that is, the reverse construction sequence.

83 The decommissioning plan submitted prior to the construction of the EOWDC will be reviewed and revised as necessary throughout the lifecycle of the project to reflect changing circumstances and regulatory requirements, and to incorporate improvements in knowledge and understanding of the marine environment and advances in technology and working practices.

84 Part 2 of the Energy Act 2004 sets out powers requiring the decommissioning of offshore renewable energy installations and their related equipment. Guidance supporting the Act requires a decommissioning plan to be in place prior to the completion of the construction of an offshore wind farm. As part of the decommissioning plan an assessment on the potential environmental impacts may also be required.

85 The International Maritime Organisation Guidelines (IMO) and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone (IMO 1989), set out the minimum global standards to be applied to the removal of offshore installations and structures. The Guidelines and Standards were designed essentially to ensure the safety of navigation and are not intended to preclude a coastal state from imposing more stringent removal requirements.

86 In large part, the UK's approach to decommissioning is governed under the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention). Agreement on the regime to be applied to the decommissioning of offshore installations in the Convention area was reached at a meeting of the OSPAR Commission in July 1998 (OSPAR 98/3). The UK's acceptance of OSPAR Decision 98/3 means that the UK will apply the provisions of that instrument when considering the decommissioning of offshore installations rather than the standards and guidelines laid down by the IMO. However, certain aspects of the IMO Guidelines and Standards are still relevant. These are:

- any disused installation or structure, or part thereof, which projects above the surface of the sea should be adequately maintained
- an unobstructed water column of at least 55 m must be provided above the remains of any partially removed installation to ensure safety of navigation
- the position, surveyed depth and dimensions of any installation not entirely removed should be indicated on nautical charts and any remains, where necessary, properly marked with aids to navigation
- the person responsible for maintaining any aids to navigation and for monitoring the condition of any remaining material should be identified
- the liability for meeting any claims for damages which may arise in the future should be clear
- on or after 1 January 1998, no installation or structure should be placed on any continental shelf or in any exclusive economic zone unless the design and construction of the installation or structure is such that entire removal upon abandonment or permanent disuse would be feasible

87 Under the terms of Decision 98/3, which entered into force on 9 February 1999, there is a prohibition on the dumping and leaving wholly or partly in

place offshore installations. The topsides of all installations must be returned to shore. All installations with a jacket weight less than 10,000 tonnes must be completely removed for re-use, recycling or final disposal on land.

3 LEGISLATIVE FRAMEWORK

3.1 The Crown Estate Lease

88 A developer must obtain a site lease from The Crown Estate (TCE) prior to installing a renewable energy device in the marine environment. The Crown Estate owns much of the foreshore and seabed from Low Water out to 12 nautical miles (nm).

89 A Strategic Environmental Assessment (SEA) is currently being prepared by Marine Scotland on behalf of the Scottish Government to assess offshore wind energy within Scottish Territorial Waters to ensure that environmental considerations are incorporated within the decision-making process and that ultimately offshore wind energy development is sustainable. Until the results of the SEA have been finalised by Marine Scotland, developers will be offered an exclusivity agreement with TCE. In the event that the results of the SEA do not rule out prospective development of the proposed site, TCE will proceed to the negotiation of an Agreement for Lease with the developer. AOWFL was awarded an exclusivity agreement with TCE for the Aberdeen site in August 2010. As noted earlier, the Draft Plan for Offshore Wind Energy in Scottish Territorial Waters confirms, “smaller areas that are suitable for test and demonstration sites, including existing sites, have been scoped out of the Draft Plan and its environmental assessment (Marine Scotland, 2010 paragraph 2.5.3). The implications of this for the EOWDC will be discussed with TCE.

90 The Agreement for Lease will contain an option (subject to the fulfilment of all conditions including statutory consents) for the developer to call for the grant of an agreed form lease. The lease will provide the right for the construction, siting and occupation of an area for the purpose of placing structures on, or passing cables over Crown Estate land.

3.2 Marine Licensing

91 On 1 April 2010, Marine Scotland - Licensing Operations Team (MS-LOT) became responsible for a range of statutory controls in waters adjacent to Scotland. Until the new marine licensing regime comes into effect (which is discussed further below), Marine Scotland is responsible for dealing with consent applications.

3.2.1 Current Statutory Regime

92 Under the current statutory regime, the following consents, licences and permits are likely to be required for the project:

3.2.1.1 <u>Marine Permissions</u>

- Section 36 Electricity Act 1989 consent from the Scottish Ministers for the offshore electricity generating station
- Section 36A Electricity Act 1989 declaration will be required to extinguish public rights of navigation

- A licence under the Food and Environment Protection Act 1985 will be required for placing materials in the sea
- A consent under the Coast Protection Act 1949 will be required for placing cables within the water

93 As stated there are presently no offshore works (ie the wind farm and indicative export cable route) within the limits Of the Harbour Board and therefore a works licence will not be required from the Ports and Harbour Authority.

94 In addition, depending upon the characteristics of the site when further investigatory work has been undertaken, the following consent/licences may also be required: wildlife consents, a CAR licence, a licence regarding wrecks, scheduled monument consent, safety zones etc. These will be applied for if necessary.

3.2.1.2 Terrestrial Permissions

95 As noted earlier, this Scoping Report only deals with the offshore element, however for completeness, the following terrestrial permissions would be required:

- an application for the onshore section of the cable route would be made under Section 37 Electricity Act 1989 with a declaration that planning permission be deemed to be granted (if it is for overhead cables)
- a separate planning application under the Town and Country Planning (Scotland) Act 1997 would be required for the onshore substation and any underground cables

3.2.1.3 Other Consents/Licences

- European Protected Species licence under the Habitats Regulations 1994 (as amended) (EPS) (if required)
- Decommissioning Plan Approved by the Department for Energy and Climate Change (DECC)

3.3 Future Statutory Regime

96 The marine consenting regime in Scotland is undergoing change. On 10 March 2010, the Marine (Scotland) Act 2010 received Royal Assent. The Act introduces a framework for the sustainable management of seas around Scotland. This requires marine plans to be produced and be compatible with terrestrial plans to deliver integrated coastal zone management. It is estimated that the marine plans will take approximately two years to produce. In terms of the consenting process, applications for consent under Section 36 of the Electricity Act 1989 and a new marine licence together with any wildlife consents that may be required will all be considered together. Part of the Marine (Scotland) Act came into effect on 1 July 2010 and there will be a phased implementation thereafter. The timing of the coming into effect of the Act will affect whether the applications for consent for the proposal will be made under the statutory regime outlined above or under the Marine

(Scotland) Act. For the terrestrial consents, the process will remain as outlined above under the current statutory regime.

3.4 Environmental Impact Assessment

97 The Environmental Impact Assessment Directive (97/11/EC) requires an EIA to be carried out in support of an application for development consent for categories of project listed in the Directive at Annexes I and II.

98 Offshore wind farm developments are listed in Annex II as 'installations for the harnessing of wind power for energy production (wind farms)'. The EIA Directive has been transposed into UK legislation through various 'EIA Regulations', generally in the form of secondary legislation associated with existing consent provisions.

99 The Electricity Works (Environmental Impact Assessment)(Scotland) Regulations 2000 (“the EIA Regulations”) apply Council Directive 85/337/EEC as amended by Council Directive 97/11/EC to the Electricity Act 1989. The EIA Regulations relate to the assessment of the environmental impact of applications for consent to construct, extend or operate a power station or install or keep installed overhead electricity lines under Sections 36 and 37 of the Act.

100 Under the EIA Regulations, all Section 36 developments, which are considered likely to have significant effects on the environment must be the subject of an EIA, and an Environmental Statement (ES) must therefore be submitted with the Section 36 application.

101 The EIA Directive has not been directly applied under FEPA regulations but there are existing provisions within the Act requiring developers to provide information equivalent to a formal Environmental Statement.

3.4.1 Scope of Environmental Impact Assessment (EIA)

102 Large projects such as an offshore wind farm need to obtain a certain degree of flexibility when applying for consents. AOWFL will submit an application including EIA, which is based on the best design and layout information available to the project when making the applications, involving an assessment allowing for different types of wind turbines and foundations.

103 As not all the details of the proposed development will be known to AOWFL at the time that the application is submitted, when assessing the wind farm, a worst case approach will be taken, according to the principles described as the “Rochdale envelope”. What is considered to be the worst case could be different depending on the receiving environment affected (eg birds, shipping & navigation etc) and the activity undertaken (construction/decommissioning or operation). Where possible, the Environmental Statement will contain a detailed project description. However, when this is not possible, the Environmental Statement will provide a clear rationale for all parameters of the Rochdale Envelope.

3.5 Appropriate Assessment

104 Where the possibility of a likely significant effect on a European offshore marine site and/or a European site cannot be excluded and the plan or project is not directly connected with or necessary to the management of the European site for conservation purposes, a competent authority must undertake an Appropriate Assessment (AA) before deciding to undertake or give any consent, permission or other authorisation for a plan in accordance with the Habitats Directive.

105 For information on Statutory Designations see Section 5.9 Statutory Designations and Conservation.

4 PHYSICAL ENVIRONMENT

4.1 Meteorological Conditions

4.1.1 Introduction

106 Information on the meteorological conditions is required to inform the design of wind farm projects. This section outlines the baseline data collected to date.

4.1.1.1 *Project Reports*

- Prevailing (2009) Aberdeen Offshore Wind Farm: Analysis of LIDAR Data (00028-001-R: 7 October 2009).

4.1.2 Baseline Information

107 The North Sea climate is characterised by large variations in wind direction and speed, a high level of cloud cover and relatively high precipitation (OSPAR, 2000; DTI, 2004). The local climate along the north-east coast is dependent to a large extent on the shelter from winds from the north and west. Predominant winds are from the south and west. Wind strengths along this stretch of coast are variable and generally affected by local topography.

108 Mean annual rainfall in the central North Sea is 400 – 600 mm (OSPAR 2000; DTI, 2004). Coastal fog ("haar") is common during spring and summer along the east coast of Scotland, with up to 14 days per month recorded in exceptional years (North Sea Pilot, 1997; DTI, 2004).

109 Wind data have been recorded at an onshore location nearby the EOWDC site using Natural Power's ZephIR remote sensing LIDAR (Light Detection And Ranging) device.

110 Wind data were recorded by the LIDAR for a period of approximately two and half months from 31 October 2008 to 22 January 2009. A summary of the LIDAR measurements is presented in Table 4.1.

TABLE 4.1
Summary of LIDAR Measurements

Measurement device	Natural Power ZephIR
Location	OS Grid Reference 395024 810254
Monitoring period	31 October 2008 to 22 January 2009
Wind speed measurement heights*	27 m, 70 m, 90 m, 125 m, 153 m
Data recorded	Horizontal and vertical wind speed, wind direction, turbulence, temperature, pressure, humidity.
Configuration	Cloud correction turned on

* Note: 1 m added to the LIDAR measurement heights to account for height of device

111 In addition to the LIDAR data, the following data from the Dyce Meteorological Station are also available:

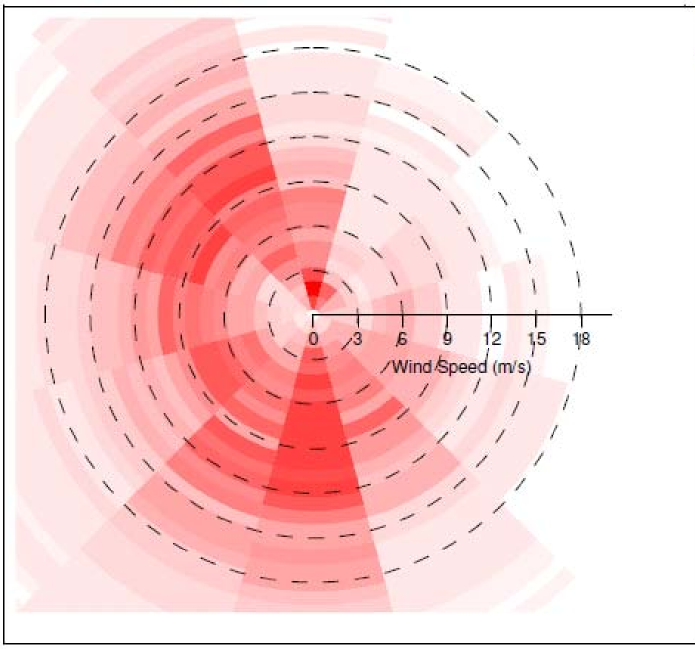
- hourly data from 1 November 2008 to 31 January 2009

- wind speed and direction data collected from January 2001 to January 2009

112 Correlations of the concurrent wind speed at Dyce and the LIDAR using hourly, daily and weekly averaging periods were conducted and the daily correlation used to derive the long-term mean wind speed of 8.74 m/s at a height of 90 m (Prevailing, 2009).

113 Data from the Dyce site has been used to derive the long-term site wind rose using a Measure-Correlate-Predict methodology. The Dyce wind rose was scaled to the predicted long-term mean wind speed of 8.74 m/s at 90 m at the LIDAR location. The resultant wind rose is shown in Diagram 4.1.

Diagram 4.1 Estimated long-term wind rose at the LIDAR location at 90 m



Sector	Probability
0	9.1%
30	2.8%
60	2.0%
90	2.4%
120	4.4%
150	8.4%
180	17.9%
210	12.2%
240	8.8%
270	7.9%
300	10.6%
330	13.4%

114 The meteorological conditions for the EOWDC area are summarised in Table 4.2.

TABLE 4.2
Meteorological conditions at EOWDC area

Meteorological Conditions	EOWDC area
Long-term wind speed*	8.7 m/s
Predominate wind speed – summer**	4.6 m/s
Predominate wind speed – winter**	5.2 m/s
Prevailing wind direction – summer**	South
Prevailing wind direction – winter*	South
Air temperature – annual average+	4.6 – 11.2 ^{o}C
Days of air frost – annual average+	53.6
Hours of sunshine – annual average+	1409
Rainfall – annual average+	816.3 mm
Days of rainfall ≥1mm – annual average+	134.2

*Long-term wind speed predicted at 90 m above ground level for LIDAR location (Prevailing report). Further offshore data collection would clarify this figure
**Dyce Station; summer (June, July & August), winter (December, January & February) measured at 10 m above ground level
+Craibstone 1971-2000 averages
Sources: *DTI (2004); +MetOffice Website (2010)

115 More detailed analysis of wind and meteorological data for the area will be conducted as part of the EIA for the EOWDC site.

4.1.3 EOWDC Future Research and Monitoring

116 Options for future wind are currently being discussed within the project.

117 It will be essential to monitor meteorological conditions throughout the life-span of the project to enable comparison between the wind dataset and the operational performance data.

4.2 Oceanographic Conditions

4.2.1 Introduction

118 This section outlines the baseline data collected to date with respect to oceanographic conditions. The information will be used in the coastal process modelling of the wind farm to assess the environmental impact.

4.2.1.1 Project Reports

- EMU Ltd. (2008a) Aberdeen Wind Farm Oceanographic Survey. Report No. 08/J/1/01/1138/0749. February 2008.

4.2.2 Baseline Information

119 EMU Ltd conducted an oceanographic survey in Aberdeen Bay in 2007/2008. Wave, tide, current and suspended solids were monitored within the previously proposed site area for 45 days, subsequently extended to 90 days, at the location shown on Figure 9.

120 A seabed mounted acoustic profiler (Nortek Acoustic Wave and Current, AWAC) was deployed, which is capable of recording current profiles, tidal heights, directional wave data and acoustic backscatter (ABS) profiles (see Plate 4.1). In addition, the frame was equipped with an environmental sonde comprising optical backscatter (OBS), salinity and temperature sensors. The ABS and OBS data were used to ascertain the suspended sediment load in combination with water samples analysed for total suspended solids (EMU Ltd, 2008a).

Plate 4.1 AWAC Seabed Frame

121 The AWAC was onsite from 12 September 2007 to 13 February 2008. During the course of this survey, the following main results were obtained:

- the tidal regime is characteristic of a standing oscillation. A standing oscillation tide is characterised by the occurrence of slack water at mid-tide. It appears as a phase difference between tidal and tidal current principal harmonic of approximately 6-7 hours, which indicates that high water and low water coincide with the periods of strongest currents
- the currents are tidally dominated with a semi-diurnal pattern, showing an expected spring-neap cycle
- the current peaks at the surface, reducing towards the seabed
- the current appears to be flowing parallel to the coast in a north-east/ south-west direction
- the dominant wave direction is south-east whereas the larger events are from due east during the survey period
- the largest recorded wave peaked at 5.5 m significant wave height. This coincided with a large storm event (1 to 5 January 2008) with a wave direction from the east. Other storm events were recorded throughout the deployment period, but none as energetic or sustained
- in general, wave periods appear to fluctuate between 4 s and 12 s, indicating that then energy recorded is both locally generated sea waves and remotely generated swell from the east
- the water samples collected returned suspended sediment values in the range of 6 mg/l to 29 mg/l. Variations in suspended solid concentration (SSC) values over time appear to show a correlation to physical forcing (waves and currents). A high SCC value throughout the water column coincided with the large storm event at the beginning of January 2008

122 Table 4.3 summarises the main statistical parameters for each data type collected during the survey period.

TABLE 4.3
Oceanography Survey (AWAC) Summary Statistics

Data Type		Maximum	Minimum	Mean	Standard deviation
Tidal Data	Height to LAT	4.675	-0.101	2.37594	0.98152
	Residual height	0.777	-0.791	0.00000	0.17809
Suspended Solid	OBS (mg/l)	1768.39 *	0.00	28.53	104.92
	ABS 2 (mg/l)	43.12	0.12720	20.67	7.97
	ABS 20 (mg/l)	39.48	0.13	11.97	6.72
Environmental data	Temperature (°C)	13.14	6.18	9.73	2.17
	Salinity (ppt)	34.86	31.05	34.14	0.41
Current data	Velocity 2 (m/s),	1.098	0.000	0.221	0.109
	Direction 2 (°T)	Major Axis 12.9-192.9			
	Easting Vector 2 (m/s)	0.489	-0.739	-0.008	0.083
	Northing Vector 2 (m/s)	0.664	-1.061	0.028	0.231
	Vertical Vector 2 (m/s),	0.204	-0.496	-0.001	0.015
	Velocity 20 (m/s),	0.889	0.002	0.287	0.162
	Direction 20 (°T)	Major Axis 15.9-195.9			
	Easting Vector 20 (m/s)	0.382	-0.390	0.00091	0.103
	Northing Vector 20 (m/s)	0.858	-0.807	0.043	0.310
	Vertical Vector 20 (m/s)	0.056	-0.484	0.001	0.015
	Velocity 40 (m/s),	1.1168	0.004	0.332	0.187
	Direction 40 (°T)	Major Axis 18.5-198.5			
	Easting Vector 40 (m/s)	0.901	-0.764	0.031	0.162
	Northing Vector 40 (m/s)	1.112	-0.988	0.026	0.342
	Vertical Vector 40 (m/s)	0.082	-0.515	-0.048	0.059
Wave data	Significant wave height (m)	5.53	0.19	1.078	0.79
	Maximum wave height (m)	6.82	0.29	1.45	0.99
	Peak period (s)	19.6	1.9	7.8	2.7
	Zero up crossing period (s)	7.2	3.1	4.5	0.6
	Mean period (s)	10.9	4.0	6.2	1.0
	Significant wave period (s)	20.0	1.9	7.9	2.8
	Peak coming direction (°T)	Northeast-Southeast			
	Peak spreading angle (°T)	40.5	0.8	24.1	10.0

4.2.3 EOWDC Future Research and Monitoring

123 Potential effects of both individual structures and a collection of structures on the physical oceanographic characteristics of the area and the potential resulting impact on coastal processes are discussed in Section 4.3 Coastal Processes.

4.3 Coastal Processes

4.3.1 Introduction

124 This section will outline the key coastal process issues which influence the form and function of the local coastal environment. At this stage a brief overview is offered in relation to the relationships between the wave, tidal and sediment regimes which will be described in further detail through the EIA phase.

4.3.2 Baseline Information

125 Aberdeen Bay is on the east coast of Scotland. It is characterised by dune backed sandy beaches which are fully exposed to the wave climate of the North Sea. The coastline adopts a crenulated bay formation whereby a sandy embayment has formed between Girdle Ness and the River Don in the south, and Collieston in the north. Offshore, the seabed bathymetry is relatively featureless forming a sloping ramp of sandy sediment. The exception to this is a narrow ridge of unknown origin situated in the region between the offshore and littoral zones; it is possible that this ridge affords some protection to the coast from wave action.

126 In the context of the overall hydrodynamic regime, tidal currents in the littoral zone are relatively weak and existing modelling studies (ABPmer, 2006) have noted that tidal currents alone are insufficient to mobilise beach sediment. Because of this it is likely that sediment transport in the nearshore area is predominantly due to wave action. Waves recorded within the vicinity of the development show that the most common wave direction is from the south-east although waves are also common from the sector between south-east and the north-east (Emu, 2008a). The south-east wave direction results in a net northerly direction of littoral transport as evidenced by the numerous small streams along the embayment that have been deflected to the north due to sediment deposition at their mouths. However, the southerly orientation of a spit across the mouth of the River Ythan at the northerly extent of the bay shows the potential for a locally net southerly littoral transport in this part of the bay. Three main rivers intersect with the coast within Aberdeen Bay namely (south to north) the Dee, the Don and the Ythan. Transport processes will be locally more complex at the mouths of the rivers Don and Ythan due to the interaction of waves, tides and freshwater flows (Halcrow Crouch, 1999).

127 Further offshore tidal processes become more important and sediment transport in the offshore zone is likely to be tidally dominant (Kenyon and Cooper, 2004). Based on regional scale BGS mapping the seabed sediment within the proposed wind farm site is generalised as predominantly sand with some gravel present further offshore, just outside the site. Net regional sediment transport direction has previously been shown to be in a northerly direction towards a bedload convergence zone which lies offshore from Rattray Head (DTI, 2004). Rates of transport are however reported to be low (HR Wallingford, 1997). Isolated areas of sand waves have also been reported in the area.

128 For the site itself, the following sections identify the currently available data and proposed additional data collection.

129 **Bathymetric data:** The principal source of bathymetry data for the EOWDC site is a swath bathymetry survey undertaken by Emu Ltd in September 2007 (Emu Ltd, 2008b). Additional surveys are also planned to cover those parts of the new site outwith the previously surveyed area.

130 In addition to the project specific bathymetric data, data is possibly available from the southern part of Aberdeen Bay collected for the Aberdeen Beach Study. We would need to seek the permission to use these data.

131 Data are also available from the United Kingdom Hydrographic Office (UKHO). The most recent data set is from December 2004, but this only

covers half the proposed model area; the remaining area is covered by data from 1965. SeaZone 'GIS ready' bathymetry data is also available as well as bathymetric survey.

132 Additional datasets, which are planned to be acquired, are the UKHO hydrospatial, digital survey bathymetry, charted raster and charted vector data.

133 Enquiries have also been made to Aberdeen University about the availability of bathymetric survey data, which was collected for the southern part of Aberdeen Bay for the Aberdeen Beach study.

134 **Beach elevation data:** Several datasets have been researched including Light Detection and Ranging (LIDAR), Ordnance Survey Landform Profile (OSLP) and NextMap Digital Surface Model (DSM). The NextMap Digital Surface Model (DSM) was identified as potentially providing a valuable data source for input into the littoral transport modelling. However, due to the potential limitations associated with the above data source and the importance of obtaining an adequate beach profile dataset, the options for undertaking a specific site survey are being considered.

135 Aberdeen University collect beach profile data along the Aberdeen Beach front between the Aberdeen North breakwater and the River Don. This information could be available from the University at a number of selected locations along this part of frontage, which is to the south of the site. There is also the possibility for ABPmer to undertake a survey to collect beach profile data and sediment samples along the foreshore adjacent to the site to inform the littoral drift modelling.

136 **Sediment size data:** This, combined with beach profile data, is a primary input into sediment modelling. Grain size information is available from 14 sediment samples collected by Fisheries Research Services (FRS) in 2006. These are located within the old site boundary and were processed using particle size analysis. Twelve samples were collected by ABPmer in 2003 along the nearshore opposite the Aberdeen Beach defences (near Beach Boulevard) as part of the Aberdeen Beach works. Permission would need to be sought to use this information for the site. The collection of project specific sediment data is planned to fill the data gap that exists within close proximity to the site as part of the offshore and intertidal grab sampling programmes, as discussed under 'Marine Ecology' and 'Intertidal Habitats and Ecology' (Sections 5.1 and 5.2). There is also the possibility for ABPmer to undertake a survey to collect beach profile data and sediment samples along the foreshore adjacent to the site to inform the littoral drift modelling.

137 Additional information identifying the offshore surface sediments is also available from the British Geological Survey (BGS).

138 **Geology:** The surface morphology and subsurface geology within the previously proposed EOWDC area has been characterised through a geophysical survey using sidescan sonar, seismics, magnetometer, AGDS and a video survey (Emu Ltd, 2008b). In addition to the geophysical survey, a desk review of available geotechnical information has also been carried out (Setech, 2009). During this study a review was carried out of BGS boreholes and maps along with the geophysical report to determine the likely subsurface geology. No new boreholes were collected for this survey. Additional

geophysical surveys are planned for the proposed site outwith the previous survey area and the geotechnical desk study updated to cover this area.

139 Additional information identifying the sub-surface geology is also available from the BGS.

140 **Tidal (hydrodynamic) data:** Tidal data for the site were collected by Emu Ltd using an AWAC device (see section 4.2) deployed in the north eastern part of the previous site (this corresponds to the south western part of the new layout area) (Emu Ltd, 2008a). This device collected tidal data between 12/09/2007 and 13/02/2008 and current data between 01/11/2007 and 13/02/2008.

141 The British Oceanographic Data Centre's (BODC) National Tidal and Sea Level Facility (NTSLF) holds data for water levels at a tide gauge maintained at Aberdeen. Water levels at the site are available from 1980 to 2010. The BODC also holds a record of in-situ current meter data at two locations in Aberdeen Bay.

142 **Wave data:** Wave data were collected by Emu Ltd between 01/11/2007 and 13/02/2008 using an AWAC (see section 4.2) deployed in the north eastern part of the previously proposed site (this corresponds to the south western part of the new layout area) (Emu Ltd, 2008a). This dataset details significant wave height, maximum wave height, peak period, zero up crossing period, mean period, significant wave period, total energy, mean coming direction, peak coming direction, mean spreading angle and peak spreading angle.

143 Limited offshore wave data are held within the CEFAS Wavenet system for two locations close to the EOWDC area. The available data was collected over the winter period of 1992 to 1993. Further information may also be available from a Datawell Waverider buoy deployed in Aberdeen Bay from 1 November 2007 to 9 August 2008 and from 24 September 2008 to 1 December 2008. The data recorded during deployment were significant wave height, average (zero crossing) wave period, dominant (peak) wave period and dominant (peak) wave direction. These data should be available through Aberdeen University or Aberdeen City Council.

144 Additional wave data are also available from the Met Office's 'European Wave Model'.

145 **Wind data:** Wind data are available from the two and half month LIDAR deployment and from Aberdeen Airport at Dyce (see section 4.1). Further data collection is planned (see section 4.1).

146 Aberdeen Harbour Board also record wind (and tidal) data at four hourly intervals, but these data will not be available for this project.

147 **Freshwater data:** The Scottish Environmental Protection Agency (SEPA) maintains river gauging stations in the River Dee, the River Don and the River Ythan. There are a number of gauging stations along each of these rivers which record daily mean flows.

148 A selection of the available datasets is shown in Figure 11.

4.3.3 Proposed Scope of Assessment

149 The proposed scope of assessment will make consideration of spatial and temporal scales using the presently available guidance (Defra, CEFAS and DfT, 2004), (OfDPM, 2001), (Defra, 2005), (SNH, 2003) which requires a specific assessment to be made of the following:

4.3.3.1 Baseline Assessment

- coastal processes which maintain the existing system, explanations for past changes and the sensitivity of the system to changes in these processes
- relative importance of high-energy, low-frequency (episodic) events versus low-energy, high-frequency events
- coastal processes controlling morphological change
- identification of sediment sources, pathways and sinks
- identification of the geological, geophysical and geotechnical sediment properties and the depth of any sediment strata within the wind farm site

4.3.3.2 Impact Assessment

- scour around the wind turbine structures and consideration of scour protection
- stability of buried cables under the influence of coastal processes
- scour around any cabling overlying the sediment surface
- effect on the spatial distribution of wave patterns, tidal flows and sedimentation (all near-field) and wave direction and energy (far-field) and any subsequent impacts on littoral transport
- non-linear interaction of waves and currents and the extent of sea bed sediment mobilisation
- sediment mobility and the natural variability of sediment depth across the near-field and the effect on wind turbine foundations and cable burial depth
- effect of cable laying on local levels of suspended sediment
- assessment of the scales and magnitudes of processes controlling sediment transport rates and pathways; and
- assessment of climate change impact on the coastal process regime

150 The baseline, or pre-construction, conditions include a description of the existing coastal process regimes prior to any works on the wind farm site. A consideration of natural changes (ie sea level rise) which may result in changes to the regime over the wind farm's operating period will be included, thus providing context for comparing natural changes against any introduced by the development.

151 Based on the understanding of the sediment and coastal processes occurring within the study area and the relative proximity of the development to the coastline the main concern will be addressing the potential impacts of the wind farm array on coastal processes. This will involve the assessment of any changes to the wave regime and any subsequent changes to rates and / or direction of littoral transport and any resultant changes to the crenulated bay form of the coastline.

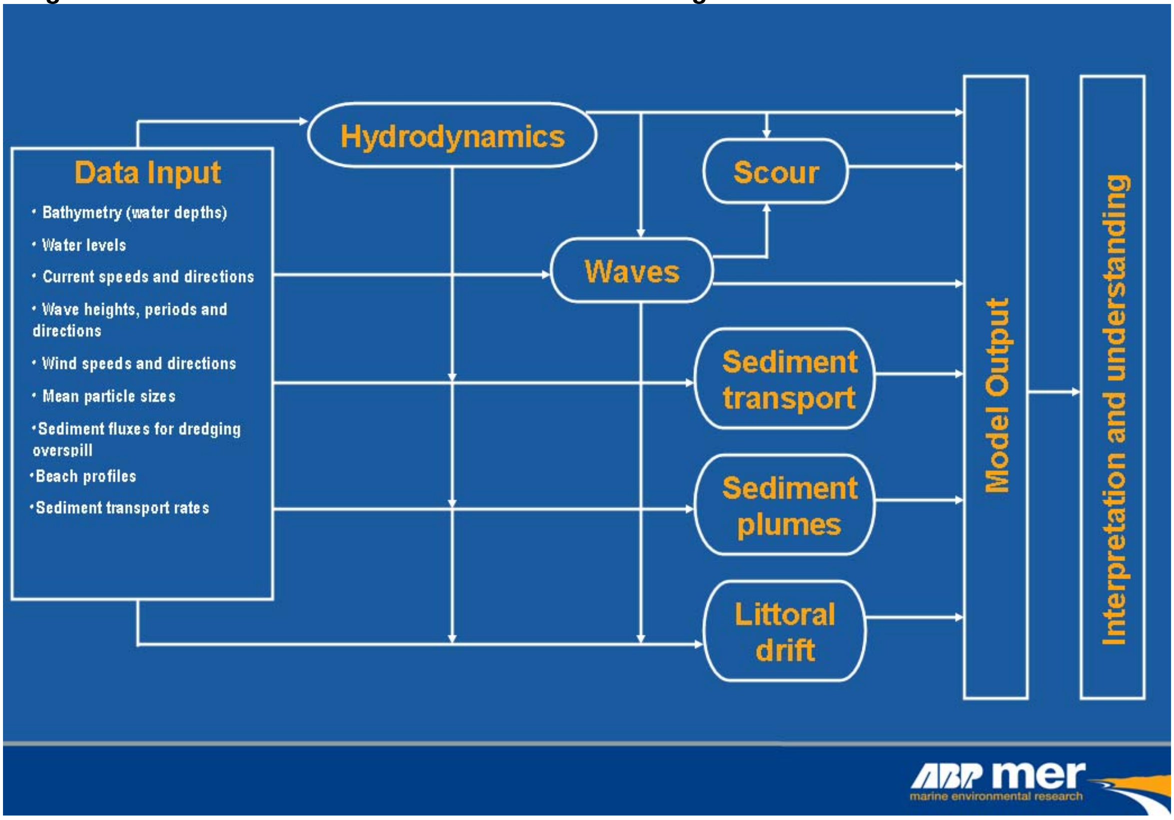
152 The oceanographic and coastal processes investigations will be conducted at different scales including:

- spatial scales:
  - near-field (ie the area within the immediate vicinity of different wind turbines/foundation types, within the wind turbine grid and along the cable route – an indicative near-field area is should on Figure 11); and
  - far-field (ie the wider environment over which effects could potentially occur an indicative far-field area is should on Figure 11)
- temporal scales:
  - baseline (pre-construction phase)
  - construction phase
  - post-construction phase
  - sediment recovery phase (period during which a new equilibrium position is attained with the wind turbines in place)
  - lifetime of the EOWDC array
  - decommissioning phase
  - post-decommissioning phase

153 Coastal process numerical modelling will be undertaken using a range of state of the art computer models which simulate tidal flow and coastal hydraulics, wind and wave, and resultant sediment transport processes. The application of the coastal process models will provide a series of quantified descriptions of changes to the wave, tidal and sediment transport regimes brought about from the proposed site development at a number of scales and representative of a number of stages during the lifecycle of the development. Outputs from the numerical modelling will be used to assess any direct and indirect impacts and provide considerations for potential mitigation and appropriate monitoring requirements (ABPmer, 2008). Diagram 4.1 outlines the modelling process.

154 Diagram 4.1 gives an overview of the modelling process; the effectiveness of modelling is highly dependent on the availability of data sources (as described in the previous section.

Diagram 4.1 Overview of the Coastal Process Modelling Process



4.3.4 Potential Impacts

155 Issues raised during the initial scoping in 2005 and ongoing consultations include the importance of understanding effects of the wind farm on patterns of erosion, deposition and on issues such as longshore drift and coastal morphology, specifically the impacts on foreshore aesthetics and harbour siltation rates. Concerns were raised that there should be no impact on the current erosion tendency of the coastline. Golf clubs have expressed concern regarding the impact on sand dunes and increasing the potential for erosion of some of the fairways and greens. FRS raised the need to consider seasonal changes in oceanic currents and wind forcing in the model. The need to consider other activities which may impact coastal processes, including offshore munitions dumping, the recent coastal defence works and dredging/aggregates removal, was also highlighted. In addition it is recognised that the Aberdeen Beach represents an important recreational resource in terms of surfing and the impacts of the development on this resource should be considered within the context of the coastal processes report (SAS, 2009).

156 Conclusions will be given that highlight the significance of any impact particularly relating to sediment movement, coastal erosion, coastal processes, depth and movement and coastal defences, with reference where appropriate to existing, consented and proposed wind farm development impacts elsewhere in the UK.

4.3.5 Cumulative Assessment

157 Coastal process studies must consider the effects of each wind farm acting cumulatively with other seabed activities. Guidance which exists from Scottish Natural Heritage (SNH) re-enforces that published by Cefas and Defra. Here it was defined that:

- all developments, both known, under consideration and in existence must be considered; and
- all developments within one tidal excursion must be considered.

158 With respect to coastal processes, other developments which are typically considered are dredging and aggregate activities. An initial consideration of other seabed users within the study area, includes:

- offshore munitions dumping. Conventional munitions are dumped within the study area (QinetiQ, 2007; OSPAR, 2005)
- coastal defence works. Coastal defence works are located to the south of the proposed wind farm site towards Aberdeen. Recent works have been carried out to enforce these defences through the installation of rock revetments. Immediately onshore of the wind farm, there are no hard defences installed with the natural dune system providing some protection to the hinterland
- dredging/aggregates. There are currently only two licensed dredge areas in Scotland (Scottish Executive, 2006) and neither is located within the study area. However, there is ongoing maintenance dredging in Aberdeen harbour.

4.3.6 Mitigation

159 Best practice procedures during construction and operation would be followed to minimise effects on coastal processes, seabed and water movements. Measures relating to coastal processes may include the installation of appropriate scour protection.

4.3.7 EOWDC Future Research and Monitoring

160 Potential effects of both individual structures and a collection of structures on the physical oceanographic characteristics of the area and the potential resulting impact on coastal process can be studied in a number of ways.

161 Possible options include an environmental station and additional array of buoys within the EOWDC research area and beyond which could be used to determine the oceanographic and coastal processes which maintain the existing system in the area before construction and any potential effects during and after construction, including:

- physical factors – temperature and salinity to ensure that any changes are the result of changes to physical processes e.g. location of tidal front due to fluid movement, rather than an external force, such as heavy run-off
- physical processes, such as effects on tidal movements/fluid dynamics leading to potential scouring/deposition, turbidity, etc.

- Effect on sediment transport of the area and comparison with sediment transport models
- scour around the different wind turbine structures / foundation types and cable routes. Effectiveness of different scour protection methods, including the potential impacts of scour and scour protection methods on benthic ecology (see reef effects Section 5.1)
- effect on the spatial distribution of wave patterns, tidal flows, sedimentation, wave direction and energy
- interaction of waves and currents and the extent of seabed sediment mobilisation
- sediment mobility and the natural variability of sediment depth at different distances from the wind turbine(s) and the effect of different wind turbine foundations and cable burial depth

4.4 Geology and Seabed Characteristics

4.4.1 Introduction

162 A review of the offshore sediments and geology in Aberdeen Bay indicates that the seabed sediments are defined as non-solid sediments laid down on the seabed by the actions of the sea during the early Holocene. The sediments in this region reflect its glacial history and hydrodynamic regime. There is little input of sediment from land most being derived from peat deposits. The sediments off Aberdeen consist predominantly of sand and slightly gravelly sand (DTI, 2004).

163 Below the seabed, Pleistocene deposits off the Aberdeenshire coast varies from soft red-brown, grey-brown and pink-grey muds to compact grey clays with scattered pebbles that probably indicate glacial tills. The soft muds probably date from late Devensian to Early Flandrian and were most likely deposited during the retreat of the last ice sheet. Seabed sediments mostly conceal bedrock in the area. The underlying bedrock along the coast between Aberdeen and Stonehaven comprises sandstones, conglomerates, mudstones and cherts.

164 Forvie is designated as a geological conservation statutory review site, this is a non statutory designation which reflects the areas earth science interest in relation to coastal geomorphology.

165 Surveys to obtain bathymetric, seabed and sub-bottom data are critical to the project, providing a basis for the foundation design work, and informing the coastal process modelling and marine ecological and archaeological impact assessments.

4.4.1.1 Project Reports

- EMU Ltd (2008b) Geophysical and Seabed Habitat Assessment of the Proposed Aberdeen Offshore Wind Farm. Report No. 07/J/1/02/1136/0716. February 2008.
- Setech Ltd (2009) Geotechnical Desktop Study. Report No. 8733-0-0. January 2009.

4.4.2 Baseline Information

166 EMU Ltd. was commissioned to undertake geophysical and seabed habitat survey of the previously proposed site (Figure 9). The aim of the survey was to determine and report on the seabed and sub-bottom conditions. The survey involved swath bathymetry, sidescan sonar imaging, shallow seismic profiling, magnetometer survey and use of an Acoustic Ground Discrimination System (AGDS) with video ground-truthing (EMU Ltd, 2008b). The survey was completed using the vessel FPV Morven between 12th and 18th September 2007.

4.4.2.1 Geophysical and Seabed Habitat Assessment Survey Results

167 Paper charts that were produced included the seismic trackplot, contoured and colour shaded bathymetry, sidescan sonar mosaic, seabed features with magnetometer and sidescan targets along with video ground truth information. Sediment isopach charts and geological cross sections are also available. Summary information is shown in Figure 9.

168 **Bathymetry:** At the previously proposed site, the bathymetry from shore, as shown in Figure 9, has an even gradient, deepening with distance offshore. Depths throughout the survey area range from 0.7 m to 29.1 m below Chart Datum and the water depth across the previous site ranges from 8.7 m nearshore to 29.1 m offshore, with a gradual gradient of 1 in 10 to 1 in 20 sloping to the east (EMU Ltd, 2008b).

169 **Seabed sediments:** The seabed sediments at the previously proposed site (as illustrated in Figure 9) are dominated by silty sand, with small patches of glacial till towards shore (and therefore in the area for the cable route). The surface sediments range from 0 m thickness at the shore to 6 m thickness at the offshore limit (EMU Ltd, 2008b).

170 The sidescan sonar data revealed five main seabed types in the survey area:

- silty sand
- exposed consolidated glacial material
- patches of glacial material exposed within seabed depression
- silty sand with patches of finer sediment
- linear ribbons of finer sediment within silty sand

171 The sidescan sonar data do not show any significant man-made debris or wrecks. Several trawl scars were noted and there were small amounts of debris including what appears to be a chain. Smaller debris may exist which cannot be resolved from the side scan or magnetometer data (EMU Ltd, 2008b).

172 **Geology and geomorphology:** Beneath the seabed sediments, there is glacial till comprising fine to coarse sand with possible areas of gravel and cobbles. The bedrock is Devonian Old Red Sandstone and increases in depth below seabed from 5 m at the shore to 30 m at the offshore boundary, being between 18 m and 25 m for most of the site. The depths and geology are therefore suitable for a range of foundations, including monopiles (EMU Ltd, 2008b).

173 **Magnetometer data:** The total magnetic field intensity chart for the survey area is dominated by large positive anomalies to the north of the survey area. These anomalies are thought to be the result of submerged geological features, possibly re-worked local material, with the high magnetic signature indicating the presence of remnant igneous material in the fabric of the till deposit. In total, 59 magnetic targets have been identified and plotted on a seabed features chart (EMU Ltd, 2008b).

174 **Video survey:** The objective of the video survey was to provide ground truth habitat identification for each of the seabed types identified from the sidescan sonar and AGDS surveys. Most of the area surveyed was silty to fine-medium sand with occasional patches of shelly fragments (EMU Ltd, 2008b).

4.4.2.2 <u>Geotechnical Study Results</u>

175 Setech (Geotechnical Engineers) Ltd. conducted a geotechnical desk study to determine anticipated soil conditions, in order to facilitate the options for foundation design, at the previously proposed site. The study used data available from the British Geological Survey (BGS) including borehole data and geological surveys, information held by Vattenfall and the Setech database.

176 The study indicated that it is likely that the site is covered by a veneer of silty Holocene Sand underlain by soft to very stiff clays with occasional sand and gravel lens of the Wee Bankie Formation. The base of Wee Bankie Formation ranges in depth from approximately 5 m BSL inshore to 22 m BSL (below seabed level), to the western extent of the previous wind farm lease boundary. Wee Bankie is likely to be underlain by Devonian Old Red Sandstone.

4.4.3 Proposed Scope of Assessment

177 Geophysical and geotechnical information currently available will be collated and assessed. An additional geophysical survey will be undertaken to assess the ground conditions in the area of the proposed site that is being taken forward in the Environmental Statement, which has seven out of the 11 wind turbines that lie outwith the previous geophysical survey area.

178 Following the recommendations by Setech (2009), a full site investigation will be undertaken to obtain site specific data on soil conditions. This would confirm the potential strength parameters of the Wee Bankie Formation, and would also verify the bedrock composition, competency and strength as an addition to the geophysical survey and this desktop study. This survey will be conducted as part of the pre-construction survey.

179 The information from geophysical and geotechnical surveys and studies will be used to assess the potential impact of the wind farm on the seabed and substrata, determine the options for foundation design and other engineering aspects of the site, and provide information for other studies, including coastal processes modelling and marine ecology. The potential impacts of the proposal on the hydrogeology (ground water / aquifers) will be investigated if considered appropriate.

4.4.4 Possible Constraints

180 From a foundation perspective, the Setech (2009) study anticipates that the soils do not pose any unusual impacts on likely foundation options.

181 Water depth has a direct effect on the required support structure height, weight of steel and fabrication cost, as well as associated costs for transport to site, and installation. However, the depth ranges at the proposed site are unlikely to pose any constraints to the proposed development.

182 There is no evidence at this stage to suggest that shallow gas will be present at the proposed site.

183 The UK is an area of low seismicity and the risk to offshore structures is considered to be correspondingly low.

184 The seabed across the proposed EOWDC area appears to be free from significant natural seabed features and from the data sources available no environmentally sensitive habitats have been reported (EMU Ltd, 2008b).

185 The Dee Valley Fault strikes diagonally across Aberdeen Harbour, however it is unlikely to affect ground conditions below the wind farm area (Setech, 2009).

4.4.5 Potential Impacts

186 The Setech (2009) study anticipates that the main issues, regarding soil conditions and foundation options, are likely to be scour in the sand, and the possibility / probability that a drill out will be required if a monopile foundation option is used due to the presence of shallow rockhead.

187 Offshore wind farm construction would not alter the geology of the site other than in localised areas directly impacted by the installation of wind turbine foundations. This is dependent upon the method of foundation chosen, effect will vary between piled foundation and gravity based structures. It is anticipated that during decommissioning, foundations would be removed to below the seabed surface.

188 Offshore wind farm construction is judged not to have a significant effect on the geomorphological features of the seabed.

4.5 Sediment and Water Quality

4.5.1 Introduction

189 The main factors affecting water quality, and in turn marine organisms, are contaminant levels (organic pollutants and metals) and levels of suspended sediments. In this area, nutrient inputs, predominantly from run-off from agricultural land, are also altering the biology of local enclosed waters such as the Ythan Estuary to the north of the proposed site.

190 Any changes to water quality as a result of the development of the wind farm, eg disturbance of polluted sediments and/or the re-suspension of sediment

during construction, have the potential to affect plankton, benthos, fish, birds and marine mammals.

191 Recreational use will also be considered here. The coast along Aberdeen and Aberdeenshire has a number of bathing waters identified under EC Bathing Water Directive (76/160/EEC) shown on Figure 12.

4.5.1.1 Project Reports

- Titan Environmental Survey (TES) Ltd (2008a) Marine Ecology - Review of Baseline Information. Report CS0208/R2/V2. May 2008.

192 Data are also available from the Fisheries Research Services (FRS) which collected sediment samples and analysed the levels of contaminants in Aberdeen Bay in 2006 (FRS, 2006).

4.5.2 Baseline Information

193 Data were collected by FRS in April 2006 to assess the level of contaminants in the sediments in Aberdeen Bay. Figure 9 indicates the location of the FRS samples.

194 **Hydrocarbons:** Levels of PAHs (polyaromatic hydrocarbons) in the FRS sediment samples from Aberdeen Bay were near or below background concentrations. The exception to this was levels of Phenanthrene, Anthracene and Pyrene at one site which were 5, 8 and 6 times higher than OSPAR's Background Assessment Criteria[2] respectively.

195 **Metals:** The results of the FRS survey indicate that metal concentrations were similar within all samples analysed. The average concentrations across all sites are presented in Table 4.4.

TABLE 4.4
Average metal concentrations in Aberdeen Bay

Metal	**As**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Zn**
Concentration in mg/kg dry weight	4.717	BDL	15.693	3.081	0.079	7.385	7.146	21.716

BDL=Below Detection limits
Source: FRS (2006), TES (2008a)

196 These average concentrations are all below OSPAR Background Concentrations (BC), i.e. those expected in the North East Atlantic if certain industrial developments had not happened, with the exception of mercury concentrations (0.08 mg/kg dry weight) which are slightly above the BC of 0.05 mg/kg. Mercury is on OSPARs list of Chemicals for Priority Action.

197 **Sewage and faecal coliforms:** Overall water quality in the vicinity of Aberdeen is good given the presence of sewage outfalls for trade and domestic effluent. Table 4.5 provides details of the sewage outfalls in the vicinity of Aberdeen.

[2] Background Assessment Criteria (BACs) are statistical tools defined in relation to Background Concentrations to enable testing of whether mean observed concentrations can be considered to be near background concentrations.

TABLE 4.5 **Sewage outfalls in the vicinity of Aberdeen**	
Activity	**Description**
Sewage (Public) Emergency Overflow (EO)	Technology Park SWS, EO to coastal waters, Bridge of Don
Sewage (Public) Combined Sewer Overflow (CSO)	Donmouth Rd PS, SSO to River Don, Bridge of Don, Aberdeen
Sewage (Public) Emergency Overflow (EO)	Bridge Terrace PS, EO to River Don, Bridge of Don, Aberdeen
Sewage (Public) Emergency Overflow (EO)	Lord Hays PS, EO to River Don, Seaton Park
Surface Water (SW) Commercial, Ind & Other	Kings Links SWS, FE to Rive Don estuary, Aberdeen
Sewage (Private) Primary	245 & 247 Don Street, STE to soakaway, Old Aberdeen, Aberdeen

Source: TES (2008a)

198 **Bathing waters:** Various bathing waters have been designated on the east coast of Scotland. The EC Bathing Waters Directive (76/160/EEC) requires monitoring of microbial indicators of faecal contamination (faecal coliform, total coliform and faecal streptococci) during the bathing season. Two main bathing waters have been identified near the proposed EOWDC development area: Aberdeen – Ballroom and Balmedie Country Park. The water quality of these bathing waters has been generally good for the past few years (2005-2007). In 2008 and 2010, Balmedie was designated as MCS Recommended (reaching the highest UK standard for bathing water quality). Aberdeen reached the guideline standard in 2010 and was given a basic pass in 2008. Water quality was poor at both beaches in 2009, Balmedie achieving a basic pass and Aberdeen failing to reach European minimum standards (MCS, 2010).

199 The Ythan estuary and the lower River Don are designated as Sensitive Areas on account of eutrophication (possibly due to run-off from agricultural land). Nutrient inputs to the Ythan estuary are at such a level that the then Scottish Office (now the Scottish Government) proposed its designation as Scotland's first Nitrate Vulnerable Zone under the EC Nitrates Directive (91/676/EEC) in 1994. Increasing weed cover (*Enteromorpha intestinalis*) in the estuary has led to a change in benthic community, with increases in the opportunistic polychaete species *Capitella capitata* noted in the 1980s (TES, 2008a).

200 **Naturally Occurring Radioactive Material (NORM):** Since 1982 offshore oil and gas equipment contaminated with low specific activity (LSA) scale or Naturally Occurring Radioactive Material (NORM) has been cleaned at an industrial site in Aberdeen Harbour. The main discharges from the offshore equipment are radium-226 and radium-228 and lead-210 and polodium-210. The contaminated wastes are discharged into Aberdeen Bay via an outfall pipe. Consequently, there is the potential that the seabed could be contaminated in Aberdeen Bay and that this could be disturbed during the construction of the proposed EOWDC.

201 Surveys undertaken near the outfall in Aberdeen Bay have not found any elevated levels of contamination in the sediments further than 50 m from the point of discharge (CEFAS, 2009). The results from NORM monitoring previously undertaken in Aberdeen Bay will be used in the Environmental Statement, but it is not thought to be of significant concern.

4.5.3 Proposed Scope of Assessment

202 Further literature reviews and detailed consultation will be undertaken in order to collate and assess existing data.

203 Sediment contaminant levels will be assessed during the benthic survey (see Section 5.1 Marine Ecology).

4.5.4 Potential Impacts

204 Potential impacts due to the development of the proposed EOWDC that may require further investigation include:

- discharges of contaminants from the construction vessels affecting water quality
- disturbance of contaminated sediment (if revealed to be present) leading to deterioration in water quality and mortality of plankton and benthos
- release of fines during construction leading to increased turbidity potentially altering planktonic growth and smothering benthic fauna

4.5.5 Cumulative Assessment

205 Data on sediment contaminants within Aberdeen Bay suggests that impacts associated with disturbance and dispersion of contaminated sediments are unlikely. The potential for cumulative impacts associated with an increase in fines during construction will be reviewed within the coastal processes assessment.

4.5.6 Mitigation

206 Implementing the following measures can mitigate potential impacts:

- adherence to MARPOL regulations which set out requirements to establish Pollution Action Plans to control pollution incidents
- good working practices to be adopted throughout the construction to prevent pollution incidents; and
- adherence to the required legislation for the use of paints and biocides

5 BIOLOGICAL ENVIRONMENT

5.1 Marine Ecology

5.1.1 Introduction

207 The North Sea is a complex and productive ecosystem, which supports important populations of fish, seabirds and marine mammals.

208 Plankton and primary productivity play a fundamental role in the food chain, providing food for the benthos and fish. Benthic communities, comprising species which live either within the seabed sediment (infauna) or on its surface (epifauna), feed off the plankton, and detritus (decomposing biogenic material), in turn providing food for larger invertebrate predators, fish and birds.

5.1.1.1 Project Reports

- Titan Environmental Survey (TES) Ltd (2008a) Marine Ecology - Review of Baseline Information. Report CS0208/R2/V2. May 2008.
- EMU Ltd (2008b) Geophysical and Seabed Habitat Assessment of the Proposed Aberdeen Offshore Wind Farm. Report No. 07/J/1/02/1136/0716. February 2008.
- Titan Environmental Survey (TES) Ltd (2008b) Marine Benthic Sampling Proposal. Report CS0208/D1/V1. May 2008.
- GoBe (2010) Review of Proposed Benthic Ecology Sampling

209 In addition, data are available from the Fisheries Research Services (FRS) from their plankton sampling off Stonehaven (FRS, 2010) and video surveys and epifaunal trawls within Aberdeen Bay (FRS, 2006).

5.1.2 Baseline Information

5.1.2.1 Plankton and Primary Productivity

210 Weekly sampling for hydrographic parameters, concentrations of inorganic chemical nutrients and the abundance of phytoplankton and zooplankton species has been carried out 5 km offshore from Stonehaven since January 1997. The objective of the sampling programme is to establish a monitoring base for assessing the status of the Scottish coastal waters ecosystem and responses to climate change (ICES, 2006; FRS, 2010).

211 The biological data show significant differences across seasons and years. The water column at the Stonehaven sampling site remains well mixed throughout much of the year, except in late summer and autumn when surface heating and settled weather often cause temporary thermoclines to appear. The seasonal minimum temperature generally occurs in the last week of February/first week of March.

212 Water movement in the area is generally southerly with quite strong tidal currents. In late summer and through autumn of most years, water with a high Atlantic Ocean content passes down the Scottish east coast. These

influxes often bring oceanic species, for example, the chaetognath *Sagitta serratodentata* and the siphonophore *Muggiea atlantica* are indicators of this oceanic influence.

213 The seasonal pattern of plankton production is clearly evident in the data collected so far, as is the variability among years in its extent. Nutrient data also show strong seasonal cycles but interannual variability.

214 Data are regularly processed in the FRS MLA database, and some of these data are displayed on the MLA website (FRS, 2010) and published in periodic reports.

5.1.2.2 <u>Benthic Habitats</u>

215 Geophysical data from the surveys of the previously proposed Aberdeen Offshore Wind Farm site boundary show that the area is relatively uniform, comprising predominantly silty sand with patches of finer sediment (Figure 10). Further offshore in the south-east corner of the area surveyed there is an area of linear ribbons of finer sand within the silty sand (TES, 2008a).

216 Two main biotope types were found in the surveys: SS.SSa.CMuSa and SS.SSa.CCS (Figure 10).

- SS.SCS.CCS: Circalittoral coarse sediment: Tide-swept circalittoral coarse sands, gravel and shingle generally in depths of over 15-20 m. This habitat may be found in tidal channels of marine inlets, along exposed coasts and offshore. This habitat, as with shallower coarse sediments, may be characterised by robust infaunal polychaetes, mobile crustacea and bivalves.
- SS.SSa.CMuSa: Circalittoral muddy sand: Circalittoral non-cohesive muddy sands with the silt content of the substratum typically ranging from 5 % to 20 %. This habitat is generally found in water depths of over 15-20 m and supports animal-dominated communities characterised by a wide variety of polychaetes, bivalves and echinoderms.

217 Data from Stephen (1922) from a group of inshore samples from around Aberdeen (20 – 40 m depth) and a transect of eight stations extending offshore in a north-westerly direction to the 100 m contour, show a community characterised by the presence of *Ophiura affinis* and *Echinocyamus pusillus*. Stephen (1922) concluded that there was large-scale geographic similarity in the offshore fauna and that it was less abundant than the inshore fauna.

218 McIntyre (1958) described the benthos of the east coast fishing grounds with reference to surveys of Aberdeen Bay. He found the benthic fauna to be dominated by lamellibranchs and polychaetes with *Abra alba*, *Tellina fabula*, *Nucula turgida* and *Ensis* sp. The polychaetes *Lanice conchilega*, *Sigalion mathildae*, *Notomastus latericeus* and *Nephtys* spp were also dominant.

219 The geophysical data show that the nature of the sediments offshore is relatively homogenous and it is expected that the planned surveys will give very similar results to those of McIntyre (1958) despite the lapse of 50 years.

220 Data from FRS summarising the epifauna trawls undertaken on the 7th of April 2006 in Aberdeen Bay (FRS, 2006) are presented in Table 5.1.

TABLE 5.1 Species collected in epifauna trawls of Aberdeen Bay			
	Haul 1	**Haul 2**	**Haul 3**
Haul duration	**20 min**	**20 min**	**23 min**
Start and end coordinates	57º12.690N 2º00.320W57º11.800N 2º00.740W	57º11.970N 2º01.430W57º11.070N 2º00.980W	57º11.170N 2º02.660W57º12.230N 2º02.380W
Depth	25m	19m	12m
Species:			
Common dab	13	13	2
Long rough dab	1	3	/
Plaice	26	29	10
Flounder	1	/	1
Pandalus	1	/	1
Asterias	17	8	/
Echinoderm	2	3	1
Brittle stars	180	50	20
Dead men's fingers	/	1	/
Pipe fish	/	1	4

221 Analysis of video footage collected by FRS during the same survey shows that the surveyed area is a seemingly barren fine grained sand bank containing no weed and no apparent life except for *Ophiura* sp and *Asterias*. Brittle stars were more abundant in the deeper part of the surveyed area (Run 1 – 25 m) whereas *Asterias* are more abundant in Run 1. There was evidence of an *Echinocardium* community due to the presence of empty tests in Runs 2 and 3 (FRS, 2006). Locations of the video runs are indicated in Figure 10.

222 None of the surveys to date have identified species which are of concern from a conservation perspective eg *Sabellaria* reefs and *Modiolus* beds within the general application area. Known seagrass beds on the east coast of Scotland are to the south of Aberdeen. Broken *Sabellaria* tubes were noted by Stephen (between 1922 and 1925) off the north east coast of Aberdeenshire, however these probably originated from masses growing near Rattray Head (Stephen, 1933, 1934).

5.1.3 Proposed Scope of Assessment

223 Further literature reviews and detailed consultation will be undertaken in order to collate and assess existing data.

224 The proposed wind farm lies close to a known front. Modelling will be undertaken, as part of the Coastal Processes modelling (Section 4.3.3) to assess the impacts of the proposed EOWDC on this front.

225 Site specific benthic grab and trawl surveys will be conducted to provide more detailed and current baseline information in order to undertake an impact assessment for the proposed EOWDC development. From a review of available data, the benthic communities in the area are likely to comprise typical and common infaunal invertebrate species of no particular conservation significance.

226 The survey will aim to provide information on habitat type and community structure in the area within which the wind turbines will be placed and the wider area which may be affected by the development. The survey will also form the baseline for future post-construction surveys and, as such, comparable control sites have been included in the survey design.

227 From the detailed geophysical data, it is evident that the habitat in and around the proposed development site is relatively homogenous. Therefore, a relatively low intensity of sampling is proposed to ground truth the habitat types present.

228 All survey data, desk studies and additional information for benthic habitats will be collated and assessed as apart of the EIA process.

229 Benthic surveys will be undertaken in accordance with recommended guidance and in consultation with Marine Scotland.

230 The proposed sampling approach is as follows:

- benthic samples at approximately 19 sites, with single grab samples (no replicates) collected at each site:
  - two sites shall be located within a single cable corridor
  - eight sites shall be within the wind turbine area
  - five sites shall be in the tidal ellipse (outside of the wind farm area) but extending from the edge of the wind turbine array and along the tidal axis
  - four sites shall be inshore of the array (between the 5 to 10 m contour)
  - replicates to be agreed with Marine Scotland
- a total of six single beam trawls of which:
  - three within the wind turbine area
  - two within the secondary impact area (one north and one south)
  - one within the cable route area

231 The beam trawls will be undertaken using a scientific beam trawl with beam width of 2 m, comprised of 20 mm mesh (knot to knot), and a 5 mm liner into the cod-end.

5.1.4 Potential Impacts

232 The planktonic community in the vicinity of the proposed EOWDC development is typical of the area and has the capacity to recover quickly due to the continual exchange of individuals with surrounding waters. Any impacts associated with the proposed EOWDC development are likely to be small in comparison with natural variations and it is proposed that impacts on plankton populations are scoped out of the EIA for this site.

233 Potential impacts on benthic habitats, which will be considered in detail in the Environmental Impact Assessment (EIA), include:

- loss of seabed habitat due to the addition of wind turbine foundations and scour protection
- loss of and disturbance to benthic habitats due to long term changes in sediment transport rates altering seabed sediment types

- release of contaminants from the seabed and contaminant discharge from construction vessels
- disturbance due to increased sediment suspension and deposition. Fine sediments could be brought into suspension during the installation works which could result in the smothering of sessile organisms. Given the relatively coarse nature of the sediments likely to be encountered across the site, it is not expected that increases in suspended sediment concentrations would be significant relative to background levels
- underwater noise and vibration which may affect the behaviour of benthic species
- electromagnetic effects from inter array and export cables which may affect the physiology or behaviours of benthic species
- provision of new habitat due to the presence of wind turbine foundations and scour protection (if required). Small and localised increases in biodiversity could be expected as species that are not regularly found in sandy / muddy environments may be able to establish themselves on the foundation structures

5.1.5 Cumulative Assessment

234 Potential impacts on plankton and marine benthos are likely to be short term and to be site specific. As a result, interactions with other activities are not anticipated and it is proposed that cumulative impacts on plankton and marine benthos are scoped out of the EIA for this site.

5.1.6 Mitigation

235 Implementing the following measures can mitigate potential impacts:

- MARPOL regulations set out requirements to establish Pollution Action Plans to control pollution incidents
- good working practices will be adopted throughout the construction to prevent pollution incidents / spillage of excavated material (if required)
- construction techniques will be used that minimise the amount of fines released into the marine environment
- the required legislation will be adhered to for the use of paints and biocides
- if the site surveys reveal any biologically sensitive areas, micrositing of foundations / cabling may be employed (on the basis of available information, this is considered unlikely)
- scour would be mitigated (as required) through the implementation of appropriate scour protection as agreed with the consenting authorities. The foundations and associated scour would introduce new surfaces for benthic colonisation

5.1.7 EOWDC Future Research and Monitoring

236 Monitoring of seabed communities would be undertaken before and after construction in order to identify any potential long term effects.

5.1.7.1 Further Research Opportunity: Reef Effect

237 The development of arrays of wind turbines at offshore locations may lead to medium-term changes in the "marine ecology" of the whole area of a site. Currents may be subtly altered, sedimentation changed, new surfaces for marine organisms introduced and, crucially, the patterns and amount of commercial fishing activity may change. The presence of hard structures will locally promote marine growth , fish and other marine organisms will in turn be attracted to these structures. The marine organisms that are associated with the turbines are likely to be composed of different species and abundances in comparison to the seabed community that existed previously and, with time, could become typical of a reef like community with encrusting epifauna. If fishing activities, particularly bottom trawling, are reduced or ceases within the wind farm footprint, then this provides an opportunity to study on a small scale potential reef effects. It has been hypothesised that, offshore wind farm sites have the potential to become large "reef complexes", with each of the turbine support structures acting as a reef module. Depending on the spacing between turbines, and, crucially, the fisheries management regime that is agreed for the site, not only would the area immediately around each wind turbine, in time, become a small reef, but the spaces between turbines might also benefit from reduced fishing pressure.

238 Artificial reefs have long been used as part of fisheries management programmes. On a local scale, they can enhance fishing success, or increase fish populations, or support fish breeding and recruitment. Marine organisms within these areas can still be actively "harvested" by sustainable techniques, or they can be left alone to act as sanctuaries and breeding grounds for fish and shellfish that could eventually disperse into the wider population.

239 The beneficial "side-effect" of wind turbine arrays as artificial reefs is poorly understood and the proposed EOWDC could provide an ideal site for a multi-disciplinary study, for the following reasons:

- Aberdeen, and its Universities and Research Institutes and government agencies, has a long and distinguished history of research into commercial fishing and aquaculture. It is well-placed to develop, implement, manage and report on a study of the effects of wind turbine arrays as reefs, and on the implications of the creation of large arrays on existing and future commercial fishing operations and the management of fish stocks
- the site has an established baseline of information, and this could be appropriately enhanced, and control sites established, before construction of the wind farm
- the site is already a multi-user environment, and changes to the status of the area and the management of the site will have to be made. The recognition that the wind farm is also an artificial reef, of benefit to other users of the sea, would be an additional catalyst for imaginative planning and management of the area, perhaps under the umbrella of a broad spectrum of stakeholder groups including fishermen

240 Specific reef study work that could be done at the site, in addition to some of the associated or complimentary studies noted elsewhere in this submission, and the studies on commercial fisheries noted below, could include the following;

- monitoring the change in condition, “health”, biodiversity and contaminant burden of the seabed and benthos (epifaunal and infauna)
- monitoring the change in numbers and species richness of fish and shellfish in and around the site
- monitoring changes in the health/quality of individuals, and the population profile and reproductive potential of populations, of commercial fish and shellfish in and around the area
- conducting trials of “sustainable” fishing methods, such as creeling and long-lining, in and around the area.

5.2 Intertidal Habitats and Ecology

5.2.1 Introduction

241 The intertidal substrate close to the proposed site is mostly sand, however, the sandy foreshore from Aberdeen to the Ythan Estuary is interrupted by a few rock platforms around Blackdog Rock. There are also rock platforms and boulders/loose rock to the south of Aberdeen (south of the Dee river) and to the North of the Ythan Estuary.

5.2.1.1 Project Reports

- Titan Environmental Survey (TES) Ltd (2008a) Marine Ecology - Review of Baseline Information. Report CS0208/R2/V2. May 2008.
- Titan Environmental Survey (TES) Ltd (2008b) Marine Benthic Sampling Proposal. Report CS0208/D1/V1. May 2008.
- GoBe (2010) Review of Proposed Benthic Ecology Sampling.

5.2.2 Baseline Information

242 **Rocky littoral and sublittoral on the east coast:** The macro alga of the rocky outcrops of north eastern Scotland were surveyed by Wilkinson (1975) who found 80 species not previously recorded from the area, including the first British record of the brown algae *Sorapion Kjelmanii* (Bennett and McLeod, 1998). Early records by Jack (1890) provided information on the marine algae of the rocky shores in the vicinity of Arbroath.

243 A large number of common and widespread species in the east coast of Scotland such as chitons, gastropods and bivalves have been recorded from many habitats along the coast. On rocky shores chitons (*Lepidochitona* sp. and *Acanthochitona sp.*), gastropods such as *Nucella lapillus*, *Patella aspera*, *P. vulgata*, *Margarites helicinus*, and several species of *Littorina* and *nudibranchs* (*Onchidoris* spp., *Archidoris*, *Facelina*, *Aeolidia*) were present. There was a large gastropod fauna including *Helcion pellucidum*, several species of Lacuna and some pyramidellids that were associated with Fucus fronds and *laminarian stipes* (Eleftheriou *et al.*, 2004).

244 **Sedimentary shores on the east coast:** The fauna of the Aberdeenshire and Angus beaches is characteristically dominated by haustorid amphipods (*Haustorius arenarius* and *Bathyporeia pelagica*) and in some cases the spionid polychaete *Nerine* (*Scolelepis*) *cirratulus* (Hart, 1971). In a rare study on the vertical and horizontal distribution of the meiofauna of the sandy

sediments at Collieston Beach, north of Aberdeen, a restricted fauna with a patchy distribution due to the local differences in the variation of the grades of sediment has been found (Seaton, 1975).

245 **Ythan Estuary:** The Ythan estuary is a small meso-tidal bar-built estuary (Davidson *et al.*, 1991) lying approximately half way between Peterhead and Aberdeen on the east coast of Scotland.

246 The faunal community of the estuary has been well studied, the amphipod *Corophium volutator*, with the gastropod mollusc *Hydrobia ulvae*, the polychaete *Nereis* (now Hediste) diversicolor and the bivalve *Macoma balthica* being widely distributed. Species such as the cockle *Cerastoderma edule*, the gastropod *Littorina littorea*, the shore crab *Carcinus maenas* and the mussel, *Mytilus edulis* exhibit more localised distributions (Bennett and McLeod, 1998). Increasing weed cover (*Enteromorpha intestinalis*) has led to increases in the opportunistic polychaete species *Capitella capitata* in the 1980s.

5.2.3 Proposed Scope of Assessment

247 Once the location of the cable landfall is known, further literature reviews and detailed consultation will be undertaken in order to collate and assess existing data and ascertain the need for further site specific surveys.

248 If surveys are required, samples would be collected from sites along the beach at high, mid and low water. In order to collect a sufficient number of animals in what is likely to be a sparsely populated area, each sample would cover an area of 0.1 m^2 to a depth of 15 cm.

5.2.4 Potential Impacts

249 Potential impacts on intertidal habitats, which will be considered in detail in the Environmental Impact Assessment (EIA), include:

- substrate loss, physical disturbance and abrasion from cable laying
- smothering of benthos from increases in sediment suspension and deposition
- heating effects

5.2.5 Cumulative Assessment

250 Other shore based activities will be reviewed and assessed at the time of the Environmental Statement compilation. However, from the information available to date, cumulative impacts are not expected.

5.2.6 Mitigation

251 Mitigation could include:

- careful siting of the cables to avoid sensitive areas
- use of appropriate cable laying tools to minimise disturbance
- burial of export cables to reduce potential heating and EMF effects

5.3 Fish, Shellfish and Elasmobranchs

5.3.1 Introduction

252 The fish ecology of any site is an important consideration during offshore wind farm development, the fish communities forming a fundamental part of the part marine ecosystem and providing stock for commercial and recreational fisheries.

253 The northern North Sea is important for its fish stocks and the commercial fisheries it supports; fishing is important to local communities and to the economy of coastal regions (see Section 6.6).

5.3.1.1 Project Reports

- Titan Environmental Survey (TES) Ltd (2008a) Marine Ecology - Review of Baseline Information. Report CS0208/R2/V2. May 2008.
- Brown & May Marine Ltd (2008) Aberdeen Offshore Wind Farm – salmon and sea trout preliminary baseline assessment. August 2008.
- Brown & May Marine Ltd (2008) Aberdeen Offshore Wind Farm – commercial fishing aspect. August 2008.

5.3.2 Baseline Information

254 The SEA 5 area supports a range of fish and shellfish species, including spawning grounds. A number of fish species found in the SEA 5 area have been included on the OSPAR Initial List of Threatened and/or Declining Species, including cod (*Gadus morhua*), common skate (*Raja batis*), spotted ray (*Raja montagui*), basking shark (*Cetorhinus maximus*), common sturgeon (*Acipenser sturio*), allis shad (*Alosa alosa*), sea lamprey (*Petromyzon marinus*) and salmon (*Salmo salar*). A number of rivers within the SEA 5 area support internationally important numbers of salmon and sea lamprey (Chapman, 2004).

255 The offshore area around Aberdeen supports a range of fish and shellfish species. Offshore fish communities are dominated by haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*) and cod, with saithe (*Pollachius virens*) and Norway pout (*Trisopterus* sp.) being associated with deeper waters. Migratory species such as herring (*Clupea harengus*) and mackerel (*Scomber scombrus*) are found throughout the area, although their distribution is seasonal. Sandeels (*Ammodytes marinus*) are also abundant and their distribution is closely associated with well-oxygenated, medium to coarse sand.

5.3.2.1 Spawning and Nursery Grounds

256 Data from Coull *et al.* (1998) show that the offshore area off north-east Scotland contains spawning grounds for cod, herring, lemon sole (*Microstomus kitt*), Norway lobster (*Nephrops norvegicus*), Norway pout, saithe, sandeel, sprat (*Sprattus sprattus*) and whiting (Diagram 5.1), as well as nursery grounds for whiting, saithe, lemon sole, sprat, plaice (*Pleuronectes platessa*) and sandeel, *Nephrops* and haddock (Diagram 5.2).

257 The proposed EOWDC site coincides with potential spawning grounds used by herring (May to August, with peak spawning period in May and June), lemon sole (February to June, with peak spawning period between April and May), sandeels (November to February) and scallops (*Pecten maximus*) (August/September and April/May) and nursery areas for lemon sole, sprat, saithe, plaice and sandeel.

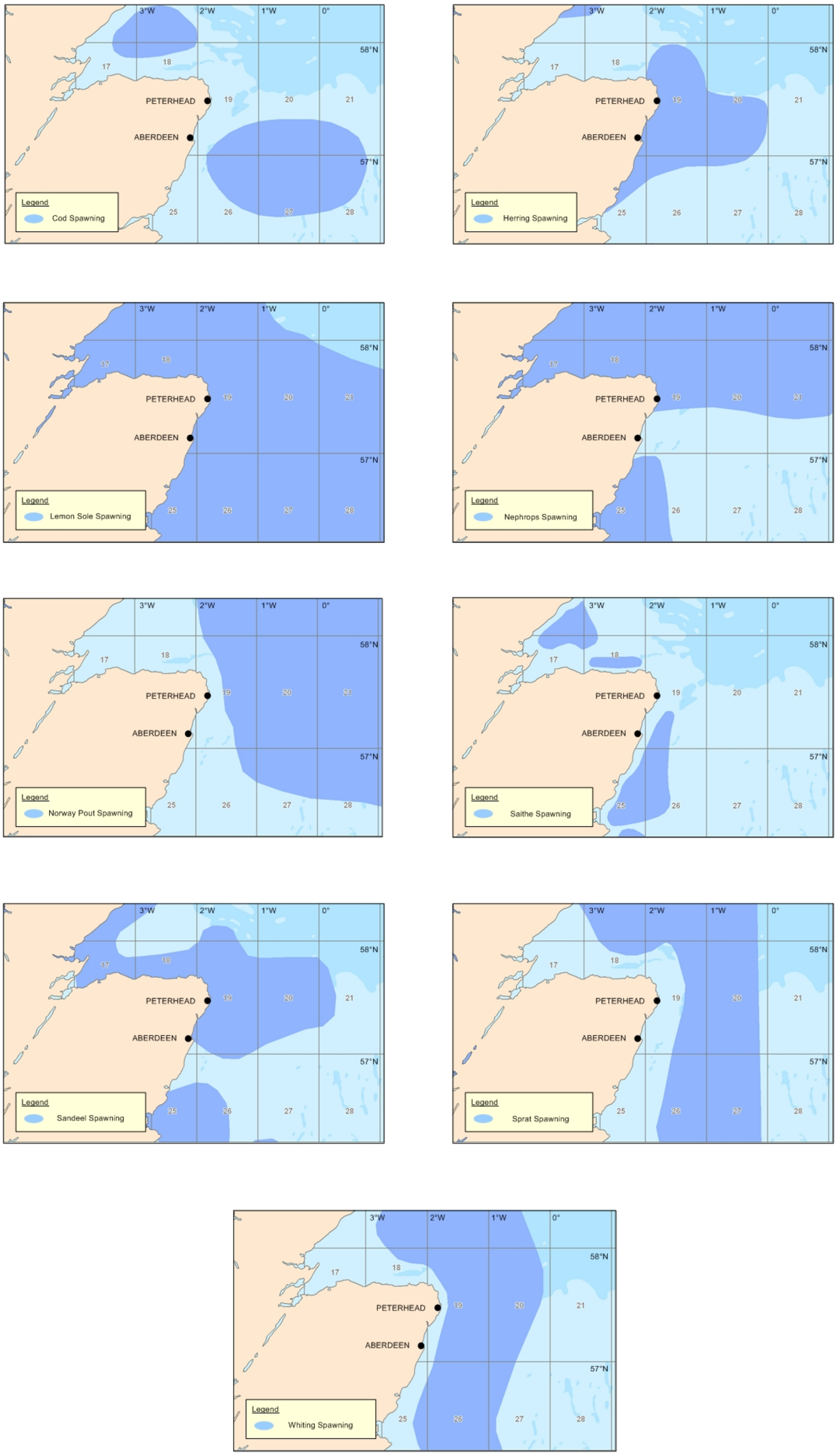
258 Spawning grounds are dynamic features of fish life history and are rarely fixed in one location from year to year. Although some fish species exhibit the same broad patterns of distribution from one year or season to the next, others show a large degree of variability. For sediment spawners, not all suitable sediment areas might be used in every year and areas used will depend on the size of the spawning stock. Therefore, the information provided in Diagram 5.1 represents the widest known distribution given current knowledge and should not be seen as a rigid, unchanging description of presence or absence. Spawning times represent the generally accepted maximum duration of spawning. In addition, fish may spawn earlier or later in the season in response to environmental change (Coull *et al.*, 1998).

259 In the North Sea, sub-populations of herring (*Clupea harengus*) spawn at different times and localised groups of herring can be found spawning in almost any month. At present there are three major populations of herring in the North Sea. These ‘races’ are mixed for the majority of the year, but separate during the breeding season when each race migrates to its own spawning grounds (Daan *et al.*, 1990). In the area off the north-east coast of Scotland, herring spawn during August to September. Spawning normally takes place in relatively shallow water, at depths of approximately 15-40 m.

260 Lemon sole are distributed throughout the central and northern North Sea and are pelagic spawners. Little is known about its spawning habits, and it is thought that Lemon sole spawns throughout its range (CEFAS, 2001).

261 There are five species of sandeel in the North Sea, though the majority of commercial landings are of *Ammodytes marinus* (CEFAS, 2001). Sandeel eggs are demersal, and are laid in sticky clumps on sandy substrates. On hatching, the larvae become planktonic, resulting in a potentially wide distribution (CEFAS, 2001).

262 The locations of nursery areas can change from year to year depending on factors such as water temperature or the availability of food. It is therefore difficult to define the limits of nurseries precisely and, as with the spawning locations the maps in Diagram 5.2 give an indication of the likely positions of juvenile concentrations and represent the widest known distribution, rather than a definitive description of the limits of all nursery grounds (Coull *et al.*, 1998).



Source: Coull *et al.* (1998)

Diagram 5.1 Fish spawning grounds off north-east Scotland

Diagram 5.2 Fish Nursery Areas off north-east Scotland
Source: Coull *et al.* (1998)

5.3.2.2 Shellfish

263 Shellfish species known to occur off Aberdeen include European lobster (*Homarus gammarus*), edible crab (*Cancer pagurus*), velvet swimming crab (*Necora puber*), shore crab (*Carcinus maenus*), giant scallops, cockle (*Cerastoderma edule*), mussels (*Mytilus edulis*), whelks (*Buccinum undatum*) and periwinkles (Littorina sp.).

264 The Norway lobster (*Nephrops norvegicus*) is by far the most important shellfish species exploited in Scottish waters. Norway lobsters are located in areas of soft mud or muddy sand in which they excavate and inhabit burrows. There are known spawning grounds to the north and south of Aberdeen Bay.

5.3.2.3 Cephalopods

265 Cephalopods (including cuttlefish, squid and octopus) are a prey item for a number of marine top predators such as fish, birds and marine mammals (Stowasser *et al.*, 2004). Evidence exists that fishing pressure has changed ecological conditions and shifts in community structures have occurred with cephalopod stocks slowly replacing predatory fish stocks (Caddy and Rodhouse, 1998).

266 Oceanic inflows from the Atlantic, coupled with the numerous shallow inshore habitats, make the northern North Sea a region of greater cephalopod diversity and abundance than the southern North Sea. Among the most frequently recorded species are: the long-finned squids, *Alloteuthis subulata* and *Loligo forbesii*; the short finned squid, *Todaropsis sagittatus*, *G. fabricii* and *Onychoteuthis banksii*; *the bobtail squids*, *Rossia macrosoma*, *Sepietta atlantica* and *Sepietta oweniana* and the octopus, *Eledone cirrhosa* (Hastie, Pierce and Wang 2008).

5.3.2.4 Non-commercial Species

267 The number of exploited and non-exploited fish species from coastal areas of SEA 5 was estimated by Potts and Swaby 1993 (cited by Swaby and Potts 1996, 1997a, b, c). Information on the distribution and abundance of non-commercial species comes from records made during routine groundfish surveys, landings data, historical records as well as scientific studies. The most abundant species found in near surface surveys in areas from Aberdeen to off Shetland were rocklings (*Gadidae*), members of the herring family (*Clupeidae*) and three-spined sticklebacks (*Gasterosteus aculeatus*) (Hislop 1979, cited by Swaby and Potts 1996). In summer and autumn, there is a large population of the sand goby (*Pomatoschistus minutus*) in the Ythan Estuary (NESBiodiversity, 2007).

5.3.2.5 Diadromous and freshwater species

268 There are several species that migrate between fresh and salt waters (diadromous species). These include the Atlantic salmon (*Salmo salar*), sea trout (*Salmo trutta*), sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*), eel (*Anguilla anguilla*), twaite shad (*Alosa fallax*) and allis shad (*Alosa alosa*) (Barne *et al.*, 1996; DTI, 2004). Atlantic salmon, river

and sea lamprey, twaite shad and allis shad are listed as protected species in Annex II of the EU Habitats Directive.

269 In addition to salmon and sea trout, the North East Scotland region has records of all seven British marine and estuarine species protected under national, European and international legislation. However, these records tend to be individual records of the lamprey and sea lamprey, allis and twaite shads, and sturgeon. These species are considered threatened in the UK and European waters.

270 There are no designated SAC sites in the vicinity of the proposed EOWDC for sea lamprey, river lamprey, allis shad and twaite shad (JNCC, 2010).

Salmonids

271 Salmonids (salmon and sea trout) spawn in freshwater and migrate to the sea to mature. On the North Sea coast, salmon rivers are concentrated in the north and northeast Scotland. Trout tend to have a more westerly distribution. Around the North East of Scotland region, the Deveron, Ugie, Ythan, Don, Dee and Bervie are the main rivers that are known to contain populations of salmon and sea trout. Smaller rivers and tributaries may also contain populations (Barne *et al.*, 1996).

272 The river Dee has been designated as an SAC for its populations of Atlantic salmon. The River Dee supports a high-quality Atlantic salmon population and contributes to a significant proportion of the Scottish salmon resource. In recent years it has contributed about 4 or 5 % of all salmon caught in Scotland (JNCC, 2010).

273 As a result of various environmental pressures, the numbers of both species, salmon and sea trout, have declined in recent years leading to increased concerns over fish stocks. International and national legislation, as well as a number of management initiatives have been introduced in an effort to halt declines and improve stocks.

274 Salmon and sea trout are of particular importance in this area with the Rivers Dee and Don having salmon and trout fisheries. In Scotland, the management of the salmon fishery is entrusted to District Salmon Fishery Boards (DSFBs) whose responsibilities include the protection and improvement of the salmon fisheries within their districts. The two Salmon Fishery Districts in the immediate vicinity of the proposed development are the Dee and Don Boards.

275 All Scottish salmon fisheries are closed for a minimum of 168 days a year for spawning. The actual dates may vary but are usually from late August to mid February. Salmon spawning periods vary between rivers and are thought to be influenced by water temperature and day length. Hatching generally occurs in spring. The length of time young salmon stay in a river varies considerably and is dependent upon water temperature and food availability. With transition into smolts (the stage between a parr and a grilse when a salmon first migrates from fresh water to the sea), fish normally leave rivers between February and June to commence their northward migration. Young fish however spend some time at the river mouth, acclimatising to the transition from fresh to salt water; observations on the River Dee have noted that this takes around three weeks, during which time the smolts are vulnerable to predation. Salmon return to their native rivers throughout the year, with districts recording different peak periods. Generally, returning

grilse (young salmon returning to freshwater after the sea) peak in June and continue until October. As with smolts, returning salmon and grilse are known to congregate around the river entrances.

276 Sea trout spawning generally occurs between mid October and January. Parr (young salmon and trout in the first two years of life) destined to become smolts leave the river slightly later than salmon, but migration is again over by mid-June. Adult sea trout return to their native rivers in May and this may continue in some areas until October. Sea trout are also known to congregate at river mouths.

Freshwater Pearl Mussel

277 The freshwater pearl mussel (*Margaritifera margaritifera*) is a rare and threatened species which is listed in Annex II of the EU Habitats Directive. The life cycle of the freshwater pearl mussel is closely linked to that of salmonids fish, therefore any potential impacts on salmonids may have implications for freshwater pearl mussels.

278 Freshwater pearl mussels inhabit cool, well-oxygenated soft water free of pollution or turbidity in fast-flowing rivers and streams with healthy salmon populations. The mussels spend their larval stage attached to the gills of salmonid fishes, attaching themselves during mid to late summer and then dropping off the following spring to settle in the riverbed gravel where they grow to adulthood (JNCC, 2009).

279 The freshwater pearl mussel is a primary reason for the selection of the River Dee SAC, along with Atlantic salmon and otter (JNCC, 2010). The River Dee supports a functional population of freshwater pearl mussel and mussels have been recorded from a location approximately 30 km from the river source to approximately 6-7 km upstream of its mouth. Juveniles make up approximately 30 % of the recorded population, among the highest proportions recorded in Scotland. This indicates that the population is recruiting strongly and is one of the most important in the UK (JNCC, 2010).

5.3.2.6 <u>*Elasmobranchs*</u>

Basking Shark

280 The basking shark (*Cetorhinus maximus*) is listed as ‘vulnerable’ on the IUCN Red List of Threatened Species and in Appendix II of CITES. The species is also listed on the Wildlife and Countryside Act (1981), Schedule 5. The distribution of basking sharks in British waters is predominantly along the west coast of the British Isles, with peak sightings occurring in May to August (MCS, 2005). Studies conducted by the Marine Conservation Society indicate an increase in the numbers of basking sharks sighted in British waters, with a 65 % increase in Scottish waters between 2001 and 2004. The majority of sightings are from the west coast of Scotland; however, there has been an increase in basking shark sightings on the Scottish east coast since 1999.

281 The basking shark is the world's second largest fish species, with a circum-global distribution in warm-temperate to boreal seas. Little is known about many aspects of the life history and biology of basking sharks, including how their distribution may be related to broader scale changes of the marine environment.

282 Reference to data from the Wildlife Trusts' basking shark study shows that there have been no basking shark sightings close to Aberdeen as their usual distribution follows the west coast of Britain. However, a basking shark was observed during a boat survey of the wind farm site on the 16th November 2007 (IECS, pers. comm.).

Other Shark and Ray Species

283 Porbeagle sharks (*Lamna nasus*) are found throughout the North Atlantic, with the largest population in UK waters found to the north of Scotland. Recorded sightings of porbeagle sharks within the North Sea have generally occurred offshore in the central North Sea, between May and September (JNCC, 2010).

5.3.2.7 *<u>Threatened and Protected Species</u>*

284 A number of fish species present in the area have been included in the OSPAR Initial List of Threatened and/or Declining Species and Habitats. These include cod (*Gadus morhua*), common skate (*Dipoturus batus*), basking shark (*Cetorhinus maximus*), allis shad (*Alosa alosa*), sea lamprey (*Petromyzon marinus*) and salmon (*Salmo salar*). A number of fish species, including the Atlantic salmon (*Salmo salar*), river and sea lamprey (*Lampetra fluviatilis* and *Petromyzon marinus*), twaite shad (*Alosa fallax*), allis shad (*Alosa alosa*) and freshwater pearl mussel (*Margaritifera margaritifera*) are listed on Annex II of the Habitats Directive (92/43/EEC). Several fish species are also protected in UK waters under Schedule 5 of The Wildlife and Countryside Act, 1981 including the sturgeon (*Acipenser sturio*), allis shad (*Alosa alosa*), twaite shad (*Alosa fallax*) and basking shark (*Cetorhinus maximus*). The basking shark has also been given protection by the Convention on International Trade in Endangered Species (CITES).

5.3.3 Proposed Scope of Assessment

285 In order to investigate the potential effects on fish including salmon and sea trout, shellfish and elasmobranches in the area, extensive consultation and a desk study will be undertaken. This will include liaison with:

- The District Salmon Fishery Boards (DSFBs)
- Aberdeen University
- Scottish Sea Fisheries Committees (SFCs)
- The Scottish Fishermen's Federation (SFF)
- Local fishermens organisations
- Marine Scotland
- SNH
- JNCC

5.3.4 Potential Impacts

286 Potential impacts to be considered within the Environmental Impact Assessment (EIA) will include:

- loss of spawning and nursery grounds due to the installation of foundations and cables

- disturbance to benthic and pelagic habitats due to an increase in sediment suspension and deposition
- remobilisation of contaminants from seabed disturbance / release of contaminants from vessels leading to a reduction in water quality
- noise and vibration which could affect fish and shellfish behaviour
- electro-magnetic fields which could affect fish and shellfish physiology and behaviour
- introduction of new habitat which could have positive impacts on fish and shellfish species
- disruption of shoaling and migration patterns

5.3.5 Cumulative Assessment

287 Relevant activities to be considered within the cumulative assessment include shipping, fishing and oil and gas exploration.

5.3.6 Mitigation

288 Possible mitigation measures to reduce and minimise potential impacts on fish and other species include:

- choice of foundation type and installation method
- timing of construction to avoid key spawning and/or migration periods
- use of a soft start to piling operations
- careful siting of wind turbines and cable routes
- contaminant management

5.3.7 EOWDC Future Research and Monitoring

5.3.7.1 <u>*Migratory Fish*</u>

289 The effects of buried electricity cables on migrating fish remain unclear and further work on this would be valuable. The impacts of construction (eg underwater noise) are also unclear. The site lies in the vicinity of the Rivers Dee and Don, two of Scotland's great salmon rivers. The city's universities and research institutes have a long history of researching the population dynamics, migration, life history and behaviours of salmonid fish. The EOWDC would therefore be a good location for further studies on this important topic. Subjects that could be studied could include:

- potential effects from noise and turbidity on life cycles and movements of migratory fish
- assessment of noise reduction mitigation measures and techniques
- EMF effects on migrating populations – establish migrating routes (salmon highway)
- benefits of various mitigation methods to eliminate or reduce impacts on salmon

5.4 Birds

5.4.1 Introduction

290 The assessment of EOWDC on the ornithological resource of the area entails identifying the species that use the area, and the extent to which the value of the overall ornithological resource of the area could be altered both directly, for example through increased mortality as a consequence of wind turbine collision, or indirectly, for example through changes to prey.

291 Aberdeen Bay is recognised as supporting a wide variety of avian species that are present throughout the year or only during winter or summer months. Although the bay itself is not a designated site it has been considered, as a possible Special Protected Area (SPA) for the concentrations of sea ducks and divers in the inshore area.

292 Many seabird colonies along the Scottish east coast have been afforded protection status under the EU “Birds” Directive as SPAs for the species breeding there and the numbers they support (JNCC, 2010). Seven Special Protection Areas (SPAs), located within the daily flight distance of their qualifying species, were identified as relevant to the development (Table 5.2 & Figure 6). The requirement for evidence based assessments of the potential impacts on the SPA interests has been identified as the most important requirement in the EIA and AA process.

293 This section outlines the bird surveys undertaken to date, which have included radar, boat-based surveys and vantage point counts, and discusses the boat-survey programme that is planned for 2010-2011. The interim results for the surveys carried out so far are presented along with the analysis planned for the impact assessment stage.

5.4.1.1 Project Reports

Radar

- Simms, I.C., Dale, S., Plonczkier, P., Budgey, R., Eassom, A. & Jowett A. (2008). Radar Study Report (Spring 2007). Bird Management Unit, Central Science Laboratory (CSL).
- Plonczkier, P., Simms, I. Radar Study Report (Spring, April 2010). Food and Environmental Research Agency (FERA).
- Walls, R.J., Brown, M.D., Plonczkier, P. & Parnell, M. (2006) A Preliminary study using bird detection radar for the remote monitoring of bird movements at the proposed Aberdeen Offshore Wind Farm - Autumn 05. Bird Management Unit, Central Science Laboratory (CSL).

Boat Based Surveys

- Boat-based survey results Year 1 Feb 07 – Jan 08, IECS, April 2008
- Monthly survey boat based survey results February-April 08 IECS, April 2008

Vantage Point Counts

- Species Accounts of Seabird Movements (April 06 - September 06), Envirocentre, August 2007
- Species Accounts of Seabird Movements (October 06 - March 07), Envirocentre, August 2007

- Species Accounts of Seabird Movements (April 07 - September 07) Parts 1 to 4, Alba Ecology Ltd, Feb 2008
- Species Accounts of Seabird Movements (October 07 - March 08), Alba Ecology Limited, July 2008

Additional Data Sources for Aberdeen Area to inform the Environmental Statement

- Dean, B.J., Webb, A., McSorley, C.A., Schofield, R.A. & Reid, J.B., 2004. Surveillance of wintering seaducks, divers and grebes in UK inshore areas: Aerial surveys and shore-based counts 2003/04. JNCC Report No. 357.
- Lewis M., Wilson L.J., Söhle I., Dean B.J., Webb A. and Reid J.R. (2008). Surveillance of winter and spring aggregations of seaducks, divers and grebes in UK inshore areas: Aerial surveys and shore-based counts 2006/07. JNCC Report No. 414.
- Mitchell, P.I., Newton, S.F., Ratcliffe, N. & Dunn, T.E., 2004. Seabird populations of Britain and Ireland. T. & A.D. Poyser, London, 511pp http://www.jncc.gov.uk/page-1548
- North East Scotland Bird Club reports.
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5.4.2 Baseline Information

294 The north-east coast of Scotland supports a wide variety of avian species and offers a variety of habitats from sea cliffs to sand dunes. A number of designated sites are located in the region, although all are outwith the proposed development area. The Ythan Estuary and Sands of Forvie is the protected site in closest proximity and is particularly important for a range of species, including pink-footed goose, common eider, cormorant, common scoter and terns (common, Sandwich and little). The Buchan Ness and Collieston coast SPA along with the Fowsheugh SPA are important sites for seabird assemblages containing more than 20,000 birds with Fowsheugh also being an SPA interest feature for breeding guillemots and kittiwakes.

295 Full species accounts of seabirds and waterbirds that are present in the Aberdeen Bay area will be provided in the Environmental Statement. The following information provides summary information of the main species present in the area.

296 Large numbers of shorebirds and waterfowl also use North Sea coastal waters and shores, particularly in winter (DTI, 2001). Divers, grebes and seaduck are primarily inshore species typically wintering in sandy bays or estuaries, although some prefer rocky shorelines. Some species are resident while others are winter visitors to Britain. Scotland is particularly important for these species, with Shetland, Orkney, the Moray Firth and the Aberdeenshire

coast rated of prime importance for divers, grebes and seaduck for all months of the year (Barton & Pollack, 2004a).

297 Tern colonies occur on the Ythan, Loch of Strathbeg and Spey Bay. Common terns also breed along the rivers of Dee and Don. The Sandwich tern colony on the Ythan is the largest in Scotland and holds more than half the Scottish breeding population. There are also smaller colonies of common, Arctic and little terns, and also a black-headed gull colony. Terns are present in the area during spring, summer and autumn with particular concentrations along the north east coast during the breeding season. All four species are listed on Annex 1 of the EU Birds Directive. Breeding populations of Sandwich tern, common tern and little tern are an interest feature of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA.

298 Daily feeding movements of cormorants and shags have been recorded passing Peterhead throughout the year (Innes, 1991) and occur throughout the Aberdeen Bay area. The shag forms part of the Buchan Ness to Collieston Coast SPA seabird assemblage interest feature.

299 Gannets are present throughout the year. At Peterhead, gannets are scarcest in the winter, but numbers present increase significantly in the spring from April onwards, peaking in May (Innes, 1991). They are observed to feed and fly along the north east coast with movements to and from their breeding colony at Troupe Head SPA and possibly the Bass Rock which is part of the Forth Islands SPA.

300 Gulls occur throughout the year. At Peterhead, black-headed, common, herring and great black-backed gulls pass along the north-east coast throughout the year (Innes 1994). Lesser black-backed gulls are regularly recorded between of March and September (Innes, 1994). Little gulls are relatively scarce but have been recorded in every month, with most sightings between June and November (Innes, 1994). Detailed counts of common gulls on the Ythan Estuary during the 1980s showed that numbers peaked in October and November, thereafter declining until return passage in the spring (Wernham *et al.* 2002). Kittiwakes pass along the north-east coast throughout the year and observations at Peterhead indicate that they are less frequent during the winter compared to the summer months (Innes, 1994). Kittiwake and herring gull form part of the Buchan Ness to Collieston Coast SPA seabird assemblage interest feature.

301 Fulmar breeding numbers in North-East Scotland have steadily increased in recent decades with increases along Banff and Buchan of 136 %; Gordon 26 %; City of Aberdeen 241 %; and Kincardine and Deeside 167 % all between 1969 and 2000 (Mitchell *et al.*, 2004). At Peterhead, fulmars pass along the north-east coast throughout the year, but are scarcest in winter (Innes, 1992). Fulmar form part of the Buchan Ness to Collieston Coast SPA seabird assemblage interest feature.

302 Auks (guillemots, razorbills, puffin) are present throughout the year with peaks in spring and autumn and numbers tend to be lower during the winter months. Auks leave colonies in the early morning to forage offshore and return in the evening.

303 Three species of diver are known to be present along the north east coast of Scotland: red-throated diver, black-throated diver and great northern diver. Of these, red-throated divers are by far the most abundant. The

Aberdeenshire coast regularly holds nationally-important numbers of red-throated diver (Barton & Pollack, 2004a). Numbers are highest during late autumn, winter and early spring with peak passages during April-May and October. All three species are listed on Annex 1 of the EU Birds Directive.

304 Seaduck (including eider, common scoter, velvet scoter and long-tailed duck) are likely to be present throughout the year. Eider forms part of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA seabird assemblage interest feature. Eider are found in nationally important numbers from Donmouth to the Ythan Estuary. The Aberdeenshire coast also regularly holds nationally-important numbers of common scoter; numbers of eider and common scoter tend to peak in late summer (Barton & Pollack, 2004a).

305 There are major concentrations of waders associated with the Ythan Estuary. In winter many species of wader are present in the estuary, including turnstone, purple sandpiper, knot, redshank, lapwing and golden plover. There is some movement of waders, both north and south, close to shore throughout the year. Redshank and lapwing form part of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA seabird assemblage interest feature.

306 Manx shearwaters are present in North East Scotland from late spring, throughout the summer and autumn. During a ten-year study of seabird movements at Peterhead, Manx shearwater passage began in April, peaked in June-July and continued through to early November (Innes, 1992). Sooty shearwaters are a scarce autumn passage migrant in North East Scotland usually seen from mid-July to mid-November. Most birds recorded are heading north with peak numbers in August and September (Innes, 1992). Manx and sooty shearwaters are thought to come closer to shore when visibility is poor. Storm and Leach's Petrels are rarely recorded in North East Scotland except from between July and September when they are frequently caught and ringed along coast. They are rarely seen during the day except during very poor stormy weather when small numbers are occasionally recorded offshore.

307 Skuas are present offshore during summer months. Great skuas occur from April with numbers increasing throughout the summer until August before dropping off towards late October/early November (Innes, 1993). Great skuas are regularly sighted at Fowlsheugh SPA. The passage of Arctic skua is generally from the April to November, with peak numbers in late summer (Innes, 1993). Pomarine skuas and to a lesser extent, long-tailed skuas are regular, but uncommon late summer-autumn passage migrants in the north-east of Scotland (Innes, 1993).

308 Apart from the resident mute swan, Swans and Geese are primarily winter visitors to north-east Scotland, arriving in autumn and spending the winter feeding on agricultural land or saltmarshes. North-east Scotland is a particularly important wintering and passage area for these species. Five species of swans and geese (whooper swan, mute swan, pink-footed goose, greylag goose and barnacle goose) occur in internationally-important numbers at coastal sites along the east coast of Scotland, (Barton & Pollack, 2004b).

309 Whooper swans have been observed over the sea during October to December. Whooper swan is listed on Annex 1 of the EU Birds Directive. Greylag, barnacle, pink-footed, white-fronted and Brent geese are present

from September through the winter until they return to breeding grounds in March and April. Greenland white-fronted goose and barnacle goose are listed on Annex 1 of the EU Birds Directive. The wintering population of pink-footed goose is an interest feature of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA. The Loch of Strathbeg is internationally important for whooper swans, pink-footed geese and barnacle geese from the Svalbard breeding population in autumn and winter. Several inland sites also hold significant numbers of Swans and Geese during the winter.

TABLE 5.2
SPA and their qualifying interest features in the vicinity of Aberdeen Bay

Site	SPA interest feature breeding	SPA interest feature non-breeding
Ythan Estuary, Sands of Forvie and Meikle Loch SPA (also Ramsar site)	Common Tern Little Tern Sandwich Tern	Pink-footed Goose Waterfowl assemblage, including Eider, Redshank and Lapwing.
Loch of Skene SPA (also Ramsar site)	-	Whooper Swan Greylag Goose
Fowlsheugh SPA	Kittiwake Guillemot Seabird assemblage including Fulmar, Herring Gull and Razorbill	-
Buchan Ness to Collieston Coast SPA	Seabird assemblage, including Fulmar, Shag, Kittiwake, Herring Gull and Guillemot	
Loch of Strathbeg SPA (also Ramsar site)	Sandwich Tern	Barnacle Goose Greylag Goose Pink-footed Goose Whooper Swan Waterfowl assemblage including Teal
Troup, Pennan and Lion's Heads SPA	Guillemot Seabird assemblage including Fulmar, Herring Gull, Kittiwake and Razorbill	-
Forth Islands SPA (includes Bass Rock)	Gannet Shag Lesser Black-backed Gull Roseate Tern Arctic Tern Common Tern Sandwich Tern Puffin Seabird assemblage including Cormorant, Herring Gull Kittiwake, Razorbill and Guillemot	
Aberdeen Bay potential coastal or marine SPA	[not stated by SNH]	[not stated by SNH]

5.4.3 Proposed Scope of Assessment

310 A comprehensive programme of surveys and studies have been undertaken and are underway for the EOWDC site in order to provide baseline data for use in the environmental impact assessment and to help inform any appropriate assessments should they be required. To date, surveys have included land based vantage point surveys, boat based surveys, and radar surveys.

311 The survey programme aims to provide data and supplement the existing information for the EOWDC site, and determine:

- the general importance of the area for birds, including the distribution and abundance of birds and densities of the birds in the area for use in population estimates
- the behaviour of birds and their use of the site for example, for feeding, resting or passage
- the flight height of birds for use in assessments of collision risk with wind turbines
- bird behavioural responses to ship-based survey vessel to gauge the extent to which counts can be influenced by avoidance responses of flushed birds
- the evidence for the site being located on any spring or autumn migratory flight route and occurrence of significant numbers of migrants

5.4.3.1 Vantage Point Bird Surveys

312 Shore-based vantage point bird surveys were conducted for two hours weekly at Blackdog and Donmouth and fortnightly at Drums and Balmedie covering a distance of up to 2 km from shore. These surveys were conducted between April 2006 and March 2008 (two years completed). The surveys gave good coverage of the inshore areas of the bay which were not accessible by boat due to shallow water depth. However, due to the distance offshore of the proposed wind turbines it was not possible to accurately survey out to the revised proposed location. The detection arc possible from each vantage point surveyed, in relation to the wind farm survey area is presented in Figure 7.

TABLE 5.3
Totals and mean numbers per hour of principal species recorded in Aberdeen Bay for the four six-month periods summer 2006, winter 2006-2007, summer 2007 and winter 2007-2008.

Species	Summer 2006	Winter 2006-2007	Summer 2007	Winter 2007-2008
Red-throated Diver	567 (5.7)	226 (3.0)	435 (4.3)	272 (2.5)
Fulmar	852 (8.6)	25 (0.3)	898 (8.8)	24 (0.2)
Gannet	4492 (45.4)	165 (2.2)	4352 (42.7)	713 (6.4)
Manx Shearwater	186 (1.9)	1 (0.01)	49 (0.5)	7 (0.1)
Sooty Shearwater	12 (0.1)	0 (0.0)	10 (0.1)	5 (0.05)
Cormorant	418 (4.2)	248 (3.3)	446 (4.4)	424 (3.8)
Shag	46 (0.5)	66 (0.9)	43 (0.4)	35 (0.3)
Eider	885 (8.9)	355 (4.7)	780 (7.7)	877 (7.9)
Common Scoter	2798 (28.3)	297 (4.0)	4665 (45.7)	1159 (10.4)
Velvet Scoter	41 (0.4)	7 (0.1)	16 (0.2)	16 (0.1)
Red-breasted Merganser	44 (0.4)	53 (0.7)	45 (0.4)	97 (0.9)
Curlew	50 (0.5)	199 (2.7)	181 (1.8)	92 (0.8)
Oystercatcher	34 (0.3)	147 (2.0)	190 (1.9)	62 (0.6)
Guillemot	5635 (56.9)	1495 (19.9)	3151 (30.9)	628 (5.7)
Razorbill	91 (0.9)	113 (1.5)	198 (1.9)	56 (0.5)
Puffin	22 (0.2)	1 (0.01)	54 (0.5)	4 (0.04)
undiff. auks	1145 (11.6)	1324 (17.7)	3354 (32.9)	838 (7.6)
Great Skua	109 (1.1)	3 (0.04)	110 (1.1)	2 (0.02)
Arctic Skua	69 (0.7)	0 (0.0)	164 (1.6)	6 (0.05)
Black-headed Gull	143 (1.4)	638 (8.5)	684 (6.7)	912 (8.2)
Common Gull	1256 (12.7)	3419 (45.6)	1215 (11.9)	3024 (27.2)
Herring Gull	6158 (62.2)	4112 (54.8)	8099 (79.4)	6737 (60.7)
Lesser Black-backed Gull	19 (0.2)	3 (0.04)	50 (0.5)	19 (0.2)
Great Black-backed Gull	360 (3.6)	178 (2.4)	232 (2.3)	367 (3.3)
Kittiwake	6429 (64.9)	67 (0.9)	4127 (40.5)	124 (1.1)
undiff. gulls	4001 (40.4)	924 (12.3)	3845 (37.7)	786 (7.1)
Sandwich Tern	2536 (25.6)	1 (0.01)	4561 (44.7)	1 (0.01)
Common Tern	1720 (17.4)	0 (0.0)	105 (1.0)	0 (0.0)
Arctic Tern	359 (3.6)	0 (0.0)	2678 (26.3)	14 (0.1)
'commic' terns	*2079 (21.0)*	*0 (0.0)*	*2783 (27.3)*	*14 (0.1)*
Little Tern	6 (0.1)	0 (0.0)	11 (0.1)	0 (0.0)
undiff. terns	70 (0.7)	0 (0.0)	1186 (11.6)	0 (0.0)

313 The vantage point surveys primarily collected data on flying birds (ie species, numbers, direction of flight, distance from shore and height), although some information on birds on the surface was noted, along with marine mammals. Weather conditions, including wind direction and sea state was also recorded for each of the surveys.

314 Vantage point surveys are very useful in establishing the bird species frequenting and passing through Aberdeen Bay and can detect the large variations in numbers for some species that have been recorded between consecutive seasons (Table 5.3). The results of the vantage point surveys are useful in providing evidence for the main passage of birds along the shorefront and the flight height of these birds. This information has been used to modify the original wind turbine layout and position it further offshore away from the main areas used by birds.

315 No further vantage point surveys are planned as they are not suitable for accurately detecting birds at the revised wind farm location.

5.4.3.2 *Boat Based Surveys*

316 Boat based surveys following the methodology of Camphuysen *et al.* (2004), were carried out monthly between February 2007 and April 2008. There has been a gap in survey coverage since April 2008. To date, boat based surveys have covered a period of 15 months, which is recognised to be below the recommended two years of survey coverage advised by SNH. For the months May to January there has only been one months worth of boat based survey data (Table 5.4). Following the recommendations of a gap analysis on the existing survey data, and advice from statutory consultees, an additional boat based survey programme has been designed. Further surveys started in August 2010 and will continue for at least 12 months, or more prior to construction.

TABLE 5.4
Summary of monthly boat based survey coverage

Month of Coverage	2007	2008
January	-	✓
February	✓	✓
March	✓	✓
April	✓	✓
May	✓	-
June	✓	-
July	✓	-
August	✓	-
September	✓	-
October	✓	-
November	✓	-
December	✓	-

✓Survey took place

317 The original boat based survey transect design, followed the statutory advice provided by JNCC and SNH and consisted of a survey area including the wind farm plus a buffer zone and control site to the north of wind farm site. The total survey area was 101.6 km^2. The boat survey track, wind farm and study site and control areas are shown on Figure 8.

318 Data obtained from all the surveys will be used to assess the importance of the site for all species, especially those likely to be from SPAs. The data will also be used to help determine the risk and significance of potential impacts and identify possible mitigation measures. A summary of the initial boat based survey results for the main species of interest is shown in Table 5.5 and brief conclusions are provided. The impact assessment section expands upon the further analysis that is planned for the complete survey dataset.

TABLE 5.5
Summary accounts of key bird species detected in the surveys in Aberdeen Bay. The three main risks to birds which are collision, displacement and barrier effects are shown with each species being assigned a low, medium or high score. Species that are highlighted in red are qualifying species of SPAs.

	Species	Comments	Risks		
			Collision	**Barrier**	**Displacement**
Auks	Guillemot	Population was estimated at over 1,000 individuals within the wind farm survey area in summer with a peak of 1,161 (95 % confidence limits 796 - 1,692) individuals in July and lower than the control area 2,419 (1812-3231). The numbers of common guillemot declines during the winter with birds dispersing further offshore. Population estimates produced were larger in the control survey area during the breeding and post breeding season, but smaller in the winter in comparison to the wind farm survey area. Birds were evenly distributed with marginally more observations in waters <20 m. One out of 243 recorded flights was above 25 m.	Low	Low	Moderate
	Razorbill	Increase in abundance occurred during the summer months. Post-breeding surveys in July, August and September featured the largest numbers of birds Peak count in wind farm area of 273 in August 2007. Up to 378 in control area (August 2007). Sightings were evenly distributed between shallow and deeper areas. Only a few individuals were detected in the survey areas during winter. All flights recorded below 25 m.	Low	Low	Moderate
	Unidentified Guillemot / Razorbill	Some common guillemot and razorbill were not identified to a species level, and as such, sightings were grouped into an unidentified common guillemot/razorbill category. The peak count from boat surveys was made in July within the control survey area, and reached 1,431 birds.	Low	Low	Moderate
	Atlantic Puffin	Increase in numbers during summer months. Peak population estimate of 285 (95 % confidence limits 172-471) birds in September (control area). Majority of birds were found in deeper waters >20 m. No sightings in winter months (Dec-Apr). Sightings were relatively scarce within the wind turbine footprint and wind farm survey area. No birds were detected flying above 15 m.	Low	Low	Moderate
	Little Auk	The little auk is an overwinter visitor to the North East coast, a total of 6 little auks were detected during the boat based surveys during the winter months.	Low	Low	Low
Terns	Common Tern	Common terns were present in the survey areas between May and	Low	Low	Moderate

		September. Populations were much lower in the wind farm survey area than in the control survey area. Numbers peaked in July with a maximum population 55 birds in the wind farm survey area and 264 birds in the control survey area. 93 % of the common terns recorded in transect were actively foraging (shallow plunging). No birds were recorded in the wind turbine footprint. Foraging concentrations were found in the south-west corner of the wind farm survey area and off the Ythan Estuary. No birds recorded flying above 25 m.			
	Arctic Tern	The Sands of Forvie support a breeding population of 76 pairs (Mitchell *et al.,* 2004). Only three Arctic terns were recorded in the control survey area during the July survey.	Low	Low	Low
	Common/Arctic Tern	A total of 29 birds classed as 'commic' tern were observed from May to September. 20 % of the individuals were recorded foraging 'in transect'.	Low	Low	Low
	Sandwich Tern	Very few birds were recorded in the ship-based survey areas. Based on extrapolation of overall density, the maximum counts were of only five birds in the wind farm survey and 21 birds in the control survey area. Majority of sightings were in close proximity to the shore in shallow waters <20 m. No birds were recorded in the wind turbine footprint. No birds recorded flying above 25 m.	Low	Low	Low
Gulls	Common Gull	The largest counts of were recorded during the winter period, producing a population estimate of 239 individuals in March in the wind farm survey area and 235 individuals in the control survey area. Estimated population sizes within the wind farm site were larger from September to February. The majority of common gulls were present in the southern part of the wind farm survey area during winter. There was a net reduction in April following the departure of birds to their main breeding ground, however, although, a small population breed in Aberdeen city, numbers were almost absent from the area during summer. The majority of birds (66 %) were observed flying below 25 m.	Moderate	Low	Low
	Herring Gull	Within the wind farm survey area, the population size was estimated to be of 417 birds in June and 456 in July. Outside the late breeding and post breeding period, monthly population estimates were very low, and the species was absent from this area in April and May. A similar pattern was observed within the control survey area, although estimated populations were very low during the breeding season. Low numbers of counts were	Moderate	Low	Low

		observed between November to May. In contrast, during the post breeding season, large concentrations occurred in the south-west corner of the wind farm site close to Aberdeen Harbour, but also around the cliffs of Collieston within the control survey area. The majority of birds (52.8 %) were observed flying above 25 m.			
	Great Blacked Gull	Great black-backed gulls were present in Aberdeen Bay all year round. Within the wind farm survey area, numbers of birds recorded in transect peaked in June, resulting in a population estimate of 123 individuals. Monthly population estimates in the control survey area were lower. Bird sightings are dispersed across the site, but small concentrations were found between the Ythan Estuary and the cliffs of Collieston, as well as the southern transects of the wind farm survey area. The majority of birds (56%) were observed flying above 25 m.	Moderate	Low	Low
	Black Legged Kittiwake	Population estimates were at their highest during the late breeding season and their lowest during the winter. Within the wind farm survey area, a population of 1,092 black-legged kittiwakes was estimated in July. Distance sampling produced similar population estimates in the control survey area with a total of 810 individuals in July (95% confidence limits on distance estimate: 405 - 1,620). Outside the breeding season the species is essentially oceanic, and low numbers were recorded from November to March. Distribution of black-legged kittiwake to be patchy during the late breeding season, but with large flocks present (single flock of up 130 individuals). This is possibly linked to the distribution of the kittiwake's main prey items across the survey area, i.e. small pelagic shoaling fish, such as sandeels, sprats and young herring. By contrast, sightings in winter consisted of one or two individuals scattered across the ship-based survey area. Majority (61.6 %) of birds were flying below 25 m, with birds observed flying upto 100 m.	Moderate	Low	Low
	Black Headed Gull	In the North Sea, black-headed gulls occur at sea only during migration periods. In the winter, black-headed gulls can be found in inshore tidal waters with a preference for bays and estuaries with sandy and muddy beaches . Eight of the nine sightings recorded during the survey programme were made in November - all in the inshore short legs between the main transects.	Low	Low	Low
	Lesser Black	Lesser black-backed gulls breed in colonies along the coast and at some	Low	Low	Low

	backed Gull	inland sites in Britain and Ireland. Only two sightings of lesser black-backed gull were made during the survey programme. Both were in June within the wind farm survey area.			
Skuas	Great Skua	Great skuas were recorded from July to September, with peak numbers in August (74 % of the sightings occurred in August). Great skuas were recorded in lower numbers than Arctic skuas. Sightings indicate a concentration of birds in the north-east part of the control survey area. 25 % of birds were observed flying within wind turbine height.	Low	Low	Low
	Arctic Skua	Arctic skuas were present in the survey areas from June to November. Peak passage occurred in November with a total of 23 birds. Several kleptoparasitic attempts were recorded during the surveys on terns, black-legged kittiwakes and common gull. Arctic skuas were more abundant and widely distributed in the control survey area than in the wind farm survey area. The majority of observations (83 %) were observed flying below 25 m.	Low	Low	Low
	Long-tailed Skua	One long-tailed skua was seen in June. The species is a passage migrant to the UK, breeding in the high Arctic.	Low	Low	Low
Cormorants	European Shag	Present in low numbers from between February 2007 and January 2008 with fewer sightings during the winter. Sightings were scattered across the ship-based seabird survey area. No birds were detected in the wind turbine footprint and majority of sightings occurred in shallow < 20 m waters. All birds were detected flying below 10 m.	Low	Low	Low
	Great Cormorant	Present all year around in Aberdeen Bay, but with lowest numbers in May and greatest numbers in September and October. Estimated population sizes indicates the control area to support the largest population, with up to 20 individuals in September. The distribution of sightings from February 2007 to January 2008 indicates the species to prefer shallow waters with the species rarely occurring in water exceeding the 20 m depth contour line. Concentrations were found in shallow waters from the Ythan estuary to the cliffs of Collieston. All birds were detected flying below 25 m.	Low	Low	Low
Gannets, Shearwaters, Fulmars	Northern Gannet	Population estimates were the highest during the breeding season in the wind farm and control survey areas with 45 birds and 62 birds, respectively in August. Outwith the breeding season, estimated populations using the site were low and the species was almost absent during the winter period. Population estimates are mainly derived from birds seen in flight ('in	Moderate	Low	Low

		transect' at the time of snapshot), which suggest that the species passes through the site rather than stopping to forage. The distribution maps indicate the sightings to be scattered across the boat survey areas during the breeding season, but occurring mainly in the deepest water of the survey areas during the post breeding season. The majority of birds (82 %) were observed flying below 25 m.			
	Manx Shearwater	During the first year of surveys, the sightings of Manx shearwater began in May, peaked in September and continued through to early November. Of a total of 22 individuals recorded during the May to November period, 90 % were recorded in flight, mainly in a northerly direction. This suggests that Manx shearwater spent most of the time passing through the area without stopping and foraging. No birds were observed flying above 10 m.	Low	Low	Low
	Sooty Shearwater	Only one individual was recorded flying north in October. Although breeding only in the Southern Ocean, sooty shearwaters disperse widely outwith the breeding season and regularly reach the North Atlantic. Sooty shearwaters are a scarce autumn passage migrant in north-east Scotland usually seen from July to mid November.	Low	Low	Low
	Northern Fulmar	With the exception of February (16 individuals), northern fulmar population estimates using the wind farm survey area were very low in comparison to the control survey area. Sightings were dispersed in water deeper than 20 m with small concentrations observed around the cliffs of Collieston, where the species nests. No birds were observed flying above 10 m.	Low	Low	Low
Seaducks	Common Scoter	Only a few sightings were recorded 'in transect' as the majority of birds were recorded between the 'short legs' and the coast in the shallowest water, and therefore outside the 300m band transect. As a result, population estimates are very low in the wind farm and the control survey areas, despite large flocks being present between Donmouth and Balmedie, in particular around Blackdog. Counts outside transect included a single flock of up to 1,200 common scoters in July 2007. During winter, low numbers of common scoters remained between Donmouth and Balmedie. Only 3 % of birds were observed flying within wind turbine height (25-100 m).	Low	Moderate	Moderate
	Common Eider	Common eiders were present in both the control and wind farm sites throughout most of the year, but in very low numbers, with only a total of 53 individuals recorded 'in transect' between February 2007 and January	Low	Moderate	Low

		2008. As the result the population size estimated by extrapolation of overall density was very low in the ship-based survey areas. Common eiders were mainly distributed in inshore shallow waters, between the short legs and the coast, and thus not shown in as these were outside transects. Only a few individuals were seen in water exceeding 10 m depth. It is noteworthy that maximum counts outside the survey area were made in August (450 birds) and September (450 birds), both around Blackdog. No birds were observed flying above 25 m.			
	Velvet Scoter	Three sightings of velvet scoter were made during the survey programme totalling 14 birds. The two sightings in February (two individuals) and July (five individuals) were associated with a flock of common scoter. The seven individuals sighted in early November at dawn were presumably birds on migration as the birds were noted to fly in a south-westerly direction. Velvet scoters passed along the north-east coast through the year, with a notable increase during the spring before numbers dropped off in the summer and peaked again in late autumn. No birds were observed flying above 15 m.	Low	Low	Low
	Long-tailed Duck	The surveys did not identify the presence of a flock within the wind farm survey area, although occasional sightings close to the beach were an indication of the preference of this species for the shallowest areas. A total of 14 birds were recorded in ship-based survey areas in April, October and November. All sightings related to birds flying parallel to the coast (flock of up to four individuals), in a northerly or southerly direction. No birds were observed flying above 15 m.	Low	Low	Low
Wildfowl	Red-breasted Merganser	Only one red-breasted merganser was recorded in March at the mouth of the river Don. Red-breasted mergansers are recorded in small numbers throughout the year in Aberdeen Bay.	Low	Low	Low
Divers	Red-throated Diver	Red-throated divers were present throughout the year in Aberdeen Bay. The greatest usage was noted to occur in spring and winter within the wind farm survey area. The peak in May probably reflected movement of divers heading to northern Scottish breeding sites or to Scandinavia, whilst the increase in winter months indicated the presence of wintering a population in Aberdeen Bay. A total of 88 birds were estimated to be using the wind farm survey area during the passage period in May whilst an estimated 55 birds were present in January. Population estimates were much lower in	Low	Low	Moderate

		the control survey area, particularly during the winter months. Distribution maps indicate that red-throated divers exhibit a preference for water shallower than 20m, but with concentrations observed on the ‘short legs’ around the 5 to 10m depth contour line. No birds were observed flying above 25 m.			
	Unidentified divers	A total of six unidentified black-throated/red-throated diver were seen in both survey areas, mainly birds in flight or taking off from the sea surface at great distances.	Low	Low	Moderate

319 Seaducks (including common scoter and common eider) exhibited a very near-shore distribution, with concentrations observed in water depths of less than 5 m, and thus in low abundance in the wind farm site itself where water depths are greater. Red-throated divers were recorded within both the proposed development area and control survey areas. The species had a less concentrated near-shore distribution than that of the seaducks, but were found around the 5 to 10 m depth contour line, and thus found in shallower area than the proposed development.

320 Terns were more abundant in the control survey area than in the wind farm survey area. Sandwich, common and Arctic terns exhibited a preference for shallow waters adjacent to the Sands of Forvie colonies.

321 Gulls were numerous during the survey programme, with black-legged kittiwake and herring gull primarily recorded during the summer months (June and July) and mew (common) gull present during the winter period. Black-legged kittiwake exhibited no particular concentration of usage within, or adjacent to, the proposed project, although the control survey area was potentially one of the preferred areas for this species.

322 Common guillemots were widespread within the wind farm survey area, but with the largest foraging aggregations found in the control survey area during the post-breeding period. A general north-south flight line was observed through the wind farm survey area, although flight movements across the survey area were undertaken below 15 m.

5.4.3.3 <u>Boat Based Surveys 2010 – 2011</u>

323 AOWFL has contracted SMRU Ltd to provide further boat surveys which will be combined to cover marine mammals and birds. The new survey design is a gradient type approach and is different to the BACI type design that was surveyed in 2007 and 2008.

324 The 2010 surveys commenced in August and will be conducted monthly over two days. The surveys will extend the survey coverage and will follow a different type of transect pattern to that used in the original survey to allow the continual collection of data during line turns (Figure 8). SNH and JNCC were consulted upon the new survey transect design and surveying schedule.

325 The survey area has been extended to cover three survey strata

- i) extending northwards, covering both the wind farm, buffer and control areas surveyed in the previous surveys
- ii) extending eastwards further offshore
- iii) a southwards stratum

326 The total survey area is 339 km^2. This gradient approach allows potential displacement of birds to be assessed once the wind farm is operational. One 2-day survey will be conducted per month, initially for a 12 month period, with at least three months of data available for inclusion in the EIA and Environmental Statement, in addition to the previous data collect for the site. The boat surveys will continue after the submission of the Environmental Statement until 12 months of data have been collected, giving two years of data for the site. The intention is to then continue the surveys before, during and after construction, using the same transect design.

327 Standardised survey methods (as described in Camphuysen *et al.* 2004) will be used to allow comparison with previous boat-based surveys. Seabird observers will be experienced and ESAS trained and survey effort will be restricted to sea states of 4 or less. The data collected will allow density estimates to be created for the survey area and the data will provide a repeatable baseline from which to monitor throughout the wind farm installation. Data collected from previous surveys once fully analysed will contribute to the new dataset and be analysed in conjunction with it.

5.4.3.4 Radar Surveys

328 Radar studies provide data on flight height and bird movements for bird species in the area. Radar also provides a way of assessing bird movement during the hours of darkness and in adverse weather conditions, such as haar. The areas of Aberdeen Bay surveyed using radar are illustrated on Figure 7. The following radar surveys have been conducted:

- Autumn 2005: two 5-day surveys were conducted at Drums (24 – 29 October 2005) and Easter Hatton (29 October – 3 November 2005).
- Spring 2007: 10-day survey conducted at Blackdog (11-27 April 2007).
- Spring 2010: 6-day survey conducted at Blackdog (24-29th April 2010).

329 The results of the Autumn 2005 study indicated that the majority (>95 %) of flight movements were outside the proposed wind farm footprint but flight transits were detected up to 5000 m offshore, with the majority of movements being within 3000 m. Flight altitude was predominantly low (<50 m) at both the Drums site and the Easter Hatton site. The study indicated a high degree of interchange between birds along the whole coastline from Ythan Estuary south to Drums, Balmedie and Blackdog.

330 The results of the Spring 2007 study conducted at Blackdog supported the results of the previous radar study in that the majority of flight activity (90.9 %) was within 1.4 km of the shore. The majority of flight altitudes were below 40 m and from the visual observations by ornithologists the flight heights for most species of seaduck and diver observed was <30 m. Due to the spring migration a considerable northern bias to flight movements was detected.

331 Night activity was of a similar magnitude to daytime bird movement activity levels. Activity levels during Haar conditions did not alter for species within the fast speed classes, (seaduck, divers, auks,) but was much reduced for slow speed class species, notably gulls.

332 During periods identified from the radar tracks as having low migrational activity there were still numbers of tracks recorded within the wind farm footprint. This would indicate that the wind farm area is used by local birds either for foraging or transit, a pattern also repeated in the visual observation results

333 The spring 2010 radar study was designed to target the spring migration of geese. Very few geese were recorded during the survey undertaken in April and it may have missed the main migration period or, it is possible that the offshore area is not frequently used by migrating geese. Studies undertaken at constructed offshore and onshore wind farms have reported a very high avoidance rates by geese with collisions with wind turbines being extremely

unusual. AOWFL are not planning to commission any further radar studies that will specifically target geese.

5.4.3.5 Aerial Surveys

334 After careful consideration, aerial surveys were not considered appropriate for this development due to the size of the site and its proximity to land and helicopter flight paths. No aerial surveys are planned as part of the EIA process.

5.4.4 Predicted Impacts

335 A preliminary analysis of all ornithological data was undertaken in order to assess the potential impacts of the original proposal for a 23 wind turbine wind farm on the sensitive species identified above. Impacts assessed were: collision risk, disturbance / displacement, barrier effects, and habitat loss. From the initial analysis of the data it was recognised that bird movement was primarily within the inshore section close to the coast, this was confirmed from the results of the vantage point counts and radar monitoring. This resulted in a redesign of the wind farm layout with wind turbines placed further offshore avoiding the area which appeared to have the highest movement of birds.

336 The impact assessment for the new wind farm area will take into account and assess collision risk, displacement / disturbance, barrier effects, habitat loss and cumulative impacts. In order to analyse the data and to calculate the total population size within the areas survey it is proposed to use distance computer modelling. Modelling the data using distance methods may not produce accurate results where the numbers of observations are very small, which will be the case for many species in Aberdeen Bay. Where this is the case, use of an alternative method is necessary to estimate population size. Where distance sampling was not possible (< 50 different observations), simple extrapolation of the overall sample density will be used to estimate the total numbers of birds in the seabird survey areas. This approach has so far been used to analyse one year’s worth of boat based data and will be extended to include all available monthly survey data at the compilation stage of the Environmental Statement. Initial population estimates of birds in the wind farm survey areas will be generated using distance sampling techniques where possible, and distribution maps of seabird and seaduck sightings will be produced on a seasonal basis.

337 The use of the gradient approach for the 2nd phase of boat based survey work (rather than Treatment – Control) allows distance from the development footprint to be included as a covariate within analyses. This is particularly useful where the level of an impact may be expected to decline with distance or the spatial extent of an impact footprint is unknown. At the Aberdeen site, it may be expected that any negative impact results in displacement of birds away from the development site, with movement along the depth gradient up/ down the coast potentially more likely than offshore displacement (particularly with species like scoter, divers and eider). By extending the survey areas to the north and south of the development site, the potential to detect any such coastal displacement of divers and sea duck is maximised.

338 **Collision risk:** Collision risk to birds transiting through the wind farm area will be assessed using the Band model (Band, 2000) and will incorporate flight

height data collected during the offshore surveys and available literature on flight heights. The collision risk calculations will include all species, with particular attention paid to key species in the wind farm area, red throated diver, common eider and common scoter and terns.

339 **Displacement:** Displacement will be assessed for sensitive receptors with a particular emphasis on the key species red throated diver, common scoter, eider, guillemot and razorbill would be likely to be most sensitive to displacement due to their presence in large aggregations or high numbers on the surface waters of the bay. For species where insufficient information exists to predict likely displacement impacts, a worst case scenario will be applied which uses the assumption that 100 per cent of birds would be displaced from the wind farm and buffer zone and that habituation would not occur. Displacement effects will be considered on a number of scales, temporary displacement during construction and longer term after the installation of the wind farms.

340 **Barrier effects:** The assessment will take into consideration the potential for disruption to flight lines, including migratory flight paths and also daily movement of birds. From the initial analysis of the data it is considered unlikely that a significant barrier effect would arise owing to the orientation of the wind turbines in a north-south direction which is parallel to the predominant flight direction identified by radar and also parallel to the shore line. If appropriate, an energetic model will be applied to bird flight tracts to determine the effect that any deviation to flight lines will have.

341 **Habitat loss:** This will be assessed in its simplest form by calculating the amount of benthic habitat lost by the installation of the wind turbine bases, inter-array cables and export cables. Consideration will also be given to potential change in habitat and indirect effects on prey due to the installation and operation of the wind farm.

5.4.5 Cumulative Assessment

342 The cumulative assessment will follow the latest recommended guidance on CIA published by COWRIE (King *et al.*, 2009). For the assessment purposes, the only consented offshore renewable development for which there are bird data available to use in a cumulative impact assessment is the Beatrice wind farm located in the Moray Firth. The cumulative assessment will therefore be restricted to species that are found off Aberdeen Bay and the Moray Firth. The cumulative assessment will make reference to other renewable developments that are planned for Scottish territorial waters and Round 3 offshore areas, however detailed cumulative assessment is not possible for projects that are at an early stage of data collection and for which no data are available.

5.4.6 EOWDC Future Research and Monitoring

343 AOWFL proposes to monitor the movement of birds around, through and over the wind turbines to determine more accurately the actual influence of the wind turbines on the birds, and the birds' interaction with the wind turbines. Other parameters that could be investigated include studies into mortality of birds through collisions with wind turbine blades. This information would help inform the theoretical mortality estimates produced for collision risk, eg the

SNH bird-collision model. Further discussion on how to best collect this type of post construction data will be held with SNH and other appropriate organisations at a later date. EOWDC could be the focus of pre-construction, construction and post-construction ornithological surveys to determine the actual effects of the wind farm on the bird species of Aberdeen Bay and also validate the predictions made within the Environmental Statement.

344 The studies will include observations by ornithologists during bird boat-based surveys. The proposed Ocean Laboratory on the site could also be used to conduct specific bird investigations from, although the design and the type of equipment on the platform have yet to be ascertained so at this early stage it is not possible to commit to particular types of equipment. Stakeholders are being contacted to discuss potential collaborations and research opportunities that the platform will bring.

5.5 Bats

5.5.1 Introduction

345 It is recognised that bats may be impacted by wind farms; evidence from a number of onshore wind farms has indicated that bats have a higher mortality rate due to wind farms than birds. Although direct collisions with the wind turbines does occur, a higher mortality rate arises from due to barotraumas caused by sudden changes in air pressure causing lethal lung damage.

346 Bats have been recorded foraging around offshore wind farms. Studies undertaken in Sweden to explore potential impacts on migrating bats discovered that non migratory bats also occurred foraging around the wind turbines as far as 10 km from shore (Ahlén *et al.,* 2007).

347 All bats in the UK are fully protected under the Wildlife and Countryside Act and the European Habitats Directive.

5.5.2 Baseline Information

348 Bats in north-east Scotland have been extensively studied with significant research over the years undertaken by the University of Aberdeen.

349 Seven species of bat are known to occur in north-east Scotland of which only two are very common, the other species are either uncommon, rare or very rare (Table 5.6). There is little or no evidence of any regular migration of European bats to or from Scotland.

350 **Common pipistrelle and Soprano pipistrelle** - Due to the similarity of the two species *Soprano pipistrelle* was not discovered until the 1990s but has since been found to be common and widespread throughout the UK, including north-east Scotland. They occur in most habitats but particularly riparian woodland and parkland. They will forage up to 5 km from their roosts and are the most frequently recorded species along the Aberdeenshire coast.

351 **Nathusiu's pipistrelle** - A previous migrant species, it has only been classified as a resident in the UK since 1996. Only one record in north-east

Scotland. Two records from oil platforms suggest that this species may be a very scarce migrant.

352 **Brown long-eared bat** - This species is widespread but less common than the pipistrelles particularly along the coast. Brown long-eared bats roost in old houses and forage within 1.5 km from their roost which are invariably near to thick woodland. Consequently they are scarce along the coast.

353 **Daubenton's bat** - Although widespread in north-east Scotland, Daubenton's bats are closely associated with fresh water and avoid urban habitats. Roosts are in mature deciduous trees and rarely in houses. The species occurs along the Ythan as well as Deeside and Donside. However, it is rare or scarce near the coast.

354 **Natterer'sbat** - Natterer's bats are found throughout most of the British Isles. Recent records have extended its range in Scotland north to the Great Glen fault. This is a very rare bat in north-east Scotland with few records reported. It does forage widely and over a wide variety of habitats including grassland, but it prefers semi-open woodland often coniferous.

355 **Whiskered bat** – Very rare with just one record in north-east Scotland. It is found throughout England and Wales and even in southern Scotland and throughout Ireland.

TABLE 5.6	
Species	**Status**
Common pipistrelle	Very Common
Soprano pipistrelle	Very Common
Nathusiu's pipistrelle	Very Rare
Brown long-eared bat	Uncommon
Daubenton's bat	Uncommon
Natterer's bat	Rare
Whiskered bat	Very Rare

5.5.3 Proposed Scope of Assessment

356 A literature review will provide the major source of information for the Environmental Statement. From the information above there are only two species potentially occurring at the proposed offshore wind farm site should foraging occur at the wind farm. The assessment will also explore the potential for migrating bats to occur within the wind farm location.

5.6 Marine Mammals

5.6.1 Introduction

357 The north east of Scotland is widely recognised as being important for marine mammals and there has been considerable research effort directed towards studying populations and marine mammals in the wider area. The EIA will review and take into account all relevant available information along with the data collected at the site to establish potential impacts associated with the proposed development and determine adequate mitigation measures to implement.

358 Marine mammals are protected under several sections of conservation legislation. All cetacean species are listed in Annex IV of the EC Habitats Directive, which protects them from any deliberate disturbance, particularly during the periods of breeding and migration. In addition, bottlenose dolphins, harbour porpoises, harbour seals, grey seals and otters are also listed in Annex II of the Habitats Directive.

359 This section outlines the marine mammal surveys undertaken to date which have included acoustic monitoring, boat-based surveys and vantage point counts, and the future monitoring that is planned for the site. The interim results for the surveys carried out thus far are presented along with the analysis planned for the impact assessment stage.

5.6.1.1 _Project Reports_

- Review of Bird and Marine Mammal Data, RPS. January 2008
- Gordon, J. (2008). Preliminary analysis of acoustic detections of porpoise from AMEC surveys off Aberdeen. Ecologic UK Ltd Report. 11pp.
- Marine Mammal Data Review, SMRU Limited, January 2010
- Travers, S., Thomson, S. and Mander, L. (2008). Aberdeen Offshore Wind Farm – ship-based Marine Mammal Survey Results (February 07-January 08). Final Report ZBB706 –F- 2008.
- Travers, S., Thomson, S. and Mander, L. (2008). Institute of Estuarine & Coastal Studies, University of Hull. 68pp.Monthly boat based marine mammal survey reports February-April 2008. The Institute of Estuarine & Coastal Studies (IECS).
- Weir, C. (2008). Photo-identification catalogue for bottlenose dolphins (Tursiops truncatus) and other cetacean species off the coast of Aberdeenshire, NE Scotland. Version 1.1 ACC.

5.6.2 Baseline Information

360 The coastal stretch between the Moray Firth and St Andrews contains a population of bottlenose dolphins. In Aberdeen Bay the bottlenose dolphins are semi-resident and are frequently observed at the mouth of the harbour entrance. Other frequently sighted marine mammals include the harbour porpoises (*Phocoena phocoena*), harbour seals (*Phoca vitulina*) and grey seals (*Halchoerus grypus*). In the summer months white-beaked dolphins (*Lagenorhynchus albirostris*) and minke whales (*Balaenoptera acutorostrata*) have been observed further offshore. Records of marine mammal sightings including from stranding records indicate 12 odontocete species, three mysticete species and three pinniped species (Table 5.8).

361 For species such as white-sided dolphins, killer whales, common dolphins, striped dolphins, long-finned pilot whales, sperm whales, humpback whales, fin whales, northern bottlenose whales, Sowerby’s beaked whales and other pinniped species, the area off north-east Scotland is either on the edge of their range or the habitat is unsuitable for them consequently, they are likely to occur only occasionally and then only be a few individuals (Hammond *et al.*, 2004).

362 The proposed wind farm site does not contain any designated sites for marine mammals, but there are a number of SACs, on the east coast of Scotland for

which marine mammals are an interest feature. These sites are the Inner Moray Firth SAC for bottlenose dolphins (*Tursiops truncatus*); Dornoch Firth and Morrich More SAC and the Firth of Tay and Eden Estuary SAC for harbour seals; Faray and Holm of Faray SAC, the Isle of May SAC and Berwickshire and Northumberland Coast SAC for grey seals (*Halichoerus grypus*). For seals there is no evidence linking the SACs further north of Aberdeen Bay with any seals present in Aberdeen. Due to the requirements of the EU Birds and Habitats Directive, assessing potential impacts on SAC interest features is an important component of the EIA process and due consideration will be given to this assessment.

363 Harbour seals are widely distributed along the east coast of Scotland. They are present in the Aberdeen area throughout the year. Their occurrence at the estuaries of the Rivers Dee and Don is seasonal with an increase in numbers during the winter and early spring. Harbour seals use haul-out sites at the Donmouth, at the mouth of the Ythan River and at Catterline. Harbour seals have been observed feeding on salmonids and flatfish at the estuaries of the Rivers Dee and Don, as well as other marine prey species. The pupping period for harbour seals occurs from June to July and moulting occurs from June to September. During these times they spend a higher proportion of their time ashore and in coastal waters. The closest SAC for harbour seals to the wind farm site is in the Firth of Tay.

364 Grey seals are also found along the east coast of Scotland. They are present in the Aberdeen area throughout the year. Grey seals use haul-out sites at the Donmouth, at the mouth of the Ythan River, outside Peterhead harbour, Cruden Bay, Boddom and at Catterline. The most well established colony in the area is at Catterline where up to five pups may be born each year. The pupping period for grey seals occurs from October to November and moulting occurs from February to April. During these times they spend a higher proportion of their time ashore and in coastal waters. Grey seals have been observed feeding on salmonids and flatfish at the estuaries of the Rivers Dee and Don, as well as on other marine prey species. The closest SAC for grey seals to the wind farm site is the Isle of May in the Firth of Forth.

365 The otter (*Lutra lutra*) is a semi-aquatic mammal which occurs in a wide range of ecological conditions including inland freshwater and coastal areas. Otters are one of the primary reasons for the site selection of the River Dee SAC. The Dee is a major east coast Scottish river which flows uninterrupted for approximately 130 km from its upland reached in the high Cairngorms to the North Sea. Surveys have indicated that the otter is found throughout the Dee catchment, from its mouth at Aberdeen to the high-altitude lochs (JNCC, 2008a). Otters are generally limited to coastal waters so any impacts on it would be near the shore. Surveys of the cable landfall and on-shore cable route would be conducted to determine the presence and potential impacts on otters.

366 There is a substantial amount of baseline information that can be used in the EIA. The most applicable reference sources and organisations that hold data are discussed below.

367 A cetacean photo-id catalogue was sponsored by AOWFL based on photographs and surveys previously conducted in the area between May 1999 and June 2007 - the ACC (2008) Aberdeenshire Cetacean Catalogue (ACC). A total of 49 dedicated boat surveys where cetacean photo-

identification images were collected were carried out between Aberdeen and Inverbervie, however dedicated photo-identification data has not been collected evenly over the 1999–2007 period. A total of 1,823 images from 88 cetacean encounters were analysed from the 1 May 1999 to 9 June 2007 period. The identified animals predominantly comprised bottlenose dolphins with some Risso's dolphins, white-beaked dolphins and minke whale. A total of 63 bottlenose dolphins has been identified during this study (ACC, 2008). This reference will be useful in identifying specific animals that are observed in future monitoring effort that can be attributed with other sightings records to help develop our understanding of how animals move within specific areas of the North Sea.

368 An overview of the distribution of cetaceans in north-west European waters is provided by Reid *et al.* (2003) based on data collected by the Seabirds at Sea Team (SAST) of the JNCC, opportunistic sightings from the SeaWatch Foundation and a (Small Cetacean Abundance in the North Sea) SCANS survey conducted in July 1994. Additional information on recorded sightings of marine mammals is also available on UKDMAP (1998).

369 Hammond *et al.* (2004) reviewed and examined the distribution and abundance of marine mammals occurring to the north and east of Scotland as part of the Strategic Environmental Assessment 5 (SEA5).

370 SCANS surveys provide information on the distribution and abundance estimates of cetaceans. The first SCANS survey was conducted in the summer of 1994 and SCANS II in the summer of 2005 (Hammond *et al.*, 2002; SCANS II, 2006).

371 The Joint Nature Conservation Committee (JNCC) conducted aerial surveys of wintering aggregations of seaducks, divers and grebes within Aberdeen Bay between 2003 and 2007. During these surveys observations of bottlenose dolphins and harbour porpoises were recorded incidentally (Söhle *et al.*, 2006; Wilson *et al.*, 2006).

372 Cetacean surveys have been conducted from the bridge of the MV Hascosay ferry between Aberdeen, Orkney and Shetland during daylight hours in summer months (April to September) from 2002 to 2006 (MacLeod *et al.*, 2007).

373 The Scottish Agricultural College (SAC) Veterinary Services at Inverness carry out necropsies on stranded and by-caught cetaceans in Scotland for the DEFRA funded Marine Mammal Stranding Program.

374 Land- and vessel based surveys for marine mammals have been conducted between 1999 and 2005, along the Aberdeenshire coast (between St Cyrus and Collieston, primarily between Stonehaven and Aberdeen) as part of SeaWatch surveys and University of Aberdeen research projects (Canning, 2007; SeaWatch, 2008; Sini *et al.*, 2005; Stockin *et al.*, 2006; Weir & Stockin, 2001, 2002; Weir *et al.*, 2007).

375 Since 1990, research on marine mammals in the Moray Firth has been conducted from the University of Aberdeen's Lighthouse Field Station in Cromarty. There have been numerous reports and peer-reviewed publications produced by the marine mammal research group the Cromarty Lighthouse Field Station and many researchers are involved in current

research projects upon marine mammals, such as the Department of Energy and Climate Change seismic study in the Moray Firth.

376 The Sea Mammal Research Unit (SMRU) conducts surveys for harbour and grey seals to monitor seal populations around the UK. SMRU provides scientific information to the Special Committee on Seals (SCOS) (SCOS, 2008).

377 An initial marine mammal desk study has been conducted to review the available information on marine mammals off north-east Scotland with particular reference to the Aberdeen Bay area, providing information their occurrence, distribution, abundance, movements, diet and seasonal sensitivities, such as calving periods. In addition, the potential impacts associated with offshore wind farm construction and operation, the possible effects on marine mammals and mitigation measures have been reviewed. Summary results of the review that illustrate the predicted seasonal occurrence of marine mammals in Aberdeen Bay are shown in Table 5.8.

5.6.2.1 *Boat Based Surveys*

378 Boat based surveys have been conducted monthly between February 2007 and April 2008. The surveys covered an area that includes the entire wind farm site plus a buffer zone (south to the limit of the shipping lane, 3 km north, 3 km east and up to the 5 m contour line to the west) and a control site immediately to the north (Figure 8).

379 The surveys were conducted over two days (one day for wind farm site and one day for control site) every month. The boat-based survey programme employed standard marine mammal survey techniques used in similar studies. Visual observations of marine mammals were conducted by two marine mammal observers (MMOs) during the surveys. Data collected included species, number, location and activity of marine mammals in the survey area. In addition, marine mammal observations were also made ‘off-transect’ when the boat was steaming to and from the survey areas.

380 The following species were observed during the boat based surveys: harbour porpoise; bottlenose dolphin; minke whale; grey seal and harbour seal. The white-beaked dolphin has only been recorded off-transect. Table 5.7 summarises the observations of marine mammals during monthly boat surveys of wind farm & control survey areas between February 2007 and January 2008 (including observations off transect). In general, the species sightings corroborate well with the existing baseline information for the area.

381 The harbour porpoise was the most commonly sighted marine mammal species. There were at least twice as many harbour porpoise sightings in the control survey area (119 sightings) compared to the wind farm survey area (47 sightings) over the course of the 12 month survey period. Within the wind farm survey area, the peak sighting index for harbour porpoises was during October-November surveys (0.1149 sightings km-1). In the control survey area, the peak sighting index was during October-November and December-January survey groups (0.2365 and 0.2500 sightings km-1 respectively) (Travers *et al.*, 2008).

382 Bottlenose dolphin were the second most commonly sighted species, however the number of sightings was relatively low . An absence of

bottlenose dolphin sightings was noted during February-March, August-September, October-November and December-January month groups (Travers *et al.*, 2008). .

383 A single minke whale was sighted during the 12 months of surveys in July 2007 (Travers *et al.*, 2008).

384 Five sightings of unidentified cetaceans were recorded during the 12 month survey period: three sightings in the wind farm survey area and two in the control survey area (Travers *et al.*, 2008).

385 Seal sightings were recorded in all month groups during the 12 month survey period apart from the April-May and August-September groups. Overall there were more than twice as many seal sightings in the control survey area (25 sightings) compared to the wind farm survey area (10 sightings), with all seal sightings recorded being of individuals (Travers *et al.*, 2008).

386 Harbour porpoise, bottlenose dolphin, seal species and white-beaked dolphin were sighted off-transect during the 12 month survey programme. Bottlenose dolphins occurred at least once off-transect in more than half of the surveys (13 out of 24 surveys). The majority of off-transect bottlenose dolphin sightings have been recorded in the vicinity of the Aberdeen Harbour mouth. Harbour porpoise were observed to a lesser extent than the bottlenose dolphin; being detected in seven out of 24 surveys off-transect. Seals were observed off-transect in one out of 24 surveys. The white-beaked dolphin was recorded during the August 2007 survey trip (Travers *et al.*, 2008).

387 The results of the first year of marine mammal survey will be pooled together with future boat based survey information. To establish the numbers of marine mammal using specific survey areas density and abundance estimates will generated for species detected where sufficient sightings allow this. Based on current sightings rates, this approach is only likely to be possible for the harbour porpoise. The harbour porpoise data could be pooled over all months and the possibility of fitting a detection function explored within the software DISTANCE. If the model fit is adequate, this could be used to generate density and abundance estimates. These estimates would be biased low because the single platform visual method cannot account for sightings missed on the transect line. Distance estimates are preferable to basic encounter rates because they take into account the effects of distance (and other covariates if there are sufficient data) on the sightings process.

5.6.2.2 Towed Acoustic Monitoring (PAM)

388 In conjunction with the boat based surveying PAM data were collected between October 20007 and February 2008. PAM enables the detection of dolphins and porpoises that might not otherwise be observed by the MMOs, for example due to poor visibility. These surveys were designed to optimise the collection of acoustic information on the occurrence of harbour porpoises. From the initial 5 months of acoustic survey effort harbour porpoises were detected every hour for every survey, in both the control and wind farm site. The acoustic data suggests a regular presence of these marine mammals during the months surveyed. Although, no acoustic survey effort occurred in Spring and Summer, from evidence supplied by the visual surveys, it is likely that the harbour porpoises will still be present throughout spring and summer months.

389 Towed acoustic monitoring is taking place for EOWDC as part of the ongoing boat based surveys which started in August 2010.

Table 5.7 Observations of marine mammals during monthly boat surveys of wind farm & control survey areas between February 2007 and January 2008 (including observations off transect) Travers *et al.* (2008)

	Survey Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bottlenose dolphin	Wind farm			Off transect	Observed	Off transect	Observed	Observed			Off transect		
	Control		Off transect	Off transect	Off transect	Observed	Off transect	Off transect	Off transect		Off transect		
Harbour porpoise	Wind farm	Off transect	Observed	Observed	Observed			Observed	Observed	Observed	Observed	Observed	Observed
	Control	Observed	Observed	Observed	Observed		Observed	Observed	Observed	Observed	Observed	Observed	Observed
White-beaked dolphin	Wind farm								Off transect				
	Control												
Minke whale	Wind farm							Observed					
	Control												
Unidentified cetacean	Wind farm							Observed	Observed	Observed			
	Control								Observed	Observed			
Seals	Wind farm	Observed	Off transect	Observed			Observed				Observed	Observed	Observed
	Control	Observed	Off transect				Observed	Observed		Observed	Observed	Observed	Observed

Key

Observed	Observed during boat surveys
Off transect	Observed off transect only
	Not observed

Table 5.8 Summary of the occurrence of marine mammals in the Aberdeen area (based on desk study and all Aberdeen offshore wind farm surveys)

Species	Occurrence	Seasonal Occurrence											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bottlenose dolphin	**Regular**												
Harbour porpoise	**Regular**												
White-beaked dolphin	**seasonal/regular**												
Minke whale	**seasonal/regular**												
Risso's dolphin	Occasional												
White-sided dolphin	rare/occasional												
Killer whale	rare/occasional												
Common dolphin	rare/occasional												
Striped dolphin	Rare												
Long-finned pilot whale	rare/occasional												
Sperm whale	Rare												
Humpback whale	Rare												
Fin whale	Rare												
Northern bottlenose whale	Rare												
Sowerby's beaked whale	Rare												
Harbour seal	**Regular**												
Grey seal	**Regular**												
Hooded seal	Rare												

Key

- Recorded during AOWF surveys (VP and boat surveys of wind farm and control survey areas, including on & off transect)
- Present in area (sighting and/or stranding based on desk study)
- Potential to be present in area (based on desk study)
- Not recorded

(Sources: Canning, 2007; Hammond *et al.*, 2001, 2002, 2004; Northridge *et al.*, 1995; Reid *et al.*, 2003; SAC, unpublished stranding data; Sabin *et al.*, 2006; Stockin *et al.*,. 2006; Stone, 2003; Travers, *et al.*, 2008; VP survey data; Weir & Stockin, 2001; Weir *et al.*, 2007; Wilson *et al.*, 2004).

5.6.2.3 Future Boat Based Surveys 2010 – 2011

390 Further boat surveys commenced in August 2010. These will be conducted monthly over two days. The surveys involve a new survey area and methodology from the previous boat surveys. The new survey methodology is based on a monitoring approach.

391 Three survey strata will be surveyed each month: i) extending northwards, covering both the wind farm, buffer and control areas surveyed in the previous surveys; ii) extending eastwards further offshore; and iii) a southwards stratum. The total survey area is 339 km^2, comprising three strata: 150.8 km^2 (north), 82.8 km^2 (south) and 105.2 km^2 (offshore).

392 The aim is to conduct one 2-day survey per month, initially for 12 months, with at least four months of these data being included in the EIA and Environmental Statement, in addition to the previous data collected for the site. The boat surveys will continue during the Environmental Statement process for 12 months, giving two years of data for the site. If there are any significant changes to the data presented in the Environmental Statement, these will be submitted as an addendum. The intention is to then to continue the surveys before, during and after construction, using the same transect design but perhaps focusing effort on key periods, for example during the pile installation period where any acoustic disturbance effects to marine mammals may occur.

5.6.2.4 Vantage Point Counts

393 Shore-based vantage point (VP) bird surveys have been conducted at the Donmouth, Blackdog, Balmedie and Drums between April 2006 and March 2008. VP surveys were undertaken at Blackdog and Donmouth (wind farm site) four times per month and fortnightly at Drums and Balmedie (control sites). Although the surveys were designed primarily for birds, the ornithologists also recorded marine mammal sightings up to 3 km from shore. During the two years of VP surveys, bottlenose dolphins were the most frequently observed marine mammal, seen in nine out of 12 months, with absences in June, September and October. Sightings for this species reached a peak in April with 15 sightings over the two survey years. Harbour porpoises were the next most frequently sighted species, seen in all seasons. The grey seal was also seen in all seasons. Only one sighting was made over the two years for the harbour seal and Risso's dolphin (Travers *et al.*, 2008). These data support the general pattern of key marine species frequenting Aberdeen Bay found during the boat-based surveys.

5.6.3 Potential Impacts

394 There are a number of potential impacts to marine mammals associated with the construction, operation and decommissioning of an offshore wind farm, these include (but are not limited to):

- underwater noise disturbance:
  - pile driving
  - other construction operations, eg drilling, rock dumping, dredging

- vessels during surveys, construction, installation and maintenance, including vessel noise, sonar systems and navigational depth sounders
    - seismic surveys
    - Trenching operations to bury sub-sea cables
    - vibration of wind turbines during operation
    - decommissioning operations
    - cumulative noise effects
- construction activities, in addition to noise:
    - increased turbidity
    - increased vessel activity
    - pollution incidents, eg fuel spill if accidental vessel-vessel or vessel-wind turbine collision
- physical presence and operation of wind turbines, in addition to noise
    - creation of artificial reefs
    - loss of seabed area
    - electromagnetic fields from cables
- decommissioning activities

395 The potential effects on marine mammals include:

- risk of physical injury, or temporary auditory hearing effects
- disturbance and displacement
- changes to foraging areas and prey availability
- barrier effects to movements
- increased collision risk with vessels

396 Information collected and evaluated from field and desk studies will be used to identify and predict impacts associated with the proposed development. The potential impacts and effects will be considered individually, and cumulatively, for all species (individuals and populations) using the proposed development site and surrounding areas.

397 The potential impacts from underwater noise, especially during any pile driving operations, have the greatest risk of having a significant effect on marine mammals. In order to assess any possible impacts, detailed modelling of underwater noise levels from different activities will be conducted. The results will help inform ranges from the development at which potential physical injury, such as permanent threshold shifts (PTS) in hearing, could occur and also distances at which the sound levels from construction will be audible to marine mammals. The assessment will cover cumulative noise dose and make recommendations of suitable stand-off distances, see also Section 5.7 Underwater Noise.

398 Consideration will be given to the requirement for a European Protected Species licence, following advice from SNH, to cover the potential risk to any injury or disturbance that may result from the construction of the wind farm.

5.6.4 Cumulative Assessment

399 There is relatively little information on the potential cumulative effects of underwater noise from construction of offshore wind farms and other coastal developments on marine mammals. The approach to the assessment of

cumulative impacts of the development will focus mainly on the noise aspects of the development, but will also cover potential loss of habitat to marine mammals. All other sources of noise that contribute either to the ambient noise level in Aberdeen Bay, or are short term events such as seismic surveys, will be reviewed and considered in relation to potential cumulative effects.

5.6.5 Mitigation

400 There are a number of potential mitigation measures that are available to minimise the risk of causing injury to marine mammals from construction noise, particularly pile driving. AOWFL will apply the results of the noise modelling studies, specifically the ranges at which marine mammals are likely to be at risk from any auditory hearing effects, and incorporate these findings into the mitigation measures.

401 For the piling activity itself, it is envisaged that monitoring both acoustical and visual will be conducted from a platform around the wind turbine and the JNCC piling protocol will be followed, specific aspects of this include:

- establishment of a pre-agreed 'monitored zone' (MZ)
- delay of commencement of piling should marine mammals be detected
- use of soft start procedure for piling operations
- use of Acoustic Mitigation Devices (AMDs) prior to piling start up will be assessed taking into account licensing requirements and current best practice advice issued by SNH

402 Other possible mitigation measures which will be assessed include:

- Timing of operations. The preliminary assessment has not identified any periods as being particularly sensitive, for example no evidence of breeding / calving areas in Aberdeen Bay.
- Use of lower-impact piling techniques, pile sleeves, pile head softening, vibropiling and/or other techniques available at the time of construction.

5.6.6 EOWDC Future Research and Monitoring

5.6.6.1 *C-PODs*

403 AOWFL have purchased 12 C-PODs. These are acoustic monitoring devices used to detect the vocalisations of marine mammals. Continuous acoustic recorders provide valuable information over a long time period. This cannot be achieved by other survey methods and would enable information to be collected during hours of darkness and poor visibility. C-PODs can be used for before, during and after construction monitoring.

404 It is planned to deploy these devices within the wind farm and surrounding area following a gradient approach design where acoustic recorders are also placed in the southerly and northerly extremities of Aberdeen Bay and in deeper waters offshore. SNH have been consulted and provided feedback on the provisional C-POD design layout put forward for the project and will be again consulted before the deployment phase. The impact range and planned distance of C-POD deployment (out to a distance of 35 km) has been

estimated with reference to the current literature (Bailey *et al.*, 2010; Carstensen *et al.*, 2006). The design layout makes an assumption that animals may be dispersed both along the coastline and offshore, and maximises the potential for detecting behavioural responses regardless of response direction (ie offshore or alongshore movements).

405 The use of acoustic devices enables detailed information to be collected about how marine mammals use Aberdeen Bay. This information is useful in terms of collecting further baseline information about general usage of the area, and will also allow an indication of relative abundance of acoustically active cetaceans. However, it is not possible to detect seals or to discriminate between dolphin species (for example bottlenose dolphin and common dolphin).

406 It would be reasonably foreseeable that during the piling phase of construction marine mammals would leave the immediate locality and only return once the piling has ceased. Using the information from C-PODS and other marine mammal studies, further information could be collected to ascertain the responses to underwater noise (for example animals temporarily leaving Aberdeen Bay) and help populate the evidence base for the duration and magnitude of impacts (for example, when marine mammals were shown to return).

407 The long-term effects of the presence of wind turbines on marine mammals are not well understood. It would be valuable to obtain data to determine if marine mammals change their behaviour or utilisation of the area or their feeding patterns or movements as a result of the presence of the wind turbines. A long-term dataset (pre-construction) would ideally be needed to provide a robust evidence base and C-POD deployment pre-construction would contribute to the existing baseline.

5.6.6.2 Ambient Noise Measurements and Validation of Construction Noise Levels

408 Further underwater noise studies are planned including measurements of ambient noise levels and construction noise. These would be useful to validate the predictions made within the impact assessment and also in the analysis of the observations of marine mammals detected visually and acoustically during post construction monitoring.

5.7 Underwater Noise

5.7.1 Introduction

409 The construction of an offshore wind farm is an activity which can generate noise. Impact piling in particular can generate high levels of predominantly low frequency underwater noise that can travel large distances. Other activities that generate underwater noise include vessel movement to and from the construction site.

410 Once operational, the wind farm is expected to generate low levels of underwater noise via the transfer of energy from the moving wind turbine blades into the seabed sediments and water column.

411 AOWFL proposes to conduct a number of noise studies that will be carried out during specific stages of the wind farm. Initial studies, commissioned to support the Environmental Statement, will aim to model and estimate the underwater noise levels generated from construction, specifically piling.

412 The noise predictions in the model will inform other parts of the EIA process notably:

- marine mammals
- fisheries
- commercial fisheries

5.7.2 Baseline Information Overview

413 In order to model sound, it is important to have information on the wind turbine design and piling details (if used) as well as oceanographic information including water depth and seabed conditions. Ambient underwater noise levels are also required. AOWFL are not aware of any underwater noise studies that have been carried out in the Aberdeen area and are proposing to collect ambient noise data within Aberdeen Bay from published reports.

414 Noise modelling will be undertaken to predict the propagation of sound from the piling location along a number of water depth transects. The sound levels that are predicted from the noise modelling can then be assessed against potential impact criteria for marine animals to inform the EIA.

415 The ranges at which hearing injury and temporary threshold shifts in hearing are expected will be estimated using recognised marine mammal impact criteria, such as Southall (2007) and other types of proposed impact thresholds, such as conservative temporary threshold hearing levels proposed by Lucke (2008).

416 Current practice to mitigate impacts to marine mammals from piling is to apply the JNCC piling guidelines which specify that a mitigation zone of 500 m, or higher is used. The mitigation zone is the area within which if a marine mammal is observed prior to starting operations then any commencement must be delayed for at least 30 minutes during which time there must be no observations of marine mammals within the zone. The use of trained MMOs and PAM will reduce the risk of a marine mammal not being detected. Modelling will be able to predict the range at which injury, defined as a Permanent Threshold Shift (PTS) in hearing is expected and this will be used as the basis for setting the mitigation zone. In the likely event that the modelling predicts PTS to be restricted to the immediate vicinity of the pile, a minimum of 500 m will be used as the mitigation zone.

417 The following data sources will be reviewed as part of the EIA process:

- ambient noise recording measurements for the North Sea, for example the DECC funded Moray Firth seismic survey ambient noise measurement programme

5.7.3 Potential Impacts

418 Impacts to marine mammals from noise are covered in Section 5.6 Marine Mammals. Impacts to fish are covered in Section 5.1 Marine Ecology.

5.7.4 Mitigation

419 The mitigation measures for underwater noise will follow the piling protocol as specified in the marine mammal chapter.

5.7.5 EOWDC Future Research and Monitoring

420 Additional noise studies are planned for the construction phase. It is expected that future noise studies will obtain noise measurements at piling locations at a range of distances and use these to provide a breakdown of the spectral levels of sound received to determine sound pressure level and sound exposure level during construction activities. The estimates of sound levels will be particularly useful in validating the noise modelling performed and the assessment of likely impacts on marine fauna made in the Environmental Statement.

421 The scope of work for the future noise studies has yet to be finalised but it is envisaged that underwater noise recording instrumentation will be deployed within the study area to characterise the frequency spectra and levels of sound received.

422 Any future noise studies will be designed to help complement and support the other research activities that are ongoing at the time, such as the acoustic monitoring studies and boat-based survey work.

5.8 Electromagnetic Fields

5.8.1 Introduction

423 The electromagnetic fields (EMF) generated by alternating current (ac), sub-sea power cables have been recognised as an environmental concern since the Round 1 sites were developed. The significance of any likely impact is difficult to quantify due to a lack of information on the type of fields generated by offshore wind farm cables and the effects these have upon marine fauna. Recent research attempted to establish the risk that EMFs pose to the marine environment (Gill, 2008). Although submarine power cables are fully electrically insulated, the fluctuating magnetic field induces a very small electric field in the environment which have the potential to affect fish behaviour. As power cables will be installed as part of the project development for EOWDC, the potential impacts of electromagnetic fields will be assessed in the EIA.

5.8.2 Baseline Information

424 Many fish and a number of other species found in UK waters are potentially capable of responding to anthropogenic sources of electric and magnetic fields. Certain fish species, including common ones such as plaice, are

understood to be both magnetically and electrically sensitive and a range of other species, notably cetaceans and many crustacea, to be magnetically sensitive. Most attention, however, has focused on elasmobranchs (sharks, skates and rays) which have specialist electro-receptive organs and are capable of detecting very small electric fields of around 0.5µV/m (Gill 2005).

425 Potential impacts could result from: *repulsion* effects leading to exclusion of animals from an area of seabed (eg for elasmobranchs in the presence of relatively high electric fields); *attraction* effects, for example, causing elasmobranchs to waste time and energy resources foraging around electric fields mistaken for bioelectric fields of prey organisms; and *disruption* to migrations for magnetically sensitive species such as eels and salmonids that may use the earth's geomagnetic field for navigational cues. The information available on magneto-sensitive species is limited, but it does suggest that potential interactions between EM emissions, of the order likely to be associated with wind farm cables, and a number of UK coastal organisms could occur from the cellular through to the behavioural level.

426 Elasmobranchs have been exposed to similar EMF signals to those generated by power cables (Gill, et al 2008). The results were inconclusive and there was no evidence to suggest any positive or negative effect on elasmobranchs exposed to typical EMF stimuli encountered at an offshore wind farm (Gill, et al 2009). However, it should be noted that the behavioural responses observed in the study are not predictable and appear to be species specific and perhaps individual specific (Gill *et al.*, 2009). It has been recognised that there are inherent difficulties in testing the significance of the EMF and further targeted research is required in order to better develop our understanding of the responses of animals to EMF stimuli.

5.8.3 Proposed Scope of Assessment

427 A literature review will provide a summary of the major sources of information for the EIA. The conclusion of most project-specific environmental impact assessments is that whilst there could be an interaction between marine species and EMF generated by sub-sea cables, it is unlikely to be of any significance at a population level. The assessment for EOWDC is likely to reach the same conclusions as previous offshore wind farms, and will support this by identifying the main species likely to be sensitive to EMF and predicting potential magnitudes of impact. The Cowrie research into EMF will be the primary data source used to support the EIA.

5.9 Statutory Designations and Conservation

428 Although the proposed site does not lie within a designated area, the north-east coast of Scotland does support many sites of national and international importance for wildlife. Table 5.9 presents the designated sites that may be affected by the proposed demonstrator project. These sites are identified on Figure 6.

TABLE 5.9 Designated sites potentially impacted by the proposed EOWDC		
Designation	**Approximate distance from proposed wind farm (km)**	**Citation Information**
Special Areas of Conservation (SACs)	*Convention of Natural Habitats and of Wild Fauna and Flora Directive (92/43/EEC), transposed in the UK through the Conservation (Natural Habitats) Regulations 1994.*	
River Dee SAC	7.5	Presence of Annex II species, Freshwater Pearl Mussel, Atlantic Salmon, Otter
Sands of Forvie SAC	7.2	Annex I habitats, Embryonic shifting dunes, shifting dunes along the shoreline with *Ammophila arenaria*, decalcified fixed dunes with *Empetrum nigrum*, humid dune slacks
Buchan Ness to Collieston SAC	12.2	Annex 1 habitats, vegetated sea cliffs
Moray Firth SAC	150	Annex II Species: Bottlenose dolphin, Annex I Habitats: Sandbanks which at all times are covered by seawater
Special Protection Areas (SPAs) and Ramsar Sites	*Council Directive 79/409/EEC on the Conservation of Wild Birds*	
Ythan Estuary, Sands of Forvie and Meikle Loch Special Protection Area (SPA)	7.2	Qualifying species, pink-footed goose, Sandwich tern, common tern, little tern and waterfowl assemblage including eider, redshank and lapwing
Ythan Estuary and Meikle Loch Ramsar	7.2	Wintering Pink footed geese, breeding sandwich terns Non-breeding waterfowl assemblages
Buchan Ness to Collieston SPA	9.5	Article 4.2: holding in excess of 20,000 seabirds: fulmar, shag, kittiwake, herring gull and guillemot.
Loch of Skene SPA	21	Qualifying species: whooper swan, greylag goose. Article 4.2 waterfowl assemblages: wintering goldeneye, goosander, common gull. Breeding tufted duck
Fowlsheugh SPA	31.1	Qualifying species: kittiwake, guillemot,. Article 4.2 seabird assemblages: fulmar, herring gull and razorbill
Loch of Strathbeg SPA	47.6	Qualifying species: Sandwich tern. Article 4.2 waterfowl assemblages: pink-footed goose, greylag goose, teal and goldeneye.
Troup, Pennan and Lion's Heads SPA	74.3	Article 4.2 seabird assemblages: fulmar, kittiwake, guillemot, herring gull and razorbill.
Forth Islands SPA	124.4	Qualifying species: gannet, shag, lesser black-backed gull, roseate tern, Arctic tern, common tern, Sandwich tern, puffin. Article 4.2 Seabird assemblages: cormorant, herring gull, kittiwake, razorbill and guillemot
National Nature Reserves (NNRs)	*National Parks and Access to the Countryside Act (1949)*	
Forvie NNR	7.2	Sand dune, foreshore, estuarine, spit, dune heath, slacks, rough pasture and cliffs habitat
Sites of Special Scientific Interest (SSSIs)	*Wildlife and Countryside Act (1981/1985)*	
Corby, Lily and Bishops Lochs SSSI	6.7	Wetland sites, aquatic vegetation, wildfowl roost
Foveran Links SSSI	4.8	Mobile foreshore and dunes, interesting

TABLE 5.9 Designated sites potentially impacted by the proposed EOWDC		
Designation	**Approximate distance from proposed wind farm (km)**	**Citation Information**
		vegetation assemblages, migrating birds, moulting and passage sea ducks and divers, and coastal geomorphology
Sands of Forvie and Ythan Estuary SSSI	7.2	Sandwich tern, common tern and little tern
Other Designations	*Ministerial Conference on the Environment (1973); Countryside Act 1968; National Parks and Access to the Countryside Act (1949)*	
Donmouth Local Nature Reserve	5.0	Birds that feed and roost, Grey seals
Balmedie Country Park	2.7	Recreation and leisure interests
Forvie Biogenetic Reserve	7.2	Heathland Interest.

429 There are no other national or local landscape designations such as national scenic areas within the vicinity of the proposal that have the potential to be affected by the proposed project. In pre-scoping consultation, SNH have highlighted, in conjunction with the JNCC, that they are currently in the process of identifying possible marine SPAs. AOWFL will ensure that any relevant changes are addressed within the Environmental Statement.

5.9.1 Conservation Designations

430 A number of protected sites and species in the vicinity of the proposed EOWDC site are designated both internationally and nationally (Table 5.9). The following section provides details of these designations and sites identified of relevance to the proposed project.

5.9.2 Requirement for an Appropriate Assessment

431 Under the Conservation (Natural Habitats, & c.) Regulations (as amended), the relevant Competent Authority (in this case the Scottish Government) must consider the effect of a development on the integrity of a European site. If the development is considered likely to have a significant effect on that site, the competent authority would undertake an Appropriate Assessment using information supplied as part of the EIA process to accurately determine risk to site integrity. Special Areas of Conservation (SACs) or Special Protection Areas (SPAs) constitute a European site.

432 Initial consultation with statutory bodies has indicated that the interaction between the proposed EOWDC and European sites in the wider area would need to be considered as part of the EIA process and that an Appropriate Assessment may be required.

5.9.2.1 International Sites

Ramsar Sites

433 These sites are internationally important wetland sites protecting wildfowl habitat. Ramsar sites are designated under the Convention of Wetlands of

International Importance. The Convention was adopted in Ramsar, Iran, in 1971 and ratified by the UK Government in 1976.

Natura 2000 Sites

434 The two most influential pieces of European legislation relating to nature conservation are the "Habitats" Directive and the "Birds" Directive. The 'Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora', commonly known as the Habitats Directive, adopted in 1992, complements and amends the 1979 'Council Directive 79/409/EEC on the conservation of wild birds', commonly known as the Birds Directive. . A further Directive *On The Conservation of Wild Birds* (Directive 2009/147/EC) amends the 1979 Directive.

435 The Birds Directive protects all wild birds, their nests, eggs and habitats within the European Community. It gives EU member states the power and responsibility to classify Special Protection Areas (SPAs) to protect birds which are rare or vulnerable in Europe as well as all migratory birds which are regular visitors.

436 The Habitats Directive builds on the Birds Directive by protecting natural habitats and other species of wild plants and animals. Together with the Birds Directive, it underpins a European network of protected areas known as Natura 2000. This network includes SPAs classified under the Birds Directive and Special Areas of Conservation (SAC) under the Habitats Directive.

437 Annexes I and II of the Habitats Directive identify a set of habitats (Annex I) and species (Annex II), which require special conservation measures to be taken by Member States. These lists of habitats and species have been used to define the 'features' of a site which form the basis for designating the site as a SAC. Marine SACs may be put forward for habitats of conservation importance (listed in Annex I to the Habitats Directive) or for species of conservation importance (listed in Annex II) (Table 5.10).

TABLE 5.10
Marine habitats on Annex I and species on Annex II of the Habitats Directive found in UK waters

Annex I Habitats Considered for SAC Selection in UK Offshore Waters	**Species Listed in Annex II Know to Occur in UK Offshore Waters**
Sandbanks which are slightly covered by seawater all the time Reefs (bedrock, biogenic and stony) – Bedrock reefs – made from continuous outcroppings of bedrock which may be of various topographical shape (eg pinnacles, offshore banks) – Stony reefs – these consist of aggregations of boulders and cobbles which may have some finer sediments in interstitial spaces (eg cobble and boulder reefs, iceberg ploughmarks) – Biogenic reefs – formed by cold water corals (eg *Lophelia pertusa*) and the polychaete worm *Sabellaria spinulosa* Submarine structure made by leaking gases Submerged or partially submerged sea caves	Grey seal (*Halichoerus grypus*) Harbour or common seal (*Phoca vitulina*) Bottlenose dolphin (*Tursiops truncatus*) Harbour porpoise (*Phocoena phocoena*)

Source: JNCC (2002, 2010)

Special Protection Areas (SPAs)

Buchan Ness to Collieston SPA

438 Buchan Ness to Collieston Coast SPA is located on the coast of Aberdeenshire in north-east Scotland, approximately 9.5 km from the EOWDC site. It is a 15 km stretch of south-east facing cliff formed of granite, quartzite and other rocks running to the south of Peterhead, interrupted only by the sandy beach of Cruden Bay. The low, broken cliffs (generally less than 50 m high) show many erosion features such as stacks, arches, caves and blowholes. The varied coastal vegetation on the ledges and cliff tops includes maritime heath, grassland and brackish flushes.

439 The site is of importance as a nesting area for a number of seabird species (Gulls and Auks). These birds feed outside the SPA in the nearby waters as well as more distantly. It is the sea bird assemblage of international importance that qualifies Buchan Ness to Collieston as a SPA. The area qualifies under Article 4.2 of the Habitats Directive (79/409/EEC) by regularly supporting at least 20,000 seabirds.

440 During the breeding season, the area regularly supports 95,000 individual seabirds (Count, as at mid-1980s) including: Guillemot (*Uria aalge*), Kittiwake (*Rissa tridactyla*), Herring Gull (*Larus argentatus*), Shag (*Phalacrocorax aristotelis*), Fulmar (*Fulmarus glacialis*).

Ythan Estuary, Sands of Forvie and Meickle Loch SPA

441 The Ythan Estuary, Sands of Forvie and Meikle Loch make up an area of 1016.24 ha. The site comprises the long, narrow estuary of the River Ythan and eutrophic Meikle Loch. At its mouth, the river splits an extensive area of sand dunes with the Forveran Links on the west bank and the Sands of Forvie dune system on the east bank. Extensive mud-flats in the upper reaches of the estuary are replaced by coarser gravels with mussel (*Mytilus edulis*) beds closer to the sea (JNCC, 2010).

442 These varying habitats give rise to a varied substrate including clay, sands and gravel, extensive areas of bare mud, small areas of salt marsh with representative northern salt marsh flora. Small areas of club-rush swamp are associated with the salt marsh. In the upper parts of the estuary there is a reed bed and near the mouth of the estuary there are shifting sand dunes and areas of bare shingle. To the west of the estuary there is a large area of improved grassland.

443 The margins of the estuary are varied with areas of salt marsh, reed bed and poor fen, heath and scrub, coniferous woodland and grassland. Meikle Loch is an important roost site for geese which feed away from the SPA on surrounding farmland in winter. It is a eutrophic loch supporting limited aquatic vegetation. In summer, the coastal habitats of the dunes and estuary provide an important breeding site for three species of tern, whilst in winter the estuary holds large numbers of waders, ducks and geese.

444 The site qualifies under a number of articles of the European Directive. Firstly, the site qualifies under Article 4.1 of the Habitats Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive. During the breeding

season it supports common tern (*Sterna hirundo),* 265 pairs representing up to 2.2 % of the breeding population in Great Britain, little tern (*Sterna albifrons*), 41 pairs representing up to 1.7 % of the breeding population in Great Britain and Sandwich tern (*Sterna sandvicensis*), 600 pairs representing up to 4.3 % of the breeding population in Great Britain (Seabird Census Register).

445 This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of migratory species. Over-winter pink-footed goose (*Anser brachyrhynchus*), 17,213 individuals representing up to 7.7 % of the wintering Eastern Greenland/Iceland/UK population (winter peak means).

446 The site also qualifies under Article 4.2 of the Directive by regularly supporting at least 20,000 waterfowl. Over winter, the area regularly supports 51,265 individual waterfowl including: redshank *Tringa totanus*, lapwing *Vanellus vanellus*, eider *Somateria mollissima*, and pink-footed goose *Anser brachyrhynchus*.

447 The Ythan Estuary and Meikle Loch sites are also designated as a Ramsar wetland site. The justification for this designation are the assemblages of internationally important waterfowl and the species/populations occurring at levels of international importance.

Loch of Strathbeg SPA

448 The Loch of Strathbeg is located in north-eastern lowland coats of Scotland, in Aberdeenshire, inland from Rattray Head and covers an area of 615.93 ha.

449 The SPA provides wintering habitat for a number of important wetland bird species, particularly wildfowl (swans, geese and ducks), and is also an important staging area for migratory wildfowl from Scandinavia and Iceland/Greenland. In summer, coastal parts of the site are an important breeding area for Sandwich tern (*Sterna sandvicensis*), which feed outside the SPA in adjacent marine areas.

450 The site qualifies under Article 4.1 of the Habitats Directive (79/409/EEC) by supporting populations of European importance of species listed on Annex I of the Directive. During the breeding season it supports Sandwich tern (*Sterna sandvicensis*), 530 pairs representing up to 3.8 % of the breeding population in Great Britain. Over winter it supports barnacle goose (*Branta leucopsis*), 226 individuals representing up to 1.9 % of the wintering population in Great Britain and whooper swan (*Cygnus cygnus*), 183 individuals representing up to 3.3 % of the wintering population in Great Britain.

451 This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of migratory species. Over winter it supports greylag goose (*Anser anser*), 3,325 individuals representing up to 3.3 % of the wintering Iceland/UK/Ireland population, pink-footed goose, (*Anser brachyrhynchus*), 39,924 individuals representing up to 17.7 % of the wintering Eastern Greenland/Iceland/UK population.

452 In addition area qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl and being a wetland of international importance. Over winter, the area regularly supports 49,452

individual waterfowl including: teal (*Anas crecca*), greylag goose, (*Anser anser*), pink-footed goose, (*Anser brachyrhynchus*), barnacle goose, (*Branta leucopsis*), and whooper swan, (*Cygnus Cygnus*).

453 The majority of the site is managed by the Royal Society for the Protection of Birds (RSPB) for conservation and primarily for the SPA interest. Scottish Natural Heritage (SNH) has piloted a Strathbeg Goose Management Scheme to alleviate the conflict between the geese which roost on the loch and the surrounding farms where they feed.

454 The Loch of Strathbeg site is also a designated Ramsar site as the loch constitutes the largest dune slack pool in the UK and the largest water body in the north-east Scottish lowlands, one of the very few naturally eutrophic lochs of the size in the region. The site also qualifies under criterion 5 and 6 with assemblages of international importance, especially peaks in winter, and species/populations occurring at levels of international importance.

Loch of Skene SPA

455 Loch of Skene lies approximately 21 km from the proposed wind farm location.

456 The qualifying species is greylag goose which roost on the loch during the winter. The population of wintering greylag geese on the Loch has declined in recent years as increasing numbers of greylag geese now winter in Orkney.

457 In addition to greylag geese the loch also holds nationally important numbers of goldeneye (*Bucephala clangula*) and goosander (*Mergus merganser*) during the winter and a large roost of common gulls occurs during the winter. During the summer the loch holds 50 to 100 pairs of tufted duck.

Fowlsheugh SPA

458 Fowlsheugh is a 10.15 ha stretch of cliffs to approximately 31.1 km south of the proposed wind farm location. It is an important site for breeding seabirds with up to 145,000 birds present including guillemot, razorbill, kittiwake, fulmar and herring gull. The site is also part of an RSPB reserve.

Troup, Pennan and Lion’s Heads SPA

459 The sea cliffs along Troup, Pennan and Lion’s Head SPA hold internationally and nationally important numbers of seabirds, notably kittiwake, guillemot, fulmar, herring gull and razorbill. There is a seaward extension out to 2 km from the cliffs which are approximately 74.3 km from the project location.

Forth Islands SPA

460 The Forth Islands SPA comprises a series of islands situated in the Firth Forth and include the Bass Rock and the Isle of May. It is a site holding internationally and nationally important seabirds including gannet, fulmar, shag, cormorant, common tern, Sandwich tern, Arctic tern and roseate tern. Three species of auk: puffin, razorbill and guillemot, and three species of gull: herring, lesser black-backed and kittiwake are found there.

Special Ares of Conervation (SACs)

Buchan Ness to Collieston Coast SAC

461 Buchan Ness to Collieston Coast, an area of 207.52 ha, is a designated special area of conservation (SAC). The site includes shingle sea cliffs and islets, bogs marshes, water fringed vegetation and fens as well as heath, scrub, maquis, garrigue, phygrana, humid grassland, and mesophile grassland. Such habitat qualifies the site as an Annex I Habitat, 1230 Vegetated Sea Cliff of the Atlantic and Baltic Coasts.

462 The vegetated cliff slopes support a wide range of coastal vegetation types with an abundance of such local species as Scots lovage (*Ligusticum scoticum*) and roseroot (*Sedum rosea*). In several places the cliff edge retains semi-natural plant communities such as maritime heath, acid peatland and brackish flushes. All these are now rare on the coast of north-east Scotland and this section of coastline contains some of the best remaining examples. Possibly due to the local microclimate and the presence of lime-rich soils, these communities contain several plants which are associated with dry, calcareous grassland, including carline thistle (*Carlina vulgaris*) and cowslip (*Primula veris*). Sea wormwood (*Seriphidium maritimum*) also occurs. The cliffs and offshore stacks support a scattered but considerable colony of cliff-nesting seabirds with bird-influenced vegetation.

Sands of Forvie SAC

463 The Sands of Forvie SAC includes an area of coastal sand dunes, beaches, machair, inland water bodies, sea cliffs, bogs, marshes, water fringed vegetation, fens, heath, scrub, marquis and garrigue, phygrana, humid grassland and mesophile grassland covering an area of approximately 734.05 ha. There are three primary reasons for selecting Sands of Forvie as an SAC. These include the embryonic shifting dunes, shifting dunes along the shoreline with *Ammophila arenaria* (white dunes), decalcified fixed dunes with *Empetrum nigrum* and humid dune slacks.

464 Sands of Forvie is one of only three sites on the east coat of Scotland which represent the northern part of the UK range of embryonic shifting dunes. Sands of Forvie is one of the most geomorphically active dune systems in the UK and as a result the site contains significant representation of dune types associated with shifting sands. Present throughout the site are identifiable zones of lyme-grass (*Leymus arenarius*) and sand couch (*Elytrigia juncea*).

465 In recent years, Terns have bred in much lower numbers owing to predation and the periodic overtopping of the favoured shingle beds by sand. There is growing concern about the effects of eutrophication on the estuary and its flora and fauna. The continuing build up of algal mats has apparently led to a reduction in the populations of invertebrates which are the prey of waterfowl such as redshank and shelduck.

466 The site forms the Forvie National Nature Reserve which is managed for its nature conservation interest under an agreed management plan. The site is also 100 % covered by SSSI designation.

Moray Firth Marine SAC

467 The Moray Firth was designated by Scottish Ministers as a Special Area of Conservation (SAC) on 17 March 2005. The Moray Firth marine SAC has been designated for the species bottlenose dolphin (*Tursiops truncatu*) which is listed on Annex II of the Habitats Directive, as well as for the Annex I habitat 'Sandbanks which are slightly covered by sea water all the time'.

468 The conservation objectives for the Moray Firth marine SAC with regards to bottlenose dolphins are:

- to avoid deterioration of the habitats of the qualifying species (bottlenose dolphin *Tursiops truncatus*) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest
- to ensure for the qualifying species that the following are established then maintained in the long-term:
    - population of the species as a viable component of the site
    - distribution of the species within the site
    - distribution and extent of habitats supporting the species
    - structure, function and supporting processes of habitats supporting the species
- no significant disturbance of the species.

469 The conservation objectives ensure that the obligations of the Habitats Directive are met; that is, there should not be deterioration or significant disturbance of the qualifying interest. This will also ensure that the integrity of the site is maintained and that it makes a full contribution to achieving favourable conservation status for its qualifying interests (SNH, 2006).

River Dee SAC

470 The River Dee SAC lies inland from the proposed project and enters the sea at Aberdeen. The river contains three qualifying species otter (*Lutra lutra*), freshwater pearl mussel (*Margaritifera margaritifera*) and Atlantic salmon (*Salmo salar*). The salmon enter the river throughout the year and the freshwater pearly mussel relies upon the salmon for part of its life cycle when it uses the salmon as a host species. Otters are infrequent on the coast and the majority of the otter population found along the Dee is upstream from the river mouth.

5.9.2.2 <u>*National Sites*</u>

Sites of Special Scientific Interest (SSSI)

Corby, Lilly and Bishops Lochs SSSI

471 Corby, Lilly and Bishops Lochs are designated as Sights of Special Scientific Interest under the Wildlife & Countryside Act (1981). The Lochs lie approximately 6.7 km inland from the proposed wind farm location. The lochs contain locally important vegetation and invertebrate populations. The Lochs also use to hold roosting greylag geese but the numbers roosting on the Lochs has reduced in recent years.

Foveran Links SSSI

472 Extensive sand dune systems lie to the north of the proposed development. Up to the Ythan Estuary. The 205 ha Foveran Links SSSI contains plant communities not found elsewhere along the coast and a variety of habitats including, fixed dunes, dune pastures, marshes and heaths.

Sands of Forvie and Ythan Estuary SSSI

473 The Sands of Forvie lie approximately 7.2 km to the north of the proposed wind farm location. The site is also covered by the SAC.

474 It is an extensive area of sand dunes containing a wide range of typical dune habitats and very diverse range of flora. The site holds the UKs largest breeding colony of eider ducks and nationally and internationally important populations of pink-footed geese and other wildfowl and waders.

5.9.2.3 *Local Sites*

Biodiversity

475 Following the 1992 Rio Earth Summit, the UK Biodiversity Action Plan was published in 1994. At the local level, this is implemented through the North East Scotland Local Biodiversity Action Plan (LBAP). LBAP is a partnership of local authorities, environmental, forestry, farming, land and education agencies, businesses and many individuals involved in biodiversity across North East Scotland (Aberdeen, Aberdeenshire and Moray)

476 Most of the North East action for biodiversity is addressed through Habitat Action Plans (HAPs) which incorporate action for associated priority species. These HAPs are grouped under the broader habitat headings of Coastal & Marine; Farmland & Grassland; Woodland; Montane, Heath & Bog; Wetland & Freshwater; and Urban (NESBiodiversity, 2007).

477 The Coastal and Marine Habitat Action Plans (HAPs) are the most relevant for the proposed development. The protection of these coastal and marine habitats is a top priority for North East LBAP and several specific action plans have been developed, including:

- Coastal Sand Dunes and Shingle
- Coastal Cliffs and Heaths [action plan development in progress]
- Marine Habitats [action plan development in progress]
- Estuarine and Intertidal Habitats

478 A number of species has been identified with dedicated North East Action Plans (NESBiodiversity, 2007).

5.9.3 Marine (Scotland) Act 2010

479 The Marine (Scotland) Act (which applies to Scottish territorial waters) introduces new powers relating to functions and activities in the Scottish marine area, including provisions concerning marine plans, licensing of marine activities, the protection of the area and its wildlife including seals, and regulation of sea fisheries. The Act comprises six key elements: the formation of Marine Scotland, a strategic marine planning system, a

streamlined marine licensing system, improved marine nature conservation measures, improved measures for the protection of seals and improved enforcement measures (JNCC, 2010).

480 Marine Scotland will deliver integrated marine management functions relating to marine science and data, planning, policy development and delivery, compliance, monitoring and enforcement, whether fully or executively devolved to Scottish Ministers out to 200 nautical miles; and will work closely with the UK Marine Management Organisation (MMO) established under the UK Marine and Coastal Access Act 2009 (JNCC, 2010).

481 Scottish Marine Protection Areas (MPAs) are a new national designation under the **Marine (Scotland) Act** for inshore waters and the **Marine and Coastal Access Act 2009** for offshore waters. Scottish Ministers have executive devolution of authority for the designation of MPAs for the conservation of important marine biodiversity and geodiversity out to 200 nm.

482 Within the Marine Nature Conservation element, powers in the **Marine (Scotland) Act** enable Scottish Ministers to designate three types of Marine Protected Area (MPA) across Scottish territorial waters: Nature Conservation MPAs; Historic MPAs; and Research/Demonstration MPAs (JNCC, 2010).

483 The Scottish MPA project has been established by Marine Scotland (Scottish Government), Scottish Natural Heritage and the Joint Nature Conservation Committee (JNCC) to identify and recommend MPAs for the conservation of nationally important features of marine biodiversity and geodiversity to Government. Scottish MPAs will be identified using science-based selection criteria, but socio-economic information may be taken into account when selecting between sites of equal scientific merit and to identify likely management issues (Natural England, 2010).

484 The new MPA powers allow Scotland to contribute to the UK's European and International marine conservation commitments, such as those laid out under the Marine Strategy Framework Directive, the OSPAR Convention and the Convention on Biological Diversity (JNCC, 2010) and the government is required by European law to introduce a network of MPAs by the end of 2012 (Natural England, 2010).

6 HUMAN ENVIRONMENT

6.1 Shipping and Navigation

6.1.1 Introduction

485 Aberdeen Harbour is important to the people and the local economy of Aberdeenshire and is one of the main commercial ports in the North of Scotland. Coastal traffic also exists along the Aberdeenshire and East of Scotland coastline. Any wind farm development has the potential to impact navigational practices and as a result careful consideration of the site and wind turbine layout is required to ensure the safety of the marine stakeholders in preserved.

6.1.2 Baseline Information

486 The proposed wind farm is 4 nm to the north of the entrance to Aberdeen Harbour in Aberdeen Bay Area to the north of a newly designated anchorage. Detailed information on annual shipping has been based on the Annual Review for Aberdeen Harbour (2009). Key points are as follows:

- import and exports: 4.54 million tonnes
- vessel arrivals: 7,933
- tonnage of shipping: 24.01 million gross tonnes
- number of passengers: 142,468

487 Three, two-week AIS and radar surveys were carried out to develop an understanding of shipping and navigational practices in proximity to the proposed development site.

488 The surveys were carried out from a site adjacent to Girdle Ness Lighthouse, south of Aberdeen harbour, at co-ordinates 57° 08'.364 North, 002° 02'.916 West, providing good coverage to the North, including Aberdeen Bay and the harbour entrance.

489 4The results from the study indicate that the majority of the shipping passing in closest proximity to the site is destined for Aberdeen Harbour. The majority of vessels are associated with offshore oil and gas industry and the Northlink passenger ferries: Hrossey, Hamnavoe and Hjaltland. Some cargo vessels were also identified using this route. The results from the study also indicated limited fishing and recreational shipping in and around the proposed wind farm site.

490 Figure 13 provides an overview of the proposed wind turbine layout relative to shipping.

6.1.3 Proposed Scope of Assessment

491 The scope of assessment has been based on the following:

- Department for Energy and Climate Change (DECC) Methodology for Assessing the Marine Navigational Safety Risks of Offshore Windfarms (2005)
- Maritime and Coastguard Agency (MCA) Marine Guidance Notice 371 (MGN 371) Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response Issues

492 Other key guidance and reference materials that will be used in the assessment are listed below:

- Trinity House Lighthouse Service (2008). Guidance based on IALA Recommendation O-139 On The Marking of Man-Made Offshore Structures, 1st Edition
- DECC Guidance Notes on Applying for Safety Zones around Offshore Renewable Energy Installations
- IMO Guidelines for Formal Safety Assessment (FSA)
- Results of the EM Investigations and assessments of marine radar, communications and positioning systems undertaken at the North Hoyle Wind farm by QinetiQ and the MCA
- BWEA, DTI, MCA & PLA (2007). Investigation of Technical and Operational Effects on Marine Radar Close to Kentish Flats Offshore Wind farm
- MCA Marine Guidance Notice 372 (2008). Guidance to Mariners Operating in the Vicinity of UK OREIs

493 The DECC methodology provides a template for preparing a navigation risk assessment. The methodology is centred on risk controls and the feedback from risk controls into risk assessment. It requires a submission that shows that sufficient risk controls are, or will be, in place for the assessed risk to be judged as broadly acceptable or tolerable with further controls or actions. The DECC assessment methodology includes:

- defining a scope and depth of the submission proportionate to the scale of the development and the magnitude of the risk
- estimating the 'base case' level of risk
- estimating the 'future case' level of risk
- creating a hazard log
- defining risk control and creating a risk control log
- predicting 'base case with wind farm' level of risk
- predicting 'future case with wind farm' level of risk

494 The key features of the Marine Safety Navigational Risk Assessment Methodology are risk assessment (supported by appropriate techniques and tools), creating a hazard log, defining the risk controls (in a Risk Control Log) required to achieve a level of risk that is broadly acceptable (or tolerable with controls or actions), and preparing a submission that includes a Claim, based on a reasoned argument, for a positive consent decision.

495 One of the primary tasks of the scope of assessment was key stakeholder consultation. This has been carried out throughout the entire project and is integral to the navigational review. The following organisations have been involved in this process:

- Aberdeen Harbour Board
- Marine Safety Forum
- Aberdeen users
- Northern Lighthouse Board
- Chamber of Shipping
- Fisheries Associations
- RYA and Cruising Association

496 In addition to the three, two week radar surveys which have been carried out, Anatec has access to a year of current AIS survey data for the area which will be used in the assessment.

6.1.4 Potential Impacts

6.1.4.1 *Merchant Shipping*

497 The proposed 11 wind turbine wind farm layout has been determined through ongoing consultation with the Aberdeen Harbour Board and other marine stakeholders associated with this area. It has been designed to minimise the impacts on shipping and to ensure safe vessel operations.

498 The layout is positioned over 4 nm to the north of the north breakwater and inshore of the main route taken by vessels heading between the port and the north, and is well clear from other routes taken by vessels to and from Aberdeen Harbour.

499 Consultation with the Harbour Board, Marine Safety Forum and Ferry Operator has indicated that wind turbines located at the proposed site will not impact their operations significantly. As a result the proposed development is unlikely to have significant navigational impacts providing reasonable mitigation measures are put in place. A hazard workshop is to be carried out with the stakeholders to ensure their views are considered and the mitigations put in place are adequate.

6.1.4.2 *Fishing Vessels*

500 Fishing vessels are also exposed to collision risks (and radar interference) in the same way as merchant ships. In addition, if fishing within the site, there would be a risk of collision and subsea cable interaction. Also if fishing activity is displaced to outside the site during construction and/or operation, this could influence the rate of vessel-to-vessel encounters and hence the collision risk.

501 A review of the survey data and information gathered over the course of this project indicated that fishing vessel activities in this area is very limited and therefore the potential impacts are considered to be very low. Further discussions will be held with the fishing stakeholders to ensure their views are considered and that the mitigation measures put in place are adequate. Figure 14 provides an overview of the proposed wind turbine layout relative to fishing vessels.

6.1.4.3 Recreational Vessels

502 Recreational vessels can pass close to and in some cases between wind turbines, which exposes them to potentially increased collision risk as well as changes in traffic movements in the vicinity. There is also a risk of blade/mast interaction which depends upon the clearance of the rotor blades in different tidal and sea conditions, and the air draught of yachts using the area. The risk can be minimised through adequate clearance height and implementation of an emergency shutdown system of the rotor blades.

503 A review of the survey data and information gathered over the course of this project has shown that recreational vessel activities in this area are very limited and therefore the potential impacts are considered to be negligible. Further discussions will be held with the recreational stakeholders to ensure their views are considered and the mitigation measures put in place are adequate.

6.1.5 Cumulative Assessment

504 The potential impact of the wind farm on vessels associated with all stakeholders eg the oil and gas industry and those associated with dredging activities will be assessed as part of the Navigational Risk Assessment.

505 No other wind farms are proposed for this area so there are no cumulative impacts to be assessed.

6.1.6 Mitigation

506 There are a range of measures that can be applied to mitigate the impacts of a wind farm development (including through site design). MGN 371 lists the following measures to be applied to a particular development as appropriate to the level and type of risk determined during the EIA:

- promulgation of information and warnings through notices to mariners and other appropriate media
- continuous watch by multi-channel VHF, including Digital Selective Calling (DSC)
- safety zones of appropriate configuration, extent and application to specified vessels
- designation of the site as an area to be avoided (ATBA)
- implementation of routeing measures within or near to the development
- monitoring by radar, AIS and / closed circuit television (CCTV) or other agreed means
- appropriate means to notify and provide evidence of the infringement of safety zones or ATBAs
- any other measures and procedures considered appropriate in consultation with stakeholders (including the MCA)
- creation of an Emergency Response Co-operation plan with the relevant Maritime Rescue Co-ordination Centre from construction phase onwards

507 Other mandatory control measures and/or standard industry practice include:

- marking and lighting the site in accordance with General Lighthouse Authority requirements (which will include a system of routine inspection and maintenance of lights and marks)
- MCA standards and procedures for wind turbine generator shut-down in the event of a search and rescue, counter pollution or salvage incident in or around a wind farm
- wind turbine rotor blade tip clearance at a minimum 22 m above Mean High Water Springs
- vessel nominated as guard vessel during construction /decommissioning activities

6.1.7 EOWDC Future Research and Monitoring

508 Navigational Risk Assessment work and projections are based on a sound understanding of shipping patterns and experience of the likely changes to shipping, ie they represent the best estimate. During construction, operation there is excellent opportunity to assess the impacts of the development in more detail and to review the mitigation measures to ensure they are appropriate and adequate. There is a requirement for this review work to be carried out over the lifetime of the development. This will be carried out by the project and is likely to rely on continued AIS monitoring of the development and continued liaison with the port and other marine stakeholders.

6.2 Aviation

6.2.1 Introduction

509 The handling of aviation issues raised by this project has been an area of high priority for the project team. Aberdeen airport serves more than 3 million travellers a year and is the world's busiest commercial heliport, transporting more than 500,000 passengers in support of the North Sea oil and gas industry.

510 An Aviation Working Group was established as early as 2005, and has met since that time (although there have been periods of lesser activity). The group has met four times in 2010 already.

511 The Civil Aviation Authority (CAA) was an early attendee at these meetings, but in recent years they have been content to allow aviation issues – largely operational in nature – to be discussed by National Air Traffic Services (NATS) (Aberdeen) and BAA (Aberdeen).

512 These meetings have also been attended by the three helicopter companies operating out of Aberdeen airport – Bond, Bristows and CHC Scotia. Also in attendance has been Oil and Gas UK, the main client for their helicopter operations.

6.2.2 Baseline Information

513 No new data has been required in relation to flight movements. Existing data are available to assess the impacts of the wind farm on aviation activities.

514 The presence of helicopter traffic is the most significant aviation issue, the previously proposed wind farm location site assumed that helicopters could fly over the wind turbines. However, following early consultation with the relevant authorities it was identified that in certain weather conditions the helicopters may descend to 1000 feet (or lower), while the tip height of the wind turbines could be in the region of 520 feet. This would breach the minimum clearance limit required for helicopter safety and consequently the wind farm layout has been amended to account for the helicopter corridors. This was a major revision to the wind farm layout, and has dominated all subsequent layout considerations.

6.2.3 Proposed Scope of Assessment

515 The assessment will address all aspects of the potential impact of the wind farm on aviation activities at Aberdeen airport. This may include the following issues:

- as part of the agreement on the final layout of the wind farm, it has been agreed that the northern helicopter route into Aberdeen could be moved to the north, thereby allowing greater clearance between the wind farm and Aberdeen Harbour entrance. The route change is shown in Figure 15. The change will be brought about by applying for an Air Space Change
- the proposed layout is within 10 km of the secondary radar facility at Aberdeen airport and as such it has been necessary to assess the potential impacts of the wind farm on this function. AOWFL has commissioned a study from QinetiQ and the report has been passed to NATS. The report shows that although there may be potentially significant effects there are a number of technical solutions available to solve them. Ongoing consultation with NATS will determine the most efficient and effective technical solution to this issue
- the presence of the wind farm will require some minor changes to helicopter procedures in the event of encountering problems during take-off and landing phases at Aberdeen which may be exacerbated in icy conditions.
- in favourable weather, Aberdeen airport enjoys a relaxation on the carrying of alternate aerodrome helicopter fuel as a result of this “coastal status”. It will be necessary for the project to confirm with the CAA that the wind farm would not prejudice such status. Informal indications are that based on the revised plans the coastal status should be maintained

6.2.4 Potential Impacts

516 The potential impacts of the project on the aviation sector around Aberdeen should be minimal. The effects of the issues listed above are expected to be:

- one minor change to air route maps (and related documents), with associated amendments to procedures, and training requirements
- the construction of a technical solution to the secondary radar issue – possibly a supplementary secondary radar, although a multilateration system using an array of approximately 4 static antenna may prove as effective and less expensive. This system would also need to be “patched in” to the new Perwinnes radar equipment serving Aberdeen airport

- some amendments to the emergency procedures of helicopter companies
- it is likely there will be no change to Aberdeen's "coastal status"

6.2.5 Cumulative Impact

517 Discussions are ongoing with NATS as to whether any of the above issues have any relevance to other wind farms under development in the Aberdeenshire area.

6.2.6 Mitigation

518 In view of the small nature of these impacts, it is believed that the measures described above will be sufficient to mitigate their effects on aviation safety and security.

519 The implementation of these measures will be the subject of ongoing monitoring by the Aviation Working Group, thereby ensuring that the objectives of minimal impact are sustained.

6.2.7 EOWDC Future Research and Monitoring

520 Consultation with CAA, NATS, BAA and the helicopter operators will be ongoing on the research issues that could be addressed by the deployment centre.

6.3 Ministry of Defence

6.3.1 Introduction

521 Consultation with the MoD has been ongoing since 2005. Two principal issues have been dealt with:

- any effect of the wind farm on the operability of the defence radar installation at Peterhead
- any effect of the wind farm on the Black Dog firing range – a small-arms firing range on the coast nearby, but with an associated exclusion zone at sea during firing

522 Liaison with MoD has been constructive, with several meetings being held at Defence Estates, and one at an RAF base in the north of England to discuss the radar interference issue.

6.3.2 Baseline Information

523 In matters of national security, the MoD is the sole holder of the relevant detail to make the assessment of the acceptability of our project on their activities.

6.3.3 Proposed Scope of Assessment

524 An assessment on the potential for interference to radar has been undertaken by the MoD including a number of radar interference trials. During consultation with the MoD, initial objections on the grounds of radar interference have subsequently changed.

525 On the Black Dog Firing range, the MoD has consistently stated that no wind turbines should be placed within the safety exclusion zone at sea.

6.3.4 Potential Impacts

526 The potential impacts of the project on MoD interests should therefore be minimal. The effects of the issues listed above are expected to be:

- confirmation from MoD that a layout of 10 wind turbines close to the current layout is acceptable in terms of radar interference has been received. AOWFL has applied to MoD for confirmation that the current layout of 11 wind turbines is acceptable
- while there will be no wind turbines within the firing range exclusion zone, there will be a need for project vessels to enter the area for the purposes of surveying, construction, operations and maintenance. It will therefore be necessary to agree access provisions with the MoD

6.3.5 Cumulative Impact

527 Cumulative impact between our project and other projects in respects of MoD issues are not anticipated.

6.3.6 Mitigation

528 It is expected that the effect of the project on the military activities described above will be minimal.

529 Operational procedures will be agreed with MoD to allow vessel access to the firing range exclusion zone for project activities during the lifetime of the project.

530 The implementation of these measures will be the subject of ongoing monitoring and communication with MoD Defence Estates in Birmingham, thereby ensuring that the objectives of minimal impact are sustained.

6.3.7 EOWDC Future Research and Monitoring

531 Consultation with the MoD on the research issues that could be addressed by deployment centre will be ongoing.

6.4 Archaeology

6.4.1 Introduction

532 An archaeological desk-based assessment of the proposed EOWDC has been carried out.

533 The aim of the archaeological assessment was to inform the overall environmental assessment of the impacts of the scheme and its associated onshore and offshore infrastructure on the historic environment and archaeology of the area.

6.4.2 Baseline Information

534 The desk-based assessment has focused upon two areas of potential archaeological interest. Firstly, the potential for the survival of submerged prehistoric archaeology, which could manifest itself in the form of either sites or landscapes dating from the Palaeolithic to the Mesolithic periods and is closely related to sea level changes. Secondly, the assessment has focussed on the potential for the presence of maritime archaeology, ie the potential for the presence of ship and boat remains and debris linked to human use of the sea from the Mesolithic to the 20th century.

535 The report concluded that potential for the presence of formerly terrestrial prehistoric archaeology exists within the survey area, but that there is currently insufficient detailed information available concerning the shallow geology and sediments to enable the presence of such archaeology to be proved. Therefore, it is currently not possible to determine potentially significant impacts nor identify suitable mitigation. The report therefore recommends that there should be an archaeological assessment of seismic and geotechnical data produced for the scheme and that there should be archaeological input in geophysical and geotechnical survey planning.

536 The report identified a total of 16 United Kingdom Hydrographic Office (UKHO) charted wreck or obstruction records in the survey area. Known wrecks are predominantly 20th century losses and include a number of steam trawlers and locally built vessels. In addition, coarse analysis of maritime records for the Aberdeen area contained within the National Monuments Record of Scotland (NMRS) database indicates that there are over 200 known vessel losses that could have occurred within the study area or in its vicinity. These known losses date from the medieval period to the 20th century but are predominantly of the Industrial period (AD 1700-1900). This loss record is likely to be unrepresentative of losses from earlier periods due to a lack of wreck reporting prior to the mid-18th century. Several of these known losses appear to be located within the study area, although their precise position is unknown.

537 The relatively dense concentration of loss records in or in the vicinity of the survey area reflects the importance of the port of Aberdeen since at least the medieval period. Loss descriptions contained in the NMRS database and other secondary sources, together with reports submitted to UKHO suggest that losses occurring within the survey area are either clustered around Aberdeen Harbour entrance or along and very close to the shore to the north.

Available wreck descriptions suggest that those charted wrecks located along the shore to the north are largely broken up.

6.4.3 Proposed Scope of Assessment

538 The desk-based assessment of the proposed project has demonstrated that the potential exists for the presence of submerged prehistoric archaeological deposits in the study area. However insufficient data are available about the shallow geology of the study area to determine the level of this potential and how extensive any archaeological deposits are likely to be.

539 The data derived from the geophysical survey will be subject to archaeological assessment and the potential for submerged prehistoric archaeology within the reassessed study area.

540 In addition, the archaeological assessment and analysis of any geotechnical data collected during the development of the wind farm also has the potential to provide information about the presence of submerged prehistoric archaeological deposits in the study area.

541 Analysis of both the charted wrecks and recorded losses for the vicinity of Aberdeen indicates that there is a high potential for the presence of maritime sites within the survey area. Several sites charted by the United Kingdom Hydrographic Office in the study area and buffer zone are of some archaeological importance, but not all are identified and their current extent and condition are unknown.

542 Analysis of available evidence about loss location and likely causal factors suggests that a significant proportion of the losses recorded may have occurred in the vicinity of the study area. Coupled with the relatively few charted wrecks, this suggests that there is high potential for known, but uncharted wrecks to be present in the wind farm development area.

543 Data obtained during the forthcoming geophysical survey for the scheme will be subject to archaeological assessment to determine the condition, character and extent of known sites within the study area and whether there is any evidence for the presence of other, currently uncharted wrecks in the area.

544 Geophysical data will be assessed for features and deposits of archaeological significance. Side scan sonar data will be reviewed to confirm the location and character of known wrecks and to identify previously unrecorded features of anthropogenic origin on the seabed. A review of the magnetometer data will identify further anomalies of anthropogenic origin and assist in confirming identification as anthropogenic of anomalies seen on the side scan sonar.

545 A proportion of the sub bottom profiler data will be reviewed to identify paleo-geographic features, for example paleo-channels and peat horizons and these will be traced through the data with a view to establishing the paleo-landscape during periods of possible hominid occupation.

546 The multi-beam/swathe bathymetry data review will provide vertical datum for the sub bottom interpretation, will aid in the identification of paleo-geographic features and help establish a baseline against which sea level change can be

assessed and will provide additional information on wreck sites identified from the side scan sonar and desk based assessment.

547 The geophysical data will be reviewed and interpreted in order to characterise key units, features and sites, to create an integrated gazetteer.

548 The EIA will include an impact assessment that, if appropriate identifies potential exclusion zones, highlight awareness of risk factors to facilitate project planning, and identify areas, which may require avoidance or mitigation.

6.4.4 Potential Impacts

549 There is potential for damage to occur during pre-construction seabed preparation, wind farm construction, cable laying and intrusive geotechnical survey to:

- submerged prehistoric archaeological sites and finds on the seabed
- wrecks that could potentially date from the later Mesolithic through to the present day
- submerged prehistoric sites and finds and submerged topographic features and deposits that contain palaeo-environmental evidence

550 Potential damage may also occur where local changes in sediment movement caused by the new structures results in scour which may result in heritage assets (wrecks, submerged prehistoric archaeological sites, and archaeological finds) being exposed or undermined. As heritage assets underwater have usually survived as a result of achieving a broadly stable equilibrium with their immediate environment, changes in this environment may trigger renewed degradation as a result of alterations in the physical, chemical and biological processes that the asset is subject to.

551 Archaeological sites identified may require protection from:

- cable burial
- foundation installation
- scour protection
- anchoring
- construction vessel movement
- decommissioning activities

6.4.5 Cumulative Assessment

552 Activities that will potentially have to be considered in relation to cumulative and in-combination impact assessment are:

- aggregate extraction and dredging
- subsea cables and pipelines
- oil and gas infrastructure and operations

553 The main impacts envisaged are movements of sediment and changes in sediment regime deriving from the construction of the wind farm or the construction or operation of the above activities in the proximity of the wind farm and potentially affecting the archaeological study area.

554 Wrecks are site specific so operations in other areas are not likely to affect wreck sites in the project area. If wreck sites are known they will be avoided so that no cumulative effects arise.

6.5 Seascape, Landscape and Visual Effects

6.5.1 Introduction

555 Consideration of landscape, seascape and visual impacts arising from the EOWDC will form an integral part of the EIA process. Initial consultation on the methodology for the Seascape, Landscape and Visual Impact Assessment (SLVIA) with Scottish Natural Heritage (SNH), Aberdeenshire Council (AC) and Aberdeen City Council (ACC) has already taken place and decisions agreed on the approach, which is discussed below.

6.5.2 Baseline Information

556 Defining the baseline character and visual amenity of the study area has been recently discussed with SNH, ACC & AC. The proposed wind farm deployment centre consists of 11 wind turbines anticipated to be of different types/heights, and lies approximately 2.2 km at its closest point from the coastline. Aberdeen City centre lies approximately 8 km south-west of the wind turbines, with its northern suburbs approximately 4.5 km from the nearest wind turbine. Balmedie is the closest settlement to the wind farm, at approximately 3 km from the nearest wind turbine, although there are individual properties which lie closer. A 35 km radius study area and a 50 km cumulative study area were requested by SNH, ACC & AC with the intention that they can be refined down depending on distance/specific areas and the likelihood of significant effects. Due to the close proximity of the offshore wind turbines to the coast the study area will include Aberdeen City, most of Aberdeenshire and limited areas within Moray.

6.5.2.1 <u>Landscape and Seascape Character</u>

557 The landscape character of Aberdeen and Aberdeenshire has been comprehensively documented in the SNH landscape character assessments which were completed in 1996 and 1998 respectively. Given the time elapsed since these were published there will have been changes in the landscape and therefore desk and field work for the SLVIA will take this into consideration when assessing the baseline character of the study area. One of the main changes to the landscape over the last 15 years has been the introduction of wind turbines which are now part of the landscape character of a number of areas in Aberdeenshire.

558 The coastline and sea within the study area has been defined as one national seascape unit (Area 4 – North East Coast) by the SNH commissioned report ‘An assessment of the sensitivity and capacity of the Scottish Seascape in relation to wind farms’ (Scott *et al.*, 2005). Regional seascape units will be established during the assessment through desk and field work. Documents such as SNH’s ‘Beaches of Scotland’ report series will also provide additional baseline information.

559 National landscape designations within 15 km of the site include two Historic Gardens and Designed Landscapes; Duthie Park and Pitmedden Gardens. Local landscape designations include the coastal 'Areas of Landscape Significance' which extend from Balmedie to Peterhead, and beyond, along the north coast of Aberdeenshire.

6.5.2.2 *Visual Amenity*

560 There are a variety of visual receptors within the study area but the key receptors are:

- residents of Balmedie, Aberdeen and its suburbs, and residents of smaller villages and isolated dwellings along the coast and inland (within approximately 5 km of the site)
- recreational users of the foreshore and in particular Balmedie Country Park, Forvie NNR, Foveran Links SSSI and Aberdeen Beach
- the development is also likely to be visible from a number of key transport routes including, ferries to and from Aberdeen, certain air-routes into Aberdeen Airport, and roads such as the A90

561 The representative viewpoints to be used to establish the effects on key visual receptors were discussed and agreed with the consultees. Although this was done on a previous layout and not the layout taken forward here in this Scoping Report it is thought that these viewpoints still represent good coverage of the site layout. Whilst the exact locations may yet be refined during the assessment, it was agreed that the viewpoints listed in Table 6.1 covered all the key receptors across the study area. The Aberdeen City viewpoints are to be confirmed following more detailed desk and field work.

TABLE 6.1
Representative Viewpoint Locations

	Location	**Grid Reference**
1	Public local road near Murcar Golf Course	NJ 956 123
2	Aberdeen Beach	NJ 954 069
3	Footdee	NJ 957 057
4	Torry Battery	NJ 966 056
5	Middleton Park	NJ 929 112
6	Anderson Drive, Kittybrewster Area,	NJ 913 077
7	Kincorth Hill	NJ 939 028
8	Balmedie Beach	NJ 977 178
9	Forvie Nature Reserve	NK 020 264
10	Brimmond Hill	NJ 856 091
11	Nr Newmachar – Formartine and Buchan Way	NJ 889 205
12	A96 Chapel of Stoneywood	NJ 866 113
13	A90 South of Tipperty	NJ 970 240
14	Near Upper Muirskie	NO 830 960
15	Bennachie, Mither Tap	NJ 682 224
16	Dunnottar Castle	NO 880, 840
17-20	Aberdeen city centre viewpoints - to be confirmed	

6.5.3 Proposed Scope of Assessment

562 A full Seascape and Landscape Visual Impact Assessment (SLVIA) will be undertaken for the Aberdeen Offshore Wind Deployment Centre in close

consultation with statutory stakeholders (eg SNH, AC & ACC). Consultation has already taken place which has confirmed study areas, methodology and initial viewpoints.

563 Relevant good practice guidance on landscape, seascape and cumulative assessment will be used. Examples of such guidance are provided below;

- Maritime Ireland/Wales Interreg 1994 – 1999 Guidance 'Guide to Best Practice in Seascape Assessment', (GSA), published in March 2001
- Guidelines for Landscape and Visual Impact Assessment, Institute of Environmental Management and Assessment (IEMA) and the Landscape Institute's (2nd edition 2002);
- Visual representation of Wind Farms Best Practice Guidance, Scottish Natural Heritage (2007);
- The Guidance on the Assessment of the Impact of Offshore Wind Farms – DTI (2005)
- Cumulative Effects of Wind Farms, SNH (2005)

564 The SLVIA process will be undertaken as follows:

565 The baseline study establishes the relevant landscape planning policy context, the scope of the assessment and the key landscape receptors. It includes the following key activities, some of which have already been undertaken with the statutory consultees:

- a desk study of relevant current national, regional and local planning policy for the study area
- agreement of the main study area radius with the local planning authority and SNH
- a desk study of nationally and locally designated landscapes for the study area
- a desk study of existing landscape character assessments for the study area, at national, regional and local level
- draft Zone of Theoretical Visibility (ZTV) studies to assist in identifying potential viewpoints and indicate the potential visibility of the proposed wind farm, and therefore scope of receptors likely to be affected (An example ZTV can be found as Figure 16, this is based on a maximum tip height of 195 m (above LAT) for all 11 wind turbines)
- the identification of and agreement upon, through consultation, the number and location of representative viewpoints within the study area.
- identification of the range of other visual receptors (public rights of way, settlements and residential properties) within the study area.
- site visits to become familiar with the study area and to identify viewpoints and receptors

566 During this stage, the scheme design may not yet have been finalised and there will be a degree of iteration between this stage (particularly in respect of preparing ZTV studies and consequent changes to likely effects on receptors) whilst the design is finalised.

567 The assessment of effects includes further desk and site based work, covering the following key activities:

- the preparation of ZTVs based on the identified and agreed worst case wind turbine layout for the offshore development

- the preparation of computer generated wireframes showing the proposed development from the agreed representative viewpoints
- an assessment of the magnitude and significance of effects upon the seascape character, landscape designations and the existing visual environment within the study area arising from the proposed development during construction, operational and decommissioning stages
- the production of photomontages from a selection of the agreed viewpoints showing the anticipated view following construction of the proposed wind deployment centre

568 A cumulative assessment of the EOWDC in relation to onshore wind farms, as well as any other relevant developments within the study area will be part of the assessment.

6.5.4 Potential Impacts

6.5.4.1 During Construction

569 Potential landscape and visual effects during construction may include the following:

- the visual impact of active, brightly coloured marine construction plant equipment such as the cranes that will be used to construct and erect the wind turbines, and already constructed wind turbines on site over the construction programme
- the visual effects associated with increased vessel movements in the area as plant, materials and personnel are moved to and from site
- the visual effects of lighting during the construction period. Lighting will be required at sea (wind turbine construction and cable installation) if there is a 24 hour construction programme. The extent of the impact will depend upon elements of the weather and types of lighting used

6.5.4.2 During Operation

570 The potential operational impacts of the extension of the EOWDC may include the following;

- the seascape, landscape and visual effects of the operating wind farm upon sensitive receptors
- the visual effects of increased vessel movements as a result of operation and maintenance activities.
- a change in the landscape or seascape character as a result of the wind turbine structures

571 Due to the proximity of the proposed wind deployment centre to the coast and a large city, the assessment of potential effects on the landscape, seascape and visual amenity of the area is an integral part of the EIA.

572 Particular consideration will need to be given to any character and visual amenity effects that might arise as a result of the anticipated different wind turbine types/heights (Example wireframes can be found as Figures 17 and 18 and these show two different viewpoints with layouts comprising two

different wind turbine heights. Wind turbines 1 to 6 with a tip height of 160 m (above LAT) and wind turbines 7 to 11 with a tip height of 195 m (above LAT).

6.5.4.3 <u>During Decommissioning</u>

573 Impacts arising during the decommissioning are expected to be similar to those experienced during the construction phase. There would be a temporary impact from the activities on site to remove structures, but this would be of relatively short duration.

6.5.5 Cumulative Assessment

574 Consideration will be given to cumulative character and visual effects with other wind farm developments or other relevant structures within 50 km of this proposal that are either operational, consented or formally lodged in the planning/consent process. At the time of writing there are no other offshore wind farms in the area but over 15 operational/consented onshore wind farms within the wider study area and at least a further 10 wind farms in the planning process. Further consultation with SNH will take place to agree an approach to assessing the cumulative effects of the offshore wind farm with the large number of onshore wind farms. This is also anticipated to include a review of which other wind farm developments should be included within the assessment, the scope of the cumulative assessment and the final extent of the study area.

575 Potential cumulative effects may include the following:

- cumulative effects upon seascape/landscape character arising from combined, successive or sequential views from sensitive receptors. This could result where a receptor may experience the presence of other existing and planned wind farm developments in conjunction with the Aberdeen Offshore Wind Deployment Centre
- cumulative effects upon seascape/landscape character arising from the Aberdeen Offshore Wind Deployment Centre when viewed in combination with other structures on land and in the North Sea.

6.5.6 Mitigation

576 Embedded mitigation measures will include the distance that the wind deployment centre is located from sensitive receptors. Also, the choice of colour for the wind turbines will mitigate any landscape and visual impacts.

577 The wind turbines will be temporary in nature (due to maximum lease duration of 22 years) with no anticipated lasting visual effects following completion of decommissioning.

6.5.7 Cultural Heritage Assessment

578 A cultural heritage assessment will be carried out in consultation with Historic Scotland and Scottish Natural Heritage to assess the potential impact on the setting of sites of national or greater significance (eg Scheduled Monuments, Listed Buildings). The locations of Scheduled Monuments and Listed Buildings in the area can be seen on Figure 12.

579 Where significant impacts are predicted, wireframes and photomontages would be produced and assessed.

580 A report on the results of the desk-based survey will be incorporated into the Environmental Statement.

6.6 Commercial Fisheries

6.6.1 Introduction

581 Until the mid 1950s, Aberdeen was Scotland's main fishing port, however, due to the rapid expansion of oil interests in the North Sea, which allowed fishermen to diversify into oil-based work, and the general downturn in the fishing industry, there is now only one fish quay. Although the market now handles significantly reduced quantities of fish, some vessels registered to other ports still land into Aberdeen. A number of fish processing plants remain in Aberdeen with fish brought by road from other ports.

6.6.2 Baseline Information

582 Aberdeen offshore wind farm is located across the boundaries of 2 ICES rectangles, 43E7 and 43E8.

583 ICES rectangle 43E7 has significantly lower landings values than other ICES rectangles in the region, although this is largely due to its small sea area. Within this rectangle, demersal trawling for *Nephrops* and whitefish is the principal method undertaken, followed by scallop dredging by mechanical dredge. Creel fishing is also deployed in inshore areas.

584 Within ICES Rectangle 43E8, there is demersal trawling and mechanical dredging, the majority of which is by the over 10 m fleet. Vessels employing these methods will target whitefish and *Nephrops*, and scallops respectively. There are low levels of pelagic activity by foreign vessels in this rectangle. Creel fishing also takes place, undertaken almost exclusively by the under 10 m fleet.

6.6.2.1 Whitefish

585 The offshore area around Aberdeen supports a range of commercially important fish species. Offshore fish communities are dominated by haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*) and cod (*Gadus morhua*), with saithe (*Pollachius virens*) and Norway pout (*Trisopterus* sp.) being associated with deeper waters. Migratory species such as herring (*Clupea harengus*) and mackerel (*Scomber scombrus*) are found throughout the area, although their distribution is seasonal.

6.6.2.2 Shellfish

586 Shellfish species that are commercially important within the Aberdeen fishing areas include the following:

- European lobster, *Homarus gammarus*

- Edible crab, *Cancer pagurus*
- Velvet swimming crab, *Necora puber*
- Shore crab, *Carcinus maenus*
- Giant scallop, *Pecten maximus*
- Cockle, *Cerastoderma edule*
- Mussel, *Mytilus edulus*
- Whelk, *Buccinum undatum*
- Periwinkle, *Littorina littorea*

587 The Norway lobster (*Nephrops* sp.) is by far the most important shellfish species exploited in Scottish waters. Norway lobsters are located in areas of soft mud or muddy sand in which they excavate and inhabit burrows; however known spawning grounds are to the north and south of Aberdeen Bay.

588 In coastal waters, a baited creel fishery exploits four species, the European lobster, edible crab, velvet swimming crab and to a lesser extent, the shore crab (Chapman, 2004). The edible crab is fished all round the coast of Scotland, mostly on inshore grounds over-lapping with the European lobster but occasionally in deeper water away from the coast. The main landing ports in the North Sea are Aberdeen, Fraserburgh, Wick and in the Orkney and Shetland Islands (Chapman, 2004).

589 Four species of bivalve mollusc are exploited in the SEA5 zone, of which the giant scallop is by far the most important. The main fisheries are located around Orkney and Shetland, in the Moray Firth and off the east coast of Scotland, with most of the landings taken within these zones.

590 Gastropod molluscs are represented by two species, the common whelk and the periwinkle. Some fishing for whelks takes place around the whole Scottish coast, though mostly in the North Sea and the Northern Isles. Winkles are inter-tidal in distribution and are harvested by hand at low tide.

6.6.2.3 *Cephalopods*

591 The commercial importance of cephalopods is of relatively recent, but growing, importance (Boyle and Pierce, 1994). Evidence exists that fishing pressure has changed ecological conditions and shifts in community structures have occurred with cephalopod stocks slowly replacing predatory fish stocks (Caddy and Rodhouse, 1998).

592 Several species of cephalopod have been recorded off north-east Scotland. The main commercial species in Scottish waters is the long-finned squid *Loligo forbesi* (Boyle and Pierce, 1994; Pierce *et al.*, 1994a,b, 1998; Stowasser *et al.*, 2004). Since 1995, annual UK landings of loliginid squid have ranged between 1600 and 3200 tonnes, making the UK the second most important fishery nation for loliginid squid within the ICES region after France.

593 Other cephalopod species of commercial interest, present in North Sea area, are the squid species (*Todarodes sagittatus*), (*Todaropsis eblanae*), (*Alloteuthis subulata*) and the octopus (*Eledone cirrhosa*) though in much smaller numbers (Stowasser *et al.*, 2004).

6.6.2.4 *Diadromous and Freshwater Species*

Salmonids

594 Salmon and sea trout are of particular importance in this area with the Rivers Dee and Don having salmon and trout fisheries. In Scotland, the management of the salmon fishery is entrusted to District Salmon Fishery Boards (DSFBs) whose responsibilities include the protection and improvement of the salmon fisheries within their districts. The two salmon Fishery Districts in the immediate vicinity of the proposed development are the Dee and Don Boards.

595 All Scottish salmon fisheries are closed for a minimum of 168 days a year for spawning. The actual dates may vary but are usually from late August to mid February. Salmon spawning periods vary between rivers and are thought to be influenced by water temperature and day length. Sea trout spawning generally occurs between mid October and January.

6.6.3 Proposed Scope of Assessment

596 The principal data sources to be used for the baseline assessment will be:

- Marine Scotland (an executive agency of the Scottish Government)
- The Scottish Executive Environment and Rural Affairs Department (SEERAD)
- International Council for the Exploration of the Sea (ICES)
- Fisheries Research Services (FRS)
- Scottish Fisheries Protection Agency (SFPA)
- The Scottish Fishermen's Federation (SFF)

597 Consultation with local fishermen began in 2007, and was principally undertaken by the Scottish Fishermen's Federation (SFF). The SFF represents approximately 90 % of Scottish fishermen. Those consulted include:

- Scottish Fishermen's Federation (SFF)
- Scottish Inshore Whitefish Producers

598 Consultation with commercial fishermen will continue throughout the development of the project. Liaison with fisheries organisations will primarily be via the contractor of the assessment.

599 A baseline report was completed for commercial fisheries in 2008. For the purposes of the EIA, this report will be reviewed and updated to include more recent information and to cover the revised site layout and cable corridor.

600 The information within the baseline assessment is expected to include:

- review of the types of commercial and traditional fisheries (including shell fisheries) in the area (eg methods/gear used, season, duration, etc.)
- review of the types of salmon and sea trout fishing in the area (eg methods/gear used, season, duration, etc.)
- review of the location of fishing grounds for commercial fisheries and salmon and sea trout (type and season)

- the location and season of spawning and nursery areas of commercial species
- update of fishing activity in and adjacent to the wind farm site (eg fishing effort, number of vessels)
- update of identification of local and foreign vessels using the area (eg size, type, operating ranges, port, nationality)
- update of fish catch and landings data for commercial fisheries and salmon and sea trout (value and amount)
- update on any known fish farms planned for the future in the area
- any hereditary rights to particular fishing grounds in the area and the legal implications of such rights
- review of fishing and angling in the surrounding rivers, the importance of these rivers, eg economic value and potential impacts associated with the wind farm development

601 Full use will be made of information from the Fisheries Statistics Unit including fisheries surveillance information, landings and fishing effort data and registered vessel lists. These data will be supplemented through discussions with local fishermen.

6.6.4 Potential Impacts

602 The following aspects are identified by CEFAS in the Defra (2004) guidelines as requiring addressing in the impact assessment.

- Presence of seabed obstacles
- Impacts on commercially exploited species
- Increased steaming times to fishing grounds
- Safety issues for fishing vessels
- Complete loss of, or restricted access to traditional fishing grounds
- Interference with fisheries activities
- Any other concerns raised by local fishermen and fishermen's organisations

603 Table 6.2 presents the impacts as identified within the impact assessment for the previous site layout. Impacts of the site now proposed are not expected to differ significantly. All aspects are assessed for construction/decommissioning and construction respectively.

TABLE 6.2 Impact Assessment for previous layout								
Environmental effect	**Description of feature(s)/people affected (receptors)**	**Spatial extent**	**Duration**	**Magnitude**	**Probability of effect occurring**	**Significance level**	**Mitigation measures and rationale**	**Significance level after mitigation**
Construction and Decommissioning								
Damage to fishing gears by presence of seabed debris	Potting vessels Demersal trawlers	Local	Temporary	Low to High	Uncertain	Negligible to Major if damage occurred	Contractors obligations and standard offshore practices would prevent, or in the case of accidental incidents, remove dropped objects	Negligible
Adverse Impacts on Commercially Exploited Species	Fish and shellfish	Local	Temporary	Low	Uncertain	Minor	Use of appropriate engineering techniques, eg soft start piling Low sensitivity of principal target species	Minor
Safety issues for fishing vessels (collision with construction vessels)	All vessels	Local	Temporary	High	Unlikely	Negligible to Major if collision occurred	Implementation and adherence to standard offshore safety procedures Involvement of the SFF for liaison and information distribution	Negligible

Increased steaming times to fishing grounds	All vessels	Local Local	Temporary Temporary	Low Low	Likely Unlikely	Minor Negligible	Transitory, short term exclusion areas around construction activities within the site Limited numbers of potentially impacted vessels Low probability of a significant number of steaming routes likely to be affected	Negligible, possibly minor for locally based potters
Complete loss or restricted access to traditional fishing grounds	All vessels	Site-specific	Temporary	Low	Certain	Minor Negligible	Transitory, short term exclusion areas around relatively small areas of sea Limited numbers of potentially impacted vessels Use of local vessels for wind farm related work	Negligible to minor
Interference to fishing activities (from construction vessels)	All vessels	Site-specific	Temporary	Low	Unlikely	Negligible	Construction vessels using existing shipping routes Fishermen’s representatives	Negligible
Restriction of access during laying of export cables	All vessels	Site-specific	Temporary	Low	Certain	Negligible, possible minor for some vessels	Short duration and small transitory area of exclusion Limited numbers of potentially affected vessels	Negligible, possibly minor for some vessels

Operational Phase								
Damage to fishing gear by presence of seabed debris	All vessels	Local	Temporary	Low to High	Uncertain	Minor to Major if damage occurred	Contractors obligations and standard offshore practices should have removed objects Any scour protection rock placement would be adjacent to wind turbine bases	Negligible
Adverse impacts on Commercially Exploited Species	All vessels	Local	Permanent	Low	Unlikely	Negligible	Scour protection will likely offer additional habitat for species by providing shelter and nursery grounds	Negligible to beneficial
Safety issues for fishing vessels (collision with wind turbines)	All vessels	Site-specific	Permanent	High	Unlikely	Minor to Major if collision occurred	Implementation and adherence to standard offshore safety procedures	Negligible
Increased steaming times to fishing grounds	All vessels	Local/ Regional	Permanent	Low	Unlikely	Negligible	Potential for fishing vessels to steam through the site in favourable conditions Limited numbers of potentially impacted vessels Low probability of a significant number of steaming routes likely to be affected	Negligible

Complete loss or restricted access to traditional fishing grounds	All vessels	Local	Permanent	Low	Unlikely	Negligible	Potential for potting gear to be deployed within the operational site Low numbers of other vessels likely to be potentially affected	Negligible to beneficial
Interference to fishing (avoidance of/collision with maintenance vessels)	All vessels	Local	Temporary	Low	Unlikely	Negligible	Maintenance vessels using existing shipping routes Fishermen's representatives	Negligible
Damage to fishing gear/vessels from exposed cables	All vessels	Local	Temporary	High	Unlikely	Minor to Major	Cable burial to a certain depth depth. Implementation and adherence to standard offshore safety procedures Cable route surveys Temporary exclusion zones until issues are rectified	Negligible to Minor

6.6.5 Cumulative Assessment

604 At present there are no offshore wind farms applying for consent off the coast of north-east Scotland. However, there are two proposed wind farms in the Moray Firth which could potentially have a cumulative impact on fisheries.

605 Other elements that could realistically contribute to cumulative impacts are:

- commercial shipping movements
- aggregate dredging
- offshore oil and gas installations
- introduction of protected marine areas

6.6.6 Mitigation

606 Mitigation measures are presented in Table 6.2 and will be further investigated.

6.7 Socioeconomics

6.7.1 Introduction

607 Offshore wind farms offer the potential for significant positive socioeconomic benefits, through job creation locally and nationally, during both the construction and operational phases of the project. In addition to job creation, the proposed development can have positive socioeconomic impacts on a national scale. The generation of renewable energy is essential in assisting the Scottish Government's goal of generating 50 % of Scotland's energy from renewable sources by 2020 (Scottish Government, 2010) and the UK Government's target of 15 % of energy from renewable sources by 2020 (DECC, 2010). Furthermore, wind farms can contribute to achieving long-term sustainable development of the Scottish Economy.

6.7.2 Baseline Information

608 Baseline information should identify key population, employment and economic data. Aberdeen has a total population of 210,400 as reported in 2009. It has an extensive existing offshore skills base generated by the oil and gas industry and between 2007 and 2008 the city had the highest GDP growth rate in Scotland (Aberdeen City Council, 2010).

609 Baseline information at both the regional and national level should be recognized, identifying specific socioeconomic impacts caused by offshore wind farms within particular regions as well as the impacts to Scotland (and the UK) as a whole. The following study areas are suggested:

- inner study area: Aberdeen and Aberdeenshire, the development will pose direct socioeconomic impacts to this area (discussed in section 6.7.4)

- wider study area: Other parts of Scotland. Possible impacts on other areas where potential suppliers and contractors exist should also be identified
- potential national impacts, such as offshore wind farms' potential to assist in national climate change commitments, could be considered at the high level

610 Local communication links including harbours, ports and links to manufacturing and assembly sites should be identified as the development of local infrastructure can result in economic benefits. Furthermore, the identification of local construction and suppliers is also of relevance as the use of local companies will lead to further positive socioeconomic impacts.

6.7.3 Proposed Scope of Assessment

611 The position and performance of Aberdeen's economy and its prospects for the future will be reviewed. This will include information on area, population, economic activity, employment and education and skills. Data on the socioeconomic impacts of existing offshore wind farms will be collated in consultation with relevant organisations, eg Aberdeen City Council and Aberdeenshire Council, the local fishing community via the Fisheries Liaison Officer (FLO), local communities and local groups such as Community Planning in Aberdeen, and via public exhibitions. The potential for job creation and local training opportunities will be assessed. Local communication links, including port facilities, will be assessed for their suitability for construction and operation activities.

612 The following data sources will be reviewed as part of the EIA process:

- The Crown Estate (2008) Socio-Economic Indicators of Marine-Related Activities in the UK Economy
- Scottish Government General Register Office for Scotland (2006) Scottish Economic Statistics

6.7.4 Potential Impacts

613 The economic impact of the project would be most significant during the construction phase, however potential benefits over the lifespan of the wind farm would also be assessed.

614 Potential impacts on socioeconomics, both positive and negative, which will be investigated are:

- construction (may also occur during decommissioning)
  - increased employment in construction and supporting industries Construction jobs relate to both construction of the wind farm itself and onshore facilities, including substation civil and electrical works.
  - increased expenditure through supply of goods and services required to develop the wind farm
  - change in population structure and consequent impacts on infrastructure requirements. The potential use of specialist contractors from out with the area could result in increased use of local accommodation and service industries.

    - academic research opportunities
- operation
    - increased employment, both local and further a field, due to maintenance and operation
    - change in population structure and consequent impacts on infrastructure requirements
    - academic research opportunities
- power generation
    - the development will result in a localised power generation consequently, less power will be wasted in transmission over long distances
    - the supply of site generated power will reduce the requirement to buy power from commercial utility companies, thus reducing fuel bills
- indirect benefits
    - improved marketing of Aberdeen as a 'green' city, leading to potential inward investments in new technologies
    - re-circulation of increased income

615 In 2009 approximately 5000 people were unemployed in the Aberdeen and Aberdeenshire area (Aberdeen City Council, 2010), in. The resultant positive socioeconomic effects of the development could alleviate unemployment.

616 Construction, operation and maintenance of the EOWDC will require both on and offshore local, national and international contractors. Thus, although the focus here has been on local socioeconomic impacts, the development will result in socioeconomic impacts in a wider sense.

617 Offshore wind farms also generate potential socioeconomic impacts on tourism, both beneficial and adverse. Impacts on tourism and commercial fisheries are dealt with in sections 6.6 and 6.8.

618 The visual impacts and mitigation methods are discussed in section 6.5 of this report.

6.7.5 Cumulative Assessment

619 The assessment of impacts would be undertaken on a site specific and cumulative basis to include the proposed project in addition to proposed other developments.

620 The development's impacts on other offshore operations, including oil and gas installations, shall also be addressed.

6.7.6 Mitigation

621 The majority of socioeconomic impacts on the area will be beneficial, thus ways to enhance such impacts must be explored. This may include:

- use of local port facilities where possible
- use of local vessels for survey and guard work where possible
- use of local employment base for both construction, operation and maintenance

- consideration of employment and training for operations and maintenance work
- use of locally manufactured supplies

622 The emphasis here is on focusing on local socioeconomic opportunities, thus consultation with local stakeholders is essential.

6.7.7 EOWDC Future Research and Monitoring

623 Monitoring will be proposed to ensure the implementation and effectiveness of the mitigation.

6.8 Recreation and Tourism

6.8.1 Introduction

624 Tourism is important to the local economy of Aberdeen, in 2008 tourism expenditure in the city was over £300 million (Aberdeen City and Shire Economic Future, 2010). The physical appearance of near shore wind farms means that visual impacts can be important and is of particular relevance to the tourism and recreation industry. Consequently, a detailed assessment of potential impacts would be required. Consultation with relevant organisations will continue throughout the project.

625 In 2005 and 2006 there were two road show events taking an exhibition to libraries, town halls and village halls along the stretch of coast. The events were open to all and were publicised in advance. The road shows proved a very successful means of engaging the public over the wind farm project and reaction was on the whole supportive. Meetings have also been held at earlier stages with both Royal Aberdeen and Murcar golf courses to inform about the project.

6.8.2 Baseline Information

626 Baseline information will identify key tourism data, including Aberdeen's most popular and profitable tourism features and if such features will be impacted by the offshore wind farm.

627 Visit Scotland statistics show that during 2008 UK residents made 1.30 million tourism trips to Aberdeen spending £242 million. Visitors from overseas took 0.25 million trips and spent £90 million in the area. Tourism related employment accounts for 8 per cent of jobs in the area (Visit Scotland, 2008).

628 In addition to summertime recreational boating, the beach adjacent to the area is used by local people for bird watching/nature walks etc.

629 SNH commissioned a review of marine and coastal recreation in Scotland (Land Use Consultants, 2006) which indicates that the most popular specialist activities on the Scottish coastline are walking, sea fishing, sailing, kayaking, canoeing, and wildlife and bird watching.

630 According to Visit Scotland (2008) the top visitor attractions in the Aberdeen and Grampian area are as follows:

- David Welch Winter Gardens, Aberdeen
- Aden Country Park, Mintlaw
- Aberdeen Art Gallery, Aberdeen
- Aberdeen Maritime Museum, Aberdeen
- WDCS Wildlife Centre, Spey Bay
- Provost Skene's House, Aberdeen
- Crathes Castle, Banchory
- Logie Steading Visitor Centre, Forres
- Loch Muick & Lochnagar Wildlife Reserve, by Ballater
- Aberdeen Arts Centre, Aberdeen

631 Coastal golf courses are also popular sites for recreation. There are currently two close-by golf courses situated along the shoreline of northern Aberdeen and further courses are planned.

632 Visual impacts are of particular relevance with regard to tourism and recreation. The geographical extent of the visual impacts of the wind farm will be identified using a ZTV map (discussed in section 6.5) which will be undertaken as part of the SLVIA. Sites that are of particular importance with regards to tourism and the extent to which such sites will be visually impacted will be identified.

633 Aberdeen's tourism resources' dependence on visual features will be identified. The extent to which each resource (eg restaurant views, foot paths, view points etc.) is dependent on the surrounding land/seascape will be identified and the visual impacts the wind farms determined.

6.8.3 Proposed Scope of Assessment

634 The EIA will include an assessment of the tourism sector in Aberdeen focussing on coastal tourism.

635 The following data sources will be referred to during the EIA process:

- Glasgow Caledonian University (2007) Economic Impact of Wind Farms on Scottish Tourism
- Scottish Renewables and the British Wind Energy Association (2002) Tourist Attitudes Towards Wind Farms
- Ladenburg *et al.*, (2006) Socioeconomic Effects: Positive Attitudes in Local Communities
- Land Use Consultants (2006) Review of Marine and Coastal Recreation F05AA608

636 Consultation with Aberdeen City Council and Aberdeenshire Council, Visit Scotland, local recreational groups.

6.8.4 Potential Impacts

637 The development is located 2 km from the coast and will follow the coastline from northern Aberdeen to Balmedie, visually impacting the seascape of the area. According to Glasgow Caledonian University's (2007) study the economic impact of wind farms onScottish tourism is relatively small. This

study was based on the impacts of onshore wind farms, however, the same basic principles can be applied to offshore wind farms.

638 Glasgow Caledonian University's study focused on four case study areas in Scotland, concluding that three quarters of tourists surveyed felt that wind farms had a positive or neutral impact on the landscape. Of the 380 tourists surveyed 39 % were positive about wind farms, 36 % had no opinion and 25 % were negative. Within the minority that were negative about wind farms, only a very small group changed their opinions about revisiting Scotland. The likelihood of those surveyed intentions to return showed that wind farms have very little impact. Three visual situations were required to determine the likelihood of return:

- those having actually seen a wind farm
- respondents were shown photos of an area before and after construction of a wind farm
- respondents were shown a photo montage of an area with an existing wind farm with illustrations of how the landscape would look if the wind farm was extended

639 In all cases the vast majority, 93-99 %, suggested that the experience of seeing a wind farm would have no effect. In addition the presence of wind farms increased the likelihood of some tourists to return to the case study areas and Scotland as a whole.

640 A number of the top visitor attractions, outlined in section 6.8.2, will be completely unaffected by the wind farm. Therefore the wind farm's economic impacts on tourism should be negligible.

641 The potential impacts on Tourism and Recreation which will be investigated are:

- construction (may also occur during decommissioning)
  - visual impacts
  - temporary disruption of offshore tourism and recreation
- operation
  - visual impacts
  - site access for offshore tourism and recreation
  - marine navigational safety
  - offshore wind farms can also present tourism potentials. Many boat operators offer tours of offshore wind farms.

642 Locally, the development may also impact bird watching, during both construction and operation.

6.8.5 Cumulative Assessment

643 The need to assess tourism and recreational impacts cumulatively will be discussed with relevant consultees.

6.8.6 Mitigation

644 A desk study and consultation will be undertaken to gain the views of the local tourist industry, and potentially consider ways of benefiting it.

645 The majority of impacts on tourism will be visual. As such, the mitigation methods outlined in section 6.5 should be considered. In addition, the wind farm may attract tourists. Of the 380 tourists surveyed by Glasgow Caledonian University 48 % agreed with the statement 'I like to see wind farms.' Thus potential ways to use wind farms as a tourist attraction, such as locally run boat trips, will be explored.

6.9 In-Air Noise

6.9.1 Introduction

646 Construction activities, such as wind turbine installation and the associated vessel movements, have the potential to generate airborne noise. The acoustic impacts during construction and operation will be assessed following the former Department of Trade and Industry's (DTI) best practice guidelines. Preliminary noise predictions have been carried out for close-by dwellings, golf course club houses, close coastal points, Balmedie Ranger Station and more. According to these calculations background noise levels will generally be below 35 dB(A).

6.9.2 Baseline Information

647 Aberdeen has a total population of 210,400 as reported in 2009. The proposed wind farm is located 2-4 km from shore north of Aberdeen City. Sensitive receptors to in-air acoustic impacts will include local residents, businesses and tourists. There are beaches and two golf courses along the coastline.

648 Local levels of background ambient noise will be used in the modelling for airborne noise levels during construction and operation.

6.9.3 Proposed Scope of Assessment

649 A detailed baseline noise survey will be conducted at representative locations onshore following consultation with Aberdeen City Council and Aberdeenshire Council with the following proposed outputs:

- identification and agreement on the location of the nearest sensitive receptors
- agreement of noise limits for each receptor with Aberdeen City Council and Aberdeenshire Council
- prediction of noise levels received at each receptor using a recognised computer model that implements the calculation method specified in ISO 9613: Acoustics – Attenuation of sound during propagation outdoors (ISO, 1996)
- comparison of predicted levels with agreed noise limits

650 Advice will be sought on whether measurements of background noise levels will be necessary.

6.9.4 Potential Impacts

651 Potential impacts on in-air noise which will be investigated are:

- construction (may also apply during decommissioning)
  - impacts on recreational users of the area
  - noise disturbance to residential populations
- operation
  - operational noise from wind turbines

6.9.5 Cumulative Assessment

652 If required, a cumulative assessment would be completed.

6.9.6 Mitigation

653 Noise during construction could be managed by the implementation of a site construction policy and, as far as is possible, minimising vessel traffic levels at the construction site.

6.10 Energy and Emissions

6.10.1 Introduction

654 In their Annual Statement (DECC 2010), DECC reports that it is likely that demand for electricity will double over the coming forty years, as a result of the need to electrify large parts of the heat and transport sectors. Further, for the UK to meet its obligations on reducing emissions of greenhouse gases, the electricity being consumed will need to be almost exclusively from low carbon sources. In the first quarter of 2010 nearly 80 % of the UK's electricity was generated by burning gas and coal. This needs to change and, as the Statement sets out, offshore wind will be crucial to delivering the UK's renewable and low carbon targets.

655 This project will be a small, but important, part of delivering a reduction in greenhouse gas emissions due to the displacement of fossil fuel use. Quantification of this will however depend on assumptions regarding the nature of the generating capacity it replaces and will be addressed in the EIA.

6.10.2 Baseline Information

656 The construction and operation of EOWDC would not significantly increase the overall CO_2, SO_x, NO_x and other pollutants within the project site area.

6.10.3 Proposed Scope of Assessment

657 The EIA will consider the current electricity generation mix and assess what greenhouse gas savings could be made. No further assessment is proposed.

6.10.4 Potential Impacts

658 Potential impacts during construction and decommissioning would be addressed through standard mitigation techniques, which are to be agreed as part of an Environmental Management Plan (EMP) for the construction phase. Potential impacts from vessels used during maintenance of the wind turbines may arise during the operation of the wind farm.

6.10.5 Cumulative Impacts

659 Cumulative impact between our project and other projects in respects of energy and emissions issues are not anticipated.

6.11 Electromagnetic Interference

6.11.1 Introduction

660 Provided careful attention is paid to siting, wind turbines should not cause any significant problems due to electromagnetic interference. Wind farms have the potential to cause adverse effects on communication systems which use electromagnetic waves as the transmission medium (for example, television, radio or microwave links).

6.11.2 Baseline Information

6.11.2.1 Television Reception

661 An on-line tool to estimate potential television interference provided by the BBC indicates that no households would be affected.

6.11.2.2 Microwave and Other Telecommunications

662 Contact was made with Ofcom regarding the proposal and information on the site centre and the radius of the development was submitted.

663 Ofcom responded that there are currently no fixed link ends within or fixed paths that cross the site in respect of microwaves.

664 For scanning telemetry the information was passed to both the Joint Radio Company (JRC) and Atkins Ltd both of whom responded with no objection to the proposal.

6.11.3 Proposed Scope of Assessment

665 Relevant organisations will be contacted again prior to consent if necessary.

6.11.4 Potential Impacts

666 Wind turbines can cause electromagnetic interference (EMI) by two means:

- physical interference
- electrical interference

6.11.5 Mitigation

667 If there are any impacts to television signals there are several solutions available that which have been used successfully at other wind farms, for example realigning aerials, fitting better aerials or the use of a digital service.

6.12 Other Marine Users

668 This section of the Environmental Statement will consider other marine users in the area that could be potentially affected by the development. Other marine users are shown on Figure 12.

669 It is likely to consider the following activities:

- existing subsea cables and pipelines
- oil and gas installations
- marine dredging areas and disposal sites
- salmon fisheries
- unexploded ordnance

6.12.1.1 Existing Cables and Pipelines

670 There are two telecommunications cables west of and close to EOWDC and it is therefore possible that crossings may be required. The design of any crossing will be agreed with the cable/pipeline owner/operator to ensure that integrity of all the assets is maintained.

6.12.1.2 Oil and Gas Installations

671 There are currently no oil and gas fields in the area of the proposed development nor is there any related infrastructure. The closest pipelines are gas pipelines entering into St Fergus Gas Terminal, north of Peterhead. Consequently, there will no impact on oil and gas installations from the proposed project.

6.12.1.3 Dredging and Disposal site

672 There are currently only two licensed dredge areas in Scotland (Scottish Executive, 2006) neither are located within the study area. Ongoing dredging activities occur in Aberdeen harbour. The quantity of dredged material and the disposal sites are to be confirmed and will be addressed within the ES.

673 There is a disused explosive dumping ground approximately 6.4 km from the project site.

6.12.1.4 Salmon Fisheries

674 There are a number of salmon fisheries along the coast between the river Don and the Ythan Estuary (Figure 12). No wind turbines are proposed within these areas, however, consultation will take place with the associated Fishery boards.

6.12.1.5 Unexploded Ordnance

675 There is a potential for unexploded ordnance to be the found on the wind farm site and in the surrounding area. There was a study commissioned by the project in 2007 (Bactec, 2007) to look at the risk of unexploded ordnance. A further study will be commissioned due to the change in site location.

6.12.2 Proposed Assessment

676 The effect of the wind farm on the above will be considered in the individual impact assessments previously discussed in this document.

7 CONSULTATIONS

677 The information provided in this document is designed to help consultees and stakeholders comment on the assessment approach outlined, raise other issues of perceived concern, provide further information and, where necessary, advise on alternative methods of assessment.

678 Below is a list of consultees to whom this scoping report has been sent. Suggestions from other bodies of any groups, organisations or individuals not on the list would also be welcome.

List of Statutory Consultees to Marine Scotland
Scottish Natural Heritage (SNH)
Scottish Environment Protection Agency (SEPA)
Aberdeen City Council
Aberdeenshire Council
Fisheries Committee
Association of Salmon Fishery Boards
British Telecom (Radio Network Protection Team)
Civil Aviation Authority (CAA)
Chamber of Shipping
The Crown Estate
Defence Estates
Health and Safety Executive (HSE)
Joint Radio Company (JRC)
Maritime and Coastguard Agency
Marine Safety Forum
Marine Scotland
NATS
Northern Lighthouse Board (NLB)
Royal Yachting Association
RSPB
Scottish Canoe Association
Scottish Fisherman's Federation
Scottish Fisherman's Organisation

List of other Consultees who will be informed of this report
Aberdeen Harbour Board
Aberdeen International Airport
Associated British Ports (ABP)
Atkins Ltd
Scottish Sub Aqua Club
Aberdeen Chamber of Commerce
COWRIE
DEFRA Marine Consents Unit
East Grampian Coastal Partnership
Scottish Federation of Sea Anglers
Friends of the Earth Scotland
Greenpeace
Joint Nature Conservation Committee (JNCC)
Local Fisherman's Organisations
Local Sailing Clubs
The Moray Firth Partnership
National Grid – Gas Distribution
National Trust For Scotland
Ofcom
Oil and Pipelines Agency
Receiver Of Wreck
Royal National Lifeboat Institution
Scottish Wildlife Trust (SWT)
Scottish and Southern Energy Plc
Scottish Water
Shell
Trinity House
University of Aberdeen
Visit Scotland

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9 APPENDIX

9.1 Calculations

Based on RenewableUK's calculation for wind energy statistics 100 MW installed capacity is estimated to produce about 260 GWh electricity per year (100 MW * 0.3 capacity factor * 8760 h/yr = 262,800 MWh ie 263 GWh).

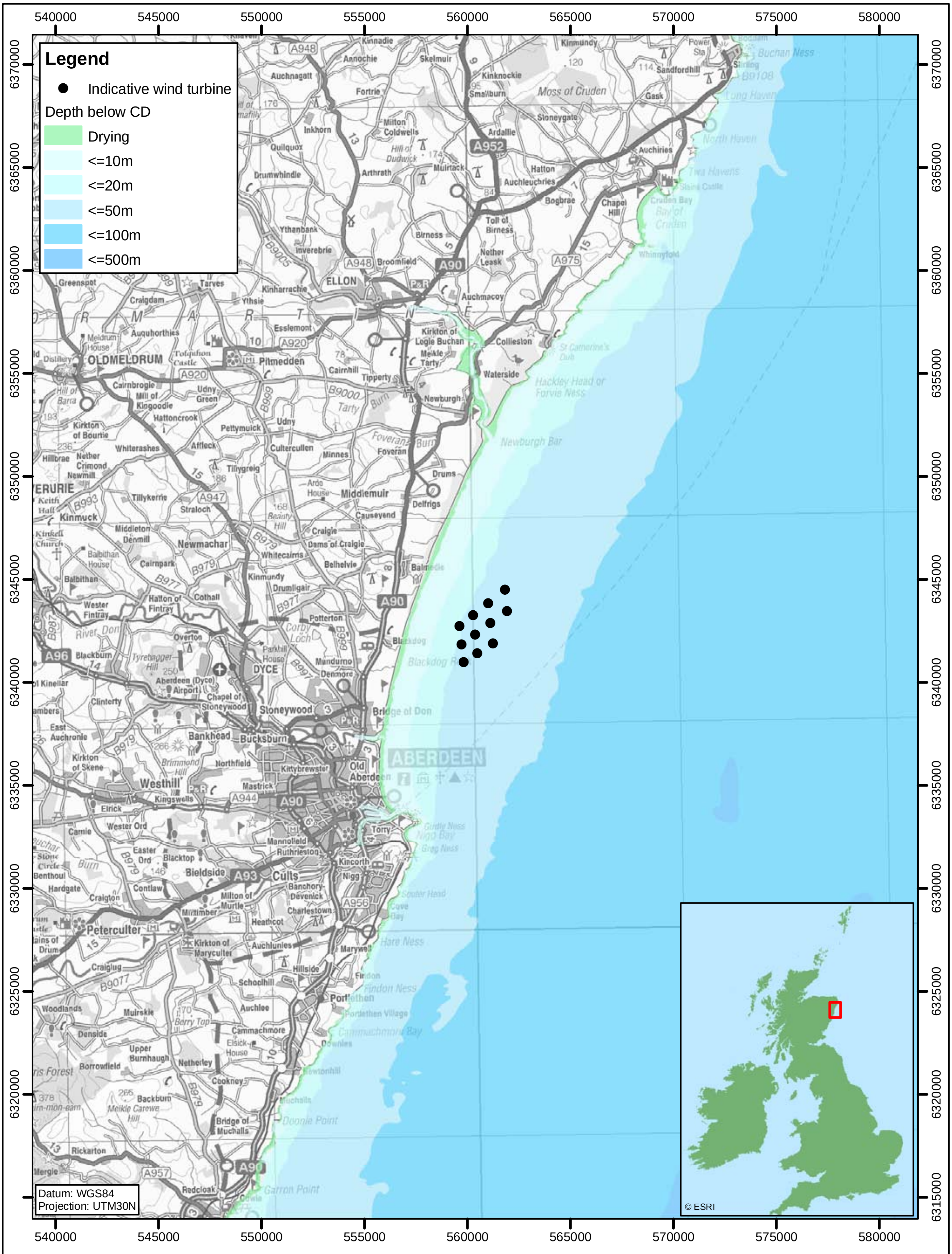
Please note that this assumes a capacity factor of 30 %, however in the offshore environment it is likely to be higher which would give a greater production of electricity. The following is stated by RenewableUK: "This is only an average estimation given that in many places, particularly Scotland and offshore, the wind speeds are higher leading to a greater electricity production per turbine, as power output is a cube of the wind speed." (http://www.bwea.com/edu/calcs.html)

According to RenewableUK an average UK household makes use of 4,700 kWh per year for household electricity. This means that 55,300 households can get their household electricity from EOWDC (260 GWh / 4,700 kWh = 55,319 ie 55,300 households).

Share of households that would have been provided with electricity from the EWODC in 2008: 55,300/102,900[3]= 53 %

Estimated share of households provided with electricity from the EOWDC in 2013: 55,300/108,150 = 51 %

[3] This assumes number of households in Aberdeen was 102,900 in 2008. This is based on the "Household Projections for Scotland 2008-based" from the General Register Office for Scotland (2010).



0 0.5 1 nm | 0 1 2 km | Original A4 Plot Scale 1:250,000

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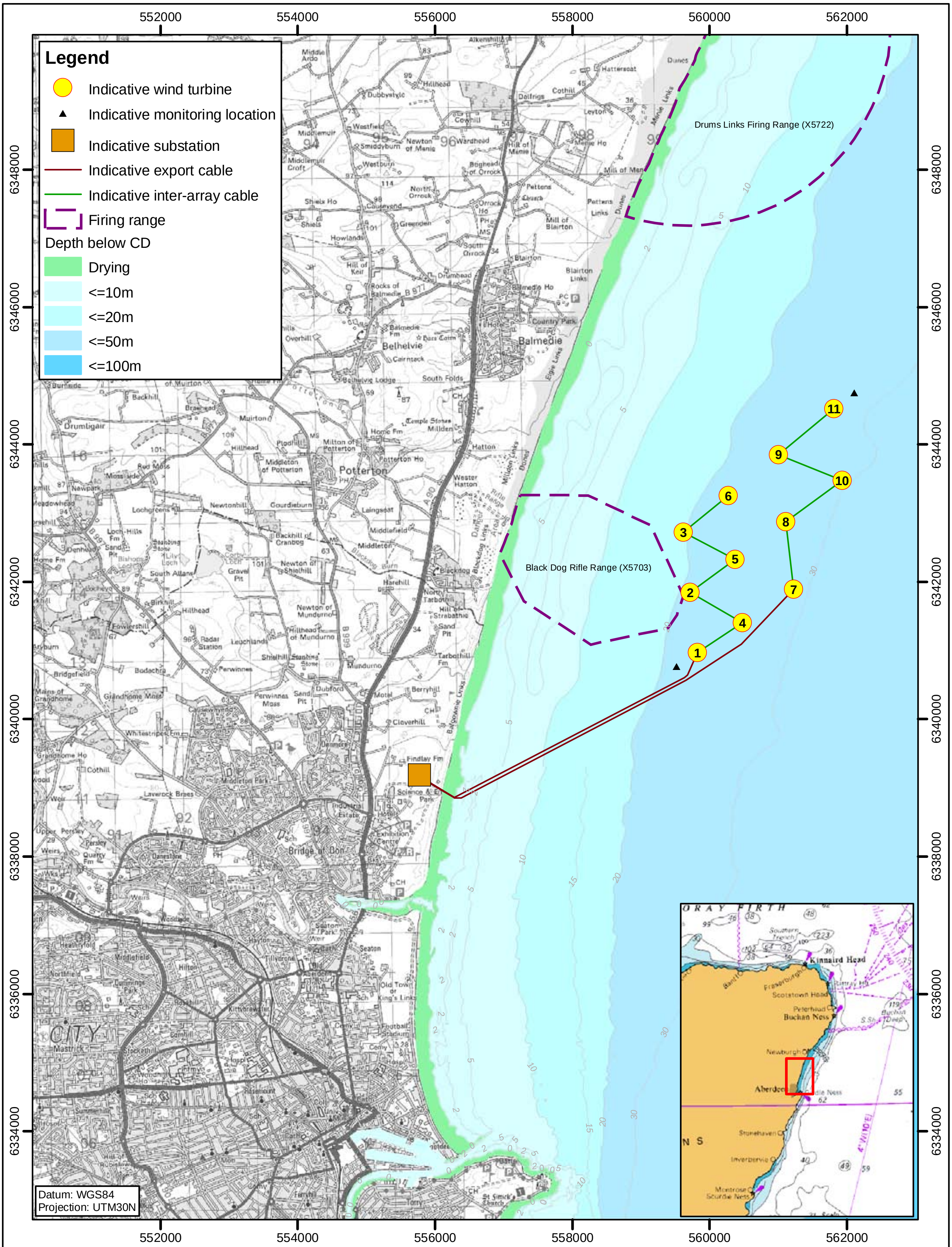
Site Location

Layout	Date	Rev	Dwg No.
LABER039	16/08/2010	A	6129-521-PA-001

Figure 1



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A	16/08/10	LH	First Issue

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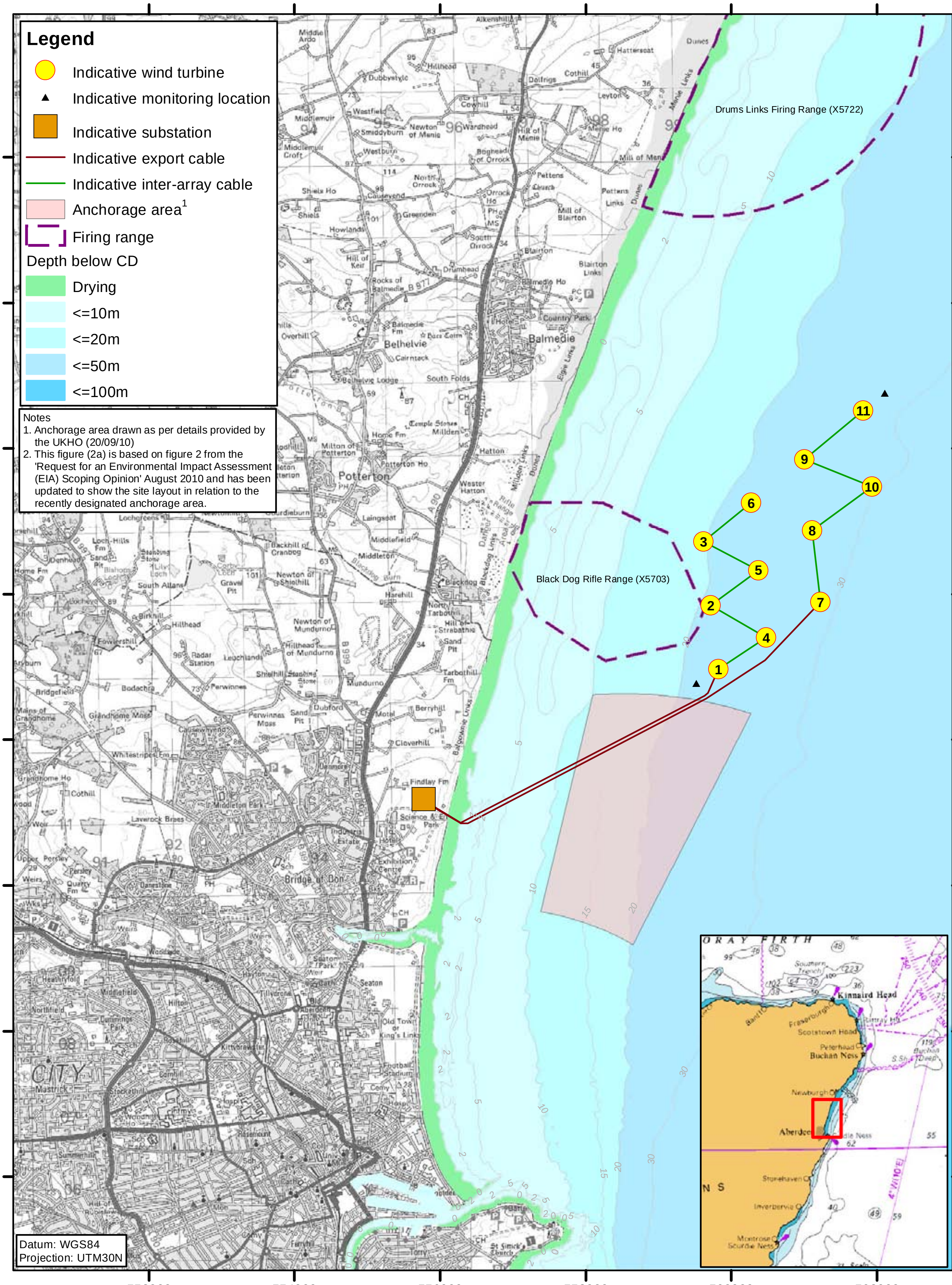
Site Layout

Layout	Date	Rev	Dwg No.
LABER039	16/08/10	A	6129-521-PA-002

Figure 2



0 0.25 0.5 nm 0 0.5 km

Original A4 Plot Scale 1:75,000

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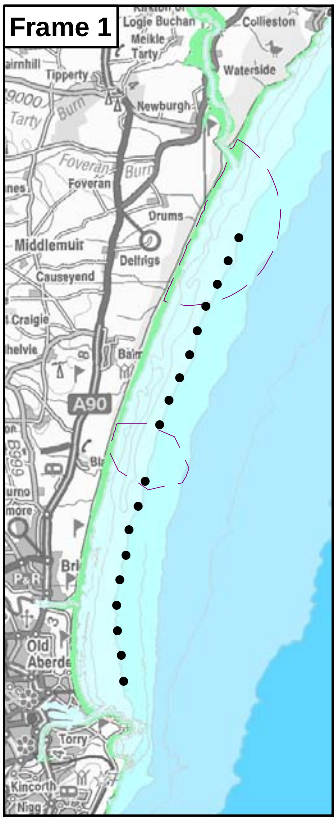
Site Layout

Layout	Date	Rev	Dwg No.
LABER039	07/10/10	A	6129-521-PA-023

Figure 2a



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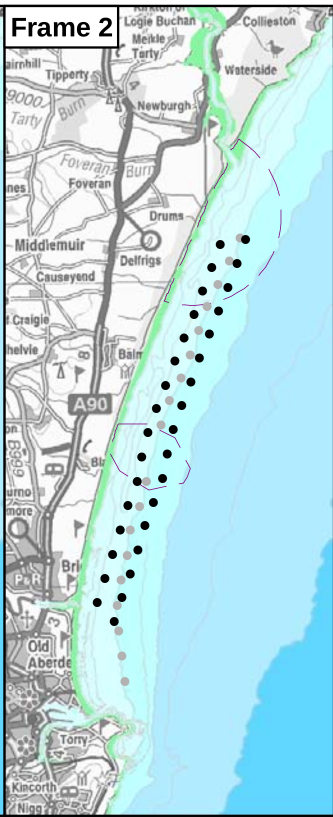

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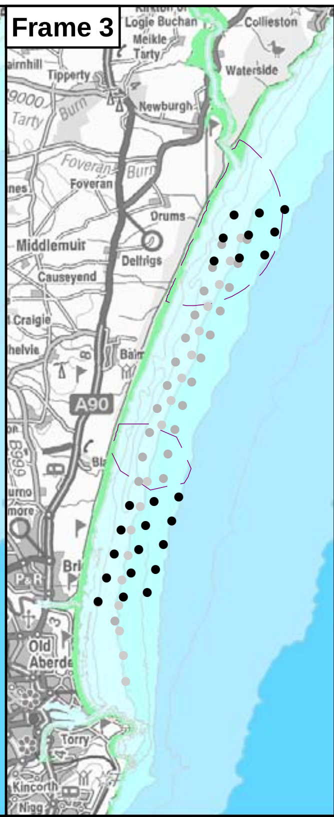

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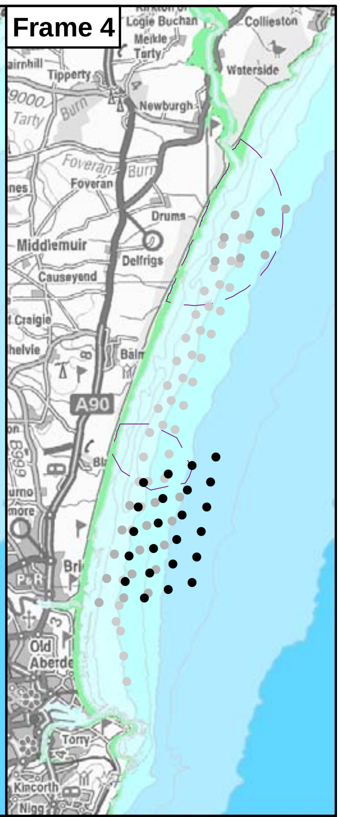

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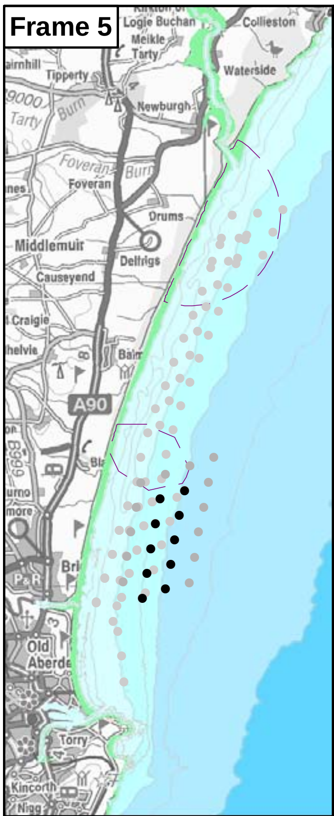

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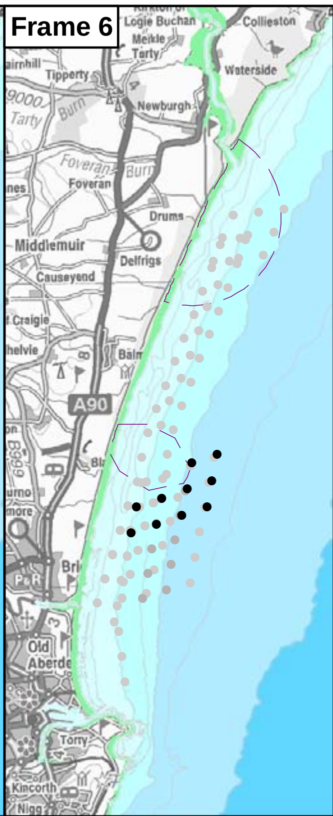

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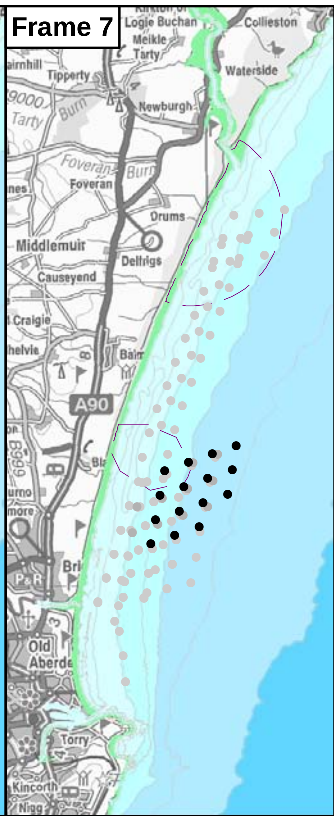

Layout ref.: LABER021
Date: September 2009

Legend

- Wind turbine
- Wind turbine from previous frame
- Wind turbine from prior frames (composite)
- Firing range

Depth below CD

- Drying
- <=10m
- <=20m
- <=50m
- <=100m

Datum: WGS84
Projection: UTM30N

See Figure 4 for further layout iterations.

See Figure 5 for composite display of layout iterations.

0 0.5 1 1.5 nm 0 1 2 km Original A4 Plot Scale 1:250,000

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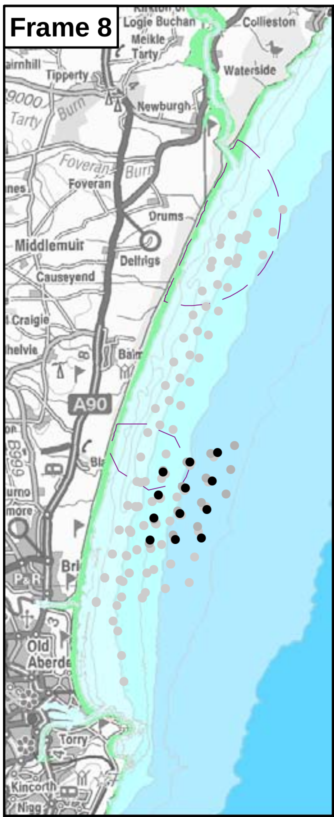
Site Iterations: 2002 to 2009

Layout	Date	Rev	Dwg No.
Multiple	16/08/2010	A	6129-521-PA-015

Figure 3



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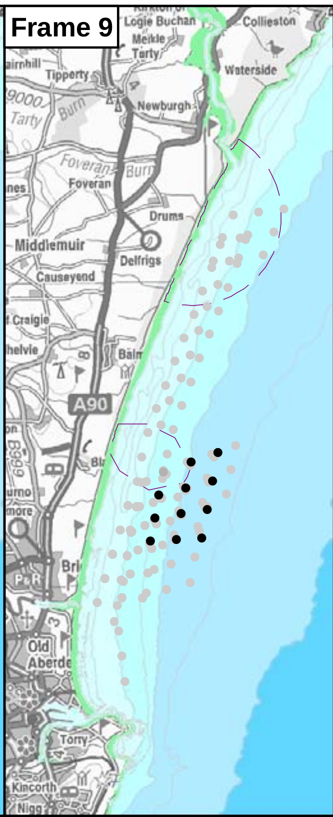

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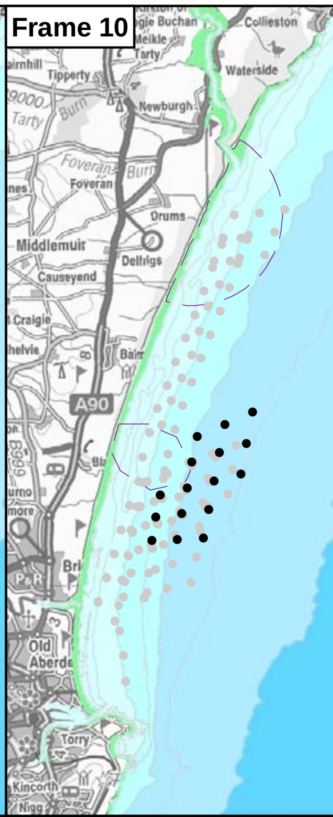

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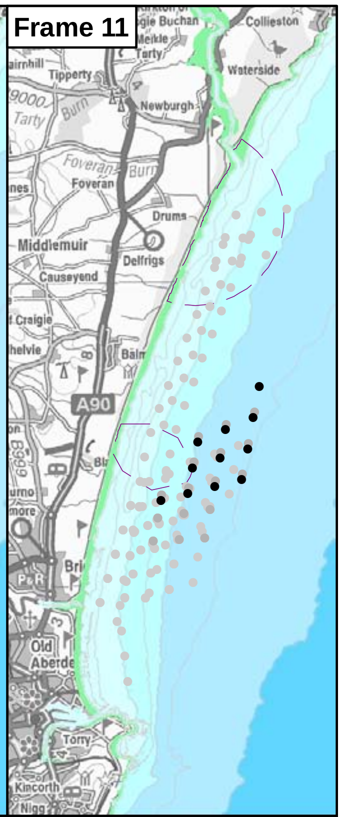

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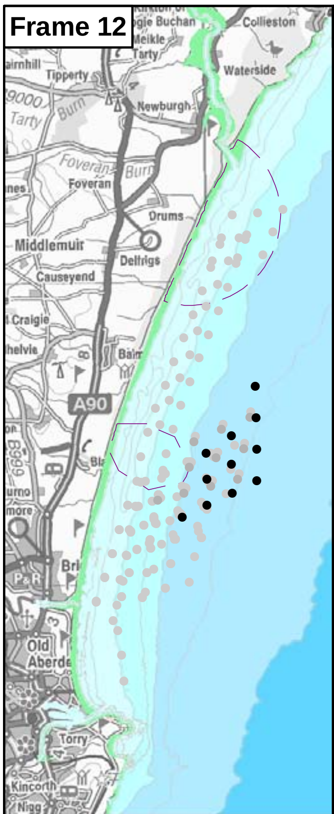

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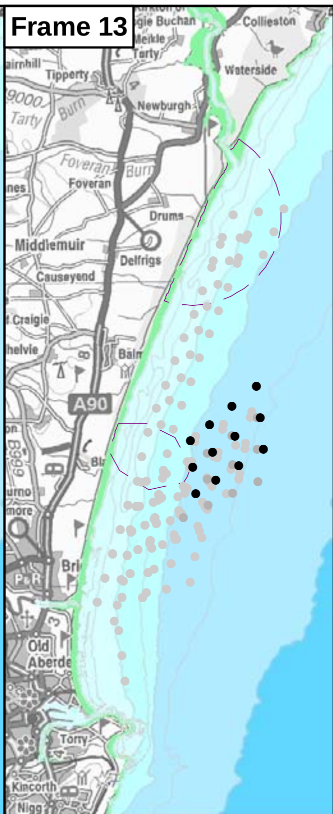

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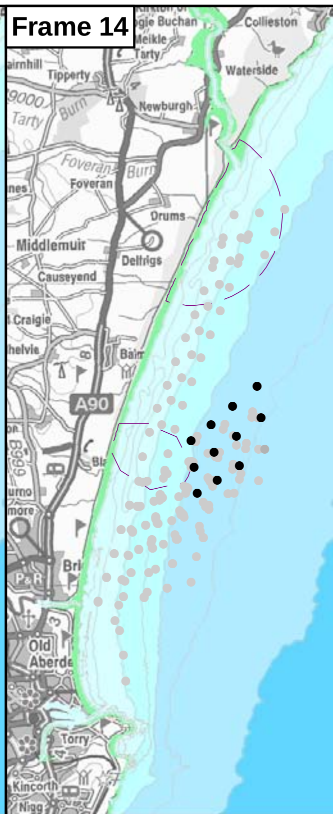

Layout ref.: LABER039
Date: April 2010

Legend

- ● Wind turbine
- Wind turbine from previous frame
- Wind turbine from prior frames (composite)
- Firing range

Depth below CD

- Drying
- <=10m
- <=20m
- <=50m
- <=100m

Datum: WGS84
Projection: UTM30N

See Figure 3 for prior layout iterations.

See Figure 5 for composite display of layout iterations.

0 0.5 1 1.5 nm   0 1 2 km   Original A4 Plot Scale 1:250,000

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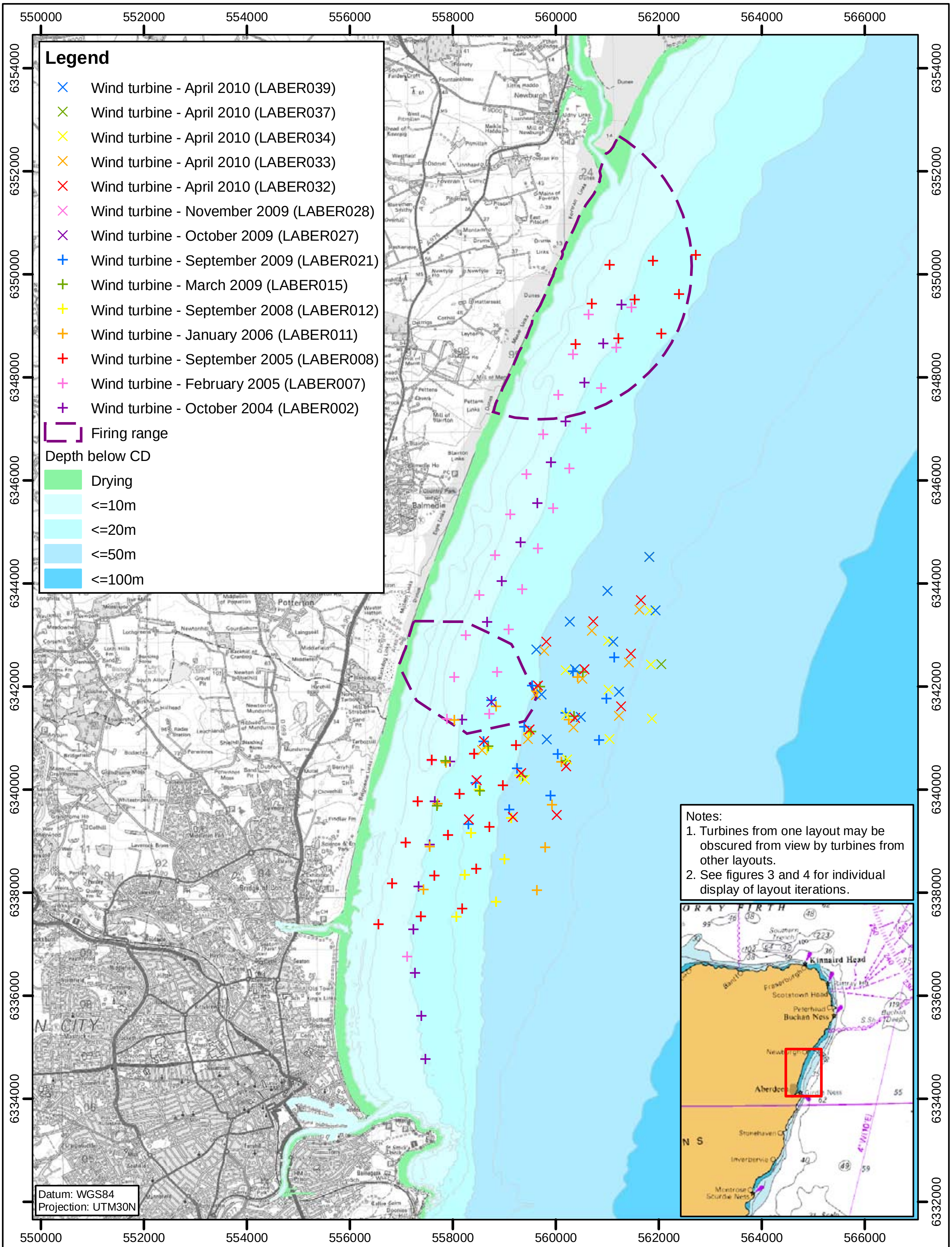
Site Iterations: 2009 - 2010

Layout	Date	Rev	Dwg No.
Multiple	16/08/2010	A	6129-521-PA-016

Figure 4



0 0.25 0.5 nm 0 0.5 1 km Original A4 Plot Scale 1:100,000

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A	16/08/10	LH	First Issue.

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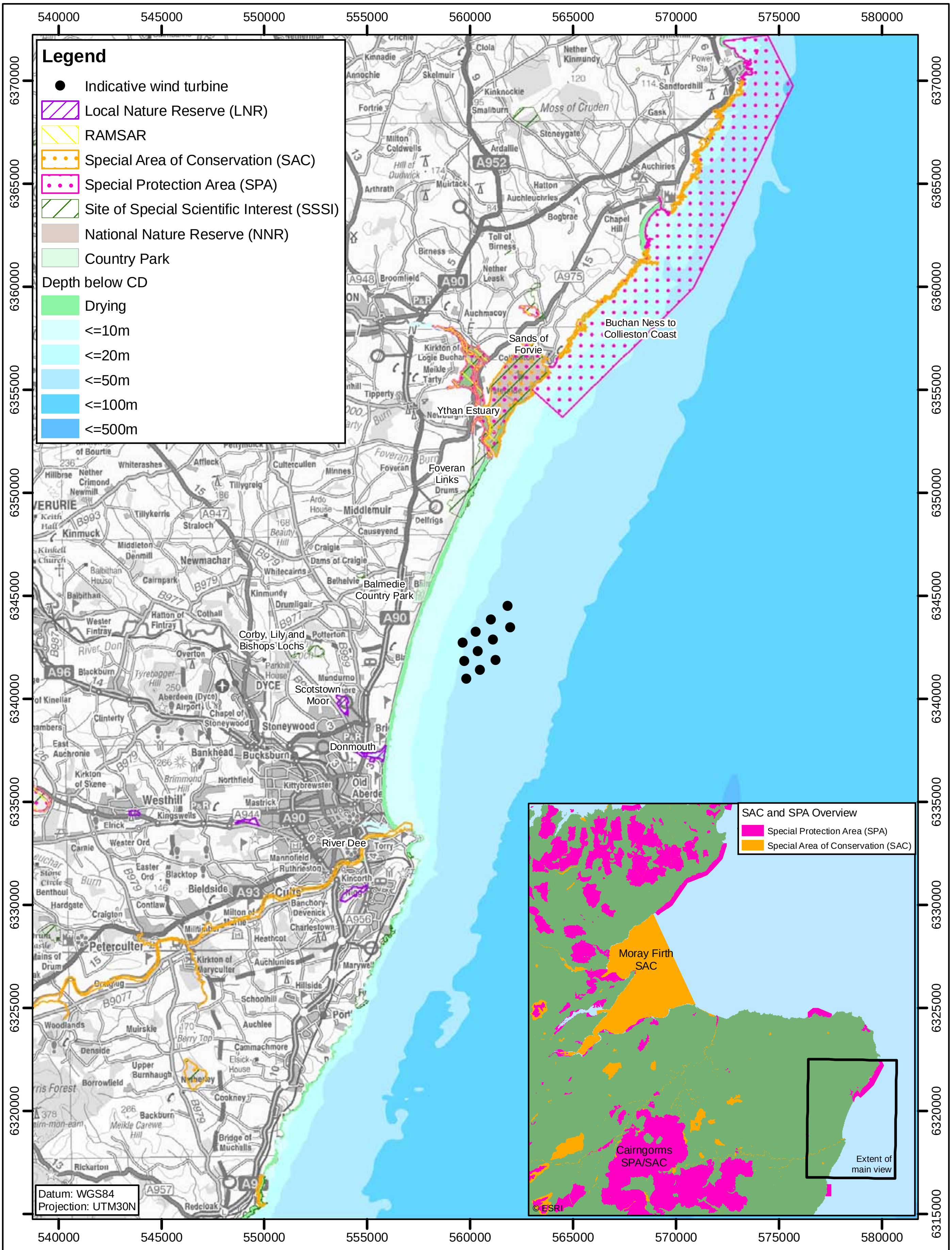
Site Iterations - Composite

Layout	Date	Rev	Dwg No.
Multiple	16/08/2010	A	6129-521-PA-007

Figure 5



0 0.5 1 nm
0 1 2 3 km
Original A4 Plot Scale 1:250,000

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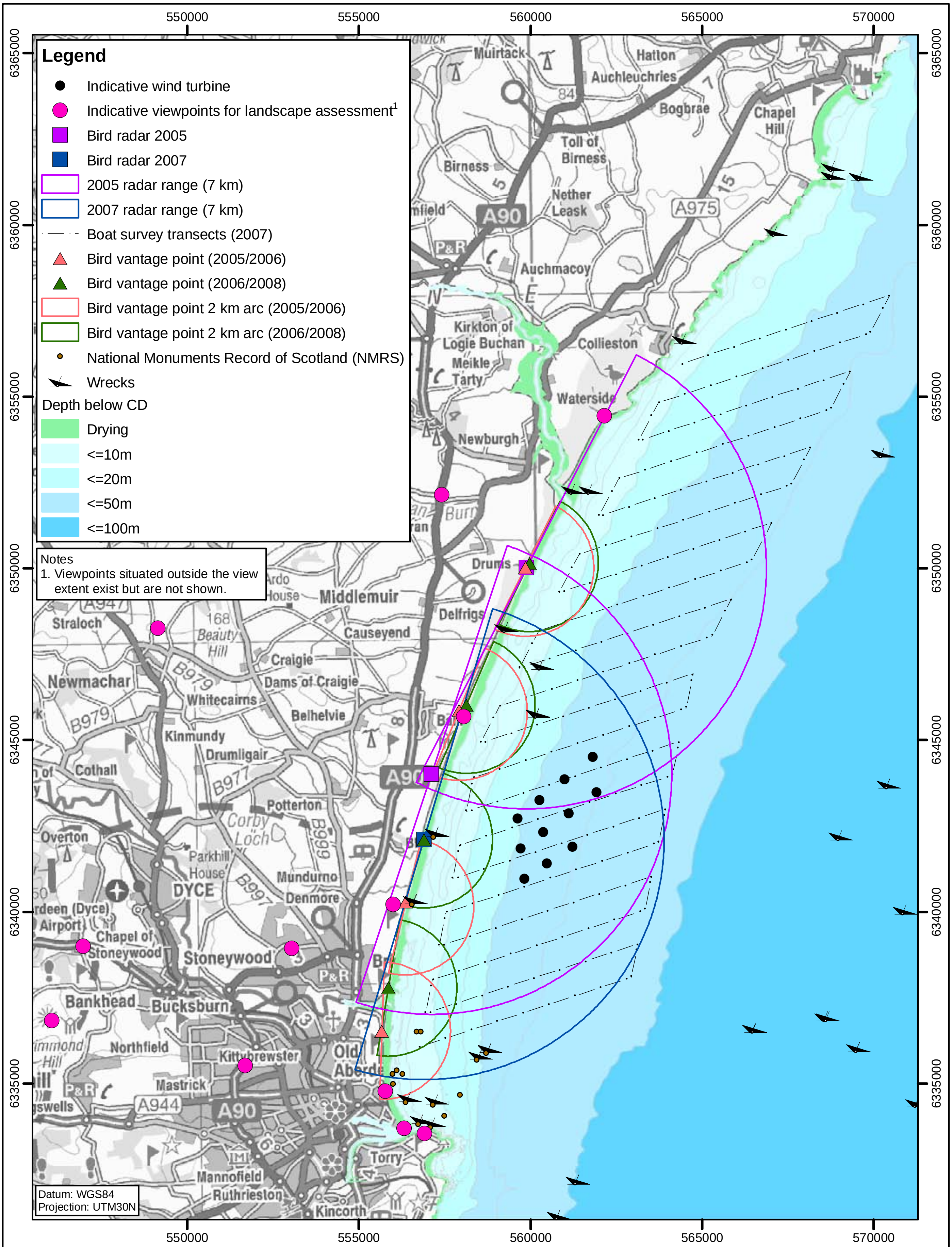
Designations

Layout	Date	Rev	Dwg No.
LABER039	16/08/2010	A	6129-521-PA-008

Figure 6



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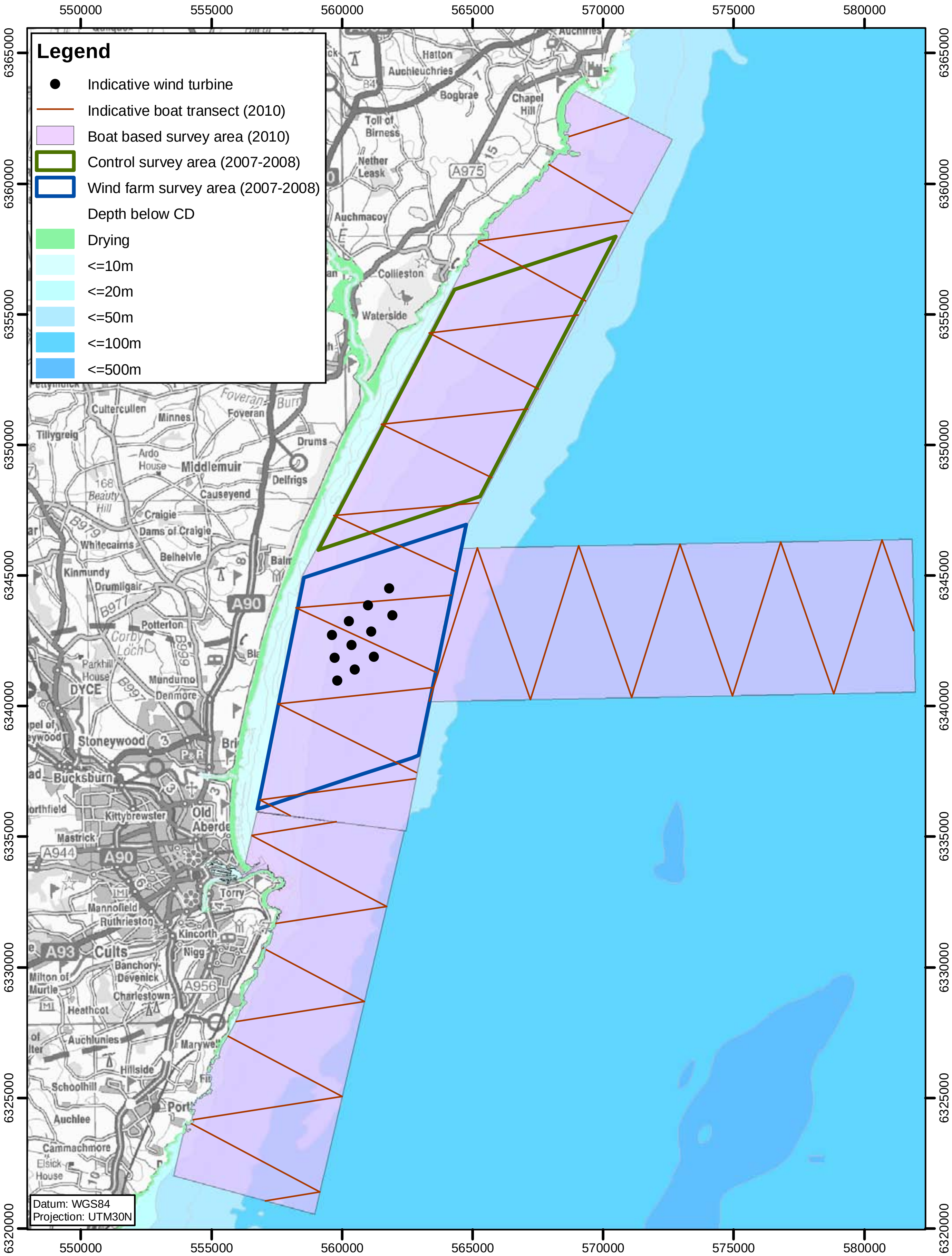
A	16/08/10	LH	First Issue

European Offshore Wind Deployment Centre

Environmental Studies

Layout	Date	Rev	Dwg No.
LABER039	16/08/2010	A	6129-521-PA-011

Figure 7



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0 1 2 km

Original A4 Plot Scale 1:200,000

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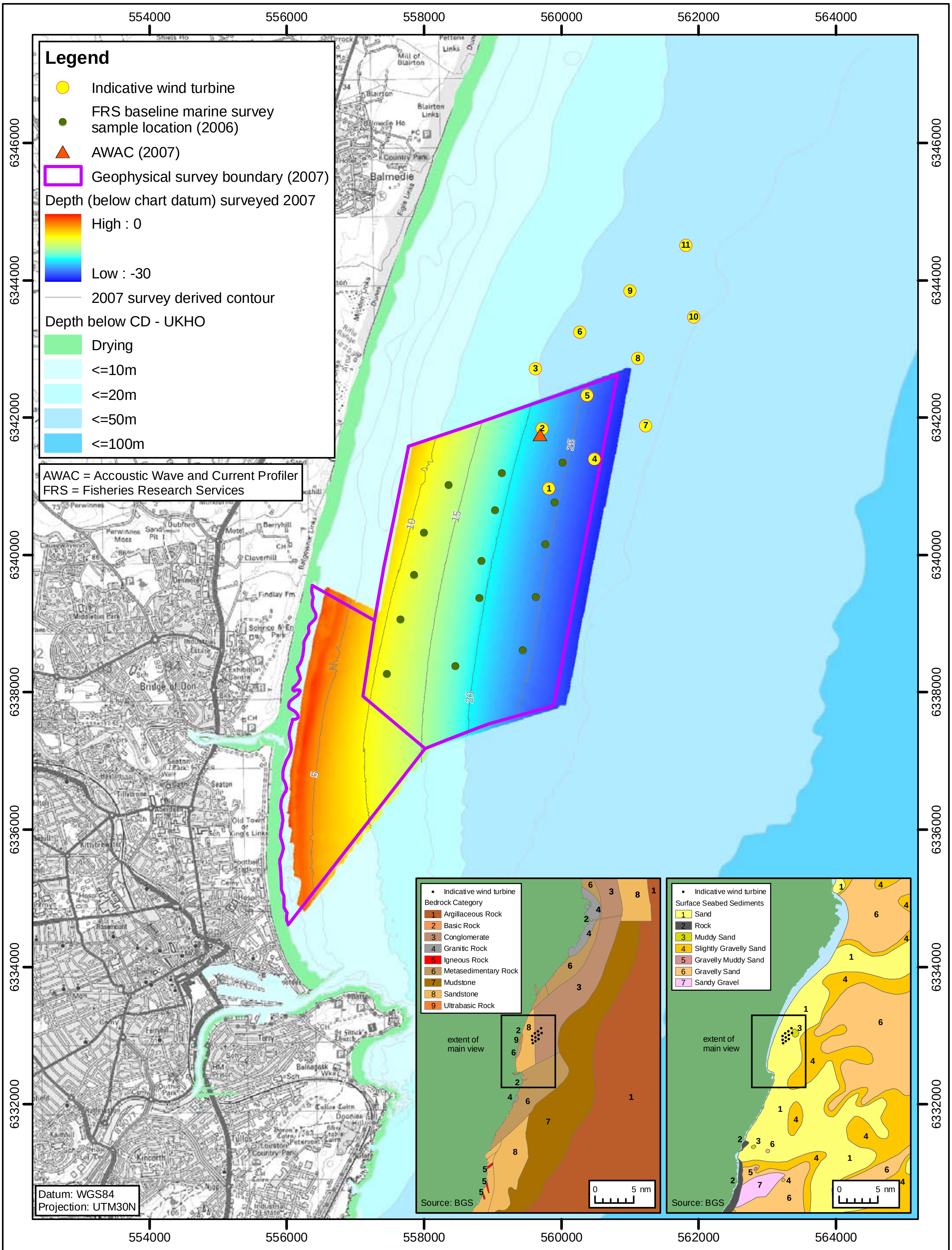
European Offshore Wind Deployment Centre

Boat Based Survey Areas

Layout	Date	Rev	Dwg No.
LABER039	16/08/2010	A	6129-521-PA-019

Figure 8



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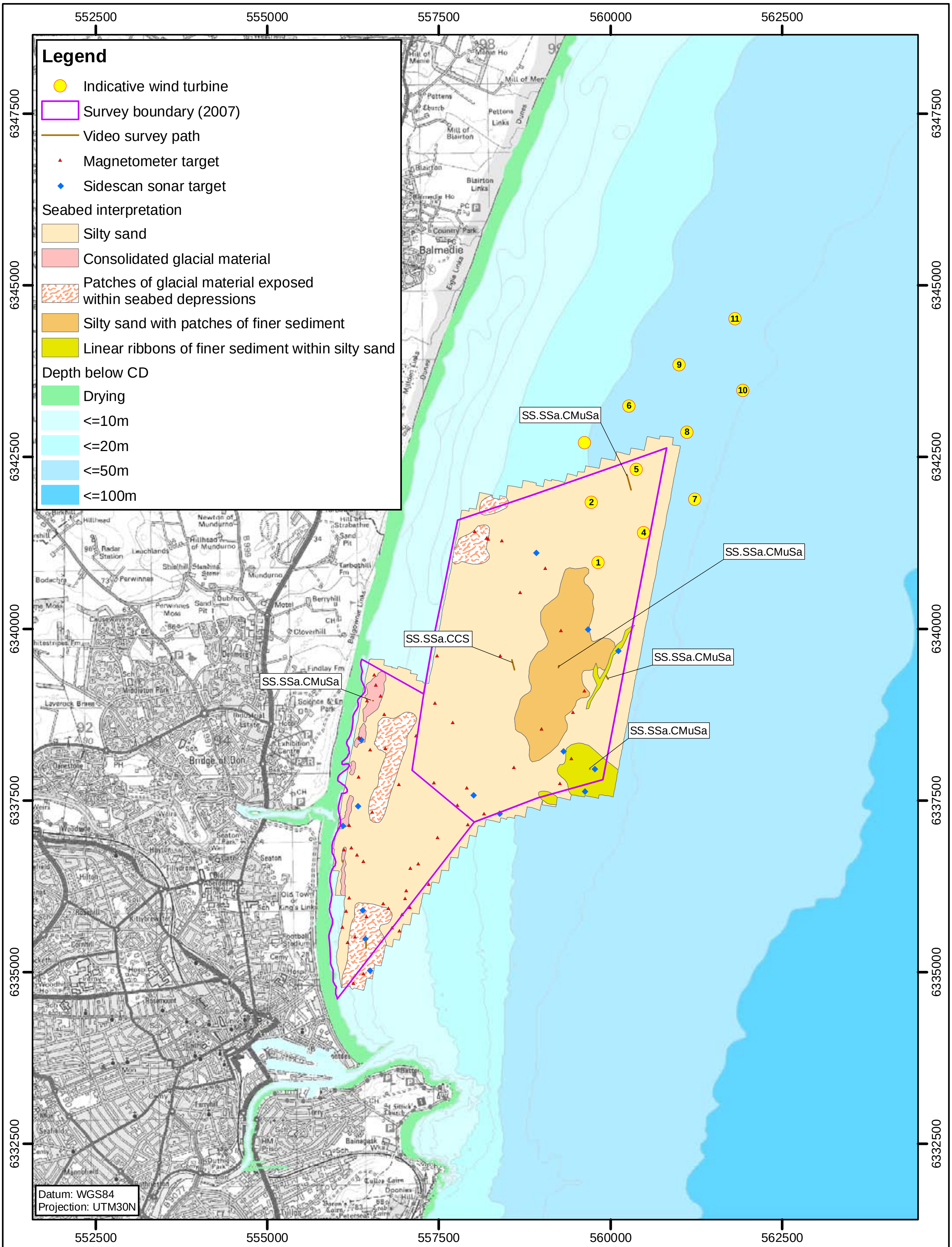
A	16/08/10	LH	First Issue.

European Offshore Wind Deployment Centre

Seabed Characteristics

Layout	Date	Rev	Dwg No.
LABER039	16/08/2010	A	6129-521-PA-010

Figure 9



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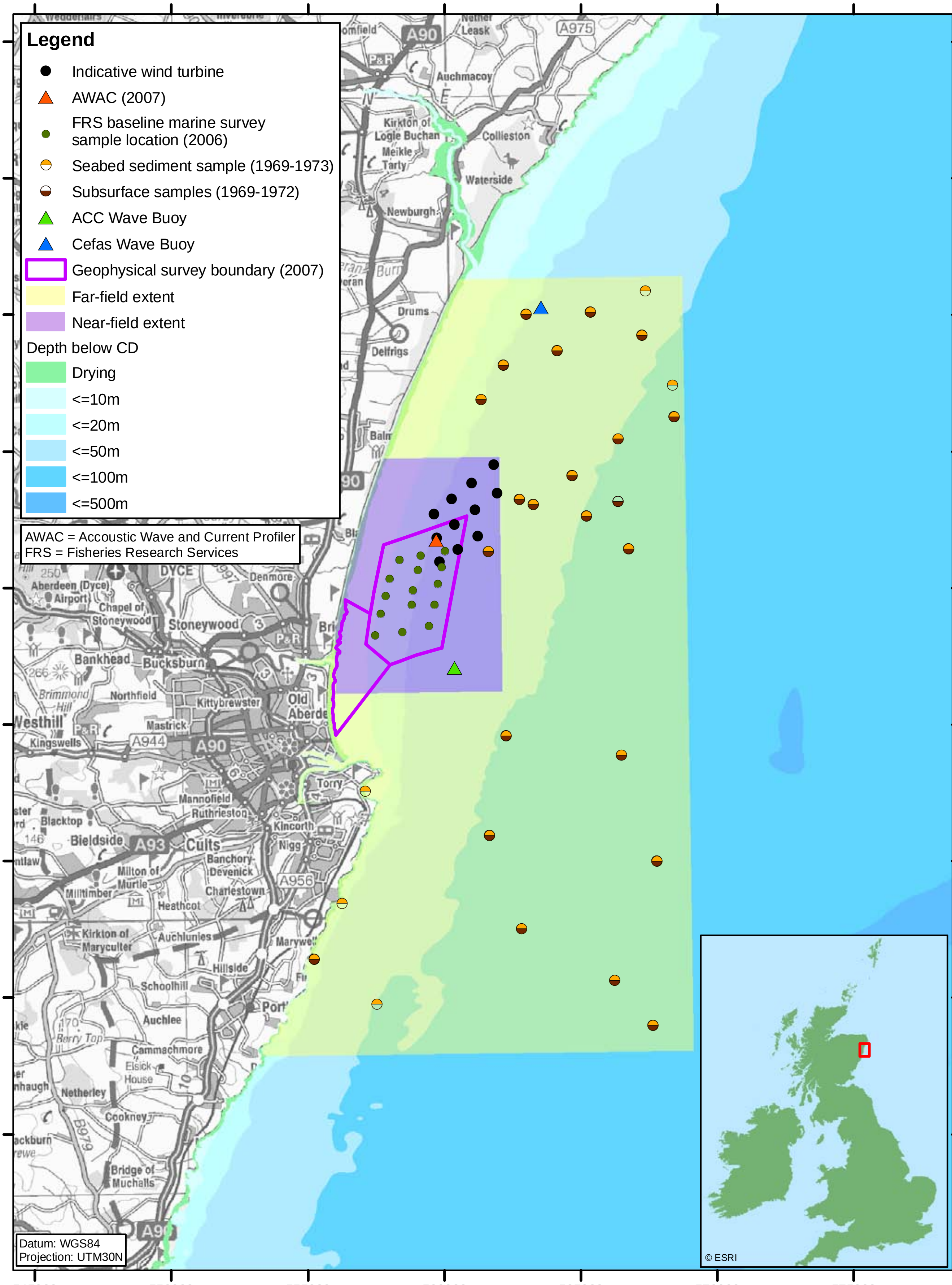
A	16/08/10	LH	First Issue.

European Offshore Wind Deployment Centre

Benthic Habitats of 2007 Survey Area

Layout	Date	Rev	Dwg No.
LABER039	16/08/2010	A	6129-521-PA-014

Figure 10



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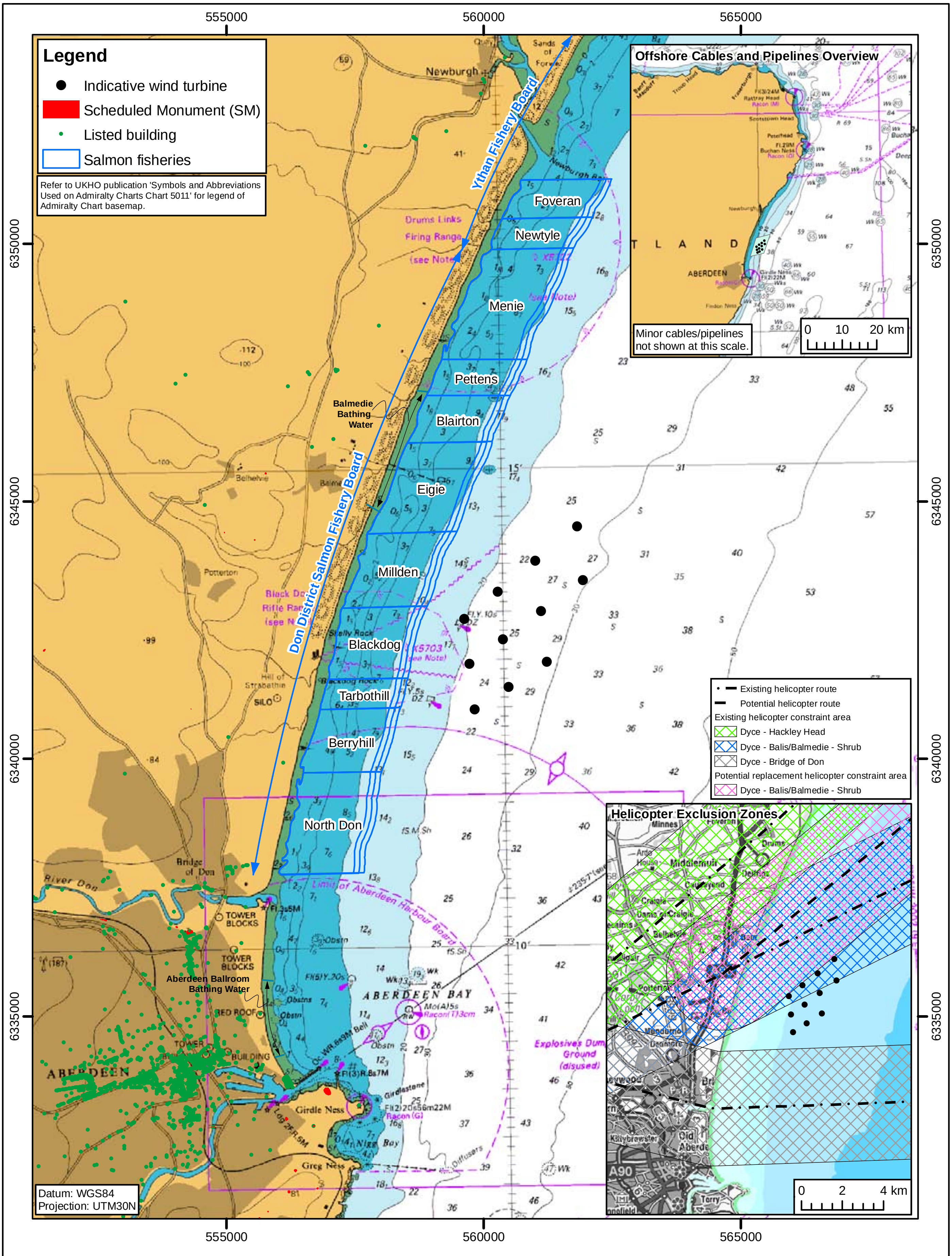
European Offshore Wind Deployment Centre

Coastal Process Modelling Data

Layout	Date	Rev	Dwg No.
LABER039	16/08/2010	A	6129-521-PA-017

Figure 11



0 0.25 0.5 nm 0 0.5 1 km

Original A4 Plot Scale 1:100,000

European Offshore Wind Deployment Centre

Other Marine Users

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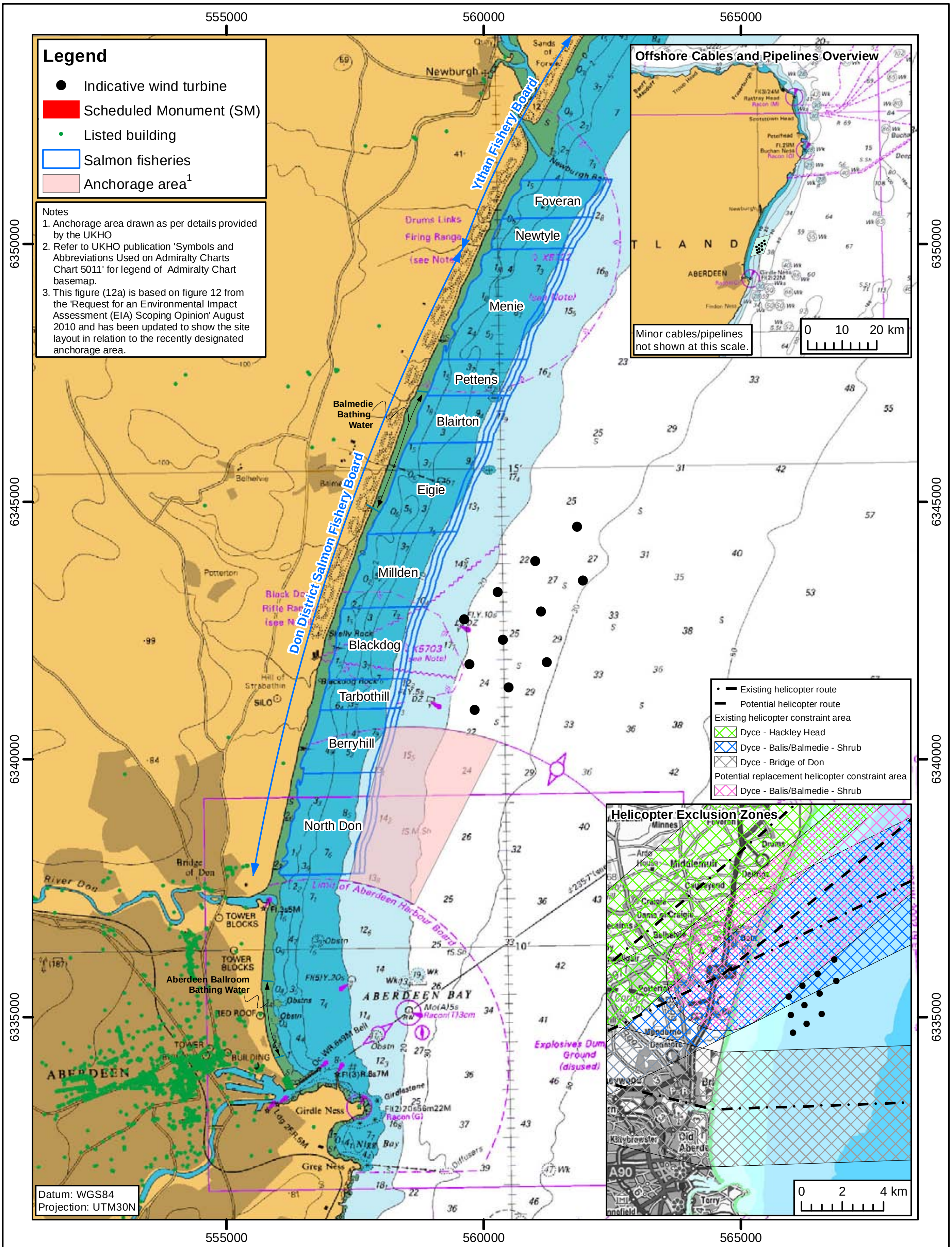
Rev	Date	By	Comment
A	16/08/10	LH	First Issue.

Layout	Date	Rev	Dwg No.
LABER039	16/08/2010	A	6129-521-PA-009

Figure 12



0 0.25 0.5 nm 0 0.5 1 km

Original A4 Plot Scale 1:100,000

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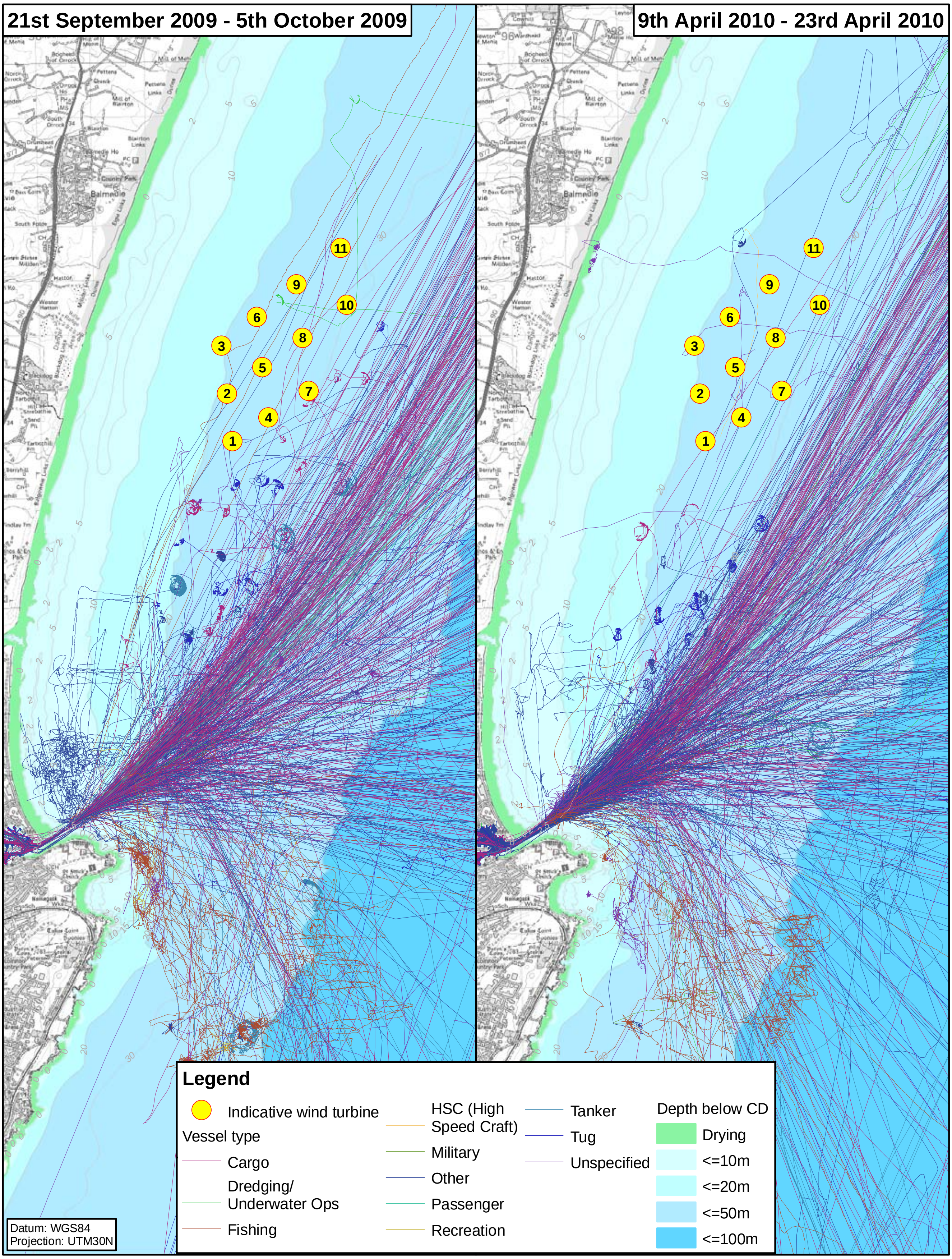
European Offshore Wind Deployment Centre

Other Marine Users

Layout	Date	Rev	Dwg No.
LABER039	07/10/2010	A	6129-521-PA-024

Figure 12a



0 0.25 0.5 nm 0 0.5 km Original A4 Plot Scale 1:100,000

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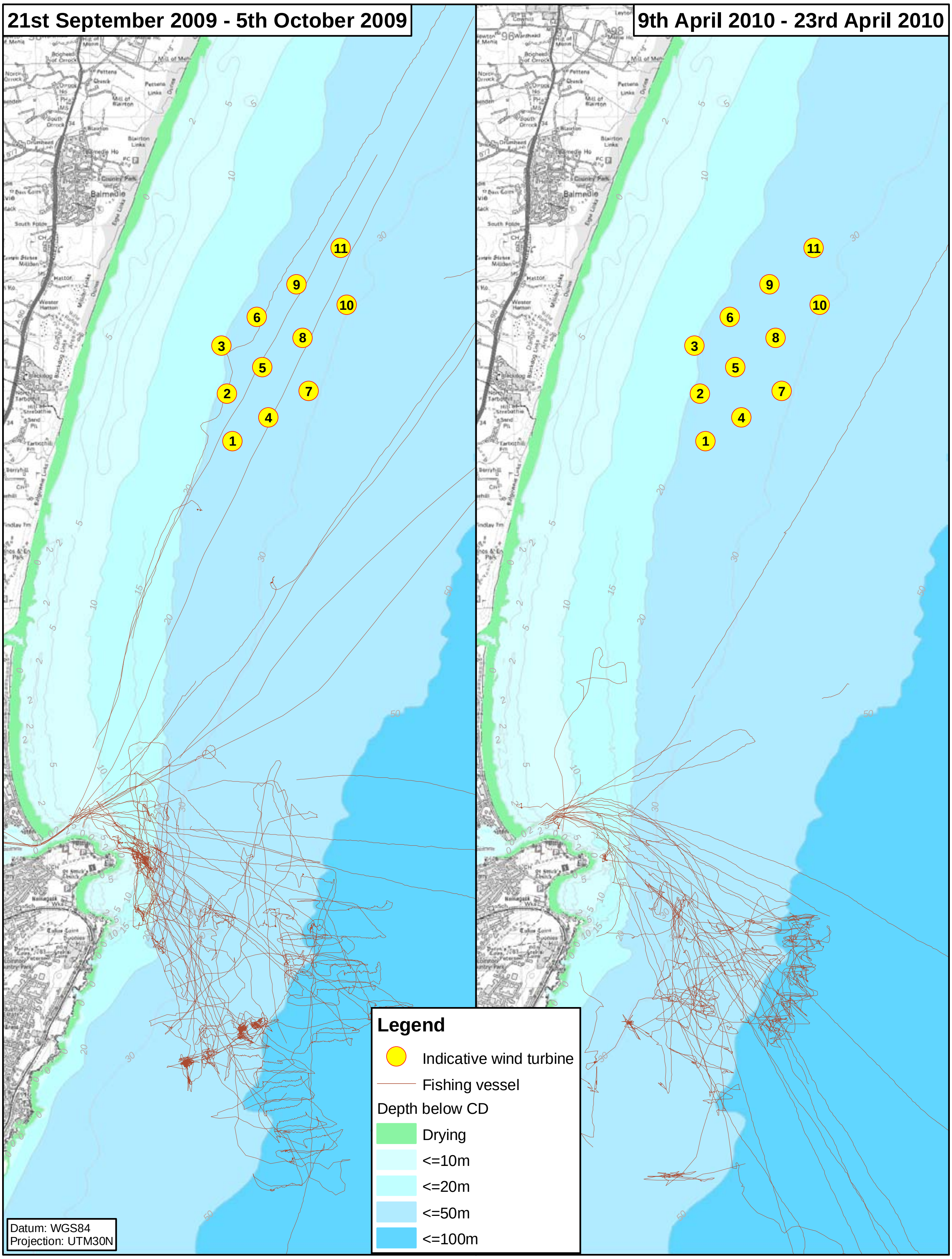
A	16/08/10	LH	First Issue.

European Offshore Wind Deployment Centre

Shipping Activity Surveys (All Vessels)

Layout	Date	Rev	Dwg No.
LABER039	16/08/2010	A	6129-521-PA-012

Figure 13



0 0.25 0.5 nm	0 0.5 km	Original A4 Plot Scale 1:100,000

VATTENFALL

areg Aberdeen Renewable Energy Group

Vattenfall Wind Power Ltd, Bridge End, Hexham, NE46 4NU, United Kingdom. Tel +44 (0) 1434 611300, Fax +44 (0) 1434 611301

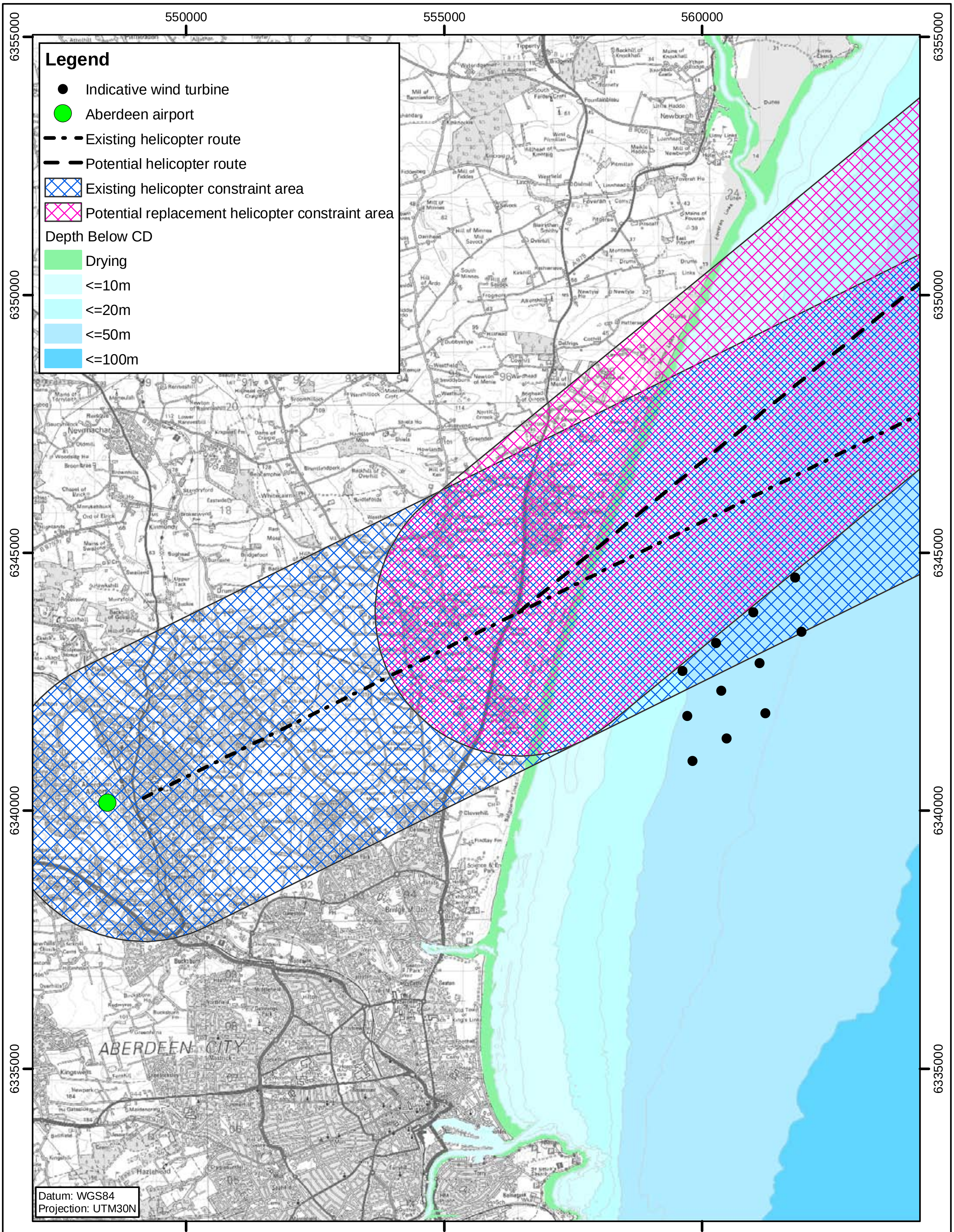
Rev	Date	By	Comment
A	16/08/10	LH	First Issue.

European Offshore Wind Deployment Centre

Shipping Activity Surveys (Fishing Vessels)

Layout	Date	Rev	Dwg No.
LABER039	16/08/2010	A	6129-521-PA-013

Figure 14



0 0.25 nm 0 0.5 1 km
Original A4 Plot Scale 1:100,000

VATTENFALL

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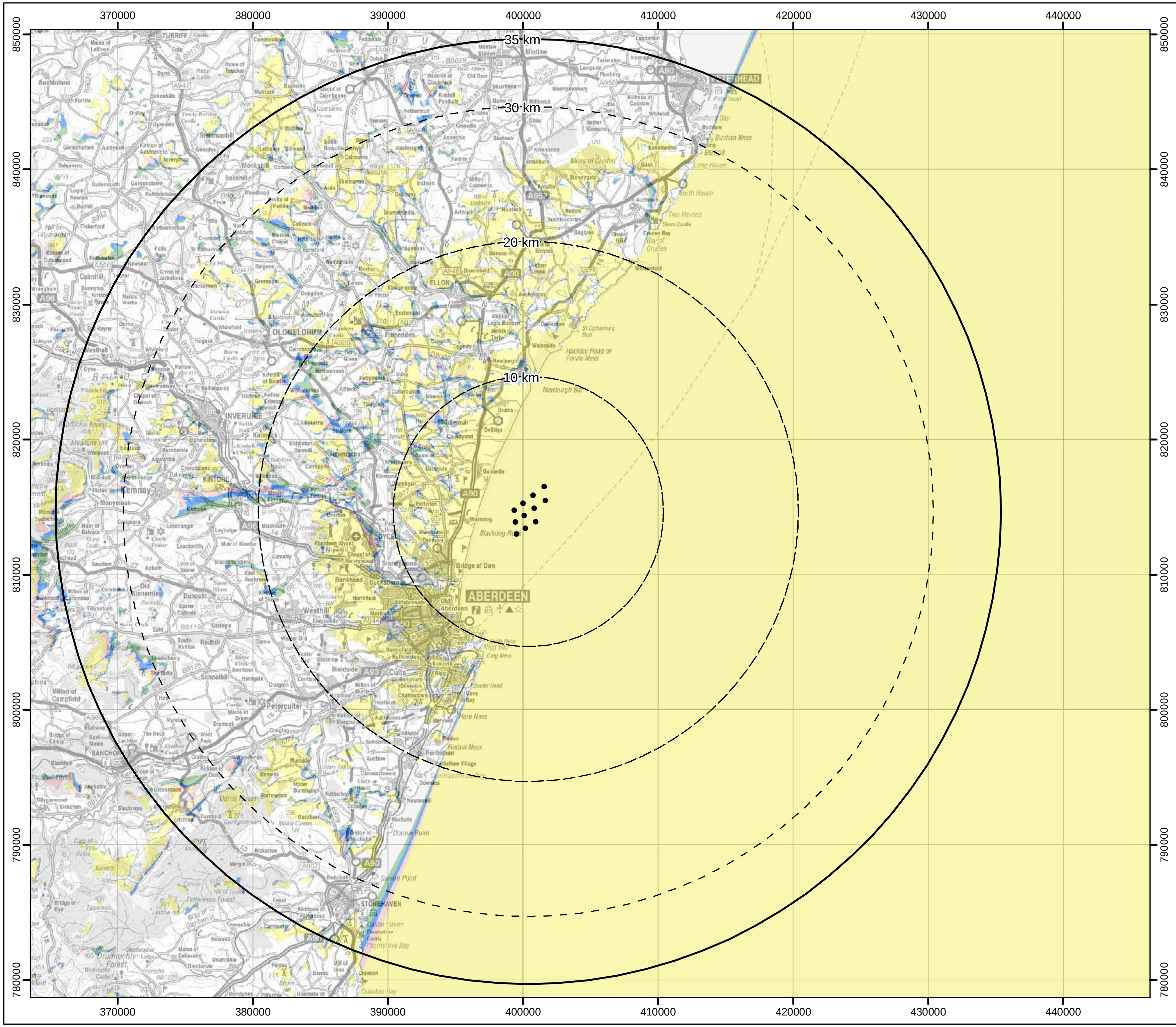
Rev	Date	By	Comment
A	16/08/10	LH	First Issue

European Offshore Wind Deployment Centre

Dyce - Balis/Balmedie - Shrub Helicopter Route

Layout	Date	Rev	Dwg No.
LABER039	16/08/2010	A	6129-521-PA-018

Figure 15



areg Aberdeen Renewable Energy Group

VATTENFALL

European Offshore Wind Deployment Centre

Zone of Theoretical Visibility to Tip Height (195 m above L.A.T.)

Legend

- ● Indicative wind turbine

Theoretical Visibility to Turbine Tip Height (195 m above L.A.T.)

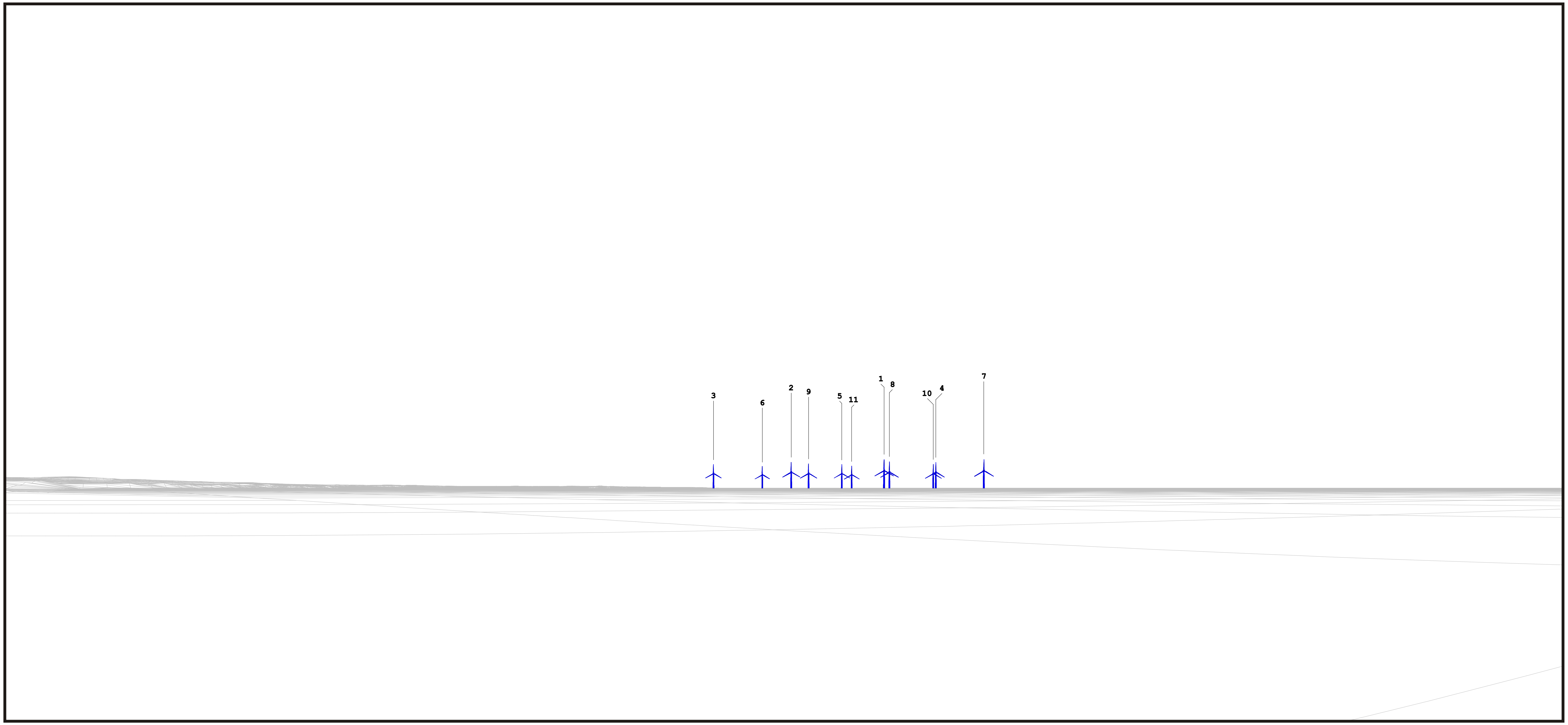
- 1 - 3 wind turbines may be visible
- 4 - 6 wind turbines may be visible
- 7 - 9 wind turbines may be visible
- 10 - 11 wind turbines may be visible

Notes
1. Calculated using Earth's curvature (radius 6367 km) and atmospheric refraction coefficient of 0.075.
2. Terrain data is derived from Ordnance Survey 50 m gridded height data.
3. ZTV calculation does not take into account any surface features such as trees and buildings.
4. Tip height - 192.85 m
5. ZTV view height - 2 m
6. ZTV calculation resolution - 50 m
7. Heights are above Ordnance Datum unless otherwise stated
8. Layout - LABER039.WFL
9. ZTV Run File - ZABER005.WFZ

0 1 2 3 km

0 1 2 nm

Drg No	6129 – 521 – PA – 020			**Figure 16**
Rev	A	Date	12/08/10	
By	LH	Layout	LABER039	



European Offshore Wind Deployment Centre

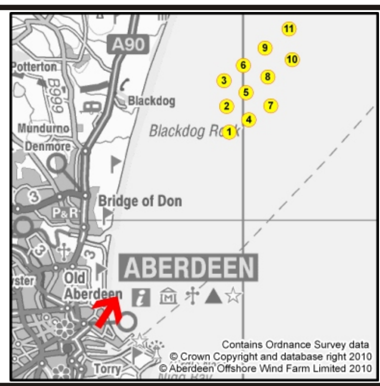
areg
Aberdeen Renewable Energy Group

VATTENFALL

Grid Reference: NJ9536806893
Terrain Height (ODN): 0 m
View Direction: 30º
Angle Of View: 67º
Observer Height: 2 m
Viewing Distance: 330 mm
Nearest Turbine: 7.4 km
Turbine Numbers 1 - 6:
Hub Height: 100 m / Rotor Diameter: 120 m
Turbine Numbers 7 - 11:
Hub Height: 120 m / Rotor Diameter: 150 m

Drg No: 6129-521-PA-021-A
Date: 13th August 2010
Layout ref: LABER039_SCOPING2
Viewpoints ref: VABER008
Earth's curvature: 6367 km
Atmospheric refraction coeff: 0.075

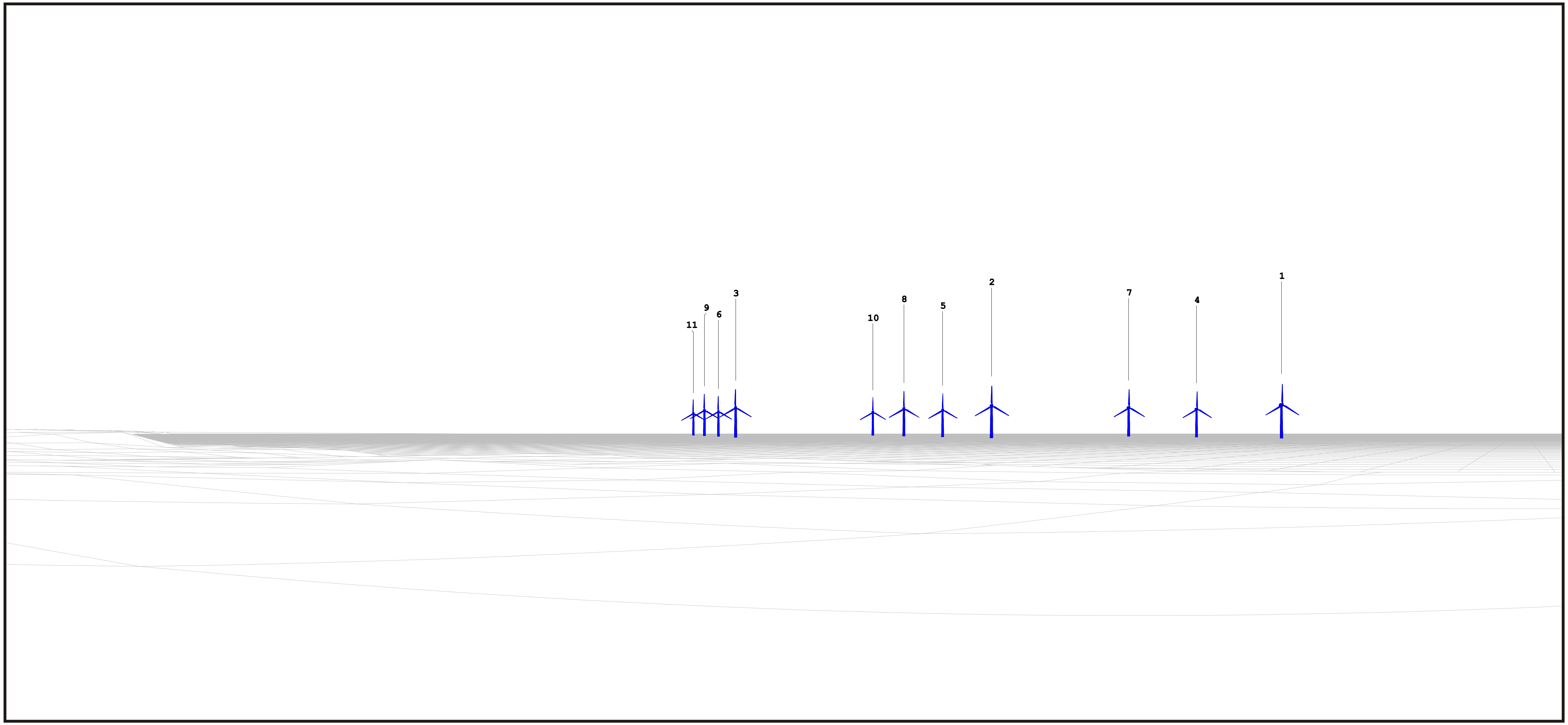
Hub heights are above L.A.T.



Viewpoint 1

View from Aberdeen Beach

Figure 17

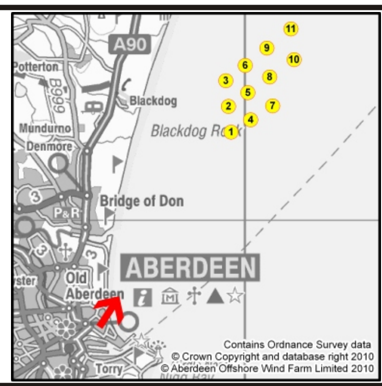


European Offshore Wind Deployment Centre

Grid Reference: NJ9568012316
Terrain Height (ODN): 19 m
View Direction: 58°
Angle Of View: 67°
Observer Height: 2 m
Viewing Distance: 330 mm
Nearest Turbine: 3.9 km
Turbine Numbers 1 - 6:
Hub Height: 100 m / Rotor Diameter: 120 m
Turbine Numbers 7 - 11:
Hub Height: 120 m / Rotor Diameter: 150 m

Drg No: 6129-521-PA-022-A
Date: 13th August 2010
Layout ref: LABER039_SCOPING2
Viewpoints ref: VABER008
Earth's curvature: 6367 km
Atmospheric refraction coeff: 0.075

Hub heights are above L.A.T.



Viewpoint 2

View from Public Road Near Murcar Golf Course

Figure 18

European Offshore Wind Deployment Centre

Environmental Statement

Appendix 4.2: Request for Scoping Opinion 2010 Responses

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

Our Ref. REF/A8/2049 [ZEF]
Your Ref.
Contact Robert Forbes
Email pi@aberdeencity.gov.uk
Direct Dial 01224 522390
Direct Fax 01224 636181

23 September 2010

Planning & Sustainable Development
Enterprise, Planning and Infrastructure
Aberdeen City Council
8th floor
St Nicholas House
Broad Street
Aberdeen AB10 1GY

Tel 01224 523470
Fax 01224636181
Minicom 01224 522381
DX 529452, Aberdeen 9
www.aberdeencity.gov.uk

Vatenfall Wind Power Ltd
The Tun Building
4 Jacksons Entry
Holyrood Road
Edinburgh
EH8 8AE

Fao D. Rodger

Dear Sir

Aberdeen Offshore Windfarm – Scoping Report

I refer to the above matter and your letter dated 20 August 2010. Thank you for the opportunity to comment on the above.

It is unclear what is meant by “onshore deployment facilities” as referred to at para 50. It is noted at para 51 that the report only deals with the offshore elements of the project. It should be noted that separate planning permission will be required for the onshore elements of the project from the relevant planning authority (e.g. substation / transmission lines). Given the integral and essential nature of the onshore elements to the project as a whole, it is recommended that they be considered as part of a robust EIA process for the wider project. This has the benefit of potentially avoiding the need for undertaking a separate EIA, as well as enabling a holistic approach to evaluation of the project impacts. It is recommended that scope of the ES should include consideration of the options for the routing of the cable connection, the location of the substation and related environmental and visual impacts, including the need for mitigation measures such as grounding of cable connections to the grid and provision of landscape measures such as tree planting. You may wish to request a screening opinion regarding the specific onshore elements from the relevant planning authority.

It is suggested that the scope of the ES also be expanded to consider the possible indirect environmental, economic and social benefits of the proposed development to the Aberdeen area resulting form the implementation of a community fund. I would appreciate clarification of what specific mechanism is proposed to ensure that such potential community benefits for the City of Aberdeen may be delivered.

As regards consultees, it is recommended that you include Scottish Enterprise (Grampian), UKOOA and North East Scotland Biological Records Centre (Nesbrec), You may also wish to contact relevant technical specialists within the Council directly (e,g, Aftab Majeed, Environmental Planner; Andrew Gilchrist, Environmental Health and Judith Stones, Archaeologist).

I trust the above comments are of some assistance and look forward to further involvement regarding this project. Should you require any clarification regarding the above, please contact me directly.

Yours faithfully

Robert Forbes
Senior Planning Enforcement Officer

Aberdeen Harbour

Our Ref: W.12

Mr David Rodger
Vattenfall Wind Power Ltd
The Tun Building
4 Jacksons Entry
Holyrood Road
EDINBURGH EH8 8AE

Dear Sir

Response to Scoping Report for European Offshore Wind Deployment Centre

Aberdeen Harbour Board welcomes the development of the European Offshore Wind Deployment Centre off Black Dog and is very interested in becoming involved in providing quayside and other facilities for the Centre's development and ongoing operational phase.

There are, however, several concerns regarding the proposal outlined in the scoping report and these are listed below:

1. Due to the high level of shipping activity both using Aberdeen Harbour and passing traffic it is essential that the location of the EOWDC does not change from that proposed. For the same reason no additional turbines or other structures should be added outside the currently proposed footprint in the future unless it is to the north.

2. The proposed cable run connecting the EOWDC to the shore currently passes through the Maritime and Coastguard Agency designated anchorage. This area is in frequent use and cannot safely be reduced in size. An alternative route for the cables should be located at a safe distance from the anchorage allowing for the possibility of a vessel dragging anchor.

3. Has sufficient information been obtained to establish the route and installation of the electricity cables in respect of the highly mobile seabed which can be subject to re-suspension throughout the tidal cycle or under stormy conditions?

4. Has modelling and monitoring been done on the impact of the turbines on the dynamic seabed? Scour and erosion are possible around the base of the turbine and if this were to increase the material in suspension it could impact on the dredging regime at Aberdeen Harbour and the beach profile of Aberdeen beach.

I trust these concerns are self explanatory, however, should you require further information please do not hesitate to contact me.

Yours sincerely

Colin Parker
Chief Executive

Aberdeen Harbour Board 16 Regent Quay, Aberdeen AB11 5SS
t: +44 (0)1224 597000 **e:** info@aberdeen-harbour.co.uk **www.aberdeen-harbour.co.uk**

Sleightholme Edwina (VA-WUS)

From: Rodger David (VA-WU)
Sent: 24 August 2010 11:19
To: Purves Lee (VA-WU)
Cc: Sleightholme Edwina (VA-WUS)
Subject: FW: European Offshore Wind Deployment Centre

psa

David Rodger
Senior Development Manager
Vattenfall Wind Power
☎ +44 (0) 131 526 3131 (switchboard)
☎ +44 (0) 131 526 3136 (direct)
+44 (0) 7595 221239 (mobile)

✉ The Tun Building, 4 Jacksons Entry, Holyrood Road, Edinburgh, EH8 8AE

E-mail: david.rodger@vattenfall.com
www.vattenfall.com

From: dale.aitkenhead@bt.com [mailto:dale.aitkenhead@bt.com]
Sent: Tuesday, August 24, 2010 10:03 AM
To: Rodger David (VA-WU)
Subject: European Offshore Wind Deployment Centre

Dear David

European Offshore Wind Deployment Centre – EIA scoping report

Thank you for your letter dated 20th August,2010.

We have studied this wind farm proposal with respect to EMC and related problems to BT point-to-point microwave radio links.

The conclusion is that, the Wind farm Project indicated should not cause interference to BT's current and presently planned radio networks.

Therefore BT will not be providing comments on the report

Regards

Dale Aitkenhead
BT Operate
Radio Frequency Allocation & Network Protection
pp 4AA CTE, Newcastle Central Tel Exch (TEL-NE), Carliol Square, Newcastle upon Tyne. NE1 1BB. Tel: 0191 2696372 Fax: 0191 261 6458 e-mail: dale.aitkenhead@bt.com

Directorate of Airspace Policy

Mr Andrew Sutherland (via e-mail)
Marine Scotland

20 September 2010

Reference: ERM/DAP/Wind/EuropeanOffshoreWDC

Dear Mr Sutherland

Proposed European Offshore Wind Deployment Centre Wind Turbine Development – Scoping Opinion Comment

Thank you for your recent correspondence relating to the proposed European Offshore Wind Deployment Centre wind turbine development. You sought related Civil Aviation Authority (CAA) comment related to the associated Scoping Report (SR); I trust the following is useful.

As alluded to with the documentation provided, like any wind turbine development, the proposed subject development has the potential to impact upon aviation-related operations; the Department for Trade and Industry (DTI – now the Department for Energy and Climate Change)-sponsored document 'Wind Energy and Aviation Interests' and Civil Air Publication 764 refer[1]. The related need to establish the scale of the potential impact of the European Offshore Wind Deployment Centre development is evident.

Having reviewed the SR and in particular the site in question, I can advise that the development might have a potential impact upon operations associated with Aberdeen Airport and note that the SR indicates ongoing consultation. All parties should be aware that aerodrome safeguarding responsibility rests with the aerodrome licensee. Any related Environmental Statement, or equivalent, would be expected to acknowledge and quantify any potential impact upon the Airport-related operations and, where applicable, detail appropriate mitigation.

Similarly, as will all wind turbine developments of this scale, the Environmental Statement will need to detail the associated viewpoints of both NATS and Ministry of Defence (MoD). To that end, I note the SR also details the ongoing consultation with these organisations and the outcomes of these and any associated mitigations as agreed should be reported in the Environmental Statement.

Not highlighted in the Scoping Report is the issue of Aviation Warning Lighting. The subject wind farm will fall under the requirements of Air Navigation Order 2009 Article 220 and this will need to be acknowledged in the Environmental Statement. Given the intensity of helicopter operations in the area, I consider this to be a significant area.

With respect to Landfall, the Environmental Statement may need to address the impact on aviation of power line routeing between Landfall and the onshore substation(s) if the power lines are a significant height above ground.

[1] These documents are available at http://www.bwea.com/pdf/Wind-Energy-and-aviation-interim-guidelines.pdf and http://www.caa.co.uk/docs/33/Cap764.pdf respectively. Please note that after a full review CAP 764 was re-issued on 12 February 2009.

Civil Aviation Authority
CAA House 45-59 Kingsway London WC2B 6TE www.caa.co.uk
Telephone 020 7453 6545 Fax 020 453 6565 marks.smailes@caa.co.uk

Additionally, if more generically, all parties should be aware that:

- International aviation regulatory documentation requires that the rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines that are deemed to be an aviation obstruction should be painted white, unless otherwise indicated by an aeronautical study. It follows that the CAA advice on the colour of wind turbines would align with these international criteria.

- There is a civil aviation requirement in the UK for all structures over 300 feet high to be charted on aviation maps. Should this development progress and the 300 feet height be breached the developers will need to provide details of the development to the Defence Geographic Agency.

- The number of pre-planning enquiries associated with windfarm developments has been significant. It is possible that the proliferation of wind turbines in any particular area might potentially result in difficulties for aviation that a single development would not have generated. It is, therefore, not necessarily the case that, because a generic area was not objected to by the aviation industry, future, similarly located potential developments would receive the same positive response. There is a CAA perceived requirement for a co-ordinated regional wind turbine development plan, aimed at meeting renewable energy priorities, whilst addressing aviation concerns and minimising such proliferation issues. Indeed, this may be an area where the centre may be able to provide some research.

Any associated Environmental Statement should mention and, where applicable, address the issues highlighted above.

Yours sincerely

{by email}

Paul Askew
Renewable Energy Projects Officer

cc.

Mr D Rodger, Senior Development Manager, Vattenfall

marine scotland

The Scottish Government

Vattenfall Wind Power Ltd
The Tun Building
4 Jacksons Entry
Holyrood Road
Edinburgh
EH8 8AE

15th December 2010

Dear Edwina

ELECTRICITY ACT 1989
THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2000

VATTENFALL AND ABERDEEN RENEWABLE ENERGY GROUP (AREG):
ENVIRONMENTAL IMPACT ASSESSMENT SCOPING DOCUMENT, EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE (EOWDC), ABERDEEN

Thank you for giving Marine Scotland Licensing Operations Team (MS-LOT) the opportunity to comment on the Environmental Impact Assessment (EIA) Scoping Report. MS-LOT is the licensing authority for the above Act which extends seaward of the mean low water spring mark. The proposal is for a commercially operated windfarm deployment centre which will hold 11 turbines and an ocean laboratory. The EOWDC site is located 2km from the Aberdeenshire coast between Aberdeen in the south and Balmedie in the north, with a lease area of 20km^2. The ocean laboratory will be consented separately.

Recently, offshore wind has focussed on large scale windfarm sites leased by The Crown Estate for Round 3 and Scottish territorial waters. These will involve the installation of a large number of turbines over several years to ensure the UK and Scottish Governments meet their commitments to generating electricity from renewable sources. Issues associated with cumulative and in combination effects of these developments will arise, MS-LOT wishes to have further discussions with the developers on this issue, at a recent meeting EOWDC indicated that a separate document addressing these matters was being drafted. The scoping document clearly states that the developer will apply for Town and Country planning for the onshore works and will not be incorporating any of the onshore infrastructure works into the EIA for the wind farm.

The definition of the ‘Rochdale envelope’ approach described in Section 3.4.1 is consistent with all large offshore wind developments. This allows developers to describe their projects in a hypothetical manner by fully assessing any impacts associated with all technology that may be considered on the site. However, MS-LOT understands that only one technology described within the EIA will be progressed towards commercial deployment. The EOWDC project is proposing to use more than one type of foundation i.e. there are 6 described in the scoping document. Therefore, the ‘Rochdale envelope approach’ should be applied differently; the assessment should include the interactions and cumulative impacts between each different type of foundation. However, if EOWDC do intend using the same foundation base throughout then the standard approach could be adopted. Due to the description of the ‘Rochdale envelope’ approach described above; points 56 – 58, within the scoping document, cannot be considered without the above assessment. Therefore, indicative layouts should be presented within the EIA. MS-LOT are available to discuss this issue in greater detail.

The same is also true for the actual turbine(s), the EIA can be drafted on a hypothetical machine with a maximum height to the tip of 195m above Lowest Astronomical Tide (LAT), the technology going forward on the site has been described as between 4-10MW, the 4MW has a maximum hub height of 100m and the 10MW turbine has a max hub height of 120m above LAT. The final design will dictate the maximum rotor diameter and an assessment should be carried out on the worst case scenario.

At the meeting on the 13/05/2010 (please refer to the minutes), EOWDC were advised by MS-LOT on the inflexibility of the Section 36 consent and that a generic EIA for the site should be undertaken. Separate assessments for each foundation could then be undertaken and inserted as an appendix when developers sign up to use the site. It was understood, by MS-LOT, at the time of the meeting, that each type of foundation chosen would require a separate consent, thus a single Section 36 consent would not cover the whole installation. MS-LOT has subsequently reviewed both the Section 36 legislation and its position in regard to the proposal set out in the scoping document and are of the opinion that a degree of flexibility might exist when considering the consenting strategy. MS-LOT would like to discuss this matter with you early in the New Year .

Inter array cabling

Installation methodologies must be detailed as the FEPA/Marine licence applications require a list of deposits. Point 74.

Construction timelines

Phase 1 – 4 x turbines year 1 (2012)
Phase 2 – 7 x turbines year 3 (2014)

MS-LOT requires a further update on the construction timeline and potential funding constraints, a further meeting should be scheduled to discuss the above information. EOWDC should note that mitigation measures for marine mammals will be included in the conditions and at this stage we warn you that a 24hr working window might not be possible as the Marine Mammal Observer onboard will not be able to identify marine mammals in the dark. However, we can discuss this aspect further and we are prepared to be open minded on the outcome of those discussions.

The scoping document highlighted (point 70) that a major turbine service would be required every 12 months. However, MS-LOT are not aware that the proposed technology is fully understood. Therefore please notify MS-LOT if this assessment is based on historical knowledge, and provide references. It was also stated that ‘gearbox oil changes are required every 5 years’, EOWDC will be required to provide method statements and contingency plans for these operations.

Section 36A

We understood that this does not apply in Scottish waters and therefore there are no provisions through section 36 for safety areas around the turbines, however, recent discussions with colleagues indicate that this situation might have changed. We will report back to you as soon as possible.

3.2 Marine Licensing

- MS-LOT will continue to administer all of the consents after April 2011.
- The Environmental Statement (ES) is the section 36 application.

Appropriate Assessment (AA)

In order for the AA to be carried out by the competent authority the installation technologies would have to be known in order to assess the impacts.

Marine Scotland Science (MSS)

The following comments have been received from MSS colleagues.

The Environmental Impact Assessment (EIA) must informatively and clearly identify the key impacts associated with the EOWDC. Within the EIA all useful sources of existing surveys and studies need to be specified.

Proposed survey techniques

The scoping document appears to have identified the potential key impacts with regard to the development. Useful sources of data from existing surveys and studies have been identified but these may not cover the whole area. However, the proposed combination of video survey and benthic grabs is essential to adequately determine the dominant habitat types and species present in the development area, large epifauna are generally under sampled by grab and trawl sampling.

Marine ecology

The Benthic Habitats Para 216 requires the reference for the biotope names to be inserted. Clarification is required within paragraph 230 as single grabs are now being collected from each position, does this mean that the sampling strategy is now considered randomly stratified; please confirm.

Sedimentary shores on the east coast Para 244: MS-LOT would like to highlight that Collieston beach is bounded by a breakwater/pier and the meiofaunal distributions may reflect this artificial situation. Therefore the sediment and the fauna distributions are localised for this area and may not represent soft sediment shores from the area of interest. Beach profiling to quantify erosion / modification should be considered, and the outcome discussed with MS-LOT prior to any action being taken., The name "*diversicolor*" should be rendered in italics.

Coastal processes

Sedimentation/erosion patterns on Aberdeen Beach are influenced by the presence of coastal structures (near shore rock structures and timber groynes), and beach re-charge. Using beach profiles taken by the University of Aberdeen may not be representative of the ongoing processes at the beach near the development site, and MS –LOT are of the opinion that a local survey would give more confidence in the interpretation of current processes and the potential impact of the development on these processes. In case Aberdeen Offshore Wind Farm Ltd has not yet been in contact with Aberdeen University regarding this data, the Aberdeen Beach project is managed by Ms. Amy Taylor and Prof. T. O'Donoghue at the School of Engineering.

Figure 11: The Ythan estuary is not in the area considered for far-field effects. Should there be significant changes in the sediment mobility in the far-field area, then this could have potentially important effects on the sedimentation/erosion patterns of the estuary. Extending the domain in the first instance, could avoid having to do this at a later stage should sediment mobility become an important issue. Again, we request you consider this point and refer to MS-LOT.

Construction

Details of any noise pollution resulting from any construction activity and any associated potential effects on cetaceans/pinnipeds/fish will be required. Noise assessments should take into consideration background noise, including vibration produced from ships' engines, piling hammers and auguring operations during the construction of turbine foundations. Considerable studies have already been conducted on cetaceans in the Moray Firth area, but the particular cause for concern is the potential additional extensive Round 3 wind farm site to the North of this development.

The proposed development will need to consider, in the first instance through a desk study, potential impacts on migratory fish including salmon (*Salmo salar*), sea trout (*Salmo trutta*), sea lamprey (*Petromyzon marinus*), river lamprey (*Hyperoplus lanceolatus*)and sandeels (*Ammodytes marinus*) during all phases of the project. The potential for offshore renewable projects to impact on migratory fish will vary depending on the design and location of the development in relation to the migration routes of adults and juveniles. Potential impacts may include physical or avoidance reactions at both the individual and population level and there may also be avoidance due to electromagnetic sensitivity at both adult and juvenile stages.

In cases where there is uncertainty over potential impacts it may be necessary for the developer to implement a monitoring strategy to assess the influence on salmonid fish populations. The expected levels of noise production must be identified in the ES and derived by using published literature, decide what impact, if any, this will have on fish movements through the area. Will it result in avoidance of the area and, if so, what does this mean for migrating fish. Please refer to Appendix A and after consideration get in contact to MS-LOT.

Inshore fisheries

From a marine fisheries perspective the following comments are provided on the range of issues and impacts identified. The assessment methodologies are proposed and sources of data identified, indicating any perceived information gaps or inaccuracies.

Section 5.3 Fish, shellfish and elasmobranches

The scoping report adequately identifies fish (commercial and non commercial), shellfish and cephalopod species known to and / or likely to occur in the area and the potential impacts of the development on these species.

Species present include some threatened and/or declining species (on OSPAR list) and UK Biodiversity Action Plan (BAP) priority species. The latter have not however been specifically identified. None of the species are unique to the area. The scoping report includes a recorded observation of a basking shark in the vicinity of the proposed development, basking sharks are protected under Schedule 5 of the Wildlife and Countryside Act thus it is a criminal offence to cause any form of disturbance to them. MS-LOT should be informed if any protected species are recorded on the site.

The report includes some reproductions of spawning and nursery grounds data from the fisheries sensitivity maps (Coull et al 1998). The developers are aware that these represent very broad scale (indicative) distributions and that more detailed and site specific information may be available elsewhere (proposal for desk studies). These maps are in some cases misleading, Nephrops distribution for example is limited by suitable (mud) habitat - both juveniles and adults live in burrows in the mud, emerging to feed and breed. MS – LOT is not aware of any specific spawning or nursery grounds within the site.

The colour reproduction of the maps, particularly the colours of the legend compared to the mapped areas make them very difficult to interpret and, in the case of Fig 5.1, render the maps misleading. If they are to be reproduced in the EIA this should be rectified.

In relation to the underwater noise impacts, MS-LOT note that no specific data will be collected on noise effects (associated with piling / installation). MS-LOT concur with the proposal that the current information is adequate for evaluating impacts of the development on fish.

Studies on possible reef effects are proposed, MS-LOT encourages this approach but recommend that it will require robust baseline information. The potential survey methodology plans should identify both mobile and more sedentary species present for all and/or part of the year. The report states there is already an established 'baseline' of data. If these data are from historic surveys it may require updating or expanding.

It is indicated in Section 5.8 that potential impact of Electromagnetic Fields (EMF) will be assessed as part of the EIA process using the results of the Cowrie studies referenced. Although this is probably adequate, given the relatively limited extent of this development and lack of others in the vicinity (limited potential for cumulative effects) results of other relevant research should be considered.

Section 6.1.4.2 fishing vessels

Few vessels appear to transit this area and restrictions during the construction phase are unlikely to cause particular problems. Discussion with fishing stakeholders about any action required appears to be reasonable.

An assessment of the cumulative impacts of fishing in association with other marine activities in the area should be addressed as indicated.

Section 6.6 commercial fisheries

Sources of 'baseline' information on fishing in the area of the proposed wind array and possible impacts on fishing have been adequately considered in the scoping document. MS-LOT would like to see the updated versions of the earlier reports. MS-LOT concurs that with mitigation residual effects on commercial fishing are likely to be minor / negligible.

MS-LOT note, however, that the area of the proposed development does not coincide with suitable habitat for *Nephrops* - interference with *Nephrops* fishing is therefore unlikely to be a major issue.

Consultation with commercial fishermen has to date been through the Scottish Fishermen's Federation (SFF). Although this is appropriate, and the SFF should continue to be consulted, the developers should be aware that many inshore fishermen in Scotland are non-affiliated i.e.

not members of Associations represented by the SFF. Some form of local consultation should therefore be considered.

Cumulative and in combination effects

A cumulative and in combination impact assessment is also a requirement of the Habitats Regulations Appraisal (HRA) with respect to the designated Special Areas of Conservation (SAC) and Special Protection Areas (SPA) which may be affected. As a result, the cumulative and in combination assessment of impacts on the marine mammals and seabirds of the Moray Firth's European designated sites will be an important consideration within the EIA process. Other cumulative effects, which consider the impacts arising from the proposed EOWDC wind farm in the context of other non wind farm developments (e.g. oil and gas operations) and activities (e.g. the shipping and fishing industries) will also be considered in the course of the EIA. MS-LOT await a document that addresses these aspects and, once it has been reviewed, may wish to update this advice.

Cable route and layout

Marine Scotland would like to emphasise that all developers are required to include maps, 'baseline' data and any details associated with the cable route within their ES as it is incorporated into the overall footprint of the works.

Throughout the document there is reference to Fisheries Research Services (FRS), Marine Scotland, and the Scottish Fisheries Protection Agency (SFPA) as data sources for all 'baseline' assessments. Developers should be aware that as of April 1 2009 - FRS became Marine Scotland Science, SFPA became Marine Scotland Compliance and that Marine Scotland is a Directorate (not an Executive agency) of Scottish Government.

Thank you for consulting with MS-LOT on this matter.

Yours sincerely

Fiona Thompson
Marine Scotland

Appendix A

Scoping comments in relation to information requirements on diadromous fish of freshwater fisheries interest

Offshore renewable developments have the potential to directly and indirectly impact diadromous fish of freshwater fisheries interest including Atlantic salmon, anadromous brown trout (sea trout) and European eel. These species use the coastal areas around Scotland for feeding and migration and are of high economic and / or conservation value. As such they should be considered during the EIA process. Developers should also note that offshore renewable projects have the potential to impact on fish populations at substantial distances from the development site.

In the case of Atlantic salmon information will be required to assess whether there is likely to be any significant effect of developments on rivers which are classified as Special Areas of Conservation (SAC's) for Atlantic salmon under the Habitats Directive. Where there is the potential for significant impact then sufficient information will be required to allow Marine Scotland to carry out an Appropriate Assessment.

In order that Marine Scotland is able to assess the potential impacts of marine renewable devices on diadromous fish and meet legislative requirements the developer should consider the site location (including proximity to sensitive areas), type of device, and the design of any array plus installation methodology. Specifically we request that developers provide information in the following areas:

1. Identify use of the proposed development area by diadromous fish (salmon, sea trout and eels)

a. Which species use the area? Is this for feeding or migration?
b. At what times of year are the areas used?
c. In the case of salmon and sea trout what is the origin / destination of fish using the area?

2. Identify the behaviour of fish in the area

a. What swimming depths do the fish utilise
b. Is there a tendency to swim on or offshore

3. Assess the potential impacts of deployed devices on diadromous fish during deployment, operation and decommissioning phases. Potential impacts could include:

a. Strike
b. Avoidance (including exclusion from particular rivers and subsequent impacts on local populations)
c. Disorientation that could potentially affect behaviour, susceptibility to predation or by-catch, or ability to locate normal feeding grounds or river of origin
d. Delayed migration

4. Consider the potential for cumulative impacts if there are multiple deployments in an area.

5. Assess 1-4 above to determine likely risk.

a. If there are insufficient data to determine use of the development area, these should be obtained

b. If there are insufficient data on the origin / destination of fish using the area then these should be obtained

c. Where it is not possible to obtain site specific data, the developer should make a convincing argument why this is the case and apply appropriate expert judgement based on published information.

6. If there is any remaining doubt as to the potential impacts of a particular development, then the developer should recommend a scientifically robust monitoring strategy to assess any impacts either on stocks as a whole, or on particular rivers as necessary.

Marine Scotland Science has just completed a review of migratory routes for Atlantic salmon, sea trout and eels relevant to Scotland, which should be available in 2011. This will assist the developers in identifying what pre-existing information is available and what supplementary site specific data will be required.

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The Scottish Government

EUROPEAN OFFSHORE WIND DEVELOPMENT CENTRE (EOWDC) – ABERDEEN

Scoping Opinion

Contents

THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2000.

SCOPING OPINION FOR THE PROPOSED SECTION 36 APPLICATION FOR THE EOWDC OFFSHORE WINDFARM, ABERDEEN

1. Introduction

I refer to your letter of requesting a scoping opinion under the Electricity Works (Environmental Impact Assessment) (Scotland) (EIA) Regulations 2000 enclosing a scoping report.

Any proposal to construct or operate an offshore power generation scheme with a capacity in **excess of 1 megawatt** requires Scottish Ministers' consent under section 36 of the Electricity Act 1989.

Schedule 9 of the Act places on the developer a duty to "have regard to the desirability of preserving the natural beauty of the countryside, of conserving flora, fauna and geological and physiological features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest". In addition, the developer is required to give consideration to the Scottish Planning Policy on Renewable Energy other relevant Policy and National Policy Planning Guidance, Planning Advice Notes, the relevant planning authority's Development Plans and any relevant supplementary guidance.

Under the Electricity Works (Environmental Impact Assessment)(Scotland)(EIA) Regulations 2000, Scottish Ministers are required to consider whether any proposal for an offshore device is likely to have a significant effect on the environment. Scottish Ministers have considered your request for an opinion on the proposed content of the Environmental Statement (ES) in accordance with regulations and in formulating this opinion Scottish Ministers have consulted with the relevant organisations.

Please note that the EIA process is vital in generating an understanding of the biological and physical processes that operate in the area and that may be impacted by the proposed offshore wind farm. We would however state that references made within the scoping document with regard to the significance of impacts should not prejudice the outcome of the EIA process.

It is important that any devices to exploit renewable energy sources should be accompanied by a robust assessment of its environmental impacts. The assessment should also consider how any negative environmental impacts could be avoided or minimised, through the use of mitigating technologies or regulatory safeguards, so that the quality and diversity of Scotland's wildlife and natural features are maintained or enhanced. Scottish Ministers welcome the commitment given in the report that the EIA process will identify mitigation measures in order to avoid, minimise or reduce any adverse impacts. Marine Scotland Licensing Operations Team (MS-LOT) would suggest that the range of options considered should be informed by the EIA process in order that these objectives can be achieved. Consultation with the relevant nature conservation agencies is essential and it is advised that this is undertaken as appropriate.

2. Aim of this Scoping Opinion

Scottish Ministers are obliged under the EIA regulations to respond to requests from developers for a scoping opinion on outline design proposals.

The purpose of this document is to provide advice and guidance to developers which have been collated from expert consultees whom the Scottish Government has consulted. It should provide clear advice from consultees and enable developers to address the issues they have identified and address these in the EIA process and the ES associated with the application for section 36 consent.

3. Description of your development

From your submitted information it is understood that Aberdeen Offshore Wind Farm Limited (AOWFL) is proposing construct and operate an offshore wind farm and deployment centre off the coast of Aberdeen. The site will be known as the European Offshore Wind Deployment Centre (EOWDC). The maximum electrical output, as governed by the crown estate lease conditions is 100 Megawatts (MW) the site is located approximately 2 to 4.5km east of Blackdog, Aberdeenshire. The development can accommodate up to 11 turbines with a variety of generating capacities. The turbine layout and size will undergo an iterative design process as the EIA progresses.

4. Land Use Planning

The Scottish Government's planning policies are set out in the National Planning Framework, Scottish Planning Policy, Designing Places and Circulars.

The National Planning Framework is the Scottish Government's Strategy for Scotland's long term spatial development.

Scottish Planning Policy (SPP) is a statement of Scottish Government policy on land use planning and contains:

- the Scottish Government's view of the purpose of planning,
- the core principles for the operation of the system and the objectives for key parts of the system,
- statutory guidance on sustainable development and planning under Section 3E of the Planning etc. (Scotland) Act 2006,
- concise subject planning policies, including the implications for development planning and development management, and
- The Scottish Government's expectations of the intended outcomes of the planning system.

Other land use planning documents which may be relevant to this proposal include:

- PAN 42: Archaeology–Planning Process and Scheduled Monument Procedures
- PAN 45: 2002 Renewable Energy Technologies
- PAN 50: Controlling the Environmental Effects of Surface Mineral Workings
- PAN 51: Planning, Environmental Protection and Regulation
- PAN 56: Planning and Noise
- PAN 58: Environmental Impact Assessment
- PAN 60: Planning for Natural Heritage
- PAN 62: Radio Telecommunications
- PAN 68: Design Statements
- PAN 69: Planning and Building Standards Advice on Flooding
- PAN 75: Planning for Transport
- PAN 79: Water and Drainage
- Marine Guidance Note 371 (M)
- The Highland Structure Plan
- West Highland and Islands Local Plan (WHILP).

5. Natural Heritage

Scottish Natural Heritage (SNH) has produced a service level statement (SLS) for renewable energy consultation. This statement provides information regarding the level of input that can be expected from SNH at various stages of the EIA process. Annex A of the SLS details a list of references, which should be fully considered as part of the EIA process. A copy of the SLS and other vital information can be found on the renewable energy section of their website – www.snh.org.uk

6. General Issues

Economic Benefit

The concept of economic benefit as a material consideration is explicitly confirmed in the consolidated SPP. This fits with the priority of the Scottish Government to grow the Scottish economy and, more particularly, with our published policy statement "Securing a Renewable Future: Scotland's Renewable Energy", and the subsequent reports from the Forum for Renewables Development Scotland (FREDS), all of which highlight the manufacturing potential of the renewables sector. The application should include relevant economic information connected with the project, including the potential number of jobs, and economic activity associated with the procurement, construction operation and decommissioning of the development.

7. Contents of the Environmental Statement (ES)

Format

Developers should be aware that the ES should also be submitted in a user-friendly PDF format which can be placed on the Scottish Government (SG) website. A description of the methodology used in assessing all impacts should be included.

It is considered good practice to set out within the ES the qualifications and experience of all those involved in collating, assessing or presenting technical information.

Non Technical Summary.

This should be written in simple non-technical terms to describe the various options for the proposed development and the mitigation measures against the potential adverse impacts which could result. Within an ES it is important that all mitigating measures should be:

- Clearly stated;
- Fully described with accuracy;
- assessed for their environmental effects;
- assessed for their effectiveness;
- Their implementation should be fully described;
- How commitments will be monitored; and
- If necessary, how they relate to any consents or conditions.

Given that the layout and design are still developing and evolving, the exact nature of the work that is needed to inform the EIA may vary depending on the design choices. The EIA must address this uncertainty so that there is a clear explanation of the potential impact of each of the different scenarios. It should be noted that any changes produced after the ES is submitted may result in the requirement of further environmental assessment and public consultation if deemed to be significant by the licensing authority.

Baseline Assessment and Mitigation

Refer to Annex 1 for consultee comments on specific baseline assessment and mitigation.

8. Archaeology and Cultural Heritage

General Principles

The ES should address the predicted impacts on the historic environment and describe the mitigation proposed to avoid or reduce impacts to a level where they are not significant. Historic environment issues should be taken into consideration from the start of the site selection process and as part of the alternatives considered.

National policy for the historic environment is set out in:

- Scottish Planning Policy *Planning and the Historic Environment at:* http://www.scotland.gov.uk/topics/built-environment/planning/National-planning-policy/themes/historic
- The Scottish Historic Environment Policy (SHEP) sets out Scottish Ministers strategic policies for the historic environment and can be found at: http://www.historic-scotland.gov.uk/index/heritage/policy/shep.htm

Amongst other things, SPP paragraph 110–112, Historic Environment, stresses that scheduled monuments should be preserved *in situ* and within an appropriate setting and states that developments must be managed carefully to preserve listed buildings and their settings to retain and enhance any special architectural or historic features of interest. Consequently, both direct impacts on the resource itself and indirect impact on its setting must be addressed in any EIA undertaken for this proposed development. Further information on setting can be found in the following document: Managing Change in the Historic Environment http://www.historic-scotland.gov.uk/managing-change-consultation-setting.pdf.

Historic Scotland recommend that you engage a suitably qualified archaeological/historic environment consultants to advise on, and undertake, the detailed assessment of impacts on the historic environment and advise on appropriate mitigation strategies.

Baseline Information

Information on the location of all archaeological/historic sites held in the National Monuments Record of Scotland, including the locations and, where appropriate, the extent of scheduled monuments, listed buildings and gardens and designed landscapes can be obtained from www.PASTMAP.org.uk

Data on scheduled monuments, listed buildings and properties in the care of Scottish Ministers can also be downloaded from Historic Scotland's Spatial Data Warehouse at
http://hsewsf.sedsh.gov.uk/pls/htmldb/f?p=500:1:8448412299472048421::NO
For any further information on those data sets and for spatial information on gardens and designed landscapes and World Heritage Sites which are not currently included in Historic Scotland's Spatial Data Warehouse please contact

hsgimanager@scotland.gsi.gov.uk. Historic Scotland are also available to provide any further information on all such sites.

9. Navigation

The ES should include the following details on the possible impact on navigation for both commercial and recreational craft.

- Collision Risk
- Navigational Safety
- Risk Management and Emergency response
- Marking and lighting of Tidal Site and information to mariners
- Effect on small craft navigational and communication equipment
- Weather and risk to recreational craft which lose power and are drifting
- In adverse conditions
- Evaluation of likely squeeze of small craft into routes of larger
- Commercial vessels.
- Visual intrusion and noise

10. Ecology, Biodiversity and Nature Conservation

Refer to Annex 1 for comments from advisors on ecology, biodiversity and nature conservation.

Species

The ES should show that the applicants have taken account of the relevant wildlife legislation and guidance, namely

- Coast Protection Act 1949 section 34
- Council Directives on The Conservation of Natural Habitats and of Wild Flora and Fauna
- Conservation of Wild Birds (commonly known as the Habitats and Birds Directives)
- Wildlife & Countryside Act 1981
- Nature Conservation (Scotland) Act 2004
- Protection of Badgers Act 1992
- 1994 Conservation Regulations
- Scottish Executive Interim Guidance on European Protected Species
- Development Sites and the Planning System and the Scottish Biodiversity Strategy and associated Implementation Plans

In terms of the SG Interim Guidance, applicants must give serious consideration to/recognition of meeting the three fundamental tests set out in this Guidance. **It may be worthwhile for applicants to give consideration to this immediately after the completion of the scoping exercise.**

It needs to be categorically established which species are present on and near the site, and where, before the application is considered for consent. The presence of protected species such as Schedule 1 Birds or European Protected Species must be included and considered as part of the application process, not as an issue which can be considered at a later stage. Any consent given without due consideration to these species may breach European Directives with the possibility of consequential delays or the project being halted by the EC. Likewise the presence of species on Schedules 5 (animals) and 8 (plants) of the Wildlife & Countryside Act 1981 should be considered where there is a potential need for a licence under Section 16 of that Act.

11. Water Environment

Developers are strongly advised to consult with the Scottish Environment Protection Agency (SEPA), at an early stage. SEPA are the regulatory body responsible for the implementation of the Controlled Activities Regulations (CAR), to identify if a CAR licence is necessary and clarify the extent of the information required by SEPA to fully assess any licence application.

All applications (including those made prior to 1 April 2006) made to Scottish Ministers for consent under section 36 of the Electricity Act 1989 to construct and operate a electricity generating station are required to comply with new legislation. In this regard MS-LOT will be advised by SEPA and will have regard to this advice in considering any consent under section 36 of the Electricity Act 1989.

SEPA produces a series of Pollution Prevention Guidelines (PPG), several of which should be fully utilised in preparation of an ES and during project development. These include SEPA's guidance note PPG6: Working at Construction and Demolition Sites, PPG5: Works in, near or liable to affect Watercourses, PPG2 Above ground storage tanks, and others, all of which are available on SEPA's website at http://www.sepa.org.uk/guidance/ppg/index.htm. SEPA would look to see specific principles contained within PPG notes to be incorporated within mitigation measures identified within the ES rather than general reference to adherence to the notes.

Prevention and clean-up measures should also be considered for each of the following stages of the development;

- Construction.
- Operation.
- Decommissioning.

Construction contractors may be unaware of the potential for impacts such as those listed below but, when proper consultation with the local fishery board is encouraged at an early stage, many of these issues can be averted or overcome.

- Increases in silt and sediment loads resulting from construction works.
- Point source pollution incidents during construction.
- Obstruction to upstream and downstream migration both during and after construction.
- Disturbance of spawning beds during construction - timing of works is critical.
- Drainage issues.

- sea bed and land contamination

The ES should identify location of, and protective/mitigation measures in relation to, all private water supplies within the catchments impacted by the scheme, including modifications to site design and layout.

Developers should also be aware of available CIRIA guidance on the control of water pollution from construction sites and environmental good practice (www.ciria.org). Design guidance is also available on river crossings and migratory fish (SE consultation paper, 2000) at http://www.scotland.gov.uk/consultations/transport/rcmf-00.asp.

12. Other Material Issues

Traffic Management

The ES should provide information relating to the preferred route options for delivering equipment etc. via the trunk road network. The EIA should also address access issues, particularly those impacting upon the trunk road network; in particular, potential stress points at junctions, approach roads, borrow pits, bridges, site compound and batching areas etc.

Where potential environmental impacts have been fully investigated but found to be of little or no significance, it is sufficient to validate that part of the assessment by stating in the report:

- the work has been undertaken, e.g. transport assessment;
- what this has shown i.e. what impact if any has been identified, and
- Why it is not significant.

13. General ES Issues

In the application for consent the applicant should confirm whether any proposals made within the ES, e.g. for construction methods, mitigation, or decommissioning, form part of the application for consent.

Consultation

Developers should be aware that the ES should also be submitted in a user-friendly PDF format which can be placed on the SG website. Developers are asked to issue ES directly to consultees. Consultee address lists can be obtained from the Energy Consents Unit. The Energy Consents Unit also requires 8 hardcopies to be submitted for onward distribution.

Where the developer has provided Scottish Ministers with an ES, the developer must publish their proposals in accordance with part 4 of the Environmental Impact Assessment (Scotland) Regulations 2000. Energy consents information and guidance, including the specific details of the adverts to be placed in the press, can be obtained from the Energy Consents website; http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-Consents

Gaelic Language

Where s36 applications are located in areas where Gaelic is spoken, developers are encouraged to adopt best practice by publicising the project details in both English and Gaelic (see also Energy consents website as above).

Ordinance Survey (OS) Mapping Records

Developers are requested at application stage to submit a detailed OS plan showing the site boundary and all turbines, access tracks and onshore supporting infrastructure in a format compatible with the SG's Spatial Data Management Environment (SDME), along with appropriate metadata. The SDME is based around Oracle RDBMS and ESRI ArcSDE and all incoming data should be supplied in ESRI shape file format. The SDME also contains a metadata recording system based on the ISO template within ESRI ArcCatalog (agreed standard used by the SG); all metadata should be provided in this format.

Difficulties in Compiling Additional Information

Developers are encouraged to outline their experiences or practical difficulties encountered when collating/recording additional information supporting the application. An explanation of any necessary information not included in the ES should be provided, complete with an indication of when an addendum will be submitted.

Application and ES

A developer checklist is enclosed with this opinion to assist developers in consideration and collation of the relevant ES information to support their application. In advance of publicising the application, developers should be aware this checklist will be used by the licensing authority in consideration of formal applications.

Consent Timescale and Application Quality

In December 2007, Scottish Ministers announced an aspirational target to process new section 36 applications within a 9 month period, provided a Public Local Inquiry (PLI) is not held. This scoping opinion is specifically designed to improve the quality of advice provided to developers and thus reduce the risk of additional information being requested and subject to further publicity and consultation cycles.

Developers are advised to consider all aspects of this scoping opinion when preparing a formal application to reduce the need to submit further information in support of your application. The consultee comments presented in this opinion are designed to offer an opportunity to consider all material issues relating to the development proposals.

In assessing the quality and suitability of applications, the licensing authority will use the enclosed checklist and scoping opinion in assessment of the application. Developers are encouraged to seek advice on the contents of ES prior to applications being submitted, although this process does not involve a full analysis of the proposals. In the event of an application being void of essential information, the licensing authority reserve the right not to accept the application. Developers are advised not to publicise applications in the local or national press, until their application has been accepted by the licensing authority.

Judicial review

All cases may be subject to judicial review. A judicial review statement should be made available to the public.

Signed
Fiona Thompson

Authorised by the Scottish Ministers to sign in that behalf

Enclosed - Developer Application Checklist

14. Annex 1

Consultee Comments Relating To EOWDC Offshore Windfarm, Aberdeen

The following organisations provided a scoping opinion in relation to the EOWDC Offshore windfarm, Aberdeen

Statutory Consultees

Scottish Natural Heritage (SNH)
Aberdeen City Council
SEPA

Non Statutory Consultees

Marine Scotland
Defence Estates
Health and Safety Executive
RYA Scotland
Marine Safety Forum
Northern Lighthouse Board
Chamber of Shipping
BT Radio Network Protection
Association of Salmon Fishery Boards
Civil Aviation Authority – Airspace
Maritime Coastguard Agency
Joint Radio Company
RSPB
Aberdeen Harbour Board
Transport Scotland
Historic Scotland
Ports and Harbours

SNH Comments

POSITION STATEMENT
In principle, we support the development of marine renewable energy devices where sensitively designed and sited – as set out in SNH Policy Statement 04/01. For this offshore windfarm proposal, we have reviewed the scoping report and our advice is provided in Appendix A, and with respect to Natura sites in Appendices D and E. A summary of the key points is provided below.

Please note the comments in this letter are made without prejudice to any further comments that we may make when consulted on an application for this proposal.

Habitats Regulations

It is important to take into account the range of interests and potential impacts of Natura sites that may need to be considered in relation to regulation 48 of the Conservation (Natural Habitats, &c.) Regulations 1994 as amended, and in particular whether an Appropriate Assessment is required. More detail on the legislative requirements relating to Natura Sites and species is contained in Appendices B and C.

Although data has been collected for some time, this has been for different iterations of the development and when submitted, there will be less than the minimum two years data which we recommend. It is also not clear how much of the data available will relate to the current site and layout. **We strongly recommend** that AOWFL consider in detail how they will prepare the report to inform an Appropriate Assessment, and whether the types and amount of information that will be available to them at the time (both their own data and that from other sources) will be sufficient.

The report to inform an Appropriate Assessment must consider the conservation objectives for each Natura site. We hope that the scoping advice contained within the appendices to this letter and the draft table we provided on 19 January 2009 (for impacts to the Moray Firth and River Dee SACs), provide a useful starting point that AOWFL can develop. We would welcome the opportunity to assist AOWFL by commenting on first a detailed scope of the report to inform an Appropriate Assessment and subsequently a draft. There is a risk that Marine Scotland will not be able to carry out the Appropriate Assessment and draw sufficiently robust conclusions when the application is submitted early next year. A detailed scope would help identify if this is the case and may be used to consider how the consenting process can address this.

Key Points

Some of the key points that we wish to draw out are:

- The layout and footprint of the proposal have changed several times and it is unclear which of the data collected so far, and available from other sources, cover the current footprint and how much data will be available when the application is submitted.
- We do not think that the report covers migrant waterfowl sufficiently. For example, there has only been one radar study that was designed to detect migrant geese and it may have taken place too late to measure anything meaningful. There needs to be more information before we can advise whether this can be dismissed as an important issue.

- Impacts on relevant Annex 1 Birds Directive species (e.g. Common Scoter, Red-throated diver, Black-throated diver etc.) and Annex IV Habitats Directive species (all cetacea) should be specifically identified, including their activity outwith any SPAs. It is unclear whether the additional boat survey will give sufficient data to assess impacts to red-throated diver and common scoter and if not, how this will be addressed.

- We strongly recommend that Aberdeen Offshore Wind Farm Limited consider in detail how they will prepare a report to inform an Appropriate Assessment, and what information will be available to them at the time (both their own data and that from other sources).

- It is important to consider the different ‘sections’ in an integrated way that considers the effect of impacts on one aspect of marine ecology on another, taking into account all relevant factors such as coastal processes.

- Little information is available on the offshore research centre and it is unclear if it is covered in the current scoping report. The report states that the location for this has yet to be decided and it will be subject to a separate consent application. We recommend that a clearer rationale is provided for the research centre and that an application is submitted at the same time as that for the offshore wind deployment centre. This would help inform the overall assessment of the project, as well as providing an opportunity for monitoring protocols to be prepared in advance on any works. More consideration of the timing that application is submitted may be needed if the centre is to be used for research before the windfarm is constructed.

- We would welcome the preparation of research proposals in a construction and post-construction monitoring plan. We recommend that the ES includes an outline of such a plan.

APPENDIX A

SNH's DETAILED ADVICE ON EOWDC SCOPING REPORT

1.6 Approach to EIA

1.6.1 Impact Assessment Methodology

Para 30 – We have raised concerns in meetings about the use of a matrix approach, both for birds and marine mammals and seascape impacts. We encourage a more flexible approach that uses a thorough assessment based on rigorous professional judgement, as this better recognises the complex and unique aspects of the proposal.

1.6.2 Cumulative and In-combination Impact

Actual projects anticipated to be included should be outlined at this stage. We recommend AOWFL consider other east coast windfarm sites such as the 3 STW sites in the Outer Forth and Tay Area (Inch Cape, Neart na Gaoithe and Forth Array), the two Round 3 Zones (Zone 1 and Zone 2) as well as the STW site in the Moray Forth (Beatrice).

2.3 The Project Concept / Consenting Process

Para 46 – We understand that the timing of this proposal is in part driven by the funding requirements of the grant this project will receive from them European Energy Programme for Recovery. In order for us to advise further, for example in relation to the consenting process, it would help to know what those funding requirements are.

2.4 Proposed Development

The report states that there are likely to be onshore deployment facilities, substation and cable which will be dealt with under a separate scoping report. It would be helpful if a timescale was given for when that scoping report and subsequent application will be submitted. Please note for the purposes of the Habitats Regulations Appraisal, the project requires to be assessed as one (please see our comments in Appendix E). We can provide further advice on this aspect once we have received the scope of the report to inform an Appropriate Assessment.

Please note that the landfall is on an erosional soft coastline. Future-proofing the cables and landfall infrastructure is therefore important. It should be ensured that there are no obstructions to net northerly sediment movement within the Bay, otherwise the existing erosion problem on the southern two thirds of Aberdeen Bay (and particularly at Blackdog) may worsen.

Fig 2 (p 161) implies two offshore cables merge into one, to cross the intertidal. The ES should consider if there would be jointing infrastructure where the cables merge as this could create a potential impact in terms of obstruction on a lowering & erosional foreshore.

2.4.1 Wind Turbines

Paras 5, 52 and 56 - It is stated that there may be multiple turbine foundation, tower and turbine designs deployed at the proposed development site. We recommend that if any of these designs depart substantially from the standard foundation (jacket, mono-pile, gravity base), tower (single tubular tower) or turbine (three bladed upwind turbine) designs that the potential for increased or additional impacts from these designs are carefully considered in consultation with us and others. For example lattice design towers may cause attraction to the wind farm and turbine as birds try to roost on the structure. Any turbine with more or fewer blades than the normal three bladed design may result in very different bird collision risk calculations. Floating turbine designs may result in increased underwater collisions for marine mammals and diving birds although there is unlikely to be sufficient depth of water for floating turbines at this site.

We support the idea of trialling new foundations so long as appropriate monitoring is in place to look at and assess the impacts.

2.4.3 Ocean Laboratory

The report states that the location for this has yet to be decided and it will be subject to a separate consent application. It is unclear whether or not it is covered in this scoping report (cf 2.4, paras 49-51) and therefore will be covered within the ES. It would be helpful to have further clarification on this aspect.

2.5 Project Construction

2.5.1 Construction Timescales

Para 62 – We note that 4 turbines are expected to be installed in 2012 and that work will be continuous during construction. Given that these four turbines may have entirely different foundations and thus differing vessel requirements, it will be important that the EIA considers all the possible options of likely numbers and types of vessels on site over the construction period.

2.5.2.3 Inter-Array Cables

Para 74 – Any stabilisation methods for the cables should not interrupt tidal or wave driven currents, otherwise they may have significant onshore implications in terms of sediment movement.

2.5.2.5 Scour Protection

Para 76 – This could be an opportunity to trial different methods which is particularly important if AOWFL wish to investigate artificial reef properties (see comments on 5.1.7.1 below).

4.1 Meteorological Conditions

4.1.2 Baseline Information

Haar is frequent on the north east coastline and the ES should take this into account e.g. increased likelihood of accidents and associated environmental effects of these measures and requirements for foghorns and lighting. The section on wind turbines (2.5.2.2) says that aviation warning lighting will be required but does not mention foghorns.

4.3 Coastal Processes

4.3.2 Baseline Information

Para 125 - 'a narrow ridge of unknown origin situated in the region between the offshore and littoral zones; it is possible that this ridge affords some protection to the coast from wave action.' This should be investigated, it may be the lower limits of former emerged shorelines, representing themselves within the nearshore. This could have implications for the cable-installation approach.

Para 126 - The implications of the wind farm on tidal currents should be considered. Halcrow (working for Aberdeen City Council) established that south-north tidal currents at the southern end of the bay, played an important role in sediment dynamics and beach health. Given the wave shadow effect of a nearshore array (with cables, defences, sour protection etc), and the propensity of erosion on the adjacent coast, it would be prudent to ensure that there are unlikely to be knock-on effects.

4.5 Sediment and Water Quality

4.5.2 Baseline Information

Please consider whether the sampling takes into account any pollution from the nearby contaminated land at Blackdog.

5.1 Marine Ecology

5.1.2.2 Benthic Habitats

Para 230 - We note that the sampling approach set out in the scoping report is different to the recently agreed benthic survey strategy. The ES should report on results obtained from the recently agreed benthic sampling strategy (September 2010).

5.1.7.1 Further research opportunity: reef effect

Para 239 - We agree this would be a good location to study the reef effects of structures and distinguish between (a) perceived benefits through enhanced diversity/productivity and (b) the structures acting simply as fish aggregation devices. This should form part of a post-construction monitoring plan that we would welcome the opportunity either to comment on or become more directly involved in. Careful consideration should be given to what would be required for post construction monitoring.

As mentioned above (2.5.2.5) there is also the opportunity to look at the best methods of scour protection and recovery of the site following cable installation.

5.3 Fish, Shellfish and Elasmobranchs

The benthic section of the report should make appropriate links to fish and shellfish where there are strong habitat associations for particular species. For example, muddy sediment is closely associated with Nephrops and their fishery. The sand and gravelly sand which dominates the area for this proposal is likely to have associations particularly with scallops, but also various flatfish and sandeels (in terms of fisheries species).

5.3.2.1 Spawning and nursery grounds

Para 256 - We are pleased that the report acknowledges the spatial and temporal variability of these areas. The spawning and nursery habitats data provided is from Coull et al (1998). Further and more recent information is/should shortly be available from the Defra Data Layers project.

5.3.2.5 Diadromous and freshwater species

Para 268 - We suggest that sparling should also be considered as a diadromous fish species of conservation importance. Sparling is included in the UK Biodiversity Action Plan Priority Species list. They are found in coastal waters and estuaries and migrate into large clean rivers to spawn. Sparling was previously known to occur in a number of Scottish rivers, but has now disappeared from almost all of these sites.

Para 269 - We note that sturgeon have been recorded which are a European Protected Species and must be considered accordingly in the ES (Please see appendix C).

Para 271 - The scoping report identifies various rivers that are important for salmonids, but does not consider whether the River South Esk SAC, to the south of the proposed site, may be affected. The qualifying interests of the River South Esk SAC are Atlantic salmon and freshwater pearl mussel. A recent review by Marine Scotland Science (Malcolm, I., Godfrey, J. & Youngson, A. In prep. Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: implications for the development of marine renewables. *Marine Scotland Science draft report*.) summarises available information on the migratory routes and behaviour of Atlantic salmon, sea trout and European eel. Although the report indicates that the dominant direction of travel for Atlantic salmon (1 SW and MSW) on the east coast of Scotland, in the area around Aberdeen, is a northerly direction, there is also some southerly movement, and there is both easterly and westerly movement on the east coast to the north of Aberdeen. The River South Esk should be included in the list of Natura sites that are identified in the report. Please see our advice in Appendix E on HRA scoping.

To the south of the River South Esk, there are three SACs with anadromous fish species as qualifying interests - the River Tay SAC (Atlantic salmon, river lamprey, sea lamprey), River Teith SAC (Atlantic salmon, sea lamprey, river lamprey) and the River Tweed SAC (Atlantic salmon, sea lamprey, river lamprey). These SACs are likely to be sufficiently well removed from the proposed site not to be significantly affected by the development.

There are also several SACs with diadromous fish and freshwater pearl mussel qualifying interests to the north of the development, but they are also likely to be sufficiently well removed from the proposed site not to be significantly affected by the development.

Para 277 - Not all sites containing freshwater pearl mussel are designated as SSSI or SAC. Any populations in non-designated sites in the vicinity of the development should be considered, but only within the ES.

<u>5.3.2.6 Elasmobranchs</u>
Para 282 – Basking Sharks are known to occur along the east coast and we recommend AOWFL look for more recent literature or sighting records to check this. They may wish to liaise with some of the some of the other east coast offshore wind developers who are also undertaking surveys to see if they are reporting similarly low numbers. We recommend that basking sharks are recorded as a feature if observed during any marine mammal or bird surveys. As Basking sharks are protected under Schedule 5 of the Wildlife and Countryside Act, no development licences are currently available.

Para 283 - We would have thought that there were other elasmobranchs in the area worth mentioning, not only basking and porbeagle sharks.

Para 286 - This should include the effects of displacing fishing activity; i.e. impacts on areas where fishing activity moves to and therefore becomes concentrated. Also could be put in wider fisheries management context, by considering efforts of Scottish Government to bring fishing (and other marine activities) within environmental and biological limits.

<u>5.3.4 Potential impacts</u>
The scoping report recognises that the potential impacts of noise, electromagnetic fields and other disturbance on diadromous fish species needs to be evaluated. A draft SNH report (Gill, A.B. & Bartless, M. In prep. Literature review on the potential effects of electromagnetic fields and subsea noise from marine renewable energy developments on Atlantic salmon, sea trout and European eel) considers the current state of knowledge with regard to the potential impacts of noise and electromagnetic fields associated with marine renewable energy, on Atlantic salmon, sea trout and European eel.

The draft report by Marine Scotland Science (referred to above, para 271) considers available information on migratory routes and behaviour of Atlantic salmon, European eel and sea trout in Scotland's coastal environment, and should also be useful.

Para 597 - The Inshore Fisheries Group (IFG) that covers this area is not yet set-up but should be established soon - this will be another appropriate point of contact for consulting local fishermen, in theory including those that are not affiliated with fishermen's associations.

Table 6.2, p133: - (a) displacement effects should be included, (b) some of the conclusions in this table make assumptions. We do not know the impacts much of the time or how effective mitigation measures will be e.g. impacts of electromagnetic fields and underwater noise.

5.4 Birds

The layout and footprint of the proposal have changed several times and it is unclear which of the data collected so far, and available from other sources, cover the current footprint and how much will be available when the ES is prepared and application submitted.

One of the subjects that we have consistently raised is the need to consider impacts to red-throated divers and common scoter. It is unclear whether the additional boat survey will give sufficient data to address this.

We also do not think that the report covers migrant waterfowl sufficiently. There has only been one radar study that was designed to detect migrant geese and it may have been undertaken too late to really measure anything meaningful. There needs to be more information before we can advise whether this can be dismissed as an important issue.

5.4.1 Introduction

Paragraph 291 and Table 5.2 – Please note that the JNCC programme for designating SPAs for inshore aggregations of non-breeding waterbirds is ongoing and Aberdeen bay is still an active Area of Search. For any marine area which does become an SPA the provisions of Article 6 of the Habitats Directive (Reg 48) will apply. Meantime the area should be considered as an important area for birds and the effects of development seen in this context. The obligations of Articles 2 and 3 of the Birds Directive also need to be considered.

Para 291 - Aberdeen bay is also used by birds during the spring and autumn migration periods and potentially by moulting birds. Indeed, para 296 notes the Aberdeenshire coast as important for divers, grebes and seaduck for all months of the year.

Paragraph 292 – it is stated that seven SPAs within “daily flight distance” of the proposed development site were identified as being relevant. It is unclear which foraging distance data was used for which species. We recommend that the distances used for each species considered is stated and those SPAs that may have connectivity to the proposed development site is listed for each species. We recommend that foraging distance data is not used as a hard cut off value, but that those SPAs that are close to the cut off value are included at this stage (Please also see our comments in Appendix D on the HRA process for SPAs).

5.4.1.1 Project Reports

Additional data sources should include all data available such as North East Scotland Bird Survey reports.

5.4.2 Baseline information

We welcome the consideration in paras 294-309. As well as considering where particular species are a feature of interest of an SPA, the ES should also consider where they are a feature of interest of an SSSI. The SSSI, SAC and SPA interests for a designated site are not always the same nor have the same boundary. For example, some SSSIs such as Corby, Bishops and Lily Lochs are not SPAs. Ramsar sites should also be considered.

Paragraph 299 – due to the very long foraging distances of northern gannet it is likely that some of the birds observed are from other breeding colonies. We recommend that at this stage other gannet colonies further north than Troup Head are scoped in (Please also see our comments on Appendix D).

Para 300: Kittiwake and herring gull also form part of the Fowlsheugh SPA interests.

Paragraph 302 – auks make multiple foraging trips per day during breeding, not one single all day foraging trip as stated here. Thus the energetic impacts due to barrier effects may be multiplied.

Paragraph 305 – note that redshank and lapwing are qualifying features of the non-breeding waterfowl assemblage of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA and not the "seabird assemblage interest feature" as stated here.

Table 5.2 – please add black-legged kittiwake to the species covered by Article 4.2 for the Troup, Pennan and Lions Head SPA. Also please add northern fulmar as a qualifying feature of the seabird assemblage of the Forth Islands SPA. Please remove whooper swan as a feature of the Loch of Skene SPA.

5.4.3.1 Vantage Point Surveys

Para 312 – it is unlikely that detectability of many species is very good as far out as 2km. If distances to each bird (or group of birds) was recorded during vantage point watches we recommend that the number birds detected is plotted against distance to estimate the detectability function for each species. For some species it may be necessary to plot age and/or sex separately (e.g. young gannets have more cryptic plumage than adults, or female eider are more cryptic than males). It should then be possible to assess the range at which each species was reliably detected and thus constrain the analysis to those records within this distance. In addition the effects of sea state may influence detectability with increasing distance. We recommend that the detectability functions for each species are compared across different sea states to determine at which sea state the detectability becomes too low to reliably record birds.

Para 314 – flight height data in the near shore area recorded from vantage point may not be a good model for flight heights further from shore and in deeper water. We urge caution in interpreting flight height data recorded by shore based observers. If flight height data recorded from shore is to be used, we recommend that analysis is undertaken to determine if flight heights measured from shore differs significantly from flight heights measured either by boat based observers or from radar.

5.4.3.2 Boat Based Surveys

Table 5.5 – It is unclear how the assessment of collision, barrier and displacement risks was made. These are probably derived from the presentation we received from Vattenfall in September 2008. Our comments on those results are contained in our letter of 10 December 2008. In particular, the assessment needs to consider all sources of data available and be based on a sufficient length of time to give confidence in the results.

Table 5.5 – We recommend that rather than providing some data on flight heights that a frequency plot of flight heights is provided for each species when these data are presented in the ES.

Table 5.5 – It is not clear where the wind farm and control survey areas are as these are not indicated in any figures. It is not clear whether these observations have been adjusted to the current proposed development foot print or whether or whether they

relate to a former iteration. If it is a former iteration it would be helpful to know which one. This also applies to section 5.4.3.4 Radar studies.

5.4.3.3 Boat Based Surveys 2010-2011
Para 326 - It is important that there is sufficient data available to enable Marine Scotland to carry out an Appropriate Assessment. Currently it is unclear whether or not this will be the case.

5.4.3.4 Radar Surveys
Para 329 - Does this refer to the current windfarm footprint or that at the time the radar study was carried out?

Para 333 – It is stated that previous studies have found that "very high avoidance rates by geese" and that collisions being "extremely unusual". There should be reference made to these studies and an indication of where they were undertaken and which species were involved and in what numbers. In order to assess the ability of the conducted radar study to adequately assess the presence and numbers of migrating geese much more information needs to be provided. We recommend that the timing of the deployment of the radar is compared to the known time of passage and numbers of geese recorded at regularly counted sites in the area (e.g. Montrose Basin, Loch of Strathbeg). It will then be possible to show whether the radar was deployed at an appropriate time but should also take into account the variation in goose movements between years. We also recommend that the results of radar ground truthing are included in the ES.

5.4.4 Predicted Impacts
Para 335 – We recommend that the details of the analysis that resulted in the redesign of the turbine layout are included in the ES. Any future analysis of impacts should include indirect effects and disturbance from increased boat traffic for operation and maintenance of the proposed turbines. It should consider all aspects of the turbines such as navigation and aviation warning measures including possible lighting and/or foghorns.

Para 336 – We recommend that for those species where there is insufficient data to apply Distance analysis, plots of the locations and numbers of birds are included, e.g. by varying the size of symbols relative to the number of birds recorded.

Para 338 - The ES should include information on how flight height data was verified.

5.4.6 EOWDC future research and monitoring
Para 343 - We welcome the proposal to continue monitoring during and post-construction and welcome the opportunity to discuss research needs further.

5.6 Marine Mammals
5.6.2.3 Future Boat Based Surveys 2010-2011
Para 392 - From the text it appears that the data presented in the ES will be four months of 'new data' combine with approximately 15 months of 'old data' which didn't cover the same points and used a different method. If it is unclear if this will be sufficient for an assessment and we advise that AOWFL ensure that the mitigation and monitoring of impacts is extremely robust. We also recommend the assessments include as much data as possible, albeit if necessary with some months having less analysis.

5.6.5 Mitigation

There is an opportunity to look at how effective different forms of mitigation are on minimising impacts of installation – noise. This is referred to in 5.7 but not with any detail. As a test centre we recommend that there is a detailed look at underwater noise and robust monitoring of marine mammals (which should include behavioural studies to determine whether behavioural effects are occurring). Ideally we would wish to see a number of readings at various distances from each installation to record noise. This would help gain a better understanding of whether or not various types of mitigation are working or indeed worth doing. We would be happy to meet with AOWFL or their consultants at an early stage to discuss this and try to get the most out of this research.

5.6.6 EOWDC Future Research and Monitoring

C-Pods are now proposed as ''future research' and not for gathering data for the ES. As explained above in the main letter, it is unclear whether there will be enough data for assessing impacts to bottle-nose dolphins both as a feature of the Moray Firth SAC and as EPS, when the ES is submitted. It would be useful to get clarification of what survey protocol will be used for C-Pods, when and where they will be deployed. Please see also our Comments in Appendix E.

5.9 Statutory Designations and Conservation

For comments on Natura sites, please refer to our advice in Appendices D and E on the HRA for SPAs and SACs.

Table 5.9 – This should include the River South Esk SAC, to the south of the proposed site. The qualifying interests of the River South Esk SAC are Atlantic salmon and freshwater pearl mussel. The draft Marine Scotland Science report referred to in our comments above indicates that the dominant direction of travel of Atlantic salmon on the south east coast is a northerly one, but there is also some southerly movement. See comments in Appendix E.

The scoping report does not directly consider Ramsar sites and we recommend these are addressed in the ES.

6.5 Seascape, Landscape and visual effects

In general, it appears that the proposed SLVIA outlined takes due cognisance of our previous scoping comments and discussions at meetings. In particular the report recognises the proximity of major and smaller population centres as sensitive receptors, and gives particular consideration to any effects arising as a result of differing wind turbines devices.

6.5.2 Baseline Information

Para 556 – Given the large height of the turbines, it is important to retain a flexible approach to the study area, increasing it if the ZTVs indicate that visual effects are likely to occur in a wider area.

6.5.2.1 Landscape and Seascape Character

Paras 557 - 558 - As we discussed at a meeting with the developer's consultants on 14th April 2010, it is important to consider how the assessments of seascape, landscape and local landscape character types will fit together to prevent duplication and avoid confusion. We would be happy to provide further advice once AOWFL have developed a methodology for this.

6.5.2.2 Visual Amenity

Para 560 – Recreation users at Donmouth LNR should also be considered.

Para. 561 and Table 6.1 - Representative viewpoint locations. Ideally to inform our input into further discussion on viewpoint locations (over and above that previously agreed), it would be useful to have a comparative ZTV, illustrating the extent of changed visibility occurring between the 2009 layout and the current 2010 layout. This would ensure optimum locations are chosen.

Para. 567 - The photomontages should illustrate a range of conditions - eg. sunrise; turbine lighting (dawn/dusk); the international aviation (2.5.2.2) requirement for the turbines to be painted white and aviation warning lighting; the size of the ocean lab (we appreciate this would be a separate application, but some initial indicators of scale, form etc. would be useful).

We had previously suggested allowing for some fixed photomontage 'boards' on site to engage the public. There is no mention of this in the scoping report (within either of the SLVIA or Recreation and Tourism sections) and we recommend that this is undertaken.

6.5.5 Cumulative Impact

Para. 574 - Further engagement on methods for cumulative impact assessment should include both Aberdeen City and Aberdeenshire councils.

Para 576 – This refers to the choice of colour of turbines being used to mitigate landscape and visual impacts, however, section 2.5.2.2 indicates that much of the turbines should be white.

6.8 Recreation and Tourism

6.8.2 Baseline Information

Paras 626-633 – Surfing is another recreational activity that takes place in Aberdeen and kite surfing at Balmedie. All forms of recreation should be considered in the ES and there should be consultation with relevant user groups.

7. Consultations

Para 678 – we recommend that the Whale and Dolphin Conservation Society (WDCS) are added to the list of other consultees. The WDCS have commented on marine mammal survey methods for this proposal and interim reports.

APPENDIX B

HABITATS & BIRDS DIRECTIVES, & HABITATS REGULATIONS

Paragraphs 434-436 of the scoping report outline the Habitats and Birds Directives. The Habitats Directive is transposed into domestic law in Scotland by the 'Conservation (Natural Habitats, &c.) Regulations 1994' which came into force on 30 October 1994 – usually called simply the Habitats Regulations. Several amendments have been made to the Habitats Regulations since they came into force.

The Habitats Regulations apply to the inshore zone, and the rules for the protection of marine Natura sites and marine European protected species (EPS) apply here exactly as they do on land.

Habitats Regulations Appraisal

Where a plan or project could affect a Natura site, the Habitats Regulations require the competent authority – the authority with the power to undertake or grant consent, permission or other authorisation for the plan or project in question – to consider the provisions of regulation 48. This means that the competent authority has a duty to:

- determine whether the proposal is directly connected with or necessary to site management for conservation; and, if not,

- determine whether the proposal is likely to have a significant effect on the site either individually or in combination with other plans or projects; and, if so, then

- make an appropriate assessment of the implications (of the proposal) for the site in view of that site's conservation objectives.

This process is now commonly referred to as **Habitats Regulations Appraisal** (HRA). HRA applies to any plan or project which has the potential to affect the qualifying interests of a Natura site, even when those interests may be at some distance from that site.

The competent authority, with advice from SNH, decides whether an appropriate assessment is necessary and carries it out if so. It is the applicant who is usually required to provide the information to inform the assessment. Appropriate assessment focuses exclusively on the qualifying interests of the Natura site affected and their conservation objectives. A plan or project can only be consented if it can be ascertained that it will not adversely affect the integrity of a Natura site (subject to regulation 49 considerations).

Further Information and Advice on HRA

In this scoping response we provide tailored advice for HRA in respect of birds that are qualifying interests of SPAs, and marine mammals, habitats and fish that are qualifying interests of SACs:

- Appendix D – SNH Advice on Habitats Regulations Appraisal for SPAs
- Appendix E – SNH Advice on Habitats Regulations Appraisal for SACs

In respect of this, further information on the qualifying interests and the conservation objectives for each relevant Natura site is available from SNH's Sitelink database.

For further advice on the HRA process please see SNH's website, including the leaflet on "Natura sites and the Habitats Regulations" which provides a helpful summary. Some of the key concepts are explained in the European Commission's guidance on Article 6 of the Habitats Directive. Revised guidance updating the Scottish Office Circular 6/1995[38] on the implementation of the Habitats and Birds Directive in Scotland was produced in June 2000. This sets out current Government policy relating to Natura sites.

APPENDIX C

EUROPEAN PROTECTED SPECIES

Certain species are listed on Annex IV of the Habitats Directive as species of European Community interest and in need of strict protection. The protective measures required are outlined in Articles 12 to 16 of the Directive. The species listed on Annex IV whose natural range includes any area in the UK are called ‘European protected species’.

SNH is the statutory nature conservation body who provides advice on EPS in respect of the Habitats Regulations in Scotland, including Scottish Territorial Waters. A summary of the legal requirements for EPS is as follows:

The Conservation (Natural Habitats, &c.) Regulations 1994 as amended. (Known as the ‘Habitats Regulations’.) Protection of certain wild animals 39. (1) It is an offence – (a) deliberately or recklessly to capture, injure or kill a wild animal of a European protected species; (b) deliberately or recklessly – i. to harass a wild animal or group of wild animals of a European protected species; ii. to disturb such an animal while it is occupying a structure or place which it uses for shelter or protection; iii. to disturb such an animal while it is rearing or otherwise caring for its young; iv. to obstruct access to a breeding site or resting place of such an animal, or otherwise to deny the animal use of the breeding site or resting place; v. to disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs; vi. disturb such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young; or vii. to disturb such an animal while it is migrating or hibernating; (c) deliberately or recklessly to take or destroy the eggs of such an animal; or (d) to damage or destroy a breeding site or resting place of such an animal. (2) Subject to the provisions of this Part, it is an offence to deliberately or recklessly disturb any dolphin, porpoise or whale (cetacean).

Scottish Government has also provided guidance on the 2007 amendments addressing EPS – Explanatory guidance for species related activities.

EPS Licences

Licences may be given authorising activities that could affect EPS which would otherwise be illegal under the Habitats Regulations. For Scottish Territorial Waters these licences will be issued either by Scottish Government or by SNH depending on the reason for the licence request. Licences are only issued under very strict conditions as set out in regulations 44 and 45 of the Habitats Regulations.

As highlighted in Scottish Government Interim Guidance, three tests must be satisfied before the licensing authority can issue a licence under Regulation 44(2) of the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) to permit otherwise prohibited acts. An application for a licence will fail unless all of the three tests are satisfied. The three tests involve the following considerations:

Test 1 - The licence application must demonstrably relate to one of the purposes specified in Regulation 44(2) (as amended). For development proposals, the relevant purpose is likely to be Regulation 44(2)(e) for which Scottish Government is currently the licensing authority. This regulation states that licences may be granted by Scottish Government only for the purpose of "preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment."

Test 2 - Regulation 44(3)(a) states that a licence may not be granted unless the licensing authority (Scottish Government) is satisfied "that there is no satisfactory alternative".

Test 3 - Regulation 44(3)(b) states that a licence cannot be issued unless the licensing authority (Scottish Government) is satisfied that the action proposed "will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range" (The licensing authority will, however, seek the expert advice of SNH on this matter).

Consideration of European protected species must be included as part of the application process, not as an issue to be dealt with at a later stage. Any consent given without due consideration to these species is likely to breach European Directives with the possibility of consequential delays or the project being halted by the EC.

APPENDIX D

EOWDC: HABITATS REGULATIONS APPRAISAL (HRA) – SPECIAL PROTECTION AREAS

Introduction

In the following advice for HRA we set out the three steps that need to be considered in order to determine whether or not the European offshore Wind deployment Centre proposal is likely to have a significant effect on the qualifying interests of SPAs, and any possible adverse impact on site integrity – Appendix B provides more detail on the legislative framework. It is the competent authority (most likely Marine Scotland) who will carry out the HRA, based on our advice and using information and data collated by the developer.

Under HRA, the potential impacts of the EOWDC offshore windfarm proposal will need to be considered alone (all aspects of the proposal i.e. including onshore deployment facilities, substation, cable and offshore research station) and in combination with other plans and projects. It needs to be considered in combination with the Scottish Round 3 zones as well as the following proposed Scottish territorial water sites (Neart na Gaoithe, Inch Cape, Forth Array and Beatrice) and with other types of industry and activity in and around Aberdeen bay and harbour.

Special Protection Areas for inclusion in HRA

We would welcome the opportunity to discuss the scope of HRA with AOWFL (as noted in this response) and we recommend that the following SPAs are considered for individual and also for cumulative assessments:

Troup, Pennan and Lion’s Heads SPA
Forth Islands SPA
Fowlsheugh SPA
Buchan Ness to Collieston Coast SPA
Ythan Estuary, Sands of Forvie and Meikle Loch SPA
Loch of Strathbeg SPA
Loch of Skene SPA
Montrose Basin SPA

Please see also our comments in Appendix A, para 299 recommending that gannet colonies further north than Troup Head are also scoped in at this stage (eg Fair Isle).

Advice for HRA in respect of SPA qualifying interests

The steps of the process are as follows and our advice is tailored to consideration of this offshore windfarm:

Step 1: **Is the proposal directly connected with or necessary for the conservation management of the SPAs?**

The EOWDC proposal is not directly connected with or necessary for the conservation management of any of the SPAs listed above.

Step 2: **Is the proposal likely to have a significant effect on the qualifying interests of the SPAs either alone or in combination with other plans or projects?**

This step acts as a screening stage: it removes from the HRA those proposals (plans or projects) which clearly have no connectivity to SPA qualifying interests or where it is very obvious that the proposal will not undermine the conservation objectives for these interests, despite a connection. When this screening step is undertaken at an early stage in the development process, it usually means that it takes the form of a desk-based appraisal. We advise that this is kept broad so that potentially significant impacts are not missed out, or discounted too early, in any HRA (or EIA).

The SPA bird interests being considered in respect of offshore windfarms are wide-ranging – many seabirds make long foraging trips, especially during the breeding season, and there are also migratory species to consider such as geese and swans. This means that offshore windfarm proposals may be ‘connected to’ SPAs at much greater distances than what has so far been experienced in respect of onshore development. Although connectivity is thus established the fact that the proposal is located further away from the designated sites means that direct impacts are less likely on qualifying species while they are within the SPA.

Expert agreement over species sensitivity should help to identify those SPA qualifying interests for which the conservation objectives are unlikely to be undermined by offshore windfarm development, despite any possible connection (e.g. SPA qualifiers which are recorded within a proposed windfarm site but where their flight behaviour and / or foraging ecology means that the windfarm will not have a likely significant effect).

Determination of ‘likely significant effect’ is not just a record of presence or absence of bird species at an offshore windfarm site, but also involves a judgement as to whether any of the SPA conservation objectives might be undermined. Such judgement is based on a simple consideration of the importance of the area in question for the relevant species. Complex data analysis should not be required at this stage. For example; How many birds have been recorded? What are they using the area for? Is this the only area that they can use for this particular activity? Understanding the behavioural ecology of the species, and the characteristics and context of the proposed windfarm site, will help in determining whether there are likely significant effects. There are three possible conclusions for this step of HRA:

a) The likely impacts are such that there is clear potential for the conservation objectives to be undermined – conclude likely significant effect.

b) The likely impacts are so minimal (either because the affected area is not of sufficient value for the birds concerned or because the risk to them is so small) that the conservation objectives will not be undermined – conclude no likely significant effect.

c) There is doubt about the scale of the likely impacts in terms of the conservation objectives – conclude likely significant effect.

<u>Step 3</u>: Can it be ascertained that the proposal will not adversely affect the integrity of the SPA, either alone or in combination with other plans or projects?

This stage of HRA is termed appropriate assessment, and it is undertaken by the competent authority based on information supplied by the developer, with advice provided by SNH. Appropriate assessment considers the implications of the proposed development for the conservation objectives of the qualifying interests for which a likely significant effect has been determined. These conservation objectives follow a standard format requiring protection of the qualifying bird interests and protection of the habitat in the SPA which supports them.

Conservation objectives for SPA bird species

To ensure that site integrity is maintained by: (i) Avoiding deterioration of the habitats of the qualifying species. (ii) Avoiding significant disturbance to the qualifying species. To ensure for the qualifying species that the following are maintained in the long term: (iii) Population of the bird species as a viable component of the SPA. (iv) Distribution of the bird species within the SPA. (v) Distribution and extent of habitats supporting the species. (vi) Structure, function and supporting processes of habitats supporting the species. **repeat of (ii)** No significant disturbance of the species.

It is important to recognise that the conservation objectives primarily offer site-based protection and that some of them will not directly apply to species when they are outwith the boundaries of the SPA. This is particularly true of objectives **(i), (v)** and **(vi)** which relate to the supporting habitats within the SPA.

Objective **(iii)** however – maintenance of the population of the bird species as a viable component of the SPA – will be relevant in most cases because:

It encompasses direct impacts to the species, such as significant disturbance to qualifying bird interests when they're outwith the SPA.

It addresses indirect impacts such as the degradation or loss of supporting habitats which are outwith the SPA but which help to maintain the population of the bird species of the SPA in the long-term.

Finally, in rare circumstances, it is possible that factors / events outside site boundaries may have the capacity to affect the long term distribution of bird species within the SPA – see objective **(iv)**.

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Issues to consider under appropriate assessment

The **key question** in any appropriate assessment for the EOWDC windfarm proposal is whether it can be ascertained that this proposal, alone or in combination, will not adversely affect the population of any qualifying bird species as a viable component of the SPAs under consideration.

In considering this matter, we refer to the helpful summary of the main risks of offshore windfarm development to birds provided in Langston 2010. In addition, there may be further issues to consider if the proposal is likely to affect the conservation objectives that relate to bird species while they're in an SPA or to the habitats in the SPA that support them.

- Will the offshore wind proposal(s) cause a deterioration in the habitats of any of the SPAs? NB. *This question relates specifically to the habitats in the SPAs that support the bird interests.*

- Will the offshore wind proposal(s) cause any significant disturbance to bird interests while they're in any of the SPAs?
  N.B. *See the previous discussion in respect of disturbance outside an SPA.*

- Will the offshore wind proposal(s) alter the distribution of the birds within any of the SPAs?

- Will the offshore wind proposal(s) affect the distribution and extent of the habitats (that support the bird species) in any of the SPAs?

- Will the offshore wind proposal(s) in any way affect the structure, function and supporting processes of habitats in any of the SPAs? NB. Those habitats which support the bird species.

We highlight that these questions will be applicable to the habitats which support bird interests in any new SPAs designated for inshore and / or offshore aggregations of seabirds – please see JNCC's website for potential areas of search, including Aberdeen Bay.

As noted above, we hope to further discuss these various aspects with AOWFL once a scope for the HRA has been provided

APPENDIX E

EOWDC: HABITATS REGULATIONS APPRAISAL – SPECIAL AREAS OF CONSERVATION

Introduction

In the following advice for Habitats Regulations Appraisal (HRA) we set out the three steps that need to be considered in order to determine whether or not the EOWDC windfarm proposal is likely to have a significant effect on the qualifying interests of Special Areas of Conservation, and any possible adverse impact on the site integrity of SACs – Appendix B provides more detail on the legislative framework. It is the competent authority (most likely Marine Scotland) who will carry out the HRA, based on our advice and using information and data collated by the developer.

Under HRA, the potential impacts of the EOWDC proposal will need to be considered alone (all aspects of the proposal i.e. including onshore deployment facilities, substation, cable and offshore research station) and in combination with other plans and projects. It needs to be considered in combination with the Round 3 development and with other types of industry and activity in the Moray Firth. We therefore recommend that the Beatrice and Round 3 developers collaborate on the assessment of cumulative impacts and we would welcome discussion of this matter and, preferably, a joint meeting between the developers, Marine Scotland and ourselves (SNH and JNCC).

For those SAC qualifying interests that are also European protected species (such as bottlenose dolphin) please see Appendix C for our advice in respect of their EPS status and for EPS licensing arrangements. The advice that we give below solely relates to their consideration as an SAC qualifying interest and how the HRA process therefore applies.

Special Areas of Conservation for Inclusion in HRA

We advise that the applicant will need to consider the following SACs. Further information, including their conservation objectives, is available from http://www.snh.org.uk/snhi/.

SACs designated for marine mammals:

- Moray Firth SAC - designated for bottlenose dolphin (Tursiops truncatus) and for subtidal sandbank habitat.

SACs designated for fish of conservation concern:

- River Dee SAC - designated for Atlantic salmon, freshwater pearl mussel and otter.
- River South Esk SAC - designated for Atlantic Salmon and freshwater pearl mussel (Please see our comments in Appendix A, para 271).

SNH advice for HRA in respect of Special Areas of Conservation

The steps of the process are as follows; our advice is tailored to consideration of this offshore windfarm proposal:

<u>Step 1</u>: Is the proposal directly connected with or necessary for the conservation management of the SACs?

The EOWDC proposal is not directly connected with or necessary for the conservation management of the South-East Islay Skerries SAC.

Step 2: Is the proposal likely to have a significant effect on the qualifying interests of the SACs either alone or in combination with other plans or projects?

This step acts as a screening stage: it removes from the HRA those proposals which clearly have no connectivity to SAC qualifying interests or where it is very obvious that the proposal will not undermine the conservation objectives for these interests, despite a connection. When this screening step is undertaken at an early stage in the development process, it usually means that it takes the form of a desk-based appraisal.

In respect of the above SACs, we identify that the EOWDC may have connectivity to the following qualifying interests, which will therefore require further consideration under HRA. While a desk-based review is helpful for this screening step, this part of the HRA will only be fully completed when the windfarm proposal has been further progressed – when survey work and analyses have been completed, and when the location of / construction methods for windfarm infrastructure, including onshore elements, has been finalised.

There are three possible conclusions to this step of HRA:

a) The likely impacts are such that there is clear potential for the conservation objectives to be undermined – conclude likely significant effect.

b) The likely impacts are so minimal that the conservation objectives will not be undermined – conclude no likely significant effect.

c) There is doubt about the scale of the likely impacts in terms of the conservation objectives – conclude likely significant effect.

However, we are not yet in a position to present a definite conclusion for this step, so we provide a **summary of our current advice** for each qualifying interest.

Marine and coastal habitats of the Moray Firth.
We do not consider any aspect of the offshore wind deployment centre will have an impact on the habitat qualifying interest of the Moray Firth SAC

Summary of our current advice: no likely significant effect.

- **Bottlenose dolphins of the Moray Firth SAC.**

  While the EOWDC proposal is located approximately 140 km from the Moray Firth SAC, the dolphins are not confined to this SAC and will range more widely within the Firth and beyond. Observations around the area of Aberdeen Harbour have confirmed sighting of individual dolphins from the Moray Firth SAC. Construction (and other) noise arising from the proposal is likely to extend beyond the windfarm footprint and may overlap with dolphin use of the surrounding environment. Boat movements, cable-laying and other construction activity may give rise to disturbance. There may also be impacts to the prey species of dolphin – either from the placement of infrastructure or due to noise. We therefore advise that there is potential for the proposal to have likely significant effects on bottlenose dolphins and we discuss below (under step 3) the issues that we think need to be considered.

It would be beneficial for applicants to collaborate on this issue with other offshore wind developers as appropriate assessment of the cumulative impacts on bottlenose dolphins is likely to be required in combination. Joint discussion and co-ordination of survey and monitoring proposals, mitigation proposals and construction time-tabling would be helpful.

Summary of our current advice: likely significant effect, so impacts (including cumulative) will need to be considered in appropriate assessment (see step 3).

- **Atlantic salmon** as a qualifying interest of the Rivers Dee and South Esk SACs.

  We recognise that there is a significant data / research gap on this issue, and that very little is known about salmon movements – adults and post-smolts – around the Scottish coastline. Marine Scotland have analysed historic tagging data and should be issuing a report soon, however, it is likely that this report will highlight further research requirements.

  We recommend that the applicant assumes all individuals are SAC salmon, and considers the effects on these fish from construction and operational noise / vibration, as well as any other types of disturbance. Mitigation could include timing restrictions on construction work / noisy activities in order to avoid any significant disturbance to migrating salmon, or disruption of their (as yet unknown) migratory routes.

  Onshore infrastructure and / or any required upgrades to roads or bridges may need to be considered under HRA if the work is likely to affect any of these freshwater SACs.

  Summary of our current advice: likely significant effect in relation to offshore infrastructure; impacts (incl. cumulative) will need to be considered in appropriate assessment (see step 3). Consideration of onshore infrastructure may also be required.

- **Freshwater pearl mussels** – qualifying interests of the Rivers Dee and South Esk SACs

  Atlantic salmon (and other salmonids) are integral to the life cycle of freshwater pearl mussel (FWPM), therefore any impacts to Atlantic salmon that prevent them from returning to their natal rivers may have a resulting effect on FWPM populations. While we consider this matter needs discussion in any appropriate assessment we do not identify any survey or research requirements. The impacts are indirect, dependent on the impacts the proposal may have on Atlantic salmon.

  Onshore infrastructure and / or any required upgrades to roads or bridges may need consideration in respect of HRA if the work is likely to affect any of these freshwater SACs.

  Summary of our current advice: likely significant effect, so indirect impacts will need to be considered in appropriate assessment as part of the assessment of any direct impacts on Atlantic salmon (see step 3).

- **Otters of the River Dee SAC**.

  The River Dee SAC is located too far away from the EOWDC proposal for there not to be any likelihood of significant effects on otters there, presuming that no onshore infrastructure is proposed in proximity to this SAC.

  Summary of our current advice: no likely significant effect, although this may need review depending on the proposed location of onshore infrastructure

<u>**Step 3**</u>: Can it be ascertained that the proposal will not adversely affect the integrity of the SAC, either alone or in combination with other plans or projects?

This stage of HRA is termed appropriate assessment, and it is undertaken by the competent authority based on information supplied by the developer, with advice provided by SNH. Appropriate assessment considers the implications of the proposed development for the conservation objectives of the qualifying interests for which a likely significant effect has been determined. We discuss this below for each of the qualifying interests listed above.

Advice for appropriate assessment in respect of bottlenose dolphin of the Moray Firth SAC

The conservation objectives for bottlenose dolphin are: (i) to avoid deterioration of the habitats of bottlenose dolphin or (ii) significant disturbance to bottlenose dolphin, thus ensuring that the integrity of the Moray Firth SAC is maintained and that the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features. And to ensure for bottlenose dolphin that the following are established then maintained in the long term: **(iii)** Population of bottlenose dolphin as a viable component of the site. **(iv)** Distribution of bottlenose dolphin within site. **(v)** Distribution and extent of habitats supporting bottlenose dolphin. **(vi)** Structure, function and supporting processes of habitats supporting bottlenose dolphin. **repeat of (ii)** No significant disturbance of bottlenose

Based on these conservation objectives the following questions may need to be addressed:

- Will the proposal cause significant disturbance to bottlenose dolphin while they are outwith the SAC such that the viability of this SAC population is affected?

- Will the proposal in any way affect the population viability of the bottlenose dolphins of the Moray Firth SAC?

The last question encompasses the indirect impacts that a windfarm development could have – such as the degradation or loss of supporting habitats or feeding grounds which are outwith the SAC but which help to maintain the population of bottlenose dolphins in the SAC in the long-term. The risk of impacts, and how many of these questions may need answered, will become clearer when the development process is further advanced and construction methods, location of cable routes, choice of port, and other aspects are finalised. It is possible that onshore elements of infrastructure will need to be considered as well as those offshore.

We advise that noise impact assessment is likely to be an important part of assessing any direct disturbance to bottlenose dolphin, including their potential displacement from feeding grounds and other supporting habitats. While we consider that the construction phase may give rise greatest risk of disturbance, we do highlight that impacts during the operational phase also need to be considered, as well as any repowering and decommissioning work. It will also be important for the applicant to consider impacts on prey species.

We highlight that cumulative impacts are a key concern and we consider that collaboration between other offshore wind applicants on noise impact assessment is likely to be helpful, along with discussion / co-ordination of mitigation proposals and construction time-tabling.

Ongoing Liaison

As noted above, SNH will continue to liaise with the west coast developers in respect of this HRA process. It may be helpful for the developers to collaborate in order to address cumulative impacts on common (harbour) seals and their mitigation.

Advice for appropriate assessment in respect of Atlantic salmon & freshwater pearl mussel

The SAC conservation objectives for Atlantic salmon and freshwater pearl mussel (where appropriate) are: **(i)** to avoid deterioration of the habitats of the qualifying species or **(ii)** significant disturbance to them, thus ensuring that the integrity of the SACs are maintained and that they make an appropriate contribution to achieving favourable conservation status for each species.

And to ensure for each species that the following are maintained in the long term:

(iii) Population of the species, including range of genetic types for salmon, as a viable component of the SACs.

(iv) Distribution of the species within sites.

(v) Distribution and extent of habitats supporting each species.

(vi) Structure, function and supporting processes of habitats supporting each species.

repeat of (ii) No significant disturbance of the species.

And for freshwater pearl mussel in particular, to ensure that the following are maintained in the long term:

(vii) Distribution and viability of freshwater pearl mussel host species

(viii) Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species

In respect of the offshore elements of infrastructure, appropriate assessment will focus on conservation objective (iii) – the population viability of Atlantic salmon – considered for the Rivers Dee and South Esk SACs.

There would not be any impacts to supporting habitats in any freshwater SACs arising from offshore infrastructure, however, the placement of onshore infrastructure – including any road / bridge upgrades – may need further consideration. We will be able to give further advice when the applicant presents more information on this aspect.

So the main impacts to Atlantic salmon would arise when the fish are outwith the freshwater SACs, on migration. An adverse impact on site integrity could arise if individuals are significantly disturbed / their behaviour altered / displaced from their migratory routes such that it affects the population viability of the species. The applicant may also need to consider whether the proposal could in any way act as a barrier to salmon movements, whether it might prevent any salmon from accessing the freshwater SACs, in particular the River Dee SAC.

Noise impact assessment is likely to be a key part of any overall appropriate assessment, and all phases of the development should be considered – construction, operation, repowering and decommissioning.

As discussed above, the applicant also needs to consider the potential (indirect) impacts to freshwater pearl mussel (FWPM) arising from offshore infrastructure. This will be a desk-based appraisal following on from the assessment of impacts to Atlantic salmon. We note that direct impacts to FWPM could arise from the placement of onshore infrastructure if this work takes place close to, or is likely to affect, the River Dee SAC.

Ongoing Liaison
We will continue to review our advice on HRA as this proposal progresses, and as survey work, modelling and other analyses are undertaken. We will discuss any strategic research needs with Marine Scotland and the Crown Estate, particularly those in respect of Atlantic Salmon.

Local Authority – Aberdeen City Council

It is unclear what is meant by “onshore deployment facilities” as referred to at para 50. It is noted at para 51 that the report only deals with the offshore elements of the project. It should be noted that separate planning permission will be required for the onshore elements of the project from the relevant planning authority (e.g. substation / transmission lines). Given the integral and essential nature of the onshore elements to the project as a whole, it is recommended that they be considered as part of a robust EIA process for the wider project. This has the benefit of potentially avoiding the need for undertaking a separate EIA, as well as enabling a holistic approach to evaluation of the project impacts. It is recommended that scope of the ES should include consideration of the options for the routing of the cable connection, the location of the substation and related environmental and visual impacts, including the need for mitigation measures such as grounding of cable connections to the grid and provision of landscape measures such as tree planting. You may wish to request a screening opinion regarding the specific onshore elements from the relevant planning authority.

It is suggested that the scope of the ES also be expanded to consider the possible indirect environmental, economic and social benefits of the proposed development to the Aberdeen area resulting from the implementation of a community fund. I would appreciate clarification of what specific mechanism is proposed to ensure that such potential community benefits for the City of Aberdeen may be delivered.

As regards consultees, it is recommended that you include Scottish Enterprise (Grampian), UKOOA and North East Scotland Biological Records Centre (Nesbrec), You may also wish to contact relevant technical specialists within the Council directly (e.g., Aftab Majeed, Environmental Planner; Andrew Gilchrist, Environmental Health and Judith Stones, Archaeologist).

SEPA

1. Scope of the ES for marine developments

1.1 This project will be developed during a period of fast development of marine policy at national and international levels and this should be addressed with respect to the Marine (Scotland) Act 2010 and Marine Strategy Framework Directive. More information can be found on the Marine Science website at http://www.scotland.gov.uk/Topics/marine/seamanagement.

1.2 From the information submitted we understand the overall project will include both onshore and offshore components including 11 turbines, foundations, cabling, ocean laboratory, and onshore works including landfall and substation. As such, the development will be subject to a range of different consenting regimes. We would encourage you to consider producing a single ES which covers all aspects of the proposed development. This will enable a full assessment of the potential effects of the development as a whole, rather than assessing certain details of the development individually.

2. Site layout and nature of construction for marine developments

2.1 The ES should contain plans giving detailed information on the site layout, including details of all onshore and offshore components such as access tracks, buildings, cabling and marine devices. These plans should be supported by a statement detailing the development, as well as reasons for the choice of site and design of the development. Depending on the types and scale of construction the information below may be required.

2.2 Plans should be included in the ES showing the layout of the devices, cabling routes and associated onshore infrastructure.

2.3 Background information that will help inform the ES process is available from European Marine Energy Centre (EMEC). The EMEC has produced guidelines to assist developers in considering the range and scale of impacts that may result from the testing of devices. These guidelines are available at www.emec.org.uk/index.asp. Generally, if this standard industry guidance is followed for scoping, preparing and undertaking EIA for marine renewables, then we are likely to be satisfied with the standard of assessment.

2.4 There may be a need to address the cumulative effects of devices on coastal processes depending upon density and location with respect to existing renewable and coastal developments.

2.5 The submission should include information on likely timing and duration of the project, possible long-term locational and/or operational impacts and short-term construction impacts.

3. River Basin Management Planning

3.1 Under the Water Environment and Water Services (Scotland) Act 2003, SEPA is responsible for producing and implementing River Basin Management Plans for the Scotland and the Solway Tweed River Basin Districts. River basins comprise all surface waters (including transitional (estuaries) and coastal waters) extending to 3 nautical miles seaward from the Scottish territorial baseline. Any proposed development within these waters must have regard to the requirements of the Water Framework Directive to ensure that all surface water bodies achieve 'Good Ecological Status' and that there is no deterioration in status. The Water Framework Directive requires the consideration of chemical, ecological and hydromorpholgical status. Further information on River Basin Management planning can be found on the SEPA website at www.sepa.org.uk/water/river_basin_planning.aspx. Information on the current status of Scotland's surface waters can be found on the water body data sheets on the the River Basin Management Planning Web Mapping Application available on SEPA's website at (http://213.120.228.231/rbmp/).

3.2 Under section 4, page 57 (baseline data) we would suggest that inclusion of the data held on 'Cruden Bay to Don Estuary' coastal water body should also be included in the baseline dataset. This water body is currently classified at high ecological status – a full datasheet is available at apps.sepa.org.uk/rbmp/pdf/200117.pdf. Any proposed development within these waters must have regard to the requirements of the Water Framework Directive (WFD) to ensure that all surface water bodies achieve 'Good Ecological Status (GES)' and that there is no deterioration in status. The WFD requires the consideration of chemical, ecological and hydromorpholgical status. The ecological status of surface water bodies which may be affected by the proposal should also be considered in section 5, alongside the discussion of protected areas for salmon and freshwater pearl mussel. These can be accessed via the interactive map at www.sepa.org.uk/water/river_basin_planning.aspx.

3.3 The cumulative assessments should consider the proposals alongside any existing coastal development already present within the water bodies in which landfall locations are being considered. EC guidance defines cumulative impacts as "impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project" (http://ec.europa.eu/environment/eia/eia-studies-and-reports/guidel.pdf).

3.4 Maps should be included in the ES showing the areas of seabed likely to be affected by the footprint of the turbine bases and cabling, and the area of intertidal zone that is likely to be affected by shoreline infrastructure development. To allow for the RBMP classification to be updated and the assessment of cumulative impacts within these water bodies footprint data for the turbines and cabling components of the development should be provided in the ES.

4. Construction Environmental Management Document (CEMD) and pollution prevention

4.1 One of our key interests in relation to major developments is pollution prevention measures during the periods of construction, operation, maintenance, demolition and restoration. The construction phase includes construction of access roads and any other site infrastructure.

4.2 We advise that the applicant, through the EIA process or planning submission, should systematically identify all aspects of site work that might impact upon the environment, potential pollution risks associated with the proposals and identify the principles of preventative measures and mitigation. This will establish a robust Project Environmental Management Process (PEMP) for large scale (eg Major and Environmental Impact Assessment Projects (EIA). A draft Schedule of Mitigation should be produced as part of this process. This should cover all the mitigation measures identified to avoid or minimise environmental effects. Details of the specific issues that we expect to be addressed are available on the Pollution Prevention and Environmental Management section of our website.

4.3 A key issue for us is the timing of works. Therefore, the Schedule of Mitigation should include a timetable of works that takes into account all environmental sensitivities, such as fish spawning, which have been raised by SEPA, SNH or other stakeholders. Timing should also be planned to avoid construction of roads, dewatering of pits and other potentially polluting activities during periods of high rainfall. We can provide useful information such as rainfall and hydrological data through our Access to Information Team.

4.4 A Construction Environmental Management Document (CEMD) is a key management tool to implement the Schedule of Mitigation. We recommend that the principles of the CEMD are set out in the ES drawing together and outlining all the environmental constraints and commitments, proposed pollution prevention measures and mitigation as identified in the ES.

4.5 The CEMD should form the basis of more detailed site specific Construction Environmental Management Plans (CEMPs) which along with detailed method statements may be required by planning condition or, in certain cases, through environmental regulation. This approach provides a useful link between the principles of development which need to be outlined at the early stages of the project and the method statements which are usually produced following award of contract (just before development commences).

4.6 We recommend that the detailed CEMD is submitted for approval to the determining authority at least two months prior to the proposed commencement (or relevant phase) of development to order to provide consultees with sufficient time to assess the information. This document should incorporate detailed pollution prevention and mitigation measures for all construction elements potentially capable of giving rise to pollution during all phases of construction, reinstatement after construction and final site decommissioning. This document should also include any site specific

CEMPs and Construction Method Statements provided by the contractor as required by the planning authority and statutory consultees. The CEMD and CEMP do not negate the need for various licences and consents, e.g. CAR, if required. The requirements from the obtained licences and consents should be included within the final CEMPs.

5. Waste management

5.1 Details of how waste will be minimised at the construction stage should be included in the ES, demonstrating that:

- Construction practices minimise the use of raw materials and maximise the use of secondary aggregates and recycled or renewable materials;
- Waste material generated by the proposal is reduced and re-used or recycled where appropriate on site

5.2 To do this effectively all waste streams and proposals for their management should be identified. Accordingly, we recommend that a site specific site waste management plan is developed to address these points. This is in accordance with the objectives of Scottish Planning Policy and the National Waste Plan which aim to minimise waste production and reduce reliance on landfill for environmental and economic reasons.

5.3 Advice on how to prepare a site waste management plan is available on the NetRegs website and from Envirowise who also provide free advice on resource efficiency. Further advice on the reuse of demolition and excavation materials is available from the Waste and Resources Action Programme. Further guidance can also be found on our website. Information on waste prevention and waste minimisation is available on SEPA's waste minimisation webpage at www.sepa.org.uk/waste/resource_efficiency.aspx.

6. Flood risk

6.1 The onshore components of the development such as the substation may be at risk from coastal flooding. The location of the substation should therefore be assessed for flood risk from all sources in line with Scottish Planning Policy (Paragraphs 196-211). Further information and advice can be sought from the Local Authority technical or engineering services department, Scottish Water and from our website. Our Indicative River & Coastal Flood Map (Scotland) is also available to view online. If a flood risk is identified then a flood risk assessment (FRA) should be carried out following the guidance set out in the Annex to the SEPA Planning Authority flood risk protocol. Our *Technical flood risk guidance for stakeholders* outlines the information we require to be submitted as part of a FRA, and methodologies that may be appropriate for hydrological and hydraulic modelling. Further guidance on assessing flood risk and planning advice can be found at our website.

7. Onshore drainage strategy

7.1 Proposed temporary and long-term foul drainage facilities for workers associated with the onshore component of the development must be described in the ES. Guidance and best practice advice can be found in PPG4 *Disposal of sewage where no mains drainage is available*. We also request the submission of a site drainage strategy, detailing methods for the collection and treatment of all surface water runoff from hard standing areas and roads using sustainable drainage principles, which should be shown on a site plan.

7.2 Surface water drainage arrangements associated with the new substation such as any new access roads and buildings should incorporate the attenuation (where appropriate) and treatment principles of sustainable drainage systems (SUDS). The SUDS treatment train should be followed which uses a logical sequence of SUDS facilities in series allowing run-off to pass through several different SUDS before reaching the receiving waterbody. Further guidance on the design of SUDS systems and appropriate levels of treatment can be found in CIRIA's C697 manual entitled *The SUDS Manual*. Advice can also be found in the SEPA Guidance Note *Planning advice on sustainable drainage systems (SUDS)*. Please refer to the SUDS section of our website for details of regulatory requirements for surface water and SUDS.

8. Marine ecological interests

8.1 A baseline assessment of existing intertidal and subtidal habitats and species should be submitted. This should include any UK Biodiversity Action Plan habitats and species (eg maerl, sea pens, eel grass, horse mussels). Additional information on the UK Biodiversity Action Plan is available at: www.ukbap.org.uk/UKPlans.aspx?ID=35. Developers will then be able to ascertain if they are required to supplement or quantify the available data with in-field surveys.

8.2 We also recommend information be submitted detailing how the development will contribute to sustainable development. Opportunities to enhance marine habitats in line with Water Framework Directive and The Nature Conservation (Scotland) Act 2004 objectives and Scottish Planning Policy guidance should be explored. Examples may include coastal realignment, the incorporation of naturalistic features in the design of shoreline works, or planting with salt tolerant species. These could be used as examples of best practice and demonstration sites under SEPA's Habitat Enhancement Initiative (HEI).

8.3 During the construction phase, it is important that good working practice is adopted and that habitat damage is kept to a minimum and within defined acceptable parameters. These should be controlled through an environmental management plan.

8.4 Advice on designated sites and European Protected Species should be sought from SNH. For marine and transitional Special Areas of Conservation (SAC) and Special Protected Areas (SPA), these are WFD Protected Areas.

Therefore, their objectives are also RBMP objectives. In this case, SNH may contact us for input on the consultation.

9. Coastal Processes

9.1 Coastal processes should be assessed as part of the ES. This should include a baseline assessment to identify the coastal and sedimentary processes operating in the area. The baseline assessment should identify the following features and processes in the environment:

- Sediments (e.g. composition, contaminants and particle size);
- Hydrodynamics (waves and tidal flows);
- Sedimentary environment (e.g. sediment re-suspension, sediment transport pathways, patterns and rates and sediment deposition);
- Sedimentary structures (e.g. protected banks);
- Typical suspended sediment concentrations.

9.2 Developers will then be able to ascertain if they are required to supplement or quantify the available data with in-field surveys and what mitigation measures are required.

9.3 With regard to diagram 4.1 in section 4.3.3.2 the hydrodynamic modelling should be robust and should represent reality as best as possible. Model performance should be checked in order to demonstrate accuracy and should include sensitivity analysis or estimate of errors in order to enable confidence levels to be applied to model results.

9.4 The magnitude and significance of any changes to the natural processes identified in the baseline assessment should be demonstrated in the ES. It would be helpful to see a series of contour plots showing the magnitude and spatial extent of +(ve) and –(ve) changes in current velocities between the 'pre development' and 'post development' scenarios. The assessment should also identify and quantify the relative importance of high energy low frequency events e.g. storm events, versus low energy high frequency processes. Any changes to the existing processes can then be used to infer the extent of any changes to sediment transport processes and potential impacts on the marine ecology.

10. Regulatory advice

10.1 Details of regulatory requirements and good practice advice for the applicant can be found on our website at www.sepa.org.uk/planning.aspx. If you are unable to find the advice you need for a specific regulatory matter, please contact a member of the regulatory team in your local SEPA office at:

Inverdee House, Baxter Street, Torry, Aberdeen, AB11 9QA

Marine Scotland

Recently, offshore wind has focussed on large scale windfarm sites leased by The Crown Estate for Round 3 and Scottish territorial waters. These will involve the installation of a large number of turbines over several years to ensure the UK and Scottish Governments meet their commitments to generating electricity from renewable sources. Issues associated with cumulative and in combination effects of these developments will arise, MS-LOT wishes to have further discussions with the developers on this issue, at a recent meeting EOWDC indicated that a separate document addressing these matters was being drafted. The scoping document clearly states that the developer will apply for Town and Country planning for the onshore works and will not be incorporating any of the onshore infrastructure works into the EIA for the wind farm.

The definition of the 'Rochdale envelope' approach described in Section 3.4.1 is consistent with all large offshore wind developments. This allows developers to describe their projects in a hypothetical manner by fully assessing any impacts associated with all technology that may be considered on the site. However, MS-LOT understands that only one technology described within the EIA will be progressed towards commercial deployment. The EOWDC project is proposing to use more than one type of foundation i.e. there are 6 described in the scoping document. Therefore, the 'Rochdale envelope approach' should be applied differently; the assessment should include the interactions and cumulative impacts between each different type of foundation. However, if EOWDC do intend using the same foundation base throughout then the standard approach could be adopted. Due to the description of the 'Rochdale envelope' approach described above; points 56 – 58, within the scoping document, cannot be considered without the above assessment. Therefore, indicative layouts should be presented within the EIA. MS-LOT are available to discuss this issue in greater detail.

The same is also true for the actual turbine(s), the EIA can be drafted on a hypothetical machine with a maximum height to the tip of 195m above Lowest Astronomical Tide (LAT), the technology going forward on the site has been described as between 4-10MW, the 4MW has a maximum hub height of 100m and the 10MW turbine has a max hub height of 120m above LAT. The final design will dictate the maximum rotor diameter and an assessment should be carried out on the worst case scenario.

At the meeting on the 13/05/2010 (please refer to the minutes), EOWDC were advised by MS-LOT on the inflexibility of the Section 36 consent and that a generic EIA for the site should be undertaken. Separate assessments for each foundation could then be undertaken and inserted as an appendix when developers sign up to use the site. It was understood, by MS-LOT, at the time of the meeting, that each type of foundation chosen would require a separate consent, thus a single Section 36 consent would not cover the whole installation. MS-LOT has subsequently reviewed both the Section 36 legislation and its position in regard to the proposal set out in the scoping document and are of the opinion that a degree of flexibility might exist when considering the consenting strategy. MS-LOT would like to discuss this matter with you early in the New Year .

Inter array cabling

Installation methodologies must be detailed as the FEPA/Marine licence applications require a list of deposits. Point 74.

Construction timelines

Phase 1 – 4 x turbines year 1 (2012)
Phase 2 – 7 x turbines year 3 (2014)

MS-LOT requires a further update on the construction timeline and potential funding constraints, a further meeting should be scheduled to discuss the above information. EOWDC should note that mitigation measures for marine mammals will be included in the conditions and at this stage we warn you that a 24hr working window might not be possible as the Marine Mammal Observer onboard will not be able to identify marine mammals in the dark. However, we can discuss this aspect further and we are prepared to be open minded on the outcome of those discussions.

The scoping document highlighted (point 70) that a major turbine service would be required every 12 months. However, MS-LOT are not aware that the proposed technology is fully understood. Therefore please notify MS-LOT if this assessment is based on historical knowledge, and provide references. It was also stated that 'gearbox oil changes are required every 5 years', EOWDC will be required to provide method statements and contingency plans for these operations.

Section 36A

We understood that this does not apply in Scottish waters and therefore there are no provisions through section 36 for safety areas around the turbines, however, recent discussions with colleagues indicate that this situation might have changed. We will report back to you as soon as possible.

3.2 Marine Licensing

- MS-LOT will continue to administer all of the consents after April 2011.
- The Environmental Statement (ES) is the section 36 application.

Appropriate Assessment (AA)

In order for the AA to be carried out by the competent authority the installation technologies would have to be known in order to assess the impacts.

Marine Scotland Science (MSS)

The following comments have been received from MSS colleagues.

The Environmental Impact Assessment (EIA) must informatively and clearly identify the key impacts associated with the EOWDC. Within the EIA all useful sources of existing surveys and studies need to be specified.

Proposed survey techniques

The scoping document appears to have identified the potential key impacts with regard to the development. Useful sources of data from existing surveys and studies have been identified but these may not cover the whole area. However, the proposed combination of video survey and benthic grabs is essential to adequately determine the dominant habitat types and species present in the development area, large epifauna are generally under sampled by grab and trawl sampling.

Marine ecology

The Benthic Habitats Para 216 requires the reference for the biotope names to be inserted. Clarification is required within paragraph 230 as single grabs are now being collected from each position, does this mean that the sampling strategy is now considered randomly stratified; please confirm.

Sedimentary shores on the east coast Para 244: MS-LOT would like to highlight that Collieston beach is bounded by a breakwater/pier and the meiofaunal distributions may reflect this artificial situation. Therefore the sediment and the fauna distributions are localised for this area and may not represent soft sediment shores from the area of interest. Beach profiling to quantify erosion / modification should be considered, and the outcome discussed with MS-LOT prior to any action being taken., The name "*diversicolor*" should be rendered in italics.

Coastal processes

Sedimentation/erosion patterns on Aberdeen Beach are influenced by the presence of coastal structures (near shore rock structures and timber groynes), and beach re-charge. Using beach profiles taken by the University of Aberdeen may not be representative of the ongoing processes at the beach near the development site, and MS –LOT are of the opinion that a local survey would give more confidence in the interpretation of current processes and the potential impact of the development on these processes. In case Aberdeen Offshore Wind Farm Ltd has not yet been in contact with Aberdeen University regarding this data, the Aberdeen Beach project is managed by Ms. Amy Taylor and Prof. T. O'Donoghue at the School of Engineering.

Figure 11: The Ythan estuary is not in the area considered for far-field effects. Should there be significant changes in the sediment mobility in the far-field area, then this could have potentially important effects on the sedimentation/erosion patterns of the estuary. Extending the domain in the first instance, could avoid having to do this at a later stage should sediment mobility become an important issue. Again, we request you consider this point and refer to MS-LOT.

Construction

Details of any noise pollution resulting from any construction activity and any associated potential effects on cetaceans/pinnipeds/fish will be required. Noise assessments should take into consideration background noise, including vibration produced from ships' engines, piling hammers and auguring operations during the construction of turbine foundations. Considerable studies have already been conducted on cetaceans in the Moray Firth area, but the particular cause for concern is the potential additional extensive Round 3 wind farm site to the North of this development.

The proposed development will need to consider, in the first instance through a desk study, potential impacts on migratory fish including salmon (*Salmo salar*), sea trout (*Salmo trutta*), sea lamprey (*Petromyzon marinus*), river lamprey (*Hyperoplus lanceolatus*)and sandeels (*Ammodytes marinus*) during all phases of the project. The potential for offshore renewable projects to impact on migratory fish will vary depending on the design and location of the development in relation to the migration routes of adults and juveniles. Potential impacts may include physical or avoidance reactions at both the individual and population level and there may also be avoidance due to electromagnetic sensitivity at both adult and juvenile stages.

In cases where there is uncertainty over potential impacts it may be necessary for the developer to implement a monitoring strategy to assess the influence on salmonid fish populations. The expected levels of noise production must be identified in the ES and derived by using published literature, decide what impact, if any, this will have on fish movements through the area. Will it result in avoidance of the area and, if so, what does this mean for migrating fish. Please refer to Appendix A and after consideration get in contact to MS-LOT.

Inshore fisheries

From a marine fisheries perspective the following comments are provided on the range of issues and impacts identified. The assessment methodologies are proposed and sources of data identified, indicating any perceived information gaps or inaccuracies.

Section 5.3 Fish, shellfish and elasmobranches

The scoping report adequately identifies fish (commercial and non commercial), shellfish and cephalopod species known to and / or likely to occur in the area and the potential impacts of the development on these species.

Species present include some threatened and/or declining species (on OSPAR list) and UK Biodiversity Action Plan (BAP) priority species. The latter have not however been specifically identified. None of the species are unique to the area. The scoping report includes a recorded observation of a basking shark in the vicinity of the proposed development, basking sharks are protected under Schedule 5 of the Wildlife and Countryside Act thus it is a criminal offence to cause any form of disturbance to them. MS-LOT should be informed if any protected species are recorded on the site.

The report includes some reproductions of spawning and nursery grounds data from the fisheries sensitivity maps (Coull et al 1998). The developers are aware that these represent very broad scale (indicative) distributions and that more detailed and site specific information may be available elsewhere (proposal for desk studies). These maps are in some cases misleading, Nephrops distribution for example is limited by suitable (mud) habitat - both juveniles and adults live in burrows in the mud, emerging to feed and breed. MS – LOT is not aware of any specific spawning or nursery grounds within the site.

The colour reproduction of the maps, particularly the colours of the legend compared to the mapped areas make them very difficult to interpret and, in the case of Fig 5.1, render the maps misleading. If they are to be reproduced in the EIA this should be rectified.

In relation to the underwater noise impacts, MS-LOT note that no specific data will be collected on noise effects (associated with piling / installation). MS-LOT concur with the proposal that the current information is adequate for evaluating impacts of the development on fish.

Studies on possible reef effects are proposed, MS-LOT encourages this approach but recommend that it will require robust baseline information. The potential survey methodology plans should identify both mobile and more sedentary species present for all and/or part of the year. The report states there is already an established ‘baseline’ of data. If these data are from historic surveys it may require updating or expanding.

It is indicated in Section 5.8 that potential impact of Electromagnetic Fields (EMF) will be assessed as part of the EIA process using the results of the Cowrie studies referenced. Although this is probably adequate, given the relatively limited extent of this development and lack of others in the vicinity (limited potential for cumulative effects) results of other relevant research should be considered.

Section 6.1.4.2 fishing vessels

Few vessels appear to transit this area and restrictions during the construction phase are unlikely to cause particular problems. Discussion with fishing stakeholders about any action required appears to be reasonable.

An assessment of the cumulative impacts of fishing in association with other marine activities in the area should be addressed as indicated.

Section 6.6 commercial fisheries

Sources of ‘baseline’ information on fishing in the area of the proposed wind array and possible impacts on fishing have been adequately considered in the scoping document. MS-LOT would like to see the updated versions of the earlier reports. MS-LOT concurs that with mitigation residual effects on commercial fishing are likely to be minor / negligible.

MS-LOT note, however, that the area of the proposed development does not coincide with suitable habitat for *Nephrops* - interference with *Nephrops* fishing is therefore unlikely to be a major issue.

Consultation with commercial fishermen has to date been through the Scottish Fishermen’s Federation (SFF). Although this is appropriate, and the SFF should continue to be consulted, the developers should be aware that many inshore fishermen in Scotland are non-affiliated i.e. not members of Associations represented by the SFF. Some form of local consultation should therefore be considered.

Cumulative and in combination effects

A cumulative and in combination impact assessment is also a requirement of the Habitats Regulations Appraisal (HRA) with respect to the designated Special Areas of Conservation (SAC) and Special Protection Areas (SPA) which may be affected. As a result, the cumulative and in combination assessment of impacts on the marine mammals and seabirds of the Moray Firth's European designated sites will be an important consideration within the EIA process. Other cumulative effects, which consider the impacts arising from the proposed EOWDC wind farm in the context of other non wind farm developments (e.g. oil and gas operations) and activities (e.g. the shipping and fishing industries) will also be considered in the course of the EIA. MS-LOT await a document that addresses these aspects and, once it has been reviewed, may wish to update this advice.

Cable route and layout

Marine Scotland would like to emphasise that all developers are required to include maps, 'baseline' data and any details associated with the cable route within their ES as it is incorporated into the overall footprint of the works.

Throughout the document there is reference to Fisheries Research Services (FRS), Marine Scotland, and the Scottish Fisheries Protection Agency (SFPA) as data sources for all 'baseline' assessments. Developers should be aware that as of April 1 2009 - FRS became Marine Scotland Science, SFPA became Marine Scotland Compliance and that Marine Scotland is a Directorate (not an Executive agency) of Scottish Government.

Appendix A

Scoping comments in relation to information requirements on diadromous fish of freshwater fisheries interest

Offshore renewable developments have the potential to directly and indirectly impact diadromous fish of freshwater fisheries interest including Atlantic salmon, anadromous brown trout (sea trout) and European eel. These species use the coastal areas around Scotland for feeding and migration and are of high economic and / or conservation value. As such they should be considered during the EIA process. Developers should also note that offshore renewable projects have the potential to impact on fish populations at substantial distances from the development site.

In the case of Atlantic salmon information will be required to assess whether there is likely to be any significant effect of developments on rivers which are classified as Special Areas of Conservation (SAC's) for Atlantic salmon under the Habitats Directive. Where there is the potential for significant impact then sufficient information will be required to allow Marine Scotland to carry out an Appropriate Assessment.

In order that Marine Scotland is able to assess the potential impacts of marine renewable devices on diadromous fish and meet legislative requirements the developer should consider the site location (including proximity to sensitive areas), type of device, and the design of any array plus installation methodology. Specifically we request that developers provide information in the following areas:

1. Identify use of the proposed development area by diadromous fish (salmon, sea trout and eels)

a. Which species use the area? Is this for feeding or migration?
b. At what times of year are the areas used?
c. In the case of salmon and sea trout what is the origin / destination of fish using the area?

2. Identify the behaviour of fish in the area

a. What swimming depths do the fish utilise
b. Is there a tendency to swim on or offshore

3. Assess the potential impacts of deployed devices on diadromous fish during deployment, operation and decommissioning phases. Potential impacts could include:

a. Strike
b. Avoidance (including exclusion from particular rivers and subsequent impacts on local populations)
c. Disorientation that could potentially affect behaviour, susceptibility to predation or by-catch, or ability to locate normal feeding grounds or river of origin
d. Delayed migration

4. Consider the potential for cumulative impacts if there are multiple deployments in an area.

5. Assess 1-4 above to determine likely risk.

a. If there are insufficient data to determine use of the development area, these should be obtained
b. If there are insufficient data on the origin / destination of fish using the area then these should be obtained
c. Where it is not possible to obtain site specific data, the developer should make a convincing argument why this is the case and apply appropriate expert judgement based on published information.

6. If there is any remaining doubt as to the potential impacts of a particular development, then the developer should recommend a scientifically robust monitoring strategy to assess any impacts either on stocks as a whole, or on particular rivers as necessary.

Marine Scotland Science has just completed a review of migratory routes for Atlantic salmon, sea trout and eels relevant to Scotland, which should be available in 2011. This will assist the developers in identifying what pre-existing information is available and what supplementary site specific data will be required.

Ministry Of Defence

The scheme outlined involves the construction of 11 free standing wind turbines with associated infra-structure. The turbines are expected to be 195 metres to blade tip above ground level.

The principal safeguarding concern of the MOD with respect to the development of wind turbines relates to their potential to create a physical obstruction to air traffic movements and cause interference to Air Traffic Control and Air Defence radar installations.

Consultation by the developer at the pre-planning stage has identified the following concerns:

Air Defence (AD) radar

The turbines will be 26 km from; in line of sight to; and will cause unacceptable interference to the AD radar at Buchan. Following trials carried out in 2005, it has been concluded that wind turbines can affect the probability of detection of aircraft flying over or in the vicinity of wind turbines. Due to this, the RAF would be unable to provide a full air surveillance service in the area of the proposed wind farm.

Accordingly the applicant should take account of MOD aviation and radar operations in completing the EIA particularly in identifying a suitable site for development and the dimensions of the turbines that are to be installed.

It should be noted that this response is based on current levels of wind farm development in the area. If additional wind farms are consented or built prior to this development being submitted for planning consent, our position may change.

Defence Estates Safeguarding wishes to be consulted and notified of the progression of planning applications and submissions relating to this proposal to verify that it will not adversely affect defence interests.

Health and Safety Executive

Environmental Impact Assessments are concerned with projects which are likely to have significant effects on the environment. HSE's principal concerns are the health and safety of people affected by work activities. HSE cannot usefully comment on what information should be included in the environmental statement of the proposed development. However, the environmental statements should not include measures which would conflict with the requirements of the Health and Safety at Work etc Act 1974 and its relevant statutory provisions.

RYA Scotland

In the case of Aberdeen Bay, recreational sailing should be considered under both ‘Shipping and navigation’ and ‘Recreation and tourism’. The approaches to the port of Aberdeen harbour can be very busy with vessels entering and leaving. Many recreational vessels follow an inshore route from the Forth to Peterhead and vice versa, often at night to take advantage of a favourable tidal flow. Only some recreational vessels are equipped with radar and AIS and great care is needed to avoid commercial vessels entering or leaving Aberdeen. Although some recreational vessels will choose to sail further offshore to avoid the development, effective marking and lighting will be essential and needs to be considered from the point of view of recreational craft as well as much larger commercial vessels. There is a further danger of squeezing recreational craft between the commercial shipping routes and the development.

Position on offshore Energy developments attached to email.

Marine Safety Forum

Whilst we are happy with the proposed locations of the wind turbines as agreed with the developer we must comment on the route proposed for the power cabling. The developers must re-route the electricity supply cables to shore well clear of the anchorage. These would present a very great marine hazard if routed as proposed even if trenched.

The Health and Safety Executive have performed studies on pipeline and cable vulnerability which will support our concerns. A vessel (which is legally entitled to use this government approved anchorage) could drag it's anchor in severe weather which in turn could foul and damage the electricity cables putting the vessel, her crew and wind deployment centre in danger.

If the cables were routed directly to shore northward of the anchorage boundaries and then southwards inshore of the western limits to the anchorage boundary then this would not pose a significant risk. We would also like to stress that it is imperative that the proposed eleven turbines are actually located as shown in the plan so as not to impinge on the safety of marine navigation any more than agreed and absolutely necessary. Any future expansions are to be only to the north and not eastwards towards the shipping lanes or southwards into the anchorage area.

Northern Lighthouse Board

With regard to the consultation and the scope of assessment, we would only comment on that part relating to Shipping and Navigational Safety contained within several sections of the consultation document. Notice(s) to Mariners, Radio Navigation Warning and publication in appropriate bulletins will be required stating the nature and timescale of any works carried out in the marine environment relating to this project.

We would advise that any final marking and lighting recommendations will be made in a formal response through the Coast Protection Act 1949: Section 34 consultation process, and will be based on IALA Recommendation O-139. All navigational marking and lighting of the site or its associated marine infrastructure will require the Statutory Sanction of the Northern Lighthouse Board prior to deployment.

We would require the Navigational Risk Assessment to be in accordance with the information given at section 6.1.3 and in line with the requirement of MCA Marine Guidance Notice 371. This should cover all aspects of the site (including cable routes) during construction, operation, maintenance and de-commissioning phases of the project. We welcome the use of a local workshop to ensure all shipping and port interests are consulted.

We can advise that we have noted the charted anchorage and would require the area to be considered within the navigational Risk Assessment already requested above.

Chamber of Shipping

The cable route should remain well clear of the designated anchorage in close proximity. We would also like to state that the developers must ensure that there should be no material change either to the proposed location or the number of the wind turbines as stated on the plan.

BT Network Radio Protection

We have studied this wind farm proposal with respect to EMC and related problems to BT point-to-point microwave radio links.

The conclusion is that, the Wind farm Project indicated should not cause interference to BT’s current and presently planned radio networks.

Therefore BT will not be providing comments on the report

Association of Salmon Fishery Boards

The proposed developments should be conducted in full consultation with the local District Salmon Fishery Boards and Fishery Trusts for these rivers. The boards hold various statutory powers and duties and they will have an interest in the potential effects of offshore installations on migratory salmonids in their marine phase, both during construction and during subsequent operation. The Trusts may have a particular interest in assessing potential impacts and monitoring the interactions between fish and developments such as these. Given that the Dee has SAC status (salmon are a qualifying species), there is a particular need to consider any actions which might impact on this status, even if they are beyond the jurisdictional boundary of the SAC.

We would like to record our own concerns that such developments will have considerable implications and these very often can be conducted without proper regard or understanding of the potential impacts on the fish species and their habitat. Some of the issues and questions we would raise on behalf of our members are itemised below:

Effects arising from construction

- What effect would the construction processes have on fish?
- Physiological and behavioural effects of underwater noise and vibration resulting from construction operations
- Direct effects on fish of water quality changes through suspension of sediment in the water column disturbed during construction
- Indirect effects of water quality changes through effects on food sources available to salmon and sea trout
- Will the effects of noise and mechanical disruption be assessed prior to construction and would on-going monitoring be put in place if the project is approved and completed?

Operational Effects

- Physiological and behavioural effects of underwater noise and vibration resulting from turbine operation
- Are there likely to be electrical or magnetic fields associated with the installation and operation and will these have a discernable effect on salmon?
- Indirect effects on fish of permanent changes in habitat
- Whilst salmon use the Firth as a migration route and are unlikely to remain there for lengthy periods, the habits of sea trout are rather different and this species will use the firth more extensively as a feeding area before migration into freshwater systems. Accordingly there may be a risk of more prolonged interaction with sea trout in relation to the turbines.

Civil Aviation Authority - Airspace

As alluded to with the documentation provided, like any wind turbine development, the proposed subject development has the potential to impact upon aviation-related operations; the Department for Trade and Industry (DTI – now the Department for Energy and Climate Change)-sponsored document 'Wind Energy and Aviation Interests' and Civil Air Publication 764 refer. The related need to establish the scale of the potential impact of the European Offshore Wind Deployment Centre development is evident.

Having reviewed the SR and in particular the site in question, I can advise that the development might have a potential impact upon operations associated with Aberdeen Airport and note that the SR indicates ongoing consultation. All parties should be aware that aerodrome safeguarding responsibility rests with the aerodrome licensee. Any related Environmental Statement, or equivalent, would be expected to acknowledge and quantify any potential impact upon the Airport-related operations and, where applicable, detail appropriate mitigation.

Similarly, as will all wind turbine developments of this scale, the Environmental Statement will need to detail the associated viewpoints of both NATS and Ministry of Defence (MoD). To that end, I note the SR also details the ongoing consultation with these organisations and the outcomes of these and any associated mitigations as agreed should be reported in the Environmental Statement.

Not highlighted in the Scoping Report is the issue of Aviation Warning Lighting. The subject wind farm will fall under the requirements of Air Navigation Order 2009 Article 220 and this will need to be acknowledged in the Environmental Statement. Given the intensity of helicopter operations in the area, I consider this to be a significant area.

With respect to Landfall, the Environmental Statement may need to address the impact on aviation of power line routeing between Landfall and the onshore substation(s) if the power lines are a significant height above ground.

Additionally, if more generically, all parties should be aware that:

- International aviation regulatory documentation requires that the rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines that are deemed to be an aviation obstruction should be painted white, unless otherwise indicated by an aeronautical study. It follows that the CAA advice on the colour of wind turbines would align with these international criteria.

- There is a civil aviation requirement in the UK for all structures over 300 feet high to be charted on aviation maps. Should this development progress and the 300 feet height be breached the developers will need to provide details of the development to the Defence Geographic Agency.

- The number of pre-planning enquiries associated with windfarm developments has been significant. It is possible that the proliferation of wind turbines in any particular area might potentially result in difficulties for aviation that a single development would not have generated. It is, therefore, not necessarily the case that, because a generic area was not objected to by the aviation industry, future, similarly located potential developments would receive the same positive response. There is a CAA perceived requirement for a co-ordinated regional wind turbine development plan, aimed at meeting renewable energy priorities, whilst addressing aviation concerns and minimising such proliferation issues. Indeed, this may be an area where the centre may be able to provide some research.

Any associated Environmental Statement should mention and, where applicable, address the issues highlighted above.

Maritime and Coastguard Agency

The Environmental Statement should supply detail on the possible the impact on navigational issues for both commercial and recreational craft, viz.

Collision Risk
Navigational Safety
Visual intrusion and noise
Risk Management and Emergency response
Marking and lighting of site and information to mariners
Effect on small craft navigational and communication equipment
The risk to drifting recreational craft in adverse weather or tidal conditions
The likely squeeze of small craft into the routes of larger commercial vessels.

Particular reference will need to be made to the impact of the marine traffic associated with the wind farm throughout the lifetime of the project.

A Navigational Risk Assessment will need to be submitted in accordance with MGN 371 (and 372) and the DTI/DfT/MCA Methodology for Assessing Wind farms.

Attention should be paid to cabling routes and burial depth and subject to the traffic volumes an anchor penetration study may be necessary. Any proposed cable route should avoid the recently established anchorage area to the south of the proposal. Close liaison with Aberdeen Harbour Board, and other users, should be maintained.

Reference should be made to any Marine Environmental High Risk Areas (MEHRAS) established on adjacent coastlines.

The Offshore Ocean Laboratory will be required to be marked in accordance with the UK Standard Marking Schedule for Offshore Installations as required by the Northern Lighthouse Board

Any application for the establishment of safety zones during the construction stage will need to be submitted in accordance with the DTI Guidance.

Casualty information from the MAIB and RNLI would also be a good data source, in establishing the risk profile for the area.

Given that the capacity of the individual wind turbine generators have not been decided the principles of the Rochdale envelope should be used in the EIA.

The MCA Shipping Route template distances are based on risks having been identified As Low As Reasonably Practical (ALARP) and evidence to demonstrate this will be expected in the Navigational Risk Assessment.

Developers need to be aware that the radar effects of OWF on ship's radars are an important issue and subject to further discussion within the radar sub group of NOREL The radar effects will need to be assessed on a site specific basis taking into consideration previous reports on the subject available on the MCA website at:

http://www.mcga.gov.uk/c4mca/mcga07-home/shipsandcargoes/mcga-shipsregsandguidance/mcga-windfarms/offshore-renewable_energy_installations.htm

Joint Radio Company

JRC analyses proposals for wind farms on behalf of the UK Fuel & Power Industry. This is to assess their potential to interfere with radio systems operated by utility companies in support of their regulatory operational requirements.

In the case of this proposed wind energy development, JRC does not foresee any potential problems based on known interference scenarios and the data you have provided. However, if any details of the wind farm change, particularly the disposition or scale of any turbine(s), it will be necessary to re-evaluate the proposal.

In making this judgement, JRC has used its best endeavours with the available data, although we recognise that there may be effects which are as yet unknown or inadequately predicted. JRC cannot therefore be held liable if subsequently problems arise that we have not predicted.

It should be noted that this clearance pertains only to the date of its issue. As the use of the spectrum is dynamic, the use of the band is changing on an ongoing basis and consequently, you are advised to seek re-coordination prior to submitting a planning application, as this will negate the possibility of an objection being raised at that time as a consequence of any links assigned between your enquiry and the finalisation of your project.

RSPB

It has always been our contention that there is a high degree of use of the Aberdeen Bay area by many species of bird, including in particular Red-throated Diver. The numbers of this species found so far exceed the revised GB 1% threshold and we believe that at times numbers could be much higher than have been found by the limited sampling offshore so far. Use of the area by some gull species and by auks and Gannets is also high, and the importance of the concentration of moulting and feeding Common Scoters and Eiders close to the shore is also clear. Some of these birds are associated with designated European Protected Sites nearby and further afield. The information presented to date in the Scoping Report and earlier documents supports this assessment. Accordingly, there are numerous important issues to address.

Important issues that should be fully considered in the ES

1. Impact on qualifying interests of existing and potential Special Protection Areas, including distant sites such as Bass Rock and Troup Head.

Aberdeen Bay is under consideration as an SPA for inshore waterbirds. Aberdeen Bay meets stage 1.1 of the UK SPA site selection guidelines for concentrations of

Red-throated Diver (in spring and autumn). If Aberdeen Bay was to be classified as an SPA, other species may be included, such as Eider, Common Scoter and possibly Velvet Scoter.

The need for **Appropriate Assessment** is referred to in Section 5.9.2. Information presented in the Environmental Statement will be used by the Competent Authority in the Appropriate Assessment. This relates to all SPAs and SACs likely to be affected by the development.

2. Determination of bird use of the area: Vantage Point Surveys

We note that no more of these are planned. See our comments below about further data sources. We also recommended previously that it would be useful to position observers on boats moored further out from shore, in the general zone likely to be occupied by the wind turbines and urge that this should be done. Figure 7 shows clearly that the only regular survey technique covering the revised wind farm envelope reliably would be boat surveys. Stationing observers on moored vessels, through some suitable arrangement, would add much useful information. This would be particularly useful for the April/May period in 2011, since this is a time when Red-throated Divers peak in numbers.

3. Determination of bird use of the area: Boat-based Surveys

We accept the revised method, and the further extension to these for at least 12 further months from August 2010 is noted. This information, coupled with earlier surveys, should produce enough baseline information for minimum level of assessment. However, we are still concerned that an application is likely to be made before a full two years of boat-based survey information has been collected. This is not good practice considering the length of time that has elapsed since the initial surveys in 2007-2008; useful data could have been gathered in the interim.

4. Determination of bird use of the area: Radar Surveys

We note the recent further survey period in April 2010. It is clear from previous deployments of radar that a very large number of birds of many species use the bay or fly through it at all times of year, in all weather conditions and throughout the 24-hour period. This activity is concentrated in the near shore area. Previous survey periods have provided only a snapshot of the year and sampled only a proportion of the possible conditions that can be encountered offshore. It is important that there should not be over-reliance on conclusions from limited periods of radar deployment; key movement periods and weather conditions may not be sampled, and records indicate that episodic large movements and short-term usage patterns are characteristic of this offshore environment. We recommend that consideration be given to further deployment to cover periods not yet sampled.

5. Predicted impacts (5.4.4.336)

Since a subjective extrapolation method is being proposed for birds recorded in low densities, it is important to provide further contextual information for this exercise from other North-East Scotland bird data sources (see below).

5.1 Assessment of potential disturbance and displacement
One key issue here is that many of the sea ducks present in summer are moulting and this will influence their behaviour and needs to be taken into account.

5.2 Assessment of potential collision risk
Gannet is a key species for inclusion in collision risk modelling as its flight height is more likely to bring it within the area swept by rotors.

5.3 Assessment of impact of changed hydrodynamic regime on coastal and benthic processes and consequent impact **on location and nature of food sources for offshore birds**. This is touched on in Sections 4.5.1.190 and 5.1.3 and in a slightly different context [reef effect] in 5.1.7.1. It should be explicitly included in the scope of assessment for shellfish and other marine invertebrates in Section 5.3.3 and the assessment proposed in 5.4.4.341 should take account of this, away from the windfarm envelope. We are concerned here about loss of potential feeding resources linked to the seabed, especially for moulting birds. Also of course, there could be changes that increase food availability. Species to consider in particular here are: Red-throated Diver, Common Eider, Common Scoter, Velvet Scoter, all Gull, Tern and Auk species

5.4 Assessment of cumulative and in-combination impacts
All available data sources should be used, including those relevant to the sites proposed offshore from the Angus coast to the south, and the possible floating turbines off Peterhead (to be developed by StatOil).

6. Information sources for birds

These should include all recent records held in the North-East Scotland Bird records database, up to 2010 and 2011. These will include numerous counts of sea duck closer inshore than boat transects can cover, and deal with the period for which there will be no further shore-based vantage point watches by the developer.

7. Mitigation

There appears to be no section on this in the Scoping Report relevant to birds. (It is mentioned in passing in Section 5.4.3.2.318). A full consideration of potential mitigation of adverse effects on birds should be included in the Environmental Statement.

8. Issues to be addressed by the proposed Centre

We welcome the proposed Ocean Laboratory and the intent to use this to monitor environmental issues. Such monitoring should certainly include ornithological aspects, as acknowledged in Section 5.4.6. There are considerable opportunities to treat the environmental aspects of offshore wind development on an equal footing with the technical and engineering aspects. We recommend strongly that if the centre goes ahead, these environmental aspects should be incorporated as core business. A detailed plan should be produced for the development of research and monitoring techniques for all environmental aspects of any test centre developments (including an allocation of the European financial award). RSPB Scotland would be prepared to work with AOWFL and others in taking forward ornithological monitoring and research in connection with a test centre.

If these issues were fully addressed, not only would it allow the potential environmental impacts of the Aberdeen Bay proposal to be assessed properly, but it would also lend credibility to a project which intends to be an international exemplar of good practice for offshore wind development.

Aberdeen Harbour Board

Aberdeen Harbour Board welcomes the development of the European Offshore Wind Deployment Centre off Black Dog and is very interested in becoming involved in providing quayside and other facilities for the Centre's development and ongoing operational phase.

There are, however, several concerns regarding the proposal outlined in the scoping report and these are listed below:

1. Due to the high level of shipping activity both using Aberdeen Harbour and passing traffic it is essential that the location of the EOWDC does not change from that proposed. For the same reason no additional turbines or other structures should be added outside the currently proposed footprint in the future unless it is to the north.

2. The proposed cable run connecting the EOWDC to the shore currently passes through the Maritime and Coastguard Agency designated anchorage. This area is in frequent use and cannot safely be reduced in size. An alternative route for the cables should be located at a safe distance from the anchorage allowing for the possibility of a vessel dragging anchor.

3. Has sufficient information been obtained to establish the route and installation of the electricity cables in respect of the highly mobile seabed which can be subject to re-suspension throughout the tidal cycle or under stormy conditions?

4. Has modelling and monitoring been done on the impact of the turbines on the dynamic seabed? Scour and erosion are possible around the base of the turbine and if this were to increase the material in suspension it could impact on the dredging regime at Aberdeen Harbour and the beach profile of Aberdeen beach.

Transport Scotland

The proposed development represents an intensification of the use of this site however the percentage increase in traffic on the trunk road is such that the proposed development is likely to cause minimal environmental impact on the trunk road network. On this basis TRNMD have no comment to make.

Historic Scotland

Information on the location of all scheduled monuments, listed buildings, gardens and designed landscapes and designated wreck sites can be obtained from www.PASTMAP.org.uk. This is a free, interactive website produced jointly by Historic Scotland and the Royal Commission on the Ancient and Historical Monuments of Scotland which allows anyone with internet access to display and search data on Scotland's historic environment.

The proposed Development

I understand that the proposed offshore elements of the development consists of the following:

- 11 offshore wind turbines and their associated foundations
- Subsea cables between the turbines;
- An export cable for connection to the transmission network;
- An Ocean Laboratory.

The proposed onshore elements of the proposal consists of:

- Onshore deployment facilities
- Onshore substation;
- The landfall connection between offshorw export cable and onshore cable.

The scoping comments below relate to the potential impacts of the offshore aspects of the scheme only (excluding the proposed Ocean Laboratory).

Marine Assets - Potential Impacts

In relation to the submitted search area of the proposed offshore wind farm, I can confirm that there are no designations within our statutory remit located within this identified area. I can also confirm that there are no such designations within the immediate vicinity of the proposed wind farm search area.

I note that the scoping report identifies that there are certain undesignated wrecks within the survey area and that there is a potential for former terrestrial prehistoric archaeology within the subsea survey area. I welcome the proposed approach in terms of incorporating archaeological assessment and input to the geotechnical data and geophysical surveys which shall be undertaken. This is consistent with guidelines set down in 'Historic Environment Guidance for the Offshore Renewable Energy Sector' (Cowrie 2007). The relevant Council Archaeology Services may also wish to comment.

It would be very helpful if the results of all archaeological assessments could be archived through the Royal Commission on the Ancient and Historical Monuments of Scotland.

Terrestrial Assets - Potential Direct Impacts

I understand that the potential direct impacts on terrestrial assets shall be addressed separately. We shall provide further comments at this stage.

Terrestrial Assets - Impact on Setting

In relation to the search area of the proposed offshore wind farm, I can confirm that there are terrestrial assets with a seascape setting, which may be subject to an indirect impact as a result of the proposed offshore turbines. I note that viewpoints are proposed to be taken from Dunnottar Castle (Index no.986) and Torry Battery, battery 130m ESE of Old South Breakwater (Index no. 9215). I would also recommend visualisations to be taken from Hare Cairn, cairn 600m W of Keir (Index no. 3277), Forvie Church and deserted village (site of) (Index no. 7644) and Straloch designed landscape.

I understand that the potential indirect impacts of the proposed onshore works shall be assessed separately. We shall provide further comments at this stage.

Cumulative Impact

We welcome the proposed cumulative assessment and would refer you to the appropriate industry guidance on this matter; Cowrie 2008, ‘Guidance for assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy’.

This can be sourced at:
http://www.offshorewindfarms.co.uk/Assets/4Archaeological%20guidance%20final%20version.pdf)

Our Views on the Principle of this Proposal

Without prejudice and on the basis of the information supplied, we can indicate that while it may be possible to accommodate a wind farm development in this location, there are certain aspects of the proposal which we would require to be assessed. In particular, this relates to the potential impacts on the setting of the assets referred to above.

In terms of assessing marine archaeology, subject to the comments provided above, in our view the proposed methodology for baseline surveys, assessment of impacts and mitigation is considered acceptable.

In terms of assessing the potential impacts on marine archaeology, subject to the comments provided above, in our view the proposed methodology for baseline surveys, assessment of potential impacts and mitigation is considered acceptable.

The relevant Council archaeological and conservation service will be able to provide information and advice on unscheduled archaeology and category B and C(S) listed buildings.

Please refer to the advice contained in our technical guidance note on setting. This documents is available at:

http://www.historic-scotland.gov.uk/managing-change-consultation-setting.pdf

Ports and Harbours

The application must include a full Navigation Risk Assessment in line with MGN 371. Having cables running through an anchorage area would appear to be a risky idea and they would need to be buried to a suitable depth to prevent damage.

Annex 2.

DEVELOPER APPLICATION AND ENVIRONMENTAL STATEMENT CHECKLIST

	Enclosed
1. Developer cover letter and fee cheque	□
2. Copies of ES and associated OS maps	□
3. Copies of Non Technical Summary	□
4. Confidential Bird Annexes	□
5. Draft Adverts	□
6. E Data – CDs, PDFs and SHAPE files	□

Environmental Statement	Enclosed	ES Reference (Section & Page No.)
7. Development Description	□	
8. Planning Policies, Guidance and Agreements	□	
9. Economic Benefits	□	
10. Site Selection and Alternatives	□	
11. Baseline Assessment data – air emissions	□	
12. Design, Landscape and Visual Amenity	□	
13. Construction and Operations (outline methods)	□	
14. Archaeology	□	
15. Designated Sites	□	
16. Habitat Management	□	
17. Species, Plants and Animals	□	
18. Water Environment	□	
19. Sub-tidal benthic ecology	□	
20. Hydrology	□	
21. Waste	□	
22. Noise	□	
23. Traffic Management	□	
24. Navigation	□	
25. Cumulative Impacts	□	
26. Other Issues	□	

N.B. Developers are encouraged to use this checklist when progressing towards application stage and formulating their Environmental Statements. The checklist will also be used by officials when considering acceptance of formal applications. Developers should not publicise applications in the local or national press, until their application has been checked and accepted by officials.

MINISTRY OF DEFENCE

Richard Maisey
Safeguarding Assistant

Safeguarding - Wind Energy
Defence Estates
Kingston Road
Sutton Coldfield
West Midlands
B75 7RL

Cyranne Taylor: 0121 311 2195
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Mr Andrew Sutherland
Socttish Government
Marine Laboratory
PO Box 101
375 Victoria Road
Aberdeen
AB11 9DB

Your Reference:
Our Reference: DE/C/SUT/43/10/1/9064

2 September 2010

Dear Mr Sutherland

MOD SAFEGUARDING: – MOD RADAR AND FLIGHT SAFETY WIND ENERGY SAFEGUARDING INTERESTS

Proposal: Scoping Opinion Request For Proposed Section 36 Application

Location: European Offshore Wind Deployment Centre, Aberdeen

Thank you for consulting the Ministry of Defence (MOD) on the scoping request with respect to the above proposal.

The scheme outlined involves the construction of 11 free standing wind turbines with associated infra-structure. The turbines are expected to be 195 metres to blade tip above ground level.

The principal safeguarding concern of the MOD with respect to the development of wind turbines relates to their potential to create a physical obstruction to air traffic movements and cause interference to Air Traffic Control and Air Defence radar installations.

Consultation by the developer at the pre-planning stage has identified the following concerns:

Air Defence (AD) radar

The turbines will be 26 km from; in line of sight to; and will cause unacceptable interference to the AD radar at Buchan. Following trials carried out in 2005, it has been concluded that wind turbines can affect the probability of detection of aircraft flying over or in the vicinity of wind turbines. Due to this, the RAF would be unable to provide a full air surveillance service in the area of the proposed wind farm.

DEFENCE ESTATES
Delivering Estate Solutions to Defence Needs

Accordingly the applicant should take account of MOD aviation and radar operations in completing the EIA particularly in identifying a suitable site for development and the dimensions of the turbines that are to be installed.

It should be noted that this response is based on current levels of wind farm development in the area. If additional wind farms are consented or built prior to this development being submitted for planning consent, our position may change.

Defence Estates Safeguarding wishes to be consulted and notified of the progression of planning applications and submissions relating to this proposal to verify that it will not adversely affect defence interests.

I hope this adequately explains our position on this matter. If you require further information or would like to discuss this matter further please do not hesitate to contact me.

Yours sincerely

Richard Maisey
Safeguarding Assistant – Wind Energy
Defence Estates

SAFEGUARDING SOLUTIONS TO DEFENCE NEEDS

DEFENCE ESTATES
Delivering Estate Solutions to Defence Needs

Northern Lighthouse Board

CAPTAIN PHILLIP DAY
DIRECTOR OF MARINE OPERATIONS

84 George Street
Edinburgh EH2 3DA
Switchboard: 0131 473 3100
Fax: 0131 220 2093
Website: www.nlb.org.uk
Email: enquiries@nlb.org.uk

Your Ref:
Our Ref: AJ/OPS/CPA/OREI/10/W – Aberdeen Bay

Mr David Rodger
Senior Development Manager
Vattenfall Wind Power Ltd
3rd Floor, The Tun
4 Jackson's Entry
Holyrood Road
Edinburgh
EH8 8AE

01 September 2010

Dear Mr Rodger

Scoping Document for the Proposed Islay Offshore Wind Farm

Thank you for your correspondence dated 20 August 2010 regarding the Scoping Document Consultation for the proposed Aberdeen Bay wind turbine site development and the intention of **Aberdeen Offshore Windfarm Limited** to deploy up to 11 turbines in test area approximately 2km off the Aberdeenshire coast.

With regard to the consultation and the scope of assessment, we would only comment on that part relating to Shipping and Navigational Safety contained within several sections of the consultation document. Notice(s) to Mariners, Radio Navigation Warning and publication in appropriate bulletins will be required stating the nature and timescale of any works carried out in the marine environment relating to this project.

We would advise that any final marking and lighting recommendations will be made in a formal response through the Coast Protection Act 1949: Section 34 consultation process, and will be based on IALA Recommendation O-139. All navigational marking and lighting of the site or its associated marine infrastructure will require the Statutory Sanction of the Northern Lighthouse Board prior to deployment.

We note that the reference to cable routes and other marine users depicted in the Annex at Fig 2 and Fig 12 do not contain the recently recommended anchorage area within Aberdeen Bay. This should be included in all future documentation.

We would require the Navigational Risk Assessment to be in accordance with the information given at section 6.1.3 and in line with the requirement of MCA Marine Guidance Notice 371. This should cover all aspects of the site (including cable routes) during construction, operation, maintenance and de-commissioning phases of the project. We welcome the use of a local workshop to ensure all shipping and port interests are consulted.

Please advise if we can be of any further assistance, or require clarification any of the above.

I would be obliged if any further communication to the Northern Lighthouse Board can be sent via fax on 0131 220 0235, e-mail to navigation@nlb.org.uk or our postal address, Northern Lighthouse Board, 84 George Street, Edinburgh, EH2 3DA.

RYA SCOTLAND

Royal Yachting Association Scotland

RYA Scotland

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David Roger
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EH8 8AE

14 February 2011

Dear David,

European Offshore Wind Deployment Centre

The RYA is the national body for all forms of recreational and competitive boating. It represents dinghy and yacht racing, motor and sail cruising, RIBs and sports boats, powerboat racing, windsurfing, inland cruising and personal watercraft. The RYA manages the British sailing team and Great Britain was the top sailing nation at the 2000, 2004 and 2008 Olympic Games.

The RYA is recognised by all government offices as being the negotiating body for the activities it represents. The RYA currently has over 100,000 personal members, the majority of whom choose to go afloat for purely recreational non-competitive pleasure on coastal and inland waters. There are an estimated further 500,000 boat owners nationally who are members of over 1,500 RYA affiliated clubs and class associations.

The RYA also sets and maintains an international standard for recreational boat training through a network of over 2,200 RYA Recognised Training Centres in 20 countries. On average, approximately 160,000 people per year complete RYA training courses. RYA training courses form the basis for the small craft training of lifeboat crews, police officers and the Royal Navy and are also adopted as a template for training in many other countries throughout the world.

There are two RYA publications which are relevant. The first is the '***RYA Position Statement on Offshore Renewable Energy Developments'***, a copy of which is attached. The RYA's concerns regarding recreational boating and offshore energy devices are included in this statement and we would expect these to be addressed in the planning of any marine development.

In addition to the position statement, the RYA has also produced the UK Coastal Atlas of Recreational Boating. The Atlas contains maps of recreational cruising routes, racing and sailing areas as well as locations of RYA affiliated clubs, training centres and also marinas (independent) around the UK. The Atlas is freely available electronically as a PDF file and is also available in GIS format for an annual £600 licence fee from the RYA (contact: emma.stewart@rya.org.uk). Please note that the routes given are those most commonly used and are based on information given by local experts. Passage planning depends on the expected weather, tidal flows, whether the vessel is under sail or power, and many other individual factors. Any increase in storminess during the normal sailing season (April 1 to 31 October) has implications for navigation in these waters.

RYA Scotland, through its network of local experts, will be happy to provide any additional detailed information required for Environmental Statements.

In summary the RYA's concerns with offshore energy developments and recreational boating relate to:

Navigational safety
Collision risk, particularly in adverse weather conditions
Risk management and emergency response, for example in response to units breaking free in a storm
Marking and lighting
Weather
Location
Loss of cruising routes and anchorages
Squeeze into commercial routes
Effect on sailing and racing areas
Cumulative effects both of other similar schemes and also other developments
Visual intrusion and noise
End of life
Dereliction
Decommissioning
Consultation
These are detailed in our position statement, referenced above and attached to this letter.

There can also be positive benefits for marine recreation from the development of marine renewables. These might include provision of onshore infrastructure, marking of underwater hazards and reduction of wave heights by wave devices.

In the case of Aberdeen Bay, recreational sailing should be considered under both 'Shipping and navigation' and 'Recreation and tourism'. The approaches to the port of Aberdeen harbour can be very busy with vessels entering and leaving. Many recreational vessels follow an inshore route from the Forth to Peterhead and vice versa, often at night to take advantage of a favourable tidal flow. Only some recreational vessels are equipped with radar and AIS and great care is needed to avoid commercial vessels entering or leaving Aberdeen. Although some recreational vessels will choose to sail further offshore to avoid the development, effective marking and lighting will be essential and needs to be considered from the point of view of recreational craft as well as much larger commercial vessels. There is a further danger of squeezing recreational craft between the commercial shipping routes and the development.

I hope the above information proves useful. Please do not hesitate to contact RYA Scotland should you have any questions.

Yours aye,

James Stuart
Chief Operating Officer

Our ref: PCS/109451
Your ref: European Offshore

If telephoning ask for:
Nicola Abrams

24 September 2010

Andrew Sutherland
Marine Renewables Licensing Advisor
Marine Scotland – Marine Planning and Policy Division
Scottish Government
Marine Laboratory
PO Box 101
375 Victoria Road
Aberdeen
AB11 9DB

By email only to: sutherlanda@marlab.ac.uk

Dear Andrew

Electricity Act 1989

The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000

Scoping Opinion For The Proposed Section 36 Application For The European Offshore Wind Deployment Centre, Aberdeen

Thank you for consulting SEPA on the scoping opinion for the above development proposal by way of your letter which we received on 30 August 2010. We consider that the following key issues should be addressed in the EIA process:

- River Basin Planning
- Pollution Prevention and Environmental Management
- Coastal Processes

Please note that all of the issues below should be addressed in the Environmental Statement (ES) for the whole project, but there may be opportunities for several of these to be scoped out of detailed consideration for specific aspects or phases. The justification for this approach in relation to specific issues should be set out within the ES.

1. Scope of the ES for marine developments

1.1 This project will be developed during a period of fast development of marine policy at national and international levels and this should be addressed with respect to the Marine (Scotland) Act 2010 and Marine Strategy Framework Directive. More information can be found on the Marine Science website at http://www.scotland.gov.uk/Topics/marine/seamanagement.

1.2 From the information submitted we understand the overall project will include both onshore and offshore components including 11 turbines, foundations, cabling, ocean laboratory, and onshore works including landfall and substation. As such, the development will be subject to a range of different consenting regimes. We would encourage you to consider producing a single ES which covers all aspects of the proposed development. This will enable a full assessment of the potential effects of the development as a whole, rather than assessing certain details of the development individually.

2. Site layout and nature of construction for marine developments

2.1 The ES should contain plans giving detailed information on the site layout, including details of all onshore and offshore components such as access tracks, buildings, cabling and marine devices. These plans should be supported by a statement detailing the development, as well as reasons for the choice of site and design of the development. Depending on the types and scale of construction the information below may be required.

2.2 Plans should be included in the ES showing the layout of the devices, cabling routes and associated onshore infrastructure.

2.3 Background information that will help inform the ES process is available from European Marine Energy Centre (EMEC). The EMEC has produced guidelines to assist developers in considering the range and scale of impacts that may result from the testing of devices. These guidelines are available at www.emec.org.uk/index.asp. Generally, if this standard industry guidance is followed for scoping, preparing and undertaking EIA for marine renewables, then we are likely to be satisfied with the standard of assessment.

2.4 There may be a need to address the cumulative effects of devices on coastal processes depending upon density and location with respect to existing renewable and coastal developments.

2.5 The submission should include information on likely timing and duration of the project, possible long-term locational and/or operational impacts and short-term construction impacts.

3. River Basin Management Planning

3.1 Under the Water Environment and Water Services (Scotland) Act 2003, SEPA is responsible for producing and implementing River Basin Management Plans for the Scotland and the Solway Tweed River Basin Districts. River basins comprise all surface waters (including transitional (estuaries) and coastal waters) extending to 3 nautical miles seaward from the Scottish territorial baseline. Any proposed development within these waters must have regard to the requirements of the Water Framework Directive to ensure that all surface water bodies achieve 'Good Ecological Status' and that there is no deterioration in status. The Water Framework Directive requires the consideration of chemical, ecological and hydromorpholgical status. Further information on River Basin Management planning can be found on the SEPA website at www.sepa.org.uk/water/river_basin_planning.aspx. Information on the current status of Scotland's surface waters can be found on the water body data sheets on the the River Basin Management Planning Web Mapping Application available on SEPA's website at (http://213.120.228.231/rbmp/).

3.2 Under section 4, page 57 (baseline data) we would suggest that inclusion of the data held on 'Cruden Bay to Don Estuary' coastal water body should also be included in the baseline dataset. This water body is currently classified at high ecological status – a full datasheet is available at apps.sepa.org.uk/rbmp/pdf/200117.pdf. Any proposed development within these waters must have regard to the requirements of the Water Framework Directive (WFD) to ensure that all surface water bodies achieve 'Good Ecological Status (GES)' and that there is no deterioration in status. The WFD requires the consideration of chemical, ecological and hydromorpholgical status. The ecological status of surface water bodies which may be affected by the proposal should also be considered in section 5, alongside the discussion of protected areas for salmon and freshwater pearl mussel. These can be accessed via the interactive map at www.sepa.org.uk/water/river_basin_planning.aspx.

3.3 The cumulative assessments should consider the proposals alongside any existing coastal development already present within the water bodies in which landfall locations are being considered. EC guidance defines cumulative impacts as "impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project" (http://ec.europa.eu/environment/eia/eia-studies-and-reports/guidel.pdf).

3.4 Maps should be included in the ES showing the areas of seabed likely to be affected by the footprint of the turbine bases and cabling, and the area of intertidal zone that is likely to be affected by shoreline infrastructure development. To allow for the RBMP classification to be updated and the assessment of cumulative impacts within these water bodies footprint data for the turbines and cabling components of the development should be provided in the ES.

4. Construction Environmental Management Document (CEMD) and pollution prevention

4.1 One of our key interests in relation to major developments is pollution prevention measures during the periods of construction, operation, maintenance, demolition and restoration. The construction phase includes construction of access roads and any other site infrastructure.

4.2 We advise that the applicant, through the EIA process or planning submission, should systematically identify all aspects of site work that might impact upon the environment, potential pollution risks associated with the proposals and identify the principles of preventative measures and mitigation. This will establish a robust Project Environmental Management Process (PEMP) for large scale (eg Major and Environmental Impact Assessment Projects (EIA). A draft Schedule of Mitigation should be produced as part of this process. This should cover all the mitigation measures identified to avoid or minimise environmental effects. Details of the specific issues that we expect to be addressed are available on the Pollution Prevention and Environmental Management section of our website.

4.3 A key issue for us is the timing of works. Therefore, the Schedule of Mitigation should include a timetable of works that takes into account all environmental sensitivities, such as fish spawning, which have been raised by SEPA, SNH or other stakeholders. Timing should also be planned to avoid construction of roads, dewatering of pits and other potentially polluting activities during periods of high rainfall. We can provide useful information such as rainfall and hydrological data through our Access to Information Team.

4.4 A Construction Environmental Management Document (CEMD) is a key management tool to implement the Schedule of Mitigation. We recommend that the principles of the CEMD are set out in the ES drawing together and outlining all the environmental constraints and commitments, proposed pollution prevention measures and mitigation as identified in the ES.

4.5 The CEMD should form the basis of more detailed site specific Construction Environmental Management Plans (CEMPs) which along with detailed method statements may be required by planning condition or, in certain cases, through environmental regulation. This approach provides a useful link between the principles of development which need to be outlined at the early stages of the project and the method statements which are usually produced following award of contract (just before development commences).

4.6 We recommend that the detailed CEMD is submitted for approval to the determining authority at least two months prior to the proposed commencement (or relevant phase) of development to order to provide consultees with sufficient time to assess the information. This document should incorporate detailed pollution prevention and mitigation measures for all construction elements potentially capable of giving rise to pollution during all phases of construction, reinstatement after construction and final site decommissioning. This document should also include any site specific CEMPs and Construction Method Statements provided by the contractor as required by the planning authority and statutory consultees. The CEMD and CEMP do not negate the need for various licences and consents, e.g. CAR, if required. The requirements from the obtained licences and consents should be included within the final CEMPs.

5. Waste management

5.1 Details of how waste will be minimised at the construction stage should be included in the ES, demonstrating that:

- Construction practices minimise the use of raw materials and maximise the use of secondary aggregates and recycled or renewable materials;

- Waste material generated by the proposal is reduced and re-used or recycled where appropriate on site

5.2 To do this effectively all waste streams and proposals for their management should be identified. Accordingly, we recommend that a site specific site waste management plan is developed to address these points. This is in accordance with the objectives of Scottish Planning Policy and the National Waste Plan which aim to minimise waste production and reduce reliance on landfill for environmental and economic reasons.

5.3 Advice on how to prepare a site waste management plan is available on the NetRegs website and from Envirowise who also provide free advice on resource efficiency. Further advice on the reuse of demolition and excavation materials is available from the Waste and Resources Action Programme. Further guidance can also be found on our website. Information on waste prevention and waste minimisation is available on SEPA's waste minimisation webpage at www.sepa.org.uk/waste/resource_efficiency.aspx.

6. Flood risk

6.1 The onshore components of the development such as the substation may be at risk from coastal flooding. The location of the substation should therefore be assessed for flood risk from all sources in line with Scottish Planning Policy (Paragraphs 196-211). Further information and advice can be sought from the Local Authority technical or engineering services department, Scottish Water and from our website. Our Indicative River & Coastal Flood Map (Scotland) is also available to view online. If a flood risk is identified then a flood

risk assessment (FRA) should be carried out following the guidance set out in the Annex to the SEPA Planning Authority flood risk protocol. Our *Technical flood risk guidance for stakeholders* outlines the information we require to be submitted as part of a FRA, and methodologies that may be appropriate for hydrological and hydraulic modelling. Further guidance on assessing flood risk and planning advice can be found at our website.

7. Onshore drainage strategy

7.1 Proposed temporary and long-term foul drainage facilities for workers associated with the onshore component of the development must be described in the ES. Guidance and best practice advice can be found in PPG4 *Disposal of sewage where no mains drainage is available*. We also request the submission of a site drainage strategy, detailing methods for the collection and treatment of all surface water runoff from hard standing areas and roads using sustainable drainage principles, which should be shown on a site plan.

7.2 Surface water drainage arrangements associated with the new substation such as any new access roads and buildings should incorporate the attenuation (where appropriate) and treatment principles of sustainable drainage systems (SUDS). The SUDS treatment train should be followed which uses a logical sequence of SUDS facilities in series allowing run-off to pass through several different SUDS before reaching the receiving waterbody. Further guidance on the design of SUDS systems and appropriate levels of treatment can be found in CIRIA's C697 manual entitled *The SUDS Manual*. Advice can also be found in the SEPA Guidance Note *Planning advice on sustainable drainage systems (SUDS)*. Please refer to the SUDS section of our website for details of regulatory requirements for surface water and SUDS.

8. Marine ecological interests

8.1 A baseline assessment of existing intertidal and subtidal habitats and species should be submitted. This should include any UK Biodiversity Action Plan habitats and species (eg maerl, sea pens, eel grass, horse mussels). Additional information on the UK Biodiversity Action Plan is available at: www.ukbap.org.uk/UKPlans.aspx?ID=35. Developers will then be able to ascertain if they are required to supplement or quantify the available data with in-field surveys.

8.2 We also recommend information be submitted detailing how the development will contribute to sustainable development. Opportunities to enhance marine habitats in line with Water Framework Directive and The Nature Conservation (Scotland) Act 2004 objectives and Scottish Planning Policy guidance should be explored. Examples may include coastal realignment, the incorporation of naturalistic features in the design of shoreline works, or planting with salt tolerant species. These could be used as examples of best practice and demonstration sites under SEPA's Habitat Enhancement Initiative (HEI).

8.3 During the construction phase, it is important that good working practice is adopted and that habitat damage is kept to a minimum and within defined acceptable parameters. These should be controlled through an environmental management plan.

8.4 Advice on designated sites and European Protected Species should be sought from SNH. For marine and transitional Special Areas of Conservation (SAC) and Special Protected Areas (SPA), these are WFD Protected Areas. Therefore, their objectives are also RBMP objectives. In this case, SNH may contact us for input on the consultation.

9. Coastal Processes

9.1 Coastal processes should be assessed as part of the ES. This should include a baseline assessment to identify the coastal and sedimentary processes operating in the area. The baseline assessment should identify the following features and processes in the environment:

- Sediments (e.g. composition, contaminants and particle size);
- Hydrodynamics (waves and tidal flows);
- Sedimentary environment (e.g. sediment re-suspension, sediment transport pathways, patterns and rates and sediment deposition);
- Sedimentary structures (e.g. protected banks);
- Typical suspended sediment concentrations.

9.2 Developers will then be able to ascertain if they are required to supplement or quantify the available data with in-field surveys and what mitigation measures are required.

9.3 With regard to diagram 4.1 in section 4.3.3.2 the hydrodynamic modelling should be robust and should represent reality as best as possible. Model performance should be checked in order to demonstrate accuracy and should include sensitivity analysis or estimate of errors in order to enable confidence levels to be applied to model results.

9.4 The magnitude and significance of any changes to the natural processes identified in the baseline assessment should be demonstrated in the ES. It would be helpful to see a series of contour plots showing the magnitude and spatial extent of +(ve) and –(ve) changes in current velocities between the ‘pre development’ and ‘post development’ scenarios. The assessment should also identify and quantify the relative importance of high energy low frequency events e.g. storm events, versus low energy high frequency processes. Any changes to the existing processes can then be used to infer the extent of any changes to sediment transport processes and potential impacts on the marine ecology.

10. Regulatory advice

10.1 Details of regulatory requirements and good practice advice for the applicant can be found on our website at www.sepa.org.uk/planning.aspx. If you are unable to find the advice you need for a specific regulatory matter, please contact a member of the regulatory team in your local SEPA office at:

Inverdee House, Baxter Street, Torry, Aberdeen, AB11 9QA

If you have any queries relating to this letter, please contact me by telephone on 01224 266698 or e-mail at planningaberdeen@sepa.org.uk.

Yours faithfully

Nicola Abrams
Senior Planning Officer
Planning Service

Copy to: Annah.Karlsson@vattenfall.com

Scottish Natural Heritage
All of nature for all of Scotland

Marine Scotland
Aquaculture, Freshwater Fisheries, Licensing & Policy
Marine Laboratory, P O Box 101
375 Victoria Road
Aberdeen
AB11 9DB
For the attention of Andrew Sutherland

By email: A.Sutherland@MARLAB.AC.UK

29 September 2010

Our ref: CNS REN WF ABOF

Dear Sir

ELECTRICITY ACT 1989
THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2000
SCOPING OPINION REQUEST FOR PROPOSED SECTION 36 APPLICATION FOR THE EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE, ABERDEEN

Thank you for your recent consultation requesting our scoping advice on this proposed offshore windfarm development to be located in Scottish territorial waters north west of Aberdeen, approximately 2km offshore. Our advice incorporates comments from the Joint Nature Conservation Committee (JNCC).

Background

Scoping for this proposal originally took place in 2005, when 33 turbines were being considered and our advice at that time was provided in our letter of 2 August 2005. The proposal has changed in location, scale and layout several times since then. We have been worked with AWOFL and its predecessors over the last five years to help identify the potential natural heritage impacts of the proposal and commented on survey methodologies and interim reports, particularly for birds and marine mammals.

The current proposal is for 11 turbines and an ocean lab with connecting cables and scour protection, 2-4.5km offshore. It is likely an application will be submitted early next year.

There will also be onshore deployment facilities and a substation which will be dealt with by a separate planning application and scoping report.

Consenting Process

We appreciate the complexity of dealing with both terrestrial and marine consenting processes; however we recommend that the onshore grid connection application is submitted simultaneously with the offshore wind deployment centre application. This would allow us to provide advice on all aspects of the proposal and give sufficient regard to potential cumulative impacts to the natural heritage. The application for the offshore research centre should be submitted at the same time for the same reasons, unless there is a need to submit it earlier so that it can be used to gather data before construction of the windfarm.

Given the nature of this proposal as a test centre, we also recommend further discussion about the consenting process. We would be happy to be involved in any such discussions with Marine Scotland and AOWFL to identify the potential options including: phasing of the development, assessment of differing and innovative turbine and / or foundation types, timing and duration of construction and operational activities etc.

Natural Heritage Interests to be Considered

In principle, we support the development of marine renewable energy devices where sensitively designed and sited – as set out in SNH Policy Statement 04/01[1]. For this offshore windfarm proposal, we have reviewed the scoping report and our advice is provided in Appendix A and with respect to Natura sites, in Appendices D and E. A summary of some of the key points is provided below.

Please note that the comments in this letter are made without prejudice to any further comments that we might make when consulted on an application for this proposal.

Habitats Regulations

It is important to take into account the range of interests and potential impacts of Natura sites that may need to be considered in relation to regulation 48 of the Conservation (Natural Habitats, &c.) Regulations 1994 as amended, and in particular whether an Appropriate Assessment is required. More detail on the legislative requirements relating to Natura Sites and species is contained in Appendices B and C.

When submitting this application, AOWFL should include a report to inform the Appropriate Assessment. We welcome the consideration that has been given to this in section 5.9.2 of the scoping report and provide further advice on the Habitats Regulations Appraisal process within Appendices D and E.

Although data has been collected for some time, this has been for different iterations of the development and when submitted, there will be less than the minimum two years data which we recommend. It is also not clear how much of the data available will relate to the current site and layout. We **strongly recommend** that AOWFL consider in detail how they will prepare the report to inform an Appropriate Assessment, and whether the types and amount of information that will be available to them at the time (both their own data and that from other sources) will be sufficient.

The report to inform an Appropriate Assessment must consider the conservation objectives for each Natura site. We hope that the scoping advice contained within the appendices to this letter and the draft table we provided on 19 January 2009 (for impacts to the Moray Firth and

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[1] Marine Renewable Energy and the Natural Heritage: An Overview and Policy Statement. No. 04/01. (Please note this is currently being revised.)

Available from: http://www.snh.gov.uk/docs/A327477.pdf

River Dee SACs), provide a useful starting point that AOWFL can develop. We would welcome the opportunity to assist AOWFL by commenting on first a detailed scope of the report to inform an Appropriate Assessment and subsequently a draft. There is a risk that Marine Scotland will not be able to carry out the Appropriate Assessment and draw sufficiently robust conclusions when the application is submitted early next year. A detailed scope would help identify if this is the case and may be used to consider how the consenting process can address this.

Key Points

Some of the key points that we wish to draw out are:

- The layout and footprint of the proposal have changed several times and it is unclear which of the data collected so far, and available from other sources, cover the current footprint and how much data will be available when the application is submitted.

- We do not think that the report covers migrant waterfowl sufficiently. For example, there has only been one radar study that was designed to detect migrant geese and it may have taken place too late to measure anything meaningful. There needs to be more information before we can advise whether this can be dismissed as an important issue.

- Impacts on relevant Annex 1 Birds Directive species (e.g. Common Scoter, Red-throated diver, Black-throated diver etc.) and Annex IV Habitats Directive species (all cetacea) should be specifically identified, including their activity outwith any SPAs. It is unclear whether the additional boat survey will give sufficient data to assess impacts to red-throated diver and common scoter and if not, how this will be addressed.

- We strongly recommend that Aberdeen Offshore Wind Farm Limited consider in detail how they will prepare a report to inform an Appropriate Assessment, and what information will be available to them at the time (both their own data and that from other sources).

- It is important to consider the different ‘sections’ in an integrated way that considers the effect of impacts on one aspect of marine ecology on another, taking into account all relevant factors such as coastal processes.

- Little information is available on the offshore research centre and it is unclear if it is covered in the current scoping report. The report states that the location for this has yet to be decided and it will be subject to a separate consent application. We recommend that a clearer rationale is provided for the research centre and that an application is submitted at the same time as that for the offshore wind deployment centre. This would help inform the overall assessment of the project, as well as providing an opportunity for monitoring protocols to be prepared in advance on any works. More consideration of the timing that application is submitted may be needed if the centre is to be used for research before the windfarm is constructed.

- We would welcome the preparation of research proposals in a construction and post-construction monitoring plan. We recommend that the ES includes an outline of such a plan.

Further Information and Advice

We hope this information is helpful and would welcome the opportunity to continue to provide advice to AOWFL by for instance, commenting on survey results before the ES is prepared. We would be grateful if you could copy us into the formal scoping opinion in due course. Please do not hesitate to contact me if I can be of any further assistance.

Yours faithfully

Sue Lawrence
Area Officer – City of Aberdeen and Aberdeenshire Central
Sue.lawrence@snh.gov.uk

cc David Rodger, Vattenfall Wind Power Ltd

APPENDIX A

SNH's DETAILED ADVICE ON EOWDC SCOPING REPORT

1.6 Approach to EIA

1.6.1 Impact Assessment Methodology

Para 30 – We have raised concerns in meetings about the use of a matrix approach, both for birds and marine mammals and seascape impacts. We encourage a more flexible approach that uses a thorough assessment based on rigorous professional judgement, as this better recognises the complex and unique aspects of the proposal.

1.6.2 Cumulative and In-combination Impact

Actual projects anticipated to be included should be outlined at this stage. We recommend AOWFL consider other east coast windfarm sites such as the 3 STW sites in the Outer Forth and Tay Area (Inch Cape, Neart na Gaoithe and Forth Array), the two Round 3 Zones (Zone 1 and Zone 2) as well as the STW site in the Moray Forth (Beatrice).

2.3 The Project Concept / Consenting Process

Para 46 – We understand that the timing of this proposal is in part driven by the funding requirements of the grant this project will receive from them European Energy Programme for Recovery. In order for us to advise further, for example in relation to the consenting process, it would help to know what those funding requirements are.

2.4 Proposed Development

The report states that there are likely to be onshore deployment facilities, substation and cable which will be dealt with under a separate scoping report. It would be helpful if a timescale was given for when that scoping report and subsequent application will be submitted. Please note for the purposes of the Habitats Regulations Appraisal, the project requires to be assessed as one (please see our comments in Appendix E). We can provide further advice on this aspect once we have received the scope of the report to inform an Appropriate Assessment.

Please note that the landfall is on an erosional soft coastline. Future-proofing the cables and landfall infrastructure is therefore important. It should be ensured that there are no obstructions to net northerly sediment movement within the Bay, otherwise the existing erosion problem on the southern two thirds of Aberdeen Bay (and particularly at Blackdog) may worsen.

Fig 2 (p 161) implies two offshore cables merge into one, to cross the intertidal. The ES should consider if there would be jointing infrastructure where the cables merge as this could create a potential impact in terms of obstruction on a lowering & erosional foreshore.

2.4.1 Wind Turbines

Paras 5, 52 and 56 - It is stated that there may be multiple turbine foundation, tower and turbine designs deployed at the proposed development site. We recommend that if any of these designs depart substantially from the standard foundation (jacket, mono-pile, gravity base), tower (single tubular tower) or turbine (three bladed upwind turbine) designs that the potential for increased or additional impacts from these designs are carefully considered in consultation with us and others. For example lattice design towers may cause attraction to the wind farm and turbine as birds try to roost on the structure. Any turbine with more or fewer blades than the normal three bladed design may result in very different bird collision risk calculations. Floating turbine designs may result in increased underwater collisions for marine mammals and diving birds although there is unlikely to be sufficient depth of water for floating turbines at this site.

We support the idea of trialling new foundations so long as appropriate monitoring is in place to look at and assess the impacts.

2.4.3 Ocean Laboratory
The report states that the location for this has yet to be decided and it will be subject to a separate consent application. It is unclear whether or not it is covered in this scoping report (cf 2.4, paras 49-51) and therefore will be covered within the ES. It would be helpful to have further clarification on this aspect.

2.5 Project Construction

2.5.1 Construction Timescales
Para 62 – We note that 4 turbines are expected to be installed in 2012 and that work will be continuous during construction. Given that these four turbines may have entirely different foundations and thus differing vessel requirements, it will be important that the EIA considers all the possible options of likely numbers and types of vessels on site over the construction period.

2.5.2.3 Inter-Array Cables

Para 74 – Any stabilisation methods for the cables should not interrupt tidal or wave driven currents, otherwise they may have significant onshore implications in terms of sediment movement.

2.5.2.5 Scour Protection
Para 76 – This could be an opportunity to trial different methods which is particularly important if AOWFL wish to investigate artificial reef properties (see comments on 5.1.7.1 below).

4.1 Meteorological Conditions

4.1.2 Baseline Information
Haar is frequent on the north east coastline and the ES should take this into account eg increased likelihood of accidents and associated environmental effects of these measures and requirements for foghorns and lighting. The section on wind turbines (2.5.2.2) says that aviation warning lighting will be required but does not mention foghorns.

4.3 Coastal Processes

4.3.2 Baseline Information
Para 125 - 'a narrow ridge of unknown origin situated in the region between the offshore and littoral zones; it is possible that this ridge affords some protection to the coast from wave action.' This should be investigated, it may be the lower limits of former emerged shorelines, representing themselves within the nearshore. This could have implications for the cable-installation approach.

Para 126 - The implications of the wind farm on tidal currents should be considered. Halcrow (working for Aberdeen City Council) established that south-north tidal currents at the southern end of the bay, played an important role in sediment dynamics and beach health. Given the wave shadow effect of a nearshore array (with cables, defences, sour protection etc), and the propensity of erosion on the adjacent coast, it would be prudent to ensure that there are unlikely to be knock-on effects.

4.5 Sediment and Water Quality

4.5.2 Baseline Information

Please consider whether the sampling takes into account any pollution from the nearby contaminated land at Blackdog.

5.1 Marine Ecology

5.1.2.2 Benthic Habitats

Para 230 - We note that the sampling approach set out in the scoping report is different to the recently agreed benthic survey strategy. The ES should report on results obtained from the recently agreed benthic sampling strategy (September 2010).

5.1.7.1 Further research opportunity: reef effect

Para 239 - We agree this would be a good location to study the reef effects of structures and distinguish between (a) perceived benefits through enhanced diversity/productivity and (b) the structures acting simply as fish aggregation devices. This should form part of a post-construction monitoring plan that we would welcome the opportunity either to comment on or become more directly involved in. Careful consideration should be given to what would be required for post construction monitoring.

As mentioned above (2.5.2.5) there is also the opportunity to look at the best methods of scour protection and recovery of the site following cable installation.

5.3 Fish, Shellfish and Elasmobranchs

The benthic section of the report should make appropriate links to fish and shellfish where there are strong habitat associations for particular species. For example, muddy sediment is closely associated with *Nephrops* and their fishery. The sand and gravelly sand which dominates the area for this proposal is likely to have associations particularly with scallops, but also various flatfish and sandeels (in terms of fisheries species).

5.3.2.1 Spawning and nursery grounds

Para 256 - We are pleased that the report acknowledges the spatial and temporal variability of these areas. The spawning and nursery habitats data provided is from Coull *et al* (1998). Further and more recent information is/should shortly be available from the Defra Data Layers project.

5.3.2.5 Diadromous and freshwater species

Para 268 - We suggest that sparling should also be considered as a diadromous fish species of conservation importance. Sparling is included in the UK Biodiversity Action Plan Priority Species list. They are found in coastal waters and estuaries and migrate into large clean rivers to spawn. Sparling was previously known to occur in a number of Scottish rivers, but has now disappeared from almost all of these sites.

Para 269 - We note that sturgeon have been recorded which are a European Protected Species and must be considered accordingly in the ES (Please see appendix C).

Para 271 - The scoping report identifies various rivers that are important for salmonids, but does not consider whether the River South Esk SAC, to the south of the proposed site, may be affected. The qualifying interests of the River South Esk SAC are Atlantic salmon and freshwater pearl mussel. A recent review by Marine Scotland Science (Malcolm, I., Godfrey, J. & Youngson, A. In prep. Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: implications for the development of marine renewables. *Marine Scotland Science draft report*.) summarises available information on the migratory routes and behaviour of Atlantic salmon, sea trout and European eel. Although the report indicates that the dominant direction of travel for Atlantic salmon (1 SW and MSW) on the east coast of Scotland, in the area around Aberdeen, is a northerly direction, there is also some southerly movement, and there is both easterly and westerly movement on the east coast to the north of Aberdeen. The River South Esk should be included in the list of Natura sites that are identified in the report. Please see our advice in Appendix E on HRA scoping.

To the south of the River South Esk, there are three SACs with anadromous fish species as qualifying interests - the River Tay SAC (Atlantic salmon, river lamprey, sea lamprey), River Teith SAC (Atlantic salmon, sea lamprey, river lamprey) and the River Tweed SAC (Atlantic salmon, sea lamprey, river lamprey). These SACs are likely to be sufficiently well removed from the proposed site not to be significantly affected by the development.

There are also several SACs with diadromous fish and freshwater pearl mussel qualifying interests to the north of the development, but they are also likely to be sufficiently well removed from the proposed site not to be significantly affected by the development.

Para 277 - Not all sites containing freshwater pearl mussel are designated as SSSI or SAC. Any populations in non-designated sites in the vicinity of the development should be considered, but only within the ES.

5.3.2.6 Elasmobranchs

Para 282 – Basking Sharks are known to occur along the east coast and we recommend AOWFL look for more recent literature or sighting records to check this. They may wish to liaise with some of the some of the other east coast offshore wind developers who are also undertaking surveys to see if they are reporting similarly low numbers. We recommend that basking sharks are recorded as a feature if observed during any marine mammal or bird surveys. As Basking sharks are protected under Schedule 5 of the Wildlife and Countryside Act, no development licences are currently available.

Para 283 - We would have thought that there were other elasmobranchs in the area worth mentioning, not only basking and porbeagle sharks.

Para 286 - This should include the effects of displacing fishing activity; i.e. impacts on areas where fishing activity moves to and therefore becomes concentrated. Also could be put in wider fisheries management context, by considering efforts of Scottish Government to bring fishing (and other marine activities) within environmental and biological limits.

5.3.4 Potential impacts

The scoping report recognises that the potential impacts of noise, electromagnetic fields and other disturbance on diadromous fish species needs to be evaluated. A draft SNH report (Gill, A.B. & Bartless, M. In prep. Literature review on the potential effects of electromagnetic fields and subsea noise from marine renewable energy developments on Atlantic salmon, sea trout and European eel) considers the current state of knowledge with regard to the potential impacts of noise and electromagnetic fields associated with marine renewable energy, on Atlantic salmon, sea trout and European eel.

The draft report by Marine Scotland Science (referred to above, para 271) considers available information on migratory routes and behaviour of Atlantic salmon, European eel and sea trout in Scotland's coastal environment, and should also be useful.

Para 597 - The Inshore Fisheries Group (IFG) that covers this area is not yet set-up but should be established soon - this will be another appropriate point of contact for consulting local fishermen, in theory including those that are not affiliated with fishermen's associations.

Table 6.2, p133: - (a) displacement effects should be included, (b) some of the conclusions in this table make assumptions. We do not know the impacts much of the time or how effective mitigation measures will be e.g. impacts of electromagnetic fields and underwater noise.

5.4 Birds

The layout and footprint of the proposal have changed several times and it is unclear which of the data collected so far, and available from other sources, cover the current footprint and how much will be available when the ES is prepared and application submitted.

One of the subjects that we have consistently raised is the need to consider impacts to red-throated divers and common scoter. It is unclear whether the additional boat survey will give sufficient data to address this.

We also do not think that the report covers migrant waterfowl sufficiently. There has only been one radar study that was designed to detect migrant geese and it may have been undertaken too late to really measure anything meaningful. There needs to be more information before we can advise whether this can be dismissed as an important issue.

<u>5.4.1 Introduction</u>

Paragraph 291 and Table 5.2 – Please note that the JNCC programme for designating SPAs for inshore aggregations of non-breeding waterbirds is ongoing and Aberdeen bay is still an active Area of Search. For any marine area which does become an SPA the provisions of Article 6 of the Habitats Directive (Reg 48) will apply. Meantime the area should be considered as an important area for birds and the effects of development seen in this context. The obligations of Articles 2 and 3 of the Birds Directive also need to be considered.

Para 291 - Aberdeen bay is also used by birds during the spring and autumn migration periods and potentially by moulting birds. Indeed, para 296 notes the Aberdeenshire coast as important for divers, grebes and seaduck for all months of the year.

Paragraph 292 – it is stated that seven SPAs within "daily flight distance" of the proposed development site were identified as being relevant. It is unclear which foraging distance data was used for which species. We recommend that the distances used for each species considered is stated and those SPAs that may have connectivity to the proposed development site is listed for each species. We recommend that foraging distance data is not used as a hard cut off value, but that those SPAs that are close to the cut off value are included at this stage (Please also see our comments in Appendix D on the HRA process for SPAs).

<u>5.4.1.1 Project Reports</u>

Additional data sources should include all data available such as North East Scotland Bird Survey reports.

<u>5.4.2 Baseline information</u>

We welcome the consideration in paras 294-309. As well as considering where particular species are a feature of interest of an SPA, the ES should also consider where they are a feature of interest of an SSSI. The SSSI, SAC and SPA interests for a designated site are not always the same nor have the same boundary. For example, some SSSIs such as Corby, Bishops and Lily Lochs are not SPAs. Ramsar sites should also be considered.

Paragraph 299 – due to the very long foraging distances of northern gannet it is likely that some of the birds observed are from other breeding colonies. We recommend that at this stage other gannet colonies further north than Troup Head are scoped in (Please also see our comments on Appendix D).

Para 300: Kittiwake and herring gull also form part of the Fowlsheugh SPA interests.

Paragraph 302 – auks make multiple foraging trips per day during breeding, not one single all day foraging trip as stated here. Thus the energetic impacts due to barrier effects may be multiplied.

Paragraph 305 – note that redshank and lapwing are qualifying features of the non-breeding waterfowl assemblage of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA and not the "seabird assemblage interest feature" as stated here.

Table 5.2 – please add black-legged kittiwake to the species covered by Article 4.2 for the Troup, Pennan and Lions Head SPA. Also please add northern fulmar as a qualifying feature of the seabird assemblage of the Forth Islands SPA. Please remove whooper swan as a feature of the Loch of Skene SPA.

5.4.3.1 Vantage Point Surveys

Para 312 – it is unlikely that detectability of many species is very good as far out as 2km. If distances to each bird (or group of birds) was recorded during vantage point watches we recommend that the number birds detected is plotted against distance to estimate the detectability function for each species. For some species it may be necessary to plot age and/or sex separately (e.g. young gannets have more cryptic plumage than adults, or female eider are more cryptic than males). It should then be possible to assess the range at which each species was reliably detected and thus constrain the analysis to those records within this distance. In addition the effects of sea state may influence detectability with increasing distance. We recommend that the detectability functions for each species are compared across different sea states to determine at which sea state the detectability becomes too low to reliably record birds.

Para 314 – flight height data in the near shore area recorded from vantage point may not be a good model for flight heights further from shore and in deeper water. We urge caution in interpreting flight height data recorded by shore based observers. If flight height data recorded from shore is to be used, we recommend that analysis is undertaken to determine if flight heights measured from shore differs significantly from flight heights measured either by boat based observers or from radar.

5.4.3.2 Boat Based Surveys

Table 5.5 – It is unclear how the assessment of collision, barrier and displacement risks was made. These are probably derived from the presentation we received from Vattenfall in September 2008. Our comments on those results are contained in our letter of 10 December 2008. In particular, the assessment needs to consider all sources of data available and be based on a sufficient length of time to give confidence in the results.

Table 5.5 – We recommend that rather than providing some data on flight heights that a frequency plot of flight heights is provided for each species when these data are presented in the ES.

Table 5.5 – It is not clear where the wind farm and control survey areas are as these are not indicated in any figures. It is not clear whether these observations have been adjusted to the current proposed development foot print or whether or whether they relate to a former iteration. If it is a former iteration it would be helpful to know which one. This also applies to section 5.4.3.4 Radar studies.

5.4.3.3 Boat Based Surveys 2010-2011

Para 326 - It is important that there is sufficient data available to enable Marine Scotland to carry out an Appropriate Assessment. Currently it is unclear whether or not this will be the case.

5.4.3.4 Radar Surveys

Para 329 - Does this refer to the current windfarm footprint or that at the time the radar study was carried out?

Para 333 – It is stated that previous studies have found that "very high avoidance rates by geese" and that collisions being "extremely unusual". There should be reference made to these studies and an indication of where they were undertaken and which species were involved and in what numbers. In order to assess the ability of the conducted radar study to adequately assess the presence and numbers of migrating geese much more information needs to be provided. We recommend that the timing of the deployment of the radar is compared to the known time of passage and numbers of geese recorded at regularly counted sites in the area (e.g. Montrose Basin, Loch of Strathbeg). It will then be possible to show whether the radar was deployed at an appropriate time but should also take into account the variation in goose movements between years. We also recommend that the results of radar ground truthing are included in the ES.

5.4.4 Predicted Impacts
Para 335 – We recommend that the details of the analysis that resulted in the redesign of the turbine layout are included in the ES. Any future analysis of impacts should include indirect effects and disturbance from increased boat traffic for operation and maintenance of the proposed turbines. It should consider all aspects of the turbines such as navigation and aviation warning measures including possible lighting and/or foghorns.

Para 336 – We recommend that for those species where there is insufficient data to apply Distance analysis, plots of the locations and numbers of birds are included, e.g. by varying the size of symbols relative to the number of birds recorded.

Para 338 - The ES should include information on how flight height data was verified.

5.4.6 EOWDC future research and monitoring
Para 343 - We welcome the proposal to continue monitoring during and post-construction and welcome the opportunity to discuss research needs further.

5.6 Marine Mammals

5.6.2.3 Future Boat Based Surveys 2010-2011
Para 392 - From the text it appears that the data presented in the ES will be four months of 'new data' combine with approximately 15 months of 'old data' which didn't cover the same points and used a different method. If it is unclear if this will be sufficient for an assessment and we advise that AOWFL ensure that the mitigation and monitoring of impacts is extremely robust. We also recommend the assessments include as much data as possible, albeit if necessary with some months having less analysis.

5.6.5 Mitigation
There is an opportunity to look at how effective different forms of mitigation are on minimising impacts of installation – noise. This is referred to in 5.7 but not with any detail. As a test centre we recommend that there is a detailed look at underwater noise and robust monitoring of marine mammals (which should include behavioural studies to determine whether behavioural effects are occurring). Ideally we would wish to see a number of readings at various distances from each installation to record noise. This would help gain a better understanding of whether or not various types of mitigation are working or indeed worth doing. We would be happy to meet with AOWFL or their consultants at an early stage to discuss this and try to get the most out of this research.

5.6.6 EOWDC Future Research and Monitoring
C-Pods are now proposed as ''future research' and not for gathering data for the ES. As explained above in the main letter, it is unclear whether there will be enough data for assessing impacts to bottle-nose dolphins both as a feature of the Moray Firth SAC and as EPS, when the ES is submitted. It would be useful to get clarification of what survey protocol will be used for C-Pods, when and where they will be deployed. Please see also our comments in Appendix E.

5.9 Statutory Designations and Conservation
For comments on Natura sites, please refer to our advice in Appendices D and E on the HRA for SPAs and SACs.

Table 5.9 – This should include the River South Esk SAC, to the south of the proposed site. The qualifying interests of the River South Esk SAC are Atlantic salmon and freshwater pearl mussel. The draft Marine Scotland Science report referred to in our comments above indicates that the dominant direction of travel of Atlantic salmon on the south east coast is a northerly one, but there is also some southerly movement. See comments in Appendix E.

The scoping report does not directly consider Ramsar sites and we recommend these are addressed in the ES.

6.5 Seascape, Landscape and visual effects
In general, it appears that the proposed SLVIA outlined takes due cognisance of our previous scoping comments and discussions at meetings. In particular the report recognises the proximity of major and smaller population centres as sensitive receptors, and gives particular consideration to any effects arising as a result of differing wind turbines devices.

6.5.2 Baseline Information
Para 556 – Given the large height of the turbines, it is important to retain a flexible approach to the study area, increasing it if the ZTVs indicate that visual effects are likely to occur in a wider area.

6.5.2.1 Landscape and Seascape Character
Paras 557 - 558 - As we discussed at a meeting with the developer's consultants on 14th April 2010, it is important to consider how the assessments of seascape, landscape and local landscape character types will fit together to prevent duplication and avoid confusion. We would be happy to provide further advice once AOWFL have developed a methodology for this.

6.5.2.2 Visual Amenity
Para 560 – Recreation users at Donmouth LNR should also be considered.

Para. 561 and Table 6.1 - Representative viewpoint locations. Ideally to inform our input into further discussion on viewpoint locations (over and above that previously agreed), it would be useful to have a comparative ZTV, illustrating the extent of changed visibility occurring between the 2009 layout and the current 2010 layout. This would ensure optimum locations are chosen.

Para. 567 - The photomontages should illustrate a range of conditions - eg. sunrise; turbine lighting (dawn/dusk); the international aviation (2.5.2.2) requirement for the turbines to be painted white and aviation warning lighting; the size of the ocean lab (we appreciate this would be a separate application, but some initial indicators of scale, form etc. would be useful).

We had previously suggested allowing for some fixed photomontage 'boards' on site to engage the public. There is no mention of this in the scoping report (within either of the SLVIA or Recreation and Tourism sections) and we recommend that this is undertaken.

6.5.5 Cumulative Impact
Para. 574 - Further engagement on methods for cumulative impact assessment should include both Aberdeen City and Aberdeenshire councils.

Para 576 – This refers to the choice of colour of turbines being used to mitigate landscape and visual impacts, however, section 2.5.2.2 indicates that much of the turbines should be white.

6.8 Recreation and Tourism

6.8.2 Baseline Information

Paras 626-633 – Surfing is another recreational activity that takes place in Aberdeen and kite surfing at Balmedie. All forms of recreation should be considered in the ES and there should be consultation with relevant user groups.

7. Consultations

Para 678 – we recommend that the Whale and Dolphin Conservation Society (WDCS) are added to the list of other consultees. The WDCS have commented on marine mammal survey methods for this proposal and interim reports.

APPENDIX B

HABITATS & BIRDS DIRECTIVES, & HABITATS REGULATIONS

Paragraphs 434-436 of the scoping report outline the Habitats and Birds Directives. The Habitats Directive is transposed into domestic law in Scotland by the 'Conservation (Natural Habitats, &c.) Regulations 1994' which came into force on 30 October 1994 – usually called simply the **Habitats Regulations**. Several amendments have been made to the Habitats Regulations since they came into force.

The Habitats Regulations apply to the inshore zone, and the rules for the protection of marine Natura sites and marine European protected species (EPS) apply here exactly as they do on land.

Habitats Regulations Appraisal

Where a plan or project could affect a Natura site, the Habitats Regulations require the competent authority – the authority with the power to undertake or grant consent, permission or other authorisation for the plan or project in question – to consider the provisions of regulation 48. This means that the competent authority has a duty to:

- determine whether the proposal is directly connected with or necessary to site management for conservation; and, if not,
- determine whether the proposal is likely to have a significant effect on the site either individually or in combination with other plans or projects; and, if so, then
- make an appropriate assessment of the implications (of the proposal) for the site in view of that site's conservation objectives.

This process is now commonly referred to as **Habitats Regulations Appraisal** (HRA). HRA applies to any plan or project which has the potential to affect the qualifying interests of a Natura site, even when those interests may be at some distance from that site.

The competent authority, with advice from SNH, decides whether an appropriate assessment is necessary and carries it out if so. It is the applicant who is usually required to provide the information to inform the assessment. Appropriate assessment focuses exclusively on the qualifying interests of the Natura site affected and their conservation objectives. A plan or project can only be consented if it can be ascertained that it will not adversely affect the integrity of a Natura site (subject to regulation 49 considerations).

Further Information and Advice on HRA

In this scoping response we provide tailored advice for HRA in respect of birds that are qualifying interests of SPAs, and marine mammals, habitats and fish that are qualifying interests of SACs:

- Appendix D – SNH Advice on Habitats Regulations Appraisal for SPAs
- Appendix E – SNH Advice on Habitats Regulations Appraisal for SACs

In respect of this, further information on the qualifying interests and the conservation objectives for each relevant Natura site is available from SNH's Sitelink database[2].

For further advice on the HRA process please see SNH's website[3], including the leaflet on "Natura sites and the Habitats Regulations"[4] which provides a helpful summary. Some of the

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2 http://www.snh.org.uk/snhi/

key concepts are explained in the European Commission's guidance on Article 6 of the Habitats Directive.[5] Revised guidance updating the Scottish Office Circular 6/1995[6] on the implementation of the Habitats and Birds Directive in Scotland was produced in June 2000. This sets out current Government policy relating to Natura sites.

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3 http://www.snh.gov.uk/protecting-scotlands-nature/protected-areas/international-designations/natura-sites/habitats-regulations-appraisal/

4 http://www.snh.gov.uk/docs/C204761.pdf

5 http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/provision_of_art6_en.pdf

6 http://www.scotland.gov.uk/library3/nature/habd-00.asp

APPENDIX C

EUROPEAN PROTECTED SPECIES

Certain species are listed on Annex IV of the Habitats Directive as species of European Community interest and in need of strict protection. The protective measures required are outlined in Articles 12 to 16 of the Directive. The species listed on Annex IV whose natural range includes any area in the UK are called 'European protected species'.

SNH is the statutory nature conservation body who provides advice on EPS in respect of the Habitats Regulations in Scotland, including Scottish Territorial Waters.[7] A summary of the legal requirements for EPS is as follows:

> The Conservation (Natural Habitats, &c.) Regulations 1994 as amended. (The Habitats Regulations.)
>
> Protection of certain wild animals
>
> 39. (1) It is an offence –
>
> (a) deliberately or recklessly to capture, injure or kill a wild animal of a European protected species;
>
> (b) deliberately or recklessly –
>
> i. to harass a wild animal or group of wild animals of a European protected species;
>
> ii. to disturb such an animal while it is occupying a structure or place which it uses for shelter or protection;
>
> iii. to disturb such an animal while it is rearing or otherwise caring for its young;
>
> iv. to obstruct access to a breeding site or resting place of such an animal, or otherwise to deny the animal use of the breeding site or resting place;
>
> v. to disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs;
>
> vi. disturb such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young; or
>
> vii. to disturb such an animal while it is migrating or hibernating;
>
> (c) deliberately or recklessly to take or destroy the eggs of such an animal; or
>
> (d) to damage or destroy a breeding site or resting place of such an animal.
>
> (2) Subject to the provisions of this Part, it is an offence to deliberately or recklessly disturb any dolphin, porpoise or whale (cetacean).

Scottish Government has also provided guidance on the 2007 amendments addressing EPS – *Explanatory guidance for species related activities.*[8]

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[7] SNH advice on EPS under the Habitats Regulations 1994 (as amended) at:

http://www.snh.gov.uk/protecting-scotlands-nature/protected-species/legal-framework/habitats-directive/euro/

[8] Scottish Government Guidance available at: http://www.scotland.gov.uk/Resource/Doc/1221/0050637.pdf

EPS Licences

Licences may be given authorising activities that could affect EPS which would otherwise be illegal under the Habitats Regulations. For Scottish Territorial Waters these licences will be issued either by Scottish Government[9] or by SNH[10] depending on the reasons for the licence request. Licences are only issued under very strict conditions as set out in regulations 44 and 45 of the Habitats Regulations.

As highlighted in Scottish Government Interim Guidance[11], three tests must be satisfied before the licensing authority can issue a licence under Regulation 44(2) of the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) to permit otherwise prohibited acts. An application for a licence will fail unless all of the three tests are satisfied. The three tests involve the following considerations:

- **Test 1** - The licence application must demonstrably relate to one of the purposes specified in Regulation 44(2) (as amended). For development proposals, the relevant purpose is likely to be Regulation 44(2)(e) for which Scottish Government is currently the licensing authority. This regulation states that licences may be granted by Scottish Government only for the purpose of "preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment."

- **Test 2** - Regulation 44(3)(a) states that a licence may not be granted unless Scottish Government is satisfied "that there is no satisfactory alternative".

- **Test 3** - Regulation 44(3)(b) states that a licence cannot be issued unless Scottish Government is satisfied that the action proposed "will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range" (Scottish Government will, however, seek the expert advice of Scottish Natural Heritage on this matter).

Consideration of European Protected Species must be included as part of the application process, not as an issue to be dealt with at a later stage. Any consent given without due consideration to these species is likely to breach European Directives with the possibility of consequential delays or the project being halted by the EC.

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9 http://www.scotland.gov.uk/Topics/Environment/Wildlife-Habitats/16330

10 http://www.snh.gov.uk/protecting-scotlands-nature/species-licensing/mammal-licensing/marine/

11 http://www.scotland.gov.uk/library3/environment/epsg.pdf

APPENDIX D

EOWDC: HABITATS REGULATIONS APPRAISAL (HRA) – SPECIAL PROTECTION AREAS

Introduction

In the following advice for HRA we set out the three steps that need to be considered in order to determine whether or not the European offshore Wind Deployment Centre proposal is likely to have a significant effect on the qualifying interests of SPAs, and any possible adverse impact on site integrity – Appendix B provides more detail on the legislative framework. It is the competent authority (most likely Marine Scotland) who will carry out the HRA, based on our advice and using information and data collated by the developer.

Under HRA, the potential impacts of the EOWDC proposal will need to be considered alone (all aspects of the proposal ie including onshore deployment facilities, substation, cable and offshore research station) and in combination with other plans and projects. It needs to be considered in combination with the Scottish Round 3 zones as well as the following proposed Scottish territorial water sites (Neart na Gaoithe, Inch Cape, Forth Array and Beatrice) and with other types of industry and activity in and around Aberdeen bay and harbour.

Special Protection Areas for inclusion in HRA

We would welcome the opportunity to discuss the scope of HRA with AOWFL (as noted in this response) and we recommend that the following SPAs are considered for individual and also for cumulative assessments:

Troup, Pennan and Lion's Heads SPA
Forth Islands SPA
Fowlsheugh SPA
Buchan Ness to Collieston Coast SPA
Ythan Estuary, Sands of Forvie and Meikle Loch SPA
Loch of Strathbeg SPA
Loch of Skene SPA
Montrose Basin SPA

Please see also our comments in Appendix A, para 299 recommending that gannet colonies further north than Troup Head are also scoped in at this stage (eg Fair Isle).

Advice for HRA in respect of SPA qualifying interests

The steps of the process are as follows; our advice is tailored to consideration of this offshore windfarm:

Step 1: Is the proposal directly connected with or necessary for the conservation management of the SPAs?

The EOWDC proposal is not directly connected with or necessary for the conservation management of any of the SPAs listed above.

Step 2: Is the proposal likely to have a significant effect on the qualifying interests of the SPAs either alone or in combination with other plans or projects?

This step acts as a screening stage: it removes from the HRA those proposals (plans or projects) which clearly have no connectivity to SPA qualifying interests or where it is very obvious that the proposal will not undermine the conservation objectives for these interests, despite a connection. When this screening step is undertaken at an early stage in the development process, it usually means that it takes the form of a desk-based appraisal. We advise that this is kept broad so that potentially significant impacts are not missed out, or discounted too early, in any HRA (or EIA).

The SPA bird interests being considered in respect of offshore windfarms are wide-ranging – many seabirds make long foraging trips, especially during the breeding season, and there are also migratory species to consider such as geese and swans. This means that offshore windfarm proposals may be 'connected to' SPAs at much greater distances than what has so far been experienced in respect of onshore development. Although connectivity is thus established the fact that the proposal is located further away from the designated sites means that direct impacts are less likely on qualifying species while they are within the SPA.

Expert agreement over species sensitivity should help to identify those SPA qualifying interests for which the conservation objectives are unlikely to be undermined by offshore windfarm development, despite any possible connection (e.g. SPA qualifiers which are recorded within a proposed windfarm site but where their flight behaviour and / or foraging ecology means that the windfarm will not have a likely significant effect).

Determination of 'likely significant effect' is not just a record of presence or absence of bird species at an offshore windfarm site, but also involves a judgement as to whether any of the SPA conservation objectives might be undermined. Such judgement is based on a simple consideration of the importance of the area in question for the relevant species. Complex data analysis should not be required at this stage. For example; How many birds have been recorded? What are they using the area for? Is this the only area that they can use for this particular activity? Understanding the behavioural ecology of the species, and the characteristics and context of the proposed windfarm site, will help in determining whether there are likely significant effects. There are three possible conclusions for this step of HRA:

a) The likely impacts are such that there is clear potential for the conservation objectives to be undermined – conclude likely significant effect.

b) The likely impacts are so minimal (either because the affected area is not of sufficient value for the birds concerned or because the risk to them is so small) that the conservation objectives will not be undermined – conclude no likely significant effect.

c) There is doubt about the scale of the likely impacts in terms of the conservation objectives – conclude likely significant effect.

<u>Step 3:</u> Can it be ascertained that the proposal will not adversely affect the integrity of the SPA, either alone or in combination with other plans or projects?

This stage of HRA is termed appropriate assessment, and it is undertaken by the competent authority based on information supplied by the developer, with advice provided by SNH. Appropriate assessment considers the implications of the proposed development for the conservation objectives of the qualifying interests for which a likely significant effect has been determined. These conservation objectives follow a standard format requiring protection of the qualifying bird interests and protection of the habitat in the SPA which supports them.

Conservation objectives for SPA bird species

To ensure that site integrity is maintained by:

(i) Avoiding deterioration of the habitats of the qualifying species.

(ii) Avoiding significant disturbance to the qualifying species.

To ensure for the qualifying species that the following are maintained in the long term:

(iii) Population of the bird species as a viable component of the SPA.

(iv) Distribution of the bird species within the SPA.

(v)	Distribution and extent of habitats supporting the species.
(vi)	Structure, function and supporting processes of habitats supporting the species.
repeat of (ii)	No significant disturbance of the species.

It is important to recognise that the conservation objectives primarily offer site-based protection and that some of them will not directly apply to species when they are outwith the boundaries of the SPA. This is particularly true of objectives **(i)**, **(v)** and **(vi)** which relate to the supporting habitats within the SPA.

Objective **(iii)** however – maintenance of the population of the bird species as a viable component of the SPA – will be relevant in most cases because:

It encompasses direct impacts to the species, such as significant disturbance to qualifying bird interests when they're outwith the SPA.

It addresses indirect impacts such as the degradation or loss of supporting habitats which are outwith the SPA but which help to maintain the population of the bird species of the SPA in the long-term.

Finally, in rare circumstances, it is possible that factors / events outside site boundaries may have the capacity to affect the long term distribution of bird species within the SPA – see objective **(iv)**.

Issues to consider under appropriate assessment

The **key question** in any appropriate assessment for the EOWDC proposal is whether it can be ascertained that this proposal, alone or in combination, will not adversely affect the population of any qualifying bird species as a viable component of the SPAs under consideration.

In considering this matter, we refer to the helpful summary of the main risks of offshore windfarm development to birds provided in Langston 2010.[12] In addition, there may be further issues to consider if the proposal is likely to affect the conservation objectives that relate to bird species while they're in an SPA or to the habitats in the SPA that support them.

- Will the offshore wind proposal(s) cause a deterioration in the habitats of any of the SPAs? *NB. This question relates specifically to the habitats in the SPAs that support the bird interests.*
- Will the offshore wind proposal(s) cause any significant disturbance to bird interests while they're in any of the SPAs? N.B. *See the previous discussion in respect of disturbance outside an SPA.*
- Will the offshore wind proposal(s) alter the distribution of the birds within any of the SPAs?
- Will the offshore wind proposal(s) affect the distribution and extent of the habitats (that support the bird species) in any of the SPAs?
- Will the offshore wind proposal(s) in any way affect the structure, function and supporting processes of habitats in any of the SPAs? NB. *Those habitats which support the bird species.*

[12] Langston (2010). Offshore wind farms and birds: Round 3 zones, extensions to Round 1 & Round 2 sites & Scottish Territorial Waters. RSPB Research Report No. 39.

We highlight that these questions may be applicable to the habitats which support bird interests in any new SPAs designated for inshore and / or offshore aggregations of seabirds – please see JNCC's website for potential areas of search, including Aberdeen Bay.[13]

As noted above, we hope to further discuss these various aspects with AOWFL once a scope for the HRA has been provided.

13 Information on potential new marine SPAs is available at: http://www.jncc.gov.uk/page-4184

APPENDIX E

EOWDC: HABITATS REGULATIONS APPRAISAL – SPECIAL AREAS OF CONSERVATION

Introduction

In the following advice for Habitats Regulations Appraisal (HRA) we set out the three steps that need to be considered in order to determine whether or not the EOWDC proposal is likely to have a significant effect on the qualifying interests of Special Areas of Conservation, and any possible adverse impact on the site integrity of SACs – Appendix B provides more detail on the legislative framework. It is the competent authority (Marine Scotland) who will carry out the final stage of the HRA (appropriate assessment), based on our advice and using information and data collated by the developer.

Under HRA, the potential impacts of the EOWDC proposal will need to be considered alone (all aspects of the proposal ie including onshore deployment facilities, substation, cable and offshore research station) and in combination with other plans and projects. It needs to be considered in combination with the Round 3 development and with other types of industry and activity in the Moray Firth. We therefore recommend that the Beatrice and Round 3 developers collaborate on the assessment of cumulative impacts and we would welcome discussion of this matter and, preferably, a joint meeting between the developers, Marine Scotland and ourselves (SNH and JNCC).

For those SAC qualifying interests that are also European protected species (such as bottlenose dolphin) please see Appendix C for our advice in respect of their EPS status and for EPS licensing arrangements. The advice that we give below solely relates to their consideration as an SAC qualifying interest and how the HRA process therefore applies.

Special Areas of Conservation for Inclusion in HRA

We advise that the applicant will need to consider the following SACs. Further information, including their conservation objectives, is available from http://www.snh.org.uk/snhi/.

SACs designated for marine mammals:

- **Moray Firth SAC** - designated for bottlenose dolphin (*Tursiops truncatus*) and for subtidal sandbank habitat.

SACs designated for fish of conservation concern:

- **River Dee SAC** - designated for Atlantic salmon, freshwater pearl mussel and otter.
- **River South Esk SAC** - designated for Atlantic Salmon and freshwater pearl mussel (Please see our comments in Appendix A, para 271).

SNH advice for HRA in respect of Special Areas of Conservation

The steps of the process are as follows; our advice is tailored to consideration of this offshore windfarm:

Step 1: Is the proposal directly connected with or necessary for the conservation management of the SACs?

The EOWDC proposal is not directly connected with or necessary for the conservation management of any of the SACs listed above.

<u>Step 2</u>: Is the proposal likely to have a significant effect on the qualifying interests of the SACs either alone or in combination with other plans or projects?

This step acts as a screening stage: it removes from the HRA those proposals which clearly have no connectivity to SAC qualifying interests or where it is very obvious that the proposal will not undermine the conservation objectives for these interests, despite a connection. When this screening step is undertaken at an early stage in the development process, it usually means that it takes the form of a desk-based appraisal.

In respect of the above SACs, we identify that the EOWDC may have connectivity to the following qualifying interests, which will therefore require further consideration under HRA. While a desk-based review is helpful for this screening step, this part of the HRA will only be fully completed when the windfarm proposal has been further progressed – when survey work and analyses have been completed, and when the location of / construction methods for windfarm infrastructure, including onshore elements, has been finalised.

There are three possible conclusions to this step of HRA:

a) The likely impacts are such that there is clear potential for the conservation objectives to be undermined – conclude likely significant effect.

b) The likely impacts are so minimal that the conservation objectives will not be undermined – conclude no likely significant effect.

c) There is doubt about the scale of the likely impacts in terms of the conservation objectives – conclude likely significant effect.

However, we are not yet in a position to present definite conclusions for this step, so instead we provide a **summary of our current advice** for each qualifying interest.

- **Marine and coastal habitats** of the Moray Firth .

  We do not consider any aspect of the offshore wind deployment centre will have an impact on the habitat qualifying interest of the Moray Firth SAC

  Summary of our current advice: no likely significant effect.

- **Bottlenose dolphins** of the Moray Firth SAC.

  While the EOWDC proposal is located approximately 140 km from the Moray Firth SAC, the dolphins are not confined to this SAC and will range more widely within the Firth and beyond. Observations around the area of Aberdeen Harbour have confirmed sighting of individual dolphins from the Moray Firth SAC. Construction (and other) noise arising from the proposal is likely to extend beyond the windfarm footprint and may overlap with dolphin use of the surrounding environment. Boat movements, cable-laying and other construction activity may give rise to disturbance. There may also be impacts to the prey species of dolphin – either from the placement of infrastructure or due to noise. We therefore advise that there is potential for the proposal to have likely significant effects on bottlenose dolphins and we discuss below (under step 3) the issues that we think need to be considered.

  It would be beneficial for applicants to collaborate on this issue with other offshore wind developers as appropriate assessment of the cumulative impacts on bottlenose dolphins is likely to be required in combination. Joint discussion and co-ordination of survey and monitoring proposals, mitigation proposals and construction time-tabling would be helpful.

  Summary of our current advice: likely significant effect, so impacts (including cumulative) will need to be considered in appropriate assessment (see step 3).

- **Atlantic salmon** as a qualifying interest of the Rivers Dee and South Esk SACs.

  We recognise that there is a significant data / research gap on this issue, and that very little is known about salmon movements – adults and post-smolts – around the Scottish coastline. Marine Scotland have analysed historic tagging data and should be issuing a report soon, however, it is likely that this report will highlight further research requirements[14].

  We recommend that the applicant assumes all individuals are SAC salmon, and considers the effects on these fish from construction and operational noise / vibration, as well as any other types of disturbance. Mitigation could include timing restrictions on construction work / noisy activities in order to avoid any significant disturbance to migrating salmon, or disruption of their (as yet unknown) migratory routes.

  Onshore infrastructure and / or any required upgrades to roads or bridges may need to be considered under HRA if the work is likely to affect any of these freshwater SACs.

  Summary of our current advice: likely significant effect in relation to offshore infrastructure; impacts (incl. cumulative) will need to be considered in appropriate assessment (see step 3). Consideration of onshore infrastructure may also be required.

- **Freshwater pearl mussels – qualifying interests** of the Rivers Dee and South Esk SACs

  Atlantic salmon (and other salmonids) are integral to the life cycle of freshwater pearl mussel (FWPM), therefore any impacts to Atlantic salmon that prevent them from returning to their natal rivers may have a resulting effect on FWPM populations. While we consider this matter needs discussion in any appropriate assessment we do not identify any survey or research requirements. The impacts are indirect, dependent on the impacts the proposal may have on Atlantic salmon.

  Onshore infrastructure and / or any required upgrades to roads or bridges may need consideration in respect of HRA if the work is likely to affect any of these freshwater SACs.

  Summary of our current advice: likely significant effect, so indirect impacts will need to be considered in appropriate assessment as part of the assessment of any direct impacts on Atlantic salmon (see step 3).

- **Otters** of the River Dee SAC.

  The River Dee SAC is located too far away from the EOWDC proposal for there not to be any likelihood of significant effects on otters there, presuming that no onshore infrastructure is proposed in proximity to this SAC.

  Summary of our current advice: no likely significant effect, although this may need review depending on the proposed location of onshore infrastructure.

Step 3: Can it be ascertained that the proposal will not adversely affect the integrity of the SAC, either alone or in combination with other plans or projects?

This stage of HRA is termed **appropriate assessment**, and it is undertaken by the competent authority based on information supplied by the developer, with advice provided by SNH.

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[14] We will raise this matter with Marine Scotland and the Crown Estate: we understand that research into the migratory routes of Atlantic salmon is a strategic requirement and a matter of relevance to marine renewables as a whole.

Appropriate assessment considers the implications of the proposed development for the **conservation objectives** of the qualifying interests for which a likely significant effect has been determined. We discuss this below for each of the qualifying interests listed above.

Our advice on the scope of appropriate assessment will become clearer when the development process is further advanced: when baseline data has been collected, and when construction methods, location of infrastructure, choice of port, and other aspects of the proposal have been finalised.

Advice for appropriate assessment in respect of bottlenose dolphin of the Moray Firth SAC

The **conservation objectives** for bottlenose dolphin are: **(i)** to avoid deterioration of the habitats of bottlenose dolphin or **(ii)** significant disturbance to bottlenose dolphin, thus ensuring that the integrity of the Moray Firth SAC is maintained and that the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features.

And to ensure for bottlenose dolphin that the following are established then maintained in the long term:

(iii) Population of bottlenose dolphin as a viable component of the site.

(iv) Distribution of bottlenose dolphin within site.

(v) Distribution and extent of habitats supporting bottlenose dolphin.

(vi) Structure, function and supporting processes of habitats supporting bottlenose dolphin.

repeat of (ii) No significant disturbance of bottlenose dolphin.

Based on these conservation objectives the following questions may need to be addressed:

- Will the proposal cause significant disturbance to bottlenose dolphin while they are outwith the SAC such that the viability of this SAC population is affected?
- Will the proposal in any way affect the population viability of the bottlenose dolphins of the Moray Firth SAC?

The last question encompasses the indirect impacts that a windfarm development could have – such as the degradation or loss of supporting habitats or feeding grounds which are outwith the SAC but which help to maintain the population of bottlenose dolphin in the SAC in the long-term. The risk of impacts, and how many of these questions may need answered, will become clearer when the development process is further advanced and construction methods, location of cable routes, choice of port, and other aspects are finalised. It is possible that onshore elements of infrastructure will need to be considered as well as those offshore.

We advise that noise impact assessment is likely to be an important part of assessing any direct disturbance to bottlenose dolphin, including their potential displacement from feeding grounds and other supporting habitats. While we consider that the construction phase may give rise greatest risk of disturbance, we do highlight that impacts during the operational phase also need to be considered, as well as any repowering and decommissioning work. It will also be important for the applicant to consider impacts on prey species.

We **highlight** that cumulative impacts are a key concern and we consider that collaboration between other offshore wind applicants on noise impact assessment is likely to be helpful, along with discussion / co-ordination of mitigation proposals and construction time-tabling.

Advice for appropriate assessment in respect of Atlantic salmon & freshwater pearl mussel

> The SAC conservation objectives for Atlantic salmon and freshwater pearl mussel (where appropriate) are: **(i)** to avoid deterioration of the habitats of the qualifying species or **(ii)** significant disturbance to them, thus ensuring that the integrity of the SACs are maintained and that they make an appropriate contribution to achieving favourable conservation status for each species.
>
> And to ensure for each species that the following are maintained in the long term:
>
> **(iii)** Population of the species, including range of genetic types for salmon, as a viable component of the SACs.
>
> **(iv)** Distribution of the species within sites.
>
> **(v)** Distribution and extent of habitats supporting each species.
>
> **(vi)** Structure, function and supporting processes of habitats supporting each species.
>
> **repeat of (ii)** No significant disturbance of the species.
>
> And for freshwater pearl mussel in particular, to ensure that the following are maintained in the long term:
>
> **(vii)** Distribution and viability of freshwater pearl mussel host species
>
> **(viii)** Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species

In respect of the offshore elements of infrastructure, appropriate assessment will focus on conservation objective **(iii)** – the population viability of Atlantic salmon – considered for the Rivers Dee and South Esk SACs.

There would not be any impacts to supporting habitats in any freshwater SACs arising from offshore infrastructure, however, the placement of onshore infrastructure – including any road / bridge upgrades – may need further consideration. We will be able to give further advice when the applicant presents more information on this aspect.

So the main impacts to Atlantic salmon would arise when the fish are outwith the freshwater SACs, on migration. An adverse impact on site integrity could arise if individuals are significantly disturbed / their behaviour altered / displaced from their migratory routes such that it affects the population viability of the species. The applicant may also need to consider whether the proposal could in any way act as a barrier to salmon movements, whether it might prevent any salmon from accessing the freshwater SACs, in particular the River Dee SAC.

Noise impact assessment is likely to be a key part of any overall appropriate assessment, and all phases of the development should be considered – construction, operation, repowering and decommissioning.

As discussed above, the applicant also needs to consider the potential (indirect) impacts to freshwater pearl mussel (FWPM) arising from offshore infrastructure. This will be a desk-based appraisal following on from the assessment of impacts to Atlantic salmon. We note that direct impacts to FWPM could arise from the placement of onshore infrastructure if this work takes place close to, or is likely to affect, the River Dee SAC.

Ongoing Liaison

We will continue to review our advice on HRA as this proposal progresses, and as survey work, modelling and other analyses are undertaken. We will discuss any strategic research needs with Marine Scotland and the Crown Estate, particularly those in respect of Atlantic salmon.

European Offshore Wind Deployment Centre
Environmental Statement

Appendix 7.1: UXO Threat and Risk Assessment

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

Unexploded Ordnance (UXO) Threat & Risk Assessment with Risk Mitigation Strategy

***Project*: Aberdeen Offshore Wind Farm**

***Client*: Vattenfall**

***Report Number*: P2219 TRA**

September 2010

Draft Version 1.0

Prepared by:	Gary Hubbard	29th September 2010
Reviewed by:	Lee Gooderham	29th September 2010
Released by:	Simon Cooke	29th September 2010

Contents

Appendices

Acronyms and Abbreviations

ALARP	As Low As Reasonably Practicable
CIRIA	Construction Industry Research and Information Association
BD	Bomb Disposal
BDO	Bomb Disposal Officer
BMAPA	British Marine and Aggregate Producers Association
dGPS	Differential Global Positioning Systems
EO	Explosive Ordnance
EOD	Explosive Ordnance Disposal
ERW	Explosive Remnants of War
GIS	Geographical Information System
HE	High Explosive
HMX	High Molecular (mass) RDX
HSE	Health and Safety Executive
IB	Incendiary Bomb
JSEODOC	Joint Service Explosive Ordnance Disposal Operations Centre
KHz	Kilohertz
Kg	Kilogram
Km	Kilometre
lb	Pound (weight)
LSA	Land Service Ammunition
M	Metres
MCM	Mine Countermeasures
MDA	Mine Danger Area
MCA	Maritime and Coastguard Agency
MoD	Ministry of Defence
mm	Millimetres
NaREC	New and Renewable Energy Centre
NEQ	Net Explosive Quantity
NGR	National Grid Reference
Nm	Nautical Mile

RDX	Research Department (composition) 'X'
ROV	Remotely Operated Vehicle
RN	Royal Navy
QA/QC	Quality Assurance/Quality Control
SAA	Small Arms Ammunition
SI	Site Investigation
SOP	Standard Operating Procedure
SSS	Side Scan Sonar
SQRA	Semi Quantitative Risk Assessment
TNT	Trinitrotoluene
UK	United Kingdom
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
WWI	World War One
WWII	World War Two

Executive Summary

Purpose

Items of Unexploded Ordnance (UXO) are regularly encountered within the North Sea and rarely become inert or lose their high explosives effectiveness with age. There is therefore, a potential risk that UXO could be encountered at the Aberdeen Offshore Wind Farm (AOWF). Vattenfall has commissioned 6 Alpha Associates Limited to conduct a detailed UXO desk based study for this wind farm development.

Aim and Objectives

The aim of this document is to address the initial stages of the UXO risk management process by providing a holistic overview of the UXO threats and risks for the marine component of the entire operation. In commissioning 6 Alpha as the project's UXO consultant, Vattenfall intends to:

- Discharge its duty of care to those involved in the development of the project site;
- Ensure that it takes appropriate "best practice" measures to manage all of the risks posed by the UXO threat;
- Protect the development itself from the risks of UXO blight and in doing so protect its investors, investment and reputation;
- Procure the most time efficient and cost effective means of managing and mitigating the UXO risk.

The report will cross reference and account for relevant statutory instruments vis-à-vis UXO risk (with which clients will have to comply), including Heath and Safety at Work legislation as well as the Corporate Manslaughter and Corporate Homicide Act of 2007 and common law liabilities. Additionally, and in particular, the report will explain how and why the Construction Design and Management (CDM) Regulations 2007 apply as does CIRIA's *UXO – A Guide for the Construction Industry*, (the latter providing the first UK "good practice guide", helping developers and the construction industry to deal with UXO).

The report will describe the potential for UXO encounter, the risks that may be posed as a result, as well as how those risks can be reduced to As Low As Reasonably Practicable (ALARP), at best value. In this way we anticipate that Vattenfall will be able to both satisfy and discharge their client's liabilities concerning corporate governance and UXO risk management through the provision of appropriate levels of project safety.

UXO Threat and Risk

The UXO threat is primarily the result of munitions and weaponry used on the Black Dog Range; although there is the background residual risk presented by UXBs and AAA projectiles from WWII. Other threat sources are recorded within the general region however given the nature of these operations and their location, 6 Alpha does not consider that this source will pose a significant threat to the project. The report will summarise this threat and will present a Semi Quantitative Risk Assessment (SQRA) concerning UXO and the effects that they may have upon personnel and the construction work that they are expected to undertake.

Conclusions and Recommendations

The report concludes that outside the Black Dog range template there is generally a low UXO risk to this project, which could be considered as the "background residual risk". 6 Alpha have therefore recommended that the following actions are required to address the UXO risk. This table should be read in conjunction with the "probability of UXO encounter map" at *Appendix 12*.

UXO Probability Rating	Grading	Action Required ahead of Intrusive Works	Associated Additional Costs Low → High
1-2	Remote - Possible	Areas defined as "background residual risk". Use, wherever possible, existing geophysical datasets for UXO risk reduction. Define smallest UXO threat items, interpret the datasets for contacts similar to UXO and avoid during future works. Brief all personnel involved in intrusive works and ensure reactive procedures/guidelines are in place. **6 Alpha Deliverable** - Client's must accept that this is not a 100% survey coverage for UXO, although if conducted by 6 Alpha the risk will be reduced to ALARP.	
3-4	Likely - Very Likely	There are three options for dealing with the risk in these areas: • **Option 1** - Relocate works to areas with a grading of 1 or 2; • **Option 2** – Conduct a UXO Specific Geophysical Survey and avoid targets. This survey should be designed to match the defined UXO threat and provide 100% coverage of specific threat area; • **Option 3** – If target avoidance not possible conduct either diver investigation or ROV inspection, which may discount the item or lead to UXO disposal. **6 Alpha Deliverable** - Once the UXO risk reduction actions have been successfully implemented and subject to our own QA/QC measures, 6 Alpha will sign-off the UXO risk as ALARP.	
5	Almost Certain	6 Alpha would strongly suggest avoiding these areas, and relocation work. As the costs associated reducing the risk to ALARP are likely to be considerable.	

1 Introduction

1.1 Overview

Vattenfall Wind Power Limited (Vattenfall) has commissioned 6 Alpha Associates Limited (6 Alpha) to conduct a detailed Unexploded Ordnance (UXO) desk based study for the Aberdeen Offshore Wind Farm (AOWF); the project's location is depicted at *Appendix 01*. The AOWF development zone is situated off the east coast of Scotland within the North Sea.

Whilst 6 Alpha considers that only marine threat items within 500m of the study will impact on the operation, a much wider search area has been considered for this report to ensure all threats are considered.

Items of UXO are regularly encountered within the North Sea, as confirmed by the media and Royal Navy, and rarely become inert or lose effectiveness with age. Over time, trigger mechanisms (such as fuzes and gaines) can become more sensitive and therefore more prone to detonation. This applies equally to items that have been submersed in water and/or lodged within the seabed. It is possible that significant kinetic energy created by the intense impacts generated by marine engineering, such as cable trenching or site investigation boreholes, could cause an inadvertent detonation.

The aim of this document is to address the gaps in the previous BACTEC study, as identified in the Situation Report (ref. P2219 dated 16th August 2010) by providing a holistic overview of the UXO threats and risks for the entire marine operation. This includes employing background research and factual data, which has been provided by (client engaged) third parties, and upon which we have relied. To ensure a comprehensive and complete report there may be a certain element of duplication from the BACTEC desk study.

1.2 Background

In commissioning 6 Alpha as the project's UXO consultant, Vattenfall intends to:

- Discharge its duty of care to those involved in the development of the project site;
- Ensure that it takes appropriate "best practice" measures to manage all of the risks posed by the UXO threat;
- Protect the development itself from the risks of UXO blight and in doing so protect its investors, investment and reputation;
- Procure the most time efficient and cost effective means of managing and mitigating the UXO risk.

2 Report Methodology

2.1 Structure

This study consists of a desk-based collation and review of readily available documentation and records relating to the possibility of encountering UXO and/or dangerous Explosive Ordnance (EO) related paraphernalia, within the study area. Certain information obtained by 6 Alpha may be either classified or restricted material or, considered to be confidential to 6 Alpha. Therefore summaries of such information have been provided. Please note that our appraisal partly relies on the accuracy of the information contained in these and other third party documents consulted and that 6 Alpha will, in no circumstances, be held responsible for the accuracy of such third party information or data supplied.

In agreement with Vattenfall the following facets will be covered within this report:

- The entire scope of the proposed wind farm project work has been considered;
- The history of the region has been considered, incorporating data from the previous reports;
- Relevant modern military records have been researched and presented;
- Wartime activities have been researched and presented;
- The holistic UXO threat has been considered, including the types that could be encountered, the probabilities of encountering them as well as exposing their potential mechanisms and risks of detonation;
- An outline assessment of how UXO interacts with the natural environment and conditions is made;
- The risks regarding UXO have been assessed;
- A semi-quantitative risk assessment (SQRA) has been undertaken employing 6 Alpha's "Azimuth ©" proprietary risk model;
- The consequences of an inadvertent High Explosive (HE) detonation has been considered;
- Conclusions have been drawn;
- Recommendations, and an overview risk mitigation strategy has been presented.

2.2 Sources of Information

The sources of information consulted for this report include:

- Royal Navy (Northern Diving Unit), Scotland;
- The National Archives, Kew;
- Naval Historical Centre, Portsmouth;
- UK Hydrographic Office, Taunton;
- 6 Alpha's "Agility Database ©" which contains historic maps, aerial photographs and records;
- Development boundary supplied by Vattenfall.

2.3 Standards, Guidance and Best Practice

In producing this document 6 Alpha has consulted the most relevant published guidance and best practice. It should be noted that some of these sources may *prima facie*, not appear to be distinctively relevant to this project/study but, in the absence of specific guidance concerning the management of UXO for the offshore renewable industry, the following sources of guidance are considered most applicable:

- Construction Industry Research & Information Association (CIRIA) – UXO A Guide for the Construction Industry (reference number C681);
- Maritime and Coastguard Agency (MCA);
- British Marine Aggregate Producers Association (BMAPA);
- Health & Safety Executive (HSE).

2.4 Joint Service Explosive Ordnance Disposal Operations Centre, UK

According to Joint Service Explosive Ordnance Disposal Operations Centre (JSEODOC – collocated with one of the British Army's Bomb Disposal Regiments at Didcot, Oxfordshire), UXO discovered during wind farm related operations have presented a problem in the recent past. However, and as yet, there is no clear guidance as to what actions should be taken to mitigate the risk nor in what circumstances the Ministry of Defence (MoD) might respond. JSEODOC directed 6 Alpha to the BMAPA guidance employed for mitigating UXO risk during dredging operations, although this only partly address the UXO risk in a wind farm situation.

In summary the pertinent points gathered from the JSEODOC are:

- There is no legal obligation on the Royal Navy (RN) to respond to UXO incidents outside the UK's 12 nautical mile (Nm) limit;
- Each reported UXO find would be risk assessed on a case by case basis;
- The RN response will depend upon the perceived risk and their commitments to other operations;
- If commercial operations are active in an area where there is a "reasonably foreseeable" risk from UXO, then commercial Explosive Ordnance Disposal (EOD) consultancy and/or contracting support should be arranged. However, in terms of offshore cable laying and foundation installation especially, there is no clear indication as to which areas have "reasonably foreseeable" UXO risk. For dredging operations, by comparison, the level of UXO distribution over the seabed and thus the associated risk is much better clarified and delivered as part of the operating license.

3 Proposed Intrusive Works

3.1 Marine Site Investigation

As part of the project, as is good practice in all offshore renewable projects, geophysical and/or geotechnical work is undertaken. This type of work involves remote and direct sensing techniques that may carry increased risk with regard to UXO. Many systems use the reflection or refraction of energy sources to derive data that can be interpreted to provide a picture of the seabed. The typical energy sources employed are acoustic, pressure or "physical energy" sources that compress or penetrate the seabed. Whilst it is theoretically possible that some of these energy sources could be employed to initiate very sensitive marine explosive ordnance it is considered practically impossible to initiate WWII ordnance in this way; there is no evidence of historic UXO in the marine environment being initiated by conventional methods of marine geophysical survey.

3.2 Marine Cable Installation

The Client will install an export cable to the Scottish mainland; in addition there will be a number if interconnector cables between the turbines. Given empirical evidence it is conceivable that potential interaction with UXO may occur during the following operations:

- **Pre-Lay Grapnel Run (PLGR)** – This is used to prove that the route is clear of disused cables or scrap. It will involve towing a heavy grapnel iron(s) along the route;
- **Cable trenching** – This will follow the PLGR and is expected to be conducted by a variety of methodologies, which will be influenced primarily by water depths and seabed conditions.
- **Deployment of barge anchors** – In areas where the water depth is less than 10m a cable plough may be deployed from a moored cable-laying vessel, to install the cable. The anchor spread will be positioned using a tugboat.

3.3 Turbine Installation

3.3.1 Foundations

Although it has not been confirmed, the foundations for the wind turbine structures are likely to be monopiles. Other techniques and structures are sometimes utilised but for this report we will assume that monopiles will be used. Monopiles are made from welded tubular steel sections, which are driven vertically into the seabed. They are a friction pile system (employing the friction between pile wall and surrounding geology), which supports the weight of the tower and turbine. Indicative monopile dimensions are shown in Table 3.3.1:

Monopile Technical Specification	
Diameter	Up to 6m
Total Length	Up to 90m
Sea bed Penetration	Up to 45m
Steel Plate Thickness	Up to 100mm
Total Weight	200 to 900te

Table 3.3.1 - Typical Monopile Dimensions

Monopiles may be installed using the Drive-Drill-Drive method. The pile is allowed to sink under its own weight and it is then driven into the seabed using a hydraulic hammer. Upon first refusal a drill rig is lowered into the pile and a socket is drilled beneath the toe. Afterwards the pile is again driven into the socket until the required penetration is achieved.

If other foundation techniques are employed the key factor is the force used and the resultant kinetic energy that may initiate UXO. Most foundation techniques usual create this situation.

3.3.2 Scour Protection Systems

It is anticipated that wind turbines will employ anti scour protection system in the form of rock emplacement. This is generally emplaced after turbine installation works are complete. The type and extent of anti scour protection depends upon the soil and sea conditions and mast foundations employed; other types may be employed that will involve interaction and intrusion into the seabed.

4 Sources of UXO Contamination

4.1 General

6 Alpha have conduct detailed research for this project, and after analysing the datasets it is envisaged that there are five principle potential sources of UXO contamination in the region, namely:

- WWII Enemy Bombing;
- Allied Defensive Sea Minefield;
- Military Firing Ranges;
- Munitions related Shipwrecks;
- Munitions Disposal Areas.

However not all of these threats do not directly impact upon the project development zone. From the five sources only one military firing range encroaches within the AOWF boundary.

4.2 British Military Activities and Firing Ranges

4.2.1 Civilian and Military Firing Ranges

There are numerous firing range located along the east coast in the vicinity of AOWF, these are depicted at *Appendix 2A and 2B*. Table 4.2.1 lists the geographically relevant areas and specifies their usage. Of these four sites only Black Dog range has direct impact on the proposed works.

Range Number	Name	Facility
N/A	Black Dog	WWII Military Land Service Ammunition and Current Small Arms Range
N243	Aberdeen	Heavy and light guns used by vessels.
244	Girdleness	Anti-Aircraft Guns Heavy and Light
N/A	Drums Link	Civilian Small Arms Range

Table 4.2.1 – Firing Ranges in proximity of the project.

4.2.2 Black Dog Firing Range

This range has been operational from 1940 to present day. During this time a number of military weapons and munitions have been used on the site. The range by-laws state the range can be utilised for the following:

- Anti Aircraft Small Arms;
- Anti Tank Guns;
- Anti Tank Rifles;
- Machine Guns;
- Mortars;
- Grenades;
- Revolvers and Rifles.

The by-laws document also stipulates that no public interference within the range boundary area is permitted and that any item discovered within the sea danger area should be returned to the sea immediately.

The range at present is assigned to the Army Training Estate (ATE) Scotland. The ranges usage currently is limited to three live firing areas, and a dry training area that may be used day or night. These ranges have been historically used for "Non-Mechanised" weapons systems.

4.2.3 Munition / Explosives Offshore Disposal

Post WWI and WWII, both chemical and conventional munitions were extensively dumped at sea, including in areas off the UK coast. The locations of some of these areas are well known as are the type and numbers of munitions deposited, but in other areas there are problems concerning accuracy of types and numbers dumped. This inaccuracy is incurred because of a combination of factors including; inadequate record keeping, the dumping of items outside designated official dumping areas; and, to an extent, the movement of munitions post dumping as the result of tidal flow.

There is an explosives/munitions disposal area to the south of the project development zone. This area is recorded as a "conventional munitions" disposal site, but is too far away to directly impact upon the project (the location is presented at *Appendix 03*).

4.3 Allied Sea Minefields

A naval mine is a self-contained explosive device placed in the water to destroy ships and/or submarines. They are weapons which are triggered by the approach of a ship. Naval mines can be used offensively, to hamper enemy shipping and lock it into it's harbour, or defensively, to protect Allied shipping and create "safe" zones. Some sources state that up to 70% of sea mines were not recovered after WWII. As a result of enemy sea mining activity, proposals were made in November 1939 to mine the North Sea. These proposals considered the likely effect on fishing as well as the requirement to provide mine-clear sea-channels for British, Dutch and Belgian shipping.

6.4.3 Mine Clearance

At the end of WWII there was a significant sea-mine clearance operation undertaken by both Allied and German Navies, who attempted to clear their respective minefields. This operation was undertaken by one of two methods:

- Using two minesweepers, a sweep-wire (with a serrated edge and an "otter" or "kite" to keep the sweep wire at the required depth), was laid into the water and both ends were attached to a winch at the stern of each ship. The sweep-wire was towed by both vessels over a mined area and, when connected to the "mooring stay" of a moored mine, the ships momentum would then force the stay to the serrated edge of the sweep wire, which cut it. The mine would then (usually), float to the surface for disposal.
- An alternative method was to use one ship only with the sweep wire attached to an oropesa float (to keep the sweep wire away from the ships), and the wire would then cut the mooring stay of the mine (as described above). The untethered mine would then (usually) float to the surface where it was then destroyed, often by rifle fire (however, on occasions the bullet only penetrated the outer casing of the mine, which allowed water to ingress and it would then sink and come to rest on the sea bed; an explosive hazard thus remained).

Historical Admiralty mapping confirmed that minefields that had been situated off the eastern coast were cleared post-War. Whether all those mines that were recorded as being laid, were *de facto* recovered during clearance, could not be confirmed (it should be noted that 100% clearance of minefields, even with today's technology, is not always achievable). The locations of the local mine lays can be seen at *Appendix 04*, they are over 18km away from the development zone and are not considered to present a direct threat to this project.

4.4 Aerial Bombing Campaign

4.4.1 Overview

Limited bombing occurred during WWI, as the main German threat in the marine environment were U-Boats. With the development of aircraft and air delivered weaponry, aerial bombardment became an important phase prior to any possible invasion during WWII. During the early stages of the war, Britain was continuously bombed between 1940 and 1943. Strategic targets along the coastlines of Britain included ports, docks, shipping lanes and power stations. Aberdeen was one such port that was regularly bombed as part of the German campaign.

4.4.2 Shipping Lanes, Sea Convoy Routes and Ports

The east coast ports of Scotland were important commercially and, as WWII progressed, they achieved strategic importance for the transport of coal, as well as for fishing (which was considered key to helping feed the UK's wartime population). A military lesson from WWI was implemented, which saw merchant ships gathered into convoys for protection. Notwithstanding the Royal Navy's attempts to afford such convoys protection, they were regularly attacked from the air. The Luftwaffe also dropped thousands of HE bombs on these convoys and regularly targeted other vessels as the opportunity arose.

Given that there is firm evidence that the vessel, SS Arcangel, was sunk by bombing close to the development boundary (*Appendix 05*), there is the risk that UXBs may remain on the seabed in this region.

4.4.3 Tip and Run

A significant number of air-to-air battles also occurred over this area, some of which resulted in numerous allied and enemy aircraft jettisoning all or part of their payloads i.e. *inter alia* medium and large capacity, UXBs (a tactic known as "Tip and Run"), either in an attempt to escape their pursuers, or to quickly offload weapons from damaged aircraft, before returning to base. Although records of these events are poor, the threat of encountering jettisoned munitions in the sea must be considered an unquantifiable risk, when assessing the background UXO threat for all areas in the North Sea.

4.4.4 Defensive Anti Aircraft Artillery (AAA)

There were two types of AAA battery deployed during WWII; heavy and light. These weapons were deployed on the ranges along the Scottish east coast, notably at Black Dog.

Heavy batteries were static and usually sited in the same position for the duration of the war. They deployed either 4.5 or 3.7 inch guns in groups of 2, 4, 6 or 8 guns per battery. Typically heavy battery was divided between two sites each with four guns and up to several miles apart. The 4.5 inch gun could fire a HE shell (weighing approximately 25kg and fitted with either a barometric or time fuze) 8 miles in 50 seconds. The 3.7 inch gun had a similar ceiling height but smaller calibre shell, again with barometric or time fuzes.

The light batteries were deployed with the 40mm Bofors gun. This weapon could fire up to 120 x 40mm HE shells per minute to approximately 6,000ft; the shells were designed to explode on impact with enemy aircraft. These batteries were not static and could be moved easily to new positions by truck when required.

If AAA shells failed to explode or strike an aircraft they would eventually fall back to land or sea, settling on the seabed in the latter case.

Naval and merchant vessels are commonly equipped with various types of deck guns to protect themselves against enemy air attack. If projectiles or AAA fire missed the target, then it could fall into the sea or over land and may still present a UXO hazard. Again records for this activity are poor and should be considered as a background residual risk.

4.5 Shipwrecks / Downed Aircraft

Shipwrecks in the region confirm that enemy aerial bombing occurred in the region. Although there are no military/munitions related wrecks are recorded within the actual development.

Both merchant and naval vessels that were sunk in WWII may have contained munitions. Empirical evidence has shown that munitions did spill from the ships as they sank and subsequently broke-up. Similarly, aircraft that were shot down or otherwise had to ditch into the sea, may have also contained munitions. In general, the risk of munitions contamination is somewhat less in the vicinity of wrecks as compared with munitions dump-sites because the munitions, in all probability, are most likely to remain enclosed and immobile within the body of the wrecks. However, it may be possible that some items may have been thrown clear of the vessel as it sank or they could become exposed as the wrecks gradually broke up.

5 Explosive Threat Items

5.1 General

Having established potential contamination sources, the following generic ordnance groups are considered likely to present a threat to the proposed development. Clearly, some varieties of UXO are likely to be more common within the project area than others. The table at *Appendix 06*, provides a schedule of dimensions and explosive quantities for the main threat items.

5.2 Weapon Fill Materials

5.2.1 High Explosives (HE)

A HE compound detonates at rates ranging from 1,000m to 9,000m per second, and may be subdivided into two explosives classes, differentiated by their respective sensitivity:

- **Primary Explosives** – are extremely sensitive to mechanical shock, friction and heat to which they will respond by burning rapidly or detonating. Examples include mercury fulminate and lead azide. This characteristic makes them unsuitable to use as base (i.e. main-fill) explosives in military ordnance. Sensitivity is an important consideration in selecting an explosive for a particular purpose, e.g. the explosive in an armour-piercing projectile must be relatively insensitive, or the shock of impact would cause it to detonate before it penetrated the target.
- **Secondary Explosives** – are relatively insensitive to shock, friction and heat. They may burn when exposed to heat in small-unconfined quantities, although the risk of detonation is always present (especially when they are confined and/or are burnt in bulk). Dynamite, TNT, RDX and HMX are classed as secondary high explosives, which are commonly used as, base explosives in military ordnance. PETN is the benchmark compound; those explosives that are more sensitive than PETN are classed as primary explosives.

5.2.2 Low Explosives

A low explosive is usually a mixture of a combustible substance and an oxidant that decomposes rapidly (in a process akin to very rapid burning and known as deflagration).

Under normal conditions, low explosives undergo deflagration at rates that vary from a few centimetres per second to approximately 400m per second. Low explosives are normally employed as propellants, included in this group are e.g. gun-powders, pyrotechnics and illumination devices such as marine markers or flares.

5.2.3 Propellants

In ballistics and pyrotechnics, a propellant is a generic name for those chemicals used for propelling projectiles (e.g. artillery shells or mortars) from a weapon system.

Propellants are always chemically different from high explosives (as compared with those used in munitions for “target effect” for example), as they are not designed to release their energy as quickly and as a result do not produce a blasting/shattering effect (such an effect would damage or destroy the weapon platform e.g. gun/howitzer or mortar).

However, some explosive substances can be used both as propellants and as “burster charges”, (e.g. gunpowder), and some of the ingredients of a propellant may be similar to those employed to make explosives. If bulk propellants are confined and burn very rapidly the result can be similar to that witnessed by a (small) high explosive charge. Propellants therefore, remain highly dangerous and can come in various forms e.g. powder or thin sticks and can be contained in pre-formed containers or bags.

A very typical propellant burns very rapidly but controllably and non-explosively, to produce thrust (generated by rapidly expensing gas, generating pressure), and thus accelerating a projectile/rocket from a weapons platform. In this sense, common or well-known propellants include:

- Gun propellants, such as:
  - Gunpowder (black powder);
  - Nitrocellulose-based powders;
  - Cordite;
  - Ballistite;
  - Smokeless powders.
- Compounds may be mixed with a solid oxidiser (such as ammonium perchlorate or ammonium nitrate), or a rubber (such as HTPB or PBAN), or a powdered metal (commonly aluminium).

5.3 Artillery Projectiles

Artillery projectiles may be classified and grouped as follows:

- **HE** – designed to cause damage by combination of high explosive blast and fragmentation;
- **Fragmentation** – designed to be used primarily against personnel;
- **AP and SAP** Armour Piercing (AP) and Semi-Amour Piercing (SAP) shells are always base fuzed and are generally designed for the attack of lightly armoured vehicles, concrete emplacements dug outs etc. they are not intended for heavily armoured targets.
- **Smoke** – Used for the production of smoke screens; various fillings are used, the most common being white phosphorous;
- **Illuminating** – designed to illuminate an area or specific target at night; a burning flare is suspended from a small parachute to provide an intense white light;
- **Practice** – commonly a solid shot fitted with a so-called “spotting charge” which gives an indication of where it lands.

5.4 Torpedoes

Torpedoes were utilised by a range of vessels including submarines and the surface fleet. Unlike sea mines (which are a “mass-weapon” system deployed in order to strike an opportunity target), torpedoes were usually specifically targeted (i.e. fired and/or guided to a known target) rather than deployed in mass.

The guidance systems used in torpedoes are often sophisticated and include homing systems reliant upon *inter alia* acoustic signature. Any power supply in WWII torpedoes is generally considered expended, and it is therefore highly unlikely that any residual current in fact exists, or that a tiny amount which may still exist, could not still be sufficient to enable the torpedo to function as originally intended.

Whilst it is possible that unexploded torpedoes might be encountered, it is anticipated that their potential discovery is likely to be less frequent than other naval weapons e.g. sea mines.

5.5 Sea Mines

5.5.1 General

Sea mines (which were employed by both sides engaged in WWI and WWII), were designed either to be buoyant or to sink; the former variety tended to be moored but if they were not initiated (or cleared at the end of the War), then they often sank and drifted on the seabed with tides/weather.

Some British mines could be programmed to self neutralise, often by sinking themselves and allowing the ingress of salt water to render the firing circuit inoperable. Although self-neutralising sea mines could not function today as originally designed, the detonators and HE charges remain intact; they are dangerous. Official records also state that not all of the mines had the "sterilisation plugs" fitted to enable self-neutralisation.

Additionally, the detonators in mines are, by design, made from a sensitive explosive compound (often picric-acid based), which remains susceptible to shock to this day; however exposure to saltwater does not generally increase this sensitivity. All WWII vintage sea mines are filled with HE (usually ammonium nitrate and TNT compositions e.g. ammonal or minol), which often remains in sufficiently good condition to detonate, to this day; thus they are dangerous.

5.5.2 Fuzing

Sea mines can be armed with more complex fuzing and initiation mechanisms, which fall into 3 main groups:

- **Hydrostatic Fuzing** – A valve that detects the difference in water pressure (i.e. generated by a passing vessel). Some sophisticated German WWII mines had this type of fuzing and were used in the North Sea;
- **Magnetic Fuzing** – A fuze that detects a displacement of the ambient magnetic field, normally by the introduction of a ferrous metal object (such as a passing vessel);
- **Sonar Fuzing** – Based upon a similar principle as radar, whereby any increased return of the underwater return signal to the sea mine, is interpreted as a potential target vessel and therefore the arming sequence is initiated.

The older generation of moored sea mines were, more commonly, designed to function upon contact with a ship or vessel. The externally mounted chemical horns (or spikes), consisted of a lead outer sheath, which contained two, separated, chemical ampoules. Upon contact, the external horn would crumple, thereby crushing the ampoules and allowing the chemicals to mix. The resultant mixture would immediately produce either an electrical charge or combustion, forming the basis for an explosive reaction and detonation of the bulk high explosive.

5.6 Depth Charges

The depth charge was designed to counter the threat posed by submarines. The generic design resembles a drum containing HE with a hydrostatic fuze, which initiated the main charge at a preset depth (as a result of water pressure). They were fired from the stern or sides of ships (or a combination of both). As the war progressed, the Royal Navy introduced the so-called “Hedgehog” and “Squid” systems, which enabled the depth charge to be fired forward from the bow the ship (which were known as forward throwing charges).

Depth charges varied in size (from 55Kg to 300Kg) and consequently the mass of HE of explosive changed to suit the type of target being attacked. Towards the end of WWII the RN were using a “Mark X” depth charge, which contained 1000kg of explosives; they were fired from tubes mounted on the decks of war-ships.

5.7 German Air-Delivered Weapons

5.7.1 Iron Bombs

Generally, most iron (i.e. air –delivered) bombs are of similar generic construction, consisting of a steel container, a fuze or fuses either located in the nose/tail of the bomb or located laterally (though sometimes in combined locations), and a stabilizing device (i.e. the bomb “tail” to aid accurate aerodynamic flight from the aircraft to the target). The steel container (i.e. the bomb body) contains either the HE content (or other contents e.g. sub-munitions).

Iron bombs are designed in broadly similar shapes (with some variations to ogive shape/angle), but in a much wider variety of masses, depending on the intention of the bombing mission and the targets. Iron bombs are generally categorised as follows;

- **General Purpose** – Designed, as the name suggests, to attack a variety of targets and normally contain an explosive content of approximately 50% of the overall mass of the bomb.
- **Armour Piercing** – Designed to create a mechanically driven entry point in the target prior to detonation, in order to maximise the consequent blast and fragmentation effect. Bunker busting systems, anti-shipping, anti-armoured fighting vehicle and counter-tunnel systems are good examples of the tactical deployment of armour piercing bombs. In general, only 30% of the overall mass contains HE with the remaining 70% made up of steel (in order to maximise penetration and any subsequent fragmentation effect). Armour piercing bombs are always fitted with tail-fuzes.
- **Anti-Submarine** – As the name suggests, primarily designed to attack known underwater targets. These types of bombs are always equipped with a tail fitted hydrostatic fuse and 85 – 90% of the overall mass consists of HE.
- **Incendiary** – These are normally constructed of a thin metal casing containing a thermite (manganese/aluminium) compound. Generally, once the compound is

exposed to oxygen, an instantaneous combustion takes place with the heat generated reaching in excess of 800°C. These bombs were often targeted against high concentrations of industry, general urban development and shipping.

- **Fragmentation** – Fragmentation bombs are normally deployed to maximise the secondary effects of an explosion. The bomb is generally constructed from thick (sometimes segmented), steel, designed to for maximum fragmentation effect. Fragmentation bombs are generally deployed against "soft" unprotected targets.

The larger size high-explosive varieties, were used against shipping i.e. 1,000kg mass and greater, (compared with the smaller bombs (e.g. 50 kg and 250 kg variants), which were often used during "carpet-bombing" campaigns on land).

6 UXO Ground Penetration, Burial and Migration

6.1 General

When assessing the potential for ordnance ground penetration it is essential not to rely solely on either an empirical, statistical and arithmetical formula. Experience has shown that a realistic penetration depth is best estimated by considering a blend of the above approaches supplemented by accounts of Explosive Ordnance Disposal Tasks (and thus empirical evidence) in the area.

6.2 Seabed Migration

Munitions can migrate across the seafloor, the main factors concerning the degree of movement concern *inter alia*; the strength and direction of hydrodynamic currents; the overall shape of the weapon (influencing the degree to which UXO are free to move without obstruction); weapon protrusions such as fins and lugs (the latter being employed for suspension from the aircraft in flight); and the UXO position on the seabed (e.g. in either sediment, gradient or a seabed recess), which could significantly impede movement.

After prolonged exposure to saline water and the action of sea, some munitions can break-up or be otherwise rendered ineffective as high explosive devices; others are still discovered (today), in excellent condition. Additionally, munitions tend to gather in seabed depressions (they roll in, but tidal action often has insufficient momentum to roll them out again). In some areas of the North Sea high concentrations of UXO may gather in such natural seabed "sinks".

6.3 Seabed Burial

Empirical evidence has shown that it is possible for UXO that initially lie on the seabed, to become subsequently buried within the "offshore" environment. This occurs especially where substantial tidal and environmental factors impact seabed conditions e.g. when there are high sedimentation rates, and thus UXO movement (into a seabed depression), and subsequent concealment. Storms and/or exceptional tidal flows could significantly alter the topography of the seabed, and although items of UXO are usually very dense, if they are not moved (and they might during strong tidal flows), they may be concealed easily with the sequential passing of tides and associated sediment movement/deposition.

On this project the highest rates of sedimentation is expected to be close to the shore; accordingly it is possible that munitions may have become buried, over time in that region. Clearly, smaller munitions are more likely to buried (such as AAA or projectiles rather than the larger items of UXO (such as sea mines and iron bombs). When establishing the options for UXO risk mitigation it is important to ascertain the level of potential sediment cover in areas of proposed works.

6.4 Seabed Penetration

The presence of a body of water will have a considerable affect on the conventional and expected penetration depth (into the seabed) for air dropped bombs. Bombs behave uniquely as they enter a body of water and their velocity is reduced significantly before the bomb comes into contact and penetrates the seabed. As a guideline and subject to specific UXO and geotechnical factors the maximum penetration of a 500kg bomb is unlikely to exceed 1m below seabed level, when more than 10m of water is present at the time the munition was delivered).

7 UXO Detonations

7.1 Initiation Scenarios

In 'normal' conditions at sea, UXO does not usually spontaneously explode. Ordinarily, high explosive requires the input of a significant amount of energy to create the conditions for detonation to occur. Although the British Geological Society seismological records suggest that there were 47 spontaneous detonations of dumped munitions in the Beauforts Dyke dumping grounds, between 1992 and 2004. However it is possible that these were the result of munitions deteriorating in the salt-water environment (which is in itself unlikely) and/or becoming more sensitive to shock with age (which is more likely).

Notwithstanding this, in the event of UXO discovery within the construction environment, there are a number of potential initiation mechanisms; they are:

- Direct impact onto the main body of the munition e.g. from the PLGR, jack up barge leg or cable trench;
- Friction impact, initiating the (more sensitive) fuze explosive caused by a number of construction related activities (for example impact from an excavator bucket, piling, or trenching equipment);
- Over pressure caused by piling that may initiate a hydrostatic fuzed munition (where applicable).

During the 1980's British Royal Navy clearance divers were informed, by technical experts from North Atlantic Treaty Organisation (NATO), that WWII-era munitions, which relied on a capacitor in the firing system, would not retain enough electrical charge to function as designed. Therefore very old items, which rely on magnetic or acoustic fuzing to initiate, are not considered a threat, although direct impact to these items may generate enough kinetic energy to initiate the item.

7.2 Detonation Variables

The consequences of munitions detonation have been the subject of a number of studies. It is generally noted that these consequences depend upon:

- The size of the item and its Net Explosive Quantity (NEQ).
- The proximity of the item to vulnerable equipment (and/or other structures).
- The type of explosive and/or fill (e.g. high explosive, incendiary, or specialist).
- Location of the item which may be:

- Floating on the body of water (buoyant mines only);
- On the seabed;
- On the surface;
- Partially buried;
- Totally buried.

- The construction and structural strength of any vessel, equipments or structures near the site of an explosion.

7.3 Underwater High Explosive Detonations

7.3.1 Underwater Detonation Hazards

When an item of UXO detonations underwater there are four main hazards:

- Fragmentation;
- Blast;
- A pulsing and rising gas bubble;
- A shockwave.

7.3.2 Direct Effects of Ordnance Detonation

If a significantly large high explosive item of UXO detonates underwater (e.g. after close contact with pile, jack up barge leg or trenching equipment), then the effect is very similar to that experienced at the surface. A high order detonation causing blast and fragmentation would certainly destroy mechanical equipment or significantly damage (shatter or buckle) part of a cable plough, for example.

7.3.3 Effect of Explosive Shockwave and Gas Bubble on Supporting Vessels

If a mine or a bomb detonated underwater at some distance from the underside of a floating vessel, fragmentation is not a primary consequence. On detonation of a high explosive charge the explosive gasses rapidly form a rising spherical bubble. The momentum imparted to the water in the early stages enables the water to expand until the pressure in the bubble is far less than the hydrostatic pressure of the surrounding water. A violent contraction therefore takes place, followed by a second expansion (almost as rapid as the first), which may be followed by further expansions and contractions.

Each expansion causes a pressure wave that is propagated outwards throughout the water in all directions. As water is highly incompressible the maximum pressure in the initial shockwave is very much higher than would occur in either the ground or in air (but the peak pressure is of much shorter duration). Although these shockwaves become gradually weaker as the bubble rises, the origin of those shockwaves (i.e. centre point of the rising bubble) is often closing with the intended target (i.e. the underside of a floating ship), and therefore it still has sufficient energy to cause considerable shock wave damage at significant distance from the point of initiation. It is possible that the energy could be sufficient to damage and sink a vessel.

8 UXO Risk Assessment Factors

8.1 Source – Pathway – Receptor

The threat in this instance must be considered in light of the proposed operations, the intrusive related activities, as well as the impact on key receptors such as personnel, key installations, high-value equipment and the environment.

8.1.1 Source

6 Alpha has considered that the threat is primarily the result of munitions and weaponry used on the Black Dog firing range, although there is always the potential background residual risk from both UXBs and AAA shells from WWII.

8.1.2 Pathway

The pathway is described as the route by which the hazard reaches the sensitive receptor. Given the nature of the site, the pathways would be during:

- Geotechnical investigation;
- PLGR;
- Marine cable trenching;
- Laying barge anchors;
- Monopile Installation.

8.1.3 Receptors

Sensitive receptors on this site would include:

- Site Investigation Crews.
- Construction Workers/Engineers.
- High-value Equipment.
- Ships/vessels
- Third party shipping/vessels in the immediate vicinity – Note extended safety distances for detonations underwater apply (for reasons we have articulated above).
- Infrastructure and people located along the coastline (close enough to be harmed UXO if was inadvertently detonated).

9 Semi-Quantitative Risk Assessment

9.1 Overview

In undertaking a series of Semi-Quantitative Risk Assessments (SQRA) across the project, we have employed the technical data associated with the items presented within this report and the proposed operation. The following sections transparently outlines the methodology and calculations used in conduction the SQRA for the project. Risk assessment tables are presented at *Appendix 07*.

9.2 Risk Rating

For the purposes of this report, Risk (R) is a function of **Probability** of occurrence (P) and **Consequence** of occurrence (C), where R = P x C. In each case, the Probability and Consequence of the identified threats has been assessed on a scale of 1 to 5. (Where 1 = Very Low, & 5 = Very High) based on expert judgement. These ratings are multiplied together to create Risk scores with a maximum of twenty-five. This allows relative weighting and comparison of risk across the project. Colour coding is provided for ease of use, grouping figures in Green as Low Risk, in Yellow as Medium Risk and Red as High Risk.

Probability			Consequence				
			1 (Very Low)	2	3 (Medium)	4	5 (Very High)
Probability	Very High	**5**	5	10	15	20	25
		4	4	8	12	16	20
	Medium	**3**	3	6	9	12	15
		2	2	4	6	8	10
	Very Low	**1**	1	2	3	4	5

Table 9.2 – Risk Matrix

9.3 Risk Rating Criteria

It is important that the numerical values assigned to the potential probability and impact of a risk match the risk tolerance of the Client. Table 9.3 outlines the risk rating rationale that has been applied in this analysis:

Risk Rating (P x C)	Grading	Risk Appetite (Tolerance)	Action Required
1-5	**Low**	Tolerable or Partly Tolerable	Little/No specific Risk Mitigation Required. Situation should be monitored. Reactive UXO risk mitigation required during operations, but overall, residual risks are carried.
6 - 12	**Medium**	Intolerable	Advance Mitigation Measures should be considered. Situation should be monitored. Risks to be mitigated subject to the mitigation being reasonable, practical and affordable. Note: High Consequence or High Probability that score as Medium Risk events should be afforded the same status as Highly Intolerable but assessed on a case-by-case basis.
15 - 25	**High**	Highly Intolerable	Risk Mitigation Measures should / will be implemented. All risks to be mitigated.

Table 9.3 – Risk Tolerability Table

The risk levels are used to determine the level of mitigation required to reduce the risk to conform to the ALARP principle. In producing the strategy the risk levels are benchmarked against the various degrees of tolerability (shown in Table 9.3 above), to determine what degree of risk is considered acceptable.

9.4 Definition of Consequence and Probability

As is accepted practice in formalised Risk Management, the Risk Rating scales are dimensionless, allowing the user to apply these methods to any desired terminology in order to fit their discrete needs.

9.4.1 Consequence

If the key consequence is financial, then 5 on this scale should equate to the amount of money that will either, stop the contract, close the operation, exceed agreed budget or any other defined critical financial figure. The scale then sub-divides that amount into 5 equal portions down to zero financial impact.

If the key impact figure is the loss of a vessel, then 5 on the scale is equal to total loss of the vessel as an operational asset, and the sliding scale represents vessel operational efficiency loss i.e. 1 = loss of 0% to 20% operational efficiency, while 5 = loss of 81% to 100% operational efficiency.

If the critical impact figure is loss of 50% of operational efficiency, then the scale represents loss of between 0% and 50% in 5 equal steps. This can be applied to any number of scenarios.

The critical consequence associated with UXO however is that associated injury or death. Both are considered unacceptable and therefore such circumstances should be avoided or the risk appropriately managed or otherwise mitigated to ameliorate such a consequence.

9.4.2 Consequences Specific to AOWF

The detonation consequence assessment assigns a site-specific consequence level to any potential UXO that may be encountered at the site. This is achieved by combining the UXO impact distance from sensitive receptors, the Net Explosive Quantity (NEQ) of the item and, where applicable, the average water depth range (assumed here to be in the region of 10-15m). A rating system for assigning impact levels has been derived based on the expected effects of a detonation event on each of the receptors identified in the project consequence matrix is presented at Table 9.4.2. The expected impacts are ranked from 1 (no significant effect) to 5 (major widespread effects / catastrophic).

Impact Level	NEQ	Expected Consequences			
		Human Health	Plant and Equipment	Vessels	Environment
1	*Low Explosive <10kg & High Explosives <5kg*	Injury requiring medical treatment	No noticeable effect	No noticeable effect	Minor disturbance
2	*High Explosive 5-15kg*	Lost time injury < 3 days	Slight superficial damage	Slight superficial damage	Significant disturbance
3	*High Explosive 15-50kg*	Serious debilitating injury	Minor component replacement repair	Repairs - non-structural	Moderate damage to habitats.
4	*High Explosive 50-250kg*	Localised fatalities	Significant component replacement repair	Repairs – structural	Moderate damage to habitats. Some long term effects.
5	*High Explosive >250kg*	Multiple fatalities over extended area	Unit destruction	Localised structural failure and collapse	Localised destruction of habitats. Moderate long-term effects.

Table 9.4.2 – Consequence Matrix

9.4.3 Probability

The Probability scale is simply the assessed likelihood of an event-taking place. If units are required, then the scale frequently used on Project Risk Registers may be utilised.

9.4.4 Probability Specific to the development of AOWF

Based on past experience, the probability levels presented at *Table 9.4.4*, have been used in building the overall risk ratings for this specific project:

Probability Level	Probability of Encountering UXO
1	Remote
2	Possible
3	Likely
4	High Likely
5	Almost Certain

Table 9.4.4 – Probability Matrix

6 Alpha have collated, reviewed and analysed the historical data and conducted an assessment based on the criteria in Table 9.4.4 to produce a chart that demonstrates “probability of UXO encounter” on the project (*Appendix 08*).

This map is not a risk map *per se* because it does not incorporate the activities that might be associated with such an “encounter” nor the likely consequences. However this map is an important tool in the risk management process as it displays areas that require UXO risk mitigation and others which should be avoided.

10 Recommended Risk Mitigation

10.1 Overview

In view of the UXO risk in this region and the proposed engineering works, 6 Alpha has designed the following mitigation strategy to reduce the risk to a level that conforms with the Health & Safety Executive's ALARP principle. This strategy has been developed in order to fully address the UXO risk across the entire development site, whilst working within critical operational and time limitations.

6 Alpha believes that avoidance of potential risk items is the key to successful UXO risk management in this environment. By adhering to robust procedures and operational guidelines the impact to the ongoing development can be significantly reduced. 6 Alpha recommend that the time window between any proactive mitigation works and the proposed works is minimised (within reasonable operational constraints).

It should be noted that the risk from UXO could never be considered 'zero' in the offshore environment, as there is always the potential for UXO migration through natural sedimentation transportation or the recorded deposition of munitions through war, training or disposal.

10.2 Marine Operations

10.2.1 Overview

Prior to undertaking any intrusive work, the "higher UXO threat areas" as displayed at *Appendix 08* should be avoided. In particular 6 Alpha would draw Vattenfall's attention to the Black Dog firing range. If the client does not want to avoid this area, as it is a viable development area, then 6 Alpha would recommend that any intrusive works are mitigated accordingly.

10.2.2 UXO Probability Grading and Mitigation Options

6 Alpha have recommended that the following actions are required to address the UXO risk. This table should be read in conjunction with the "probability of UXO encounter map" at *Appendix 08*.

UXO Probability Rating	Grading	Action Required ahead of Intrusive Works	Associated Additional Costs Low High
1-2	**Remote - Possible**	Areas defined as "background residual risk". Use, wherever possible, existing geophysical datasets for UXO risk reduction. Define smallest UXO threat items, interpret the datasets for contacts similar to UXO and avoid during future works. Brief all personnel involved in intrusive works and ensure reactive procedures/guidelines are in place. **6 Alpha Deliverable** - Client's must accept that this is not a 100% survey coverage for UXO, although if conducted by 6 Alpha the risk will be reduced to ALARP.	
3-4	**Likely - Very Likely**	There are three options for dealing with the risk in these areas: • **Option 1** - Relocate works to areas with a grading of 1 or 2; • **Option 2** – Conduct a UXO Specific Geophysical Survey and avoid targets. This survey should be designed to match the defined UXO threat and provide 100% coverage of specific threat area; • **Option 3** – If target avoidance not possible conduct either diver investigation or ROV inspection, which may discount the item or lead to UXO disposal. **6 Alpha Deliverable** - Once the UXO risk reduction actions have been successfully implemented and subject to our own QA/QC measures, 6 Alpha will sign-off the UXO risk as ALARP.	
5	**Almost Certain**	6 Alpha would strongly suggest avoiding these areas, and relocation work. As the costs associated reducing the risk to ALARP are likely to be considerable.	

Table 10.3.2 – Risk Mitigation Options

11 Conclusions

11.1 Key Findings

In terms of UXO threat, this report has demonstrate that the UXO threat is primarily the result of munitions and weaponry used on the Black Dog Range; although there is the background residual risk presented by UXBs and AAA projectiles from WWII. Other threat sources are recorded within the general region however given the nature of these operations and their location 6 Alpha does not consider that this source will pose a significant threat to the project. This has been reflected in the SQRA tables presented at *Appendix 11*.

It is conceivable that live HE items would have been fired out to sea (from land based weapons platforms) at the Black Dog range and a proportion of UXO could still be present in the area today. Therefore it would be prudent to avoid this area for all future intrusive works.

Due to the relatively slow tidal movement within the North Sea, tides are likely to have a minimal short-term effect on seabed munitions movement. The maximum penetration of a 500kg bomb along this route, is not likely to exceed 1.0m below seabed level. It is conceivable that, if present, any bombs, mines, torpedoes and parachute mines would be on or just below the seabed.

Where detonation occurs underwater, potential damage may result from direct fragmentation as well as the pulsing gas bubble and its resultant shock wave. The main consequence depending upon water depth is likely to include injury to personnel and damage to installation vessels, and associated support vessels and equipment. Given typical water depths seen in the area, assumed to be between 10-15m (TBC), a reasonable and practical working assumption is that any UXO which has a charge weight of 40kg or greater, is capable of causing significant damage.

As many of the sea mines and bombs that may be encountered have a NEQ of around 100kg or greater, the effect of them detonating (even on the seabed), is likely to be catastrophic, and remain extremely serious in the deeper waters.

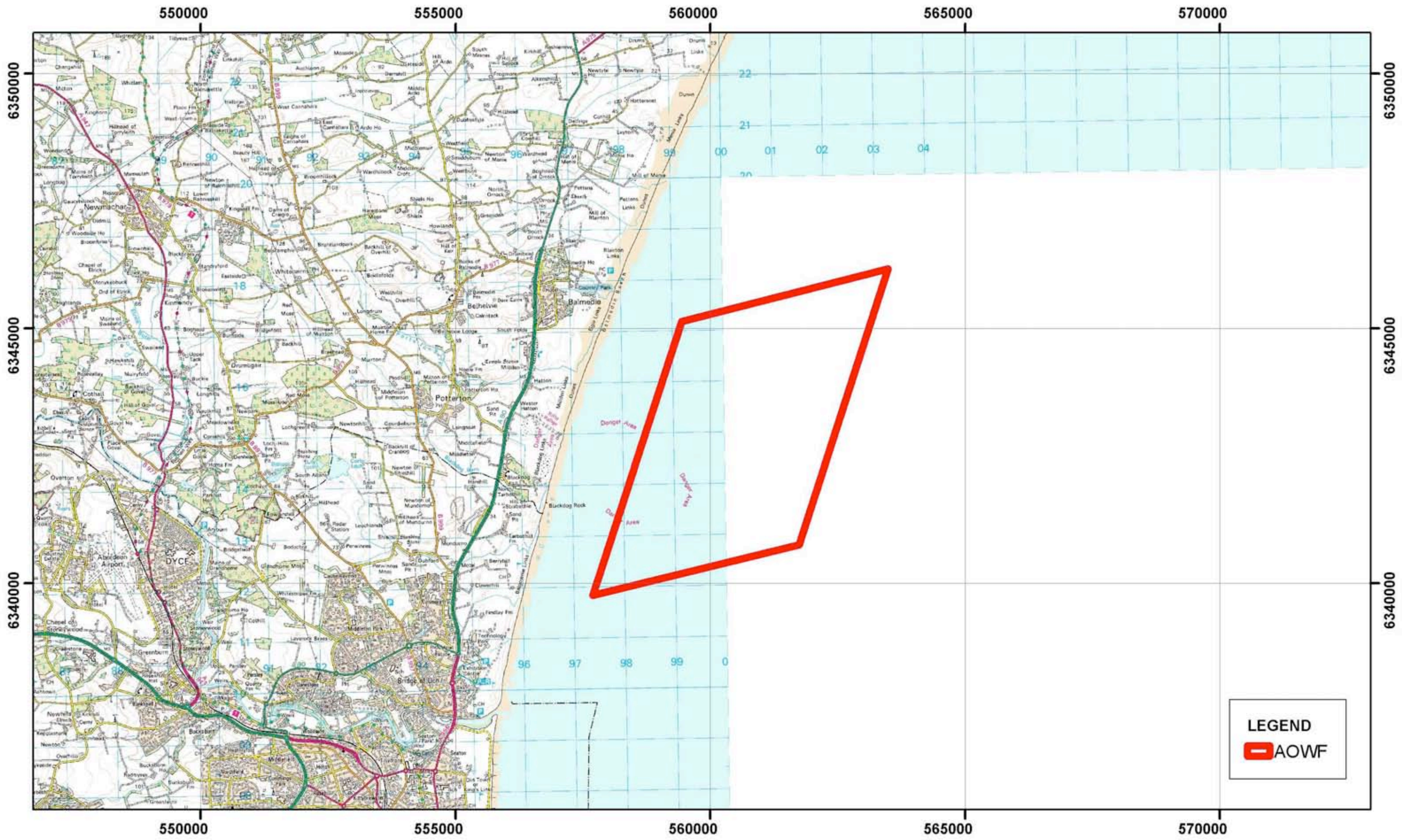
Appendices

Appendix 01

Project Location

Aberdeen Offshore Wind Farm
Project Location

Appendix 01



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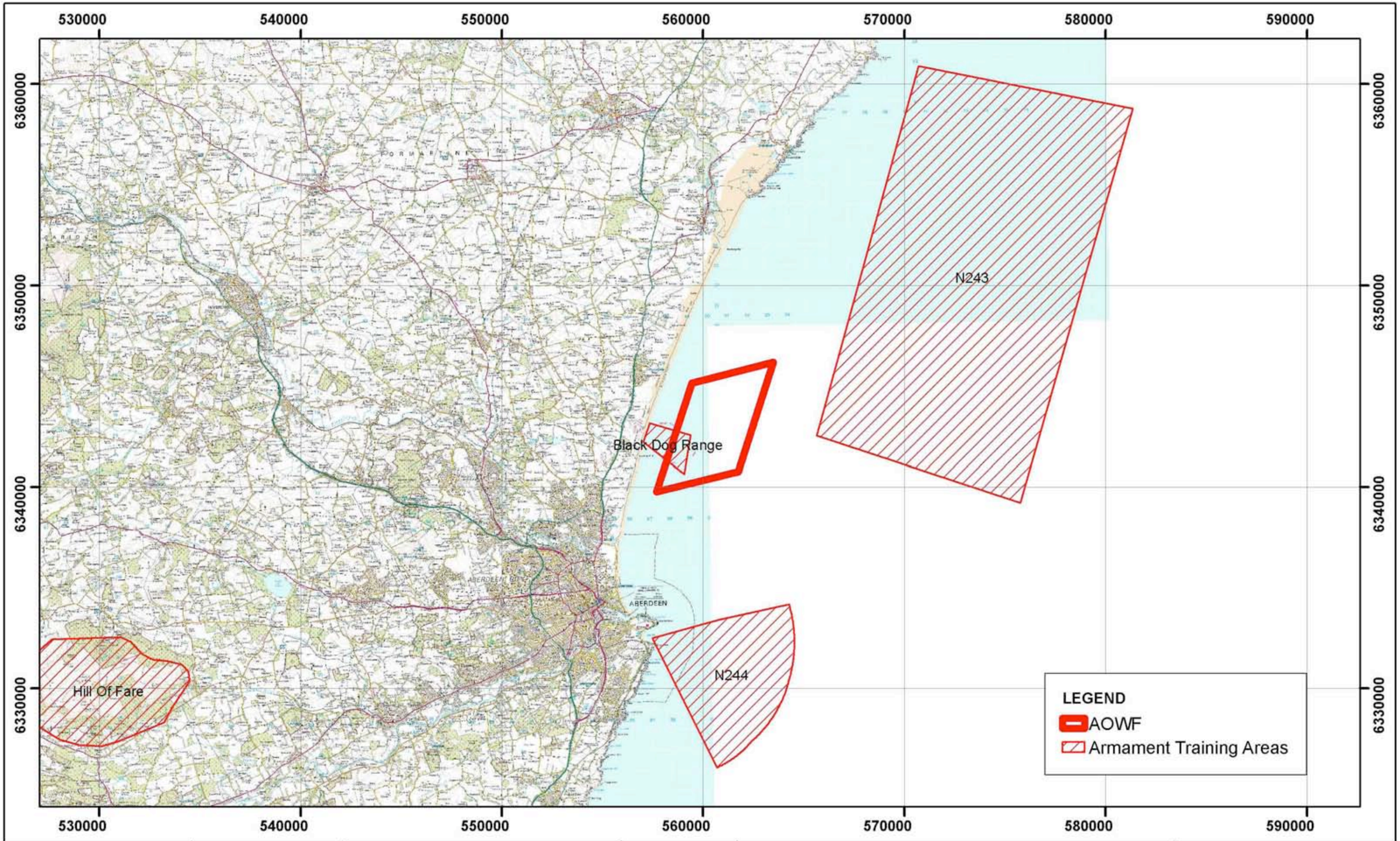
Appendix 02

Military Training Areas and Firing Ranges

Aberdeen Offshore Wind Farm
WWII Armament Ranges

Appendix 02A



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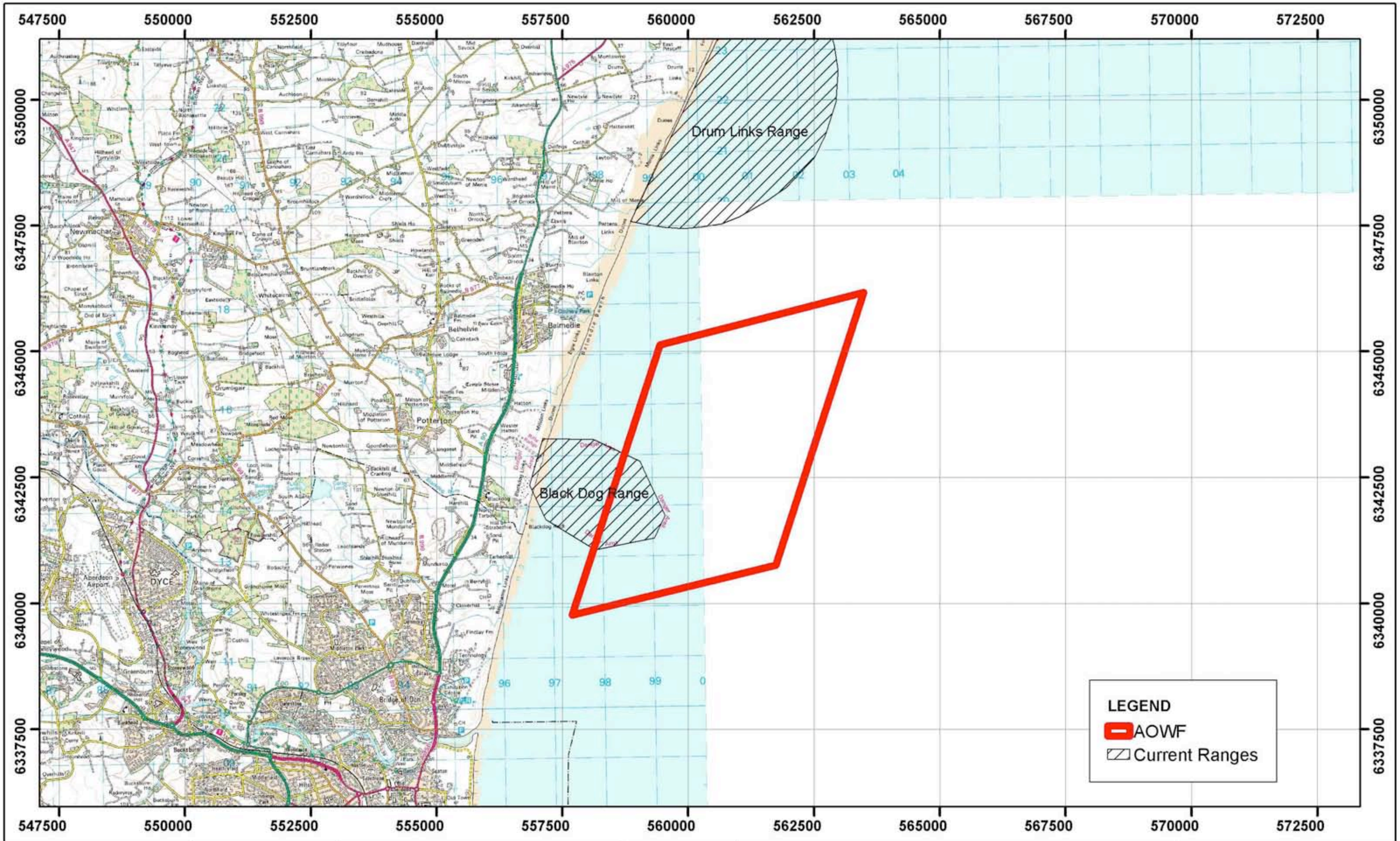
Aberdeen Offshore Wind Farm
Drums Link And Black Dog Ranges

Appendix 02B



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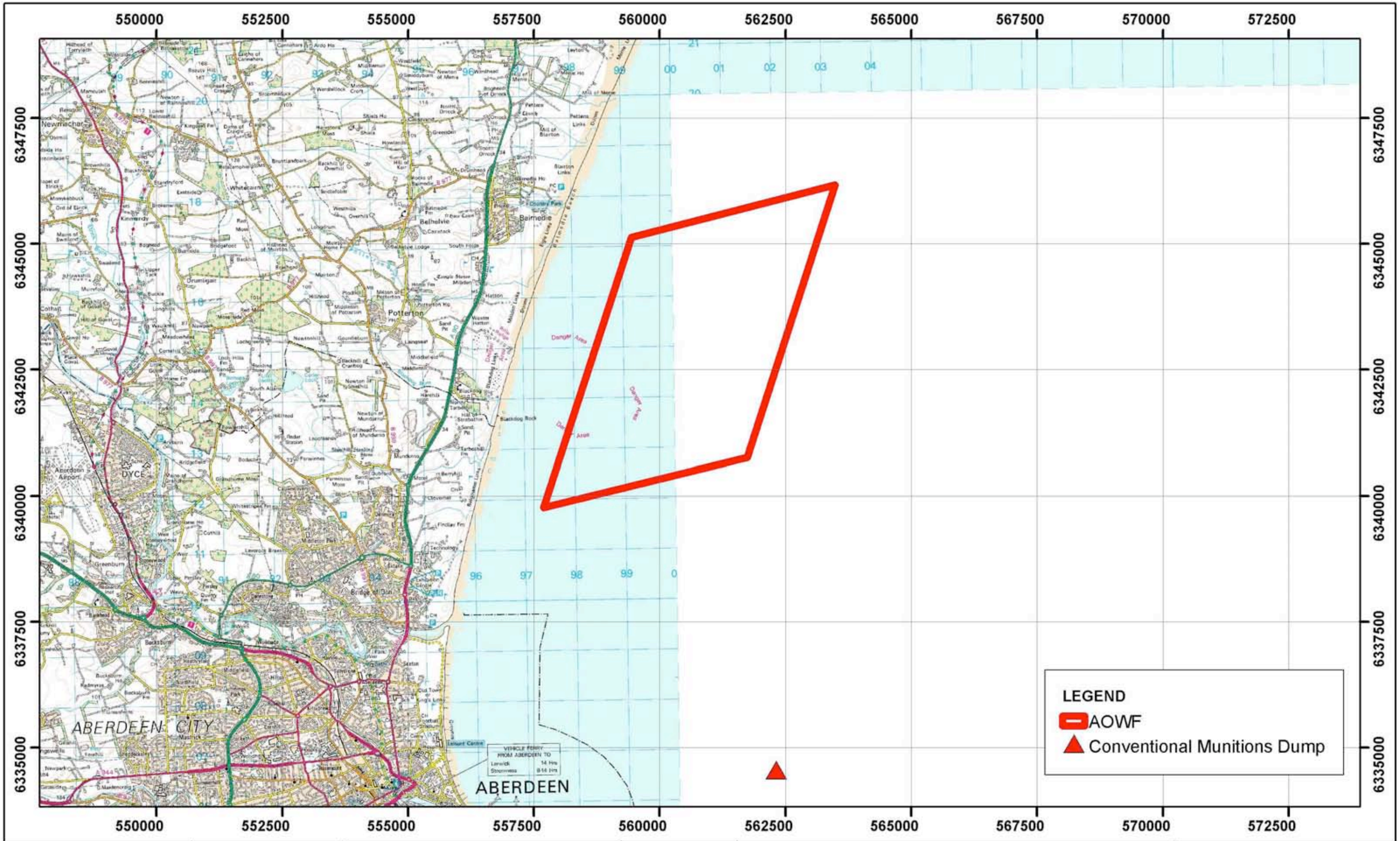
Appendix 03

Munitions/Explosives Disposal Area

Aberdeen Offshore Wind Farm
Explosives / Munitions Disposal Area

Appendix 03



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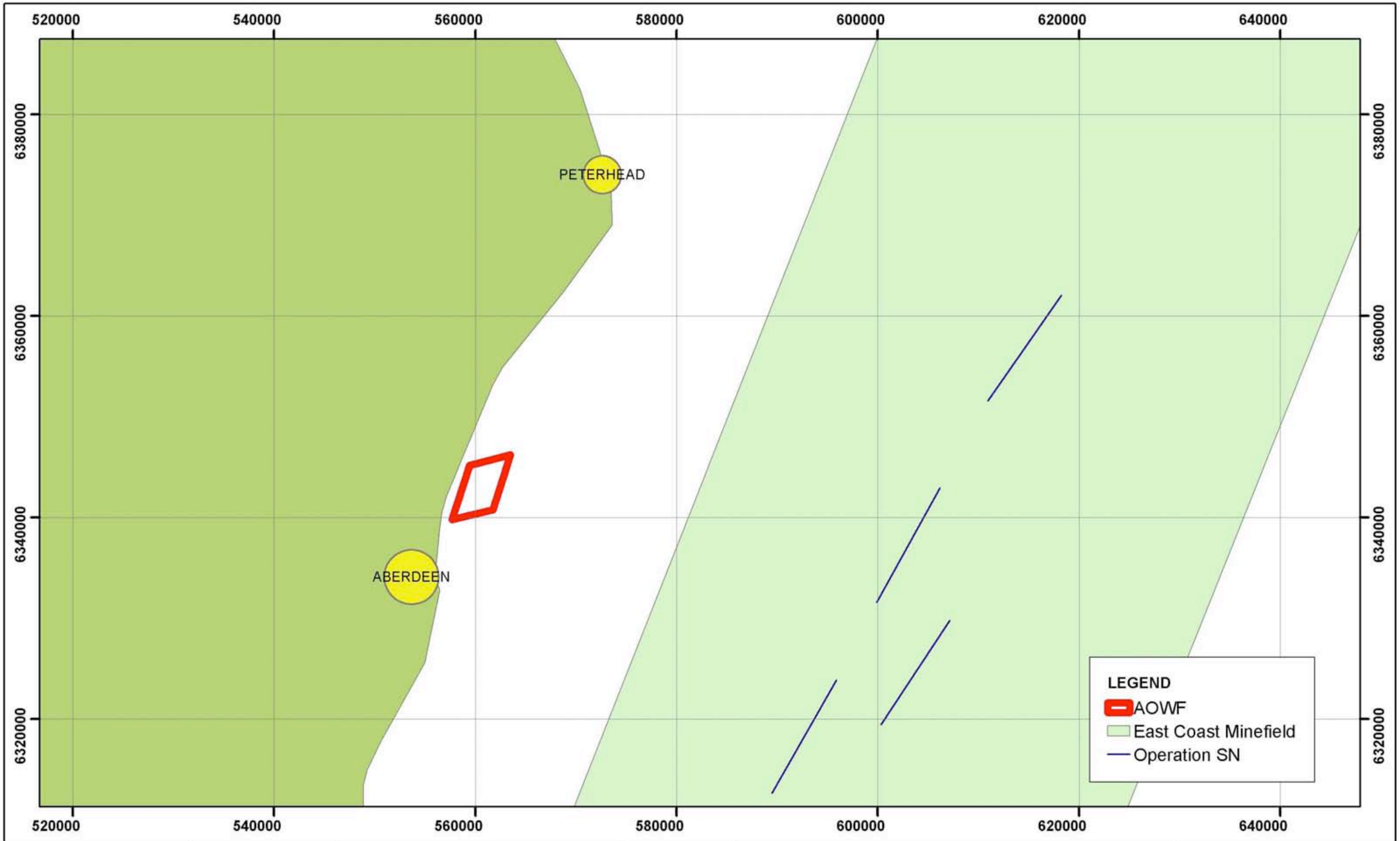
Date: 28th September 2010

Appendix 04

British Minefields

Aberdeen Offshore Wind Farm
WWII British Mine Fields and Mine Lays

Appendix 04



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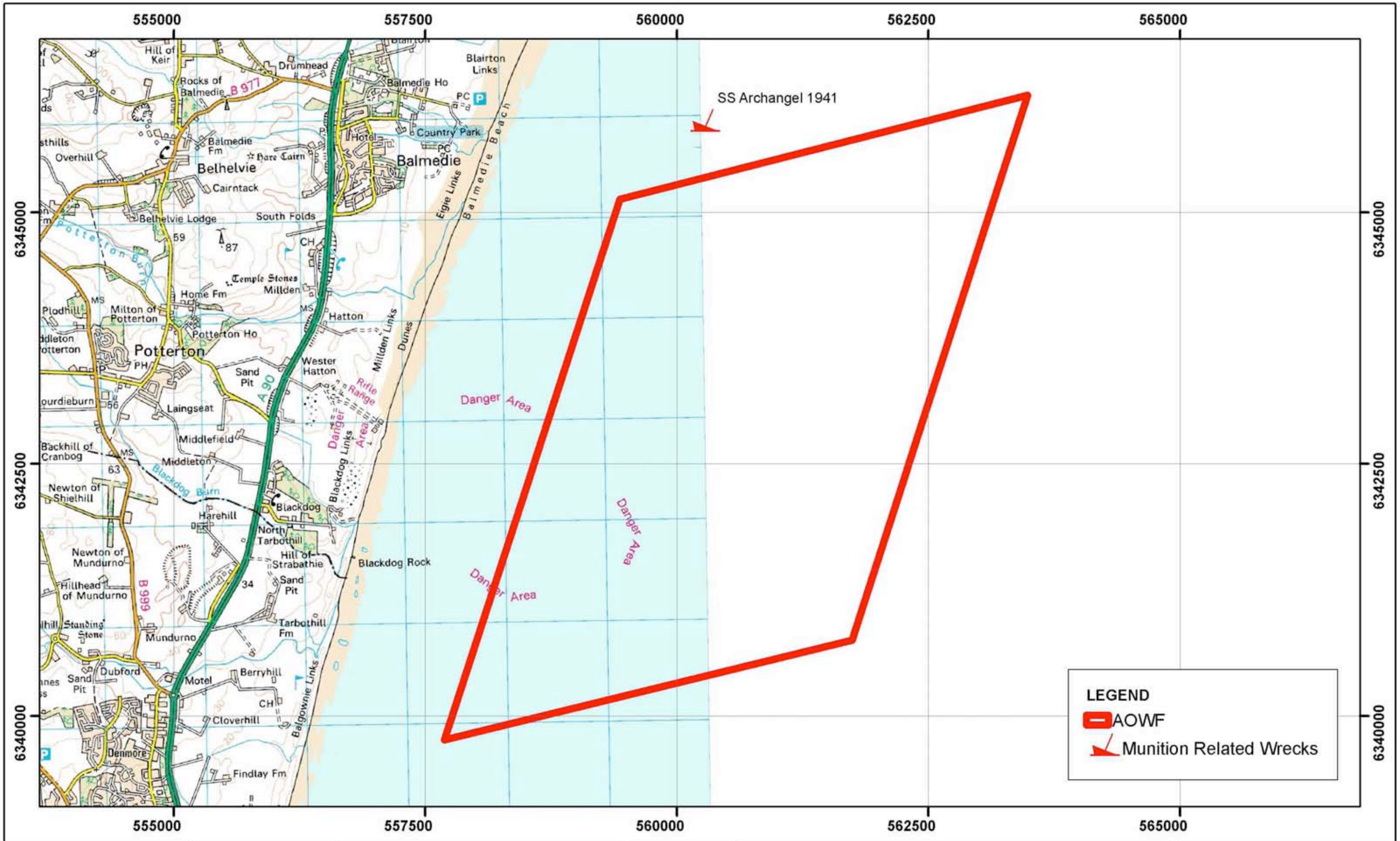
Date: 28th September 2010

Appendix 05

Munitions Related Shipwrecks

Aberdeen Offshore Wind Farm
Munition Related Shipwrecks

Appendix 05



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Appendix 06

Ordnance Characteristics

WWII Sea Mines				
Ordnance Variant	**Shape**	**Width**	**Length**	**Charge Weight**
German Contact Mine. Code EMA/EMB British Designation: GU	Ovoid	EMA: 1600m EMB: ~1400mm	EMA: 800m EMB: 900mm	EMA: 220kg EMB: 150kg
German Contact Mine. Code BMC British Designation: GM	Cylindrical with hemispherical top and bottom	660mm	1000mm	50kg
German Contact Mine. Code EMC British Designation: GY	Spherical	1120m diameter	1120mm diameter	300kg
German Contact Mine. Code KMA British Designation: GJ	Spherical	380mm diameter	380mm diameter	12kg
German Influence Mine. Code KMA British Designation: GA/GD	Cylindrical with hemispherical nose and rear parachute housing	660mm diameter	1800mm	300kg
German Influence Mine. Code LMF British Designation: GT	Cylindrical, finned	530mm diameter	2700m	230kg
German Influence Mine. Type LMB British Designation: GB/GC	Cylindrical with hemispherical nose and rear parachute housing	660m diameter	Up to 3200mm	700kg
German Influence Mine. Type GMB British Designation: GN & GS	Cylindrical with hemispherical ends	GN: 530mm diameter GS: 530mm diameter	GN: 3100mm GS: 2300mm	GN: 900kg GS: 420 to 560kg
German "Mine-bomb". Type BM1000 British Designation: GG	Cylindrical	660mm diameter	~2000mm long depending on tail unit	725kg
British Contact Mine Mk XIV & XV	Ovoid	1016mm diameter	1016mm diameter	145kg or 295kg
British Contact Mine. Mk XVII	Ovoid	1016mm diameter	1016 diameter	145kg
British Contact Mine. Mk XIX & XIXS	Spherical	790mm diameter	790mm diameter	45kg

WWII High Explosive Bombs				
Ordnance Variant	**Bomb Shape**	**Dimensions**	**Body Diameter**	**Charge Weight**
German SC 50	Cylindrical	1090 x 280mm	200mm	25kg
German SC 250	Cylindrical	1640 x 512mm	368mm	125-130kg
German SC 500	Cylindrical	1957 x 640mm	470mm	250-260kg
German SC 1000	Cylindrical	2580 x 654mm	654mm	530-590kg
German SC 1800	Cylindrical	3500 x 670mm	670mm	1000kg
German SC 2500	Cylindrical	3895 x 829mm	829mm	1700kg

Appendix 07

Project Risk Assessment Tables

Risk Assessment Table notes (applicable to all segments):

1. Risk level is prior to risk mitigation actions for that specific operation but in operational order i.e. previous action may have reduced cumulative risk level;
2. Values for both probability and consequence to be found in main report;
3. Risk mitigation measures are cumulative and assumes that previous stage has been undertaken;

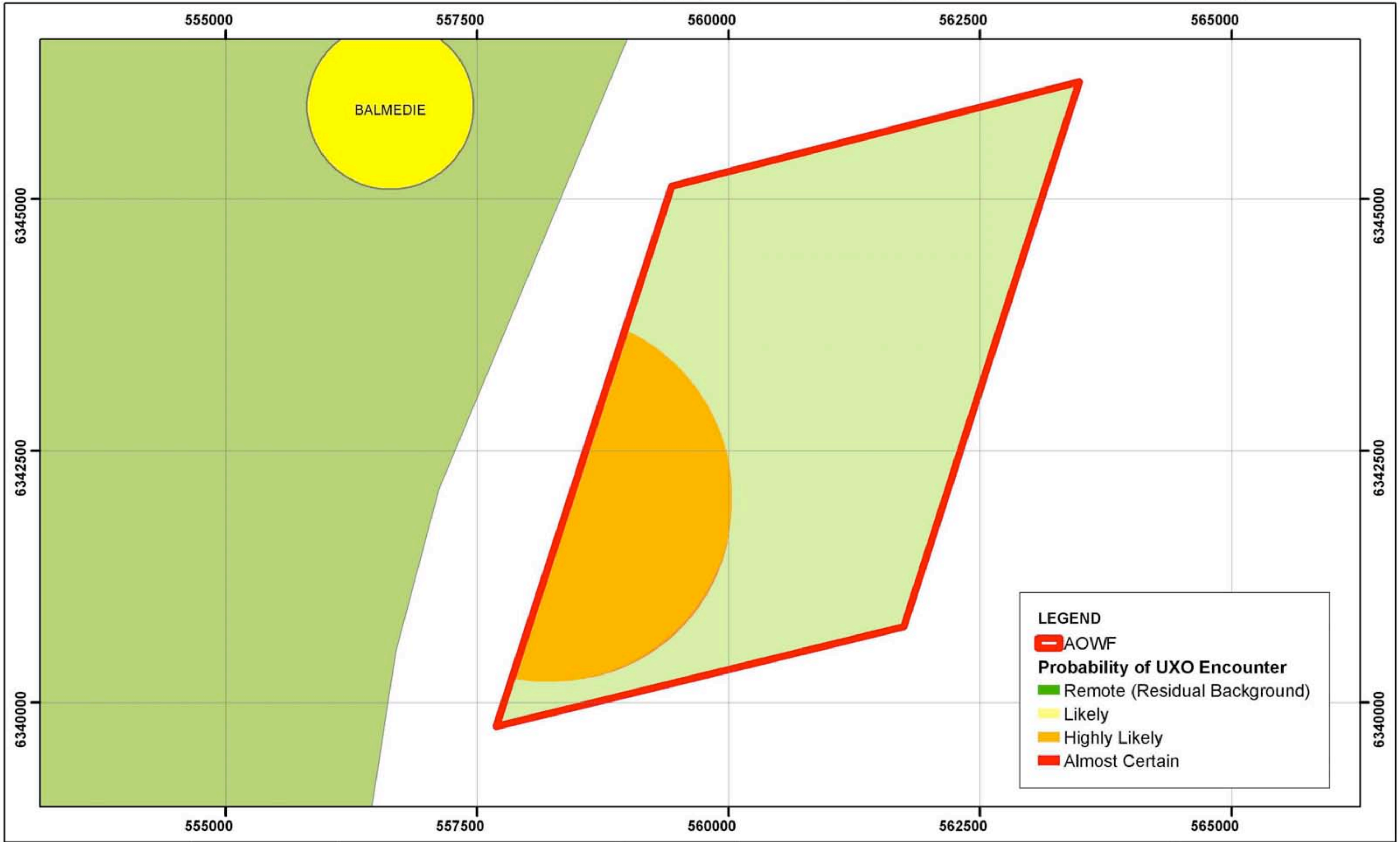
Aberdeen Offshore Wind Farm						
Phase	**Activity**	**Ordnance Variant**	**Probability of Encounter**	**Consequence of Initiation**	**Risk Level (Note 1)**	**Risk Mitigation Actions to lower risk to ALARP**
Site Investigation	Geophysical/Grab Samples Survey	Allied Sea Mines/Torpedoes	1	2	2	Ensure geophysical survey array does not encounter seabed. For trawl survey and grab samples ensure specific UXO guidelines are implemented.
		Air-delivered Bombs	1	2	2	
		Artillery Projectiles	2	1	2	
		Axis Influence Mines	1	2	2	
	Geotechnical Investigation	Allied Sea Mines/Torpedoes	1	4	4	Avoid Black Dog Range Template. "Standard" geophysical survey and target avoidance.
		Air-delivered Bombs	1	4	4	
		Artillery Projectiles	4	1	4	
		Axis Influence Mines	1	4	4	
Cable Installation	PLGR seabed operations	Allied Sea Mines/Torpedoes	1	3	3	Avoid Black Dog Range Template. "Standard" geophysical survey and target avoidance.
		Air-delivered Bombs	1	3	3	
		Artillery Projectiles	4	1	4	
		Axis Influence Mines	1	3	3	
	PLGR equipment recovery to vessel	Allied Sea Mines/Torpedoes	1	5	5	Safety procedures to be followed in the event of item recovery.
		Air-delivered Bombs	1	5	5	
		Artillery Projectiles	3	3	9	
		Axis Influence Mines	1	5	5	
	Barge Anchor Deployment	Allied Sea Mines/Torpedoes	1	3	3	Avoid Black Dog Range Template. "Standard" geophysical survey and target avoidance.
		Air-delivered Bombs	1	3	3	
		Artillery Projectiles	4	1	4	
		Axis Influence Mines	1	3	3	
	Trenching seabed operations	Allied Sea Mines/Torpedoes	1	4	4	No further action
		Air-delivered Bombs	1	4	4	
		Artillery Projectiles	4	1	4	
		Axis Influence Mines	1	4	4	
Turbine Installation	Foundation Installation	Allied Sea Mines/Torpedoes	1	4	4	"Avoid Black Dog Range Template. "Standard" geophysical survey and target avoidance.
		Air Delivered Bombs	1	4	4	
		Artillery Projectiles	4	1	4	
		Axis Influence Mines	1	4	4	

Appendix 08

UXO Probability Map

Aberdeen Offshore Wind Farm
Probability of UXO Encounter

Appendix 08



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European Offshore Wind Deployment Centre

Environmental Statement

Appendix 9.1: Marine Ecology, Intertidal Ecology, Sediment and Water Quality Baseline Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

the INSTITUTE of ESTUARINE and COASTAL STUDIES

European Offshore Wind Deployment Centre (EOWDC)

Marine Ecology, Intertidal Ecology and Sediment and Water Quality

Baseline Technical Report

Report to Aberdeen Offshore Wind Farm Limited
(AOWFL)

Institute of Estuarine and Coastal Studies
University of Hull

5th May 2011

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Report: ZBB772-F-2011

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THE UNIVERSITY OF HULL
Institute of Estuarine and Coastal Studies (IECS)

Aberdeen Offshore Wind Farm Ltd (AOWFL)

European Offshore Wind Deployment Centre (EOWDC) Marine Ecology, Intertidal Ecology and Sediment and Water Quality Baseline Technical Report

5th May 2011

Reference No: ZBB772-F-2011

For and on behalf of the Institute of Estuarine and Coastal Studies	
Approved by:	Nick Cutts
Signed:	
Position:	Deputy Director
Date:	5th May 2011

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MARINE ECOLOGY, INTERTIDAL ECOLOGY AND SEDIMENT AND WATER QUALITY

1 The Institute of Estuarine and Coastal Studies (IECS) at the University of Hull was commissioned by Aberdeen Offshore Wind Farm Limited (AOWFL) to undertake the Baseline Technical report for the proposed European Offshore Wind Deployment Centre (EOWDC).

2 The present report focuses on marine ecology baseline information and presents an update of the literature review carried out by Titan Ltd (TES, 2008a) which was based on a previous turbine layout. The Titan Ltd report included analysis of sediment and water quality, benthic ecology, natural fish and shellfish species. This information has been incorporated with the results of the benthic sampling and analysis programme undertaken by the Centre for Marine and Coastal Studies Limited (CMACS Ltd) in September 2010 and additional data from Marine Scotland Science.

1. Information for the Non-Technical Summary

3 The proposed EOWDC area (i.e. the area inside the development lease boundary) shows physical, chemical and biological characteristics resembling those of the surroundings. There is general agreement between scientific literature and survey results.

4 Well-washed fine sandy sediments are present in the site in the vicinity of the proposed EOWDC. A gradient in sediment characteristics has been observed with a decrease in mud and organic content in sediments at inshore, shallower stations. This is as expected given the higher degree of sediment re-suspension caused by tidal movements, wave action and coastal currents in these areas.

5 Contaminant levels measured in sediments during the benthic survey did not raise any concerns, predominantly being below detection limits (organic compounds such as polycyclic aromatic hydrocarbons, polychlorinated biphenyls, organotin compounds), or below international benchmarks indicating potential adverse biological effects in aquatic systems (as for heavy metals). The sediment contamination in the site is in line with the background contamination levels reported for the North Eastern Atlantic zone.

6 The water quality in the Aberdeen area is generally good given the presence of a large sewage outfall for trade and domestic effluent. This is confirmed by the information on the quality of nearby bathing waters for the past few years.

7 The intertidal areas in Aberdeen Bay are mostly represented by sandy shores with moderate exposure to wave action, wind and tidal streams. The intertidal benthic fauna is dominated by mobile crustaceans (such as haustorid amphipods). These habitats may provide feeding grounds to fish species using the adjacent sublittoral areas.

8 The sublittoral benthic community is dominated by polychaetes (mainly *Notomastus latericeus)* and bivalves (mainly *Nucula nitidosa* and *Tellina fabula*). Ophiuridae are also characteristic of the surveyed benthic assemblages, particularly at offshore stations. Depth and distance offshore highly affects benthic assemblages. Assemblages (and biotopes) present within the proposed EOWDC area are consistent with those found further offshore where the benthic community strongly resembles the JNCC biotope SS.SSA.CMuSa.AalbNuc (*Abra alba* and *N. nitidosa* in

circalittoral muddy sand or slightly mixed sediment). At inshore sites sparser benthic assemblages occur, matching well with the biotope SS.SSA.IFiSa.NcirBat (*Nephtys* cirrosa and *Bathyporeia* spp. in infralittoral sand). This latter biotope, however, is not present within the proposed EOWDC area, where only the biotope SS.SSA.CMuSa.AalbNuc occurs. The biotopes SS.SSA.CMuSa and SS.SSA.IFiSa are considered as a priority habitat under the UK BAP designation (sublittoral sands and gravels). The UK Habitat Action Plan aims to ensure that the best examples of sublittoral sand and gravel habitats are protected from the adverse effects human activities, such as wind farm development. However this is also the most common habitat found below the level of the lowest low tide around the coast of the United Kingdom, and is not uncommon in the wider Aberdeen Bay area, hence is not considered to have an especially high ecological importance at the local scale.

9 The invertebrate epibenthic fauna in the site is sparse and is composed of brittle stars, brown shrimp and swimming crabs. The most common fish species are flatfish such as dab and plaice, particularly in inshore stations. Hooknose and whiting are also abundant. Fishing grounds are located farther offshore or northwards with respect to the proposed development area. No specific spawning or nursery grounds are reported in the proposed EOWDC area, although areas with these roles have been identified at a larger spatial scale. The epibenthic survey carried out in the proposed EOWDC site seems to confirm the absence of spawning grounds. A high abundance of juvenile flatfish (plaice and dab) has been recorded in inshore stations, suggesting their use as a nursery. However, it is likely that similar nursery grounds extend over a wider area along the Scottish coast.

10 A number of sites designated for conservation interest (SAC, SPA, Ramsar sites, SSSI and NNR) occur along the coast in the Aberdeen area. However, the proposed EOWDC area and the surroundings do not fall within a designated statutory conservation area and no designated species are present within them, as confirmed by the survey results. There is the possibility that migration routes of Atlantic salmon and sea trout cross the proposed EOWDC site, having the species important spawning areas in the nearby rivers (e.g. River Dee). These species are discussed in detail within the salmon and sea trout assessment for the proposed EOWDC, although there is a notable lack of knowledge on how these salmonids migrate and behave along the east coast of Scotland.

2. Introduction

11 The proposed EOWDC site is a wind farm and deployment centre located approximately between 2 and 4.5 km east of Blackdog, off the Aberdeenshire coast. The project is expected to comprise 11 wind turbines between 4 and 10 MW. An Ocean Laboratory for meteorological and other environmental monitoring is proposed and would be subjected to a separate consent application. The lease boundary for development will cover up to 20 km^2 between northern Aberdeen and Balmedie and this area will be referred to in this document as the “proposed EOWDC area” (green area in Figure 1). Where in text there is discussion regarding the wider area where the proposed development will fall (e.g. lease boundary and its surroundings) this will be referenced as the “proposed EOWDC site”.

12 Offshore wind farm developments are listed under Annex II of the Environmental Impact Assessment Directive (97/11/EC) as “installations for the harnessing of wind power for energy production (wind farms)” and, as such, an Environmental Impact Assessment (EIA) must be carried out in support of any application for development consent. Whilst the proposed EOWDC area is outside any designated statutory conservation areas, there are a number of European Directive designated sites nearby and these should be taken into account in any assessment of potential impacts.

13 Assessing the impact of offshore wind farm developments on marine habitats and species must account for the natural variability within marine ecosystems (e.g. resulting from extreme weather conditions, storms, smothering following natural sediment movement, changes in predator/prey populations) so that distinction between natural and anthropogenically induced change can be made (Hiscock *et al.*, 2002).

14 This section provides baseline data for the physical and chemical properties of the sediment (particle size and persistent contaminants), the macrofaunal communities living within the sediment (infauna) and those species living at the sediment/water column interface (epifauna). Information available from the literature has been integrated with data obtained during benthic and epibenthic surveys carried out in the proposed EOWDC site. These data were collected in order to characterise the benthic ecology in the proposed EOWDC area and its surroundings. The data will also provide a baseline for the assessment of both direct and indirect (e.g. sedimentation) impacts of the scheme in the wider area during future monitoring. A review of existing information on the water quality and nature conservation status in the area is also provided in this section.

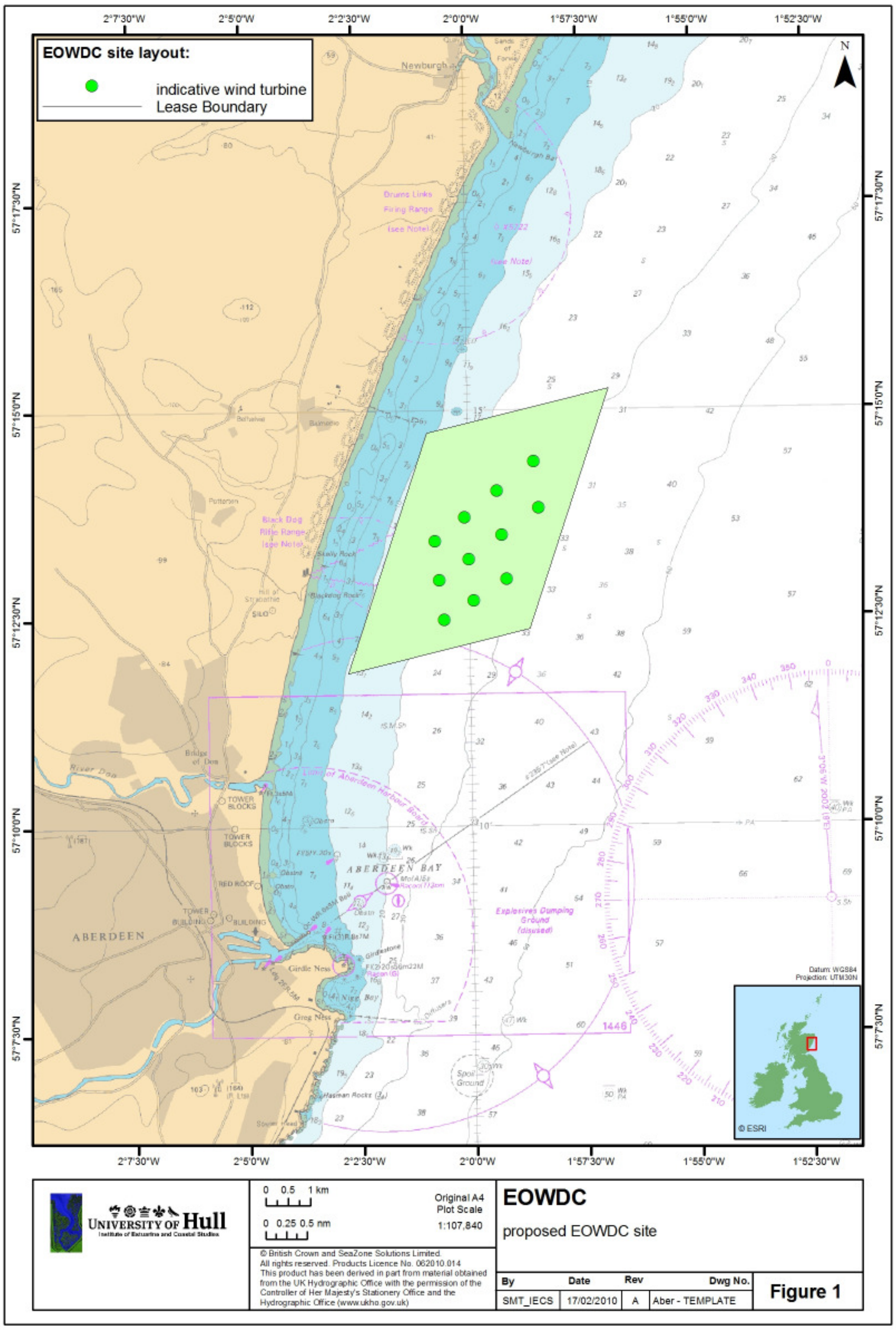


Figure 1. Proposed EOWDC site location in Aberdeen Bay. The wider area where the proposed development will fall is referred to as the proposed EOWDC site, whereas the lease boundary for development is referred to as the proposed EOWDC area (green area in figure).

2.1. METHODOLOGY CONSULTATION

15 Responses to the Request for Scoping Opinion 2010 which were relevant to marine ecology aspects were received from following organisations:

- Sue Lawrence, Area Officer – City of Aberdeen and Aberdeenshire Central, Scottish Natural Heritage (10/09/29);
- Robert Forbes, Senior Planning Enforcement Officer, Aberdeen City Council (10/09/23);
- Nicola Abrams, Senior Planning Officer, Scottish Environmental Protection Agency (10/09/24);
- Fiona Thompson, Marine Scotland (10/12/15)
- Fiona Thompson, Marine Scotland (Scoping Opinion, and Consultee comments therein, in particular comments from Scottish Natural Heritage, Scottish Environmental Protection Agency, Marine Scotland, Association of Salmon Fishery Boards) (11/02/24)

16 A previous Request for Scoping Opinion was submitted in 2005 when the project was a commercial wind farm and responses relevant to marine ecology were received from:

- James C McKie, Fisheries Research Services (FRS) (05/07/06)
- Ron MacDonald, Area manager, Scottish Natural Heritage (05/08/02)

17 The above responses raised main concerns regarding UK BAP priority species, migratory fishes, and elasmobranchs. These aspects were then taken into account when compiling the baseline technical report and main concerns regarding the impact assessment were also addressed in the EIA report and in the Environmental Statement (ES) chapter.

18 Prior to the benthic sampling and analysis programme (CMACS Ltd, 2010), a Method Statement was provided by Vattenfall and agreed with statutory consultees. These documents are listed below:

- Titan Environmental Survey (TES) Ltd (2008b). Marine Benthic Sampling Proposal. Report CS0208/D1/V2. April 2008
- GoBe (2010). Review of proposed Benthic Ecology Sampling
- EOWDC (2010). European Offshore Wind Deployment Centre: Proposed Benthic Sampling Strategy ver. 2.

2.2. KEY GUIDANCE DOCUMENTS

- Canadian Council of Ministers of the Environment (CCME) (2001). Canadian sediment quality guidelines for the protection of aquatic life. Summary tables. Updated in Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

- CEFAS (2004). Offshore wind farms: Guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements. Version 2. Prepared by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) on behalf of the Marine Consents Unit (MCEU). 45pp

- English Nature (2001). Wind farm development and nature conservation. Publication by English Nature, Royal Society for the Protection of Birds, World Wildlife Fund UK & British Wind Energy Association. Goldaming: WWF-UK.

- JNCC (Joint Nature Conservation Committee) (2009). Species pages for 2007 UK BAP priority species. http://www.jncc.gov.uk/_speciespages/437.pdf

- JNCC (2008). UK Biodiversity Action Plan; Priority Habitat Descriptions. BRIG (ed. Ant Maddock) 2008.

- OSPAR (2006). OSPAR Agreement 2005-2006. Agreement on Background Concentrations for Contaminants in Seawater, Biota and Sediment. OSPAR Commission, London. Revised by ASMO 2006 (ASMO 2006 Summary Record (ASMO 06/12/1) § 5.38

- OSPAR (2004). Draft background document on problems and benefits associated with the development of offshore windmill farms (OWF). Annex 1. Report BDC/03/4/2-E

- Scottish Natural Heritage (2004). Marine renewable energy and the natural heritage: an overview and policy statement. Policy Statement No. 04/01.

- Scottish Natural Heritage (2010). Renewable energy and the natural heritage. Ref No. 2010/02.

2.3. Data Information and Sources

19 This section lists the sources of data used to describe the baseline environment within and around the proposed EOWDC area.

- Heath M.R., Adams R.D., Brown F., Dunn J., Fraser S., Hay S.J., Kelly M.C., Macdonald E.M., Robertson M.R., Robinson S. and Wilson C. (1999). Plankton monitoring off the east coast of Scotland in 1997 and 1998. Fisheries Research Services Report, No */99

- SEA 5 Environmental report, September 2004, Department of Trade and Industry http://www.offshore-sea.org.uk/site/scripts/book_info.php?consultationID=5&bookID=6

- Fisheries Research Services (FRS) survey (2006). Data from Video survey, assessment of the level of contaminants and epifauna trawls in Aberdeen Bay.

- ICES (2006). Cooperative Research Report No 281: Zooplankton monitoring results in the ICES area, Summary Status Report 2004/2005, Sept. 2006, pp.19-21.

- EMU Ltd (2007) Geophysical and seabed habitat assessment of the proposed Aberdeen Offshore Wind Farm. Report to Aberdeen Renewable Energy Group and Amec Wind Energy Ltd. Report No: 07/J/1/02/1136/0716.

- Titan Environmental Survey (TES) Ltd (2008a) Marine Ecology – Review of Baseline Information. Report CS0208/R2/V2. May 2008.
- Centre for Marine and Coastal Studies Ltd (CMACS Ltd) (2011) Benthic Survey Technical Report Ref: J3154 Field Report v3. February 2011.
- British Crown and SeaZone Solutions Limited, Product Licence No. 062010.014
- OSIRIS Projects Ltd (2010). Report: Aberdeen offshore wind farm. Geophysical survey. December 2010. Volume 2a, b
- European Offshore Wind Deployment Centre (EOWDC) (2010). Request for an Environmental Impact Assessment (EIA). Scoping Opinion. August 2010.
- Marine Scotland Science survey (2010). Trawl and video data from benthic survey in Aberdeen Bay.

3. Baseline Description

20 A literature review was carried out in 2008 by Titan Environmental Survey (TES) Ltd. describing the North Sea environment and the area around Aberdeen Bay, including references to previous studies (TES, 2008a). The majority of information used to compile the literature review in the present document has come from the TES report (2008a). This information has then been integrated with the results of benthic and epibenthic surveys carried out in the proposed EOWDC site, in order to provide an updated picture of the benthic ecology in the area. In order to characterise the area for the purposes of the EIA only a single faunal sample has been analysed. If the site is consented it is AOWFL's intention to analyse the remaining two samples for the purposes of statistically robust BACI (Before-after Control Impact) type analysis ie pre and post construction comparison.

3.1. General Remarks on the Ecology of the Region

21 This section reports on the general characteristics of the marine ecology in the wider area. The spatial scale that will be chosen to discuss the ecology is the area covered in the Strategic Eenvironmental Assessment 5[1] (Figure 2), where the proposed EOWDC is located.

22 The North Sea is a complex and productive ecosystem, which supports important populations of benthic animals, fish, seabirds and marine mammals. Pelagic and benthic communities are interlinked in more or less tightly coupled food webs which, together with the abiotic environment, make up marine ecosystems.These ecosystems are dynamic and influenced by a range of biological, physical and chemical factors operating over different spatial and temporal scales.

23 Climatic and hydrographic variability, in particular the extent of Atlantic inflow, are important ecological determinants in the North Sea area, particularly affecting the character and extent of plankton communities. In recent years, spring and autumn phytoplankton blooms in the Area SEA 5 have become more evident, with primary production increasing throughout the year. Oceanographic conditions also influence the transport of zooplankton, fish larvae and cephalopods with direct consequences for associated predator populations.

24 Fish spawning areas are found throughout the Area SEA 5, with the juvenile stages of many commercial fish species remaining within coastal nursery areas for a year or two before moving offshore. Offshore areas are characterised by fish communities dominated by haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*) and cod (*Gadus morhua*). Migratory species such as herring (*Clupea harengus*) and mackerel (*Scomber scombrus*) are also found although their distribution is seasonal. Diadromous species such as Atlantic salmon (*Salmo salar*), sea trout (*Salmo trutta*), sea lamprey (*Petromyzon marinus*) and European eel (*Anguilla anguilla*) are present, with coastal rivers supporting important populations. Sandeels (*Ammodytes* spp.), a key prey item for a number of seabird and marine mammal species, are distributed throughout the area and are closely associated with well-oxygenated, medium to coarse sand. Important *Nephrops* stocks are found on a range of muddy-sand

[1] In 1999, the Department of Trade and Industry's (DTI) commenced a Strategic Environmental Assessment (SEA) process for offshore energy with a sequence of sectoral SEAs of the implications of further licensing of the UKCS for oil and gas exploration and production. The main focus of SEA 5 was the potential further licensing for oil and gas exploration of offshore areas of the UK Continental Shelf (UKCS) to the east of the Scottish mainland, Orkney and Shetland.

sediments. Benthic communities are intrinsically linked to the physical nature and characteristics of the substratum. As such, the offshore communities are spatially distributed over the area, with distinct species assemblages being associated with particular substratum types. In particular sedentary species with high abundance and biomass dominate in the sheltered coastal areas, whereas exposed beaches have lower diversity, abundance and biomass. Dense populations of intertidal benthos found in many of the sheltered inner firths and estuaries also support important fish and waterbird populations.

25 Key predators include seabirds with colonies along the east coast of Scotland that have been given protected status under the EU "Birds" Directive as Special Protected Areas (SPAs) for the species breeding there, and the number they support. Marine mammals including harbour porpoise (*Phocoena phocoena*), harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*) are frequently sighted along the north east coast of Scotland, and white-beaked dolphin (*Lagenorhynchus albirostris*) and minke whale (*Balaenoptera acutorostrata*) are present further offshore (particularly during summer). Bottlenose dolphins (*Tursiops truncatus*) are regularly sighted within Aberdeen day with a peak occurrence during the winter and spring months (November-May), when they can be observed almost daily feeding at Aberdeen Harbour.

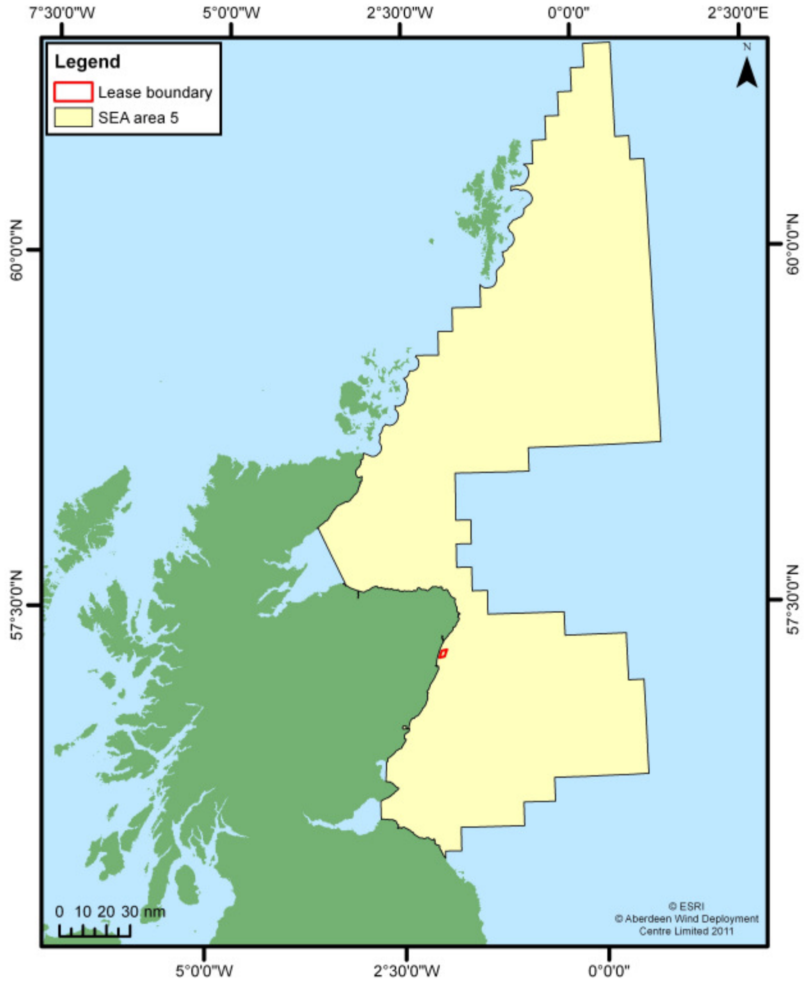


Figure 2. Location of the Strategic Environmental Assessment (SEA) 5 Areaand the proposed EOWDC lease boundary.

3.2. SEDIMENT AND WATER QUALITY

3.2.1. Sediment characteristics and contamination

26 This section reports on the information available on sediment characteristics and contamination for the proposed EOWDC site and the wider Area SEA 5 where it will fall, as gathered from background data and the benthic surveys undertaken by CMACS Ltd in 2010.

3.2.1.1. BACKGROUND INFORMATION

27 The sediments of the Area SEA 5 consist predominantly of sands, sandy gravels and gravel (Figure 3). Gravel and sandy gravel generally occur in nearshore areas where there are very strong tidal and wave driven currents, particularly around Shetland and Orkney. Large mobile sandwaves and sandbanks are also present. Muddy sediments are restricted to deeper waters and very sheltered coastal areas in the Area SEA 5.

28 According tho the broad scale map of seabed sediment distribution in the Area SEA 5 (Figure 3), the sediments off Aberdeen Bay consist predominantly of sand and slightly gravelly sand. Recent surveys carried out in the Aberdeen Bay area confirmed these data:

- A geophysical survey carried out in 2007 by EMU Ltd for AOWFL including swath bathymetry, side scan sonar imaging, shallow seismic profiling, Acoustic Ground Discrimination System (AGDS) and the collection of sediment samples for processing, confirmed the proposed EOWDC site to be dominated by muddy sand with small patches of glacial material towards the shore, and finer sediment features in places with occasional patches of shell fragments in others (EMU Ltd, 2007).
- A geophysical survey carried out in 2010 by OSIRIS Projects for AOWFL, including detailed bathymetric information, seismic profiling and information on magnetic anomalies in/on the seabed, confirmed that in the proposed EOWDC site sediments are mostly fine silty sand, frequently shelly, with localised patches of coarser grained sediments towards the shore (outside the proposed EOWDC lease area) (OSIRIS Projects Ltd, 2010).

29 The main factors affecting water quality and marine organisms are contaminant levels (organic pollutants and metals) and levels of suspended sediments. If present in sufficient concentrations, contaminants may have the potential to disturb biological processes through a variety of mechanisms. These include increased toxicity, mutagenicity, interference with reproductive physiology and availability of food and nutrients.

30 In general, riverine and atmospheric transport accounts for the largest inputs of contaminants to the north-east Atlantic and North Sea. However, transport, shipping, military activities and offshore industries, including oil and gas production, all have the potential to make significant contributions (OSPAR, 2000).

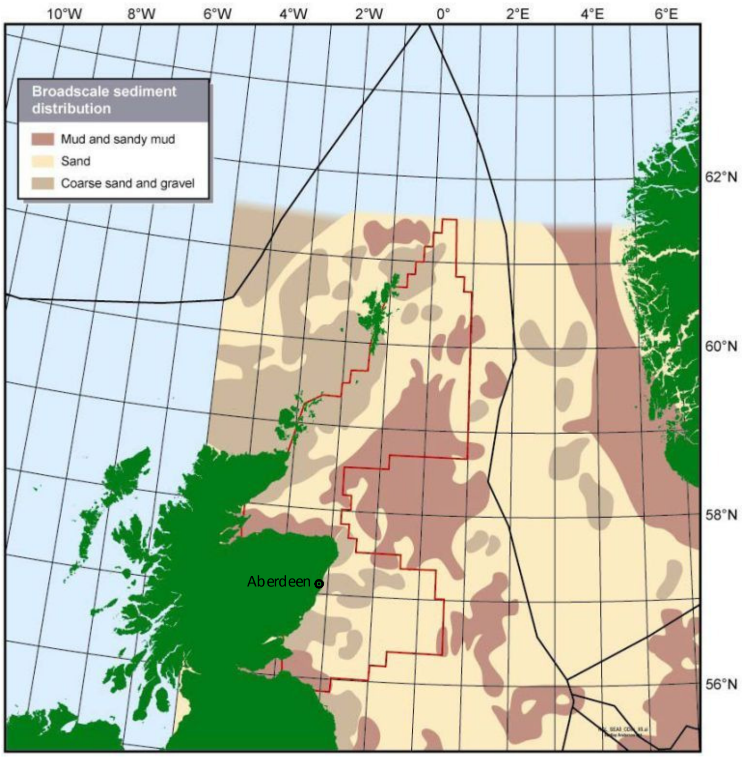


Figure 3. Broadscale seabed sediment distribution in the Area SEA 5. Source: OSPAR 2000.

31 FRS carried out a survey in April 2006 to assess the level of contaminants in the sediments in Aberdeen Bay, with sampling locations falling within the proposed EOWDC site (Appendix 5.1). The data collected during this survey were provided by FRS, and were taken into account to integrate the background information on the sediment contamination in the proposed EOWDC site.

32 Maximum Polycyclic Aromatic Hydrocarbons concentrations (total PAH) of 1732.2 µg/kg dry weight were found at station 11ABZ06 inside the proposed EOWDC area (Appendix 5.1). This concentration can be compared to the background reference concentrations (BCRs), background concentrations[2] (BCs) and provisional background assessment criteria[3] (BAC) provided by OSPAR (OSPAR, 2006). Except for Phenanthrene, Anthracene and Pyrene concentrations at station 11ABZ2006 (which are 5, 8 and 6 times higher than OSPAR's BACs, respectively), the level of PAHs in the sediments in Aberdeen Bay in 2006 can be considered to be near or below background concentrations.

33 In terms of metal concentrations in the sediments of Aberdeen Bay, the average values measured across all sampling sites during the FRS 2006 survey are given in

[2] "Background concentrations" (BCs) are assessment tools intended to represent the concentrations of certain hazardous substances that would be expected in the North-East Atlantic if certain industrial developments had not happened. (OSPAR Agreement 2005-6)

[3] "Background assessment criteria" (BACs) are statistical tools defined in relation to the background concentrations (BCs), which enable testing of whether mean observed concentrations can be considered to be near background concentrations. (OSPAR Agreement 2005-6)

Table 1. Cd concentration was always below detection limits (BDL), as well as Hg concentration (except for station 13ABZ2006) (Table 1, Appendix 5.1). All average concentrations were below OSPAR Background Concentrations (BCs), i.e. those expected in the North-east Atlantic if certain industrial developments had not happened. The results of the FRS 2006 survey also showed that the distribution of metals was rather uniform in the samples analysed (Appendix 5.1).

Table 1. Average metal concentrations (mg/kg dry weight) for all sites from FRS survey (Source: FRS, 2006) and relative Background Concentration BC (OSPAR, 2006).

Metal	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
FRS 2006 survey	4.717	BDL*	15.693	3.081	0.079	7.385	7.146	21.716
BC	15	0.2	60	20	0.05	30	25	90

*BDL=Below Detection limits

34 Sediment contamination by PAHs, PCBs and heavy metals was also measured during the benthic survey carried out in the proposed EOWDC site by CMACS Ltd in 2010. The main results are provided in the section below.

3.2.1.2. Information taken from CMACS Ltd survey 2010

35 In October 2010, CMACS Ltd undertook benthic environmental surveys in the proposed EOWDC area and in the surrounding marine environment. Sediment samples were collected from 14 stations (6 in and 8 outside the proposed EOWDC area) by means of grab sampling (see Figure 1 in Appendix 5.3 for sampling stations location). Sediment subsamples were analysed for particle size (PSA), total organic carbon, and contamination levels. Further details on the sampling and laboratory methodologies, the data analysis and the raw data are provided in the CMACS Ltd Technical Report (Appendix 5.3).

36 The sediments were homogeneous across the proposed EOWDC area and around it, being generally well sorted (i.e. composed of similar particle sizes in each sample). Fine sand was the dominant sediment type in the area, with medium sand also being present at stations 1, 2, 6, 7, 13 and 14. A silt/clay fraction was also detected at some stations (Figure 4).

37 Spatial distribution of sediment types was related to the variation in depth and distance offshore (with depth and distance from the shore being closely related). The inshore stations (2, 13 and 14, all located outside the proposed EOWDC area) were characterised by well-washed sand with low mud content, as a result of tidal movements, wave action and coastal currents re-suspending sediments in shallower, inshore areas, thus preventing the settlement of finer particles. A lower organic content was also recorded at these inshore stations compared to the others.

38 When comparing the other stations, no major differences were detected in particle size composition between those outside and inside the proposed EOWDC area. Fine-medium sandy bottoms, with a silt/clay fraction and a higher organic content characterised these stations.

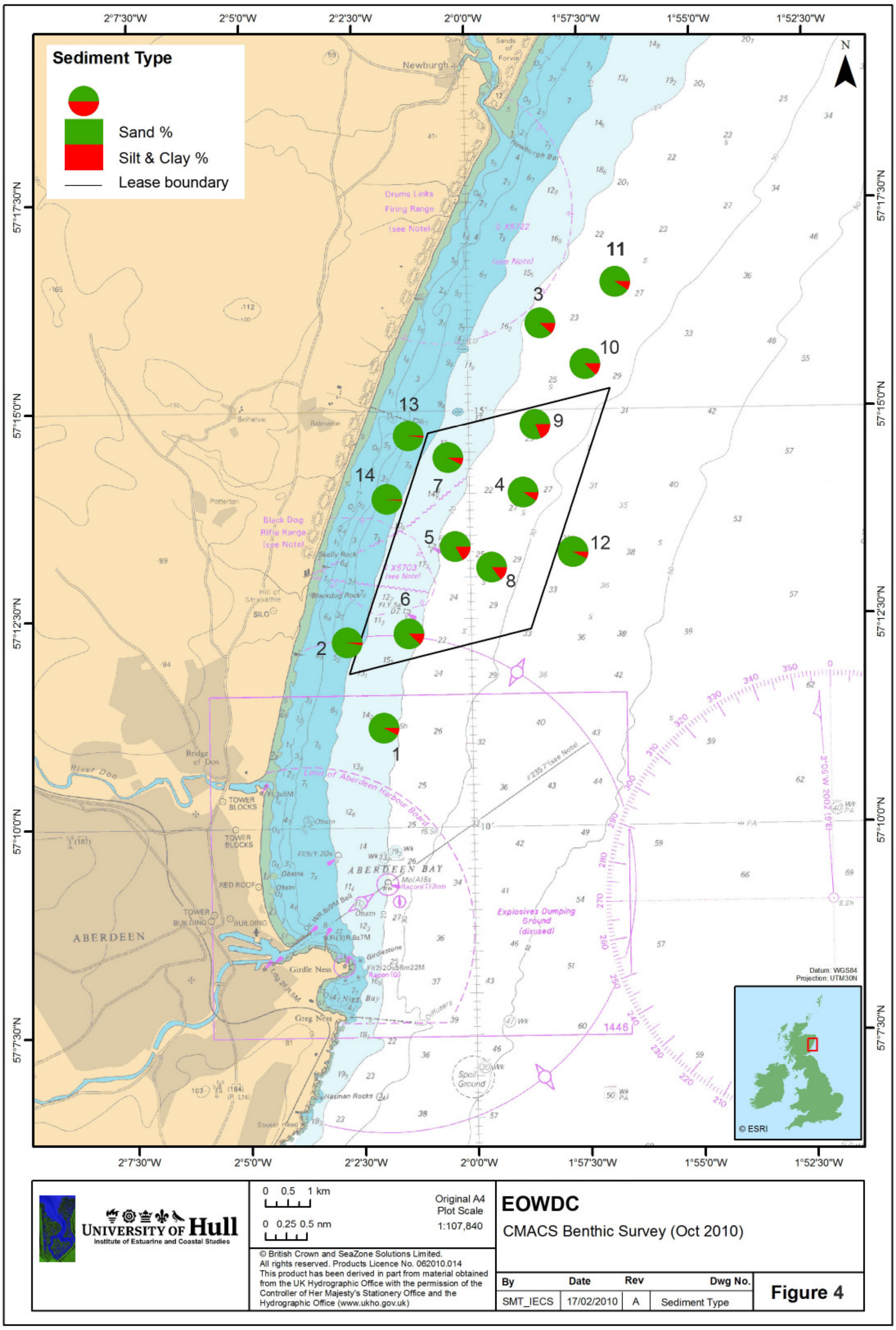


Figure 4. Geographical distribution of sand and silt/clay content across the proposed EOWDC site (stations are numbered as from CMACS Ltd Technical Report, Appendix 5.3). Map drawn by IECS based on CMACS Ltd 2010 data.

39 Mean concentrations of all PAH[4] and PCB[5] compounds were below the detection limits of 0.1 mg kg^{-1} and 0.01 µg kg^{-1}, respectively. Also concentrations of tributyl tin and other organotin compounds were all below detection levels (< 0.02 mg kg^{-1}) in all samples. For certain PAM compounds their detection limit exceeded the Interim Sediment Quality Guidelines levels (ISQG) and the Probable Effects Levels (PEL) given by CCME (2001) (see CMACS Ltd Technical Report for details, Appendix 5.3).

40 Mean concentrations of heavy metals, including cadmium, chromium, copper, lead, mercury, nickel and zinc were below the ISQG and PEL values. Arsenic concentrations exceed the ISQG of 7.24 mg kg^{-1}, but only at station 11 (7.6 mg kg^{-1}) (Appendix 5.3). However, this value is well below the PEL value for this contaminant, and, following dilution and dispersion, upon disturbance should not cause any pollution problems. Heavy metal concentrations were similarly distributed throughout the area although levels of zinc were slightly lower at station 13 than in the other stations (Appendix 5.3).

3.2.2. Water quality

41 This section reports on the background information available on water quality in the area of the proposed EOWDC site.

42 Sewage discharges are associated with coastal communities along the Area SEA 5 coastal margin, ranging in size from <100 to >100,000 population equivalent. The population equivalent and the sensitivity of waters receiving the discharges determine the level of treatment required. With regard to sewage sludge, which is left over from the treatment process, UK legislation now prohibits the disposal of sewage sludge to sea (DTI, 2004a).

43 The Ythan Estuary and lower River Don are designated as Sensitive Areas on account of eutrophication (possibly due to run-off from agricultural land), none of the east Scottish, Orkney and Shetland coasts are classified as such. Estuarine and coastal waters formerly identified as *Less Sensitive Areas* (*High Natural Dispersion Areas* under the transposing regulations) have now all been revoked (after Defra website[6]).

44 Various Bathing Waters and Shellfish Production Waters have been designated on the east coast of Scotland, north of Aberdeen. The Bathing Waters Directive (76/160/EEC) requires the monitoring of microbial indicators of faecal contamination (faecal coliform, total coliform and faecal streptococci) during the bathing season. Forty of Scotland's 60 identified Bathing Waters are located in the Area of SEA 5 and in 2003 monitoring by SEPA classified all 40 as "excellent" (i.e. meeting the Directive's guideline quality standards) or "good" (i.e. meeting the Directive's mandatory quality standards) (DTI, 2004a).

45 Overall, the water quality in the vicinity of Aberdeen is generally good, despite the presence of a large sewage outfall for trade and domestic effluent. Two main bathing waters have been identified near the proposed EOWDC site: Aberdeen –

[4] Polycyclic aromatic hydrocarbon, one of a class of chemical compounds, organic pollutants

[5] Polychlorinated biphenyls are a class of organic compounds

[6] http://www.defra.gov.uk/environment/quality/water/waterquality/sewage/sensarea/sensareas-summary.htm

Ballroom/Footdee and Balmedie Country Park Beach. The water quality of these bathing waters has been generally good for the past few years (source: Marine Conservation Society - http://www.goodbeachguide.co.uk).

3.2.3. Conclusions

46 The results of the sediment grab surveys carried out by CMACS Ltd in 2010 (Appendix 5.3) confirmed the presence of well-washed fine sandy bottoms in the proposed EOWDC area and its surroundings. A spatial pattern of increasing mud and organic content in bottom surface sediments was observed with increasing depth and distance offshore. This would be expected given the higher degree of sediment re-suspension in shallower, inshore areas, due to tidal movements, wave action and coastal currents preventing the settlement of finer particles.

47 As indicated by previous studies (e.g. the FRS benthic survey in 2006 (Appendix 5.1)), the sediment contamination in the proposed EOWDC site is in line with the background contamination levels provided for the North-eastern Atlantic area (OSPAR, 2000). Contaminant levels measured in sediments during the 2010 CMACS Ltd benthic survey (Appendix 5.3) confirm that there are no elements of concern in the area. Concentrations of the contaminants present are either below detection limits (as for PAH, PCB and organotin compounds) or below international benchmarks (ISQG and PEL) indicating potential adverse biological effects in aquatic systems (as for heavy metals).

48 The water quality in the Aberdeen area is generally good, despite the presence of a large sewage outfall for trade and domestic effluent. This is confirmed by the information on the quality of nearby bathing waters for the past few years which is generally good (Marine Conservation Society - http://www.goodbeachguide.co.uk).

Summary of sediment characteristics, contamination and water quality

Overall, the composition of the sediments is homogeneous across the survey area. The sediments at the inshore stations within the study area are characterised by fine well-sorted sands, whereas sediments further offshore and in deeper water are composed of very fine muddy sands.

The concentration of contaminants is below the Probable Effects Level (PEL) throughout the area for all contaminants measured. Arsenic is marginally above the Interim Sediment Quality Guidelines level (ISQG) but still below the PEL. All hydrocarbons, organotin and PCB concentrations are below the limit of detection.

The water quality in the Aberdeen area is generally good, as confirmed also by the information on the quality of nearby bathing waters for the past few years.

3.3. INTERTIDAL BENTHIC ECOLOGY

49 This section addresses the background information available on the intertidal benthic assemblages present along the north east coast of Scotland in general and in Aberdeen Bay in particular.

3.3.1. Background information

50 Most of the shores of the east Scottish mainland are moderately exposed to wave action, having a northerly or north-easterly orientation and the complex shore geology has created a high diversity of intertidal habitats. Sandy beaches are more prominent on the north-east coast of Scotland (Rattray Head and north of Aberdeen), south of Montrose (Lunan Bay) and south of the Firth of Tay (Tentsmuir, West Sands). The intertidal substratum in the Aberdeen Bay is also mostly sandy, with rocky platforms and boulders/loose rock southwards of Aberdeen (River Dee) and northwards of the Ythan Estuary. Also the sandy foreshore from Aberdeen to the Ythan Estuary is interrupted by a few rock platforms around Blackdog Rock, whereas the shores from Duncansby Head to Coldingham Bay are predominantly rocky.

3.3.1.1. SEDIMENTARY SHORES

51 The intertidal fauna on the east Scottish sandy beaches can be generally described as follows (Stephen, 1930; Eleftheriou and McIntyre, 1976; Eleftheriou and Robertson, 1988):

- the upper foreshore is inhabited mainly by the crustaceans *Talitrus saltator* and *Bathyporeia pilosa*;
- the middle and lower reaches have a fauna of crustaceans such as *Eurydice pulchra*, *Haustorius arenarius*, *Bathyporeia pelagica* and *B. sarsi*, along with the polychaetes *Paraonis fulgens*, *Eteone longa*, *Ophelia rathkei* and *Scolelepis(Scolepepis) squamata*;
- the lower foreshore is inhabited by polychaetes (*Spio filicornis*, *Nephtys cirrosa*, *Spiophanes bombyx* and *Lanice conchilega*), crustaceans (*Bathyporeia elegans*, *B. guilliamsoniana*, *Pontocrates altamarinus*, *Pontocrates arenarius, Atylus swammerdami* and *Monopseudocuma gilsoni*) and bivalves (*Angulus tenuis* and *Donax vittatus*).

52 Besides these general characteristics, some differences occur in the faunal composition of sandy beaches according to the degree of exposure to wind and wave action (Eleftheriou and Nicholson, 1975; Eleftheriou and McIntyre, 1976; Eleftheriou and Robertson, 1988). Extreme exposure, in fact, limits species richness by eliminating or restricting the sedentary forms of many bivalves and polychaetes, favouring in turn the presence of a fragile fauna of crustaceans. In turn, intertidal assemblages in sheltered beaches are generally dominated by sedentary species with high abundance and biomass.

53 A moderate degree of exposure to wave action, wind and tidal streams characterises most of the open coast beaches of Eastern Scotland, due to their easterly and north-easterly orientation. This type of beaches is generally short, steep and consists of medium sand and their intertidal fauna is restricted to 9-26 species and includes very few sedentary forms (Eleftheriou and Robertson, 1988). It is generally dominated by

fast swimming crustaceans such as the haustorid (*H. arenarius* and *B. pelagica*) and oedicerotid amphipods (*Pontocrates* spp.) and also cirolanid isopods (*E. pulchra*), whose overall abundance and biomass are low (Eleftheriou and Robertson, 1988). A local study carried out in Nigg Bay, to the south of the River Dee, confirmed the dominance of haustorid amphipods (*H. arenarius*) (Hart, 1971). This study highlighted also a dominance of the spionid polychaete *Scolepis cirratulus*in this beach, another species typical of exposed intertidal sandflats.

54 More sheltered beaches along the Scottish east coast are found at the inner part of firths, and are protected by headlands or by sandbanks. Tentsmuir and St. Andrews in Fife are some examples. They are generally flat or gently undulating, with fine sandy sediments, and their fauna consists of 24-48 species of which a high percentage are sedentary forms present in high abundance and biomass (Eleftheriou and Robertson, 1988). The intertidal fauna, in fact, is dominated by bivalves such as *Angulus tenuis* and *D. vittatus*, the polychaetes *N. cirrosa, S. filicornis, S. (Scolelepis) squamata* and the cumaceans *Bodotria pulchella* and *Cumopsis goodsir*. In those beaches with a flattish profile and a high retention of seawater there may be some evidence of an incursion of subtidal species well into the intertidal, such as *Tellina fabula*, as well as the amphipod *B. guilliamsoniana*, mysids, the polychaete *Nephtys hombergii* and several cumaceans (Eleftheriou and Robertson, 1988).

3.3.1.2. Rocky Shores

55 The littoral rocky shoreline extends sublittorally as outcrops of bedrock of variable extent and size. On vertical surfaces barnacles and limpets replace fucoid algae as the dominant organisms. The communities of plants and animals occurring on hard substrata between the tidal extremes are dependent on a combination of factors: wave exposure, shore topography, geology and geographical location. However, it should be noted that important stretches of hard substrata on the east coast are either only partially surveyed, or, in some cases, there is no information available.

56 The macroalgae of the rocky outcrops of north-eastern Scotland were studied by Wilkinson (1979) who found 80 species not previously recorded from the area. The first British record of the brown algae *Sorapion kjellmanii* was also recorded from this area, as reported by Bennett and McLeod (1998). Early records by Jack (1890) provided information on the marine algae of the rocky shores in the vicinity of Arbroath.

57 In the early 20th century, the distribution of fucoid algae was described for the Ugie (Peterhead), the Ythan (Newburgh), the Don (Aberdeen) and the Dee (Aberdeen) estuaries (Chater, 1927). The Ugie and the Don were similar in that they were both small estuaries supporting an abundance of the fucoid alga *Fucus ceranoides*. Much of the Ythan consisted of muddy shores but where rock occurred it supported a variety of fucoids. A range of fucoid algae also characterised the lower part of the Dee estuary but only *F. ceranoides*, which can tolerate reduced salinity, penetrated the estuary beyond Victoria Bridge, Aberdeen. The Don was then heavily polluted by effluent from a paper mill, but since the installation of a biological treatment plant, water quality has much improved and the estuary was declared a Local Nature Reserve in 1993 (Bennett and McLeod, 1998). The paper mill has now closed.

58 A large number of common and widespread intertidal faunal species are found on the rocky shores along the east coast of Scotland. Chitons (*Lepidochitona* and *Acanthochitona*), gastropods such as *Nucella lapillus, Patella aspera, P. vulgata, Margarites helicinus*, and several species of *Littorina* and nudibranchs (*Onchidoris spp., Archidoris, Facelina, Aeolidia*) are present on these habitats. A large gastropod

fauna including *Ansates pellucida*, several species of *Lacuna* and some pyramidellids have been also recorded, in association with *Fucus* fronds and laminarian stipes (Eleftheriou *et al.,* 2004).

3.3.2. Conclusions

59 The intertidal substratum in Aberdeen Bay is mostly sandy and moderately exposed to wave action, wind and tidal streams. Hence, an intertidal assemblage typical of moderately exposed beaches, as described above, is likely to be found along the shores possibly affected by the proposed EOWDC development. The dominant species in it (errant amphipods and spionid polychaetes) are adapted to living in a highly perturbed environment, and general unspoilt conditions are reported for most of the coast in the area (Bennett and McLeod, 1998). Hence, although the available data are dated, it is considered unlikely that the intertidal fauna has significantly changed since the data were collected.

60 Sandy intertidal habitats may also function as feeding grounds for the juveniles of many fish species (e.g. plaice *Pleuronectes platessa*; Gibson, 1973; Kuipers, 1977), hence supporting the populations of the adjacent sublittoral areas.

Summary of Intertidal Benthic Community

The open coast beaches of east Scotland are generally moderately exposed to wave action, wind and tidal streams, and the complex shore geology has created a high diversity of intertidal habitats. Sandy beaches are more prominent, although rocky shores are also present along the coast.

In the Aberdeen area, sandy shores are present, with an intertidal fauna being generally dominated by mobile crustaceans (such as haustorid amphipods) and showing a lower diversity, abundance and biomass than more sheltered sandy beaches (such as those at St. Andrews), where sedentary species dominate on richer assemblages.

3.4. SUBLITTORAL BENTHIC ECOLOGY

61 This section reports on the information available on sublittoral benthic fauna for the proposed EOWDC site and the wider area (North Sea and Area SEA 5), as gathered from background data and the CMACS Ltd 2010 benthic survey (Appendix 5.3).

3.4.1. Background information

62 In spite of the fact that the North Sea has been one of the most studied marine environments in the world, historically most investigations have concerned fish populations. As a result there was relatively little information available about the benthic fauna up until 30 years ago, particularly with regard to the northern North Sea (TES, 2008a). The need for further investigations covering the northern and central areas of the North Sea was widely acknowledged (Kingston and Rachor, 1982). Recently this gap has been partly filled by intensive small-scale surveys required for oil and gas exploration in the area. A Working Group on North Sea Benthos was established in 1981 by the International Council for the Exploration of the Sea (ICES). The Working Group organised a survey of the North Sea benthos, which was completed in early 1986. Wide-ranging benthic surveys (Basford and Eleftheriou, 1988; Eleftheriou and Basford, 1989; Basford *et al*., 1989, 1990, 1993; Künitzer *et al*., 1992), as well as epifaunal surveys (Dyer *et al*., 1982, 1983; Jennings *et al*., 1999; Zulhke, 2001) have also been undertaken, providing a database for the description of the benthic fauna of the entire North Sea. A thorough literature review for the Aberdeen Bay area was carried out in 2008 by TES Ltd, describing the North Sea environment and the area around Aberdeen Bay, including references to previous studies, and little new information has become available since its release (TES, 2008a).

63 At the North Sea scale, Künitzer *et al*. (1992) describe a division of the infauna between northern and southern assemblages occurring along the 70 m depth contour. Assemblages were further separated by the 30, 50 m and 100 m depth contour as well as by the sediment type. Cold water species did not occur further south than the northern edge of the Dogger Bank, which corresponds to the 50 m depth contour, whereas warm water species were not found north of the 100 m depth contour. The factors structuring species distributions and assemblages seemed to be temperature, the influence of different water masses (e.g. nutrient rich Atlantic water), the type of sediment and the food supply to the benthos. Much of the primary productivity in the northern North Sea is associated with the input of nutrient rich water from the North Atlantic and this has an effect on the benthic community structure in the northern part of the North Sea. At a North Sea scale, assemblages of other benthic groups such as the meiofauna (Huys *et al.,* 1992) and the epifauna (Dyer *et al.,* 1983; Frauenheim *et al.,* 1989) are structured and grouped within similar spatial patterns as the macrobenthic infauna assemblages.

64 The major division in macro-zoobenthic assemblages between the deeper northern and the shallower southern North Sea was confirmed by the findings of recent macrobenthic infaunal and environmental data from various sources, published by ICES in 2007 (Rees *et al.,* 2007). Separation of assemblages occurred along the Frisian Front at around 30 m depth and at the northern lower slope margin of the Dogger Bank (at a depth between 50 and 70 m). The influence of Atlantic inflow was again highlighted to be an important factor in structuring northern communities. General trends of increasing diversity and density are correlated with increasing latitude and depth.

65 Changes in community structure along the British coast between 1986 and 2000 were also described by Rees *et al*. (2007). A general trend of decreasing species richness was observed with a parallel increase in species abundance. Rees *et al.* (2007) suggest that increased abundances of cold-temperate species, such as the small polychaete *Paramphinome jeffreysii* and the interface-feeding *Myriochele* spp., north of the 50 m contour line could be an indication of the influence of colder northern water masses.

66 Within Aberdeen Bay, Stephen (1933, 1934) reported on a group of samples from around Aberdeen (20 – 40 m depth) and a transect of eight stations extending offshore in a south-easterly direction to the 100 m contour. The above stations, along with another fifteen dispersed widely throughout this sub-division of Area SEA 5, were considered to be from a community characterised by the presence of *Ophiura affinis* and *Echinocyamus pusillus*. Stephen (1933, 1934) concluded that there was large-scale geographic similarity in the offshore fauna and that it was less abundant than the inshore fauna. Stephen (1933, 1934) also noted a sub-community off the north-east coast of Aberdeenshire. Here large numbers of broken *Sabellaria* tubes (species of high nature conservation importance), probably originating from the masses growing near Rattray Head, formed the substratum for a community characterised by the molluscs *Astarte compressa, Cardium fasciatum, Venus ovata* and *Leda (*now *Nuculana) minuta*, and the polychaetes *Glycera lapidum* and *Ophelia limacina*.

67 At a later date, McIntyre (1958) described the benthos of the east coast fishing grounds with reference to surveys of St. Andrews and Aberdeen Bays. He found the fauna to be dominated by lamellibranchs and polychaetes together with the bivalves *A. alba, T. fabula, Nucula turgida* and *Ensis* sp. In addition the polychaetes *L. conchilega, Sigalion mathildae, Notomastus latericeus* and *Nephtys* spp. were dominant in both bays. Aberdeen Bay had a quantitatively richer fauna than St. Andrews Bay. The poorer offshore fauna was dominated by *A. alba* at St. Andrews and by *N. turgida* in Aberdeen Bay.

68 According to the results of a drop down video survey undertaken in 2007 by EMU Ltd for AOWFL, two main biotopes were described in the proposed EOWDC area, namely SS.SSa.CMuSa and SS.SSa.CCS. Tide-swept circalittoral coarse sand, gravel and shingle (SS.SCS.CCS) is a habitat occurring generally at depths of over 15-20 m and is typical of tidal channels of marine inlets, along exposed coasts and offshore. As with shallower coarse sediments, this biotope is characterised by robust infaunal polychaetes, mobile crustacea and bivalves. Circalittoral non-cohesive muddy sands (SS.SSa.CMuSa) is a biotope characterised by a silt content of the substratum typically ranging from 5% to 20%. This biotope is generally found in water depths of over 15-20 m and supports animal-dominated communities characterised by a wide variety of polychaetes, bivalves and echinoderms.

69 The proposed EOWDC site is located between two main estuarine areas: the Ythan Estuary, northwards, and the River Dee estuary, southwards. The invertebrate fauna of the Dee estuary was studied by Eleftheriou (1964). As might be expected, the maximum densities of marine, estuarine and freshwater species were found at the mouth, middle and head of the estuary respectively. The Ythan Estuary is a small meso-tidal bar-built estuary (Davidson *et al*., 1991) lying approximately half way between Peterhead and Aberdeen on the east coast of Scotland. It is a well-understood small-scale ecosystem (Raffaelli, 1992) and has been the subject of many studies based at the Culterty Field Station of the University of Aberdeen. At the mouth of the Ythan the sediments are sandy with stones and mussel beds and with occasional patches of muddy sand. In the middle reaches of the estuary the

sediments are muddy sand becoming finer further into the inner estuary (Baird and Milne, 1981). The faunal community is well studied with the amphipod *Corophium volutator*, the gastropod mollusc *Hydrobia ulvae*, the polychaete *Hediste diversicolor* and the bivalve *Macoma balthica* being widely distributed. Species such as the cockle *Cerastoderma edule*, the gastropod *Littorina littorea,* the shore crab *Carcinus maenas* and the mussel *Mytilus edulis* exhibit more localised distributions (Bennett and McLeod, 1998). Increasing weed cover (*Enteromorpha intestinalis*) led to increases in the the abundance of the opportunistic polychaete species *Capitella capitata* in the 1980s. Also local populations of less common species occur in the Ythan, such as the annelid *Lumbriculus variegatus*, the very local mollusc *Hydrobia ventrosa* and the very rare marine midge *Halocladius braunsi* (Scottish Natural Heritage, http://www.snh.org.uk/pdfs/publications/nnr/ForvieNNRTheReserveStory.pdf).

70 Also, rocky platforms and boulders/loose rock occur to the south of Aberdeen (River Dee) and to the north of the Ythan Estuary, with the littoral rocky shoreline extending sublittorally as outcrops of bedrock of variable extent and size. The invertebrate fauna associated with these habitats is described in Section 3.3. Intertidal Benthic Ecology of the present document.

3.4.2. Information taken from CMACS Ltd Survey 2010

71 The CMACS Ltd benthic grab survey was conducted in October 2010, using a standard weighted Day grab with a 0.1 m^2 sample area for all sediment sampling. Fourteen stations were visited in total, 6 in (and 8 outside) the proposed EOWDC area (see Figure 1 in Appendix 5.3 for sampling stations location). Macrofaunal analysis was carried out at the CMACS Ltd laboratory in the Isle of Man which participates in the National Marine Biology Analytical Quality Control Scheme. Further details on the sampling and laboratory methodologies, the data analysis and the raw data are provided in the CMACS Ltd Technical Report (Appendix 5.3). Additional analyses carried out by IECS on CMACS Ltd benthic data are provided in Appendix 5.4.

72 A total of 70 species was recorded from the survey area as a whole. The key dominant species (making up 85% of total abundance in the area) are reported in Table 2.

73 The mean number of species recorded across the sites was 18.3 (ranging from 10 to 32), whereas abundance values ranged from 17 to 145 individuals/0.1 m^{-2} (with an average value of 60.43 individuals/0.1 m^{-2}) (Appendices 5.3 and 5.4).

74 In general, the greatest number of species and abundances were recorded from the deeper stations in the proposed EOWDC site. This is likely to be due to the increasing depth and distance from the shore and the fact that there was a relatively high proportion of silt/clay present at these stations. This is supported by the data collected from stations 4, 8 and 9 which are located in the proposed EOWDC area (Figure 4). These stations have the highest number of taxa and are all in waters deeper than 27 m. When considering stations outside the proposed EOWDC area, this pattern was less evident, as, for example, stations at depths between 28 and 31 m showed either high (station 10) or low (station 3 and 11) number of taxa.

75 The species diversity (measured by the Shannon-Wiener diversity index H'(log_2) and the Pielou's evenness index (J') varied throughout the area with some of the shallower stations (such as station 1) having a more varied species composition and

some of the deeper stations (e.g. station 8) being more dominated by large numbers of a single species (as indicated by the lower values of the evenness index) (Appendix 5.4). The values of these indices across the stations, together with the relatively low abundance ratio, indicate a general even spread of the individuals between the species, suggesting that the communities are not dominated by one or very few species.

76 The dominant faunal groups found were polychaetes (Annelida), crustaceans and the molluscs (Appendix 5.3). The dominant species of polychaetes were *N. latericeus*, *S. bombyx*, *Galathowenia oculata*, *Pholoe baltica*, *N. cirrosa* and *Nephtys assimilis*. The most abundant molluscs were the bivalves *N. nitidosa*, *T. fabula*, *Kurtiella bidentata* and *A. alba*. The most abundant crustaceans were the amphipods, such as *Bathyporeia guilliamsoniana* and *Ampelisca brevicornis*. Other groups accounted for less than 7% of the total faunal abundance.

77 The most abundant species across the survey area as a whole was the annelid worm *N. latericeus* (243 individuals being found across 12 out of the 14 stations). *N. latericeus* is a polychaete (bristle worm) with a wide distribution across the North Sea and is generally thought to be found in low numbers. It is thought to inhabit sediment with a mud content of 0-50%, preferring sediments with a mud content of 10-30% (Warwick and Davies, 1977). This species is found across the survey area (Appendix 5.3), particularly in relatively deep locations. The stations where *N. latericeus* was particularly prevalent are all deeper than 25 m.

78 The second most common taxa at the proposed EOWDC site were juvenile brittle stars from the Ophiuridae family (Appendix 5.4). It is likely that these are *Ophiura ophiura*, but small juveniles are often difficult to identify to species level. The distribution of this taxon shows that these are more abundant towards the south of the lease boundary, stations 5, 6 and 9 having the highest numbers of juvenile Ophiuridae. These sites were all classed as muddy sand, suggesting the juvenile brittle stars have an affinity for muddier sediment types.

79 The third most abundant species was *N. nitidosa* (Appendix 5.4), which is a bivalve mollusc found throughout the North East Atlantic and European coastal waters. *N. nitidosa* shows a similar distribution to *N. latericeus*, being present at higher abundances in deeper waters. However, when compared with *N. latericeus* individual numbers per station were considerably lower.

80 The forth most abundant species was *T. fabula* (Appendix 5.4), which is a small burrowing bivalve commonly found in most coastal areas and occurring in a wide range of sediments. The distribution of *T. fabula* shows that it was absent from the closest inshore stations but appears to be present throughout the rest of the survey area, showing overall higher abundances outside the proposed EOWDC area. Although *T. fabula* was the third most abundant species, individual numbers are low and do not exceed 12 at any stations.

Table 2. Key infaunal species (top 85% abundance) for the survey area as a whole (CMACS Ltd Benthic Survey 2010).

Species	Taxonomic group	Ranked abundance
Notomastus latericeus	Polychaeta	1
Ophiuridae juv.**	Echinodermata	2
Nucula nitidosa	Bivalvia	3
Tellina fabula	Bivalvia	4
Spiophanes bombyx	Polychaeta	5
Galathowenia oculata	Polychaeta	6
Acrocnida brachiata	Echinodermata	7
Pholoe baltica	Polychaeta	8
Kurtiella bidentata	Bivalvia	9
Abra alba	Bivalvia	10
Nephtys cirrosa	Polychaeta	11
Nephtys assimilis	Polychaeta	12
Amphiura filiformis	Echinodermata	13
Nephtys sp. juv.	Polychaeta	14
Chamelea striatula	Bivalvia	15
Amphiuradae sp. juv.	Echinodermata	16
Bathyporeia guilliamsoniana	Amphipoda	17
Thyasira flexuosa	Bivalvia	18
Diastylis bradyi	Cumacea	19

**Ophiuridae juv. include Ophiuridae juv and *Ophiura* sp. Juv

81 The multivariate analysis carried out on the species abundance data highlighted the presence of two distinct groups of stations showing different benthic assemblages (Appendices 5.3 and 5.4). All the stations in the proposed EOWDC area (stations 4-9) and 5 of the stations outside it (stations 1, 3, 10-12) (Group A) showed benthic assemblages characterised by higher species richness and abundance than the rest of stations (stations 2, 13 and 14; Group B), located inshore, outside the proposed EOWDC area. Dominant species in stations from the Group A are the polychaete *N. latericeus*, followed by the bivalves *N. nitidosa* and *T. fabula* and brittle star of the family Ophiuridae. In turn, the polychaete *N. cirrosa* and amphipods dominated the benthic assemblage in stations from Group B, though with very low abundances if compared to the values recorded in the other group. The patterns in the species distribution and communities observed were found to be highly related to sedimentary and depth parameters (mainly median grain size, % sand, % silt/clay and depth, as indicated by the BIOENV analysis). Such a correlation between sediment types and depth is likely to reflect the difference between shore positions.

82 The infaunal communities are clearly strongly influenced by the depth and distance offshore (these two being indistinguishable on this open coast). The above results (combining faunal and sediment data) allowed the identification of two major biotopes in the survey area (Appendices 5.3 and 5.4). The biotope SS.SSA.CMuSa.AalbNuc (*A. alba* and *N. nitidosa* in circalittoral muddy sand or slightly mixed sediment) occurred at the majority of stations (these are the stations included in Group A defined by the multivariate analysis presented above). The biotope SS.SSA.IFiSa.NcirBat (*N. cirrosa* and *Bathyporeia* spp. in infralittoral sand) occurred at the inshore stations (these are the stations included in Group B defined by the

multivariate analysis presented above) where a much lower silt/clay content was detected (being predominantly fine-medium sands).

3.4.3. Conclusions

116 The proposed EOWDC area supports a benthic infaunal community similar to that occurring in the surrounding environment. There are no major differences in the community characteristics (species richness, abundance and diversity) or the taxonomic structure between the stations inside and outside the proposed EOWDC area (when considering similar depth conditions).

117 Overall, the benthic faunal characteristics in the area reflect those reported in the literature for Aberdeen Bay, with particular regard to the study by McIntyre (1958). Benthic infauna is quantitatively dominated by polychaetes (Annelida), such as *N. latericeus*, and the bivalves *N. nitidosa* and *T. fabula*. Ophiuridae are also characteristic of the surveyed benthic assemblages, particularly at offshore stations. This is consistent with previous findings of Stephen (1933, 1934) regarding the Aberdeen Bay area.

118 Most of the surveyed area is characterised by circalittoral non-cohesive muddy sands supporting animal-dominated communities characterised by a wide variety of polychaetes, bivalves and echinoderms, partly confirming the biotope analysis carried out in 2007 by EMU Ltd. In particular, the dominant benthic community strongly resembles the JNCC biotope SS.SSA.CMuSa.AalbNuc (*A. alba* and *N. nitidosa* in circalittoral muddy sand or slightly mixed sediment).

119 Although the previous biotope analysis (EMU Ltd., 2007) also described the presence of tide-swept circalittoral coarse sand, gravel and shingle (SS.SCS.CCS) in a small patch within the proposed EOWDC area, this biotope was not identified during the CMACS Ltd benthic survey in 2010. However, it should be noted that biotope analysis by EMU Ltd 2007 was based on geophysical data only. An additional biotope was described by CMACS Ltd study at inshore sites (outside of the proposed EOWDC area) not explored in 2007. These sites are characterised by finer sands, with sparser benthic assemblages matching well with the biotope SS.SSA.IFiSa.NcirBat (*N. cirrosa* and *Bathyporeia* spp. in infralittoral sand).

120 The differentiation between the benthic assemblages in the area is clearly strongly influenced by the depth and distance offshore, with the assemblage/biotope in the proposed EOWDC area being consistent with those found at stations located outside the lease boundary at a greater distance offshore.

Summary of Infaunal Community and Biotope Mapping

Species richness, abundance and diversity are variable across the site. These biological parameters are somewhat higher at deeper offshore stations than inshore ones. Numbers of species and abundance are somewhat lower outside the proposed EOWDC area; however, Shannon-Weiner diversity remains similar.

Two types of communities occur across the proposed EOWDC site, mainly reflecting sedimentary and depth characteristics. A community with a low number of species and abundance is present at inshore shallow stations with fine-medium, well-washed, sandy sediments. This community is characterised by the polychaete *N. cirrosa* and amphipods. A community with a relatively high number of species and abundance occurs at the offshore stations (including those present in the proposed EOWDC area), where the sediments are generally classified as muddy sand. The most abundant species in this community are the polychaete *N. latericeus*, the bivalves *N. nitidosa* and *T. fabula* and brittle stars of the family Ophiuridae.

These two communities can be characterised by two major biotopes: SS.SSA.CMuSa.AalbNuc (*A. alba* and *N. nitidosa* in circalittoral muddy sand or slightly mixed sediment) and SS.SSA.IFiSa.NcirBat (*N. cirrosa* and *Bathyporeia* spp. in infralittoral sand).

3.5. EPIBENTHIC FAUNA AND FISHERY ECOLOGY

121 This section reports on the information available on epibenthic invertebrate and fish fauna for the proposed EOWDC site and the wider area (North Sea and Area SEA 5), as gathered from background data and the epibenthic surveys carried out in the area in 2010 by CMACS Ltd (specifically for this project) and Marine Scotland Science (MSS, not for this project).

3.5.1. Background information

3.5.1.1. EPIBENTHIC INVERTEBRATES

122 Dyer *et al.* (1982) mapped the abundances of the most common or locally abundant epifauna species in the North Sea. Seven of these occurred in Area SEA 5: the echinoderms *Echinus acutus* and *Asterias rubens*, the polychaete *Hyalinoecia tubicola*, the red sea pen *Pennatula phosporea*, Dead Men's Fingers *Alcyonium digitatum*, the Norway Lobster *Nephrops norvegicus* and the bryozoan *Flustra foliacea*.

123 In Aberdeen Bay, Stephen (1933, 1934) reported on a group of samples from around Aberdeen (20 – 40 m depth) and a transect of eight stations extending offshore in a south-easterly direction to the 100 m contour. The above stations, along with another fifteen dispersed widely throughout this sub-division of Area SEA 5, were considered to be from a community characterised by the presence of *Ophiura affinis* and *Echinocyamus pusillus*. Stephen (1933, 1934) concluded that there was large-scale geographic similarity in the offshore fauna and that it was less abundant than the inshore fauna. Stephen (1933, 1934) also noted a sub-community off the north-east coast of Aberdeenshire. Here large numbers of broken *Sabellaria* tubes (species of high nature conservation importance), probably originating from the masses growing near Rattray Head, formed a substratum for a community characterised by the molluscs *A. compressa, C. fasciatum, V. ovata* and *N. minuta*, and the polychaetes *G. lapidum* and *O. limacina*.

3.5.1.2. SPAWNING AND NURSERY GROUNDS

124 The offshore area around Aberdeen is reported as a spawning ground for many commercially important species. The juvenile stages of many of these species remain within coastal nursery areas for a year or two before moving offshore. The offshore areas are characterised by fish communities dominated by haddock, whiting and cod, with saithe (*Pollachius virens*) and Norway pout (*Trisopterus esmarki*) being associated with deeper waters. Lemon sole (*Microstomus kitt*) are distributed throughout the central and northern North Sea and are pelagic spawners (February to June, with peak spawning period between April and May; Coull *et al.*, 1998). Little is known about this species' spawning habitats, and it is thought the lemon sole spawns throughout its range (CEFAS, 2001).

125 According to broad scale maps of fishery sensitivity areas in British waters, spawning grounds of herring, lemon sole and sandeel *Ammodytes marinus*, and nursery areas for lemon sole, sprat *Sprattus sprattus*, saithe, plaice and sandeel are present in the area where the proposed EOWDC site is located (Coull *et al.*, 1998 – see Appendix 5.2).

126 These maps have been updated for some species with more recent larval and juvenile data obtained from ichthyoplankton and groundfish surveys (CEFAS, 2010). The updated maps seem to confirm the spawning of sandeel in the area, while highlighting also the presence of nursery areas of herring, whereas a minor importance as spawning or nursery grounds was highlighted for plaice in the area (no updated data were available for lemon sole, sprat and saithe). Sandeel and herring play a key role in the North Sea food web. Sitting in a mid-trophic position, they are major predators of zooplankton and the principal prey of many top predators such as Atlantic salmon and sea trout. Sandeel eggs are demersal, and are laid in sticky clumps on sandy subratrata from November to February (Coull *et al.*, 1998). On hatching, the larvae become planktonic, resulting in a potentially wide distribution (CEFAS, 2001). Herring is a migratory species and is found throughout the area, although its distribution is seasonal.

127 The above mentioned maps represent very broad scale distributions and do not take into account the different suitability of habitats for the species within the highlighted areas. Sandeel, for example, is closely associated with well-oxygenated, medium to coarse sand, hence its distribution will be limited to this suitable habitat (not detected in the proposed EOWDC area, where fine to very fine sandy sediments occur). In addition, spawning grounds are dynamic features of fish life history and are rarely fixed in one location from year to year. Although some fish species exhibit the same broad patterns of distribution from one year or season to the next, others show a large degree of variability. For sediment spawners, not all suitable sediment areas might be used in every year and areas used will depend on the size of the spawning stock. Also the locations of nursery areas can change from year to year depending on factors such as water temperature or the availability of food. It is therefore difficult to define the limits of nurseries precisely. The maps provided in Appendix 5.2 as well as those provided by CEFAS (2010) must therefore be considered an indication of the likely positions of juvenile and egg concentrations, representing the widest known distribution rather than a definitive description of the limits of all spawning and nursery grounds.

128 No specific information has been found in the literature on the use of the proposed EOWDC site as a fish nursery or spawning ground. However, an indication that no specific spawning or nursery grounds are present within the site came from the Marine Scotland Licensing Operations Team in its scoping response (2010).

3.5.1.3. Migratory Species

129 There are several species that migrate between fresh and salt waters (diadromous species) in the North Sea, such as Atlantic salmon, sea trout, sea lamprey, river lamprey (*Lampetra fluviatilis*), European eel, twaite shad (*Alosa fallax*), allis shad (*Alosa alosa*) and sparling (*Osmerus eperlanus*) (Barne *et al.*, 1996; DTI, 2004b).

130 Atlantic salmon, anadromous sea trout and European eel, in particular, may use the coastal areas of Scotland for feeding and migration and are of high economic and / or conservation value (see Section 3.6. Nature Conservation Status). However the knowledge on the migration routes of these species along the east coast of Scotland is rather scarce and uncertain (Malcom *et al.*, 2010). Further details on this issue are provided in the salmon and sea trout assessment for the proposed EOWDC.

3.6.1.4. Non-commercial fish species

131 The numbers of exploited and non-exploited fish species from coastal areas of Area SEA 5 were estimated by Swaby and Potts in 1993 (in Swaby and Potts, 1996,

1997a, b, c). Information on the distribution and abundance of non-commercial species comes from records made during routine groundfish surveys, landings data, historical records as well as scientific studies. The most abundant species found in near-surface surveys in areas from Aberdeen to off Shetland were rocklings (Gadidae), members of the herring family (Clupeidae) and three-spined sticklebacks (*Gasterosteus aculeatus)* (Swaby and Potts, 1996).

3.5.1.5. CEPHALOPODS

132 Cephalopods are important elements in food webs and interact with commercial fisheries of finfish. Evidence exists that fishing pressure has changed ecological conditions and shifts in community structure have occurred with cephalopod stocks slowly replacing predatory fish stocks (Caddy and Rodhouse, 1998). Their commercial significance to world fisheries is relatively recent but is increasing (Boyle and Pierce, 1994). According to Stephen (1944) frequently occurring cephalopod species in the North Sea include *Eledone cirrhosa*, *Sepiola atlantica*, *Sepiola pfefferi*, *Sepietta oweniana*, *Rossia macrosoma*, *Rossia glaucopis*, *Sepia officinalis*, *Loligo vulgaris*, *Loligo forbesi*, *Alloteuthis subulata*, *Illex coindetii*, *Todaropsis eblanae* and *Todarodes sagittatus.* Infrequently occurring species are *Bathypolypus arcticus*, *Benthoctopus piscatorum*, *Sepietta neglecta*, *Sepia elegans*, *Onychoteuthis banksi*, *Architeuthis monachus*, *Architeuthis harveyi*, *Sthenoteuthis caroli* and *Brachioteuthis riisei.* The main commercial species in Scottish waters is the long-finned squid *L. forbesi* (Boyle and Pierce, 1994; Pierce *et al.*, 1994a, b, 1998). Since 1995, annual UK landings of loliginid squid have ranged between 1600 and 3200 tonnes, making the UK the second most important fishery nation for loligonid squid within the ICES region after France. Figure 5 shows the total squid landings for Area SEA 5 in 1998. Although squid are caught off the Aberdeen coast, this area is not the most important in terms of Area SEA 5 as a whole.

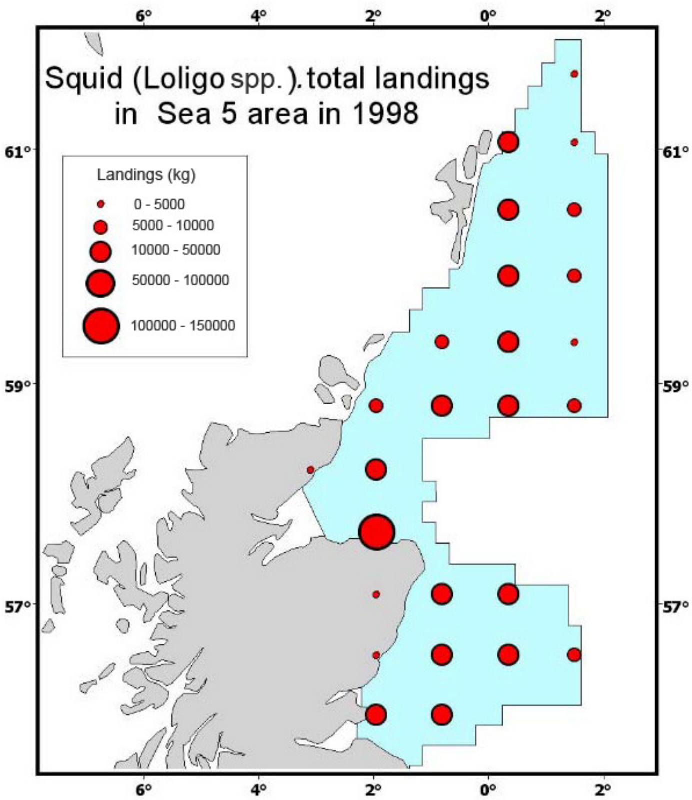


Figure 5. Squid total landings in Area SEA 5 in 1998. Source: Stowasser *et al.* (2004).

3.5.1.6. ELASMOBRANCHS

133 Elasmobranchs are cartilaginous fish that share life history characteristics which make them vulnerable to over fishing (e.g. slow growing, late maturity, low fecundity), meaning that once depleted, populations take a long time to recover.

134 Several elasmobranchs species (sharks, skates and rays) occur in the Scottish waters. According to the results of the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) groundfish surveys, spiny dogfish *Squalus acanthias* and starry ray *Amblyraja radiata* are frequently found in the North Sea, as well as lesser-spotted dogfish *Scyliorhinus canicula* and cuckoo ray *Leucoraja naevus* (Ellis *et al.*, 2005). Other less frequent species are tope *Galeorhinus galeus*, smoothound *Mustelus asterias,* spotted ray *Raja montagui*, common skate *Dipturus batis*, sandy ray *Leucoraja circularis*, shagreen ray *Leucoraja fullonica*, thornback ray *Raja clavata* (Ellis *et al.*, 2005). Many of these species have depleted populations, with the common skate being nearly extirpated from the UK waters (Fowler *et al*., 2004). As a result many species of sharks and rays are on the OSPAR list of Threatened and Declining Species due to their removal as both target and non-target species of fishery (Scottish Government, 2011). These species are found mainly off the north-west coast of Scotland (e.g. spiny dogfish, shagreen ray, thornback ray, spotted ray) (Scottish Government, 2011), where their main nursery areas are located (CEFAS, 2010). Hence a significant occurrence of these species in the shallow area where the proposed EOWDC site is located is unlikely.

135 Porbeagle sharks (*Lamna nasus*) are also found throughout the North Atlantic, with the largest population in UK waters found to the north of Scotland. Recorded sightings of porbeagle sharks within the North Sea have generally occurred offshore in the central North Sea, between May and September (Weir, 2001).

136 The Basking shark, *Cetorhinus maximus,* is the world's second largest fish species, with a circum-global distribution in warm-temperate to boreal seas. Sightings data indicate that this species is common along the west coast of the UK as far north as the Shetland Islands, and is infrequently recorded off the east coast of the UK mainland (Figure, 6). According to TES (2008a) a basking shark was reported during a boat survey close to the proposed EOWDC area on the 16th November 2007. A survey carried out by Travers *et al.*, 2008, also in 2007, did not record any basking sharks in Aberdeen Bay and it may be that the TES sighting was an unusual and isolated event.

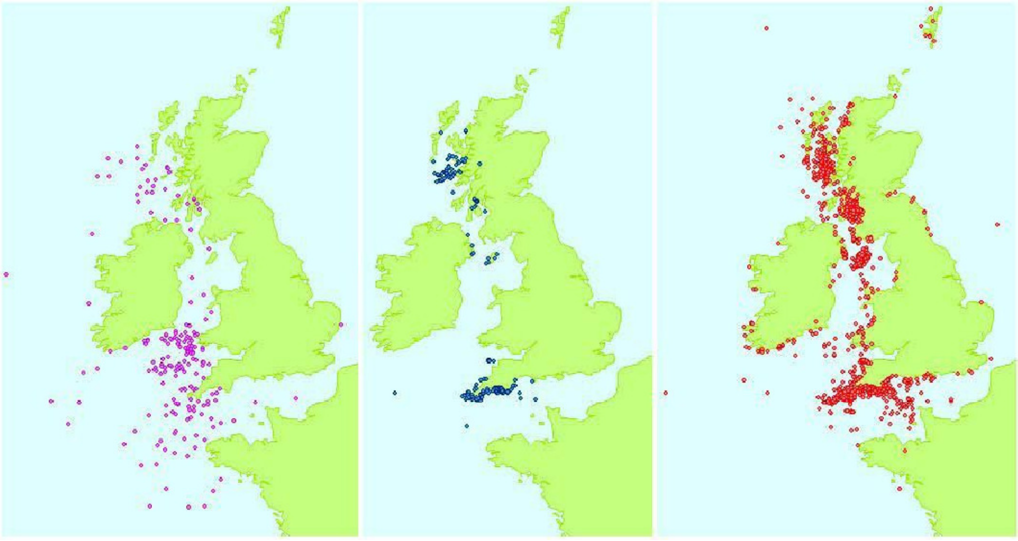


Figure 6. Distributions of basking sharks on the European continental shelf, determined using three independent methods: pink, tag geolocations; blue, scientific surveys; red, public sightings. Survey and sightings data from CEBS partners. Source: Basking shark population assessment research project – Report produced by CEFAS on behalf of the Global Wildlife Division, Defra.

3.5.2. Information taken from CMACS Ltd and MSS Epibenthic Surveys 2010

137 Epifaunal benthic surveys were undertaken in October 2010 in the proposed EOWDC area and in the surrounding marine environment by the CMACS Ltd (Appendix 5.3). Additional benthic survey data, collected in the same year (in September), were presented by MSS and these have been analysed by IECS (Appendix 5.5) and the results integrated with the CMACS Ltd survey results. In both cases, data were obtained by the combination of video camera surveys and epibenthic trawls in the area.

138 The CMACS Ltd epibenthic survey programme comprised 15 underwater camera stations (6 in the proposed EOWDC area, and 9 outside it, as a reference) and 10 stations which were sampled using a 2 m scientific beam trawl (4 stations inside and 6 outside the proposed EOWDC area). Further details on the CMACS Ltd epibenthic survey methods and data analysis are provided in Appendix 5.3.

139 The MSS survey was carried out in Aberdeen Bay at 14 video camera stations and at 7 stations sampled by means of Agassiz trawl net. Most of the stations were located in the area where CMACS Ltd survey took place, except for stations TV 42, TV 43, TV44, ABAG4 and ABAG5, located 1 to 5 km further offshore (see Appendix 5.5 for station locations). Further details on the MSS epibenthic survey and on the data analysis (carried out by IECS on MSS data) are provided in Appendix 5.5.

140 The main results obtained from the CMACS Ltd and MSS 2010 surveys (detailed in Appendices 5.3, 5.4, and 5.5) are presented here and compared to the data obtained during a previous epibenthic survey carried out in 2006 (April 7th) in Aberdeen Bay by FRS[7] (Table 3).

[7]The 2006 FRS survey consisted of 3 epifaunal trawls (between 12 and 25 m of depth) with video footage being obtained during the same survey. The raw data were provided by FRS in 2006, during the first consultation round.

Table 3. Species from Aberdeen Bay caught in epifaunal trawls during 2006 survey. Source: FRS, 2006.

	Haul 1	**Haul 2**	**Haul 3**
Haul duration, min	20	20	23
Start and end coordinates	57°12.690N 2°00.320W 57°11.800N 2°00.740W	57°11.970N 2°01.430W 57°11.070N 2°00.980W	57°11.170N 2°02.660W 57°12.230N 2°02.380W
Depth, m	25	19	12
Species:			
Common dab	13	13	2
Long rough dab	1	3	/
Plaice	26	29	10
Flounder	1	0	1
Pandalus	1	0	1
Asterias	17	8	0
Echinoderm	2	3	1
Brittle stars	180	50	20
Dead mens fingers	0	1	0
Pipefish	0	1	4

141 A fairly uniform seabed was observed in the proposed EOWDC area during CMACS Ltd and MSS 2010 surveys and no sensitive habitats were observed during the camera surveys. The sediments were mainly composed of fine sand, silt/clay and shell fragments, and sand ripples on the sea bed were noticeable. The observed sediment characteristics were consistent with the results of sediment analysis (Section 3.2. Sediment and Water Quality). No seaweed was recorded at these stations. The epifauna was sparse, with only brittle stars being seen regularly in high numbers. Also some fish species, mostly plaice and common dab (*Limanda limanda*), were detected.

142 During the MSS survey, deeper areas farther offshore (1 to 5 km far from the proposed EOWDC area) were also explored in addition to the shallow areas surveyed by both MSS and CMACS. These deeper sites comprised areas of mixed sediments including coarse sediments, stones, pebbles and boulders with silt/clay particles. Relatively slow current speeds and lower water turbidity were also recorded at these stations. A more diverse and abundant epifauna was recorded with the common starfish *Asterias rubens*, the bryozoan *Flustra foliacea* and dead man's fingers *Alcyonium digitatum* occurring in large numbers at these stations. Attached epifaunal species (anemones, bryozoans, sponges) were also notable on the video footage.

143 The trawl surveys carried out in the area in 2010 by CMACS Ltd and MSS gave similar results on the overall structure of epifauna assemblages. It is of note that similar sampling methods were employed in all surveys. Specific differences may be ascribed to the different timing of sampling (September for the MSS survey, late October for the CMACS Ltd survey) and to the different areas explored during the two surveys (with the MSS survey also covering offshore areas).

144 Brittle stars were always present as a quantitatively important taxon in the invertebrate epifaunal community of the studied site (Appendices 5.3 and 5.5). These organisms are typical of sandy and muddy sandy sea beds from the shallow sublittoral through to 200 m depth. The common starfish was also found in the area. It is common and widespread throughout British coastal waters and occurs in most

sublittoral zones, particularly on soft sediments. These results confirmed the observations carried out previously by FRS in the Aberdeen area in 2006 (Table 3).

145 The brown shrimp *Crangon crangon* dominated the epifaunal invertebrate assemblage in the CMACS Ltd catches (late October 2010), whereas it was not detected in the MSS catches (September 2010), where brittle stars dominated the epifaunal assemblage (Figure 7). Although *C. crangon* is common in shallow coastal waters, its abundance is highly seasonal in these areas (Campos and van der Veer, 2008). Larger catches are usually obtained in autumn, when *C. crangon* is generally present in large numbers in the shallower fishing grounds near the coast. Peak autumn landings in recent years have proven to extend later in the autumn season (Campos and van der Veer, 2008) hence higher abundances of the species are expected in late October than in September.

146 In late October 2010 (CMACS Ltd survey), high abundances of the swimming crab *Liocarcinus holsatus* were also recorded in the area (Figure 7). This is a common species which is found throughout in the North Sea. Its high abundance in the CMACS Ltd samples can be related to the presence and abundance of the brown shrimp in the area in late October since this species is the principle food source for swimming crabs.

147 The distribution of invertebrate epifauna across the site was clearly related to depth and distance from shore. Some correlations between species distribution and sediment type were also suggested by the results. Higher numbers of brittle stars, for example, were associated with muddy areas although there were some muddy areas where brittle stars abundance was low. *C. crangon* also showed an apparent correlation with softer sediment types and in general, a higher number of taxa was also detected at deeper stations than in the shallower, inshore stations (CMACS Ltd survey 2010, Appendix 5.3).

148 In terms of fish fauna, the dominant species in the area were always two flatfish species, the common dab and plaice, with these two species being found throughout the entire survey site in 2006 (FRS survey, Table 3) and in 2010 (CMACS Ltd and MSS surveys, Appendices 5.3, 5.4, and 5.5, Figure 8). These are common species around the UK coastline, usually found within a few meters to about 100 m water depth. The majority of individuals from these commercial species were caught as juveniles below the legal landing size.

149 Hooknose *Agonus cataphractus* was also abundant in the survey area in both 2010 surveys (Figure 8). This is a small, non commercial species that is common around UK coastal areas, particularly on sandy seabeds.

150 Other abundant species included Norway pout, which was particularly abundant in the September 2010 catches (MSS survey), and whiting, which was more abundant in late October (CMACS Ltd survey). Both species showed a high degree of temporal variability.

151 As well as dab, plaice and whiting, other species of commercial fish included sprat, haddock, witch (*Glyptocephalus cynoglossus*), bib (*Trisopterus luscus*) and grey gurnard (*Eutrigla gurnardus*).

152 Sandeels were also present in the catches, in particular in late October, although low abundances were detected during the 2010 CMACS Ltd survey in the area (43 individuals overall, mainly at shallower inshore stations).

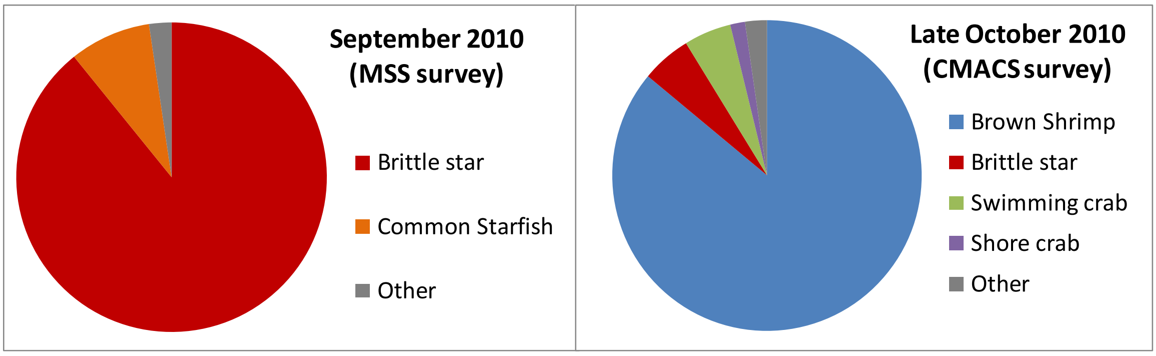


Figure 7. Composition (% abundance) of the invertebrate epifauna assemblages in the study area based on the two surveys carried out in 2010.

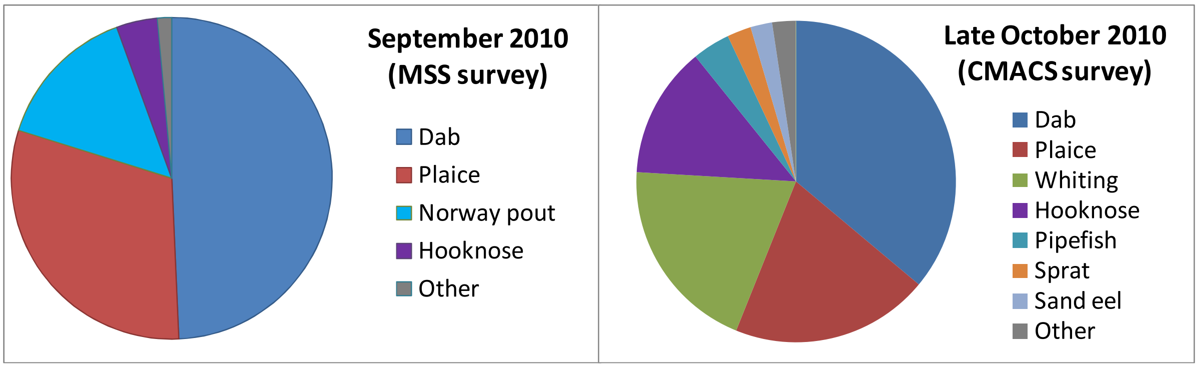


Figure 8. Composition (% abundance) of the fish assemblages in the study area based on the two surveys carried out in 2010.

153 The distribution of fish fauna across the site (the 2010 CMACS Ltd and MSS surveys) seemed related to depth and/or distance from shore. In general, higher numbers of fish taxa occurred at the more inshore locations, this pattern being contrary to that detected for epifaunal and infaunal assemblages. Dab and plaice, in particular, were recorded with higher numbers at the shallower, inshore stations, whereas hooknose and whiting were more abundant in deeper waters. Differences among fish assemblages were particularly evident when comparing offshore stations (station 8 of the 2010 CMACS Ltd survey and station ABAG4 of the 2010 MSS survey) with the inshore stations. Lower abundances of flatfish and brittle stars characterised the offshore areas, and this can be related mainly to the greater depth and distance from the shore.

3.5.3. Conclusions

154 Overall, the epibenthic invertebrate fauna in the area is sparse and composed of brittle stars, brown shrimp and swimming crabs (the latter two species being mainly represented later in the autumn period). The most common fish species are flatfish, such as dab and plaice, particularly at inshore areas. Hooknose and whiting are also abundant. These survey findings confirm what is reported in the literature.

155 According to large scale mapping, the proposed EOWDC area appears to fall within nursery and spawning grounds of several fish species which are either of commercial interest (such as flatfish) or may constitute important feeding resources for other fish predators (e.g. sandeel and herring). However, no specific spawning and nursery grounds are known to exist in the proposed area (MS-LOT reference in Scoping response 2010).

156 The low abundance of sandeels recorded during the surveys in the proposed EOWDC area and its surroundings seems to support the absence of a spawning ground for the species in the area. During autumn and winter, sandeels usually lie dormant, buried in the sediment, hence bottom trawl surveys carried out in these periods should have provided good estimates of the abundance of local populations (Greenstreet *et al*., 2010). The observed low abundances of sandeels could possibly be ascribed to a preference of the species towards coarser sandy bottoms (Dickey-Collas *et al*., 2010), not present in the proposed EOWDC area. Sandeel is also a key prey species for Atlantic salmon and sea trout, which have important spawning areas in nearby rivers (e.g. River Dee). The low abundance of sandeels in the proposed EOWDC area suggests the area is not an important feeding ground for these predator species.

157 The epibenthic survey in the area recorded high abundances of juveniles of flatfish species. The inshore, shallower coastal areas are likely to serve as nursery grounds for flatfish (mainly plaice and dab) extending over a wider area along the Scottish coast (Appendix 5.2).

158 The coastal waters in the Aberdeen Bay, where the proposed EOWDC area is situated, are likely also to be used as migratory routes by the Atlantic salmon and the sea trout, which have important spawning areas in nearby rivers (e.g. Rivers Dee and Esk). This is discussed within the salmon and sea trout assessment for the proposed EOWDC.

159 Other relevant commercial fish species (e.g. whiting, cod, Norway pout), although present in the proposed EOWDC area, are associated mainly with deeper waters. It therefore seems unlikely that the proposed EOWDC development will raise concerns regarding their distribution. The same is considered valid for other species of interest, for example basking sharks or squids.

160 The only elasmobranch recorded during the 2010 epibenthic surveys in the proposed EOWDC site was the cuckoo ray, but its presence was occasional in the catches.

Summary of Epifaunal and Fish Community

The invertebrate epifaunal community includes brittle stars, brown shrimp and swimming crabs (the latter two species being mainly represented later in the autumn period).

The most common fish species are dab and plaice which were recorded at all stations in relatively high numbers. The distribution of these flatfish species, found mainly at juvenile stages, suggests the presence of nursery grounds in the shallow inshore areas.

Hooknose is also abundant, as well as whiting (particularly in October). Sandeel is present in the area, although in low numbers.

The distribution pattern for whiting and hooknose shows an increase in individuals with increasing depth and distance from the shore. This is not the case for dab and plaice which are recorded in high numbers near the shore.

3.6. Nature Conservation Status

161 Several sites designated for conservation interest are present in the general area of Aberdeen. These are:

- Special Areas of Conservation (SACs), i.e. strictly protected sites designated under the EC Habitats Directive (92/43/EEC).
- Special Protection Areas (SPAs), i.e. strictly protected sites classified for rare and vulnerable birds, and for regularly occurring migratory species, in accordance with Article 4 of the EC Birds Directive (79/409/EEC).
- Ramsar sites, i.e. wetlands of international importance designated under the Ramsar Convention.
- Sites of Special Scientific Interest (SSSIs), i.e. sites that, within the UK, are nationally important for plants, animals or geological or physiographical features, and are protected by law.
- National Nature Reserves (NNR), declared by Scottish Natural Heritage as a selection of the very best parts of UK SSSIs.

162 A list of these sites and the species and habitats they have been designated for is provided in Table 4. None of the above mentioned sites falls within the proposed EOWDC area, the closest designated sites being at a distance of 5 to 7 km from it (Table 4).

163 A range of national and international designation acts, plans and directives (e.g. the Wildlife and Countryside Act 1981, the UK Biodiversity Action Plan (UK BAP), the OSPAR Initial List of Threatened and/or Declining Species and Habitats, the European Habitats Directive, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)) identify conservation priority habitats and species which are under threat because of their rarity and/or rate of decline, and, as such, need protection.

164 According to these designations and to the information gathered from the recently published Scotland's Marine Atlas (Scottish Government, 2011) several benthic organisms of conservation significance occur in the inshore and shelf subtidal areas along Scottish coasts (e.g. the bivalve molluscs *Arctica islandica* and *Atrina fragilis,* the reef forming species *Sabellaria spinulosa* and *Modiolus modiolus*). None of these species are present in or close to the proposed EOWDC area, as confirmed also by the benthic surveys carried out in the site (CMACS Ltd and MSS surveys 2010).

165 As regards fish, Table 5 provides the list of designated species possibly occurring along the coast of east Scotland and reports their likelihood of occurrence in the proposed EOWDC site, according to the information gathered from literature and from the results of the epibenthic surveys carried out by CMACS Ltd and MSS in 2010.

166 Many of the inshore habitats in the Aberdeen area are reported as important nursery and spawning grounds of species like herring and sandeels, which constitute important feeding resources for other fish and bird species of conservation interest (e.g. Atlantic salmon and trout). However, according to the epibenthic surveys

carried out in the area and to the information gathered in Section 3.5 epibenthic Fauna and Fishery Ecology, sandeel occurs in the proposed EOWDC site but in low numbers and it is unlikely to be an important food source for salmonids in this area. In turn, herring has not been recorded in the proposed EOWDC site during the epibenthic surveys in 2010, and its spawning grounds are likely to be located further offshore.

167 Cod and whiting have been recorded in the proposed EOWDC site during the epibenthic surveys in 2010. However, cod was present in very low numbers, occurring only in the MSS survey 2010, and both species, although present in the proposed EOWDC area, are associated mainly with deeper waters. Plaice was also present in the 2010 epibenthic catches from the proposed EOWDC site, with higher numbers at the shallower, inshore stations.

168 Migration routes of Atlantic salmon and sea trout might cross the proposed EOWDC site, having the species important spawning areas in the nearby rivers (particularly in the River Dee) (see salmon and sea trout assessment for proposed EOWDCfor details.) Indirect impacts on these migratory species might also lead to an indirect impact on the River Dee SAC populations of freshwater pearl mussel (*Margaritifera margaritifera*). This is a rare and threatened species, being one of primary reasons for the selection of the River Dee SAC, and highly dependent on the presence of Atlantic salmon and sea trout as hosts for their larvae.

169 Other migratory fish, which move from seas to freshwater habitats to spawn and which could occur in the area include the sparling (Osmerus eperlanus) (or European smelt) and the common sturgeon (Acipenser sturio). The sparling is of conservation importance and is included in the UK Biodiversity Action Plan Species List, whilst the common sturgeon is critically endangered, included on the IUCN Red List and on Schedule 5 of the Wildlife & Countryside Act, Annexes II & V of the EU Habitats Directive and Appendix II of the Bern Convention, as well as on the UKBAP Priority Species List.

170 However, although once relatively widespread in rivers around Scotland, the breeding status of the sparling is now extremely restricted in Scottish rivers (Cree, Forth and Tay), and the common sturgeon is not known to have bred in Britain.

171 As such, whilst the occasional occurrence of these species in waters in Aberdeen Bay cannot be ruled out (although available data would not suggest a presence), it is considered unlikely that the proposed EOWDC would have any significant impact on these two species and therefore they have been scoped out of further assessment.

172 As already mentioned (Section 3.5. Epibenthic Fauna and Fishery Ecology), elasmobranch species occur mainly off the north-west coast of Scotland or farther offshore than the proposed EOWDC site. No significant records in the proposed EOWDC site are reported. The only elasmobranch occasionally recorded during the epibenthic surveys 2010 in the proposed EOWDC site is the cuckoo ray. In contrast to the elasmobranchs reported in Table 5, this is a smaller, rapidly growing and more fecund species for which a stable or increasing population abundance is reported (Fowler *et al.,* 2004).

173 Priority habitats have also been recognised under the UK BAP, being considered of particular importance for biodiversity conservation. Together with the habitats created by the reef forming species *S. spinulosa* and *M. modiolus*, other habitats such as native oyster (*Ostrea edulis*), blue mussel (*M. edulis*) and eelgrass (*Zostera marina* and *Nanozostera noltii*) beds occur frequently in the intertidal and subtidal

areas along the coasts of Scotland. However, these habitats occur mostly on the west coast of Scotland, and none of them is present in in Aberdeen Bay (Scottish Governement, 2011). This was also confirmed by the benthic surveys carried out in the proposed EOWDC site (CMACS Ltd and MSS surveys 2010).

174 The dominant substratum found in the proposed EOWDC site matches well with the UK BAP habitat "sublittoral sands and gravels". This habitat is described as well sorted medium and fine sands on exposed coasts subjected to frequent wave action and variable tidal currents are typified by errant polychaetes such as *N. cirrosa* and isopods such as *Bathyporeia* spp (common in full salinity areas of many estuaries) (JNCC, 2008). Illustrative Level 4 biotopes for this habitat are SS.SSa.CMuSa (Circalittoral muddy sand) and SS.SSa.IFiSa (Infralittoral fine sand), as those found in the proposed EOWDC site. The UK Habitat Action Plan aims to ensure that the best examples of sublittoral sand and gravel habitats are protected from the adverse effects of fishing, dredging, aggregate extraction and other activities such as wind farm development. Therefore, where wind farms are proposed, their development should respect, and where possible further, the objectives and targets for priority habitats and species listed in the UK Biodiversity Action Plan. However, it must be noted that sublittoral sand and gravel sediments are the most common habitats found below the level of the lowest low tide around the coast of the United Kingdom. The biotope SS.SSA.CMuSa.AalbNuc is not uncommon in the wider Aberdeen Bay area, and although *A. alba* is a common food source for *Asterias rubens* and different species of demersal fish (MarLIN), it is not considered to have an especially high ecological importance at the local scale.

Table 4. Designated sites in a range up to 150 km from the proposed EOWDC development.

Designation	Site (approx. distance from the proposed EOWDC)	Designated for
SAC	River Dee (7.5 km)	Atlantic salmon, freshwater pearl mussel and otter
	Sands of Forvie (7.2 km)	Embryonic shifting dunes, shifting dunes along the shorelines with *Ammophilia arenaria*, decalcified fixed dunes with *Empetrum nigrum*, humid dune slacks
	Buchan Ness to Collieston (12.2 km)	Vegetated sea cliffs
	Garron Point (30 km	Narrow-mouthed whorl snail *Vertigo angustior*
	Moray Firth (150 km)	Bottlenose dolphin, sandbanks which all the times are covered by seawater
SPA	Ythan Estuary, Sands of Forvie and Meikle Loch (7.2 km)	Breeding population of common tern; breeding population of little tern; breeding population of sandwich tern; Wintering population of pink-footed goose; regularly supporting at least 20,000 waterfowl of which the notable components are redshank, lapwing, eider and pink-footed goose
	Buchan Ness to Collieston (9.5 km)	Regularly supporting at least 20,000 seabirds of which the notable components are guillemot, kittiwake, herring gull, shag and fulmar
	Loch of Skene (21 km)	Over wintering area for greylag goose and whooper swan, breeding population of tufted duck, supporting waterfowl assemblages of which the notable components are wintering goldeneye, goosander, common gull
	Fowlsheugh (31.1 km)	Breeding population of guillemot; breeding population of kittiwake; regularly supporting at least 20,000 waterfowl of which the notable components are razorbill, herring gull, fulmar, guillemot and kittiwake
	Loch of Strathbeg (47.6 km)	Sandwich tern, supporting waterfowl assemblages of which the notable components are pink-footed goose, greylag goose, teal and goldeneye
	Troup, Pennan and Lion's Heads (74.3 km)	Supporting seabird assemblages of which the notable components are fulmar, kittiwake, guillemot, herring gull and razorbill

Designation	Site (approx. distance from the proposed EOWDC)	Designated for
	Forth Islands (124.4 km)	Gannet, shag, lesser black-backed gull, roseate tern, Arctic tern, common tern, Sandwich tern, puffin; supporting seabird assemblages of which the notable components are cormoranyt, herring gull , kittiwake, razorbill and guillemot
Ramsar sites	Ythan Estuary, Sands of Forvie and Meikle Loch (7.2 km)	Aggregation of breeding sandwich tern, aggregation of non-breeding pink-footed goose and waterfowl assemblage
National Nature Reserve	Forvie (7.2 km)	Sand dune, foreshore, estuarine, spit, dune heath, slacks, rough pasture and cliffs habitat
SSSI	Foveran Links (4.8 km)	Sand dune, coastal geomorphology, vegetation assemblages, migrating birds, large moulting and passage flocks of seaduck and divers occurring off-shore, nesting site for the little tern
	Corby, Lily and Bishops lochs (6.7 km)	Non-breeding graylag goose; mesotrophic loch, aquatic vegetation, wetland sites
	Sands of Forvie and Ythan Estuary (7.2 km)	Non-breeding population of pink-footed goose, breeding populations of Sandwich tern, common tern, eider, breeding bird assemblage; sand dune; coastal geomorphology
	Nigg Bay (10 km)	Quaternary geomorphology
	Collieston to Whinnyford (15 km)	Seabird colony; breeding: kittiwake, guillemot, razorbill, fulmar, shag; maritime cliff; dalradian geology
	Meikle Loch and Kippet Hills (17 km)	Non-breeding: Greylag goose, pink-footed goose, teal; quaternary geomorphology
	Bullers of Buchan (25 km)	Seabird colony; breeding: kittiwake, guillemot; maritime cliff; coastal geomorphology

Table 5. Fish species designations possibly occurring along the east coast of Scotland.

Taxon Group	Species	OSPAR	Habitats Directive	EC Cites	IUCN Red list	UK BAP 2007*	SNH**	Wildlife and Countryside Act 1981	occurrence in the proposed EOWDC site
bony fish	*Alosa alosa*	x	x			x	x	x	Unlikely
bony fish	*Alosa fallax*		x			x	x	x	Unlikely
bony fish	*Ammodytes marinus*					x	x		Yes
bony fish	*Ammodytes tobianus*						x		Yes
bony fish	*Anguilla anguilla*	x			x	x	x		Unlikely
bony fish	*Clupea harengus*					x	x		Likely
bony fish	*Gadus morhua*	x			x	x	x		Yes
bony fish	*Merlangius merlangus*					x	x		Yes
bony fish	*Osmerus eperlanus*					x	x		Unlikely
bony fish	*Pleuronectes platessa*					x	x		Yes
bony fish	*Salmo salar*	x	x			x	x		Likely
bony fish	*Salmo trutta*					x			Likely
bony fish	*Solea solea*					x			Unlikely
elasmobranch	*Amblyraja radiata*				x				Unlikely
elasmobranch	*Cetorhinus maximus*	x		x	x	x	x	x	Unlikely
elasmobranch	*Squalus acanthias*	x			x	x			Unlikely
elasmobranch	*Dipturus batis*	x			x	x	x		Unlikely
elasmobranch	*Galeorhinus galeus*				x	x			Unlikely
elasmobranch	*Raja montagui*	x							Unlikely
elasmobranch	*Leucoraja circularis*				x	x			Unlikely
elasmobranch	*Raja clavata*	x					x		Unlikely
elasmobranch	*Lamna nasus*	x			x	x			Unlikely

* taxon designations that are assessed as "least concern" using the IUCN classification are excluded. **Scottish Biodiversity List, http://www.snh.gov.uk/protecting-scotlands-nature/biodiversity-scotland/scottish-biodiversity-list/

3.6.1. Conclusions

175 Several sites designated for conservation interest (SAC, SPA, Ramsar sites, SSSI and NNR) occur along the coast in the Aberdeen area, but none of the designated areas coincide with the proposed EOWDC site.

176 The species designated under national and international legislation have been considered and are not thought to occur within the proposed EOWDC area (at least not in significant numbers). This is mainly due to the habitat preferences of the different species which locate them far from the proposed EOWDC area (e.g. further offshore or within estuarine areas). However, the possibility of migration routes of Atlantic salmon and sea trout crossing the proposed EOWDC site needs to be taken into account, the species having important spawning areas in the nearby rivers.

177 Many of the inshore habitats in the Aberdeen Bay area are reported as important nursery and spawning grounds of species like herring and sandeel, which constitute important feeding resources for other fish and bird species of conservation interest (e.g. Atlantic salmon and sea trout). According to the epibenthic surveys carried out in the proposed EOWDC site and to the information gathered in Section 3.5. Epibenthic Fauna and Fishery Ecology, sandeel is not present at high densities and is unlikely to be an important food source for salmonids in this area.

178 The dominant substratum found in the proposed EOWDC site corresponds to the UK BAP habitat “sublittoral sands and gravels”, well illustrated by the biotopes SS.SSa.CMuSa (Circalittoral muddy sand) and SS.SSa.IFiSa (Infralittoral fine sand).

Summary of Nature Conservation Status

Several sites designated for conservation interest (SAC, SPA, Ramsar sites, SSSI and NNR) occur along the coast in the Aberdeen area.

According to the knowledge on the distribution of nationally and internationally designated species, and following the results of the surveys carried out in the area, none of the designated species occur in the proposed EOWDC area or in its surroundings. The presence of migration routes of salmonids in the area is discussed in the salmon and sea trout assessment for the proposed EOWDC.

The dominat substratum found in the proposed EOWDC site corresponds to the UK BAP habitat “sublittoral sands and gravels”, well illustrated by the biotopes SS.SSa.CMuSa (Circalittoral muddy sand) and SS.SSa.IFiSa (Infralittoral fine sand).

4. Summary

179 This document provides the baseline information on the marine ecology of the proposed EOWDC area in Aberdeen Bay. Information from the available literature was integrated with the results from benthic and epibenthic surveys carried out within the proposed EOWDC area and in the surroundings. A combination of camera (15 stations), grab (14stations) and trawl (10 stations) sampling was undertaken by CMACS Ltd for OSIRIS Projects Ltd on behalf of AOWFL in October 2010. Additional benthic survey data were provided by FRS (survey carried out in April 2006) and MSS (survey carried out in September 2010), and information on sediments was available from EMU Ltd (2007) and OSIRIS Projects Ltd (2010) work.

180 According to a geophysical survey carried out by EMU Ltd for AOWFL, the seabed sediments in the proposed EOWDC site are dominated by muddy sand with small patches of glacial material towards the shore, and finer sediment features in places with occasional patches of shell fragments in others. The sediment analysis carried out by CMACS Ltd in 2010 complemented these results, showing a homogeneous composition of the sediments in the area, with a common pattern of variation following the gradient of depth and distance from the shore. At inshore stations, medium-fine well-sorted sands dominate, whereas sediments farther offshore and at deeper sites are dominated be fine-very fine muddy sands.

181 According to the CMACS Ltd 2010 survey results, there are no contaminants in the sediments showing concentrations above the Probable Effect Level (PEL) and all hydrocarbons, organotin and PCB concentrations were below detectable limits. Among heavy metals, only Arsenic was marginally above the Interim Sediment Quality Guidelines (ISQG) level but still below the PEL. Overall, the sediment contamination in the area is in line with the background contamination levels reported for the North-eastern Atlantic area.

182 The intertidal substratum in the area is mainly composed of sandy shores. The intertidal macrofauna is dominated by haustorid amphipods (*H. arenarius* and *B. pelagica*) and in some cases the spionid polychaete *S. cirratulus*, whereas sedentary species are less abundant, in agreement with the moderate exposure of the shores.

183 The sublittoral benthic survey results showed that the infaunal community changed mainly along the gradient of depth/distance offshore. The infaunal community at inshore shallower stations was characterised by low number of species and abundance, and was dominated by the polychaete *N. cirrosa* and amphipods. A relatively high number of species and abundance was detected at the stations farther offshore, where the most abundant species were the polychaetes *N. latericeus*, the bivalves *N. nitidosa* and *T. fabula* and brittle stars *Ophiura* sp. These two communities characterise two major biotopes: SS.SSA.CMuSa.AalbNuc (offshore) and SS.SSA.IFiSa.NcirBat (inshore). The Level 4 biotopes SS.SSA.CMuSa and SS.SSA.IFiSa are considered as a priority habitat under the UK BAP designation (sublittoral sands and gravels).

184 The invertebrate epifaunal community present in the proposed EOWDC site is sparse and composed mainly of brittle stars, brown shrimp and swimming crabs (the latter two species being mainly represented later in the autumn period). The most common fish species were dab, plaice, whiting and hooknose, recorded at all stations in relatively high numbers. The distribution pattern for whiting and hooknose showed an increase in abundance with increasing depth and distance from the shore, whereas dab and plaice were recorded with higher numbers near the shore. The latter species, in particular, were present in the area mainly as juveniles, suggesting

the presence of nursery grounds for these flatfish along this part of the Scottish coast.

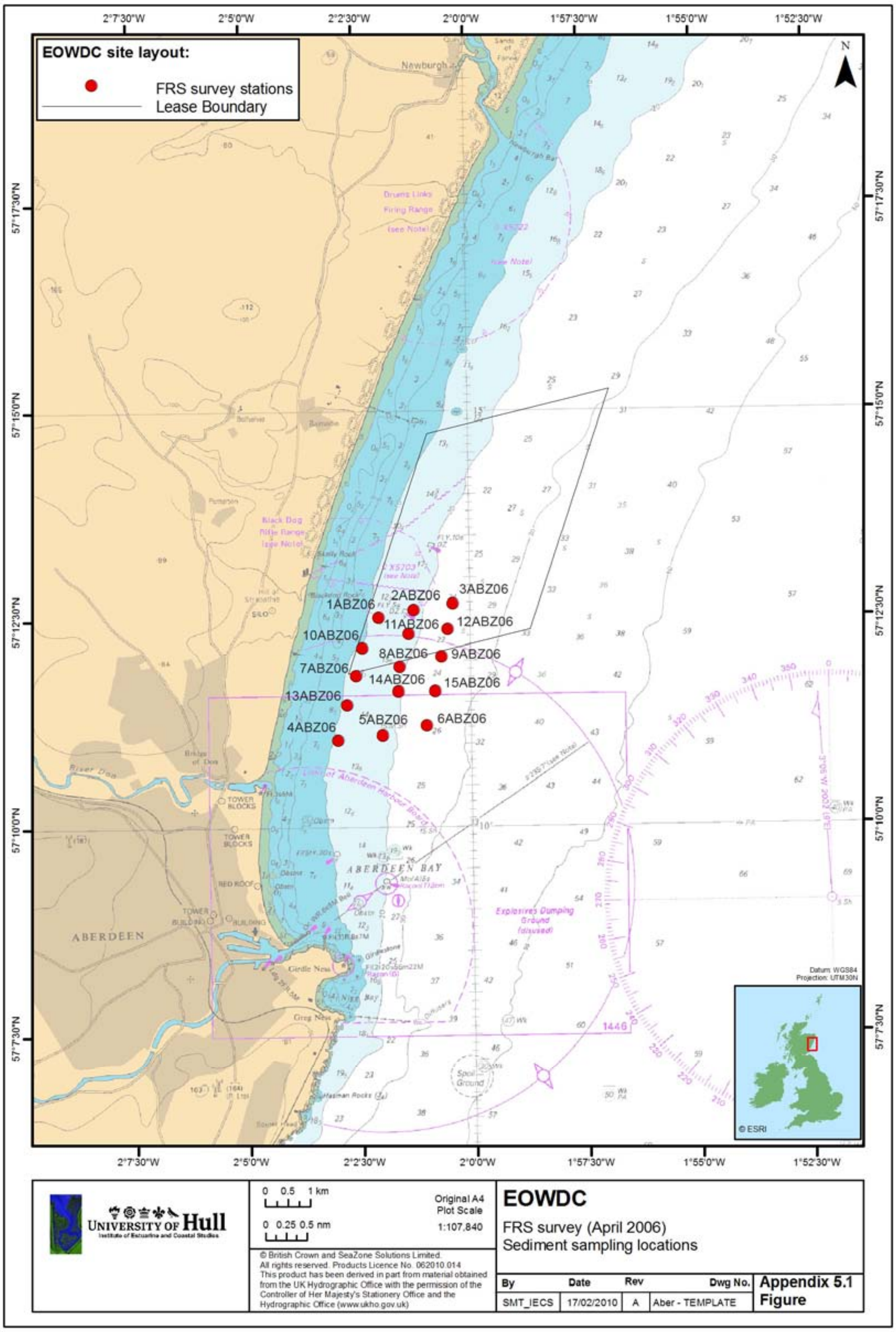
185 Although extensive spawning grounds for several species are known to be present along the east coast of Scotland, no specific spawning grounds are reported in the proposed EOWDC site. This seems to have been confirmed, e.g. for sandeel and herring, by the results of the epibenthic survey, which showed no significant abundances of the species in the trawl catches. This could also be explained by the preference of these species for coarser bottom sediments than those present in the proposed EOWDC site.

186 The wider east coast around Aberdeen displays a wide variety of habitats. Some of them are rare in a national and/or international context, or support important bird colonies, hence being designated as areas for conservational interest (SAC, SPA, Ramsar sites NNR and SSSI). However, no such areas are present within the proposed EOWDC area and in the close vicinity. Furthermore, designated species and habitats (except for the above mentioned UK BAP habitat sublittoral sands and gravels) have not been found in the site. No main conservation concerns have been identified for the area. However, the possibility that migration routes of Atlantic salmon and sea trout cross the proposed EOWDC site must be taken into account. A separate assessment of Atlantic salmon and sea trout has been undertaken.

5. Appendices

APPENDIX 5.1.

FRS BENTHIC SURVEY 2006 – LOCATION OF STATIONS AND RAW DATA



Sampling locations of the benthic survey carried out by FRS in 2006 (map drawn by IECS, based on FRS 2006 survey stations location).

Sediment contamination in Aberdeen Bay (FRS survey 2006) – PAH compounds.
All concentration values expressed in µg/kg dry weight. Latitude and longitude are expressed in degrees and decimals of degrees (WGS 84).

	1ABZ06	2ABZ06	3ABZ06	4ABZ06	5ABZ06	6ABZ06	7ABZ06	8ABZ06	9ABZ06	10ABZ06	11ABZ06	12ABZ06	13ABZ06	14ABZ06	15ABZ06
Latitude	57.2086	57.2100	57.2113	57.1840	57.1849	57.1868	57.1969	57.1986	57.2006	57.2024	57.2052	57.2061	57.1911	57.1938	57.1937
Longitude	-2.0340	-2.0210	-2.0064	-2.0495	-2.0330	-2.0166	-2.0425	-2.0263	-2.0108	-2.0401	-2.0228	-2.0084	-2.0460	-2.0269	-2.0133
Date Time	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06
Date Time	13:03:44	14:21:52	14:29:44	13:36:16	13:55:34	14:55:38	13:20:16	14:10:00	14:41:30	13:15:18	14:16:14	14:34:48	13:28:32	14:04:20	14:49:22
Depth (m)	13	18.0	24	6	17.0	24.0	11.0	18	24.0	11.0	18.0	24.0	10.0	18.0	24.0
Naphthalene		0.9			4.5	1.0	0.4		4.5	TR	10.3	3.4	0.5	1.8	0.9
Phenanthrene		9.0			42.9	8.4	2.2		37.8	0.4	153.4	14.6	1.8	11.7	3.4
Anthracene		2.4			10.6	1.8	0.7		8.8	ND	38.1	4.2	0.4	3.5	0.8
Fluoranthene		12.0			51.4	9.2	4.9		55.9	0.7	141.1	22.2	2.9	13.6	5.6
Pyrene		10.6			46.1	9.0	4.6		50.7	0.6	141.9	20.4	2.9	13.1	5.1
Benz[a]anthracene		5.5			25.9	4.2	2.7		29.1	0.4	62.0	10.2	1.5	6.4	2.9
Chrysene + Triphenylene		5.9			26.8	4.7	2.9		29.9	0.5	62.5	10.3	1.7	6.8	3.3
Benzofluoranthene		17.6			68.2	14.7	8.6		80.2	2.3	130.6	30.6	6.8	19.3	11.8
Benzo[a]pyrene		7.5			29.9	5.9	3.5		36.6	0.7	73.1	13.7	2.3	8.2	4.2
Indenopyrene		7.5			25.4	6.6	3.9		32.6	1.3	52.5	13.8	3.4	8.7	5.5
Benzoperylene		6.1			21.2	5.6	3.1		26.6	1.1	47.8	11.4	2.8	7.3	4.4
Acenaphthylene		0.2			0.4	0.3	TR		0.5	ND	0.3	0.2	ND	TR	TR
Acenaphthene		1.0			4.6	0.9	0.2		3.7	ND	32.9	2.4	0.2	1.7	0.3
Fluorene		1.1			5.2	1.0	0.2		3.6	TR	18.2	1.9	0.2	1.5	0.4
Dibenz[a,h]anthracene		1.20			4.50	1.00	0.60		5.60	0.20	9.00	2.30	0.50	1.40	0.80
TOTAL PAH		185.3			802.1	159.6	85.9		850.5	20.1	1732.2	360.9	68.3	223.6	116.4

ND, Not detected; TR, Trace.

Sediment contamination in Aberdeen Bay (FRS survey 2006) – Heavy metals.
All concentration values expressed in mg/kg dry weight. Latitude and longitude are expressed in degrees and decimals of degrees (WGS 84).

	1ABZ06	2ABZ06	3ABZ06	4ABZ06	5ABZ06	6ABZ06	7ABZ06	8ABZ06	9ABZ06	10ABZ06	11ABZ06	12ABZ06	13ABZ06	14ABZ06	15ABZ06
Latitude	57.2086	57.2100	57.2113	57.1840	57.1849	57.1868	57.1969	57.1986	57.2006	57.2024	57.2052	57.2061	57.1911	57.1938	57.1937
Longitude	-2.0340	-2.0210	-2.0064	-2.0495	-2.0330	-2.0166	-2.0425	-2.0263	-2.0108	-2.0401	-2.0228	-2.0084	-2.0460	-2.0269	-2.0133
Date Time	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06	7/4/06
Date Time	13:03:44	14:21:52	14:29:44	13:36:16	13:55:34	14:55:38	13:20:16	14:10:00	14:41:30	13:15:18	14:16:14	14:34:48	13:28:32	14:04:20	14:49:22
Depth (m)	13	18.0	24	6	17.0	24.0	11.0	18	24.0	11.0	18.0	24.0	10.0	18.0	24.0
As	4.27	4.41	5.04	4.16	5.02	6.06	4.44	4.38	4.81	4.22	4.83	4.84	4.32	5.02	4.95
Cd	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cr	14.09	15.01	20.72	13.80	16.85	13.86	14.42	14.85	18.29	16.97	19.98	16.28	14.18	12.62	13.47
Cu	2.01	2.88	4.58	2.22	3.68	3.25	2.04	3.11	4.17	2.54	3.81	3.78	2.64	2.75	2.74
Hg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.08	BDL	BDL
Ni	5.85	7.32	10.08	6.68	8.04	7.17	5.83	7.53	9.38	5.83	8.89	8.68	5.97	6.82	6.69
Pb	5.46	6.72	10.22	6.14	8.10	7.52	5.56	7.12	8.84	5.80	8.39	8.63	5.92	6.42	6.32
Zn	20.65	22.27	29.39	23.28	22.69	20.69	16.04	20.95	26.96	16.58	24.87	25.47	17.19	19.57	19.13

BDL, Below Detection Limits.

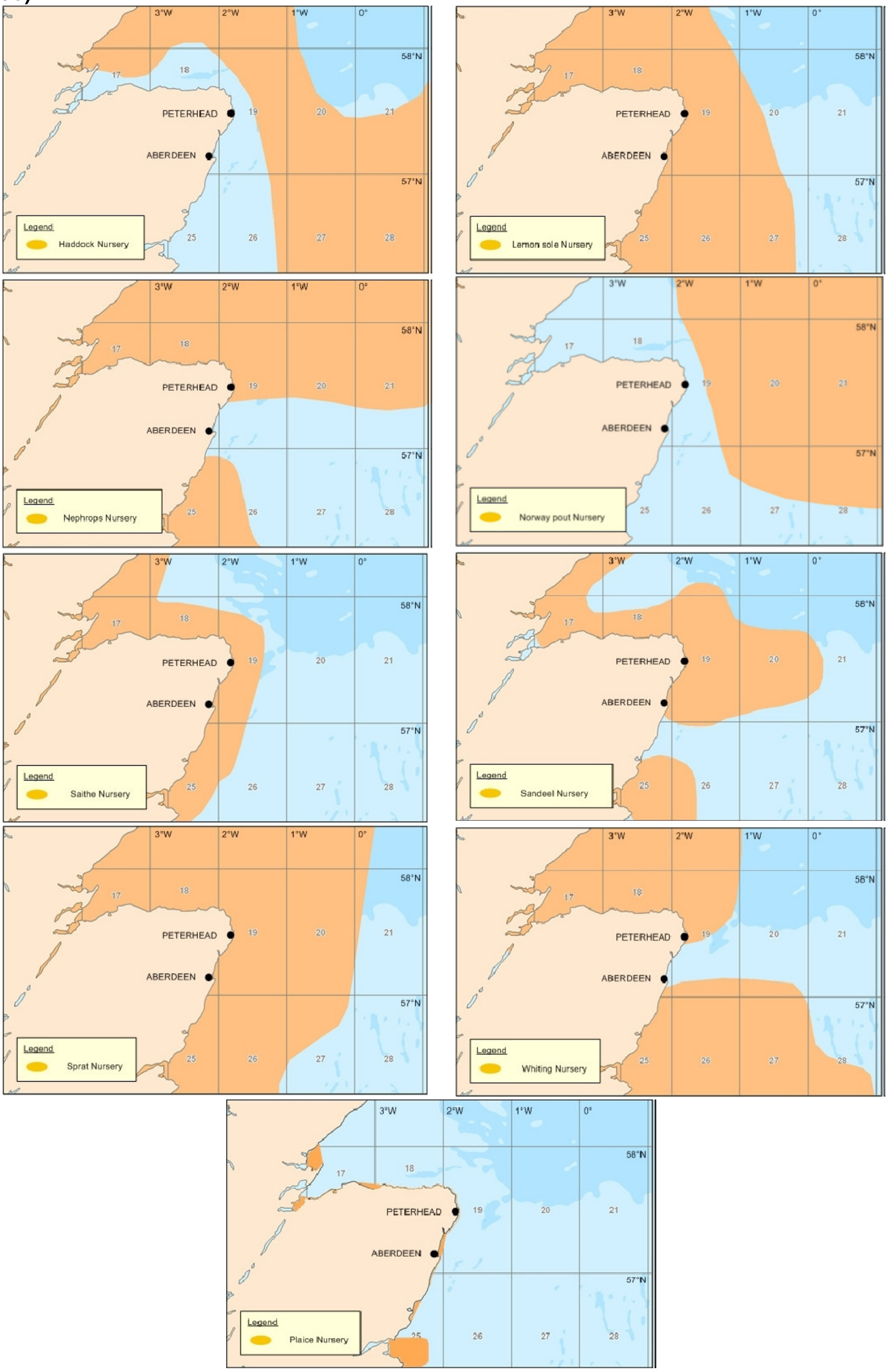
APPENDIX 5.2.

NURSERY AND SPAWNING GROUNDS

Broad nursery and spawning areas of fish and *Nephrops* are presented for the area off north-east Scotland, as from Coull *et al*. (1998).

Fish and *Nephrops* spawning grounds off north-east Scotland. Source: Coull *et al.* (1998)

Fish and *Nephrops* nursery grounds off north-east Scotland. Source: Coull et al. (1998)



APPENDIX 5.3.

CMACS LTD BENTHIC SURVEY 2010 – TECHNICAL REPORT V3 (FEB. 2011)

APPENDIX 5.4.

INTEGRATIVE ANALYSES CARRIED OUT BY IECS ON CMACS LTD 2010 BENTHIC DATA

5.4.1. Introduction

1 Additional analyses were carried out by IECS on the benthic data obtained during the CMACS Ltd survey in 2010, in order to update and integrate results of the CMACS Ltd Technical Report (Appendix 5.3).

5.4.2. Additional data analysis

2 Measured values and descriptive statistics for primary and derived biological parameters were calculated by IECS both for the survey area as a whole and for individual stations. The following biological parameters were calculated using PRIMER v. 6 (Plymouth Routines in Marine Ecological Research):

- The total number of species (S) at each station and for the survey area as a whole;

- Total abundance (A) of organisms expressed as individuals / 0.1 m^{-2} at each station;

- Abundance ratio (A/S) which gives an indication of the level of dominance of particular species within a community. Low values indicate a low number of organisms spread between a large number of species whereas high values indicate few species each with a large number of individuals (i.e. the community is dominated by very few species occurring at high abundances);

- Shannon-Wiener diversity (H'(log_2)), incorporating both species richness and evenness (a measure of the distribution of the individuals between the species):

  $$\mathbf{H' = - \sum p_i \log_2 p_i}$$

  Where,
  p_i = proportion of individuals in the ith species = n_i / N
  n_i = number of individuals of the ith species in the sample
  N = total number of individuals

  High values of H' indicate high diversity. Differences in the absolute values of the index obtained here with respect to those reported in the CMACS Ltd Technical Report (Appendix 5.2) likely arise from a different basis for the logarithm used in the H' index calculation (not specified in the CMACS Ltd Technical Report).

- Pielous Evenness index (J') gives a measure of the relative abundance of each species:

  $$\mathbf{J' = H' / \log_2 S.}$$

  Low values (close to zero) indicate that a community is dominated by one or few species and indicate low diversity. Communities where there is an even spread of the individuals between the species (J' values approaching 1) are considered to be diverse.

3 Description of the biological communities for individual stations and for the survey area as a whole was carried out by ranking the species in terms of their abundance, percentage contribution to the community (% dominance) and cumulative percent dominance.

4 Multivariate techniques allowing comparison of communities based on their component species and their relative importance in terms of abundance were also applied to faunal data. In order to complement multivariate analyses carried out by CMACS Ltd (namely cluster and MDS analyses, see Appendix 5.3) BIOENV was used to determine relationships between environmental and biological parameters in order to identify the combination of environmental variables best relating to community structure patterns. This procedure allows the calculation of rank correlations between the Euclidean distances of samples based on environmental variables and benthic community dissimilarity.

5.4.3. Results

5 The biological parameters for benthic fauna were variable, as demonstrated by the coefficient of variation values, ranging from 9.2 to 70.3% across the survey site, reflecting the variable and possibly mobile or frequently disturbed nature of the sediments (Table 1).

6 The number of species ranged from 10 at station 14 to 32 at station 12 with between 20 and 30 species being recorded from stations 4, 5, 8, 9 and 10 (Figure 1). The mean number of species recorded across the site is 18.3. Abundance values ranged from 17 individuals / 0.1 m^{-2} at station 14 to 145 individuals / 0.1 m^{-2} at station 8, with an average value of 60.43 individuals/0.1 m^{-2} (Figure 2).

7 Shannon-Weiner diversity (H'(log_2)) was highest at station 10 (H'=3.7) with diversity being greater than 3 at the majority of stations (Figure 3). Pielou's evenness (J') values ranged from 0.65 at station 8 to 0.95 at station 14 and all values were greater than 0.7 (Figure 4). These values, together with relatively low abundance ratio (A/S, Figure 5) indicate an even spread of the individuals between the species and that the communities are not dominated by one or very few species.

8 A total of 70 species were recorded from the survey area as a whole, most of them recorded in low numbers (Table 2). The top 85% abundance of the community was composed of 19 species and was dominated by the polychaete *N. latericeus* (85% frequency of occurrence) and brittle stars of the family Ophiuridae (93% frequency of occurrence, including juvenile individuals from the family Ophiuridae and from the genus *Ophiura*) which together accounted for 42% of the total benthic abundance (Table 2) and were present in abundances ranging from 1 to 46 individuals / 0.1 m^2. Other species present in notable abundances included the bivalves *N. nitidosa*, *T. fabula*, and the polychaetes *S. bombyx* and *G. oculata* (Table 2).

Table 1. Descriptive statistics for the biological parameters across the area as a whole (IECS analysis of data collected during CMACS Ltd Benthic Survey 2010).

	S	A	J'	H' (log_2)	A/S
Mean	18.29	60.43	0.83	3.33	2.96
Standard Error	1.83	11.36	0.02	0.08	0.32
Standard Deviation	6.84	42.49	0.08	0.31	1.20
Minimum	10.00	17.00	0.65	2.97	1.58
Maximum	32.00	145.00	0.95	3.76	5.58
%Coefficient of Variation	37.43	70.32	9.72	9.17	40.36

*S=Number of species; A= abundance; J' = Pielous evenness; H' (log_2) = Shannon-Weiner diversity; A/S = abundance ratio

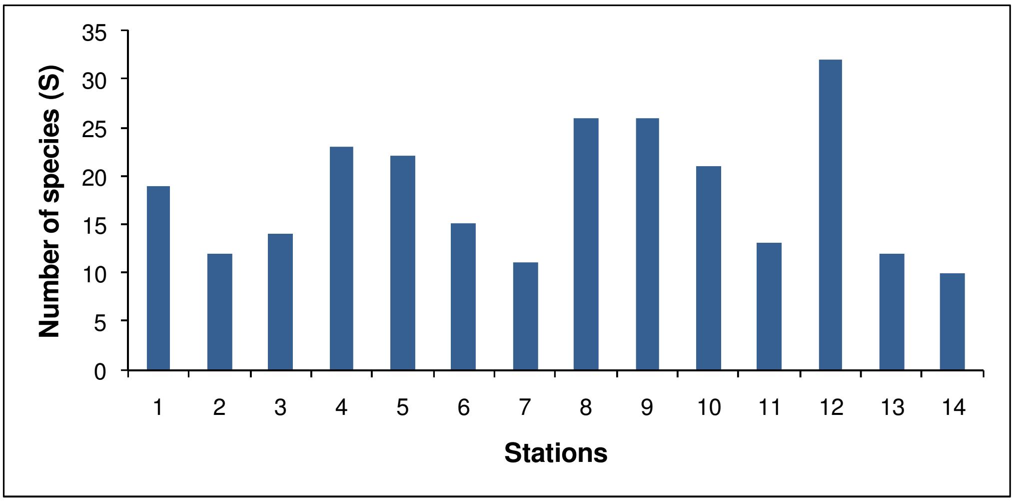


Figure 1. Number of species recorded from each sampling station across the site (IECS analysis of data collected during the CMACS Ltd Benthic Survey 2010; see Fig. 1 in Appendix 5.3 for station numbering).

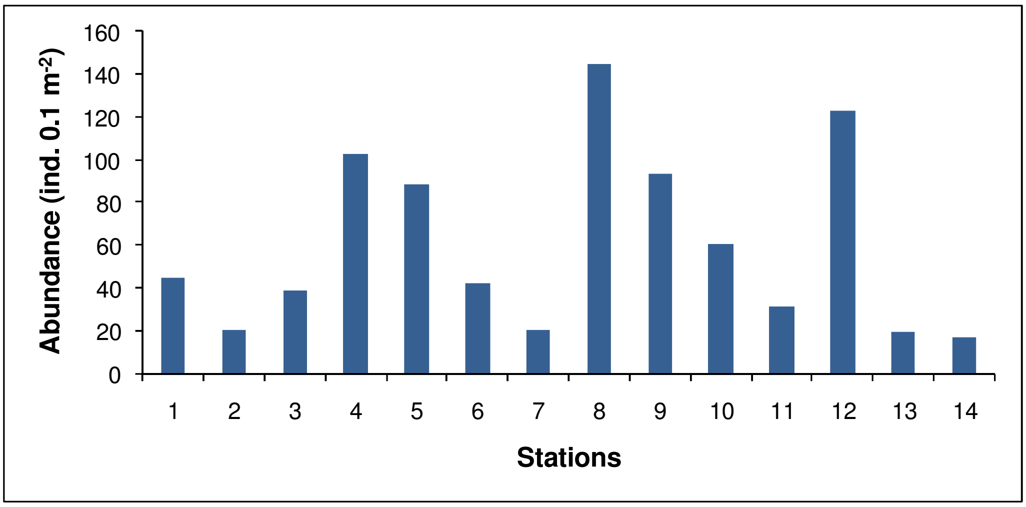


Figure 2. Abundance of individuals (A, individuals/0.1 m^{-2}) recorded from each sampling station across the site (IECS analysis of data collected during the CMACS Ltd Benthic Survey 2010; see Fig. 1 in Appendix 5.3 for station numbering).

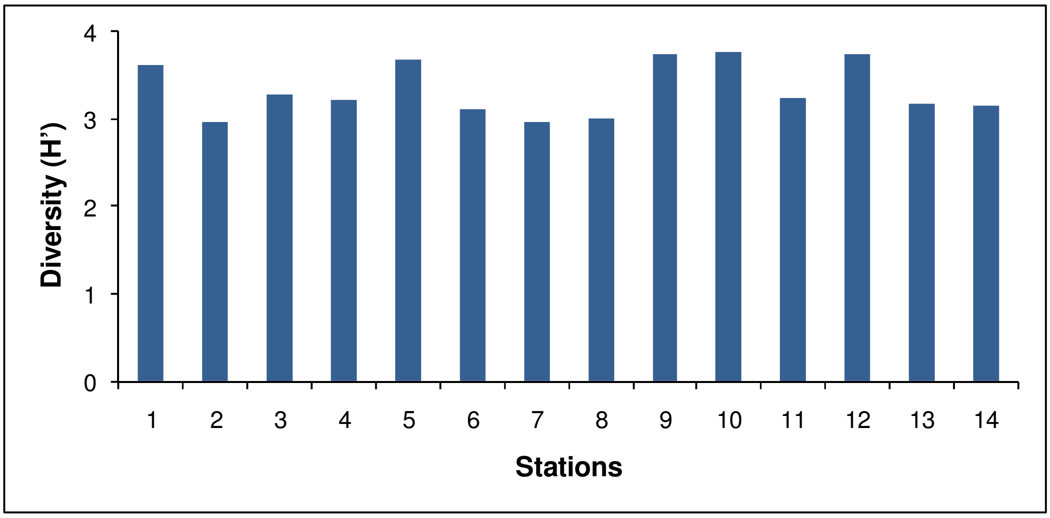


Figure 3. Shannon Weiner diversity (H'(log_2)) index for each sampling station across the site (IECS analysis of data collected during the CMACS Ltd Benthic Survey 2010; see Fig. 1 in Appendix 5.3 for station numbering).

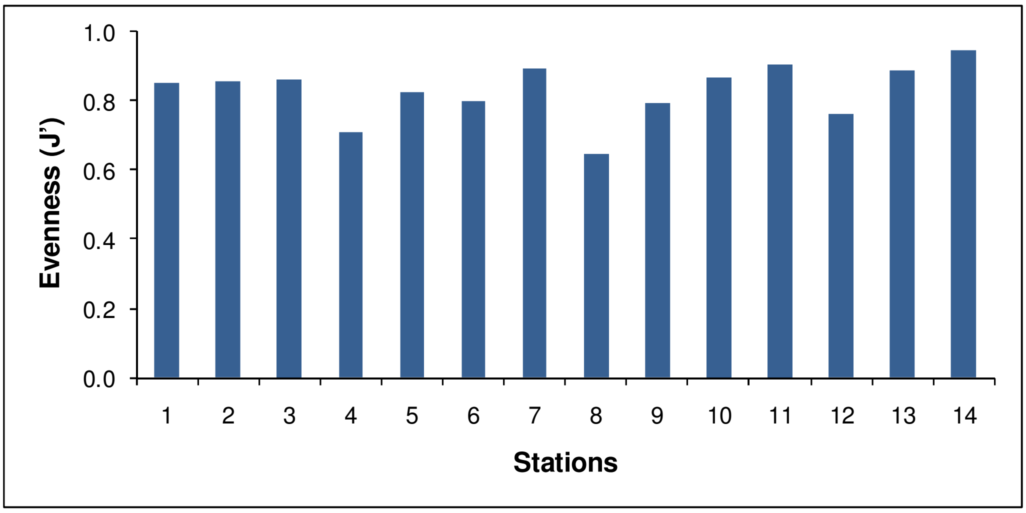


Figure 4. Pielou's evenness (J') for each sampling station across the site (IECS analysis of data collected during CMACS Ltd Benthic Survey 2010; see Fig. 1 in Appendix 5.3 for station numbering).

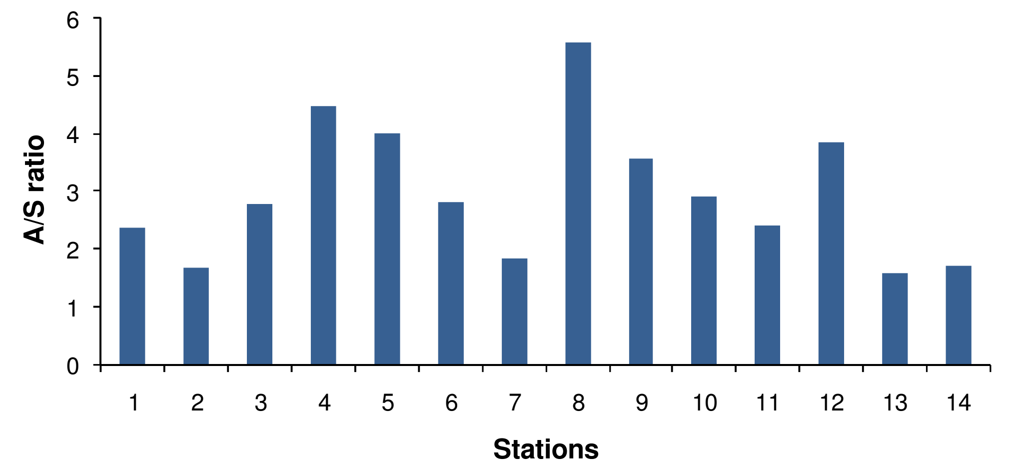


Figure 5. Abundance ratio (A/S) for each sampling station across the site (IECS analysis of data collected during CMACS Ltd Benthic Survey 2010; see Fig. 1 in Appendix 5.3 for station numbering).

Table 2. Abundance and dominance of the key (top 85%) infaunal species for the survey area as a whole (IECS analysis of data collected during CMACS Ltd Benthic Survey 2010).

Species	Taxonomic group	Total A*	% Dom*	Cum %*	FO %*
Notomastus latericeus	Polychaeta	243	28.7	28.7	85.7
Ophiuridae juv.**	Echinodermata	109	12.9	41.6	92.9
Nucula nitidosa	Bivalvia	67	7.9	49.5	92.9
Tellina fabula	Bivalvia	63	7.4	56.9	78.6
Spiophanes bombyx	Polychaeta	34	4.0	60.9	71.4
Galathowenia oculata	Polychaeta	27	3.2	64.1	50.0
Acrocnida brachiata	Echinodermata	23	2.7	66.8	57.1
Pholoe baltica	Polychaeta	22	2.6	69.4	50.0
Kurtiella bidentata	Bivalvia	15	1.8	71.2	57.1
Abra alba	Bivalvia	15	1.8	73.0	42.9
Nephtys cirrosa	Polychaeta	15	1.8	74.7	28.6
Nephtys assimilis	Polychaeta	14	1.7	76.4	64.3
Amphiura filiformis	Echinodermata	14	1.7	78.0	28.6
Nephtys sp. juv.	Polychaeta	11	1.3	79.3	42.9
Chamelea striatula	Bivalvia	11	1.3	80.6	42.9
Amphiuradae sp. juv.	Echinodermata	11	1.3	81.9	14.3
Bathyporeia guilliamsoniana	Amphipoda	10	1.2	83.1	28.6
Thyasira flexuosa	Bivalvia	8	0.9	84.1	35.7
Diastylis bradyi	Cumacea	7	0.8	84.9	42.9

*Total A – sum abundance values for all stations, % Dom – dominance, Cum % - cumulative %, FO % - frequency of occurrence

**Ophiuridae juv. – this contains Ophiuridae juv and *Ophiura* sp. Juv (these two taxa were analysed separately in the CMACS Ltd Technical Report, Appendix 5.3).

9 The two groupings of stations identified by the multivariate analyses carried out by CMACS Ltd (Appendix 5.3) were interpreted in the light of the assemblage species richness and of the main species contributing to the similarity within the two groups. For the purpose of clarity, stations 2, 13 and 14 were named “group B”, whereas the other stations were named “group A” (see Figures 17 and 18 in Appendix 5.3).

10 The richest community in terms of number of species and abundance was in group A, including 11 stations. The most impoverished community, in terms of the number of species and abundance, was in group B.

Table 3. Characteristic taxa within each cluster and frequency of occurrence across the proposed EOWDC site. Top 21 species in terms of abundance presented for group A, for group B all species included (IECS analysis on data from the CMACS Ltd Benthic Survey 2010).

Group A	Total Ab.	% Dom	FO %		Group B	Total Ab.	% Dom	FO %
Notomastus latericeus	241	30.5	91		*Nephtys cirrosa*	14	24.6	100
Nucula nitidosa	65	8.2	100		*Pontocrates altamarinus*	6	10.5	100
Tellina fabula	63	8.0	100		*Bathyporeia guilliamsoniana*	6	10.5	67
Ophiuridae juv.	58	7.3	91		*Bathyporeia elegans*	5	8.8	67
Ophiura sp. juv.	48	6.1	91		*Donax vittatus*	3	5.3	100
Spiophanes bombyx	33	4.2	82		Ophiuridae juv.	3	5.3	67
Galathowenia oculata	27	3.4	64		*Notomastus latericeus*	2	3.5	67
Acrocnida brachiata	23	2.9	73		*Pontocrates arenarius*	2	3.5	67
Pholoe baltica	22	2.8	64		*Nucula nitidosa*	2	3.5	67
Kurtiella bidentata	14	1.8	64		*Eteone longa/flava* (agg.)	2	3.5	33
Abra alba	14	1.8	45		*Nephtys assimilis*	1	1.8	33
Amphiura filiformis	14	1.8	36		*Nephtys hombergii*	1	1.8	33
Nephtys assimilis	13	1.6	73		*Spiophanes bombyx*	1	1.8	33
Nephtys sp. juv.	11	1.4	55		*Diplocirrus glaucus*	1	1.8	33
Chamelea striatula	11	1.4	55		*Atylus falcatus*	1	1.8	33
Amphiuradae juv.	11	1.4	18		*Iphinoe trispinosa*	1	1.8	33
Thyasira flexuosa	8	1.0	45		*Diastylis bradyi*	1	1.8	33
Ampelisca brevicornis	7	0.9	36		*Crangon allmanni*	1	1.8	33
Magelona johnstoni	7	0.9	27		*Kurtiella bidentata*	1	1.8	33
Ophiura ophiura	7	0.9	27		*Abra alba*	1	1.8	33
Scoloplos armiger	6	0.8	45		*Abra prismatica*	1	1.8	33

11 Stations of group A are located farther from the shore and characterised by fine muddy sand. This group contains 64 species, and the top 21 species in

terms of abundance. Predominant species of this group are the polychaete *N. latericeus*, which contributed over 30% into community, followed by the bivalves *N. nitidosa* and *T. fabula* and brittle stars of the family Ophiuridae (Table 3).

12 Stations of group B are located inshore and are characterised by fine-medium well-washed sand. This group is poor in terms of number of species (with a total number of species of 22) and abundance (Table 3). The most abundant taxa in this group is the polychaete *N. cirrosa* and amphipods, although still these taxa were recorded in very low numbers (Table 3).

13 The BIOENV test (based on all sediment physical parameters) indicated that the highest correlation between physical parameters and the species assemblages (r= 0.766) was with median mm grain size, % sand, % silt/clay and depth. Therefore, the patterns in the species distribution and communities appear to best relate to sedimentary and depth parameters.

14 The above results allowed the identification of two major biotopes in the survey area, as detailed in Appendix 5.3. According to the biotope descriptions provided in the CMACS Ltd Technical Report, these two biotopes are: SS.SSA.CMuSa.AalbNuc (*A. alba* and *N. nitidosa* in circalittoral muddy sand or slightly mixed sediment) and SS.SSA.IFiSa.NcirBat (*N. cirrosa* and *Bathyporeia* spp. in infralittoral sand) (an error in the legend of the biotope mapping in Figure 19 of the CMACS Ltd Technical Report was found, hence the amended map is provided in Figure 6 below).

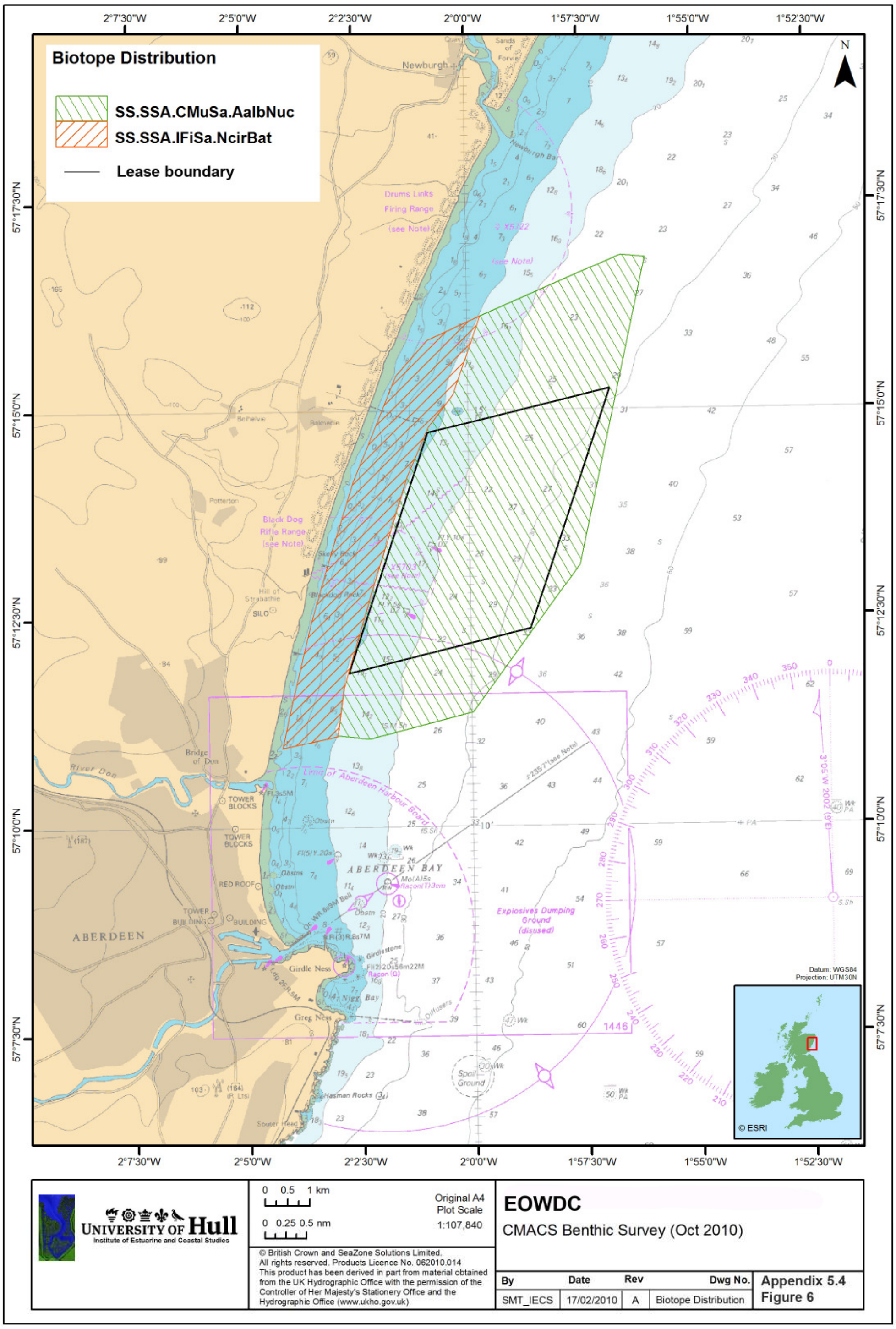


Figure 6. Biotope map showing the estimated extent of the two biotopes present (modified and redrawn from the CMACS Ltd Tecnical Report, Appendix 5.3).

APPENDIX 5.5.

MSS EPIBENTHIC SURVEY

The detailed methods and results of the epibenthic survey carried out by MSS in 2010 in the proposed EOWDC site are presented.

The data were provided by MSS and analysed by IECS.

5.5.1. Field sampling

1 MSS carried out an epibenthic survey in Aberdeen Bay in September 2010 on the FRV Alba Na Mara. Both data from video camera surveys and epibenthic trawls were obtained.

2 The TV tows were taken at 14 stations and trawl samples were taken from 7 locations. Most of the stations were located inshore, except for 6 stations (TV41, TV42, TV43, TV44, ABAG4 and ABAG5), which were located farther offshore (Figure 1).

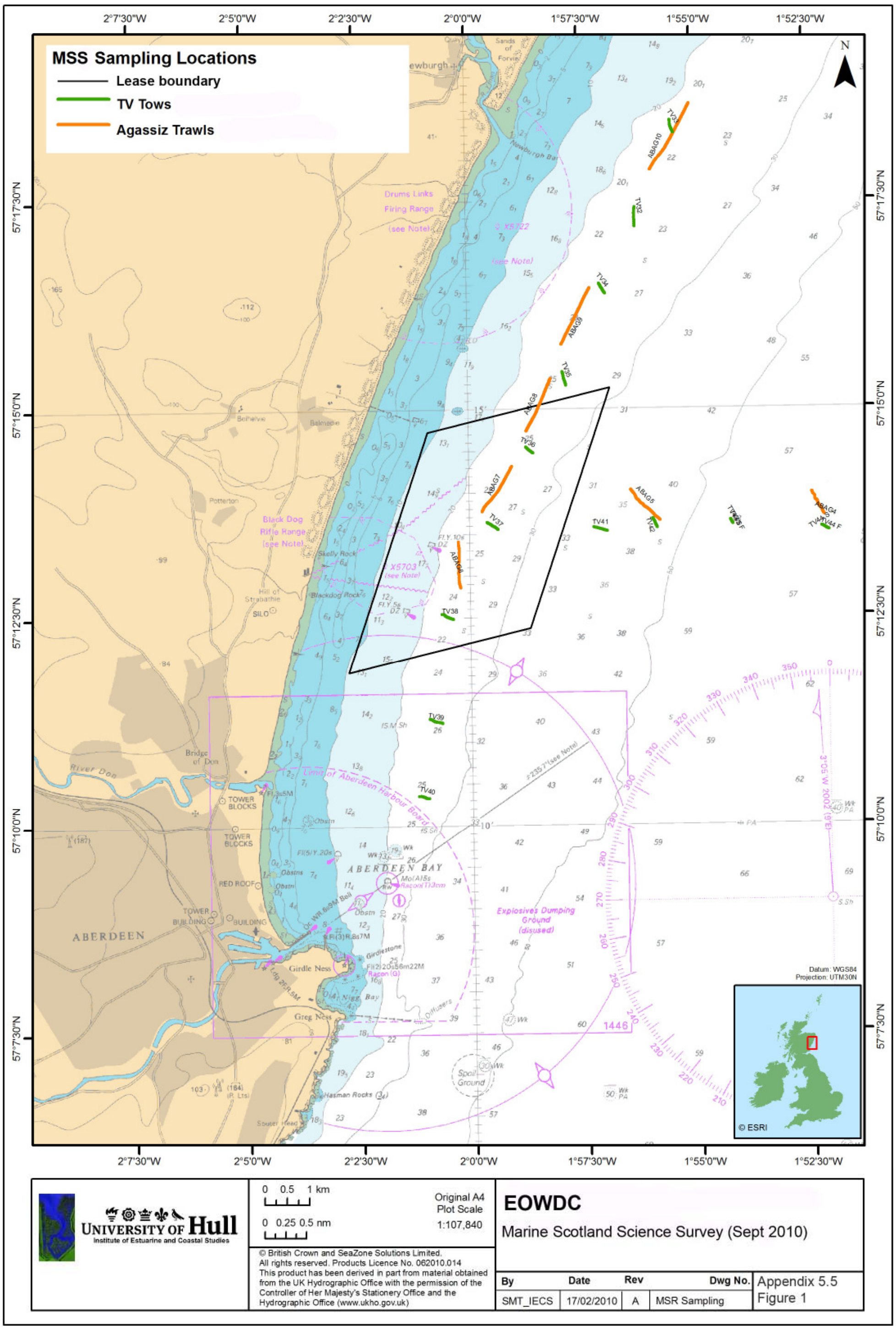


Figure 1. Trawl and video stations (MSS survey 2010).

3 The seabed video-footage was collected using a drop-frame TV system with video and digital still capabilities. The drop-frame was deployed with an armoured cable over the stern of the vessel typically steaming ahead at 1 knot into the tide or wind, whichever was the strongest. Once the drop-frame had reached the sea bed, a tow of typically ten to forty minutes duration was completed and the device then retrieved. The drop-frame was positioned approximately 1 m above the sea bed to ensure the best focal range for the digital camera. Vertical positioning of the drop frame is gauged by the deployment of a steel weight off the base of the drop frame which should only touch the sea bed surface. During deployment, a written record of macrobenthos, litter and sea bed type was recorded on an appropriate datasheet every minute. Digital stills were also recorded at approximately 1 minute intervals. Arc View was used to record the locations of the drop-frame TV and of the digital stills recorded during the tow. The video-footage was recorded directly onto DVD and the digital stills downloaded from the camera after the recovery of the drop-frame onto the vessel.

4 Epibenthic sampling was carried out by means of 2 m Agassiz trawl. It was deployed over the stern of the vessel while steaming ahead at between 1 and 2 knots. The Agassiz trawl was lowered to the seabed at a speed of up to 50 m per second. Once the Agassiz trawl had reached the sea bed, a tow of typically ten minutes duration was completed and then the Agassiz trawl was retrieved. The data on trawl position, vessel speed, towing direction and water depth were recorded using a datasheet and directly into Arc View. Once on deck, all animals were removed from the cod end and belly of the net and then transferred to the vessel's fish house for processing. All animals caught were identified, sorted and counted immediately on board the vessel. Non-biological material was thrown overboard during sorting.

5.5.2. Data analysis

MSS survey data were analysed by IECS.

5 Measured values and descriptive statistics for primary and derived biological parameters were presented both for the survey area as a whole and for individual stations. The following biological parameters were calculated using PRIMER v. 6 (Plymouth Routines in Marine Ecological Research):

- The total number of species (S) at each station and for survey area as a whole;
- Total abundance (A) of organisms expressed as individuals / 0.1 m^{-2} at each station;
- Shannon-Wiener diversity (H'(log_2)), incorporating both species richness and evenness (a measure of the distribution of the individuals between the species).

  $$H' = -\sum p_i \log_2 p_i$$

  Where,
  p_i = proportion of individuals in the ith species = n_i / N
  n_i = number of individuals of the ith species in the sample
  N = total number of individuals

  High values indicate high diversity.

- Pielou's Evenness index (J') gives a measure of the relative abundance of each species:

  $J' = H' / \log_2 S$.

  Low values (close to zero) indicate that a community is dominated by one or few species and indicate low diversity. Communities where there is an even spread of the individuals between the species (J' values approaching 1) are considered to be diverse.

6 Description of the biological communities for individual stations and for the survey area as a whole was carried out by ranking the species in terms of their abundance.

7 Multivariate techniques were also applied, allowing comparison of communities based on their component species and their relative importance in terms of abundance. Such techniques enable the interpretation of large data sets as a whole rather than examination of different components individually. Calculation of the Bray-Curtis similarity coefficient gives the percentage similarity between each pair of samples (i.e. all samples are compared with each other) and can be plotted in the form of a dendrogram, or an ordination plot (using Multi Dimensional Scaling) so that groups of samples with distinct community structures can be identified.

8 Multivariate analysis was carried out on the trawl data using the PRIMER v6.0 program to determine difference in epifaunal community structure between sample stations, particularly between those inside and outside the proposed EOWDC area. Sample data were fourth-root transformed prior to analysis, to reduce the effect of dominant species. A multi-dimensional scaling (MDS) diagram was generated to visualize the similarity among sites.

5.5.3. Results

9 The detailed results from the video analysis are presented in Appendix 5.6. The video footage from the inshore stations (TV32 to TV40) showed very similar characteristics of the sea bed. At all videos from these sites, the high current speed, large amount of organic matters and significant amount of silt/clay content was recorded. Due to the high sediment load, a very poor diversity of epifauna was observed. Brittle stars *Ophiura* sp. were observed in high numbers, but it was difficult to enumerate them using the video footage due to the poor visibility. Some fish species, mostly plaice and common dab were also detected. Sediments were mainly composed of fine sand, silt/clay and shell fragments. Sand ripples on the sea bed were also noticeable. No seaweed was recorded at these stations.

10 The sediments at stations TV41 and TV42 were very similar to those described above, but with greater content of shell fragments. Current speed at these stations was somewhat slower, and sand ripples were very noticeable. Species of brittle stars and common starfish *Asterias rubens* were recorded on the sea bed.

11 Mixed types of sediments were recorded further offshore (stations TV43 and TV44), with coarse sediments, stones, pebbles and boulders with silt/clay particles detected at these stations (Appendix 5.6). A relatively slow current

speed was present and the water was clear. Common starfish, bryozoans *Flustra foliacea* and dead man's fingers *Alcyonium digitatun* were present in large numbers at these stations. Attached epifaunal species (anemones, bryozoans, sponges) were also notable on the video footage (Appendix 5.6).

12 In total 14 species of fish, 7 species of decapods and 8 species of other invertebrates were recorded in trawl samples (raw data are provided in Appendix 5.7).

13 Fish accounted for 30% of the overall abundance in the trawl catches, with the predominant species being common dab *Limanda limanda* and plaice *Pleuronectes platessa* (Figure 2). These species were recorded in particularly high numbers (total of 823 and 510 individuals respectively) at the inshore stations (Appendix 5.7). Norway pout *Trisopterus esmarki* was also abundant, but only at station ABAG10 (240 individuals) (Appendix 5.7). Other species were recorded with lower abundances.

14 Crustacea accounted just for 1% of the overall abundance in the trawls catches, with the predominant species being harbour crab *Liocarcinus depurator* and circular crab *Atelecyclus rotundatus* (Figure 2).

15 Sixty-nine percent of the overall trawl catch abundance was accounted for by other invertebrate species, with brittle stars being the predominant taxon (Figure 2).

16 Low numbers of fish species and abundance were generally recorded at the offshore stations, although decapods occurred with a higher number of species and abundance in these areas (particularly at station ABAG4) (Figures 3 and 4). At inshore stations large numbers of brittle stars and common starfish were present (Figure 4, Appendix 5.7). The largest number of common starfish was recorded at the furthest offshore station ABAG4, and was also observed from the video analysis for this station. Higher species diversity and evenness values were found at offshore stations ABAG5 and ABAG4, as well as at station ABAG10 (Figures 5 and 6).

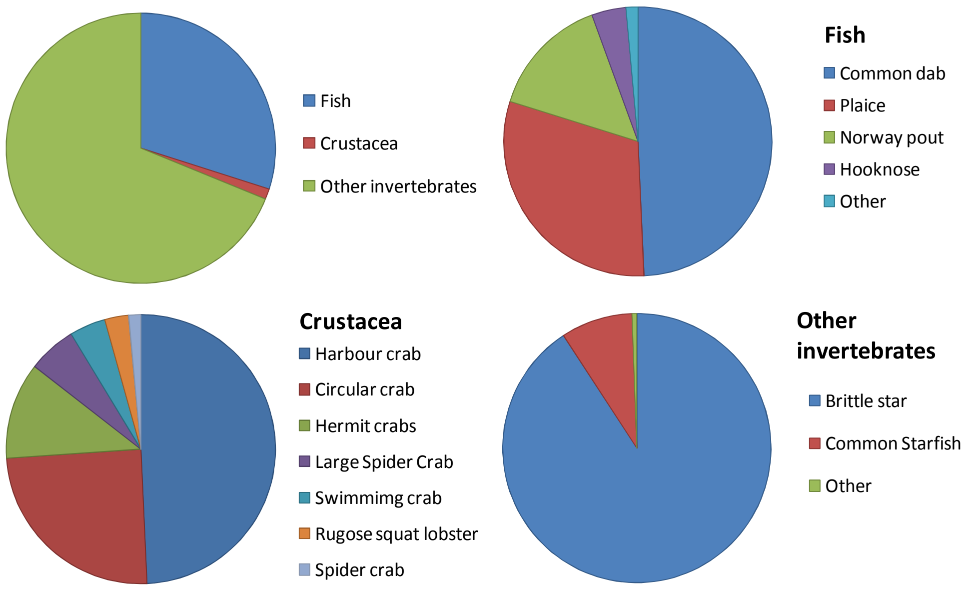


Figure 2. Overall composition (% abundance) of the epibenthic trawl catches carried out by Marine Scotland Science (September 2010).

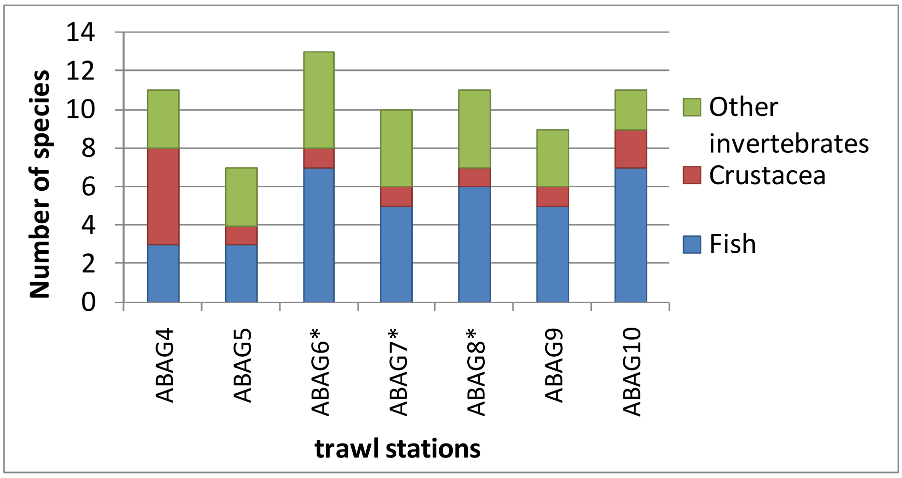


Figure 3. Number of species in the epibenthic trawl catches carried out by MSS (September 2010) at the 7 stations in Aberdeen Bay (asterisks indicate trawls inside the proposed EOWDC area).

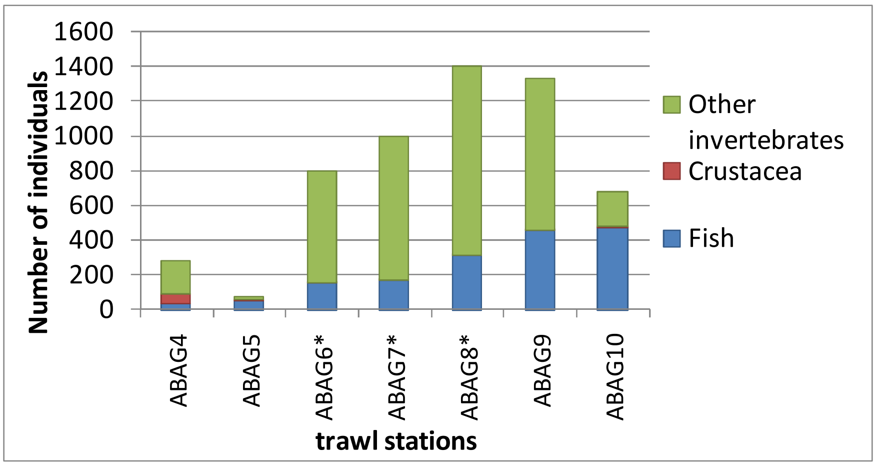


Figure 4. Total abundance in the epibenthic trawl catches carried out by MSS (September 2010) at the 7 stations in Aberdeen Bay (asterisks indicate trawls inside the proposed EOWDC area).

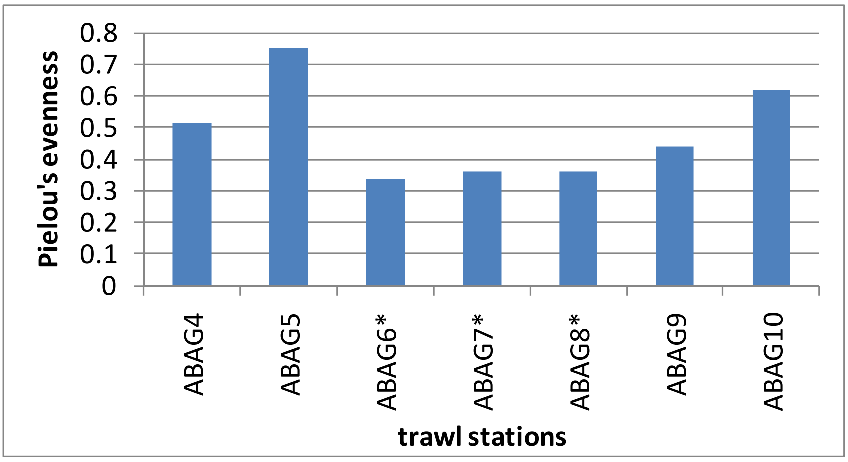


Figure 5. Pielou's evenness index measured on the epibenthic trawl catches carried out by MSS (September 2010) at the 7 stations in Aberdeen Bay (asterisks indicate trawls inside the proposed EOWDC area).

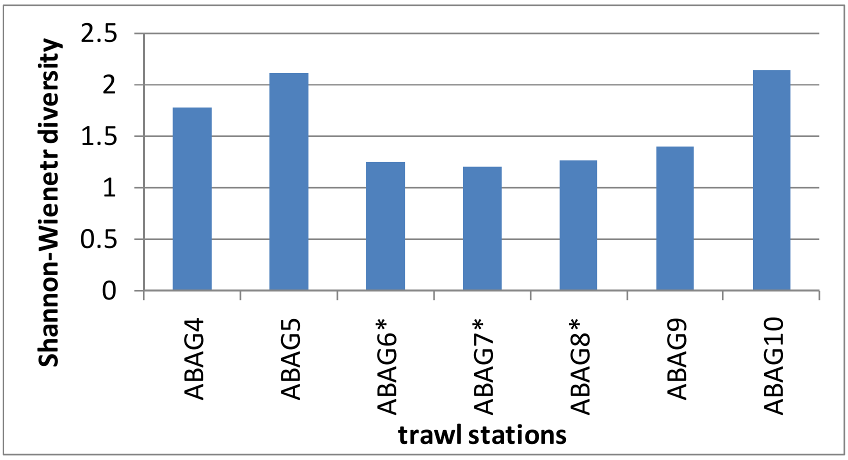


Figure 6. Pielou's evenness index measured on the epibenthic trawl catches carried out by MSS (September 2010) at the 7 stations in Aberdeen Bay (asterisks indicate trawls inside the proposed EOWDC area).

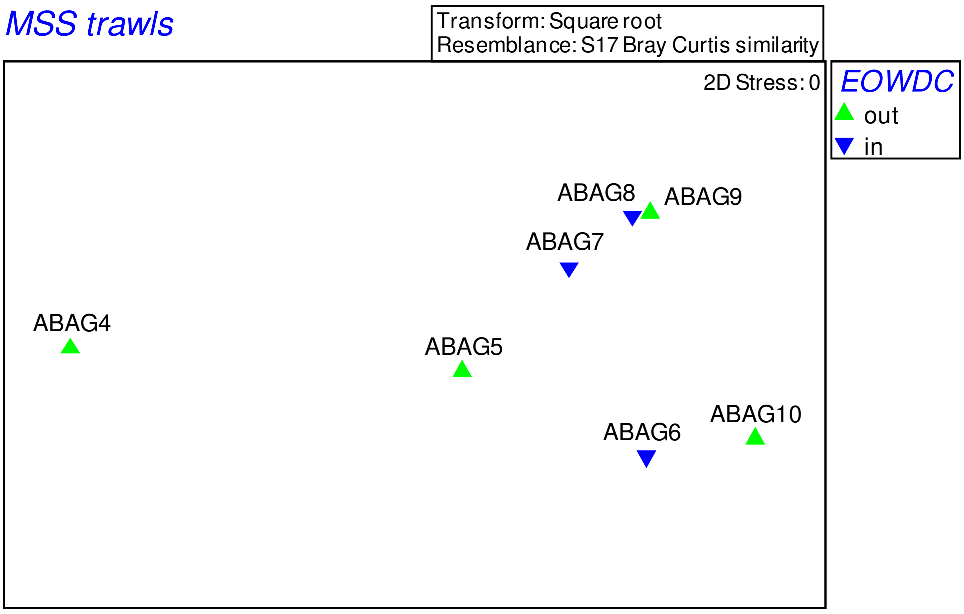


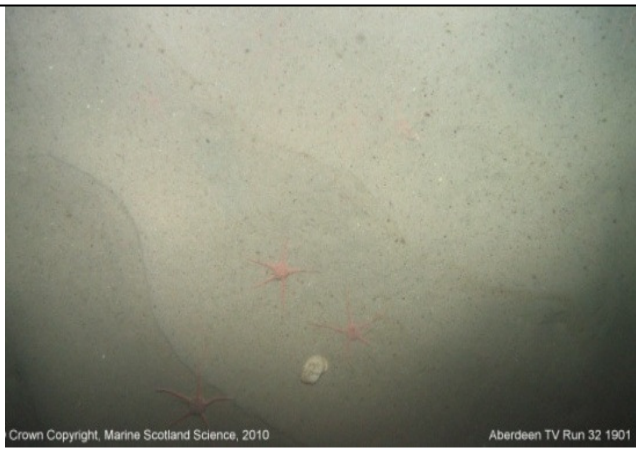
Figure 7. MDS plot (√√ transformed) based on the species abundance composition at each station (distinguished by their location inside or outside the proposed EOWDC area) (MSS epibenthic survey 2010).

17 The Multi Dimensional Scaling (MDS) diagram, representing similarities among stations according to the structure of epibenthic assemblages (in terms of species abundance) is shown in Figure 7. No major differences were detected between stations located inside the proposed EOWDC area, and those outside. In turn, station ABAG4, located farther offshore (Figure 1), showed an epibenthic assemblage well distinguished from the assemblage in the other stations. This result was mainly ascribed to the higher abundance of hooknose, harbour and circular crabs, and of common starfish present at the station, as well as to a lower abundance of flatfishes (common dab and plaice) and brittle stars compared to the other stations, and this can be related to the differences in depth and distance from the shore.

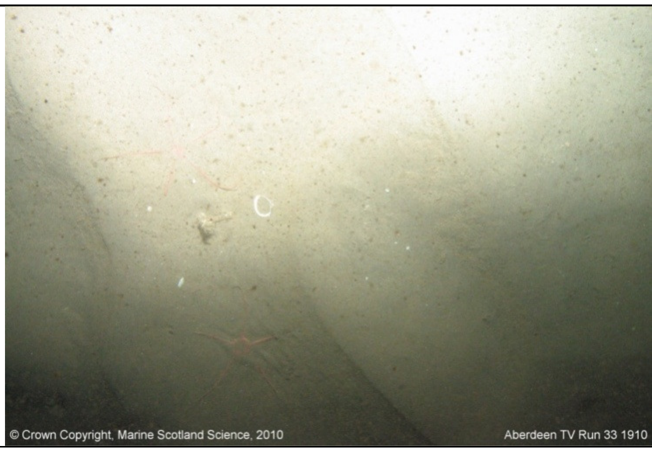
APPENDIX 5.6.

MSS EPIBENTHIC SURVEY 2010 – ANALYSIS OF VIDEO RUNS

VIDEO NO.	**TV32: 15/09/2010**
Duration (mins)	10
Summary	High current speed, large amount of Suspended Organic Solids. *Ophiura* sp. present, but hard to see them on the video footage due to muddy water. Some shell material and dead shells on the sea bed. Sand ripples, fine muddy sand, no weed
Real time	
17.19	*Asterias rubens* x 1
17.19	Plaice
17.21 17.26	*Asterias rubens* x 5
17.26	Plaice or dab x 1
17.27	*Asterias rubens* x 1
17.27	Plaice or dab x 1
17.28	Plaice or dab x 1; *Asterias rubens* x 1



VIDEO NO.	**TV33: 15/09/2010**
Duration (mins)	10
Summary	High current speed, large amount of Suspended Organic Solids. Camera jumps, very bad visibility. Sediments are as described above.
Real time	
17.47	Plaice x 1
17.47	Pisces indet. x 1
17.48	*Asterias rubens* x1
17.50	Plaice or dab x 2
17.53	*Ophiura* sp. x 6
17.54	Plaice or dab x 1
17.55	Plaice or dab x 1



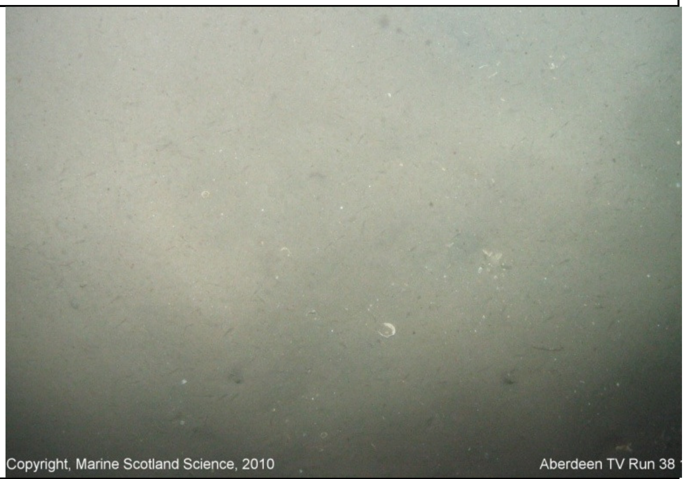
VIDEO NO.	**TV34: 16/09/2010**
Duration (mins)	10
Summary	High current speed. Sediments are as described in video 32.
Real time	
7.24 7.25	*Asterias rubens* x 4
7.26	Plaice or dab x 1
7.28	Crustacea indet.
7.29	*Asterias rubens* x 3
7.30	Plaice x 1
7.31	*Asterias rubens* x 2

VIDEO NO.	**TV35: 16/09/2010**
Duration (mins)	10
Summary	High current speed. Sediments are as described in video 32.
Real time	
7.47	Common dab x 1
7.49	*Asterias rubens* x 1
7.49	Plaice x 1
7.49	*Asterias rubens* x 1
7.50	Plaice x 2
7.50 7.51	Plaice or dab x 2
7.51	*Asterias rubens* x 1
7.51	Plaice x 1
7.51	Common dab x 1
7.53	*Asterias rubens* x 2
7.54	Common dab x 1
7.54	*Asterias rubens* x 3
7.55	Common dab x 2
7.56	See weed?
7.56	*Asterias rubens* x 1

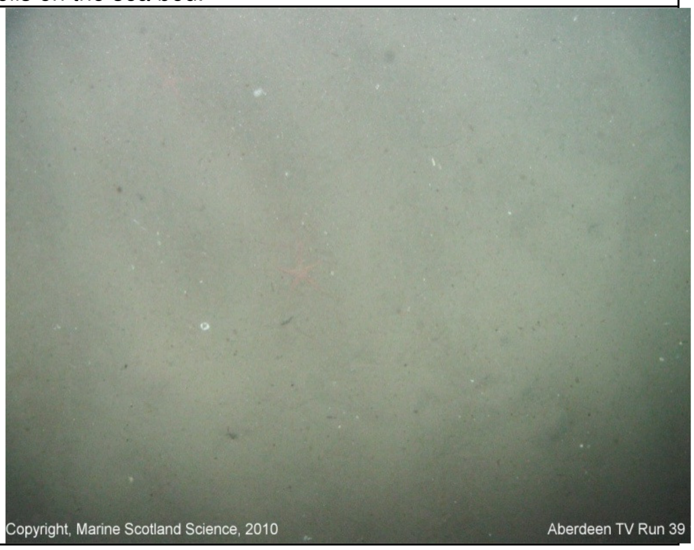
VIDEO NO.	**TV36: 16/09/2010**
Duration (mins)	10
Summary	High current speed. Sediments are as described in video 32.
Real time	
8.12	*Asterias rubens* x 1
8.13	Plaice or dab x 1
8.13	*Asterias rubens* x 1
8.14	Plaice or dab x 1
8.15	*Asterias rubens* x 1
8.16	Empty razor shells
8.18	Plaice or dab x 1
8.20	*Asterias rubens* x 3
8.20	*Solea solea* x 1
8.21	*Asterias rubens* x 1
8.21	Plaice or dab x 1
8.21	*Asterias rubens* x 1
8.21	Plaice or dab x 1

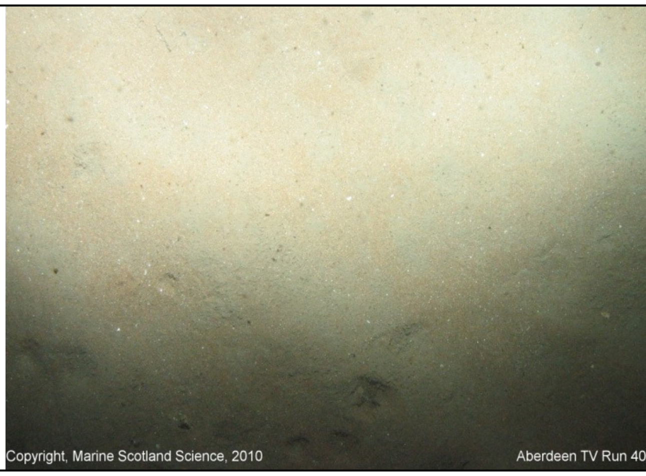
VIDEO NO.	**TV37: 16/09/2010**
Duration (mins)	10
Summary	High current speed, large amount of Suspended Organic Solids. *Ophiura* sp., *Asterias rubens* and *Flustra folicea* spread widely, but not clear on the video footage due to very muddy water. Some shell material and dead shells on the sea bed. Sand ripples, fine muddy sand, no weed.
Real time	
8.39	Crustacea indet.
8.39	*Asterias rubens* x 1
8.39	*Flustra foliacea*
8.40	Common dab x 1
8.40	Plaice or dab x 1
8.40	*Asterias rubens* x 1
8.41	Plaice or dab x 1
8.41	Common dab x 1
8.42	*Asterias rubens* x 4
8.42	Common dab x 1
8.42 8.43	*Asterias rubens* x 3
8.43	Crustacea indet.
8.43	Pipe fish
8.43 8.44	*Asterias rubens* x 2
8.44	Razor shells x 1
8.44 8.46	*Asterias rubens* x 5
8.46	Common dab x 1
8.47	*Asterias rubens* x 1
8.47	Razor shells x 1
8.48	*Asterias rubens* x 1

VIDEO NO.	**TV38: 16/09/2010**
Duration (mins)	10
Summary	Large amount of Suspended Organic Solids. Water is very muddy. Silt/clay type sediment on the surface, some burrows are visible. Some shell material and dead shells on the sea bed.
Real time	
9.04	Common dab x 2
9.06 9.08	*Asterias rubens* x 7
9.08	Common dab x 1
9.09	*Asterias rubens* x 2
9.12	Asterias rubens x 1; Razor shells x 1
9.14	*Asterias rubens* x 2
9.14	Echinodermata indet.

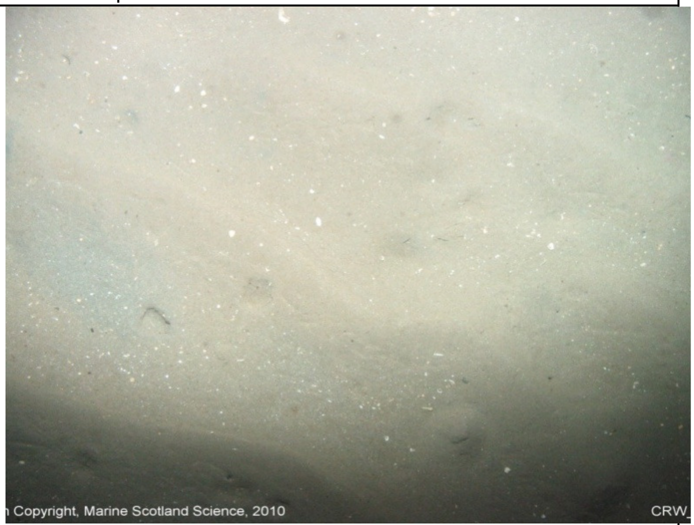


VIDEO NO.	**TV39: 16/09/2010**
Duration (mins)	10
Summary	Large amount of Suspended Organic Solids. Water is very muddy. Silt/clay presented on the sediments surface, fine sand sediments, sand ripples. Some shell material and dead shells on the sea bed.
Real time	
9.31	Common dab x 1
9.32	Plaice or dab x 3
9.34	Pisces indet. x 1
9.34 9.36	*Asterias rubens* x 5
9.36	Plaice or dab x 1
9.38	Razor shells x 1
9.38	Plaice or dab x 1
9.39	Ohiuroidea spp.
9.39	*Asterias rubens* x 1



VIDEO NO. Duration (mins)	**TV40: 16/09/2010** 8	
Summary	Large amount of Suspended Organic Solids. Water is very muddy. Silt/clay type sediment on the surface, fine sand sediments. Some shell material and dead shells on the sea bed.	
Real time		
9.55	*Asterias rubens* x 1; Whelk (Buccinum sp.)	
9.56	*Asterias rubens* x 1	
9.56	Decapoda indet.	
9.57	Common cockle?	
10.01	*Asterias rubens* x 1	
10.02	Crustacea indet.	
VIDEO NO. Duration (mins)	**TV41: 16/09/2010** 10	
Summary	Very similar sediments as above, large amount of Suspended Organic Solids. Silt/clay and fine sand on the sediment surface. Some shell material and dead shells on the sea bed. Species of *Ophiura* sp. and *Asterias rubens* present on the surface.	
Real time		
11.02	Ohiura sp.	
11.03	Gastropod x 1	
11.03 11.05	*Asterias rubens* x 5	
11.08	Razor shells x 1	
11.08	Sea urchin?	
11.09	*Asterias rubens* x 1	
11.10	*Ohiura* sp.	
11.10 11.12	*Asterias rubens* x 5	
11.12	*Ohiura* sp. X 2	

VIDEO NO.	**TV42: 16/09/2010**
Duration (mins)	10
Summary	The sediment is mostly the same type as described above, but slightly darker in colour. Relatively slow current speed.
Real time	
11.23	*Asterias rubens* x1; Decapoda indet. x 1
11.24	*Asterias rubens* x5
11.25	Crustacea? x 1
11.25	Whelk (Buccinum)
11.25	*Asterias rubens* x 2
11.27	*Flustra foliacea* x 1
11.27	*Asterias rubens* x 1
11.27	*Ohiura* sp. x 1
11.27	*Asterias rubens* x 1
11.28	*Flustra foliacea* x 1
11.28	*Asterias rubens* x 6
11.29	*Flustra foliacea* x 1
11.30	*Asterias rubens* x 1
11.30	Sponge?
11.31	*Asterias rubens* x 1
11.31	*Ohiura* sp. x 1
11.31 11.33	*Asterias rubens* x 6



VIDEO NO.	**TV43: 16/09/2010**	
Duration (mins)	10	
Summary	Mostly coarse sediments, stones, pebbles and boulders presented. Silt/clay particles covering coarse sediments. Relatively slow current speed, some attached epifauna present (Anemones, bryozoans, sponges), large amount of corals (*Alcyonium digitatun*) and sea stars.	
Real time		
11.46	*Alcyonium digitatun* x 2	
11.46	*Alcyonium digitatun* x 2; Echinodermata? x 1	
11.46 11.48	*Asterias rubens* x12; *Alcyonium digitatun* x10; *Flustra foliacea* x 2; Actiniaria indet.x 1	
11.48 11.51	*Asterias rubens* x 21; *Alcyonium digitatun* x 19; *Flustra foliacea* x 1; Crustacea indet. x 3; Whelk x 1;	
11.51 11.55	*Asterias rubens* x 23; *Alcyonium digitatun* x 43; *Flustra foliacea* x 14?	

VIDEO NO.	**TV44: 16/09/2010**
Duration (mins)	10
Summary	Coarse sediments, pebbles and stones, mixed types of sediments. Moderate currents speed, some attached epifauna recorded (Anemones, bryozoans), large amount of sea stars *Asterias rubens*.
Real time	
12.12 12.17	*Asterias rubens* x 137; *Alcyonium digitatun* x 10; *Flustra foliacea* x 4; *Ohiura* sp. x 1; Decapoda indet. x 2; *Cancer pagurus* x 1;
12.18 12.19	*Asterias rubens* x 50; *Alcyonium digitatun* x 7; *Flustra foliacea* x 3
12.20	*Asterias rubens* x 41; *Alcyonium digitatun* x 11; *Flustra foliacea* x7
12.21	Pectinidae spp. x 1

APPENDIX 5.7.

MSS EPIBENTHIC TRAWL SURVEY 2010 – RAW DATA

Epifaunal composition from trawl survey (MSS survey 2010).

Common Name	**Species name**	**ABAG4**	**ABAG5**	**ABAG6**	**ABAG7**	**ABAG8**	**ABAG9**	**ABAG10**	**Totals**
Fish									
Common dab	*Limanda limanda*	4	20	80	90	211	331	87	823
Plaice	*Pleuronectes platessa*		31	60	70	92	123	134	510
Norway pout	*Trisopterus esmarki*					2	2	240	244
Hooknose	*Agonus cataphractus*	34	5	11	12	5	2		69
Long rough dab	*Hippoglossoides platessoides*						2	5	7
Flounder	*Platichthys flesus*			1				4	5
Cod	*Gadus morhua*					1		2	3
Greater pipefish	*Syngnathus acus*			1	1				2
Red Gurnard	*Aspitrigla cuculus*					2			2
Whiting	*Merlangius merlangus*			1					1
Cuckoo Ray	*Raja naevus*			1					1
Dragonet	*Callionymus lyra*	1							1
Long spined scorpionfish	*Paracentropogon longispinis*				1				1
Long-spined Bullhead	*Taurulus bubalis*							1	1
Crustacea species									
Harbour crab	*Liocarcinus depurator*	30				1		3	34
Circular crab	*Atelecyclus rotundatus*	17							17
Hermit crabs	*Pagarus* sp.	2		2				4	8
Large Spider Crab	*Inachus* sp.	4							4
Swimming crab	*Necora puber*		2		1				3
Rugose squat lobster	*Munida rugosa*	2							2
Spider crab	*Macropodia deflexa*						1		1
Other species									
Brittle star	*Ophiura albida*		2		780	1040	850		2672
Brittle star	Ophiuroida			619				200	819

Common Name	Species name	ABAG4	ABAG5	ABAG6	ABAG7	ABAG8	ABAG9	ABAG10	Totals
Common Starfish	*Asterias rubens*	183	13	16	42	52	24	3	333
Common heart urchin	*Echinocardium cordatum*		1	5	4	1	2		13
Sea urchin	*Psammechinus miliaris*	4							4
Astrapecten	*Astropecten polyacanthus*			1	1	1			3
Whelk	*Neptunea* sp.	1							1
Sea mouse	*Aphrodite aculeata*			1					1

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European Offshore Wind Deployment Centre

Environmental Statement

Appendix 9.2: Marine Ecology, Intertidal Ecology, Sediment and Water Quality EIA Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

1 MARINE ECOLOGY, INTERTIDAL ECOLOGY AND SEDIMENT AND WATER QUALITY

1 The Institute of Estuarine and Coastal Studies (IECS, University of Hull) was commissioned by Aberdeen Offshore Wind Farm Limited (AOWFL) to undertake the Environmental Impact Assessment (EIA) for the proposed European Offshore Wind Deployment Centre ("EOWDC"). The EIA process described in this report provides a description of the potential impacts of construction, operation and decommissioning upon the benthic ecology and fish communities within the proposed development area. A summary of the baseline data is also provided with detailed information presented in Section 1.1.1.

1.1 Information for the Non-Technical Summary

1.1.1 Background

2 This report assesses the possible environmental impacts of the proposed EOWDC off the coast of Aberdeen on the marine ecology of the area. The assessment process involves a review of the potential development options and assesses the option with the potential to have the greatest impact on each receptor, the 'worst case scenario'.

3 The various receptors that may be impacted by the development have been grouped into the following broad categories:

- invertebrates such as worms, shrimps and molluscs that live in the intertidal (beach) and subtidal (seabed) sediment;
- fish and shellfish (such as crabs and lobster) that live on the seabed and in the water column.

4 Potential impacts to these groups are considered in the context of the three main stages of the development – construction, operation and decommissioning.

5 The proposed development site contains physical, chemical and biological characteristics which resemble those of much of the surrounding area of Aberdeen Bay. These include a substratum of predominantly fine sandy sediment with no contaminants present at a level of concern and a generally good water quality. The animals living in the sediment of the beaches in the vicinity of the development are mostly mobile crustaceans which may provide food for fish living in the area. On the seabed, the main animals living in the sand are worms, with the most common species being *Notomastus latericeus*, and bivalves (mainly *Nucula nitidosa* and *Tellina fabula*). The community of animals living on the surface of the seabed is quite sparse but includes brittle stars and swimming crabs. The most common fish species using the area are flatfish such as dab and plaice, with hooknose and whiting also abundant. Fishing grounds are located outside the development area to the north and no specific spawning or nursery grounds have been identified in the development area.

6 A number of sites designated for their conservation importance (e.g. under European and UK law) occur along the coast in the Aberdeen Bay area.

None of these are located within the proposed development area (i.e. within the lease boundary). The closest Special Area of Conservation (SAC) to the site is the River Dee SAC, located 7.5 km south of the proposed EOWDC area, which supports three Annex II species, the freshwater pearl mussel, Atlantic salmon and otter.

1.1.2 Assessment of Impacts

7 Impacts on animals living in the beach sediment near the development are considered to be largely restricted to the construction phase when cable laying may disturb their habitat and lead to some small scale short-term direct habitat loss (from trenching) and indirect loss (from smothering by spoil). However, following cable installation, it would be expected that a rapid recolonisation of the habitat would occur. As such, the overall impact is assessed as being of minor to negligible significance. Decommissioning effects are expected to be similar, or below the level of those for construction. During the operation of the wind farm, it is probable that the cabling will increase the temperature of the surrounding sediment by a small amount. This is a very localised effect and, as the cable is likely to be buried at a minimum depth of 0.6m, well below the zone where most animals live (e.g. the top 15 cm of sediment), impacts would be of negligible significance.

8 Potential impacts to animals living on and in the seabed are expected to include temporary loss of and damage to the seabed soft sediment habitat (and associated animals) from the construction of foundations and associated scour protection and 'habitat loss' during the operational phase. The area of loss will be relatively small in the context of the development area, and partially offset by the creation of new hard substratum habitat associated with the new structures. The habitat which would be lost is not of a particularly high conservation value, and is characteristic of much of the wider Aberdeen Bay area. As such, habitat damage and loss are considered likely to be localised and of low magnitude and the impact has been assessed as minor at a habitat scale. Other minor issues with regard to sediment re-suspension during construction may occur, but given that the communities in the area are likely to be adapted to naturally high levels of such conditions, impacts are considered to be negligible. Similar types of impact have been identified for the decommissioning phase, although a lower significance is anticipated. The operational phase could also create potential impacts from the effects of underwater noise pressure and vibration, electromagnetic fields (EMF) and a temperature rise in the sediments around the cables. The effects on fauna are anticipated to be extremely localised and thus negligible. A potential impact from noise and vibration could also occur, particularly during construction works, but this has been assessed as of negligible to minor significance, due to the low magnitude of the effect and the low to medium sensitivity of the receptor.

9 Fish and shellfish in the development area are potentially going to be affected by noise and vibration generated during wind farm construction work (mainly from piling). However, these effects are likely to be short-term and intermittent, and their magnitude is expected to decrease with distance from the noise source. The most abundant species in the proposed development area tend to be less sensitive to noise and vibration than many species, and no significant sensitive fish habitats (spawning or

nursery grounds) occur in the proposed development area. Furthermore, most fish are able to move out of an area when conditions become unsuitable. However, due to sound propagation towards deeper waters, this impact might affect spawning populations of herring along the coast in Aberdeen Bay, even if no important spawning grounds of the species are present directly on the proposed development site. Due to the paucity of presence/absence data of herring spawning grounds in the wider area of influence of noise disturbance around the proposed EOWDC site, a precautionary approach has been adopted. As such, worst case impacts from construction noise on fish are considered to be of minor to possibly moderate significance, but with a strong likelihood that they are of no more than a minor significance. Other potential impacts on fish and shellfish during construction may arise from sediment re-suspension, contaminant release from construction works and loss of key habitats, but these have been assessed as of negligible to minor significance. Similar types of impact to those described above have been identified for the decommissioning phase, although a further lower significance is assessed due to the absence of a permanent habitat loss. Potential impacts on fish during the operational phase mainly arise from electromagnetic emissions associated with cabling. Research, e.g. through COWRIE, has identified Elasmobranchs as having a medium to high sensitivity to EMF. However, whilst they may occur within the development site, data would indicate their presence to be in low numbers and as such, the magnitude of the effect is considered to be low and the significance of the impact minor.

1.1.3 Cumulative & In-Combination Effects

10 Potential cumulative impacts arising from the possible presence of other activities and installations in the proposed development area have been assessed. The only plan or project identified near the proposed development area is the proposed Ocean Laboratory which, if approved, would be installed in close proximity to turbine location 1. Impacts arising from the construction, operation and decommissioning of this structure are likely to be broadly similar (in type) to those assessed for an individual turbine located within the proposed EOWDC. However, these impacts are likely to be of lower significance compared to those caused by the wind farm development, given the smaller scale of the Ocean Laboratory. As such, most effects would be masked by existing operations and any additive effects are considered to be minimal in the context of existing predicted impacts.

11 As the status of the freshwater pearl mussel is dependent upon the presence/absence of salmonids, the potential direct and indirect impacts of the proposed development on this species have been addressed within the salmon and sea trout assessment for the proposed EOWDC. The Habitats Regulations Assessment has also been addressed in this way. The Assessment should conclude no impact other than that consistent with impacts to the salmonid population.

1.2 Introduction

12 The Environmental Impact Assessment (EIA) process seeks to identify those impacts associated with the development through all phases of its evolution. These are based on knowledge of the existing environment (baseline conditions), the definition of the project proposed and the response of the environment to the potential changes. Where possible, mitigation is built into the project design to reduce impacts "at source", and where this is not possible a range of mitigation measures may be applied to reduce any residual impacts which might arise, often with a monitoring condition attached.

13 The construction, operation and decommissioning of an offshore wind farm will inevitably have some impact upon the physical properties of the seabed and the quality of the overlying water with consequent impacts upon the benthic communities and fish present and, ultimately on their predators (sea mammals and birds). Although these impacts have been widely monitored (see CEFAS, 2010a for a recent review), a certain degree of uncertainty still occurs, particularly in relation to the long-term and cumulative impacts of a proposed development and any other licensed and proposed activities within the area (CEFAS, 2010a). However, with respect to the benthic environment, many of the impacts of construction and estimated recovery times are expected to be similar to those associated with other anthropogenic activities, such as dredging, which are well documented (e.g. Kenny and Rees, 1994, 1996; Newell *et al.*, 2004; Cooper *et al.*, 2006, 2007, 2011).

14 This document provides information on the impacts of the proposed development on different aspects of the marine environment, namely intertidal benthos, subtidal benthos and epibenthos, and fish and shellfish communities. Potential effects on plankton assemblages have not been assessed in detail, as they are not considered to be an important issue in the impact assessment of offshore wind farms (Wilson *et al*., 2010). In addition to the absence of any substantive conservation reasons of targeting plankton within the EIA process, potential impacts on this group are unlikely due to its high natural spatial and temporal variability.

15 Where specific life stage aspects have been identified then these have been considered in the appropriate section (e.g. spawning areas and larval fish stages).

16 The EIA process has been carried out for individual components of the construction, operational and decommissioning stages and the potential impacts and their severity and permanency are characterised and discussed.

1.2.1 Methodology Consultation

17 Information on the EIA methodology and on the issues to be addressed during this process has been derived from relevant consultation responses such as:

- Sue Lawrence, Area Officer – City of Aberdeen and Aberdeenshire Central, Scottish Natural Heritage (10/09/29);

- Robert Forbes, Senior Planning Enforcement Officer, Aberdeen City Council (10/09/23);
- Nicola Abrams, Senior Planning Officer, Scottish Environmental Protection Agency (10/09/24);
- Fiona Thompson, Marine Scotland (10/12/15);
- Fiona Thompson, Marine Scotland (Scoping Opinion, and Consultee comments therein, in particular comments from Scottish Natural Heritage, Scottish Environmental Protection Agency, Marine Scotland, Association of Salmon Fishery Boards) (11/02/24).

18 The main points provided in the above consultation responses were:

- to consider onshore elements as part of the EIA process;
- to address aspects like the duration of impacts and timing of works;
- to take into consideration impacts on elasmobranchs other than basking and porbeagle sharks;
- to make appropriate links to fish and shellfish where there are strong habitat associations for certain species.
- to account for potential indirect impacts on pearl freshwater mussels and to make explicit reference also to River South Esk SAC when considering potential in-combination impacts.

All of these comments have been addressed within the EIA process.

1.2.2 Key Guidance Documents

A number of guidance documents are available to inform and direct the impact assessment process:

- IEEM, 2010. *Guidelines for ecological impact assessment in the United Kingdom*. Final document.
- *Environmental impact assessment: guide to procedures* http://www.communities.gov.uk/documents/planningandbuilding/pdf/157989.pdf
- *Guidelines on information to be contained in Environmental Impact Statements (EIS)* http://www.epa.ie/downloads/advice/ea/guidelines/EPA_advice_on_EIS_2003.pdf
- CEFAS, 2004. *Offshore wind farms: guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements.* Version 2. Prepared by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) on behalf of the Marine Consents Unit (MCEU). 45pp.
- EMEC, 2008. *EIA guidance for developers at the European Marine Energy Centre*. GUIDE003-01-03 20081106 21

- European Commission, 1999. *Guidelines for the assessment of indirect and cumulative impacts as well as impact interactions*. Document no. NE80328/D1/3.

- Metoc Plc., 2000. *An assessment of the environmental effects of offshore wind farms.* Report prepared for the Department of Trade and Industry/ETSU by Metoc Plc. [ETSU W/35/00543/REP].

- Scottish Government, 2010. *Renewables Action Plan*. Renewable Energy Division, June 2009.

- Scottish Natural Heritage, 2004. *Marine renewable energy and the natural heritage: an overview and policy statement.* Policy Statement No. 04/01.

- Scottish Natural Heritage, 2010. *Renewable energy and the natural heritage.* Ref No. 2010/02.

1.2.3 Data Information and Sources

Baseline data for the EIA process for this development have been derived from a range of published and grey sources, primarily:

- *European Offshore Wind Deployment Centre (EOWDC) request for an Environmental Impact Assessment (EIA). Scoping Opinion.* August 2010 (referred to as Scoping Report 2010).

- *EOWDC Baseline technical report for the European Offshore Wind Development Centre* (referred to as Baseline Report 2011).

- Seazone Hydrospatial Data, 2011. Provided for use on the European Offshore Wind Deployment Centre (Aberdeen Bay) under Seazone Licence Number 012005.003.

- OSPAR, 2004. *Draft background document on problems and benefits associated with the development of offshore windmill farms (OWF).* Annex 1. Report BDC/03/4/2-E.

- OSPAR, 2006. *Review of the current state of knowledge on the environmental impacts of the location, operation and removal/disposal of offshore wind-farms*. Publication Number: 278/2006.

- OSPAR, 2008. *Assessment of the environmental impact of offshore wind-farms.* Publication Number: 385/2008

- OSPAR, 2009a. *Assessment of the environmental impacts of cables.* Publication Number: 437/2009.

- OSPAR, 2009b. *Overview of the impacts of anthropogenic underwater sound in the marine environment*. Publication Number: 441/2009.

- Bio/consult, 2006. EIA Report – Fish - Horns Rev 2 Offshore Wind Farm. Doc. No. 2676-03-001.

- CEFAS, 2010. *Strategic review of offshore wind farm monitoring sata associated with FEPA licence conditions*. Final Report. Project code ME1117.
- SCIRA, 2006. *Preliminary assessment of WTG foundation types and their influence on the seabed. SCIRA Offshore Energy Limited Sheringham Shoal Windfarm.* Document No. SCIRA-8-1-2-SS-RP-04385 Rev. A4.

1.2.4 Impact Methodology

19 The assessment methodology used in this document follows a broadly common approach based around the IEEM Guidelines (IEEM, 2010), but adapted to address issues in the subtidal environment.

20 Impacts were assessed separately for each component of the marine ecology (receptors) and for the different project phases. The criteria in the assessment were based on the combined evaluation of the magnitude of effects and the sensitivity of each receptor.

21 In order to assess the magnitude of an effect, its spatial extent, duration and scale were taken into account. This information was gathered from available literature and previous assessments of similar effects, taking into account the technical information on the development structures and methodologies (e.g. power and number of turbines, footprints of foundations, etc.).

22 The assessment of the sensitivity of a receptor was based on its importance and recoverability. This information was mainly derived from the baseline technical report and, where possible, from additional assessments of impacts on the same or similar receptor.

23 The evaluations of the magnitude of effect and of the sensitivity of receptor were then combined in a final assessment of the impact significance, following the matrix in Table 1.

Table 1. Matrix for Significance of Impact

	Sensitivity of Receptor (based on importance and recoverability)				
		Very High	**High**	**Medium**	**Low**
Magnitude of Effect (based on spatial, duration and scale of effect)	**Very High**	Major	Major	Major	Moderate
	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

1.2.5 Implications of Significance

24 Where the significance is classified as moderate to major or major this is considered to be a potentially significant effect. It should be noted that significant effects need not be unacceptable or irreversible.

1.2.6 Cumulative and In-Combination Impact Assessment Methodology

1.2.6.1 Cumulative Impact

25 Schedule 3 of the Electricity Works EIA (Scotland) Regulations 2000 requires that the potential for cumulative impacts should be considered and, where appropriate, assessed.

26 Guidance for the assessment of cumulative impacts is given in the guidance note for EIA in respect of FEPA and CPA requirements (CEFAS, 2004), which states that assessment must cover the potential impacts of any development cumulatively with those of all adjacent wind farm consented and proposed sites.

27 Cumulative impact assessment should include impacts that arise from any reasonably foreseeable project/development activities in the area, such as for example other wind farms, aggregate extraction and dredging, navigation and shipping, established fishing activities, existing and planned construction of subsea cables and pipelines, potential port/harbour developments, oil and gas installations.

28 As such the cumulative assessment addressed where predicted impacts of the EOWDC construction and operation could interact with impacts from other industry sectors within the same region and impact sensitive receptors. This may be through direct effects or spatially/temporally separated impacts on the same population of a receptor.

29 Broad scale information was gathered from the recently published Scotland's Marine Atlas (Scottish Government 2011) and from Seazone Hydrospatial Data (2011). No active international and inshore telecommunications cables are present within or close to the proposed development site (one international cable, CNS FIBRE OPTIC, is present, and approximately 20km north of the development area). An out of use BT submarine cable is present, laid from the shore to the proposed EOWDC area, but this is expected to remain *in-situ*, hence no additional impacts are anticipated to occur.

30 Similarly, no additional potential port/harbour development is present in the area.

31 With regard to renewable energy installations and power cables, no other wind farms are sited or planned for development near the proposed development site. The closest wind farm developments to the EOWDC site are the proposed Firth of Forth developments 58 km to the south and the Moray Firth developments 117 km to the north.

32 In addition, no oil and gas installations were identified near the proposed development, nor any aggregate extraction sites. On the north-east coast, the St Fergus gas terminal is the largest single gas importing facility in the UK, receiving gas from a large number of North Sea fields. However it is located far north of the proposed development area (approx. 40 km). Oil production from a number of central and northern North Sea fields feeds into the main pipeline at the Forties Charlie platform from where it is transported 175 km to Cruden Bay. These installations are located well to

the north of the proposed EOWDC area, hence no cumulative impacts are likely to occur.

33 No important fishing grounds are present within the proposed development area as confirmed by the baseline data. This is also supported by the results of a shipping activity survey carried out in 2009-2010, highlighting the presence of very few fishing vessel routes crossing the proposed EOWDC area (Scoping Report, 2010).

34 The proposed installation of an Ocean Laboratory on the wind farm site has also been considered as a source of additional impact. This particular development will be subject to a separate consent application which would be discussed with the relevant consenting authorities. The impacts of the construction, operation and decommissioning of the Ocean Laboratory are likely to be similar (in type) to those derived from the wind farm development, given that similar foundation type and installation methodologies will be used, but of a smaller magnitude given the developemnt size. Cumulative impacts with the Ocean Laboratory are considered for each impact.

1.2.6.2 In-Combination Impacts

35 The assessment of in-combination impacts considers any other industrial activities or plans or projects which could in-combination have an impact upon species and areas protected under the Habitats Directive. The main industries that have been considered for potential in-combination impacts are the aggregate industry, oil and gas and shipping.

36 The only species protected by the Habitats Directive and with the potential to be subject to significant in-combination effects, is the freshwater pearl mussel which is a qualifying feature of the River Dee SAC. The fresh water pearl mussel is a long-lived filter feeding species, which only lives in rivers and streams. Scottish populations of this species are of world-wide importance as half the world's known breeding population of pearl mussels are found in Scotland. Besides requiring clear and fast flowing waters and gravelly-sandy bottoms, the species is highly dependent on the presence of salmon and trout in the river. In summer (July to September), after reproduction, pearl mussel pelagic larvae are released; most of them are swept away downstream, whereas some are inhaled by juvenile Atlantic salmon and sea trout and they encyst onto their gills. This allows larvae to be retained in the freshwater environment and be transported upstream, where they drop off the gills the following spring (May to early June) and, if settling in clean, sandy or gravelly substrates, they settle and start to grow (Skinner *et al.*, 2003).

37 Due to these life cycle requirements and the distance of designated SACs for this species from the proposed EOWDC area (> 7 km), it is considered that the freshwater pearl mussel is unlikely to be subject to direct impacts from the proposed development, however, indirect effects might arise as a result of possible impacts on their host populations (Atlantic salmon and sea trout).

38 Therefore, the characterisation of potential in-combination impacts of the development on migratory salmonids and on the freshwater pearl mussel are addressed separately within the salmon and sea trout assessment for the proposed EOWDC. It is expected that any in-combination impacts on the freshwater pearl mussel will not be significant if the impact on the salmonid population is not significant.

1.2.7 Worst Realistic Case

39 As part of the proposed development project, there is the intention to install a mix of "first run of production" wind turbines on a mix of conventional and novel foundations. The final types of structures (e.g. turbine or foundation) will be unknown at the time of the consent application and will be decided post consent during the detailed engineering design phase.

40 Eleven wind turbines are to be installed in the proposed development area, with the possible deployment of 4 wind turbines in 2013, and of 7 wind turbines in 2014 (although all 11 could potentially be installed in 2013). Each of these wind turbines will be of between 4 and 10 MW generative capacity. Five different foundation types are under consideration (namely concrete/steel monopile, jacket on piles, tripod on piles, gravity base structure, and suction caisson/bucket). The various options may require different levels of scour protection and different installation methods (Scoping Report, 2010; Chapter 3, Description of the Proposed Development).

41 Based on the technical information available to date (see chapter 3, Description of the Proposed Development), and following the 'Rochdale Envelope Approach', the impact assessment has used a 'worst case scenario' in order to assess the worst possible impacts of the proposed development on the marine ecology of the area. This approach provides flexibility to AOWFL in a changing market but also ensures that all possible impacts of the test site have been assessed.

1.3 Impact Assessment

42 Different sources of impact on marine communities (intertidal and subtidal benthos, fish and shellfish) have been identified. The potential impacts, mitigation measures, residual and in-combination impacts, and monitoring related to these different sources are presented separately for the different project phases.

43 The assessment of impacts which are likely to arise during construction of the proposed development took into account the different activities which are likely be carried out during this project phase, such as shipping, transport of components to site, assemblage on site, anchoring, jack-up rigs installation, excavation, foundations and cable installation.

44 With regards to the operational phase, the assessment has accounted for the potential impacts arising from the physical presence of the development structures (wind turbines, foundations, scour, cables) in the area.

45 Decommissioning and removal of the structures, foundations and cables will be necessary within a period of 22 years (i.e. the maximum design life of the proposed EOWDC). Piled foundations will be cut below the seabed and anything above this will be removed. Suction and gravity base type foundations will be fully removed. It is likely that the subsea cables would be left buried and notified as being disused, and therefore no associated impacts are anticipated. Removal of cables is not intended except where surveys before decommissioning identify a risk of them becoming uncovered.

46 It is anticipated that the decommissioning approach would follow industry standards at the relevant time in the future. The expected effects of decommissioning activities are expected to be broadly similar to those associated with the construction phase (OSPAR, 2004).

1.3.1 Water Quality Impairment (Release of Contaminants)

1.3.1.1 Construction & Decommissioning Phase

Potential Impacts

47 Barges, tugs, jack-up rigs and other support vessels will be required to transport components to/from site and assemble/remove them on site (further details in Chapter 3, Description of the Proposed Development).

48 There is potential for contaminants to be accidentally released directly during the construction and decommissioning works, including drilling lubricants, degreasing agents and detergents from vessels, as well as subsequent release of sewage, ballast water, chemicals (oil). If grout and anti-fouling paints are to be used, then grout spills can alter the pH of the local environment temporarily, whereas biocides are, by their nature, toxic to marine species. A consequent impairment of water and sediment chemical quality might arise. Adherence to regulatory operational standards such as MARPOL 73/78, the UK Merchant Shipping (prevention of pollution) Regulations 1983 and the Merchant Shipping (Prevention of Pollution by Garbage) Regulations 1988, UK Offshore Chemical Regulations 2001 will ensure that such a potential release is minimised. Any potential discharges are likely to be very localised and short-term in duration. In addition, the proposed EOWDC development is located in an area of high hydrodynamic energy and a high level of dispersion and dilution of any contaminants is expected. The overall magnitude of this effect is therefore assessed as negligible.

49 The construction and decommissioning works (including cabling) will re-suspend seabed sediment, with the potential for any sediment-bound contaminants to be released into the water column, impairing water quality. Data from sediment analyses (CMACS, 2010) show that no significant sediment contamination has been detected, therefore this issue has been scoped out of the assessment.

50 If an accidental spillage occurs, there may be potential adverse biological effects of contaminant release on subtidal benthos, fish and shellfish receptors.

51 Possible toxic effects on subtidal benthos would be restricted to the immediate area of the construction site (site-specific effect), and the effect would be reversible. The potential impact on benthos has been assessed as of negligible magnitude, the receptor of medium sensitivity (due to the fact that this receptor is sedentary and unable to move away from the effect) and therefore the significance of the impact would be negligible.

52 Contrary to the situation for the most of the benthos, the fish fauna has the ability to escape from the local affected area if conditions become poor, hence its sensitivity to contaminant release is assumed to be lower than for benthos. The potential impact on fish has been assessed of negligible magnitude, the receptor of medium to low sensitivity and therefore the significance of the impact would be negligible.

Mitigation

53 No additional mitigation for this impact is required.

Residual Impacts

54 The residual impacts have been assessed as of negligible significance.

Cumulative Impacts

55 As any impacts would be extremely localised and, given adherence to operational standards, unlikely, cumulative impacts are not expected.

In-Combination Impacts

56 No in-combination impacts are predicted.

Monitoring

57 No specific monitoring is required.

1.3.1.2 Operational Phase

58 This impact is unlikely to occur during the operational phase.

1.3.2 Sediment Resuspension / Redeposition

1.3.2.1 Construction & Decommissioning Phase

Potential Impacts

59 Activities during foundation installation and removal of the above-seabed structures are predicted to generate levels of suspended sediment above those found naturally. In terms of the volume of sediment disturbance, the worst case scenario is based on the installation/removal of the 11 x 10 MW wind turbine array as a single phase, with gravity base foundations used (see Coastal Processes Assessment, Section 8. Further sediment resuspension and deposition will also result from the cable laying activities in the proposed development area.

60 The surface sediments over the majority of the proposed EOWDC site comprise fine sand, and any disturbance to such sediments is likely to result in bed-load transport rather than in suspension. Given the weak tidal currents in the area (responsible for the sediment transport offshore) (ABPmer, 2011), it is likely that, following disturbance by the bed levelling process, sandy material would fall close to the point of disturbance and

then become part of the active baseline sedimentary regime. However, areas with a higher proportion of silt content also occur within the lease boundary of the proposed wind farm site. Disturbance of finer material from this area would result in fine sediments being transported in suspension and dispersing over a wide area. It is likely that the main effects would be restricted to the EOWDC area (and the areas around the cables) given the localised nature of the sediments that might be resuspended and the probability of relatively local dispersion. Consequently, an assessment of the potential effects of the increase in suspended sediments can be limited to those receptors that exist within the proposed EOWDC site.

61 Potential adverse biological effects of sediment resuspension/redeposition in the aquatic system may affect subtidal benthos, fish and shellfish receptors.

62 Raised levels of suspended sediment may impact benthic communities through clogging of respiratory and feeding mechanisms. Sediment displacement may cause smothering of the bed and the benthos in the immediate area of the construction/decommissioning site (Hiscock *et al.*, 2002; Metoc Plc, 2000; OSPAR, 2004). Sediment displacement may also lead to temporary changes in the characteristics of the sediments, such that they no longer provide an optimum habitat for existing communities to function. However, benthic communities in circalittoral sands are generally well adapted to high energy conditions and will tolerate changes such as sediment disturbance, increased turbidity or increased levels of suspended sediments relatively well, with an ability to recover rapidly in the case of strong impacts (Kaiser & Spencer, 1996; Elliot *et al.*, 1998; Connor *et al.*, 2004). This is confirmed by the assessment of the sensitivity of the benthic communities in the proposed development site with respect to the sediment disturbance carried out on the basis of data given in MarLIN (Appendix 1). None of the biotopes present are sensitive to increased suspended sediment loads, are of only low sensitivity to sediment disturbance, and are expected to recover immediately after smothering. Consequently, <u>the potential impact on benthos has been assessed as of low magnitude, the receptor of low sensitivity and therefore the significance of the impact would be negligible</u>.

63 An increase in sediment loads above background levels caused by the construction and decommissioning activities has the potential to locally affect fish and shellfish receptors in the proposed EOWDC site. It is likely that mobile fish in the vicinity of any excavation and piling work would temporarily move from the area as soon as noise levels increase and would, therefore, not be exposed to the greatest increases in suspended sediment levels that would arise locally. Effects on non-mobile organisms (e.g. many shellfish) are expected to be greater as they are less able to escape from the affected area if conditions become poor. However, no significant populations of sedentary shellfish were recorded within the proposed development site. Given the relatively homogeneity of the benthic habitat in this coastal area, escaping fish are likely to find similar habitats in adjacent, unaffected, areas (e.g. suitable nursery habitats for flatfish). Although there are no direct data to describe this, indications on habitat use and population levels in these surrounding areas would suggest that there is some assimilative capacity here for displaced populations. As such, these adjacent areas may be capable of buffering

the local and temporary impairment of the habitat within the proposed development area. Furthermore, the species recorded in the baseline surveys will to some extent be adapted to regular increases in suspended sediments above background levels due to the natural conditions that exist in the Aberdeen Bay. In fact, suspended sediments in this area are relatively high compared to many other UK coastal areas with significant fluctuations resulting from tidal or weather (storm) events.

64 Increased sediment deposition may also lead to potentially adverse impacts upon fish spawning habitat, with particular regard to demersal spawners (e.g. sandeel and herring). Deposition of sediment (and particularly fine sediment) onto such habitats may reduce water flow to the eggs and subsequently reduce their oxygenation. However, only low levels of deposition are likely to occur within the proposed EOWDC site and outside the site boundaries deposition would be negligible. In addition, no specific spawning grounds were detected in the proposed development area.

65 Based on the fact that (a) the effects will be temporary and localised; (b) no important spawning or nursery grounds are present or are strictly localised within the proposed development area; (c) the majority of fish resources recorded within the site are typical of the wider region, already adapted to natural increases in suspended sediment levels, and mobile, the potential impact on fish has been assessed as of low magnitude, the receptor of low to medium sensitivity and therefore the significance of the impact would be negligible to minor.

Mitigation

66 Given the negligible to minor significance of the impact, no specific mitigation is required.

Residual Impacts

67 The residual impacts have been assessed as of negligible to minor significance.

Cumulative Impacts

68 The additional impacts arising from the construction and decommissioning of the Ocean Laboratory on the proposed EOWDC site are likely to be of lower significance than those caused by the wind farm development, given the smaller scale of the Ocean Laboratory. Given the negligible to minor impact identified during wind farm development construction, it is unlikely that there would be the potential for significant cumulative impacts particularly as construction periods for the proposed installations are unlikely to overlap. This would also be the case for the decommissioning phase.

In-Combination Impacts

69 None anticipated.

Monitoring

70 The coastal processes studies for the proposed EOWDC identified that even for the worst case development scenario suspended sediments levels are expected to be within naturally occurring ranges, therefore there is not anticipated to be any advantage in monitoring this aspect.

1.3.2.2 Operational Phase

71 This impact is not expected to occur during the operational phase.

1.3.3 Habitat Loss

1.3.3.1 Construction & Decommissioning Phase

Potential Impacts

72 As highlighted in Section 1.3.1, barges, tugs, jack-up rigs and other support vessels will be required to transport material for the foundations/piling, together with the turbine components themselves to the site. The legs of jack-up barges and the anchorage of construction vessels are likely to result in physical disturbance and abrasion and/or displacement of the seabed with a consequent habitat loss occurring. Although the exact method of wind turbine placement has yet to be finalised, it is likely that jack-up rigs would be required with the worst case scenario involving the installation of the 11 x 10 MW wind turbine array. Footprint area will depend on the final vessel set-up, and the worst case scenario has been assumed to be a maximum of 12 (6 legged jack-up and 6 legged barge) footprints per turbine. Taking into account multiple operations, this could entail an area of impact of up to 4200 m^2/turbine. This would lead to a seabed disturbance area corresponding to 0.2% of the total proposed EOWDC area (20 km^2). Coastal process modelling for the proposed EOWDC demonstrates that the impacts upon the seabed from construction and decommissioning are considered to be of negligible significance.

73 Temporary habitat loss will also arise both in the intertidal and subtidal areas following cable lying. Cables running both between the turbines and to the shore are generally placed in trenches and buried in order to prevent damage to the cable and to prevent disturbance to fishing activities. Options for cable laying include trenching prior to cable laying or by ploughing or jetting directly into the sediment (further details in Chapter 3, Description of the Proposed Development). Each of these methods may be employed in the proposed EOWDC site, although ploughing and jetting are most appropriate to the substrate in the area. Furthermore, the movement of heavy construction vehicles on the intertidal area could cause churning and/or compaction of the surface sediment, resulting in further habitat loss (further details in Chapter 3, Description of the Proposed Development) , the worst case impact, in relation to direct substratum loss in the subtidal and intertidal area, would result from ploughing, with a loss of 10.38 m^2 of habitat per meter of cable laid (including the likely footprint of equipment used). This would lead to a total seabed loss of 0.27 km^2 from the export cable laying (max 26 km total length), and a 0.13 km^2 from the inter-array cable laying (max 13 km total length), this latter area corresponding to 0.7% of the proposed lease boundary. The depth of impact is anticipated to be up to 3 m but final working depth would be based on further studies and suited to the seabed conditions. Any loss will be temporary as, once instated, the sediment would either be backfilled or re-deposit naturally over the cables.

74 Construction activities, in particular foundation installation, will lead to further seabed habitat loss directly within the footprint of these structures. This impact is dealt in detail in Section 1.3.3.2.

75 Potential adverse biological effects of temporary habitat loss will affect benthic communities, both in the subtidal and in the intertidal areas.

76 Impacts on the subtidal benthic ecology would include damage or mortality to invertebrate species (Hiscock *et al.*, 2002). Due to the relatively small area affected at any one time, recolonisation may be rapid after the construction/decommissioning activities have ceased. Within the proposed development area one biotope type, SS.SSA.CMuSa.AalbNuc, has been identified. The higher level biotope SS.SSA.CMuSa of which SS.SSA.CMuSa.AalbNuc is a component is designated as a UK BAP priority habitat. However, the Level 4 biotope SS.SSA.CMuSa.AalbNuc is not uncommon in the wider Aberdeen Bay area, and although *Abra alba* is a common food source for *Asterias rubens* and different species of demersal fish (MarLIN, http://www.marlin.ac.uk/habitatimportance.php), it is not considered to have an especially high ecological importance at the local scale. In addition, the biotope is considered to have a high recoverability, and only a small percentage of the total benthic habitat in the proposed development area is expected to be lost (<1%, considering both foundation and cabling activities). Furthermore the impact will be temporary as it is expected that much of the seabed would be returned to a similar physical condition soon after the disturbance ceases. As such the potential impact on subtidal benthos has been assessed as of low magnitude, the receptor of low to medium sensitivity and therefore the significance of the impact would be negligible to minor.

77 A localised (site-specific) and temporary impact on intertidal benthos would arise from the laying/removal of the export cable route. Although the exact location of the cable route is currently unknown, as this is dependent on the location of the onshore substation, available data show that the coast in this area is characterised by moderately exposed sandy beaches, with the intertidal fauna dominated by haustorid amphipods (*Haustorius arenarius* and *Bathyporeia pelagica*) and in some cases the spionid polychaete *Scolelepis cirratulus* (Hart, 1971). According to the JNCC biotope classification, this habitat matches with the biotope LS.LSa.MoSa.AmSco (Amphipods and *Scolelepis* spp. in littoral medium-fine sand) (Connor *et al.,* 2004), occurring in coarse sandy beaches on exposed and moderately exposed shores, with sediment grain sizes ranging from medium to fine, often with a fraction of coarser sediment. The recoverability of this biotope from substratum damage is considered to be high, as is its recoverability from smothering (MarLIN).

78 Observations of the temporary habitat disturbance and benthic recolonisation following pipe laying operations carried out in the Lavan Sands near Bangor (North Wales) highlighted a continual repopulation of the disturbed area by mobile organisms, such as the gastropod *Hydrobia ulvae*, during the construction works, and a rapid post-disturbance recolonisation (Rees, 1978). Several species, including the polychaetes *Arenicola marina*, *Eteone longa* and *Scoloplos armiger* were recruited preferentially to the disturbed area. Longer lived species (e.g. *Scrobicularia plana*) showed higher depression of their numbers, lower recruitment and took several years to return in significant numbers after

the pipeline operations had been completed (Rees, 1978; Hiscock *et al.*, 2002). However, for the proposed EOWDC, such an effect is likely to be negligible, as larger, longer lived, usually sedentary species are not found with significant abundances in the exposed shores along Aberdeenshire coast. In turn, the recolonisation of the disturbed intertidal areas by opportunistic species along the Aberdeenshire coast, following the completion of the proposed EOWDC development construction and decommissioning activities, is expected to be rapid, hence the effect would also be reversible over the short to medium term. <u>The potential impact on intertidal benthos has then been assessed as of low magnitude, the receptor of low to medium sensitivity and therefore the significance of the impact would be negligible to minor.</u>

Mitigation

79 Given the negligible to minor impact assessed, no specific mitigation measures are required. However, good construction practices will be discussed with contractors and could include backfilling trenches to just below the adjacent beach surface level to allow natural accretion to fill the upper surface.

Residual Impacts

80 Residual impacts of negligible to minor significance are expected which will be reversible.

Cumulative Impacts

81 The additional impacts arising from the construction and decommissioning of the Ocean Laboratory on the proposed EOWDC site are likely to be of lower significance than those caused by the wind farm development. Furthermore, the supply cable from the Ocean Laboratory to shore is likely to be routed via the main wind farm export cable route, potentially installed in the same trench. Given the minor impact identified during wind farm development construction/decommissioning, it is unlikely that there would be the potential for significant cumulative impacts particularly as construction periods for the proposed installations are unlikely to overlap.

In-Combination Impacts

82 None envisaged.

Monitoring

83 No specific monitoring planned.

1.3.3.2 <u>*Operational Phase*</u>

Potential Impacts

84 The installation of wind turbine foundations will lead to permanent habitat loss directly within the footprint of the turbines, supporting structures and any protection. The extent of such impacts will be highly dependent on the final choice of the structures to be installed (wind turbines, foundations and scour protection). Due to the greater extent of the total footprint and the requirement for seabed preparation/levelling, the installation of 11 × 10 MW wind turbines with gravity base foundations has been considered to have the greatest potential impact on the seabed communities, with the 'worst worst-case' scenario assuming that no scour protection is provided (according to the coastal process assessment for the proposed EOWDC). Each gravity base foundation area (including scouring) would be a

maximum of 1865 m^2, leading to a total loss of 0.03 km^2 seabed area within the lease boundary, corresponding to 0.17% of the lease boundary (including foundation + scour footprint) (see Section 8.2). Not taking in to account potential scouring or scour protection the total habitat loss from each gravity based structure would be 1,257 m^2 with a total loss of 0.0138 km^2 seabed area corresponding to 0.07% of the lease boundary. In areas of mobile sands, such as those present within the proposed development site, the substratum exposed by scour is likely to be of a similar type to that naturally present, although the high current speeds in the development area may cause a reduction in sediment fines in any scour pits. However, as scour develops and reaches equilibrium, instability is unlikely to occur for more than 12 hours at any foundation location (see Section 8.2).

85 Potential adverse biological effects of permanent habitat loss within the footprint of the wind farm structures will affect subtidal benthic communities, fish and shellfish.

86 The permanent loss of seabed will affect the infaunal component of the benthic community. In the case of this development, the soft sediment communities present will include the robust polychaetes and bivalves. The less mobile epifaunal organisms will also be affected, such as the abundant brittle stars in the area. More mobile epifaunal organisms (such as shrimps and crabs) are likely to avoid any direct effects by moving away from the affected area.

87 The direct habitat loss that will occur within the proposed lease boundary will be the SS.SSA.CMuSa.AalbNuc biotope. This will include a direct loss of 0.17% of the biotope within the proposed development area (assuming a worst case of 40 m diameter gravity base foundations and associated scour). The higher level biotope SS.SSA.CMuSa includes SS.SSA.CMuSa.AalbNuc which is designated as a UK BAP priority habitat. However, given the extent of the Level 4 biotope in the wider area, it is not considered to be of particular ecological importance at the local scale, and as such, the overall impact of the direct habitat loss on benthic communities in the development area will be small, although permanent. The potential impact on subtidal benthos has been assessed as of low magnitude, the receptor of medium sensitivity and therefore the significance of the impact would be minor.

88 Direct habitat loss within the footprint of the proposed development structures may potentially impact sensitive habitats such as fish and shellfish spawning and nursery grounds. Broad scale studies place the proposed EOWDC site within spawning and nursery habitats for a number of commercial and non-commercial species (Coull *et al.,* 2008; CEFAS, 2010b). However, baseline studies did not identify the proposed development site as being of particular importance to fish and shellfish communities. No ‘hot spots’ of biodiversity or important sensitive habitats, such as spawning and nursery grounds, were detected in the proposed development area. Furthermore, with respect to non-commercial species, such as dragonet and gobies, the potential loss of spawning and nursery habitat from the proposed wind farm development would represent a negligible proportion of similar habitat for these species, as these habitats are ubiquitous throughout the Aberdeen Bay strategic area. The same conclusion has been reached for some commercial species, such as

flatfish, which have potential nursery areas extending in the shallow waters along Aberdeenshire coast, and which may buffer any local nursery habitat impairment from the proposed EOWDC.

89 As such, the loss of potential sensitive habitats due to the installation of the main wind farm structures is likely to be a very small proportion of similar habitats in the wider area. Furthermore, no significant spawning grounds, e.g. for sandeel, herring or Norway lobster, have been identified in the proposed development area and in its surroundings, possibly due to these species' preference for coarser (as for sandeel and herring) or muddier (as for *Nephrops*) sediments than those in the survey area. No significant populations of these species were found in the proposed development site during the epibenthic surveys carried out to assess the baseline conditions. The surveys suggest the minor importance of the site as feeding ground for other important predator species, such as Atlantic salmon and sea trout (sandeel and herring being important prey for such fish species). Given the above considerations, the potential impact on fish has been assessed as of low magnitude, the receptor of medium sensitivity and therefore the significance of the impact would be minor.

Mitigation

90 Given the minor impact assessed, no specific mitigation is required.

Residual Impacts

91 Residual impacts of minor significance are expected.

Cumulative Impacts

92 The additional impacts arising from the construction and decommissioning of the Ocean Laboratory on the proposed EOWDC site are likely to be of lower significance than those caused by the wind farm development. Given the minor impact identified during wind farm development construction/decommissioning, cumulative impacts will also be of minor significance.

In-Combination Impacts

93 None envisaged.

Monitoring

94 No specific monitoring planned.

1.3.4 Effects of the Physical Presence of the Submerged Structures

1.3.4.1 Construction & Decommissioning Phase

Potential Impacts

95 This impact is likely to occur during the operational phase.

1.3.4.2 Operational Phase

Potential Impacts

96 The presence of the wind turbine and their foundations is likely to modify the hydrodynamic regime around the development site (Elsam Engineering A/S and ENERGI E2 A/S, 2005; OSPAR, 2006). The resistance from the

foundations can influence the current and wave conditions in the wind farm area, leading to possible alteration to the character of the topography of the seabed in terms of sand wave redistribution, although this latter impact is expected to be local. However, the coastal process (see Section 8.2) modelling work has shown that impacts upon tidal currents and residual flows as a result of the proposed EOWDC will be of negligible significance.

97 The physical presence of foundations, turbines and any scour protection will provide an artificial reef structure for colonisation by aquatic organisms, known as the "reef effect" (Wilson, 2007).

98 Potential biological effects of the physical presence of the wind farm structures may affect subtidal benthos, and fish and shellfish communities.

99 The submerged wind turbine structures are likely to provide a new habitat for colonisation by epifaunal and encrusting species, as well as by fish, thus leading to changes in the benthic and fish communities in the area (Hiscock *et al*., 2002; Lewis *et al.,* 2002; OSPAR, 2004). Based on the epifaunal communities present in the area, colonisation by bryzoans, sponges, hydroids and the encrusting polychaete *Pomatoceros* spp. is likely, together with several decapod, mollusc and echinoderm species. Infaunal organisms, or those requiring some sediment, may colonise areas of sediment deposition between rocks. Colonisation of the wind turbines by encrusting organisms may provide a new food source for local fish and shellfish and may also create new habitats that could provide refuges for many fish species. Once fully installed and operational, the wind turbine structures would form a hard substratum that did not exist previously in the area and which would be colonised quickly by communities of benthic organisms and other associated species including commercially important species of fish and shellfish. The overall effect of the foundations and scour protection will be to replace small areas of the existing sandy biotopes with typical hard substrate epifaunal communities. This is likely to increase (albeit extremely locally) the overall species diversity and productivity (Wickens & Barker, 1996; Grossman *et al.,* 1997; OSPAR, 2004). Epibenthic colonisation is dependent upon water depth, hydrography and the degree of scour, with the greatest degree of colonisation being associated with areas of more stable substrata. It should be noted that changes to the sediment properties as a result of scour may prevent recovery of the original benthic community, although they may possibly increase local biodiversity and may also provide a food source for fish and crustaceans (Hiscock *et al*., 2002).

100 Bio/Consult (2004b, 2005b) concluded that the epifauna on the turbine foundations at the Horns Rev Offshore Wind Farm off the Danish coast led to an eight-fold increase in biomass compared with the typical soft sediment fauna of the area (even though the colonisation on the turbines appeared not to be particularly high in this area due to strong scouring effects). Monitoring reports from other offshore wind farm sites describe the invertebrate recolonisation succession, with common mussels, barnacles (Cirripediae) and red macroalgae dominating the fouling community in the wind farm submerged structures in the first year after the structure deployment (Birklund, 2005; Leonhard and Pedersen, 2005). The organisms that develop on submerged wind farm structures may provide a new, direct food source for certain fish and shellfish species. Alternatively, encrusting species may attract small organisms, such as

mantis shrimps, to graze upon the wind turbines, and these species would themselves be a potential food source for larger fish species. For example, the new hard substrate communities may provide a valuable food source for fish species such as North Sea cod and pout (Bouma and Lengkeek, 2009). The use of wind turbine foundations as spawning and nursery grounds has also been suggested following the observation of the presence of abundant juvenile crab species and egg masses of invertebrates on the foundations and scour protection (Leonhard and Pedersen, 2005).

101 Wind turbines may also produce some form of aggregation of local fish stocks, acting as Fish Aggregation Devices (FAD) (CEFAS, 2010a). This effect has been observed, for example, at the Burbo Bank offshore wind farm, in Liverpool Bay at the mouth of the River Mersey (CEFAS, 2010a).

102 Based upon the evidence from monitoring programmes at existing offshore wind farm sites, there is a possibility that the submerged structures in the proposed EOWDC site would provide a new habitat leading to a positive impact on the benthic biodiversity and also attracting certain fish and shellfish species. However, although the overall effect of the hard structures is considered to be positive, it is considered as localised and it is judged unlikely that populations as a whole in the area would increase above existing levels. The potential impact on benthos, epibenthos and fish has been assessed as of low magnitude, the receptor of low sensitivity and therefore the significance of the impact would be negligible (although positive).

103 The physical presence of wind turbine structures might also adversely affect the shoaling behaviour of pelagic fish, such as sprat and herring, leading to possible dispersal of shoals. Sprat and herring exhibit shoaling behaviour throughout their life cycle for a number of reasons, including aiding migration to spawning grounds and increasing protection from predators. Consequently, a disruption to shoaling activity or behaviour as a result of the presence of wind turbines may potentially have an adverse effect on the local ecology of these species. However, there is relatively little evidence to prove or disprove the claim that offshore wind turbines may disrupt shoaling behaviour. In reality, if a large shoal of pelagic fish does come across a wind turbine, or multiple wind turbines, it is judged unlikely that the integrity of the shoal would be significantly adversely affected. Such behaviour may occur naturally (e.g. due to the presence of wrecks or other underwater obstructions) and whilst the shoal may become temporarily fragmented it is likely that the strong behavioural instinct to reform the shoal would result in the shoal integrity being restored quickly. Based upon the considerations above in relation to shoaling behaviour and the potential spacing of the wind turbines in the proposed EOWDC site, the potential impact on fish has been assessed as of low magnitude, the receptor of low sensitivity and therefore the significance of the impact would be negligible.

Mitigation

104 No mitigation is required for this impact.

Residual Impacts

105 The residual impact is assessed as of negligible significance.

Cumulative Impacts

106 The additional impact arising from the physical presence of the Ocean Laboratory on the proposed EOWDC site is likely to be of lower significance than that one caused by the wind farm development. Given the negligible impact identified for the wind farm development, it is unlikely that there would be the potential for significant cumulative impacts.

In-Combination Impacts

107 The potential direct and indirect impacts of the proposed development on salmonid, and indirect impacts on freshwater pearl mussel, populations of the River Dee and River South Esk SACs have been addressed within the salmon and sea trout assessment for the proposed EOWDC.

Monitoring

108 Monitoring will be agreed with the relevant statutory authorities and requirements incorporated into the Marine Licence.

1.3.5 Noise and Vibration

1.3.5.1 Construction & Decommissioning Phase

Potential Impacts

109 Noise is associated with many activities during wind farm development, e.g. construction works, vessel movements, piling activities, etc. It is in respect of pile-driving that the greatest levels of noise are likely to arise, being predominantly low frequency underwater noise, that can travel large distances and that can lead to acute short term disruption of the marine fauna (Hiscock *et al.*, 2002; Nedwell *et al.*, 2007, 2011; OSPAR, 2008). Other sources of noise, such as for example rock dumping (for provision of scour protection), cable trenching of inter-array cables, or increased vessel traffic during construction/decommissioning activities are unlikely to contribute significantly to background noise (which might be relatively high, due for example to the large volumes of shipping already occurring in the area) or to provoke significant effects on marine fauna (Nedwell *et al.,* 2003).

110 In the context of the construction/decommissioning of the proposed EOWDC development, the worst case scenario is assumed to be the installation of the largest piles (8.5 m) (Nedwell *et al.*, 2011). This has the likely potential to cause disturbance over the greatest distances, although on a reduced number of occasions (Parvin *et al.,* 2006). According to the underwater noise modelling carried out in support of the EOWDC and accounting for the worst case scenario, the expected peak to peak Source Level of this pile driving operation will be around 250 dB re 1 µPa @ 1 µm, with a propagation with lower losses in deeper waters, out to the east of the proposed development site (Nedwell *et al.*, 2011).

111 Potential biological effects of the underwater noise produced during construction works could affect subtidal benthos, and fish and shellfish communities.

112 The impacts of noise during wind turbine array construction upon the benthic communities are not well understood (Metoc Plc, 2000; OSPAR, 2009b). There have been no specific investigations on the effects of marine construction and industrial activities on marine invertebrates (OSPAR, 2009b). However a certain amount of physical damage to invertebrate organisms living in close proximity to pile driving activities is expected. The effects of the pressure wave will be higher on sessile invertebrates, as the more mobile benthic organisms would be able to move away from the area. Significant impacts such as mortality of larval fish and crustaceans are likely to be constrained to within a few metres of the piling activity (Dr J Allen, pers. comm.). However, recruitment to areas where damage could have occurred is likely to be rapid due to the presence of other benthic organisms in the vicinity. The potential impact on benthos has been assessed as of low magnitude, the receptor of low to medium sensitivity and therefore the significance of the impact would be negligible to minor.

113 The approach to the assessment of the resulting effects on fish in the United Kingdom is to concentrate on times when fish can be considered to be at their most vulnerable to noise disturbance (e.g. spawning seasons, migration, etc.) for those species at risk on a case by case basis (OSPAR, 2008). Fish are receptive to noise with hearing and the detection of vibrations being two of their most developed senses. Typically fish hear at very low frequency (typically 10 Hz to 1000 Hz) (Nedwell and Brooker, 2008). Different species of fish have different hearing abilities, the main reason for this being ascribed to adaptive physiology. According to this, fish have been distinguished as hearing “specialists” (having specialisations that enhance hearing, as for example swim bladder or gas filled bullae) and “generalists” (not having such specialisations). Hearing “specialists” tend to detect sound pressure with greater sensitivity and in a wider bandwidth than “generalists”. In particular, herring and sprat are considered as highly sensitive species to noise; species like dab, plaice, salmon and sandeel are considered to have low sensitivity to noise and vibrations, whereas intermediate sensitivity is reported for gadoids (cod, haddock, hake), mackerel and eel (Nedwell *et al.,* 2003).

114 The noise associated with the construction of offshore wind farms (particularly piling noise) may affect marine fish through immediate or delayed fatal injuries (often caused by ruptures to swim bladders in fish, or gas sacks of some larval stages), other injuries such as deafness may impact upon survival, and through behavioural effects (including avoidance). In the case of high intensity sound, damage effects on the air-filled body spaces may occur, leading to possible mortality.

115 The negative effects on fish arising from piling noise produced during the construction works are likely to be limited to within a predictable distance from the source of noise. According to the underwater noise modelling carried out in support of the EOWDC, lethal effects are expected out to a range of 3 m from the piling works, whereas the expected distance for physical injuries is 60m (Nedwell et al., 2011). However, it must be considered that fish are able to move away from the disturbed area. A minimum safe standoff distance from piling operations has been estimated as of 1750 m for hearing specialists like herring, and of 20 m for hearing generalists like dab (Nedwell et al., 2011). According to this information, and as dab and plaice are the most common fish species in the area

(Baseline Technical Report 2011), it is likely that the great majority of fish would vacate the area before significant damage is done, and that impacts would generally be of low magnitude. A 'soft start' to piling, whereby the power of the piling activity is increased slowly over time, should allow fish to move away from the site prior to noise levels increasing, reducing the risk of lethality and possible physical impairment.

116 The spatial range within which behavioural disturbance to fish is present has also been calculated by Nedwell *et al.* (2011). The maximum estimated range from piling is of 20-24 km for herring, extending mainly out to the east of the site (given the higher attenuation in shallow waters), whereas it is around 6 km for dab. Disturbance to flatfish populations is likely to be low, given the low sensitivity of these demersal species to noise disturbance. In turn, disturbance of herring during their spawning period (autumn) could potentially have effects upon the overall reproduction for the year. No important spawning grounds of the species are present directly on the proposed development site, but no specific data on their presence in the surroundings are available. However, this sensitive habitat might occur offshore within the area of disturbance from piling noise, given the presence of suitable sediment types (gravelly sands) for herring spawning 15-20 km offshore from the proposed EOWDC area (Seazone Hydrospatial Data, 2011). Therefore, although there is every likelihood that the impactis likely to be negligible to minor, the absence of data to categorically demonstrate an absence of spawning sites within the area of effect means that a precautionary approach is required, and as such there is the possibility that the significance of the impact is moderate on spawning populations of herring along the coast in Aberdeen Bay.

117 Underwater noise generated during construction could have a physiological or lethal effect particularly on young fish (eggs and larvae). A conservative estimate of 230-240 dB re 1 µPa @ 1m has been used as a limit for likely significant levels of damage to young stages of fish (Gausland, 2003). According to the estimates obtained by Nedwell *et al.* (2011) for the proposed EOWDC, 240 dB would be reached within approximately 3 m of an 8.5 m monopile. Hence, as a conservative but also very simplistic estimate, the mortality of all eggs and larvae may be assumed within the 3 m radius of piling. However, considering that the mortality levels characterising fish eggs and larvae are naturally high, such an effect over a wider marine ecological context would be negligible.

118 A potential impact of underwater noise production (mainly by piling activities) might also affect salmonid migration routes in the area. This aspect is assessed in the salmon and sea trout assessment for the proposed EOWDC..

119 Given the above considerations, the potential impact on fish has been assessed of low to possibly medium magnitude, receptor of medium sensitivity and therefore the significance of the impact would be minor to possibly moderate. The latter classification mainly derives from the aforementioned precautionary approach adopted in the assessment of the possible effect on herring spawning grounds, given the lack of specific data on their local distribution within the area of influence of the impact.

Mitigation

120 No additional mitigation is required.

Residual Impacts

121 Residual impacts on benthos will be of negligible to minor significance and are expected to be of a short-duration. Given that the construction effects are likely to be short-term, intermittent and of low to medium magnitude, residual impacts on fish are anticipated to be of minor significance, although a possibly moderate significance is acknowledged, following the aforementioned precautionary approach.

Cumulative Impacts

122 Given that the additional impacts arising from the construction and decommissioning of the Ocean Laboratory on the proposed EOWDC site are likely to be of lower significance than those caused by the wind farm development, and that construction periods for the proposed installations are unlikely to overlap, it is unlikely that there would be the potential for significant cumulative impacts.

In-Combination Impacts

123 The potential direct and indirect impacts of the proposed development on salmonid, and indirect impacts on freshwater pearl mussel, populations of the River Dee and River South Esk SACs have been addressed within the salmon and sea trout assessment for the proposed EOWDC.

Monitoring

124 Monitoring will be agreed with the relevant statutory authorities and requirements incorporated into the Marine Licence. In the case salmon and sea trout, AOWFL will consult with Marine Scotland, Scottish Natural Heritage and the Dee, Don and Ythan Salmon District Fishery Boards in order to identify feasible and relevant monitoring options.

1.3.5.2 <u>Operational Phase</u>

Potential Impacts

125 Current evidence from noise monitoring at operational offshore wind farms suggests that the noise generated is generally at a low frequency, which may be within the best hearing frequency for many fish species, but of a level that is typically lower than sound generated by most vessel activity, even when considering the worst case of 11 x 10 MW operating wind turbines. The noise and vibration produced would increase with increasing wind speeds, with a corresponding increase in background noise levels also expected in these conditions, such that there would be a broadly constant level above background noise (Nedwell and Howell, 2004).

126 Potential biological effects of the underwater noise and vibration produced during the operational phase could affect subtidal benthos, and fish communities.

127 The impacts of noise and vibration during turbine operation, upon the benthic communities are not well understood. A relatively low level of operational noise is expected across all options and it is unlikely that benthic invertebrates would be significantly affected. Certain invertebrate species, including edible crab, have been frequently seen in very high numbers living on the piles of large operating wind turbines. Leonhard and Pedersen (2005) reported a total of 70 invertebrate taxa recorded during

post-construction surveys (in March and September) within the Horns Rev offshore wind farm, including 14 epifaunal species newly recorded within the seabed area. This study also indicated an increase in edible crab and suggested that the wind turbine foundations can function as hatchery and nursery grounds for some species. Several of the species found at Horns Rev are also found across the Aberdeen Bay including the brown shrimp, edible, harbour and hermit crab. The potential impact on benthos has been assessed as of low magnitude, the receptor of low sensitivity and therefore the significance of the impact would be negligible.

128 Operating wind turbines would produce near field noise and vibration which may be detected by fish using their lateral line systems. As fish are thought to use particle displacement (i.e. vibrations caused by the back and forth movement of water molecules) for prey (and predator) detection, it is possible that the operating wind turbines would disguise such signals. However, Hoffman *et al*. (2000) state that the regular, low-frequency hydrodynamic fields generated by operating wind turbines are likely to be perceived very differently by fish in comparison to the fields generated by animals.

129 Herring has a fairly broad response to the low frequency components of underwater sound, with a hearing threshold at levels below 80 dB re 1 µPa (Enger 1967), and as such may potentially detect such noise. Other fish species tend to have much poorer hearing and the noise levels generated by the operating wind farm may be below that required in order to stimulate an avoidance response. Gadoid species such as cod have been shown to aggregate around noisy underwater structures such as operational oil and gas rigs (Valdemarsen 1979; Soldal *et al*., 2000). This is because the cod either habituate to the operational wind turbine noise, or tolerate it because of the benefits provided (e.g. shelter from currents or an increase in food source). Post-construction surveys for fish and benthic invertebrates within the Horns Rev wind farm recorded a number of species which included hearing-sensitive species such as the sprat and mackerel, and schools of cod (Elsam Engineering A/S and ENERGI E2 A/S, 2005).

130 The potential impact on fish has been assessed as of low magnitude, the receptor of low to medium sensitivity and therefore the significance of the impact would be negligible to minor.

131 There is also the possibility that operational underwater noise and vibration might affect salmonid migration routes in the area, but this has been assessed within the salmon and sea trout assessment for the proposed EOWDC.

Mitigation

132 No specific mitigation measure is recommended.

Residual Impacts

133 Residual impacts are assessed as of negligible to minor significance.

Cumulative Impacts

134 No cumulative impacts are anticipated.

In-Combination Impacts

135 None envisaged.

Monitoring

136 No specific monitoring required.

1.3.6 Electromagnetic Fields

1.3.6.1 Construction & Decommissioning Phase

Potential Impacts

137 This impact is likely to occur during the operational phase.

1.3.6.2 Operational Phase

Potential Impacts

138 It was shown by CMACS (2003) that industry standard AC offshore cables (three-core XLPE) do not generate an electric field outside the cable directly. However, a magnetic field is generated in the local environment by the alternating current in the cable, and this generates an induced electric field close to the cable. The potential impacts of electromagnetic fields (EMF) in the marine environment are the subject of ongoing research under the auspices of the Collaborative Offshore Wind Research Into the Environment (COWRIE; Huddleston, 2010).

139 Potential biological effects of the EMF produced during the wind farm operation may affect subtidal benthos and fish communities.

140 The fields produced by the sub-sea power cables used in offshore wind farm developments are within the ranges that could affect the behaviour of electro-sensitive fish species and species sensitive to magnetic fields, although very little information on the importance of any such changes in behaviour is available (OSPAR, 2006, 2008). The main area of concern relates to impacts on electro-sensitive fish species such as elasmobranchs, which may be attracted to the EMF emissions of buried cables or forced to avoid an affected area entirely.

141 The potential for EMF to have similar effects on benthic invertebrates is extremely limited. Although little information is available, it can be assumed that electro- and magnetic-sensitivity is of negligible influence on the behaviour, distribution and orientation of the range of benthic species found within the proposed EOWDC area. This assumption appears to be supported by the results of monitoring studies carried out at Horns Rev (Bio/Consult, 2004a, 2005a) and North Hoyle (NPower Renewables, 2008), which showed no evidence of a change in the benthic community, during operation that could be attributed to the presence of the wind farm. The potential impact on benthos has been assessed as of low magnitude, the receptor of possibly low sensitivity and therefore the significance of the impact would be negligible.

142 Field studies on fish provided the first evidence that operating cables change migration and behaviour of marine animals (Klaustrup, 2006). The potential environmental receptors of EMF impacts include a range of species that are considered to be of up to high level importance (most

elasmobranchs, all migratory and commercial fish species). Gill *et al.* (2009) undertook research on EMF and benthic elasmobranchs and concluded that they can respond to EMF, but that the response is unpredictable and in some instances does not occur, with a degree of species and individual specifics.

143 Magnetic field and field anomalies may be used by fish for orientation especially when migrating (Fricke, 2000). This is the case, for example, for European eel, Atlantic salmon and sea trout juveniles, as reviewed by Gill and Bartlett (2010). Possible effects on salmonids migration are detailed within the salmon and sea trout assessment for the proposed EOWDC and are not considered for the impact assessment in this section.

144 Elasmobranch fish (sharks and rays) are of particular interest to the offshore wind farm industry given their ability to detect very low levels of electromagnetic field. Elasmobranch fish can detect magnetic fields which are weak compared to the earth's magnetic field, these fishes being more than ten-thousand fold as electrosensitive as the most sensitive teleosts (OSPAR, 2009a). In addition it is currently thought that elasmobranch stocks are in decline (Ellis *et al.,* 2005) and whilst the reasons for this are poorly understood (although overfishing is widely perceived to be important) it is possible that the impacts of EMF may contribute to this decline. Hence, these receptors' electro-sensitivity can be considered as high. However, the presence of sharks and rays in the Aberdeen Bay is scarce, as gathered from the Baseline Report 2011, hence the effect is likely to be of low magnitude.

145 Indirect impacts on fish behaviour might arise also from attractive or repulsive electrical fields. An attractive artificial field may induce a food search investigation of seabed by individual animals, hence leading to a waste of energy. A repulsive field, in turn, could have a direct impact by actively repelling animals, thereby interrupting normal behaviour and potentially excluding habitat from use.

146 The orientation of the export cable route in the proposed EOWDC development is considered to be optimal for minimising potential impacts on fish species moving into and out of the Aberdeen Bay from the North Sea, as the corridor runs roughly up the centre and parallel to the coast of the Aberdeen Bay. This would allow access into and out of the Aberdeen Bay from both north and south. The potential impact on fish has been assessed as of low magnitude, the receptor of medium to high sensitivity and therefore the significance of the impact would be minor.

Mitigation

147 No specific mitigation is required. Industry standards and best practice arising out of ongoing research work would be adopted for the EOWDC development where practicable.

Residual Impacts

148 Residual impacts are assessed as of minor significance.

Cumulative Impacts

149 The additional impact arising from the physical presence of the Ocean Laboratory on the proposed EOWDC site is likely to be of lower significance than that one caused by the wind farm development. During the operational phase, the additional impact is likely to be generally minor,

leading to a cumulative impact of minor to moderate significance. In addition, no important fishing grounds are present in the proposed development site, and as such, the possible additional impact on fish and shellfish receptors arising from fishing activities is considered to be low.

In-Combination Impacts

150 The potential direct and indirect impacts of the proposed development on salmonid, and indirect impacts on freshwater pearl mussel, populations of the River Dee and River South Esk SACs have been addressed within the salmon and sea trout assessment for the proposed EOWDC.

Monitoring

151 Monitoring will be agreed with the relevant statutory authorities and requirements incorporated into the Marine Licence.

1.3.7 Heating

1.3.7.1 Construction & Decommissioning Phase

Potential Impacts

152 This impact is likely to occur during the operational phase.

1.3.7.2 Operational Phase

Potential Impacts

153 There is potential for heating effects of cables on the surrounding habitats in the intertidal area (from the export cable) and in the subtidal area (from export and inter array cables). Depending upon the properties of the cables, the electrical current running through them and the thermal resistance of the surrounding sediments, there is potential for temperature increase in the sediments around the cables. Studies in Long island and Connecticut showed that a pair of 4.1 inch diameter sublittoral cables (40 km long; 330 MW; 140 kV direct current) buried to 1.8 m caused an estimated increase in seabed surface temperature of 0.1 ^{o}C and an estimated increase in overlying water temperature of 0.000003 ^{o}C (London Array Ltd, 2005). These cables and conditions are comparable to those at the proposed EOWDC development.

154 Potential biological effects of sediment heating around the cables might impact on the intertidal and subtidal benthos, by affecting the physiology and survival of certain species, or altering the benthic community by leading to emigration or immigration in the impacted area.

155 However, given that the cables will be buried to at least 0.6 m, the overall effect of sediment heating on the intertidal fauna is expected to be low (if detectable) in magnitude and very localised, as the majority of animals in intertidal areas inhabit the top 15 cm (Eleftheriou and McIntyre, 2005). The potential impact on intertidal benthos has been assessed as of low magnitude, the receptor of low sensitivity and therefore the significance of the impact would be negligible. Such an impact would be expected to be largely reversible once operation ceases.

156 It is also likely that the heating effects on the sublittoral conditions associated with both the array and shore transmission cables will be both extremely small, and extremely localised. Such effects may well be below limits of detection, particularly when considered in the context of natural fluctuations in temperatures (London Array Ltd, 2005). The potential impact on subtidal benthos has been assessed as of low magnitude, the receptor of low sensitivity and therefore the significance of the impact would be negligible.

Mitigation

157 No mitigation measures are required.

Residual Impacts

158 The residual impact on intertidal and subtidal benthic communities arising from sediment heating is expected to be negligible and reversible.

Cumulative Impacts

159 The additional impacts arising from the construction and decommissioning of the Ocean Laboratory on the proposed EOWDC site are likely to be of lower significance than those caused by the wind farm development. Furthermore, the supply cable from the Ocean Laboratory to shore is likely to be routed via the main wind farm export cable route, potentially installed in the same trench. Given the minor impact identified during wind farm development operation, it is unlikely that there would be the potential for significant cumulative impacts.

In-Combination Impacts

160 No in-combination impacts are anticipated.

Monitoring

161 Monitoring will be agreed with the relevant statutory authorities and requirements incorporated into the Marine Licence.

1.3.8 EOWDC Future Research and Monitoring Opportunities

162 The presence of a Ocean Laboratory in association with the proposed wind farm development would provide a good opportunity to allow research organisations to undertake long-term environmental studies on several aspects of the marine ecology in the area, as well as monitoring of the actual impacts and of the efficacy of possible mitigation measures applied.

163 Research information on the impacts of noise and vibration on fish, could be initiated in the area for the different project phases.

164 Research into the relative benefits of reef and FAD effects from the newly introduced artificial structures could also be carried out, taking into account their impact on commercial fisheries.

165 On a local scale, these effects can enhance fishing success, or increase fish populations by also supporting fish breeding and recruitment. Hence, research on the role of these newly created habitats and the monitoring of the structure and functioning of associated communities (species richness, biodiversity, functional guilds, population status) over time is suggested.

166 Additional research could also be carried out to determine (and audit) actual operational increases in temperature in the sediments around the cables and its effect on intertidal benthic communities (structure and functioning of the community, behavioural responses).

1.3.9 Summary of Impact Assessment

167 The potential impacts arising from the proposed wind farm development and related to the worst case scenario, as explained before, are summarised in table 2.

Table 2. Impact Assessment Summary

Impact source	Project phase	Receptor	Magnitude of Effect	Sensitivity of Receptor	Significance	Possible Mitigation	Significance after Mitigation	Monitoring	Cumulative / In-combination impacts
Water quality impairment (release of contaminants)	Constr. / Decomm.	Subtidal benthos and epibenthos	Negligible (built-in mitigation measures will be undertaken)	Medium	Negligible	--	Negligible	--	Negligible
		Fish and shellfish	Negligible (built-in mitigation measures will be undertaken)	Low to Medium	Negligible	--	Negligible	--	Negligible
Sediment Resuspension / Redeposition	Constr. / Decomm.	Subtidal benthos and epibenthos	Low	Low	Negligible	--	Negligible	--	Negligible
		Fish and shellfish	Low	Low to Medium	Negligible to Minor	--	Negligible to Minor	--	Negligible to Minor
Habitat Loss	Constr. / Decomm.	Intertidal benthos	Low	Low to Medium	Minor	--	Minor	--	Minor
		Subtidal benthos and epibenthos	Low	Medium	Minor	--	Minor	--	Minor
Habitat Loss	Operation	Subtidal benthos and epibenthos	Low	Medium	Minor	--	Minor	--	Minor

Impact source	Project phase	Receptor	Magnitude of Effect	Sensitivity of Receptor	Significance	Possible Mitigation	Significance after Mitigation	Monitoring	Cumulative / In-combination impacts
		Fish and shellfish	Low	Medium	Minor	--	Minor	--	Minor
Physical Presence of the Submerged Structures	Operation	Subtidal benthos and epibenthos	Low	Low	Negligible	--	Negligible	--	Negligible
		Fish and shellfish	Low	Low	Negligible	--	Negligible	--	Negligible
Underwater noise and vibration	Constr. / Decomm.	Subtidal benthos and epibenthos	Low	Low to Medium	Negligible to Minor	--	Negligible to Minor	--	Negligible to Minor
		Fish and shellfish	Low to Medium	Medium	Minor to possibly Moderate	Noise mitigation at source (e.g. soft-start procedure)	Minor to possibly Moderate	Monitoring will be agreed with the relevant statutory authorities	Minor to possibly Moderate
	Operation	Subtidal benthos and epibenthos	Low	Low	Negligible	--	Negligible	--	Negligible
		Fish and shellfish	Low	Low to Medium	Negligible to Minor	--	Negligible to Minor	--	Negligible to Minor
Electromagnetic fields	Operation	Subtidal benthos and epibenthos	Low	Low	Negligible	--	Negligible	--	Negligible

Impact source	Project phase	Receptor	Magnitude of Effect	Sensitivity of Receptor	Significance	Possible Mitigation	Significance after Mitigation	Monitoring	Cumulative / In-combination impacts
		Fish and shellfish	Low	Medium to high	Minor	--	Minor	--	Minor
Heating	Operation	Intertidal benthos	Low	Low	Negligible	--	Negligible	--	Negligible
		Subtidal benthos and epibenthos	Low	Low	Negligible	--	Negligible	--	Negligible

1.4 Summary

168 This report assesses the possible impacts of the proposed European Offshore Wind Deployment Centre ("EOWDC") off the coast of Aberdeen on the marine ecology present within the development site and within the wider Aberdeen Bay area. The status of different receptors (namely intertidal benthos, subtidal benthos, epibenthos, shellfish and fish) has been assessed against the possible effects arising from the construction, operation and decommissioning activities in the proposed development site.

169 As the details of the main physical structures of the development (e.g. turbine foundations, scour protection, cable array) and installation methods have not yet been decided, the impact assessment has been based on an identified worst case scenario. This has generally been assumed as the installation of 11 turbines and foundations rated at a generative capacity of 10 MW, and with the installation of these occurring over a single phase. Further installation details where applicable have also selected a worst case in terms of the likely highest impact option to individual receptors.

Intertidal Benthos

170 Impacts on intertidal benthos are considered to be restricted to laying/removal (during construction and decommissioning phases) and to the presence (during operational phase) of the export cable connecting the offshore wind farm development to the onshore substation. Cable laying or removal would cause a localised and temporary disruption to the status of the soft sediment intertidal communities along the cable route through direct habitat loss (trenching) and indirect loss (smothering by spoil). However, following instatement, it would be expected that a rapid recolonisation would occur, initially by opportunistic species and then by a more characteristic infauna. Greater impacts are expected on longer-lived sedentary species, due to their lower recoverability rate, but these species are of minor importance in the intertidal benthic assemblage of the moderately exposed shores typical of the Aberdeenshire area. As such, the overall impact is assessed as of minor to negligible significance.

171 Data indicate that an increase in temperature can be also detected in sediments around export cables, and that this might possibly affect the physiology and mortality of benthic species, with subsequent alteration of intertidal benthic communities. Although little information on the effect of small temperature changes on benthic communities is available, any effect is likely to be highly localised and of very low magnitude. As cables will be buried to a depth of around 60 cm or more, i.e. below the depth that most animals occur, impacts are predicted to be negligible.

Subtidal Benthos & Epibenthos

172 Potential impacts on subtidal benthic and epibenthic fauna are expected to arise during the construction phase, due to habitat disturbance and permanent habitat loss, accidental release of contaminants from construction works and underwater noise.

173 Based on a worst case design and installation option for the proposed development and knowledge of the prevailing baseline sediment conditions

in the area (e.g. low sediment contamination levels), impacts from habitat damage and loss are considered likely to be localised and of low magnitude. The benthic biotope present in the potentially affected area has a generally low sensitivity to temporary habitat disturbance, has no particularly high conservation value and is not uncommon in the wider area. Overall subtidal habitat loss impacts during the construction phase have therefore been assessed as of minor significance.

174 Minor issues have been raised with regard to the effects of increased turbidity and sediment re-suspension on benthic and epibenthic subtidal communities during construction. However, given that the infaunal communities in the area are likely to be adapted to naturally high levels of such conditions, impacts are predicted to be of negligible significance. Similar types of impact can be identified for the decommissioning phase, although a lower significance is assessed in this case, due to the absence of a permanent habitat loss (linked to the footprints of installed structure which are expected to be readily recolonised after removal).

175 The operational phase will involve an ongoing ‘habitat loss’, the effects of which are considered of low magnitude. Given the medium sensitivity of the receptor the impact has been assessed as of minor significance. Possible additional issues identified for the operational phase include the effects of underwater noise, electromagnetic fields (EMF) and heat. The potential sensitivity of the receptors has been identified as low and effects during the operational phase have been assessed as of low magnitude. Impact significance is therefore negligible.

Shellfish & Fish

176 Noise and vibration generated during wind farm construction work (mainly from piling) are likely to have the greatest impacts on the fish fauna of an area, potentially leading to injuries, mortalities and behavioural effects. For the EOWDC development, these effects are likely to be short-term and intermittent, and their magnitude is expected to decrease with distance from the noise source. Most fish are able to exhibit avoidance behaviour that can naturally reduce impact levels when conditions become unsuitable. Soft start procedures will allow fish to move away from the noise source before maximum noise levels are reached. Furthermore, the most abundant species in the proposed development area (e.g. flatfish) are believed to have low sensitivity to noise and vibrations, and no significant sensitive fish habitats (spawning or nursery grounds) occur in the proposed development site. Such sound pressure has the potential to propagate outside the proposed development site, and could potentially affect hearing sensitive habitats further offshore (e.g. herrings spawning grounds), although there are no data available on the local distribution of these habitats in the possible range of disturbance of piling noise. Due to this lack of information, it has been necessary to adopt a precautionary approach and an overall assessment of construction noise impacts on fish (using the worst case development scenario) is considered to be of minor to possibly moderate significance.

177 Other potential impacts on fish and shellfish during construction may arise from sediment re-suspension and contaminants release, but these have been assessed as of negligible to minor significance due to their effect being highly localised and temporary. Similar types of impact to those

described above can be identified for the decommissioning phase, although a further lower significance is assessed in this case.

178 Potential impacts on fish during the operational phase mainly arise from electromagnetic emissions associated with cabling, these considered to be being of minor significance. EMFs from subsea cables might interfere with electro-sensitive fish, such as medium sensitive salmonids (medium sensitivity) and elasmobranchs (high sensitivity). However, the presence of sharks and rays in Aberdeen Bay is infrequent hence the effect has been assessed of low magnitude and the impact of minor significance. Impact on migrating salmonids is assessed in detail within the salmon and sea trout assessment for the proposed EOWDC.. Cable burial can provide a possible mitigation to such an impact, and, given the current general paucity of information, it is considered that industry standard mitigation measures should be implemented at the time of construction/operation. Residual impacts are therefore considered to be of minor significance.

179 Other potential impacts to fish and shellfish may arise from underwater noise generated during operational activities, whilst the presence of seabed/water column structures could affect shoaling behaviour of pelagic fishes. However these impacts are considered to be of low magnitude, due to the generally low disturbance intensity (for noise) and temporary effect (for shoaling disruption). A further impact could arise from the “reef effect” and “FAD effect” associated with the presence of the artificial hard substratum structures. However this impact is assessed as being positive (providing new habitat which would be of value for many fish and shellfish), although given the extent of such features within the wider development site, any positive effects would be negligible.

Cumulative impacts

180 Potential cumulative impacts arising from the possible presence of other activities and installations in the proposed development area have been assessed. However, no other such plans or projects were identified near the proposed development site, except for the proposed Ocean Laboratory, which should be installed on the wind farm site itself. Additional impacts arising from the construction, operation and decommissioning of this structure are likely to be broadly similar (in type) to those assessed for the wind farm development. However, these impacts are likely to be of lower significance compared to those caused by the wind farm development, given also the smaller scale of the Ocean Laboratory. Hence cumulative impacts have been assessed as of the same significance levels of those arisen from the proposed development.

181 The potential direct and indirect impacts of the proposed development on salmonid, and indirect impacts on freshwater pearl mussel, populations of the River Dee and River South Esk SACs have been addressed within the salmon and sea trout assessment for the proposed EOWDC.

Water Framework Directive and Good Ecological Status

182 The EU Water Framework Directive (WFD) requires Member States to produce a series of River Basin Management Plans (RBMPs) which are designed to ensure that water bodies achieve Good Ecological (and chemical) Status (GES).

183 The proposed development site is located within the area of the River Basin Management Plan for water body Cruden Bay to the Don Estuary (Identifier Code 200117). This water body has been classified as having an overall High with High Confidence Status with an overall Ecological Status of High and Chemical Status of Pass. As such, within the context of the WFD, the water body currently meets the objective of Good Ecological Status. Within the requirements of the WFD, water bodies have to be maintained in GES.

184 In order for the Cruden Bay to the Don Estuary water body to be maintained in GES, there are a series of measured parameters included in the classification, which contribute to the status values outlined above. These parameters synthesise attributes for chemical and biological determinands, including water quality metrics such as Dissolved Oxygen and pollutant levels; biological metrics such as benthic invertebrates (infaunal quality index), alien species and phytoplankton; and hydro-morphologic attributes.

185 As part of the baseline ecology review and subsequent impact assessment phase, details of such metrics have been characterised and assessed.

186 Based on the findings of this assessment process, it is considered that the construction, operation and decommissioning of the proposed development will have a generally negligible impact on the immediate ecology of the surrounding waters and seabed, and no significant medium or far field impacts. It is considered that the development would have no measurable effect on the attributes used to classify the water body as being in Good Ecological Status, and will not lead to the deterioration of Good Ecological Status at the site.

187 The conclusion of the assessment process is therefore that the development will not affect the Good Ecological Status of the Cruden Bay to the Don Estuary water body.

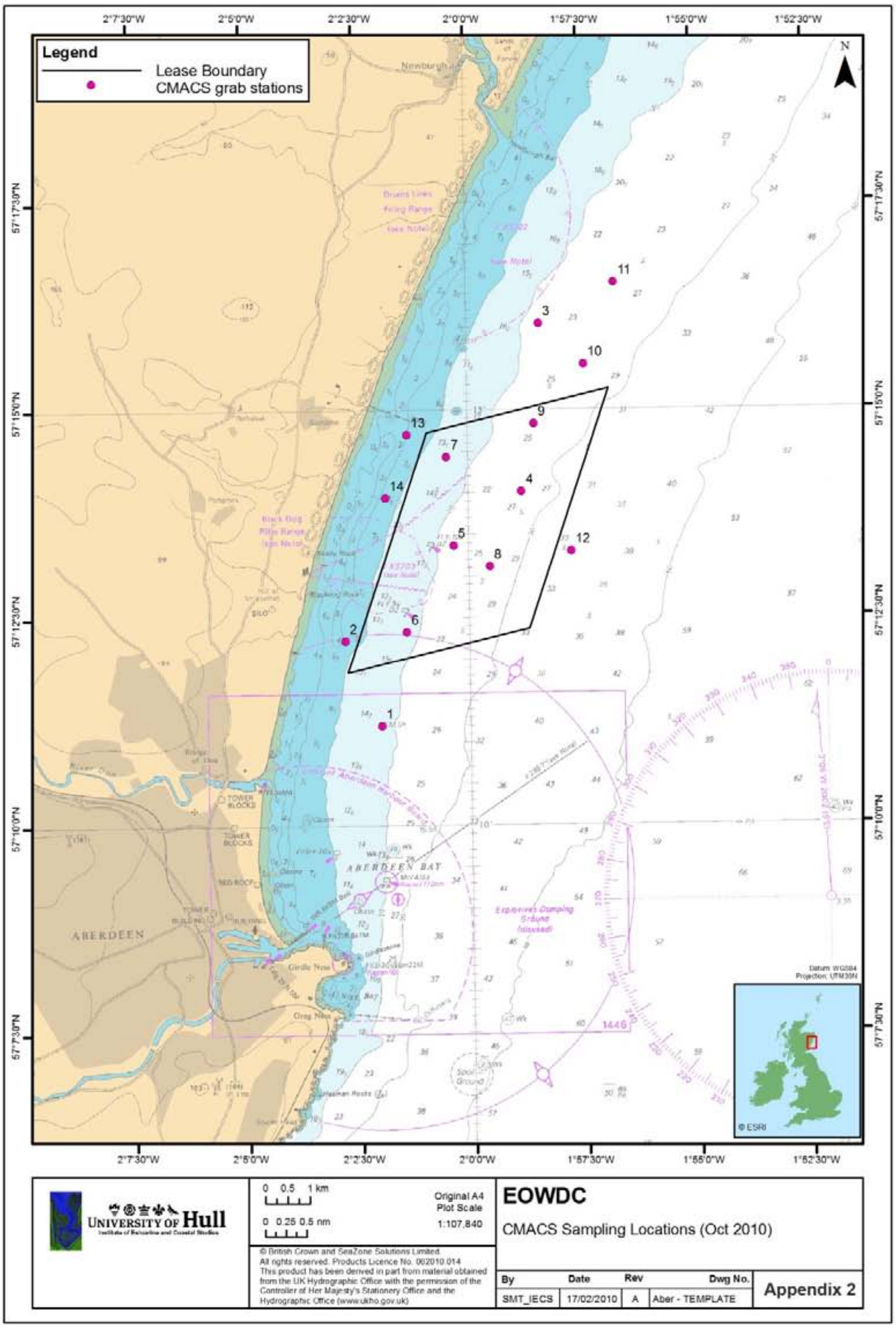
1.5 Appendices

1.5.1 Appendix 1. Sensitivity of benthic biotopes present in the proposed EOWDC area (based on data given in MarLIN)

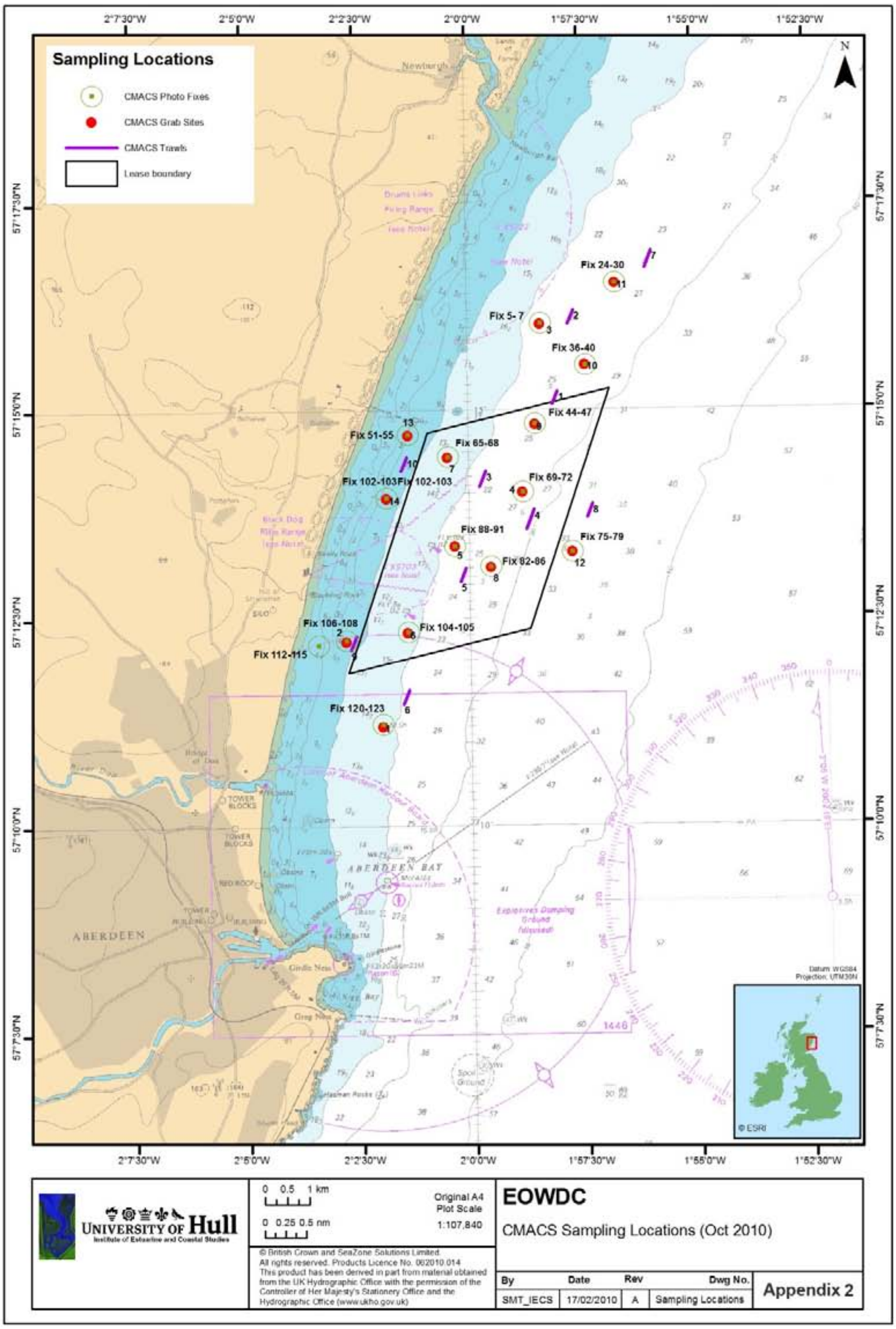
Biotope	**SS.SSA.IFiSa.NcirBat**	**SS.SSA.CMuSa.AalbNuc**
Dominant species	*Nephtys cirrosa, Pontocrates altamarinus*, *Bathyporeia* sp.	*Notomastus latericeus, Nucula nitidosa, Tellina fabula,* Ophiuridae*, Pholoe baltica, Abra alba*
Stations (CMACS survey 2010)	2, 13, 14	1, 3, 4*, 5*, 6*, 7*, 8*, 9*, 10, 11, 12
Sensitivity to increased suspended sediments	Not sensitive	Very low
Sensitivity to abrasion and physical disturbance	Very low	Low
Smothering recoverability	Immediate	Immediate
Substratum loss recoverability	Very high	High

* stations within the proposed development lease boundary (see Appendix 2)

1.5.2 Appendix 2. CMACS Benthic Survey 2010 - Grab Survey Locations



CMACS Benthic Survey 2010 - Survey Locations



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European Offshore Wind Deployment Centre

Environmental Statement

Appendix 10.1: Ornithology Baseline and EIA Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

GENESIS

Report

Ornithological Baseline and Impact Assessment

Genesis Job Number J-71666/A

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Contents

1 NON TECHNICAL SUMMARY

This report presents the results from baseline ornithological surveys undertaken in order to inform the Environmental Impact Assessment (EIA) prepared for the proposed European Offshore Wind Deployment Centre (EOWDC) and the findings of the impact assessment undertaken.

The proposed EOWDC development lies to the north of Aberdeen, in Aberdeen Bay, approximately 2 km at its closest point, off the coast. The proposed development comprises of the potential installation of 11 wind turbines and a potential future option of an ocean laboratory, which would be subject to a separate application. The EOWDC is a test centre for wind turbine technology and therefore the potential structures of the wind turbines that could be installed are currently unknown. In order to take these uncertainties into account a worst case scenario has been applied when assessing the potential impacts.

Prior to undertaking any assessment a variety of bird surveys have been commissioned since 2005 aimed at identifying the potential bird sensitivities that may occur within Aberdeen Bay throughout the year. The surveys comprised of monthly boat-based bird surveys undertaken between February 2007 and April 2008 and again from August 2010 to present. Further boat-based bird surveys are planned until at least August 2011. Due to the proximity of the proposed development to land, Vantage Point surveys have been undertaken on a monthly basis for a period of three years between March 2005 and October 2005 and March 2006 to March 2008. The surveys complimented those undertaken by boat and provide data on birds present in nearshore waters of Aberdeen Bay. In addition to the boat-based and Vantage Point surveys, three studies using radar have been commissioned: in October 2005, April 2007 and April 2010. These radar studies provided information on the use of Aberdeen Bay over a wider area and during periods of darkness and or poor visibility.

The data from all the surveys have been used to help inform the impact assessment.

The impact assessment has considered all species of bird recorded from all surveys undertaken in Aberdeen Bay. It has also considered other sources of published data, e.g. North-east Scotland Bird Reports, JNCC aerial surveys (Söhle *et al.* 2006; Lewis *et al*. 2008) and the Birds of North-east Scotland (Buckland, Bell & Picozzi 1990).

The potential impacts on all bird species that were identified as qualifying species for a Special Protected Area (SPA) have been assessed in detail within the impact assessment. Other species which were recorded in significant numbers and had the potential to be impacted by the proposed EOWDC have also been addressed within the main impact assessment, Section 4. All other species that occurred in low numbers for which it was determined that there is unlikely to be a significant effect based on the data collected and relevant published documents have been summarised at the end of the report.

For the purposes of this impact assessment an evidence based approach has been used to determine potential impacts as well as expert judgement based on the baseline information and results from other offshore wind farms. An impact matrix has been used to provide a structure and consistency of approach and has been used as tool to help inform the impact assessment. However, the results from the impact matrices have not been considered to be definitive, nor in isolation. The assessment is ultimately based on the latest published data available on potential impacts, i.e. wherever possible an evidence based approach has been adopted.

The impact assessment recognises that under the EIA Regulations, significance is used to determine the relative importance of an effect on a feature. Whereas under the Habitats Regulations it is a coarse filter to determine whether a further Appropriate Assessment is required (IEEM 2010). In determining the level of significance for the EIA the recommendations made in Maclean *et al.* (2009) have been used.

Two types of sensitivity have been identified: Non-impact and Species specific sensitivities.

Non-impact sensitivities are based largely on legislative requirements and population sizes. Species with relatively small populations and/or are qualifying species for a designated site have been considered to be of high sensitivity. Species with larger populations or are a non-qualifying species are assessed as having a lower sensitivity.

Species specific sensitivities have been undertaken in line with recommendations made in Maclean *et al* (2009). Sensitivities of species groups to particular impacts have been ranked and combined with the non-impact sensitivities to give an overall sensitivity. The main types of impact identified are:

- Collision Mortality,
- Barrier effect,
- Displacement (including disturbance and indirect impacts, i.e. depletion of prey).

Collision Risk

Collision risk modelling has been undertaken based upon the Band *et al.* (2000) model. For the purposes of this assessment a range of avoidance rates have been considered to give a range of potential mortality rates. The avoidance rates used are 98%, 99% and 99.5% based on SNH guidance (SNH 2010). However, in order to determine potential effects a precautionary 98% has been used for nearly all species within this EIA. Not all species recorded within Aberdeen Bay are at significant risk of collision. The level of risk depends on a large extent as to whether the species frequently flies at rotor height. Birds can fly at any height and may change depending upon weather conditions or behaviour. However, by using data from both site specific boat-based survey data and other extensive data sets from other offshore wind farm locations a large sample size of flight heights are available for collision risk assessment. The species selected for collision risk modelling have been selected on their frequency of flying at rotor height and the frequency at which they are recorded in Aberdeen Bay. Collision risk modelling was undertaken on the following species:

- Red-throated diver
- Fulmar
- Gannet
- Cormorant
- Pink-footed goose
- Barnacle goose
- Common scoter
- Guillemot
- Common gull
- Herring gull
- Kittiwake
- Sandwich tern
- Common tern

Barrier effect

Barrier effects may arise should the species avoid flying through the proposed development and by doing so incur additional energetic costs required to fly the extra distance around the turbines (Speakman, Gray & Furness 2009; Masden *et al.* 2010).

The risk of an impact is largely dependent on the number of times a bird may have to cross the obstruction and also the individuals' fitness. Should a bird be required to avoid an area only once or twice a year when undertaking a migration then it is likely that the potential impact will be lower than if a bird regularly flies around a barrier, e.g. between a feeding or roosting site (Speakman, Gray & Furness 2009).

In order to assess the potential impacts from displacement it is assumed that, unless data from other wind farms indicated otherwise, all individuals avoid flying through the site and detour around it and by doing so fly further than would have otherwise been the case. To calculate the potential length of a detour it is assumed that the detour started 1 km in front of the proposed development and that the bird detoured back on to the original course 1 km beyond the proposed development. Where appropriate, results from energetics modelling have been considered to assess the potential incremental increase in daily energy expenditure (Speakman, Gray & Furness 2009).

Displacement

Disturbance caused by the proposed EOWDC may lead to displacement of birds from potential feeding areas, resulting in effective habitat loss. Displacement may be caused by disturbance from vessels associated with the proposed development or from secondary impacts, i.e. the depletion of prey in the development area. The significance of the displacement is difficult to quantify but for species that rely on localised or patchy food supplies the affect may be more significant than it is for species that have a wide area of food supply. Based on the Maclean *et al.* (2009) report, the impact assessment has considered sensitivity of a species depending on its habitat flexibility, i.e. how restricted is the species to a particular habitat preference.

Significance of impact

The potential significance of the impact is based on the possible magnitude of an effect occurring and the overall sensitivity of each species to the impact. The results from which indicate the likely significance any impact may have on the receptor. However, this is only an indicative sensitivity and evidence from existing wind farms and expert judgement is used to determine whether the potential impact was likely to be either significant or adverse.

Where the potential significance is identified as being negligible or minor it is considered to be of limited or no concern. Moderate significance is of concern but may be tolerable depending on the causes that give rise to the potential impact. Major concerns are considered to be a potentially significant effect.

Determining potential adverse effects.

The Habitats and Birds Directives require an assessment to be undertaken to determine whether there are any potential adverse effects on a species. In order to do this the impact assessment has identified all the relevant SPAs for which there may be an interaction with the qualifying species and the proposed development. The assessment to ascertain whether there is an adverse effect on site integrity is a judgement based one based on the best available evidence.

Assessment of cumulative impacts

The cumulative impact assessment considers all other industries which have the potential to impact on the birds that may be present at the proposed development location, these include:

- Offshore renewables,

- Shipping,
- Aggregates,
- Dredging,
- Oil & gas.

Offshore renewable projects that have been identified as having the potential for a cumulative effect include two developments in the Moray Firth and three in the Firth of Forth. The sites in the Moray Firth are approximately 150 km to the north and those in the Firth of Forth approximately 120 km to the south of the proposed development.

The construction of the proposed EOWDC may overlap with construction activities being undertaken at other planned developments. However, given the stage of development of the renewable projects yet to be constructed and the uncertainty as to the types of foundations and turbines that will be used, there is sparse information available to incorporate into any impact assessment, which limits the effectiveness of cumulative assessments considering conceptual projects yet to be subject to a formal planning application and for which no environmental or design data are currently available.

Therefore, the cumulative impact assessment can only be undertaken with data available from the currently operating Beatrice demonstrator project in the Moray Firth. Although, the assessment does wherever possible consider potential cumulative impacts from other yet unconsented renewable projects.

Shipping associated with the harbour which has been undertaken in Aberdeen Bay over many centuries with currently approximately 16,000 vessel movements per year. There are no known plans that are likely to cause a significant increase in the level of shipping currently being undertaken in Aberdeen Bay and any impacts shipping may currently be having on the birds within Aberdeen Bay will be part of the baseline.

There are no aggregates activities within Aberdeen Bay. There are no licensed dredging sites within Aberdeen Bay but occasional dredging of the harbour may occur, with the next dredging scheduled for 2012.

Aside from associated shipping there are no oil and gas related activities within Aberdeen Bay.

Assessment of in-combination impacts

The Conservation (Natural Habitats, & c.) Regulations 1994 (as amended) require that a Habitats Regulations Appraisal (HRA) must be conducted by a competent authority. The HRA considers the implications for European sites in view of the European sites conservation objectives, in respect of any plan or project which is not directly connected with or necessary to the management of the European site for conservation purposes and which is likely to have a significant effect on the European site either alone or *in-combination* with other plans or projects.

Therefore the term ‘in-combination’ will be used when considering the impacts of the proposals with other plans or projects on European sites.

The main industries considered for potential in-combination impacts are proposed offshore wind farms, aggregate industry, dredging, oil and gas and shipping. Of these, proposed offshore wind farms and shipping are the only activities identified for which there is a potential for an in-combination impact.

Impact assessment summary

The results of the initial impact assessment identified 36 species of bird that due to either their conservation status, i.e. are a qualifying species for an SPA or due to the numbers recorded within the proposed development area could be impacted by the proposed development.

Following the use of matrices to indicate the significance of a potential impact arising from the construction, operation and decommissioning of the proposed development an evidence based assessment has been undertaken to determine the overall significance of the potential impacts.

The results indicate that for most species the proposed development is likely only to have a negligible or a minor effect on the species present.

However, the impact assessment has identified the potential for impacts of moderate significance on four species of bird: red-throated diver, little tern, Sandwich tern and common tern.

Red-throated diver may be displaced from the area of the proposed development during construction, operation and decommissioning phases. Site specific data indicate that although the higher numbers of red-throated diver occur to the north of the proposed development area a proportion of the local regional population may be displaced. The effects of the possible displacement on red-throated divers are unknown but could be significant were all those displaced not to survive. However, this scenario is considered improbable as the red-throated diver is not resident in Aberdeen Bay and the proposed development is in an area not favoured by red-throated diver. Any Divers that may be displaced will be able to move to other suitable foraging areas. Therefore, although the impact may be moderate in terms of displacement the actual impact on the Diver population within Aberdeen Bay will be negligible or minor.

Three species of Tern were identified as being at potential risk of a moderately significant impact due to possible indirect impact on their prey should pile driving occur during the construction period. However, it is also considered that any displacement of prey would be temporary as fish would return to the area following cessation of piling. Consequently, the possible impacts were considered to be of a temporary nature and would not have a long-term effect.

Mitigation and Monitoring

Detailed mitigation and monitoring measures aimed to avoid, remove or reduce any potentially significant impacts will be developed more fully during consultation with the Regulator and their statutory advisors and other stakeholders.

The main potential impacts arising from the proposed development relate primarily to direct or indirect displacement effects on Divers and Terns. Mitigation measures that may be considered as measures to help avoid, remove or reduce them include:

- Minimising the proposed development area as far as practicable in the early design stage.
- Vessel management plans to ensure vessels minimise disturbance as far as practicable,
- Installing Foundation types that reduce noise levels during construction,
- Timing and duration of installation,
- Minimising aviation and navigation lighting.

It is important that monitoring is undertaken that is designed to address specific concerns or potential impacts identified during the EIA process. Poorly designed *ad hoc* monitoring is likely to be inefficient and not provide useful or meaningful results. It is therefore important that a detailed monitoring programme is developed in collaboration with the Regulator and statutory advisors and taking note of key stakeholders comments during the consultation period. A detailed monitoring programme aimed at specific issues or concerns would be developed with the Regulator and advisors should consent be granted.

2 BIRD SURVEY METHODS

2.1 Introduction

Three different types of bird surveys have been undertaken since 2005 in order to obtain suitable ornithological survey data to inform the Environmental Impact Assessment and, if required, Habitat Regulations Appraisals.

Monthly boat-based surveys were undertaken between February 2007 to April 2008 and an additional 12 months of surveys commenced in August 2010. In addition to the Boat-based surveys, three years of Vantage Point surveys were undertaken from March 2005 to October 2005 and between March 2006 and March 2008 and three radar surveys were carried out in October 2005, April 2006 and April 2010 (Figure 2-1).

The results from these surveys along with additional information have been used to help inform the Environmental Impact Assessment.

2.2 Boat-based Survey Methodology & Data Analysis

Survey Area and Transects Route

There have been two periods of boat-based bird surveys undertaken in support of the proposed development.

Between February 2007 and April 2008 boat-based surveys were undertaken on a monthly basis. Each survey covered an area of 101.6 km^2, which included the then proposed development site plus a buffer zone and a 'control' survey area located immediately to the north (Figure 2-2). The 'control' survey area of 50.8 km^2 was the same size as the then proposed EOWDC site (including the buffer zone). The site proposed at the time the surveys were being undertaken represented 12% of the total area surveyed, and 24% of the proposed EOWDC survey area. The distance of the shoreline to the proposed EOWDC survey area varied between 0.6 km to 7 km and to the 'control' survey area between 0.5 km to 6 km. The 'control' survey area was positioned in an area exhibiting similar physical attributes (bathymetry and seabed type) to that of the development site survey area (IECS 2008).

Various transect designs were considered when establishing the survey methodology (e.g. parallel to the coast, perpendicular and zigzag). At the time it was considered that a perpendicular alignment provided the best option in terms of data collection and analysis, as it best captured environmental factors such as depth and wave exposure. As such, the sampling design comprised a grid of systematically spaced line transects approximately perpendicular to the coast. The transects, spaced 1 km apart, were conducted perpendicular to the coast on an approximately east-west orientation (Figure 2-2).

The 'control' and development areas each consisted of 10 main transects 6.5 km long, together with nine short legs 1 km long, and therefore constituted two separate samples. The 20 transects were travelled over two days, preferably on two consecutive days (with 10 transects per day). The transects were steamed at a constant speed of approximately 8 knots. The survey route was designed to give a total boat transect length of 74 km per site, considered to be approximately the maximum length of transect which can be covered in daylight hours during the winter at this location.

The 'short legs', which preserved the spacing of 1 km between the main transects, were surveyed to gather additional data. The shoreward side was always covered in both the inshore and offshore short legs. To ensure coverage of the shallow areas, it was necessary to operate the 300 m band transect on the port side when commencing from the south end of the site, and on the starboard side when starting from the north end of the site. The four start points for the 'control' and proposed EOWDC survey areas were randomised between the surveys. The transect band on the main transects were operated alternatively on the port and starboard sides to avoid the sun glare.

In order to reduce disturbance to birds (and marine mammals) prior to and after surveying, the survey vessel did not travel through the survey area when positioning or returning from the northernmost extent of the site. Instead, the boat followed an offshore route outside the survey area.

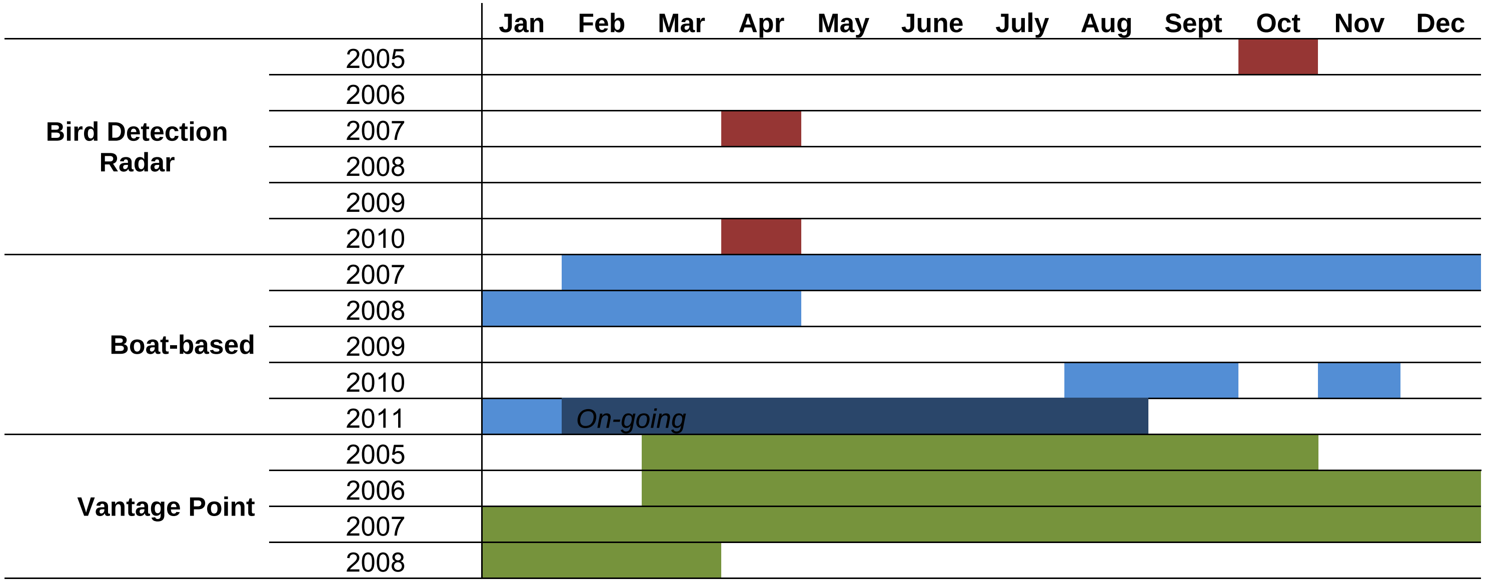
Following the completion of the Year 1 bird surveys the location and size of the proposed development was amended. This meant that although the previous surveys did cover the revised location for the proposed development (Figure 2-3), to ensure better potential for future monitoring an alternative survey area was designed for the boat-based bird surveys undertaken since August 2010 (Figure 2-4).

In addition to the differing survey area due to the revised location of the proposed development, the survey design was also amended to take into account advances in understanding of the limitations in using Before After Control Impact (BACI) designs. The use of the gradient approach allows distance from the development footprint to be included as a covariate within the analysis. Consequently, it improves the future potential to detect change in seabird distributions and abundances. Three areas were surveyed each month to the north, south and eastwards outwards to 25 km allowing a gradient approach to be used (SMRU 2011b). The total surveyed area each month was 339 km^2, comprising of three strata: 150.8 km^2 (north), 82.8 km^2 (south) and 105.2 km^2 (offshore) (Figure 2-4).

The surveys undertaken since August 2010 have also been undertaken in equally spaced zigzag line transect as opposed to linear parallel surveys as previously undertaken. By doing so this allows continuous surveying and less time wasted in transit between parallel transects. It also provides coverage of the full depth, distance to shore and wave exposure gradients present. The survey design was carried out using the Distance software to ensure even coverage probability within each stratum.

The start point of transects routes was randomised to account for any confounding effects of time of day and port activity e.g. bird activity may decline from a morning peak and port activity increase.

Figure 2-1: Survey periods



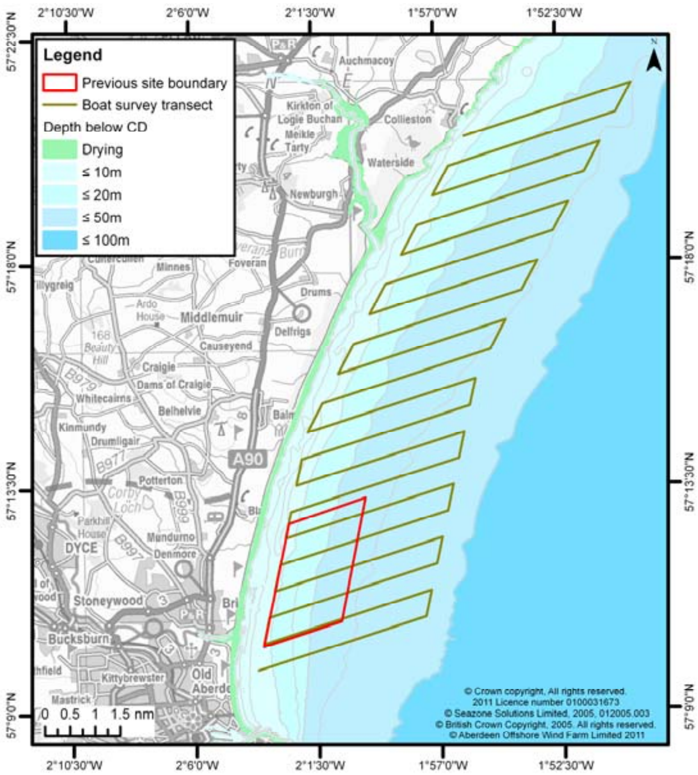


Figure 2-2: Areas surveyed from boats for birds and marine mammals between February 2007 and March 2008 and the proposed EOWDC location at the time surveys were undertaken.

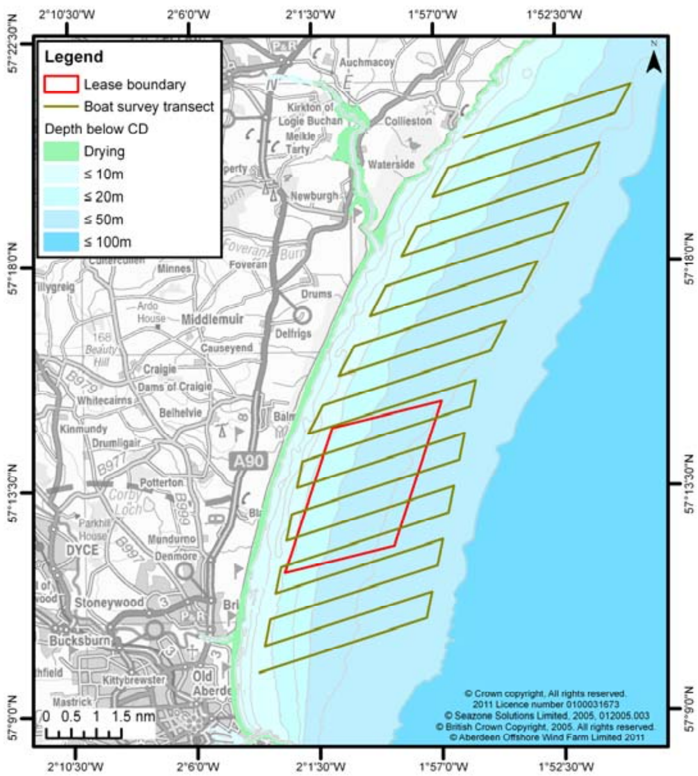


Figure 2-3: Areas surveyed from boats for birds and marine mammals between February 2007 and March 2008 and the revised EOWDC location.

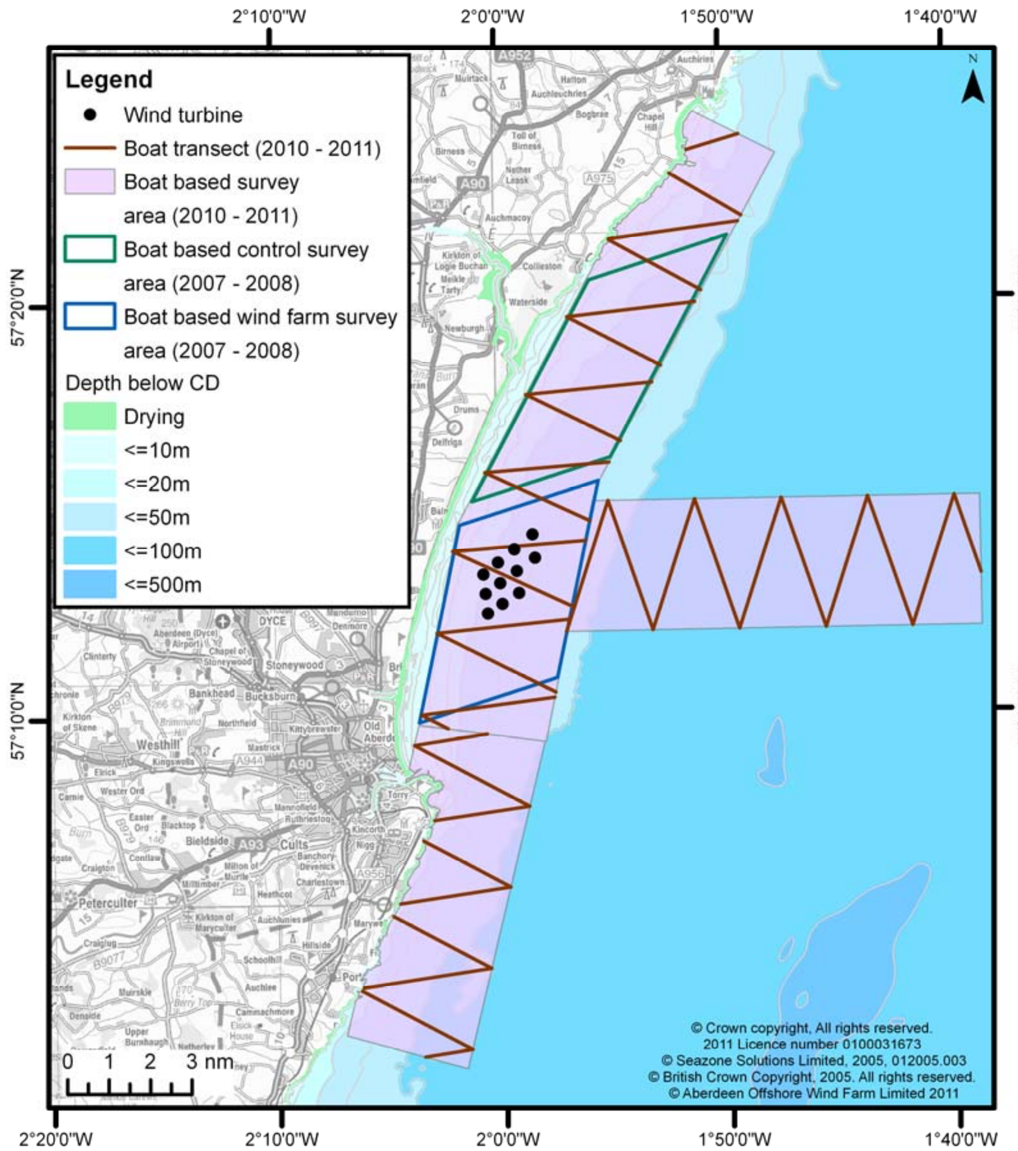


Figure 2-4: Survey strata and transects in the context of previous areas surveyed and the approximate area of the development site.

Survey Programme

Between February 2007 and March 2008 and August 2010 to January 2011, surveys were conducted once every month during daylight hours and efforts were made to undertake the survey over two consecutive days. Due to issues arising outwith the control of the project no surveys were undertaken during October 2011 and December 2011. However, double the number of surveys will be undertaken in periods of potentially higher sensitivity in June and July 2011. Surveys were primarily conducted in conditions of less than sea state 3 with consideration given to residual swell levels prior to the surveys being undertaken. The times of the surveys were dependent on the weather conditions, availability of the survey boat and of the observers. However, the survey programme was scheduled to cover different tidal states, and times of the day (where possible during the longer hours of daylight in the summer), in order to get an adequate coverage of the factors that may affect the distribution, abundance and activities of birds and marine mammals in the Aberdeen Bay area.

Boat-based surveys were conducted in February 2008 to coincide with the Vantage Point (VP) watches (See Section 2.3) with shore-based observations undertaken by an experienced bird/marine mammal observer, to monitor any potential disturbance of birds and marine mammals by the survey vessel.

Sampling Methods

Both boat-based survey programmes employed the standard seabird census techniques for use on a boat platform as described by Camphuysen *et al.* (2003). The methods involved a band transect, operated on one side and ahead of the ship, and with short time-intervals in a continuous series, to sample short stretches of water with a known surface area and location.

All surveys were undertaken by a team of three experienced observers who had been Joint Nature Conservation Committee (JNCC) European Seabirds at Sea (ESAS) trained and included observers who had completed the JNCC's Seabirds at Sea Team (SAST) training course for seabird surveyors (Edinburgh 2005 & 2006), and had experience of surveying seabird populations including numerous ship-based seabird surveys.

Observers undertook a 90º scan with a 300 m band transect using a snapshot technique. The 300 m strip on one side of the ship with the best visibility (least glare etc.) was divided into a series of distance bands running perpendicular to the ship (using the Camphuysen *et al.* 2003 divisions).

Birds observed within the band (A-D) were noted as being '*in transect*'. Flying birds were recorded '*in transect*' using the *snapshot technique* to overcome biases caused by the flux of flying birds. Bird data were summarised on field data forms every minute using a snapshot at a speed of 8 kts (frequency of snapshot could be adjusted according to the speed of the boat). A recording interval of 1 minute was considered to be most applicable for such a relatively small area and coastal location, subsequently allowing a more detailed analysis of species distribution.

Two observers were present on the observation deck counting birds simultaneously. The role of the primary observer was to detect by naked eye, birds on the sea (within transect) and in the air through an arc of 90º. The secondary observer recorded observations and assisted the primary observer in the detection of birds by naked eye. The third observer was dedicated to the forward detection of divers and seaducks, which are known to flush from the sea surface at considerable distance from the vessel. In contrast to the first two observers, detection of birds by the third observer was made by continuous forward scanning using high quality binoculars in order to improve the detection of escaping and diving birds. Each bird was only recorded once, and 'ship associates' were ignored. The third observer assisted the main team of two observers during the spring migration (March, April & May) and autumn migration (September & October) when it was thought that potentially large movements of divers, seaducks and auks might occur during these periods. All three surveyors alternated roles during surveys to reduce observer fatigue and standardise findings.

Distance and band estimates of Observers were checked during surveys to ensure consistency across transects and observers.

In addition to the parameters required by the ESAS methodology, extra information was recorded by the observers in order to assess the potential problems of double counting and bird disturbance (particularly to Divers and seaducks) created by the survey vessel. The extra information included the behavioural response from the approaching vessel (e.g. escaped/dived or flushed) and the distance at which the birds responded.

For each observation the details shown in Table 2-1 were recorded.

Table 2-1: Biological variables collected by bird surveyors and order of recording priority.

1	Species:	Identification to species level. However, this is not always possible and in this case the most precise identification possible should be given e.g. common guillemot/razorbill, large gull sp. (great black-backed gull/lesser black-backed gull and herring gull).
2	Numbers:	Number of individuals present within the sighting.
3	Transect:	A tick placed in a column of the recording sheet if the bird is '*in transect*'. A blank is left if the bird is not '*in transect*'.
4	Behaviour:	On the water or flying.
5	Distance from the ship:	Distances of the bird from ship are estimated using a range finder, and coded as follows. For birds on the water the SAST sub-divide the 300 m band transect into four zones. A: 0-50 m, B: 50-100 m, C: 100-200 m, D: 200-300 m and E> 300 m. For flying birds; 1: 0-100 m, 2: 100-1,000 m and 3: > 1,000 m.
6	Flight height:	The distribution of flying height is estimated and assessed from the ship, by categorising any birds seen in flight to its altitude. Categories are expressed as 0-2 m, 2-10 m, 10-15 m, 15-25 m, 25-50 m, 50-100 m, 100-200 m, >200 m to avoid confusion. Flight height categories follow the COWRIE guidelines.
7	Direction:	Flight direction of each sighting is recorded.
8	Behavioural response to survey vessel:	Flushed to flight (F) or diving in response to survey vessel (E/D).
9	Distance of response:	Distances of the bird flushed to flight or diving from the ship estimated in metres.
10	Plumage, moult, age and sex of the bird:	Where age is unknown, a blank is left otherwise coded as follows: A: Adult and IMM: Immature. For plumage, S: summer and W: winter are used.
11	Cetaceans:	Cetacean and sea mammal sightings recorded where appropriate.

Additional environmental data in the form of a survey log was maintained during the surveys, with data collated including weather conditions and sea state, as well as additional observations such as positions of fishing boats and other vessels, with observational data on species logged on modified SAST recording sheets. Prior to the survey programme commencing, all transect start and finish points were inputted into the ship's GPS system, and subsequent transects were then steamed using these co-ordinates. Survey logging of transects was determined using a handheld GPS. Output from the GPS provided the position (in latitude and longitude), speed, and bearing of the boat for every time interval recorded.

Boat-based Surveys Data Treatment and Analysis

Estimating population size in the ship-based survey areas

Total population size within an area surveyed was estimated using a variety of methods, including:

- Extrapolation of density
- Distance sampling; and
- Summed interpolated (kriged) abundances derived from geostatistical analyses

The effectiveness of the methods for producing accurate total population size estimates is discussed in McSorley *et al.* (2005). Distance sampling is a widely applied method of estimating total numbers and is currently the only method that allows estimation of 95 confidence limits. This method, using the *Distance* computer programme, is used as a primary method of estimating population size for the most frequently recorded species in this report. However, *Distance* may not produce accurate results where the numbers of observations are very small; where this is the case, use of an alternative method is necessary to estimate population size. Where distance sampling was not possible (<50 different observations), simple extrapolation of the overall sample density was used to estimate the total numbers of birds in the ship-based seabird survey areas. Further details are provided below.

Distance sampling using Distance computer programme

Distance sampling is a widely used and accepted statistical method that accounts for a major source of potential underestimation during surveys. The method has been demonstrated to produce accurate population estimates for seabirds (Buckland *et al.,* 2001), and is widely available and accessible through the use of Distance 5.0 software (Thomas *et al.,* 2002).

There are four basic assumptions of distance sampling that should be adhered to if an unbiased density estimate is to be obtained:

1. Birds directly on or close to the transect line are always detected.
2. Birds are detected at their initial location prior to natural movement or movement in response to the observer's presence. It is assumed that birds do not move in response to the survey platform.
3. Distances are accurately measured.
4. Objects are distributed randomly with respect to the survey transects.

All birds recorded on the sea surface '*in transe*ct' (on the main transects) were included for analysis. The data input to the *Distance* computer programme was restricted to those collected on the main transects, as the inclusion of data from 'short legs' risked double sampling of birds from the areas at the corners where the boat turned to begin the next main transect (Buckland *et al.*, 2001).

Data collected during the 'snapshot' (i.e. flying birds in 'transect') were not suitable for distance sampling (Camphuysen *et al*. 2003). Since only data collected on the sea surface may be included in the distance sampling analyses, the population estimates may be artificially reduced, as they exclude birds in flight. In order to rectify overall population estimates, estimation of birds in flight using extrapolation of birds recorded at the time of the snapshot (i.e. 'in transect'), were added to population estimates on the sea surface.

The population size in flight was estimated by multiplying the overall density in flight by the total study area.

Extrapolation of overall estimate

Where distance sampling using the *Distance* computer programme was not possible (<50 observations), simple extrapolations of the overall density were used to estimate the total number of birds in the ship-based seabird survey areas. The extrapolation of overall density is a relatively quick and simple method of estimating total abundance within the sampled area. However, this method makes assumptions about the data used; overall density assumes that birds are uniformly distributed across the study site (i.e. there is no clumping due to social aggregation or habitat selection), and use of mean density is only accurate if sample densities are normally distributed.

Correction factors were applied to birds on the water to account for variations in detection at different distances from the ship's trackline. These were applied by multiplying the number of birds recorded for a species by its correction factor to give a value with which to calculate the density of each seabird species on the water. Due to the small sample size, it was not possible to calculate correction factors for the study area, instead published corrections factors based upon large data sets were applied to the data (Table 2-2).

The population size on the water was estimated by multiplying the corrected overall density per sampled area by the total study area. As correction factors cannot be applied to flying birds recorded 'in transect', simple extrapolation was used to estimate population size in flight as discussed in previous section. Estimated populations in flight and on water were added together to produce a total population size for the 'control' and proposed EOWDC survey areas.

Table 2-2: Correction factors from Skov *et al.* (1995).

Species	Correction Factors
Red-throated diver	1.4
Great cormorant	1.2
Northern fulmar	1.2
Northern gannet	1.4
Mew (common) gull	2.2
Common scoter	1.7
Herring gull	1.2
Great black-backed gull	1.7
Black-legged kittiwake	1.8
Sandwich tern	1.5
Common tern	1.5
Common guillemot/razorbill	1.6
Common guillemot	1.6
Razorbill	1.6
Atlantic puffin	2.0

Population estimate tables

Where distance sampling using the *Distance* computer programme was not possible (<50 observations), simple extrapolations of the overall density were used to estimate the total number of birds in the ship-based seabird survey areas. Table 2-3 shows the species and months eligible for *Distance* during the Year 1 survey programme.

Table 2-3: Summary table of month/species where *Distance* was applicable in the 'control' and proposed EOWDC survey areas.

Species	EOWDC survey area	'control' survey area
Red-throated diver	N/A	N/A
Common scoter	N/A	N/A
Common eider	N/A	N/A
Northern fulmar	N/A	N/A
Northern gannet	N/A	N/A
Great cormorant	N/A	N/A
Common gull	N/A	N/A
Herring gull	N/A	N/A
Great black-backed gull	N/A	N/A
Black-legged kittiwake	N/A	July 07
Sandwich tern	N/A	N/A
Common tern	N/A	N/A
Common guillemot	Feb 07, May 07 to Oct 07	May 07 to Oct 07
Razorbill	N/A	Aug 2007
Common guillemot / razorbill	N/A	N/A
Atlantic puffin	N/A	Sept 07

2.3 Vantage Point surveys

Vantage Point (VP) Surveys were undertaken from a total of six locations between March 2005 and March 2008: Two locations were used throughout: Drums and Balmedie and two were in very similar locations: Blackdog and Murcar, and Donmouth and Promenade (Table 2-4) (EnviroCentre 2007a,b; Alba Ecology 2008a,b).

Table 2-4: Vantage Point Survey Locations in Aberdeen Bay.

Years	Site	Elevation (metres)
March 2005 – October 2005	Promenade	10
March 2006 – March 2008	Donmouth	11
March 2005 – October 2005	Murcar	15
March 2006 – March 2008	Blackdog	16
March 2005 – October 2005 March 2006 – March 2008	Balmedie	21
March 2005 – October 2005 March 2006 – March 2008	Drums	16

Watches were conducted during daylight hours in conditions of good visibility, by a single observer with binoculars and telescope for two hours from each VP site. Two surveys were undertaken at each location most months, with up to four surveys per month in the then proposed EOWDC area (Donmouth and Blackdog) (Figure 2-5). Surveys were conducted at dawn and dusk (alternating between dawn and dusk surveys between each site visit). Dawn surveys started approximately 30 minutes before sunrise and dusk surveys extended to sunset or within about 15 minutes after.

At the start of each survey (along with any changes during the survey), the observer recorded the weather conditions, visibility, cloud cover, sea state, time of high tide and height (from tide tables), wind speed and direction, times of sunrise and sunset. In conditions of poor visibility (<1 km) surveys were not conducted or aborted if necessary.

The one to two hour long surveys were broken into 10 minute intervals, during which the observer counted all the individual birds moving through their telescope field of view (straight out from the VP, covering 0-3km and approximately 60°), noting their direction of flight, estimated distance from shore and flight height. If the birds exhibited notable behaviour, such as feeding, roosting, diving and fighting, this was also recorded.

Distance from shore was categorised into 0-1 km, 1-2 km, 2-3km and 3+ km distance bands, where possible based on marker buoys (Balmedie: 1 km (NJ990175) and Blackdog: 2.3 km (NJ986132)). Flight height was categorised in to 0-30 m, 30-150 m and 150+ m height bands, based on the size of the proposed wind turbines.

At the start of each survey period, the visible area was scanned with binoculars and the species, approximate number and behaviour of any birds on the sea surface and shore was recorded. During the two hour long survey general notes on birds on the sea surface and on the shore within the immediate field of view were recorded. Any significant changes to large feeding flocks out at sea or large movements of birds along the foreshore were also recorded.

A total of 294 VP surveys and 582 hours of surveys have been undertaken over a period of three years from six sites and across four different areas of Aberdeen Bay (Table 2-5).

Table 2-5: Vantage Point survey summary.

	No. of VP Surveys	No. of Hours
Drums	55	114
Balmedie	52	102
Blackdog	84	167
Murcar *	10	16
Donmouth	83	163
Promenade *	10	20
Total	294	582

* - Data collected between March 2005 and October 2005.

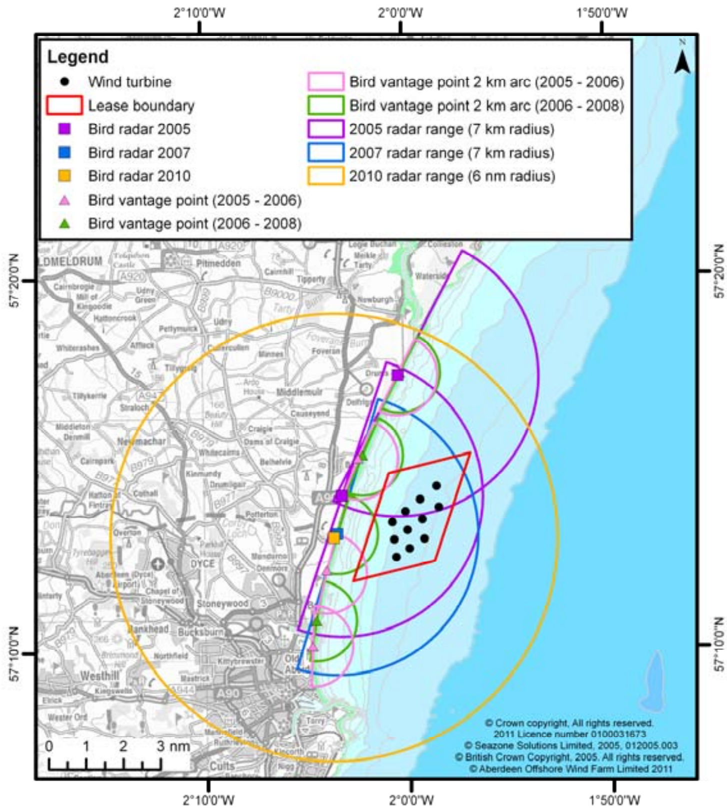


Figure 2-5: Location of the Vantage Point and radar survey sites and the location of the proposed EOWDC.

Data obtained from Vantage Point surveys has been used to compliment the data collected further offshore from boat-based surveys. The benefits of Vantage Point surveys are that data on seabird distributions passing close to shore are obtained which may otherwise be missed from purely boat-based surveys. Comparing the data with that obtained from boat-based surveys a better understanding of bird distributions are obtained. However, it is recognised that there is an increasing probability of birds being missed with increasing distance from the observer and unlike with boat-based data it is not possible to produce detectability functions to data collected by Vantage Points. In order to calculate detectability functions it is assumed that there is an even density of birds across the area or that there is a constant age or sex ratio. This is not the case from shore-based counts and therefore detectability functions cannot be produced from data collected from Vantage Point surveys.

2.4 Bird Detection Radar Surveys

Bird Detection radar has been used on three occasions during periods predicted to be of high migration in Aberdeen Bay: October 2005, April 2006 and April 2010 (Table 2-6).

The use of Bird Detection radar has allowed the tracking of bird movements continuously up to a range of 11 km including during periods of darkness or poor weather conditions. The radar could detect bird movements, their flight trajectory, flight speed and altitude to a height of 1.4 km. In favourable conditions the radar could track birds for up to 22 km and could detect animals as small as insects. The radar was used in all weather conditions including periods of poor visibility, rain and during hours of darkness.

The original surveys were undertaken at Easter Hatton and Drums but were later moved to Blackdog, closer to the proposed development area (Figure 2-6, Figure 2-7). The survey undertaken in April 2010 was aimed to coincide with period of peak pink-footed goose migration. However, delays in starting meant that it was not deployed until 24 April.

In addition to manning and monitoring the live radar screens, detailed vantage point field monitoring synchronised with the radar deployment was undertaken during the surveys. The observers confirmed the species and composition of the tracks initially detected by radar as well as providing additional information such as flock size and formation, height and flight behaviour. The radar ornithologists swapped between the roles of radar monitoring and visual tracking approximately every 2 hours in order to minimise observer fatigue during periods of observation (Walls *et al.* 2010).

Table 2-6: Location and duration of radar studies undertaken in Aberdeen Bay.

Location	Range (km)	Start Date	End date	Running time (hr)	
Drums	7	24 October 2005	29 October 2005	115	Walls *et al.* 2006
Easter Hatton	7	29 October 2005	3 November 2005	104	Walls *et al.* 2006
Blackdog	7	11 April 2007	26 April 2007	N/A	Simms *et al.* 2007
Blackdog	11	14 April 2010	29 April 2010	124	Walls *et al*. 2010

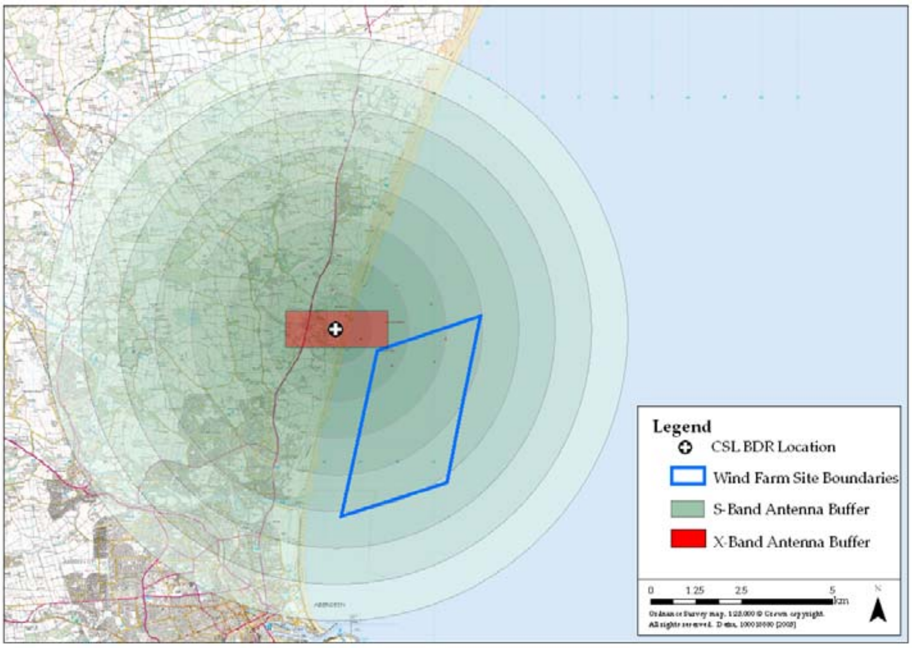
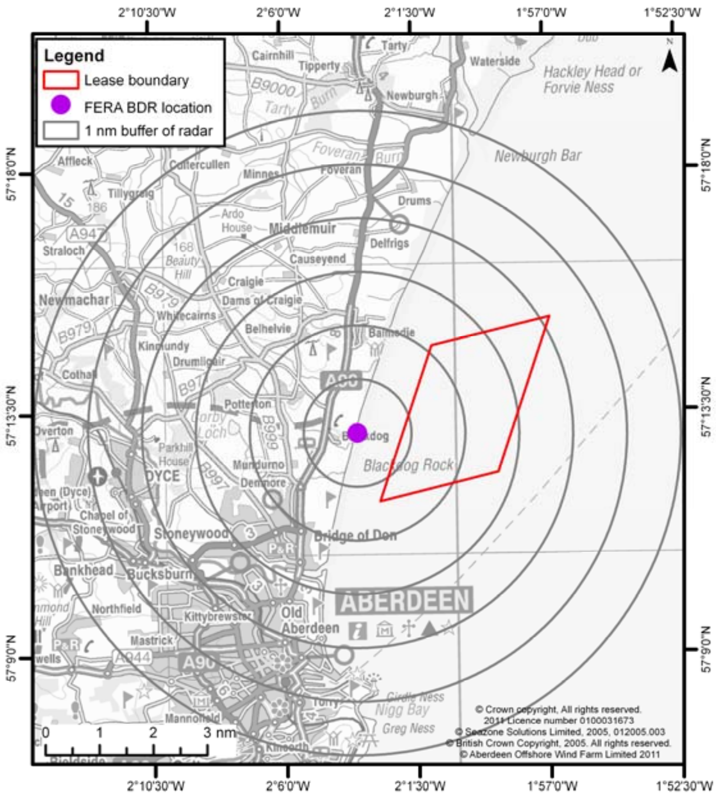


Figure 2-6: Outline radar coverage from Blackdog location during April 2007 surveys.



(Source FERA 2010)

Figure 2-7: Location of radar study undertaken in April 2010 in relation to proposed development area.

3 IMPACT ASSESSMENT METHODOLOGY

3.1 Introduction

This section identifies the potential impacts arising from the proposed development on birds. It is based on site specific data from Aberdeen Bay obtained in order to inform the project and for the purposes of this assessment. It also draws upon other published information on the birds likely to be present in the area, i.e. North-east Scotland Bird Reports and JNCC reports. The results are summarised for each species in Section 4.

Whenever possible additional information from existing offshore wind farms has been used in order to inform the impact assessment.

A request for a formal scoping opinion was made in 2010 and a number of comments were received with respect to potential ornithological impacts arising from the proposed project. These have been considered when undertaking this impact assessment.

The assessment is based on the project parameters as outlined in the project description (Section 3).

3.2 Potential Impacts

There are a large number of publications that provide detailed analysis of the potential impacts the development of an offshore wind farm may have on birds (e.g. Percival 2001; Langston & Pullan 2003; Drewitt & Langston 2006; Zucco *et al*. 2006).

The conclusions from all the publications identify three (or four if disturbance is considered separate from displacement) main potential impacts:

Collision risk: Birds are at risk of colliding with wind turbines. The level of collision depends on the location and size of the development and the species present. Different species are at varying risks of collision depending on a number of factors including the heights at which they fly and the proportion of time that they are flying at within the range of the rotor blades. Species such Auks, Divers and Scoter fly predominantly below rotor height where as other species such as Gulls may more frequently fly at rotor height. Avoidance rates are very important in determining the level of risk. Far field avoidance, where birds make detours to avoid flying through the wind farms at distances of one or more kilometres has been reported for many species, e.g. Gannets, Geese and Swans and sea-duck and near-field avoidance where a bird makes a quick detour at relatively close proximity to the wind turbines, e.g. Gulls and Terns. Other factors influencing collision risk include the frequency of passage, i.e. breeding birds flying through a site to and from a breeding colony and potentially weather conditions and visibility with birds at potentially greater risk during periods of poorer weather or at night. Overall, the majority of studies pertaining to offshore wind farms have indicated very low collision risks with most species having near-field avoidance rates of 99% or more and some far-field avoidance rates ranging from 50% for Divers and eider to over 90% for gannets and common scoter. The potential significance of any collision mortality depends on the population size, its conservation status the longevity of the species and its fecundity rate. Long-lived species with low fecundity rates and with small or declining populations are at greatest risk of being significantly affected by collision mortality.

Displacement: Birds that would otherwise use an area may avoid entering the wind farm and therefore be displaced. The displacement may be caused by a number of reasons. Birds may not enter the site due to the physical presence of the wind turbines as may be the case for red-throated diver or they may be disturbed (a disturbance impact) from the site by the vessels associated with the development, e.g. Divers and Scoter. There may also be an indirect impact on the food supply that could be reduced and therefore birds search elsewhere for their prey, e.g. Terns.

The level of displacement reported has varied across species and sites with some displacement identified for Divers, cormorants and possibly Auks. The significance of any displacement, should it occur, is dependent on the scale and duration of impact and whether other suitable sites are available to which the birds may go.

Barrier effects: Birds may avoid flying through the wind farms and select to fly over or around them. Should they choose to fly around them then this may entail flying further than they would otherwise have done so. Many species have been recorded avoiding offshore wind farms by flying around them, often by altering course at a distance of 1 km or more, e.g. wildfowl and gannets. This increase in flight distance causes a corresponding increase in energy expenditure that may, depending on the frequency that the effect occurs and the fitness of the individual bird, have a negative impact on the bird. The greatest concerns arise when birds undertake frequent flights around the wind farm, e.g. to and from feeding grounds or roost sites.

The impact assessment has been based on the above recognised potential effects.

3.3 Temporal Scales

There are four main phases in the development proposed programme that are considered:

- Pre-construction,
- Construction,
- Operation,
- Decommissioning,

Pre-construction phase

During the pre-construction phase baseline data have been obtained using boat-based, land-based and radar surveys. The collection of the data over a number of years provides baseline information on usage of the proposed development area and further afield by birds that have the potential to be impacted. It provides the basis upon which the potential impacts can be assessed and against which any changes in populations can be measured

Construction phase

The construction phase is of relatively short duration and consequently potential impacts arising from it are predicted to also be of short duration. As this is a demonstrator project the exact type of turbines that may be installed is still to be determined.

Construction activities involve the use of a number of vessels to install the turbines and cables that may cause disturbance and consequently displacement to species that avoid vessels, e.g. Divers and Scoter. The installation of turbines may cause the temporary displacement of prey species depending on the installation technique, e.g. pile-driving.

Operational phase

Potential impacts arising from the operational phase are collision mortality, displacement and barrier effects. There may be some disturbance from maintenance vessels that could cause displacement and a very small loss of habitat due to the direct physical impact on the seabed of the eleven wind turbines.

Decommissioning

How the turbines will eventually be decommissioned is still to be determined but it will involve the use of a number of vessels and the use of cutting equipment. The potential effects arising from decommissioning are predicted to be similar to those from installation, i.e. displacement.

3.4 Designated Sites

Although the proposed site does not lie within a designated area, there are a number of SPAs along the east coast of Scotland that have the potential to be impacted by the proposed development. For the purposes of the EIA, qualifying species from SPAs between Troup, Pennan and Lion's Head 74 km to the north and Forth Islands SPA approximately 134 km to the south have been considered (Table 3-1) and assessed against the relevant Conservation Objectives. The selection of sites is based largely on the potential foraging areas or known passage routes of the species recorded during surveys undertaken within the proposed development area.

For the purposes of the impact assessment all SPA species have been considered to be Very Highly sensitive if individually cited or Highly sensitive if cited as part of an assemblage. The potential effects on SPA species are assessed within the main impact section (Section 4).

Conservation Objectives

To avoid deterioration of the habitats of the qualifying species (listed [*for each site*]) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and

To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site,
- Distribution of the species within site,
- Distribution and extent of habitats supporting the species,
- Structure, function and supporting processes of habitats supporting the species,
- No significant disturbance of the species.

Table 3-1: SPAs identified as being at potential risk of adverse effect from proposed project.

SPA	Approximate distance EOWDC (km)	Qualifying species
Troup, Pennan and Lion's Head SPA	74.3	Article 4.1 - *Breeding* - Guillemot Article 4.2 - at least 20,000 seabirds breeding season, 150,000 individual seabirds including: razorbill, kittiwake, herring gull, fulmar guillemot.
Loch of Strathbeg SPA	47.6	Article 4.1 - *Breeding* - Sandwich tern. *Winter* - barnacle goose, whooper swan. Article 4.2 - *Winter* - greylag goose , pink-footed Goose Article 4.2 - supporting at least 20,000 waterfowl. Over winter supports 49,452 individual waterfowl including: teal, greylag goose, pink-footed goose, barnacle goose, whooper swan.
Buchan Ness to Collieston Coast SPA	9.5	Article 4.2 - supporting at least 20,000 seabirds. Breeding the area regularly supports 95,000 individual seabirds including: guillemot, kittiwake, herring gull, shag, and fulmar.
Ythan Estuary, Sands of Forvie and Meikle Loch SPA	7.2	Article 4.1 - *breeding* Sandwich tern, common tern, little tern. Article 4.2 - *wintering* pink-footed geese, common eider, *breeding*, diverse assemblage of breeding seabirds (13 species). regularly supporting over 20,000 waterfowl including redshank and lapwing.
Loch of Skene	21	Article 4.2 - *winter* greylag goose.
Fowlsheugh SPA	31.1	Article 4.2 by regularly supporting in excess of 20,000 individual seabirds. The colony regularly supports 145,000 seabirds. The colony further qualifies under Article 4.2 by regularly supporting populations of European importance of the migratory species: common guillemot, black-legged kittiwake, razorbill, fulmar, herring gull.
Montrose SPA	61	Article 4.2 - *winter* - greylag goose, knot, pink-footed goose, redshank. Article 4.2 - supporting at least 20,000 waterfowl. Winter, the area regularly supports 54,917 individual waterfowl, including: dunlin, oystercatcher, common eider, wigeon, shelduck, redshank, knot, greylag goose, pink-footed goose.
Firth of Tay and Eden Estuary	96	Article 4.1 - *Breeding* - little tern, Marsh harrier *Winter*; bar-tailed godwit Article 4.2 - *Winter*; greylag goose, pink-footed Goose, redshank. Supporting at least 20,000 waterfowl. In winter, the area regularly supports 34,074 individual waterfowl including: velvet scoter, pink-footed goose, greylag goose, redshank, cormorant, shelduck, common eider, bar-tailed godwit, common scoter, black-tailed godwit, goldeneye, red-breasted Merganser, goosander, oystercatcher, grey plover, sanderling, dunlin, long-tailed duck.

Firth of Forth SPA	124	Article 4.1 - *Passage*; Sandwich tern, Winter; bar-tailed godwit, golden plover, red-throated diver, Slavonian grebe. Article 4.2 - *Winter* - knot, pink-footed goose, redshank, shelduck, turnstone. Article 4.2 - supporting at least 20,000 waterfowl. Winter, regularly supports 86,067 individual waterfowl including: scaup, Slavonian grebe, golden plover, bar-tailed godwit, pink-footed goose, shelduck, knot, redshank, turnstone, great crested grebe, cormorant, red-throated diver, mallard, curlew, common eider, long-tailed duck, common scoter, velvet scoter, goldeneye, red-breasted Merganser, oystercatcher, ringed plover, grey plover, lapwing, dunlin, wigeon
Imperial Dock, Leith SPA	130	Article 4.1 - breeding season common tern.
Forth Islands SPA	134	Article 4.1 - breeding season – Arctic tern, common tern, roseate tern, Sandwich tern. Article 4.2 - Breeding season – gannet, lesser black-backed gull, puffin, shag. Article 4.2 - Supporting at least 20,000 seabirds Breeding season the area regularly supports 90,000 individual seabirds including razorbill, guillemot, kittiwake, herring gull, cormorant, fulmar, puffin, lesser black-backed gull, shag, gannet, Arctic tern, common tern, roseate tern, Sandwich tern.

3.5 EIA Methodology

Species regularly recorded offshore and that are qualifying species for an SPA presented in Table 3-1 have been assessed in the main section of this document (Section 4). Records of all other species are summarised in section 5. However, it is recognised that species may also occur in the area that were not recorded and others may have been under recorded due to their nocturnal flights or intermittent migration. However, there is no recorded evidence of any migration corridor across Aberdeen Bay and therefore for those species only infrequently recorded or were not recorded offshore, i.e. many waders, wildfowl and passerines no further assessment has been made as there is not likely to be any significant or adverse effect to these species from the proposed development.

It is recognised that the strict use of a matrix approach when undertaking an EIA can be inflexible and risks drawing erroneous conclusions. However, the use of an impact matrix can and does provide structure to an otherwise judgemental process and as long as the matrix is used appropriately it can be a useful tool in identifying the overall potential significance of an impact. The development of impact specific matrices by Maclean *et al.* (2009) has provided more focussed and robust matrices specific to potential impacts.

For the purposes of this EIA an evidence based approach has been used to determine potential impacts as well as expert judgement based on the baseline information and results from other offshore wind farms. An impact matrix has been used to provide a structure and consistency of approach and has been used as tool to help inform the impact assessment. The structure and content of the tables are based on those originally developed by Percival *et al.* (1999) and developed further by Maclean *et al.* (2009). They have been widely used in various similar forms for nearly all offshore wind farms. However, the results from the impact matrices have not been considered to be definitive, nor in isolation. The assessment is ultimately based on the latest published data available on potential impacts, i.e. wherever possible an evidence based approach has been adopted.

Determining Significance.

What may be considered to be significant differs across legislative requirements.

Under the EIA Regulations, significance is used to determine the relative importance of an effect on a feature. Whereas under the Habitats Regulations it is a coarse filter to determine whether a further Appropriate Assessment is required (IEEM 2010).

In determining the level of significance for the EIA the recommendations made in Maclean *et al.* (2009) have been used.

Two types of sensitivity have been identified:

- Non-impact specific sensitivity
- Species specific sensitivity

For non-impact sensitivities a series of definitions have been used to describe the potential sensitivity of the species to the impact (Table 3-2) (Percival 1999).

Very High: - For the purposes of the EIA a very high sensitivity was identified for all species, which are listed as cited interests for an SPA and within range of potential interaction, i.e. was within the known foraging range of the species. Foraging ranges were taken from Roos (2010) and Thaxter *et al.* (2010). The SPAs that were identified as having a potential for interaction are presented in (Table 3-1).

High: - A definition of high sensitivity was given for species identified as being part of an SPA assemblage or within the potential area of impact greater than 1% of the national population could be affected. Species for which less than 300 pairs nest in the UK were also considered as being of high sensitivity.

Medium: - Species were considered to be of medium sensitivity if a regionally important population was potentially affected. For the purposes of the EIA the regional population was defined as being between the Firth of Forth and Troup Head. Regional populations were based on latest SPA populations and mean 5 year peak WeBS counts (Table 3-15). If greater than 1% of the regional population was considered as being potentially effected then the species was considered to be Medium sensitivity.

Low: All species that were not covered by any of the above categories were given a low sensitivity.

Table 3-2: Definition of terms relating to the non-impact sensitivity of the species.

Sensitivity	Definition
Very High	Cited interest of SPAs. Cited means mentioned in the citation test for the site as a qualifying species for which the site is designated.
High	Other species that contribute to the integrity of the SPA. An impact on a local population of more than 1 per cent of the national population of a species. An impact on ecologically sensitive species (e.g. large birds of prey or rare birds - <300 pairs in Britain.
Medium	Regionally important population of a species, either because of population size or distributional context, EU Birds Directive Annex 1, EU Habitats Directive priority habitat/species or Species of European Conservation Concern (SPEC) and or Wildlife and Countryside Act Schedule 1 species (if not covered above). UK BAP priority species (if not covered above).
Low	Any other species of conservation interest (e.g. species listed on the Birds of Conservation Concern not covered above).

Further refined species specific sensitivity assessment has been undertaken in line with recommendations made in Maclean *et al* (2009). Sensitivities of species groups to particular impacts are ranked and combined with the non-impact sensitivities to give an overall sensitivity. The main types of impact identified are:

- Collision Mortality,
- Barrier effect,
- Displacement (including disturbance and indirect impacts, i.e. depletion of prey).

Collision Mortality

Collision risk modelling has been undertaken based upon the Band *et al.* (2000) model.

The Risk is assessed based on the probability of a bird flying through the rotor swept area and the probability of it colliding. This is then multiplied by number of flights predicted to occur through rotor swept area based on site specific data and no avoidance.

However, data from existing offshore wind farms indicate that there is a significant avoidance of wind turbines, typically greater than 99% (e.g. Pettersson 2005, Petersen *et al*. 2006) and the probability of a bird colliding takes this into account by including an avoidance rate. For the purposes of this assessment a range of avoidance rates have been used to give a range of potential mortality rates. The avoidance rates used are 98%, 99% and 99.5% based on SNH guidance (SNH 2010) but it is also noted that Maclean *et al*. (2009) recommended avoidance rates of 99% or greater. However, in order to determine potential effects a precautionary 98% has been used for nearly all species within this EIA.

Not all species recorded within Aberdeen Bay are at significant risk of collision. The level of risk depends on a large extent as to whether the species frequently flies at rotor height. Birds can fly at any height and may change depending upon weather conditions or behaviour. However, by using data from both site specific boat-based survey data (Table 3-3) and other extensive data sets from other offshore wind farm locations a large sample size of flight heights are available for collision risk assessment.

The species selected for collision risk modelling were selected on their frequency of flying at rotor height and the frequency at which they were recorded in Aberdeen Bay. Collision risk modelling was undertaken on the following species:

- Red-throated diver
- Fulmar
- Gannet
- Cormorant
- Pink-footed goose
- Barnacle goose
- Common scoter
- Guillemot
- Common gull
- Herring gull
- Kittiwake
- Sandwich tern
- Common tern

Body sizes were obtained from BTO BirdFacts website (BTO 2011).

Annual Mortality Rates were obtained from BTO BirdFacts website (BTO 2011).

Avoidance Rates from SNH (2010).

Flight speeds were obtained from Pennychuick (1997), Alerstam *et al*. (2007).

Table 3-3: Flight heights of birds recorded in Aberdeen Bay.

Species	Boat-based surveys 2007-2008		
	Sample size	%>15 m	%>25 m
Red-throated diver	55	7	0
Black-throated diver	3	0	0
Common scoter	377	30	1
Velvet scoter	7	0	0
Common eider	93	3	0
Long-tailed duck	17	0	0
Wigeon	1	100	100
Teal	1	100	100
Tufted duck	2	0	0
Goldeneye	2	0	0
Fulmar	213	1	0
Manx shearwater	9	0	0
Gannet	404	29	17
Cormorant	44	7	0
Shag	17	0	0
Great skua	8	63	25
Arctic skua	16	38	19
Long-tailed skua	1	1	0
Black-headed gull	4	0	0
Common gull	494	71	33
Kittiwake	907	43	22
Herring gull	362	55	40
Lesser black-backed gull	1	100	1
Great black-backed gull	128	79	60
Common tern	22	23	14
Arctic tern/Com. tern	24	17	0
Sandwich tern	79	53	4
Guillemot	271	1	1
Razorbill	354	0	0
Guillemot/Razorbill	398	0	0
Puffin	32	0	0
Little auk	7	0	0
Golden plover	2	0	0
Oystercatcher	1	100	100
Dunlin	2	0	0
Curlew	2	0	0
Shelduck	7	14	0
Barnacle goose	817	62	35
Goose sp.	85	100	100
Meadow pipit	7	0	0
Swift	1	0	0
Skylark	1	0	0

Flight heights were collected as being at greater than 15 m and greater than 25 m. Those at 25 m or above have been considered to be at risk of collision. It is not possible to produce frequency plots of flight heights from these data but existing published data from other offshore developments have been used to put into a wider context using a much larger data set the data collected from Aberdeen Bay.

Species sensitivities are based on the results from the collision risk modelling and the adult survival rates (Table 3-4) combined with the non-impact sensitivities (Table 3-2) to give an overall sensitivity presented in Table 3-5.

Table 3-4: Sensitivity of population based on adult survival rate.

Sensitivity Due to Population recovery Time	Definition
Very High	Annual Survival > 0.90 – Fulmar, Gannet, Manx shearwater, Barnacle goose, Eider, Auks, Kittiwake, Lesser black-backed gull, Great black-backed gull, Black-headed gull, Common tern, Arctic tern
High	Annual Survival 0.85 – 0.90 – Cormorant, Shag, Pink-footed goose, greylag goose, Shelduck, Skuas, Herring gull, Common gull, sandwich tern, Little tern
Medium	Annual Survival 0.80 – 0.85 – Divers, Swans,
Low	Annual Survival <0.80 Ducks, Grebes [(1)] Waders

Source: BTO Birdfacts (2011) 1 = Abt & Konter (2009)

Table 3-5: Overall sensitivity of species to collision.

Non-impact Sensitivity (Table 3-2)	Sensitivity of Receptor (based on adult survival rate) (Table 3-4)			
	Very High	High	Medium	Low
Very High	Very High	Very High	High	Medium
High	Very High	High	High	Medium
Medium	Very High	High	Medium	Low
Low	High	Medium	Low	Low

Barrier effect

Barrier effects may arise should the species avoid flying through the proposed development and by doing so incur additional energetic costs required to fly the extra distance around the turbines (Speakman, Gray & Furness 2009; Masden *et al.* 2010). The risk of an impact is largely dependent on the number of times a bird may have to cross the obstruction and also the individuals' fitness. Should a bird be required to avoid an area only once or twice a year when undertaking a migration then it is likely that the potential impact will be lower than if a bird regularly flies around a barrier, e.g. between a feeding or roosting site (Speakman, Gray & Furness 2009).

In order to assess the potential impacts from displacement it was assumed that, unless data from other wind farms indicates otherwise, all individuals avoided flying through the site and detoured around it and by doing so had to fly further than would have otherwise been the case. To calculate the potential length of detour it was assumed that the detour started 1 km in front of the proposed development and the bird detoured back on to the original course 1 km beyond the proposed development. The original distance the bird would have flown if had not detoured is subtracted from the additional distance the bird has flown to get a figure for the potential increase in distance travelled. However, it is also recognised that some birds may start to detour at greater distance than 1 km and others may not and some may not detour at all.

It was assumed that all flights were potentially along the longest axis, i.e. north-south.

The total length of the proposed development is approximately 4 km and the width 2 km. The distance flown in order to avoid the proposed development from 1 km all round is 7.2 km. Therefore, the incremental increase in flight distance caused by flying around the proposed development is 3.2 km.

Where appropriate, results from energetics modelling have been considered to assess the potential incremental increase in daily energy expenditure (Speakman, Gray & Furness 2009).

To assess the potential sensitivity of a species to a barrier effect a species specific sensitivity, based on wing loads (Table 3-6), combined with non-impact sensitivities (Table 3-2), have been used to provide an overall sensitivity (Table 3-7) after Maclean *et al.* (2009).

Table 3-6: Species sensitivity due to barrier effects.

Sensitivity due to barrier effects	**Species**
Very High	Black-throated diver
High	Red-throated diver
Medium	Ducks,
Low	Fulmars, Skuas and Gulls Gannets, Terns, Waders & Passerines

Table 3-7: Overall sensitivities due to barrier effect

Non-impact Sensitivity (Table 3-2)	**Species Sensitivity due to barrier effects** (Table 3-6)			
	Very High	High	Medium	Low
Very High	Very High	Very High	High	Medium
High	Very High	Very High	High	Medium
Medium	Very High	High	Medium	Low
Low	High	Medium	Low	Low

Displacement

Disturbance caused by the proposed EOWDC may lead to displacement of birds from potential feeding areas, resulting in effective habitat loss. This may be caused by a number of reasons but for some species for which displacement have been identified it is not known why displacement occurs. Displacement may be caused by disturbance from vessels associated with the proposed development or from secondary impacts, i.e. the depletion of prey in the development area. However, whatever the cause, the effects are the same; birds are displaced from an area and relocate to somewhere else. The significance of the displacement is difficult to quantify but for species that rely on localised or patchy food supplies the affect may be more significant than it is for species that have a wide area of food supply. Based on the Maclean *et al.* (2009) report the impact assessment has considered sensitivity of a species depending on its habitat flexibility, i.e. how restricted is the species to a particular habitat preference (Table 3-8). Potential impacts relating to disturbance by vessels are addressed in the species accounts.

The overall sensitivity is based on the species specific and non-impact sensitivities (Table 3-9).

Table 3-8: Species sensitivity due to displacement.

Sensitivity due to habitat flexibility	Species
Very High	Red-necked grebe
High	Divers, Scoter, Cormorant , Great-crested Grebe
Medium	Eider, Common Tern, Arctic Tern, Little Gull
Low	Sandwich Tern, Great Black-backed Gull, Auks, Great Skua, Black-headed Gull, Kittiwake, Gannet, Lesser Black-backed Gull, Herring Gull, Fulmar.

Table 3-9: Overall sensitivity due to displacement.

Non-impact Sensitivity (Table 3-2)	Species Sensitivity due to barrier effects (Table 3-8)			
	Very High	High	Medium	Low
Very High	Very High	Very High	High	Medium
High	Very High	Very High	High	Medium
Medium	Very High	High	Medium	Low
Low	High	Medium	Low	Low

For the purposes of the assessment two assumptions have been made as to the level of displacement that may occur. For Divers and Auks it is assumed that there is total displacement within the proposed EOWDC area and out to 1 km beyond the furthest turbine. There is then a further 50% displacement of birds out a further 1 km. For other species of seabird for which displacement effects may occur, e.g. seaduck, it is assumed that there is total displacement within the proposed development area and 80% displacement out to 1 km and 20% displacement out an additional 1 km. This takes into account the current understanding of the differing potential displacement effects on species but is still precautionary, as for many species displacement effects of this magnitude have not been recorded.

In order to determine potential number of birds at risk of being displaced the maximum recorded density obtained from any location from any of the boat-based surveys has been used. This provides a very precautionary number for the potential numbers of birds displaced, as for the majority of species peak densities were recorded outwith the proposed development area.

A worked example is presented in Table 3-10.

Table 3-10: An example of calculations used for potential displacement.

Calculations used for displacement	
Area	*Peak density of common scoter – 23.1 birds/km^2*
Area of EOWDC – 4.3 km^2	4.3 * 23.1 = 99
Area of 1 km buffer at 80% displacement = 12.3 km^2	(12.3 * 23.1)*0.8 = 227
Area of 2 km buffer at 20% displacement = 20.3 km^2	(20.3 * 23.1)/0.2 = 94
Total displaced	99+227+94 = 420

Magnitude of effect

The magnitude of effect for potential displacement and collision mortality is based on the definitions developed by Percival (1999) (Table 3-11). However, this is not suitable for determining the potential magnitude arising from barrier effect and consequently the assessment of the potential magnitude of barrier effects is based on Maclean *et al.* (2009)
Table 3-12).

Table 3-11: Definition of potential magnitude of an effect from collision mortality and displacement.

Magnitude	**Definition**
Very High	Potential total loss or very major alteration to key elements/features of the baseline conditions such that post development character/composition/ attributes will be fundamentally changed and may be lost from the site altogether. Guide: >80% of population/habitat lost
High	Potential for major alteration to key elements/ features of the baseline (pre-development) conditions such that post development character/composition/attributes will be fundamentally changed. Guide: 20-80% of population/habitat lost
Medium	Potential for loss or alteration to one or more key elements/features of the baseline conditions such that post development character/ composition/ attributes of baseline will be partially changed. Guide: 5-20% of population/habitat lost
Low	Potential for a minor shift away from baseline conditions. Change arising from the loss/ alteration will be discernible but underlying character/ composition/ attributes of baseline condition will be similar to pre-development circumstances/patterns. Guide: 1-5% of population/habitat lost
Negligible	Potential for a very slight change from baseline condition. Change barely distinguishable, approximating to the “no change” situation. Guide: <1% of population/habitat lost

Table 3-12: Criteria used to determine one of the components of the magnitude of impact due to barrier effect.

Magnitude of impact	Definition
Very High	(i) Wind farm is located between breeding site and key foraging area of a species flying through the site in nationally or internationally important numbers and/or (ii) is located close to key stopover, breeding or wintering site of species flying through the site in internationally important numbers and/or (iii) is located along the migration route of a species flying through the site in internationally important numbers.
High	(i) Wind farm is located close to key stopover, breeding or wintering site of species flying through the site in nationally important numbers and/or (ii) is located along the migration route of a species flying through the site in nationally important numbers.
Medium	(i) Wind farm is located between breeding site and key foraging area of a species flying through the site in regionally important numbers (ii) is located close to key stopover, breeding or wintering site of a species flying through the site in nationally important numbers (ii) Is located along the migration route of a species flying through the site in regionally important numbers.
Low	(i) Wind farm is located between breeding site and key foraging area of any other breeding species and/or (ii) is located close to a key stopover, breeding or wintering site of any other species and/or (iii) likely to be located on a migration route of any other species.
Negligible	None of the above

By combining the overall sensitivity of a receptor with the potential magnitude an indicative overall significance of the impact to the receptor is obtained (Table 3-13). However, it is recognised that this is only indicative and evidence from existing wind farms and expert judgement is used to determine whether the potential impact is likely to be either significant or adverse.

Table 3-13: Potential significance of impact.

Magnitude	Overall Sensitivity of Receptor			
	Very High	High	Medium	Low
Very High	Major	Major	Major	Moderate
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Moderate	Minor
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

Implications of significance

Where the potential significance is identified as being negligible or minor it is considered to be of limited or no concern. Moderate significance is of concern but may be tolerable depending on the causes that give rise to the potential impact. Major concerns are considered to be a potentially significant effect.

It should be noted that the significance derived at by the use of matrices is only a guide and the final conclusions of the impact assessment for each species is drawn upon the currently available evidence for each species.

Determining potential adverse effects.

To determine potential adverse effects the assessment is based on the Conservation Objectives and qualifying species of the site.

To identify whether an impact is potentially adverse with respect to potential impacts on population levels a measure based upon the 1% of baseline mortality rate has been used as a guide. This guidance is based on an EC Report on the application of the Birds Directive and although does not relate specifically to impacts from wind farms does provide suitable guidance against which an assessment can be made (EC 2000). If there is an increase in the baseline mortality rate of more than 1% then there is the potential for an adverse effect.

In order to determine whether there is the potential for an adverse effect the SPA population of the species has to be determined. Population levels can increase or decrease often by natural change. Consequently, the population within the SPA citation may not be comparable with the more recent counts and by making an assessment against historical population levels as published in the sites citation an inaccurate conclusion may be drawn. For the purposes of this assessment the latest SPA population figures have been used, although it is recognised that the population at the time of citation may still be relevant. The figures have been obtained from SNH and JNCC sources (SNH 2011, JNCC 2011a) (Table 3-15).

For many species of bird present in Aberdeen Bay it is likely that birds of the same species may be from different SPA sites, e.g. guillemots may be from Fowlsheugh SPA, Troup, Pennan and Lion’s Head SPA and Buchan Ness to Collieston SPA. It is not possible to identify from which specific SPA the birds present within Aberdeen Bay are from. Without this information the assessment assumes that any birds potentially at risk of an impact are all from a single SPA. However, it also recognises that this will not be the case and a proportion of birds will be from other designated sites.

Ultimately the approach to ascertaining whether there is a potential adverse effect on site integrity is a judgement based on the totality of the evidence available.

3.6 Assessment of cumulative impacts

The assessment of cumulative impact considers all other activities that have the potential to significantly impact on the birds that may be present at the proposed development location, these possible activities include:

- Offshore renewables,
- Shipping,
- Aggregates,
- Dredging,
- Oil & gas.

Offshore renewable projects that have been identified as having the potential for a cumulative effect include two developments in the Moray Firth and three in the Firth of Forth. The sites in the Moray Firth are approximately 150 km to the north and those in the Firth of Forth approximately 120 km to the south of the proposed development (Table 3-14).

The construction of the EOWDC is planned for 2013 and 2014 and so there is the potential for an overlap in construction activities in 2014 with Neart Na Gaoithe and Beatrice offshore wind farms. However, given the stage of development of the renewable projects yet to be constructed and the uncertainty as to the types of foundations and turbines that will be used, there is sparse information available to incorporate into any impact assessment, which limits the effectiveness of cumulative assessments considering conceptual projects yet to be subject to a formal planning application and for which no environmental or design data are currently available.

Therefore, the cumulative impact assessment can only be undertaken with data available from the currently operating Beatrice demonstrator project in the Moray Firth. Although, the assessment does wherever possible the potential cumulative impacts from other yet unconsented renewable projects.

Shipping associated with Aberdeen harbour, has been undertaken in Aberdeen Bay over many centuries with currently approximately 16,000 vessel movements per year. There are no known plans that are likely to cause a significant increase in the level of shipping currently being undertaken in Aberdeen Bay and any impacts shipping may currently be having on the birds within Aberdeen Bay will be part of the baseline.

There are no aggregates activities within Aberdeen Bay. There are no licensed dredging sites within Aberdeen Bay but occasional dredging of the harbour may occur, with the next dredging scheduled for 2012.

Aside from associated shipping there are no oil and gas related activities within Aberdeen Bay.

Table 3-14: Potential renewable energy developments.

Name of development	Developer	MW	Possible number of Turbines	Project timeframe construction
The Beatrice Demonstrator	Joint Venture Talisman and Scottish and Southern Energy	10	2	Installed operational
The Moray Firth Eastern Development	Moray Offshore Renewables Ltd	1,300	67	Construction starts 2015
The Moray Firth Western Development	Moray Offshore Renewables Ltd	1,300	Not yet known	Unknown >2015 (EIA commences 2013)
Beatrice	Sea Energy Renewables Ltd & Scottish and Southern Energy	920	184	2014
Firth of Forth: Phase 1	SeaGreen	1,075	215	2015
Firth of Forth: Phase 2	SeaGreen	1,435	287	Unknown >2015
Firth of Forth: Phase 3	SeaGreen	955	191	Unknown >2015
Neart na Gaoithe	Mainstream Renewable Power	420	130	2014
Inch Cape	SeaEnergy	905	181	2015

3.7 Assessment of in-combination impacts

The Conservation (Natural Habitats, & c.) Regulations 1994 (as amended) require that a Habitats Regulations Appraisal (HRA) must be conducted by a competent authority. The HRA considers the implications for European sites in view of the European sites conservation objectives, in respect of any plan or project which is not directly connected with or necessary to the management of the European site for conservation purposes and which is likely to have a significant effect on the European site either alone or *in-combination* with other plans or projects.

Therefore the term ‘in-combination’ will be used when considering the impacts of the proposals with other plans or projects on European sites and their associated qualify features or species.

The main industries considered for potential in-combination impacts are proposed offshore wind farms, aggregate industry, dredging, oil and gas and shipping. Of these, proposed offshore wind farms and shipping are the only activities identified for which there is a potential for an in-combination impact.

Table 3-15: National, Scottish and Regional SPA species populations.

Species	Season	National Pop^{n}	Scottish Pop^{n}	Regional SPA Pop^{n}	1% regional SPA Pop^{n}
Whooper swan	Summer	<15 *p.*	3-7 *p.*	0	0
	Winter	10,678 *i.*	4,142 *i.*	330	3 *i.*
Red-throated diver	Summer	1,014 – 1,551 *p.*	1,000 – 1,500 *p.*	0	0
	Winter	17,000 *i.*	2,270 *i.*	317 *i.*[1]	3 *i.* [1]
Great-crested grebe	Summer	8,000 *p.*	240 – 365 *p.*	0	0
	Winter	16,000 *i.*	900 –1,500 *i*	156	2 *i.*
Fulmar	Summer	530,000 Aon	486,000 Aon	6,418 Aon	128 *i.*
	Winter	-	-	-	-
Northern gannet	Summer	230,000 Aon	182,511 Aon	51,647 Aon	1,032 i
	Winter	-	-	-	-
Manx shearwater	Summer	277,803 – 311,263 *p.*	126,545 Aon	0	0
	Winter	0	0	0	0
Great cormorant	Summer	8,400 *p.*	3,600 Aon	198 *p.*	3 *i.*
	Winter	23,000 *i.*	9 – 11,000 *i.*	-	-
European shag	Summer	27,000 Aon	21,500 – 30,000 Aon	3,218 *p.*	64 *i.*
	Winter	-	60,000 – 80,000 *i.*	-	-
Pink-footed goose	Summer	0	0	0	0
	Winter	340,000 *i.*	200,000 *i.*	348,000 *i.*	3,480 *i.*
Greylag goose	Summer	35,177	25,000 *i.*	0	0
	Winter [2]	83,677	85,000 *i.*	6,529 i	65 *i.*
Barnacle goose (Svalbard pop^{n})	Summer	0	0	0	0
	Winter	32,000 *i.*	32,000 *i.*	2,200 *i.*	22 *i.*
Shelduck	Summer	11,000 *i.*	1,750 *p.*	-	-
	Winter	78,000 *i.*	70,000 *i.*	5,268 *i.*	53 *i.*
Eurasian wigeon	Summer	400 *p.*	240 – 400 *p.*	-	-
	Winter	359,236 *i.*	76,000 – 96,000 *i.*	6,083 *i.*	61 *i.*
Eurasian Teal	Summer	<2,050 *p.*	1,950 - 3,400 *p.*	-	-
	Winter	192,000 *i.*	22,500 – 125,000 *i.*	504 *i.*	5 i
Mallard	Summer	48,000 – 114,000 *p.*	17,000 – 43,000 *p.*	-	-
	Winter	352,000 *i.*	65,000 – 90,000 *i.*	2,546 *i.*	25 *i.*

Species	Season	National Pop^{n}	Scottish Pop^{n}	Regional SPA Pop^{n}	1% regional SPA Pop^{n}
Goldeneye	Summer	200 *p.*	125 – 150 *p.*	-	-
	Winter	25,000 *i.*	10,000 – 12,000 *i.*	836 *i*	8 *i.*
Common eider	Summer	31,000 *p.*	20,000 *p.*	1,500 *p.*	30 *i.*
	Winter	73,000 *i.*	64,500 *i.*	9,000 *i* [1]	90 *i.* [1]
Long-tailed duck	Summer	0	0	0	0
	Winter	16,000 *i.*	15,000 *i.*	<100 *i.* [1]	1 *i.*[1]
Common scoter	Summer	9 – 52 *p.*	9 – 52 *p.*	6,500 *i.*[1]	65 *i.*
	Winter	50,000 – 65,000 *i.*	25,000 – 30,000 *i.*	2,187 *i*	22 i.
Velvet scoter	Summer	0	0	600 *i.* [1]	6 i.
	Winter	3,000 *i.*	2,500 – 3,500 i	-	-
Red-breasted Merganser	Summer	2,400 *p.*	2,000 *p.*	80 *i* [1]	<1 [1]
	Winter	10,200 *i.*	8,500 i	-	-
Guillemot	Summer	1,300,000 *i.*	780,000 *p.*	86,187 *i*	861 *i.*
	Winter	-	750,000 *i.*	-	-
Razorbill	Summer	110,000 *p.*	93,300 *p.*	12,275 *i.*	123 *i.*
	Winter	-	50,000 – 250,000 i	-	-
Atlantic puffin	Summer	579,000 *p.*	493,000 *p.*	58,867 Aon	1,177 *i.*
	Winter	-	20,000	-	-
Great skua	Summer	9,650 *p.*	9,650 *p.*	-	-
	Winter	0	0	0	0
Arctic skua	Summer	2,100 *p.*	2,100 *p.*	-	-
	Winter	0	0	0	0
Black-headed gull	Summer	130,000 *p.*	43,200 Aon	-	-
	Winter	2,200,000 *i*	150,000 *i.*	-	-
Common gull	Summer	48,000 *p.*	48,100 *p.*	-	-
	Winter	620,000 – 721,000 *i.*	79,700 *i.*	-	-
Herring gull	Summer	131,000 Aon	72,000 Aon	-	-
	Winter	450,000 *i.*	91,000 *i.*	9,801 *p.*	196 *i.*
Lesser black-backed gull	Summer	110,000 *p.*	25,000 Aon	2,920 *p.*	58 *i.*
	Winter	118,000 – 131,000 *i.*	200 – 600 *i.*	-	-
Great black-backed gull	Summer	17,000 *p.*	14,800 Aon	-	-
	Winter	71,000 – 81,000 *i.*	7,500 – 10,000 *i*	-	-

Species	Season	National Pop^{n}	Scottish Pop^{n}	Regional SPA Pop^{n}	1% regional SPA Pop^{n}
Black-legged kittiwake	Summer	370,000 *p.*	282,200 Aon	48,894 *p.*	818 *i.*
	Winter	-	10,000 *i.*	-	-
Little tern	Summer	1,900 *p.*	331 Aon	36 *p.*	<1 *i.*
	Winter	0	0	0	0
Sandwich tern	Summer	11,000 *p.*	1,100 Aon	645 *p.*	13 *i.*
	Winter	0	0	0	0
Common tern	Summer	10,000 *p.*	4,800 Aon	384 *p.*	8 *i*
	Winter	0	0	0	0
Arctic tern	Summer	52,600 *p.*	47,300 *p.*	903 *p.*	18 *i*
	Winter	0	0	0	0

(1) = non SPA species in Aberdeen Bay; (2) = Icelandic wintering population of greylag goose
Sources: BTO 2011, Calbrade *et al.* 2010; Forrester *et al* 2009, NESBR
p. = pairs; *i.* = individuals; Aon = Apparently occupied nests

3.8 Impact assessment summary

The results from undertaking the impact assessment based on the matrices are summarised below in three separate tables:

- Collision risk
- Barrier effect
- Displacement

Each of the results are considered further within the individual species assessments presented in Section 4 where the use of site specific information, evidence from existing offshore developments and expert judgement are used to determine the risk and potential significance from each impact for each the main species recorded during the studies undertaken.

Table 3-16: Potential sensitivities and significance of impact from collision risk.

Species	Non Impact Sensitivity	Adult Survival	Overall Collision sensitivity	Magnitude	Significance
Whooper swan	Very High	Medium	High	Negligible	Negligible
Pink-footed goose	Very High	High	Very High	Negligible	Minor
Greylag goose	Very High	High	Very High	Negligible	Minor
Barnacle goose	Very High	Very High	Very High	Negligible	Minor
Shelduck	Very High	High	Very High	Negligible	Minor
Eurasian wigeon	Very High	Low	Medium	Negligible	Negligible
Eurasian Teal	Very High	Low	Medium	Negligible	Negligible
Mallard	Very High	Low	Medium	Negligible	Negligible
Common eider	Very High	Very High	Very High	Negligible	Minor
Long-tailed duck	Very High	Low	Medium	Negligible	Negligible
Common scoter	Very High	Low	Medium	Negligible	Negligible
Velvet scoter	Very High	Low	Medium	Negligible	Negligible
Goldeneye	Very High	Low	Medium	Negligible	Negligible
Red-Brst Merganser	Very High	Low	Medium	Negligible	Negligible
Red-throated diver	High	Medium	High	Negligible	Negligible
Fulmar	Very High	Very High	Very High	Negligible	Minor
Manx shearwater	Low	Very High	High	Negligible	Negligible
Northern gannet	Very High	Very High	Very High	Low	Moderate
Great cormorant	Very High	High	Very High	Negligible	Minor
European shag	Very High	High	Very High	Negligible	Minor
Great-crested grebe	Very High	Low	Medium	Negligible	Negligible
Arctic skua	Medium	High	High	Negligible	Negligible
Great skua	Medium	High	High	Negligible	Negligible
Golden plover	Very High	Low	Medium	Negligible	Negligible
Kittiwake	Very High	Very High	Very High	Low	Moderate
Black-headed gull	Low	Very High	High	Negligible	Negligible
Common gull	Low	High	Medium	Negligible	Negligible
Herring gull	Very High	High	Very High	Low	Moderate
Lsr blck-backed gull	Very High	Very High	Very High	Low	Moderate
Grt blck-backed gull	Low	Very High	High	Low	Minor
Little tern	Very High	High	Very High	Negligible	Minor
Sandwich tern	Very High	High	Very High	Low	Moderate
Common tern	Very High	Very High	Very High	Low	Moderate
Arctic tern	Very High	Very High	Very High	Low	Moderate
Guillemot	Very High	Very High	Very High	Negligible	Minor
Razorbill	Very High	Very High	Very High	Negligible	Minor
Atlantic puffin	Very High	Very High	Very High	Negligible	Minor

Table 3-17: Potential sensitivity and significance of impact from barrier effects.

Species	Non Impact Sensitivity	Barrier	Overall Barrier sensitivity	Magnitude	Significance
Whooper swan	Very High	Medium	High	Low	Minor
Pink-footed goose	Very High	Medium	High	Medium	Moderate
Greylag goose	Very High	Medium	High	Low	Minor
Barnacle goose	Very High	Medium	High	High	Major
Shelduck	Very High	Medium	High	Negligible	Negligible
Eurasian wigeon	Very High	Medium	High	Negligible	Negligible
Eurasian Teal	Very High	Medium	High	Negligible	Negligible
Mallard	Very High	Medium	High	Negligible	Negligible
Common eider	Very High	Medium	High	Medium	Moderate
Long-tailed duck	Very High	Medium	High	Low	Minor
Common scoter	Very High	Medium	High	Medium	Moderate
Velvet scoter	Very High	Medium	High	Medium	Moderate
Goldeneye	Very High	Medium	High	Negligible	Negligible
Red-Brst Merganser	Very High	Medium	High	Low	Negligible
Red-throated diver	High	High	Very High	Medium	Major
Fulmar	Very High	Low	Medium	Medium	Minor
Manx shearwater	Low	Low	Low	Negligible	Negligible
Northern gannet	Very High	Low	Medium	Low	Minor
Great cormorant	Very High	Low	Medium	Low	Minor
European shag	Very High	Low	Medium	Low	Minor
Great-crested grebe	Very High	Medium	High	Negligible	Negligible
Arctic skua	Medium	Low	Low	Low	Negligible
Great skua	Medium	Low	Low	Low	Negligible
Golden plover	Very High	Low	Medium	Low	Minor
Kittiwake	Very High	Low	Medium	Low	Minor
Black-headed gull	Low	Low	Low	Low	Negligible
Common gull	Low	Low	Low	Low	Negligible
Lsr blck-backed gull	Very High	Low	Medium	Low	Minor
Herring gull	Very High	Low	Medium	Medium	Minor
Grt blck-backed gull	Low	Low	Low	Low	Negligible
Little tern	Very High	Low	Medium	Low	Minor
Sandwich tern	Very High	Low	Medium	Medium	Minor
Common tern	Very High	Low	Medium	Low	Minor
Arctic tern	Very High	Low	Medium	Low	Minor
Guillemot	Very High	Low	Medium	Medium	Minor
Razorbill	Very High	Low	Medium	Medium	Minor
Atlantic puffin	Very High	Low	Medium	Medium	Minor

Table 3-18: Potential sensitivity and significance of impact from displacement and Disturbance.

Species	Non Impact Sensitivity	Displacement	Overall Displacement sensitivity	Magnitude	Significance
Whooper swan	Very High	Low	Medium	Negligible	Negligible
Pink-footed goose	Very High	Medium	High	Negligible	Negligible
Greylag goose	Very High	Medium	High	Negligible	Negligible
Barnacle goose	Very High	Medium	High	Negligible	Negligible
Shelduck	Very High	Low	Medium	Negligible	Negligible
Eurasian wigeon	Very High	Low	Medium	Negligible	Negligible
Eurasian Teal	Very High	Low	Medium	Negligible	Negligible
Mallard	Very High	Low	Medium	Negligible	Negligible
Common eider	Very High	Medium	High	High	Major
Long-tailed duck	Very High	High	Very High	Low	Moderate
Common scoter	Very High	High	Very High	High	Major
Velvet scoter	Very High	High	Very High	High	Major
Goldeneye	Very High	Low	Medium	Negligible	Negligible
Red-Brst Merganser	Very High	Medium	High	Medium	Moderate
Red-throated diver	High	Very High	Very High	Medium	Major
Fulmar	Very High	Low	Medium	Negligible	Negligible
Manx shearwater	Low	Low	Low	Negligible	Negligible
Northern gannet	Very High	Low	Medium	Negligible	Negligible
Great cormorant	Very High	High	Very High	Low	Moderate
European shag	Very High	High	Very High	Low	Moderate
Great-crested grebe	Very High	High	Very High	Negligible	Minor
Arctic skua	Medium	Low	Low	Negligible	Negligible
Great skua	Medium	Low	Low	Negligible	Negligible
Golden plover	Very High	Low	Low	Negligible	Negligible
Kittiwake	Very High	Low	Medium	Negligible	Negligible
Black-headed gull	Low	Low	Low	Negligible	Negligible
Common gull	Low	Low	Low	Negligible	Negligible
Lsr blck-backed gull	Very High	Low	Medium	Negligible	Negligible
Herring gull	Very High	Low	Medium	Negligible	Negligible
Grt blck-backed gull	Low	Low	Low	Negligible	Negligible
Little tern	Very High	Low	Medium	Negligible	Negligible
Sandwich tern	Very High	Low	Medium	Medium	Minor
Common tern	Very High	Medium	High	Low	Minor
Arctic tern	Very High	Medium	High	Low	Minor
Guillemot	Very High	Medium	High	Low	Minor
Razorbill	Very High	Medium	High	Low	Minor
Atlantic puffin	Very High	Low	Medium	Low	Minor

4 SPECIES ACCOUNTS

4.1 Whooper swan (*Cygnus cygnus*)

4.1.1 Protection & Conservation Status

The whooper swan is listed in Annex I of the Birds Directive, Appendix II of the Bern Convention, Appendix II of the Bonn Convention, Schedule 1 under the Wildlife and Countryside Act, 1981 and is on the Amber List of Species of Conservation Concern.

4.1.2 Background

Whooper swan		
GB Population	Breeding: <15 prs. Winter: 10,678 ind.	Holling 2010 Calbrade *et al*. 2010
Scotland	Breeding: 3 – 7prs Winter: 4,142	Forrester *et al.* 2007
International threshold	210 ind.	Calbrade *et al*. 2010
GB threshold	57 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Loch of Strathbeg – 333 ind	SNH 2011 JNCC 2011a
European population estimate	Breeding 16,000 – 21,000 Wintering >65,000	Birdlife 2004
European population trend	Status: 'Large increase' Trend: 'secure'	Birdlife 2004
World population	180,000 'adults'	Birdlife 2011

Whooper swans are a rare breeding bird in the UK and Scotland with less than 15 pairs nesting each year, approximately half of which nest in Scotland. Wintering birds arrive from their main breeding grounds in Iceland during October and November and spend the winter on lowland farmland, lochs and marshland (Forrester *et al*. 2007). In North-east Scotland small numbers of whooper swans can occur in many of the freshwater lochs but the main wintering area is the Loch of Strathbeg where over 300 whooper swans have occurred in recent years, although up to 600 were present there in the early 1980's (Buckland, Bell & Picozzi 1990).

Satellite tagging studies have indicated that the majority of whooper swans migrating along the east coast are associated with the wintering sites in East Anglia but no birds were recorded flying along the North-east coast of Scotland with birds crossing the Firth of Forth moving predominantly north-west/south-east direction (Griffin, Rees & Hughes 2010).

Boat-based surveys

No whooper swans were recorded during boat-based surveys undertaken in Aberdeen Bay.

Vantage Point surveys

The only record of whooper swan during any of the surveys was of a flock of five birds, which were recorded inland heading north-west at Drums during October 2005. The birds were flying at approximately 20 m altitude.

Bird Detection Radar

No whooper swans were recorded during any of the radar studies undertaken.

4.1.3 Summary of Results

Only one flock of whooper swans was recorded during surveys undertaken in Aberdeen Bay. The flock was flying inland and below 20 m.

4.1.4 Initial Assessment of Significance

Whooper swan	Overall sensitivity	Magnitude	Significance
Collision	High	Negligible	Negligible
Barrier	High	Low	Minor
Displacement	Medium	Negligible	Negligible

4.1.5 Species Sensitivities

Qualifying species

There are twenty Special Protection Areas (SPA) in the UK for which whooper swan is a qualifying species, of which one is within an area of potential impacts from the proposed development:

- Loch of Strathbeg SPA & Ramsar (47.6 km).

Formerly whooper swan was also a qualifying feature for the Loch of Skene SPA and under the last review, the Loch of Skene held 307 whooper swan based on the 5 year peak mean from between 1991/92 and 1995/96 (Stroud *et al.* 2001). Recent counts at Loch of Skene indicate a decline in the use of the site by whooper swans with peak counts of 27 in 2007.

The Loch of Strathbeg review reported 183 whooper swans (3.3% of the wintering population in Great Britain) based on the 5yr peak mean from between 1991/92 and 1995/96 (Stroud *et al.* 2001). More recent data have recorded a five year peak mean of 333 whooper swans with the latest published counts being of 92 in 2008 (Calbrade *et al*. 2010).

Flight height

The median flight height for whooper swans across the Moray Firth is 1 m with 83% of flights at or below 20 metres and 100% of flights below 50 m. Elsewhere, recorded flight height have been higher, e.g. across the Wash the median flight heights are higher at 30 m with 22% below turbine height (Griffin, Rees & Hughes 2010).

Collision risk

Evidence from site specific monitoring from boat-based and land-based surveys indicate that whooper swans are infrequent within the area of the proposed development with no sightings within the footprint of the proposed development and only one sighting of five birds flying inland. Data from satellite tagging studies indicates a relatively low usage of the coast from North-east coast of Scotland by whooper swans, with the majority of birds flying overland (Griffin, Rees & Hughes 2010).

Evidence from other offshore wind farms indicate that migrating whooper swans will, if migrating along the coast, remain in nearshore waters. Nearly 90% of migrating whooper swans in Liverpool Bay were recorded within 2.5 km of the coast with 70% along the coastline (RBA 2005).

Flight height data obtained from radio tracking studies suggest that the majority of whooper swans fly below turbine height. Evidence from existing wind farms indicate that 70% of whooper swans fly below 30 m (RBA 2005).

Based on the evidence from existing offshore wind farms and site specific data indicating a very low, if any, usage of the area by whooper swans, the risk of any significant impact or adverse affect on whooper swans is negligible.

Barrier effect

Evidence from studies undertaken in Sweden suggests that Swans (including whooper swan) and geese may avoid flying into wind farms during migration (Pettersson 2005).

In order to avoid the turbines the birds may incur additional energetic expenditure. The proposed EOWDC is at its longest point approximately 4 km and at its widest 2 km. Assuming birds avoid the wind farm at 1,000 m then they may incur an overall increase in flight distance of 3.2 km. For whooper swans flying to or from Iceland the potential increase in distance flown in order to avoid the turbines is negligible.

Displacement

Whooper swans rarely settle on the sea surface and tend to do so only in poor weather during periods of migration. They do not forage offshore and therefore there will not be any potential displacement of whooper swans due to the proposed development.

Cumulative and in-combination

The very low level of usage of the site indicates that there will not be any cumulative or in-combination impacts.

4.1.6 Conclusions

Habitats Appraisal

Based on the available evidence from site specific surveys undertaken at the proposed development area and other offshore wind farms in particular, the very low usage of the site during migration and that the Loch of Strathbeg SPA is located to the north and therefore birds migrating from Iceland will not cross the proposed development area to and from their breeding grounds. It is concluded that the proposed development will not have an adverse effect on whooper swans as a qualifying feature for Loch of Strathbeg SPA.

Environmental Impact Assessment

Based on the apparently low numbers crossing the proposed development site and the known behaviour of Swans, it is predicted that there will not be a significant environmental impact arising from the proposed development on whooper swans.

4.2 Pink-footed goose (*Anser brachyrhynchus*)

4.2.1 Protection & Conservation Status

The Pink-footed goose is listed in Appendix II of the Bern Convention, Appendix II of the Bonn Convention and is on the Amber List of Species of Conservation Concern.

4.2.2 Background

Pink-footed goose		
GB Population	Winter – 340,000 ind.	Calbrade *et al.* 2010
Scotland Population	Winter – 200,000 ind.	Forrester *et al.* 2007
International threshold	2,700 ind.	Calbrade *et al.* 2010
GB threshold	2,400 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Ythan Estuary, Sands of Forvie and Meikle Loch – 16,300 (07/08 Loch of Strathbeg 53,454 (08/09) Firth of Forth: 3,220 (08/09) Firth of Tay & Eden Estuary: 2,704 (08/09) Montrose Basin: 38,911 (08/09)	Calbrade *et al.* 2010
European population estimate	Breeding 50,000 – 69,000 pairs Wintering – >290,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	310,000 'adults'	Birdlife 2011

The pink-footed goose population that winters in the UK breed in Iceland and eastern Greenland. They migrate to the UK in the autumn in large numbers during September and October and winter in eastern Scotland, north-west England and Norfolk and start returning north in March and April. In North-east Scotland pink-footed geese are widespread occurring across the region from September through to April. Peak numbers occur in mid-October when pink-footed geese arrive from their breeding grounds during which time up to 25% of the British population may occur at the Loch of Strathbeg and Meikle Loch. Birds disperse southward for the winter and return again in March when birds overwintering to south of the region migrate northwards. Between October and March the number of pink-footed geese in the region is lower but those that remain feed on farmland and roost in large numbers on a few freshwater lochs, primarily Loch of Strathbeg and Meikle Loch.

Birds flying offshore peak during September and October with up to 800 birds per month past Peterhead with numbers dropping in November and December when less than 100 birds per month have been recorded. There is a smaller passage of pink-footed geese past Peterhead during April when 200 birds per month were recorded. Sightings were of birds out to 3 km from shore (Innes 1996).

The pink-footed goose population has increased substantially in recent decades from approximately 50,000 in the 1960's to a present day total of approximately 340,000 individuals and this increase has been reflected in the number of birds occurring in North-east Scotland where the use to be only 1,000 to 2,000 birds present to over 50,000 in recent years (Buckland, Bell & Picozzi 1990; Calbrade *et al.* 2010; NESBR).

Boat-based surveys

No pink-footed geese were recorded during any of the boat-based surveys undertaken between February 2007 and April 2008 and again from August 2010 and January 2011 (SMRU 2011b).

Vantage Point surveys

In Aberdeen Bay, pink-footed geese were recorded from four Vantage Point sites between October and March but none were recorded during 23 hours of survey undertaken during September and October 2005. There was only one record of three birds in September (Alba Ecology 2008a) and no records of pink-footed geese during April. Counts were of a relatively small number of skeins comprising of between 18 and 230 individuals and only three skeins of pink-footed geese were recorded between October and March 2006. The majority of sightings were of birds between 1-3 km from the coast and between 50% and 100% of were flying between 30 m–150 m.

Bird Detection Radar

During radar studies undertaken in October 2005 a total of 12 skeins of pink-footed geese were recorded totalling 858 birds. All sightings were made from Drums with no records from Easter Hatton (Walls *et al.* 2005). Birds were recorded out to 3.0 km with the majority within 500 m from shore (Figure 4-1).

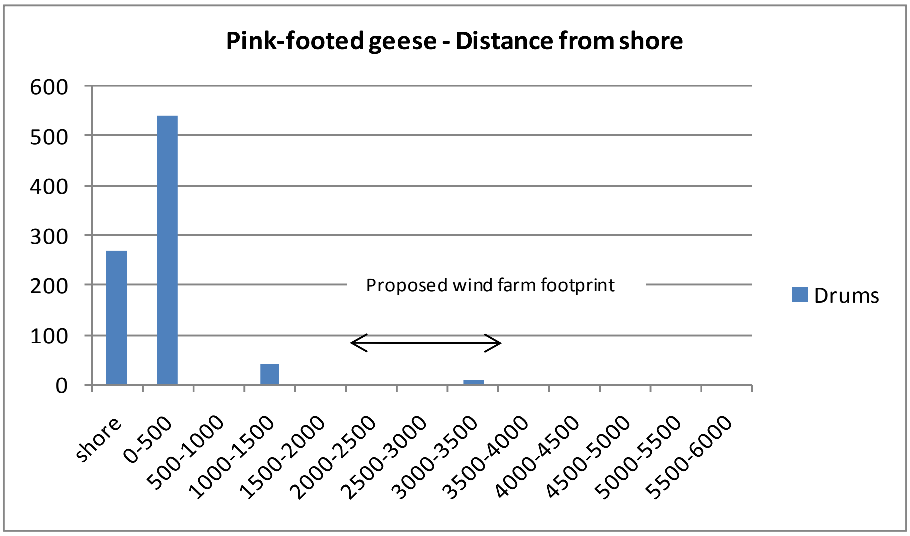


Figure 4-1: Number of pink-footed geese and distance from shore observed from surveys at Drums in October 2005 (Adapted from Walls *et al*. 2006).

Seventeen days of radar studies recorded 102 pink-footed geese in four skeins flying north between 11 April and 26 April 2007. All sightings were from between 0.5 km and 2 km from shore and below 30 m (Simms *et al.* 2007). A further radar study aimed to detect migrating geese across Aberdeen Bay during six days in April 2010 recorded three skeins of geese, one of which was confirmed to be pink-footed geese. All three skeins were moving northwards and the one skein that was visually observed was of 90 birds (Plonczkier & Simms 2010).

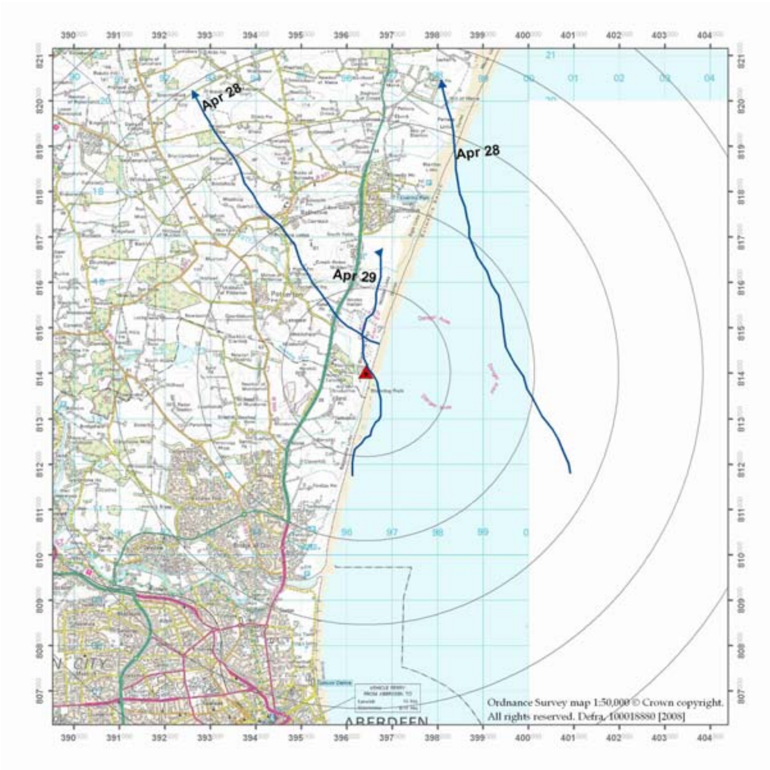


Figure 4-2: Flight directions of Geese sp. crossing Aberdeen Bay April 2010.

4.2.3 Summary of Results

Pink-footed geese were occasionally recorded in Aberdeen Bay during migration periods. Numbers recorded were generally low with no significant migration detected. The majority of birds were recorded flying above 30 m and most sightings were of birds within 2 km from shore.

Numbers of pink-footed geese recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.2.4 Initial Assessment of Significance

Pink-footed goose	Overall sensitivity	Magnitude	Significance
Collision	Very High	Negligible	Minor
Barrier	High	Medium	Moderate
Displacement	High	Negligible	Negligible

4.2.5 Species Sensitivities

Qualifying species

The nearest SPAs to the proposed development for which the pink-footed goose is a qualifying species are the Ythan Estuary, Sands of Forvie and Meikle Loch SPA & Ramsar and the Loch of Strathbeg SPA & Ramsar. Elsewhere, the Montrose Basin, Firth of Forth and Firth of Tay & Eden Estuary SPA & Ramsar, also have pink-footed geese as qualifying species (SNH 2011).

Flight height

No pink-footed geese were recorded from boat-based surveys but flight heights from Vantage Point surveys indicated that between 50 – 100% of recorded flights were between 30 – 150 m above the sea surface and therefore at potential risk of collision.

Data from other offshore wind farms have recorded 46% of all flights as flying at potential rotor height (n=12,294).

Collision risk

Evidence from site specific surveys indicate that pink-footed geese occur in Aberdeen Bay particularly during the spring and autumn and are more frequently recorded within 2 km of the coast than further offshore (Figure 4-1).

Collision Risk Modelling undertaken for pink-footed goose is based on:

- Body length of 65 cm
- Wingspan of 153 cm
- Flight speed of 18.8 $m.s^{-1}$
- % at rotor height –46%
- Avoidance rate – 98, 99, 99.5%

(Koffijberg & Mennobart 1995; Gremillet, Schmid & Culik 1995)

The number of pink-footed geese recorded within the proposed development area was very low. Therefore, the collision risk modelling undertaken was based on a very precautionary ‘worst-case’ scenario using following assumptions:

1. The total number of pink-footed geese passing through North-east Scotland each autumn is 340,000. This is based on the entire UK wintering population occurring in North-east Scotland, which is not thought to be the case, as some but an unknown number of geese will arrive directly into the north-west England from their breeding grounds in Iceland (WWT 2007).
2. All pink-footed geese migrate south across a front of up to 5 km offshore and 5 km inland and therefore over a 10 km wide front. The maximum width of the proposed development is 3.6 km and therefore intercepts 36% of the potential flight path. This is precautionary as site specific data indicates that the majority of geese fly within 1 km from shore (Figure 4-1) and therefore do not interact with potential development. However, for the purposes of the collision risk modelling it assumed that 36% of the UK wintering population of pink-footed geese cross the proposed development area, i.e. 122,400 birds and that they pass through the site each autumn and spring, i.e. a total passage of 244,800 birds per year.
3. Those that do fly across the development area, 46% do so at turbine height and that there is no far field avoidance.
4. The same rate of passage occurs during the spring as it does during the autumn is also very precautionary as the numbers of pink-footed geese in the spring are always significantly lower than those in the autumn indicating that less pink-footed geese will pass through the region during the spring migration.

The Collision Risk Modelling has been undertaken on these precautionary assumptions using a range of avoidance rates: 98%, 99% and 99.5%.

Table 4-1: Results from collision risk modelling undertaken on pink-footed geese.

Collision probability	Avoidance rate (%)		
	98	99	99.5
8.4%	56	28	14

Based on the various very precautionary scenarios and using a precautionary avoidance rate of 99% as recommended by SNH, it is predicted that up to a total of 28 collisions per year may occur (Table 4-1).

The annual mortality rate for pink-footed goose is 13.7% (BTO 2011). Consequently, out of a population of 340,000 an annual mortality of 45,560 pink-footed geese may be predicted. Therefore, 1% of the baseline mortality is 4,556 birds per year.

Based on the results from the very precautionary Collision Risk Modelling undertaken, the number of pink-footed geese that may collide is lower than the rate of mortality which may cause concern of a potentially significant impact on pink-footed geese.

To assess whether there is the potential for an adverse effect on pink-footed geese as qualify species for the relevant regional SPAs, the assessment is based on the 5 year peak mean counts as opposed to numbers published at the time of SPA citation as the populations of pink-footed geese have increased significantly since the SPA citations were originally made. It is also assumed that each SPA population is separate from each other and any collision impacts relate to birds only associated with that SPA. This is known to be an incorrect and precautionary assumption as evidence from ringing studies indicates that pink-footed geese frequently move between sites during the winter period and that many birds migrate south-west from North-east Scotland to north-west England and are therefore not going to interact with the proposed development (WWT 2007; Mitchell & Hearn 2004). As the counts relate only to the autumn passage of geese the modelling is based on a similar rate of passage across each site in the spring.

Table 4-2: Predicted natural mortality rates of pink-footed geese at relevant SPAs.

Site SPA/Ramsar	Population	Natural Mortality	1% of Natural Mortality
Ythan Estuary, Sands of Forvie and Meikle Loch	16,300	2,233	22
Loch of Strathbeg	53,454	7,323	73
Firth of Forth	3,220	441	4
Firth of Tay and Eden Estuary	2,704	370	4
Montrose Basin	38,911	5,330	53

Based on the above and the precautionary guidance threshold of a 1% increase in baseline mortality, the results from the Collision Risk Modelling indicate that there is the potential for an adverse effect to occur should all the potential collisions relate to geese associated with three of the SPAs. However, this is based on the very precautionary assumptions made that the whole Icelandic population of pink-footed geese pass through the area and do so through a 10 km wide coastal corridor during both the autumn and spring migrations.

Intensive surveys have been undertaken at offshore wind farms to assess the potential collision risk of pink-footed geese. All studies undertaken to date have indicated a very high avoidance rate for pink-footed geese and very low risk of collision.

Studies undertaken at Barrow offshore wind farm in the East Irish Sea reported that pink-footed geese recorded flying in line of the wind farm adjusted their flight height to pass above the wind farm and continue their migration. Of the nine pink-footed geese recorded entering the wind farm at rotor height, all flew between the turbines without any collisions. No collisions were observed from a total of 16,542 observed passing birds of all species during the 21 days survey at Walney Island (BOW 2007).

The results from three years of studies assessing the potential impacts on birds in the Kalmar Sound from the two offshore wind farms of Utgrunden and Yttre Stengrund recorded very few collisions of any species. Although only a small proportion of the birds observed were pink-footed geese, nearly 120,000 other geese were recorded flying through the Sound. These were mainly barnacle, brent and white-fronted goose. Both prior and post construction the majority of the Geese flew along the shores of the Sound, with relatively few through the wind farm area. However, the number of geese migrating through the wind farm area increased from 6% of the total prior to construction to 13% of the total post construction. A total of 7,224 geese were recorded in the autumns of 2001 and 2002, all of which were seen to avoid the turbines.

At Nysted offshore wind farm in Denmark intensive radar studies undertaken tracked amongst other species (notably eider), approximately 10,000 geese each autumn and the results indicate that there was a significant decrease in the proportion of flocks entering the wind farm from between the pre-construction period and the current operational period. It reported that post construction, 9% of the birds entered the turbines compared with 40% crossing the same location before construction and no geese were recorded colliding with the turbines (Deshom & Kahlert 2005).

Similar results obtained from Horns Rev have also indicated that Geese, including pink-footed geese avoid operating offshore wind farms. A total of 11 flocks of geese observed on an intercept course with Horns Rev, one flock of 53 individuals was observed entering the wind farm area, without changing course, the remaining 10 flying past also without apparently altering course. Although course changes could have occurred before entering the radar area or due to their original line of approach they had no need to consider altering course. The flock that did alter course increased flight altitude when approaching the wind farm and when flying within the wind farm, ultimately flying at rotor height. Within the wind farm, the birds appeared to show less stability in flight resulting in a disrupted flock structure. The mean altitude of geese flocks was 64.2m and all flocks were within the rotor height (Christensen *et al.* 2004).

A total of 560 hours of observations undertaken at the eight turbines that make up the Rønland offshore wind farm in Denmark used both visual observations and radar to detect birds at night. Out of 30,977 birds recorded, 7,309 were Brent geese. Two collisions: one of a cormorant and the other of a pale bellied Brent goose were recorded during the study. This accounts for 0.07% of the total observations. Observations indicate that approximately 8% of all birds flew within 100 metres of the turbines and 4.5% of the flocks. But the risks of collision were much lower than those reported at other Danish wind farms (Jensen 2006).

Table 4-3 presents a summary of the data obtained on geese from existing constructed wind farms and the actual number of observed collisions. It is recognised that the total number of geese recorded includes geese observed that may not have had to take any avoidance behaviour as they were not originally flying in line with the turbines and also the observed collisions only occur during periods of daylight.

Table 4-3: Summary of data obtained on geese from constructed offshore wind farms.

Wind farm	No. of turbines	Length of study post construction	Species recorded	Total no. recorded	No of observed collisions
Utgrunden & Yttre Stergrund [1]	12	2 years	Bean goose	284	0
			Pink-footed goose	3	0
			White-fronted goose	9,992	0
			Greylag goose	1,143	0
			Canada Goose	311	0
			Barnacle goose	68,787	0
			Brent goose	17,592	0
			Red-breasted goose	1	0
			Goose *Sp*.	5,293	0
Nysted [2]	72	3 years	Barnacle Goose	2,353	0
			Brent Goose	3,450	0
Horns Rev [2]	80	3 years	Greylag goose	123	0
			Brent goose	142	0
			Goose *sp*	10	0
Rønland [3]	8	3 years	Brent goose	7,309	1
Barrow [4]	30	1 year	Pink-footed goose	4,732	0
Totals	**202**	**12 years**	**8 Species**	**121,525**	**1**

References - [1] Pettersson 2005, [2] Petersen *et al*. 2006, [3] Jensen 2006, [4] BOW 2007

Based on the above evidence and the highly precautionary nature of the Collision Risk Modelling undertaken and the site specific data indicating a low usage of the site by pink-footed geese it is concluded that risk of a significant or adverse effect is negligible.

Barrier effect

Although pink-footed geese may fly through wind farms (e.g. BOW 2007) they have also been recorded avoiding wind farms consequently there may be a barrier effect

Should a barrier effect occur then pink-footed geese will fly around the proposed development. By doing so, this could cause an overall increase in flying distance of up to approximately 3.2 km. For a bird migrating from Iceland to North-east Scotland, a distance of over 1,000 km then this will cause an increase of 0.3% in flight distance. This is considered to be a negligible impact and not cause any adverse effect.

Displacement

Pink-footed geese do not use Aberdeen Bay for feeding or roosting and therefore no displacement effects will occur.

Cumulative and in-combination

Potential cumulative and in-combination impacts on pink-footed geese have been addressed by many Round 1 and Round 2 offshore wind farms.

Cumulative collision risk totals based on Collision Risk Modelling are presented in Table 4-4. The collision risk modelling undertaken at the time was based on avoidance rates of 95%, 99% and 99.5%. Based on an avoidance rate of 99% a total of up to 167 pink-footed geese are predicted to be impacted from all the currently consented offshore wind farms. Based on the total UK population of 340,000 and 1%

baseline mortality rate of 4,556 individuals per year the cumulative impacts are therefore considered to be minor.

Table 4-4: Predicted potential collision mortality for pink-footed geese.

Site	Avoidance rate		
	95%	**99%**	**99.5%**
Ormonde	77	15	8
Walney	6	1	<1
West of Duddon Sands	5	1	<1
Barrow	15	15	8
Docking Shoal		15	8
Humber Gateway		48	24
Lincs	171 - 262	34 – 52	17 – 26
Lynn & Inner Dowsing	100 - 165	20 – 33	10 – 17
Total	**374 - 530**	**149 – 167**	**69 – 85**

Further evidence to support the conclusions that the potential impacts from collision risk are minor come from Population Viability Analysis (PVA) undertaken on pink-footed geese which indicate that the pink-footed goose population may be able to withstand an increase in mortality (from whichever source) of 5,000 birds per year (Trinder *et al.* 2005). Further PVA commissioned by DECC to model the possible effects of additional mortality on the pink-footed goose population over a 25 year period indicated that over a 25 year period there was a 2% chance of the pink-footed goose population decreasing to below 150,000 if, due to collisions, wind farms increase the annual mortality by more than 1,000 birds over and above current impacts, e.g. hunting. (Trinder 2008). The predicted level of mortality from all offshore wind farms based on precautionary collision risk modelling indicates that the level of mortality is below the threshold above which cumulative mortality rates could have an adverse effect.

4.2.6 Conclusions

Habitats Appraisal

Based on the site specific data indicating a low usage of the area by pink-footed geese and evidence from existing offshore wind farms indicating a very high avoidance rate; an adverse effect is not predicted to occur at any of the SPAs for which pink-footed goose is a qualifying species.

Environmental Impact Assessment

Based on the site specific data and data from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on pink-footed geese.

4.3 Greylag goose (*Anser anser*)

4.3.1 Protection & Conservation Status

The Greylag goose is listed in Appendix II of the Bern Convention, Appendix II of the Bonn Convention and is on the Amber List of Species of Conservation Concern.

4.3.2 Background

Greylag goose (Icelandic)		
GB Population	Winter – 85,000 ind.	Calbrade *et al.* 2010
Scottish Population	Summer – 25,000 prs Winter – 85,000 ind.	Forrester *et al.* 2007
International threshold	870 ind.	Calbrade *et al.* 2010
GB threshold	819 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Loch of Skene: 790 (2010) Loch of Strathbeg: 580 (2007) Montrose Basin: 2,519 (2011) Firth of Tay: 2,640 (08/09)	SNH 2011 JNCC 2011a
European population estimate	Breeding 120,000 – 190,000 prs Wintering – >390,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	1 – 1.100,000 'adults'	Birdlife 2011

Greylag geese breed in Iceland, north-west Scotland and many parts of Eurasia. They winter along the north-west and east coasts of Scotland particularly in Orkney where the population of over wintering birds has increased substantially in recent years from 3,000 in the 1990's to 43,000 in 2003 (Forrester *et al.* 2007). During the winter birds forage on farmland and are relatively sedentary until March when they start returning to their breeding grounds (Forrester *et al.* 2007).

In North-east Scotland greylag geese have been recorded passing Peterhead primarily in October with relatively few at other times of the year. In October up to 180 birds per month were recorded between 1978 and 1988 (Innes 1996). The wintering population of greylag geese in North-east Scotland has decreased in recent years as birds that used to winter in the region are now thought to do so in Orkney. Only relatively small numbers now winter at what used to be large winter roosts, particularly the Loch of Skene and Dinnet lochs that held up 15,000 and 30,000 birds each in the 1990's and now hold less than 1,000 birds each (Buckland, Bell & Picozzi 1990; NESBR).

The Greylag goose is notified feature for Corby Loch SSSI, which lies 4 km north of Aberdeen. Up until the early 1990's there was a winter roost of greylag geese of up to 2,600 birds but since then the numbers roosting there have declined and the loch is now only infrequently used by greylag geese (Hearn & Mitchell 2004, NESBR).

Boat-based surveys

No Greylag geese were recorded during any of the boat-based surveys undertaken between February 2007 and April 2008.

Vantage Point surveys

In Aberdeen Bay, greylag geese were recorded from Vantage Point sites during December and January 2006/2007 when four small skeins were recorded totalling 37 birds flying between 1-3 km from shore and none within the 30-150 m height band

(EnviroCenter 2007b). Further singles were recorded once in August 2006 and March 2008.

Bird Detection Radar

No positive sightings of greylag geese were made from the radar studies undertaken in October 2005, April 2007 or April 2010.

4.3.3 Summary of Results

Greylag geese were only occasionally recorded in Aberdeen Bay with the only records of note during December and January. The few sightings were of birds below 30 m and within 3 km from shore.

Numbers of greylag geese recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.3.4 Initial Assessment of Significance

Greylag goose	Overall sensitivity	Magnitude	Significance
Collision	Very High	Negligible	Minor
Barrier	High	Low	Minor
Displacement	High	Negligible	Negligible

4.3.5 Species Sensitivities

Qualifying species

The nearest SPAs to the proposed development for which the Greylag goose is a qualifying species is the Loch of Skene SPA and the Loch of Strathbeg SPA & Ramsar. The greylag goose is also a qualifying species for Montrose Basin SPA & Ramsar and Firth of Tay SPA & Ramsar (SNH 2011).

Flight height

No greylag geese were recorded from boat-based surveys but flight heights from Vantage Point surveys indicated that none were flying between 30 m – 150 m and therefore not at potential risk of collision.

There is very limited data on flight heights of greylag geese from other offshore wind farms (Table 4-3). However, data from birds moving to and from roosts in North-east Scotland recorded 33% of flights as being between 50 m– 150 m (Patterson 2006).

Collision risk

Evidence from site specific surveys indicate that greylag geese occasionally occur in Aberdeen Bay particularly during the winter. However, as there were only six records of a total of 39 birds from all surveys and all were flying below turbine height the frequency of occurrence is low. Evidence from other offshore wind farms for all geese species indicate that they have a very high avoidance rate and even if the area is used more extensively than records suggest, this and low flight altitude indicate that the risk of collision is low and the impact on greylag geese should it occur, negligible.

Barrier effect

Although greylag geese may fly through wind farms they have also been recorded avoiding wind farms; consequently, there may be a barrier effect

Should a barrier effect occur then greylag geese will fly around the proposed development. By doing so this could cause an overall increase in flying distance of up to approximately 3.2 km. For a bird migrating from Iceland to North-east Scotland, a distance of approximately 1,000 km then this will cause an increase of 0.3% in flight distance. This is considered to be a negligible impact and will not cause any adverse effect.

Displacement

Greylag geese do not use Aberdeen Bay for feeding or roosting and therefore no displacement effects will occur.

Cumulative and in-combination

No cumulative or in-combination impacts on greylag geese have been recorded for any of the existing Round 1 or Round 2 offshore wind farms. There are no data available yet on whether greylag geese are being recorded during surveys being undertaken for the planned Round 3 offshore wind farms or those in Scottish Territorial Waters. However, the majority of greylag geese wintering in the UK are now doing so in Orkney and Caithness (Calbrade *et al*. 2010) and are therefore not at risk of potential risk with other offshore wind farms to the south.

On the basis that there is unlikely to be any substantial interaction with other offshore wind farms and that, as with other Geese, it is predicted that there will be a high avoidance rate, small potential of a barrier effect and no displacement, it is concluded that there will be a negligible adverse effect or cumulative impact.

4.3.6 Conclusions

Habitats Appraisal

Based on the site specific data indicating a low usage of the area by greylag geese and evidence from existing offshore wind farms indicating a very high avoidance rate for Geese as a whole an adverse effect is not predicted to occur at any of the SPAs for which greylag goose is a qualifying species.

Environmental Impact Assessment

Based on the site specific data and data from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on greylag geese.

4.4 Barnacle goose (*Branta leucopsis*)

4.4.1 Protection & Conservation Status

The barnacle goose is listed in Annex I of the Birds Directive, Appendix II of the Bern Convention, Appendix II of the Bonn Convention and is on the Amber List of Species of Conservation Concern.

4.4.2 Background

Barnacle goose (Svalbard)		
GB Population	Winter – 32,000 ind.	Calbrade *et al.* 2010
Scottish Population	Winter – 32,000 ind.	Calbrade *et al*. 2010
International threshold (Svalbard)	270 ind.	Calbrade *et al.* 2010
GB threshold	220 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Loch of Strathbeg	JNCC
European population estimate	Breeding 41 – 54,000 pairs Wintering – 370,000	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population (Svalbard)	32,000 ind.	Calbrade *et al.* 2010

Barnacle geese breed in the Arctic and winter in the UK and the mainland of Europe. They arrive in their UK wintering grounds during September and October and migrate north again during the spring. There are two distinct populations wintering in the UK. Birds from Svalbard occur in North-east Scotland as mainly passage migrants on their way to and from their main wintering site on the Solway Firth. Barnacle geese from Greenland winter along the west coast of Scotland and are not known to occur in the region.

The population of barnacle geese wintering in the Solway has increased considerably since the 1940's when there were 300 individuals. The wintering population has now increased to around 30,000 (Forrester *et al.* 2007).

Barnacle geese have been recorded passing Peterhead from late September through to late October when up to 400 birds per month have been recorded and again in the spring when up to 250 birds per month were recorded flying north during April and May. Birds were recorded out to a distance of 3 km (Innes 2006).

Peak counts at Loch of Strathbeg and elsewhere in North-east Scotland vary considerably across years but numbers have increased with up to 680 in October 2006 (NESBR 2007) and an exceptional 6,000 in September 2005. During the same period up to 2,270 were recorded flying south at Blackdog (Buckland, Bell & Picozzi 1990; NESBR 2006). The Loch of Strathbeg is an important staging post for barnacle geese from Svalbard and is one of only three sites in the UK that holds internationally important numbers; the others being the Solway Firth and Lindisfarne (Calbrade *et al.* 2010).

Boat-based surveys

A total of 831 barnacle geese were recorded from boat-based surveys undertaken between February 2007 and January 2008. All sightings were made on the 12 October 2007 when 14 skeins of barnacle geese were recorded ranging in size from 7 to 220 birds, the majority of which were recorded along a single transect (Figure 4-3) indicating a single 'pulse' of migrating barnacle geese occurred during that survey period. The majority of birds were flying in a southerly direction and 29%

were flying above 200 metres; 32% were between 15 m and 200 m and 6% between 25 m and 200 m.

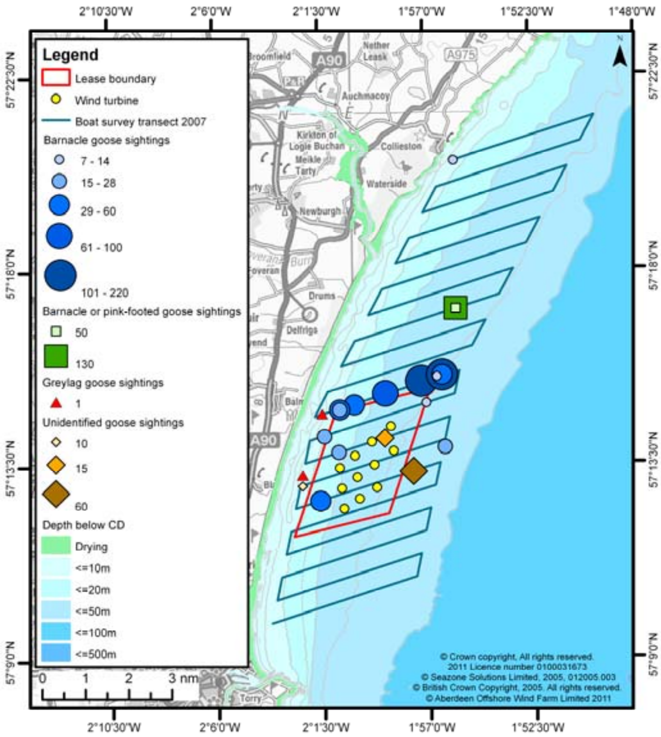


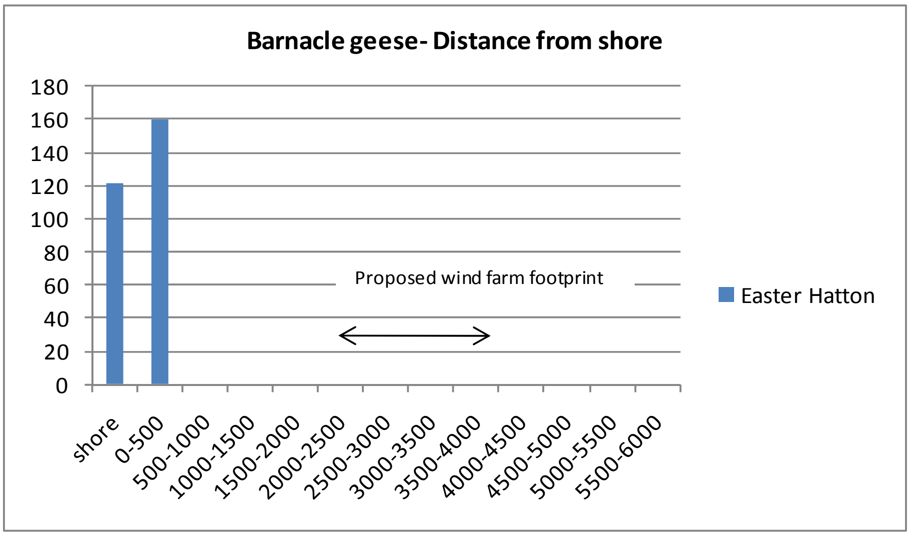
Figure 4-3: Geese distribution in Aberdeen Bay - February 2007 to April 2008 (all sightings).

Vantage Point surveys

No Barnacle geese were recorded during the autumn of 2005 but up to 300 barnacle geese per hour were recorded past Drums in September 2006 and single skeins of 29 in December 2007 and 17 in January 2008 (Alba Ecology 2008b). Of the 300 birds recorded in 2006, nine birds per hour were recorded flying between 30 m and 150 m above sea surface. The majority of records were from between 1-2 km from shore with no sightings further offshore.

Bird Detection Radar

A total of five flocks of barnacle geese, comprising 281 birds were recorded during the Bird Detection Radar studies undertaken in October 2005. All sightings were of birds flying below 35 m and were within 500 m from shore (Figure 4-4) (Walls *et al.* 2006).



(Adapted from Walls *et al.* 2006, Simms *et al.* 2007)

Figure 4-4: Number of barnacle geese recorded and distance from shore at Easter Hatton during October 2005.

4.4.3 Summary of Results

Barnacle geese were the most frequently recorded goose in Aberdeen Bay where large numbers were recorded passing through the bay during September 2006 and on one date in October 2007. Relatively few barnacle geese were recorded outwith these peak periods. No geese were reported as having landed in the bay. Land based observations recorded the majority of birds within 2 km from shore but there were sightings out to at least 3 km. Of those birds recorded in flight from boat-based surveys 6 were flying above 25 m but below 200 m. Land-based observations recorded all barnacle geese as flying below 35 m.

The numbers of barnacle geese passing through Aberdeen Bay were above the threshold for a site of national and international importance.

4.4.4 Initial Assessment of Significance

Barnacle goose	Overall sensitivity	Magnitude	Significance
Collision	Very High	Negligible	Minor
Barrier	High	High	Major
Displacement	High	Negligible	Negligible

4.4.5 Species Sensitivities

Qualifying species

The nearest SPAs to the proposed development for which the Svalbard population of the Barnacle goose is a qualifying species are the Loch of Strathbeg and Solway Firth SPAs (JNCC 2011a, SNH 2011).

Flight height

Data from site specific boat-based studies recorded up to 6% of the barnacle geese as flying between 25 m and 200 m and therefore at turbine height.

There are currently no other data available on flight heights of barnacle geese from other UK offshore wind farms.

Collision risk

Evidence from site specific surveys indicate that barnacle geese occur in Aberdeen Bay particularly during the spring and autumn and are more frequently recorded within 2 km of the coast than further offshore.

Collision Risk Modelling undertaken for barnacle goose is based on:

- Body length of 64 cm
- Wingspan of 139 cm
- Flight speed of 18.0 $m.s^{-1}$
- Percentage at rotor height –100%
- Avoidance rate – 98, 99, 99.5%

(Patterson 2006)

As the number of barnacle geese recorded within the proposed development area was low, in order to undertake collision risk modelling based a potentially realistic ‘worst-case’ scenario the following assumptions were made:

1. The total number of barnacle geese passing through North-east Scotland each autumn is 2,200, based on the peak count at Loch of Strathbeg since 2004 (Calbrade *et al.* 2010).
2. All barnacle geese migrate south across a front of up to 5 km offshore and 5 km inland and therefore over a 10 km wide front. The maximum width of the proposed development is 3.6 km and therefore intercepts 36% of the potential flight path. This is precautionary as site specific data indicates that the majority of geese fly within 1 km from shore and therefore do not interact with potential development. However, for the purposes of the collision risk modelling it assumed that 36% of the total Svalbard population of barnacle geese pass through the offshore area, i.e. 23,040 birds per year.
3. That 46% of those that do fly across the development area do so at turbine height. This is based on data from pink-footed geese.
4. That a return passage during the spring occurs at the same level as in the autumn. This is highly precautionary as records of barnacle geese in North-east Scotland are relatively few compared to the autumn counts.

The Collision Risk Modelling has been undertaken on these precautionary assumptions using a range of avoidance rates: 98%, 99% and 99.5%.

Table 4-5: Results from collision risk modelling undertaken on barnacle geese.

Collision probability	Avoidance rate (%)		
	98	99	99.5
8.5%	5.3	2.6	1.3

Based on the various scenarios and using a precautionary avoidance rate of 99% as recommended by SNH, it is predicted that a total of 2.6 collisions per year may occur (Table 4-5).

The annual mortality rate for barnacle goose is 9% (BTO 2011). Consequently, out of a population of 32,000 an annual mortality of 2,880 barnacle geese may be predicted. Therefore, 1% of the baseline mortality is 28 birds per year.

Based on the results from the precautionary Collision Risk Modelling undertaken, the number of barnacle geese that may collide is lower than that that may cause concern of a potentially significant impact or adverse effect on the barnacle goose population as a whole.

To assess whether there is the potential for an adverse effect on barnacle goose as a qualifying species for the relevant regional SPAs the assessment is based on the 5 year peak mean counts as opposed to numbers published at the time of SPA citation as the populations of barnacle geese have increased significantly since the SPA citations were originally made. It also, incorrectly, assumes that each SPA population is separate from each other and any collision impacts relate to birds only associated with that SPA.

Table 4-6: Natural mortality rates for barnacle geese associated with relevant SPAs.

Site SPA	Population	Natural Mortality	1% of Natural Mortality
Loch of Strathbeg	726	65	0.6
Solway Firth	29,403	2,646	26

Based on the above, the results from the Collision Risk Modelling indicate that there is the potential for an adverse effect to occur should all potential collisions relate to geese associated with only the Loch of Strathbeg SPA.

As described in section 4.2.5 there are numerous studies indicating that Geese are at low risk of collision. Nearly 87,000 barnacle geese were recorded migrating past two offshore wind farms in Kalmar Sound and avoidance behaviour was observed and no collisions detected (Pettersson 2005). Similar results from other offshore wind farms for other similar species of geese support the findings of the study.

Based on the above evidence and the highly precautionary nature of the Collision Risk Modelling undertaken and the site specific data indicating a relatively low usage of the site by barnacle geese, it is concluded that risk of an adverse effect is negligible and the potential significance of any impact minor.

Barrier effect

Although barnacle geese may fly through wind farms they have also been recorded avoiding wind farms consequently there may be a barrier effect (Pettersson 2005).

Should a barrier effect occur then barnacle geese will fly around the proposed development. By doing so this could cause an overall increase in flying distance of up to approximately 3.2 km. For a bird migrating from Svalbard to North-east Scotland, a distance of approximately 2,500 km then this will cause an increase of 0.1% in flight distance. This is considered to be a negligible impact and not cause any adverse effect.

Displacement

Barnacle geese do not use Aberdeen Bay for feeding or roosting and therefore no displacement effects will occur.

Cumulative and in-combination

Barnacle geese migrating from Svalbard to the Solway Firth do so by travelling down the west coast of Norway before crossing to north-east and eastern Scotland and flying south-west to the Solway where they winter. Their return flights are similar but more direct and to the south of the proposed development area (Griffin, Rees & Hughes 2010). Consequently, there are little cumulative or in-combination impacts from existing offshore wind farms. There is the potential for cumulative impacts arising with planned developments in the Firth of Forth area. However, no data are available on the number or size of turbines being considered by the developments nor any data on whether barnacle geese have been observed from offshore surveys. Therefore no cumulative impact assessment is possible. However, the very high avoidance rates recorded for geese and the relatively low flight heights recorded indicate that the potential for a significant environmental impact or an adverse effect is unlikely.

4.4.6 Conclusions

Habitats Appraisal

Based on the site specific data indicating a low usage of the area by barnacle geese and evidence from existing offshore wind farms indicating a very high avoidance rate; an adverse effect is not predicted to occur at any of the SPAs for which barnacle goose is a qualifying species.

Environmental Impact Assessment

Based on the site specific data and data from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on barnacle geese.

4.5 Shelduck (*Tadorna tadorna*)

4.5.1 Protection & Conservation Status

The Shelduck is listed in Appendix II of the Bern Convention, Appendix II of the Bonn Convention and is on the Amber List of Species of Conservation Concern.

4.5.2 Background

Shelduck		
GB Population	Summer – 11,000 prs. Winter – 78,000 ind.	BTO 2011
Scottish Population	Summer – 1,750 prs. Winter – 7,000 ind.	Forrester *et al.* 2007
International threshold	3,000 ind.	Calbrade *et al.* 2010
GB threshold	782 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Montrose Basin: 988 (08/09) Firth of Forth: 3,166 (08/09) Forth of Tay and Eden Estuary 1,114 ind.	Calbrade *et al*. 2010 JNCC 2011a
European population estimate	Breeding: 41 – 54,000 pairs Wintering: 370,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'small decline'	Birdlife 2004
World population	580,000 – 710,000 'adults'	Birdlife 2011

Shelduck is a widespread coastal breeding species in the UK with a UK population of 11,000 pairs, of which 1,750 pairs breed in Scotland (Forrester *et al*. 2007). In winter they occur along coastal estuaries and mud flats. A proportion of Scottish breeding shelduck undertake a seasonal migration to Helgoland during July where they moult and return to eastern England in late August after which they then move north to their wintering grounds. There is also a moulting flock in the Firth of Forth.

In Eastern Scotland Shelduck occur widely in suitable coastal habitats with the main sites being the Firth of Forth and Montrose Basin where mean peak counts of up to 3,166 and 988 have been recorded between 2004 and 2009 (Calbrade *et al*. 2010).

Sightings of shelduck past Peterhead occurred throughout the year but with a distinct spring passage when up to 300 birds per month pass, predominantly northwards. The majority of sightings were within a few hundred metres from shore (Innes 2006).

In North-east Scotland Shelduck occur along all suitable coasts and in particular, the Ythan Estuary where up to 200 birds may occur in the spring and between 50 and 80 pairs breed on the adjacent Forvie nature reserve (Buckland, Bell & Picozzi 1990). During the autumn and winter numbers in the region are lower until March when birds start returning to the region.

Boat-based surveys

Seven Shelduck were recorded during boat-based surveys with two in April, four in May and one in January. The January bird was heading north while the spring birds were flying in a southerly direction. All records were of birds flying below 25 m.

Vantage Point surveys

Shelduck were recorded infrequently during vantage point surveys with a total of 37 individuals over the three years of surveys. Most records were between March and May, although the maximum count was in August when ten were seen in 2006.

There were two records during winter months with one in January 2008 and three in February 2007.

Bird Detection Radar

Five Shelduck were recorded, with one at Drums and four at Easter Hatton in five days of surveys during October 2005 (Walls *et al* 2005). A further 20 birds were seen during additional radar studies undertaken at Blackdog in April 2007 (Simms *et al.* 2007).

4.5.3 Summary of Results

Shelduck were regularly recorded in low numbers from shore based counts, particularly during the spring period. Of those for which flight heights were reported all Shelduck were flying below 25 m.

The numbers of shelduck recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.5.4 Initial Assessment of Significance

Shelduck	Overall sensitivity	Magnitude	Significance
Collision	Very High	Negligible	Minor
Barrier	High	Negligible	Negligible
Displacement	Medium	Negligible	Negligible

4.5.5 Species Sensitivities

Qualifying species

There are three SPAs in the region for which shelduck are part of the qualifying assemblage: Montrose Basin, Firth of Forth and Forth & Tay Estuary SPA.

Flight height

Of those recorded in flight and for which flight heights were recorded all were flying below 25 m.

Elsewhere data from other offshore wind farms on flight heights for shelduck are limited with only eleven recorded flight heights from surveys undertaken at ten offshore wind farms. The few records recorded 36% of flights at rotor height.

Collision risk

Evidence from site specific monitoring indicate shelduck are scarce in Aberdeen Bay and those for which flight heights were recorded were below turbine height and most records were of birds within 2 km of the coast. Consequently the risk of significant environmental impact arising from collision is low and should it occur the significance on the regional population negligible. The SPAs for which shelduck are qualifying species as part of assemblages are over 60 km away and the likelihood of shelduck associated with these SPAs at risk of collision from the proposed development is remote. The risk of an adverse effect on the qualifying species being caused by collision mortalities arising from the proposed development is negligible.

Barrier effect

There is no evidence from existing offshore wind farms as to whether a barrier effect may occur. However, based on behaviour of other wildfowl it is predicted that at least some shelduck will avoid flying through the proposed development.

Should a barrier effect occur then shelduck may fly around the proposed development. This would incur an overall increase in flying distance of approximately 3.2 km. The movements of shelduck in Aberdeen Bay are not fully understood but there is no evidence of any regular feeding or roosting flights across the bay. Consequently, many flights are potentially *ad hoc* and or passage related; therefore, any additional energetic costs arising from the proposed development will not be regular but likely to be only occasional. The relatively small additional distance flown should shelduck fly around the proposed development will not be significant nor have an adverse effect.

Displacement

Shelduck do not use Aberdeen Bay for feeding or roosting and therefore no displacement effects will occur.

Cumulative and in-combination

The low level of usage of the site by shelduck indicates that there will not be any cumulative or in-combination impacts.

4.5.6 Conclusions

Habitats Appraisal

There are no SPAs for which shelduck is a qualifying species that will be effected by the proposed development.

Environmental Impact Assessment

Based on the relatively low numbers of shelduck recorded and their known behaviour it is predicted that there will not be a significant environmental impact arising from the proposed development on shelduck.

4.6 Eurasian Wigeon (*Anas Penelope*)

4.6.1 Protection & Conservation Status

The (Eurasian) wigeon is listed in Appendix II of the Bonn Convention, Appendix III of the Berne Convention and is on the Amber List of Species of Conservation Concern.

4.6.2 Background

Wigeon		
GB Population	Winter 359,236 ind.	Calbrade *et al*. 2010
Scottish Population	Summer – 240 – 400 prs. Winter 76,000 – 96,000 ind.	Forrester *et al* 2007
International threshold	15,000 ind.	Calbrade *et al*. 2010
GB threshold	4,060 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Montrose Basin: 3,944 ind. Firth of Forth: 2,139 ind.	Calbrade *et al.* 2010 JNCC 2011a
European population estimate	Breeding 85,000 – 100,000 pairs Wintering – >140,000 individuals	Birdlife 2004
European population trend	Status 'decreasing' Trend 'moderate decline	Birdlife 2004
World population	2,800,000 to 3,300,000	Birdlife 2011

Wigeon occur widely across northern Europe and Russia and there is a relatively small breeding population in the UK with between 48 and 124 pairs (Holling *et al*. 2010). In the autumn wigeon arrive from central and eastern Europe and Russia to winter in the UK where there is a large wintering population of 360,000 individuals of which between 76,000 and 96,000 winter in Scotland (Wernham *et al*. 2002, Forrester *et al*. 2007).

During the non-breeding season wigeon are mainly coastal, foraging on mudflats and coastal foreshores.

The main wintering sites in Scotland are the Moray Firth where up to 20,000 wigeon may winter and the Dornoch Firth with up to 15,000 wintering wigeon. In North-east Scotland wigeon occur with an average peak count in the region between 1992 and 2002 of 3,045 (Forrester *et al*. 2007). On the Ythan Estuary peak counts of wigeon occur during the winter months when up to 1,000 birds may be present, particularly during November and December (NESBR). Peak numbers of wigeon passing Peterhead occurred during September and October with few sightings during the winter. There is evidence of a small spring passage of birds heading north during March, April and May (Innes 1996). All sightings at Peterhead were of birds passing within a few hundred metres from shore.

Boat-based surveys

Twenty-eight wigeon were recorded during boat-based surveys with a flock of 20 birds in September 2007 and nine birds in three flocks in October. The only other record was of a single bird in April.

Vantage Point surveys

Wigeon were observed flying through Aberdeen Bay between April 2007 and March 2008 with up to seven birds per hour passing Blackdog during October 2007. The majority of sightings from the Donmouth were between 2–3 km from shore whereas those from Blackdog were predominantly 2 – 3 km from shore. All records were of birds flying below 30 metres.

Further records all of less than 20 birds were from Blackdog in August, September and December, Balmedie in September and Drums in December (EnviroCentre 2007b).

Bird Detection Radar

Sixteen wigeon were recorded, at Easter Hatton during the radar studies undertaken in October 2005 and 10 were seen from Blackdog during further radar studies undertaken in April 2007 (Walls *et al* 2005, Simms *et al.* 2007).

4.6.3 Summary of Results

Relatively few wigeon were recorded during surveys undertaken in Aberdeen Bay. Most records were obtained from Vantage Point surveys with birds recorded out to 3 km from shore. Of those for which flight height was reported, all wigeon were flying below 30 m.

4.6.4 Initial Assessment of Significance

Wigeon	Overall sensitivity	Magnitude	Significance
Collision	Medium	Negligible	Negligible
Barrier	High	Negligible	Negligible
Displacement	Medium	Negligible	Negligible

4.6.5 Species Sensitivities

Qualifying species

There are two SPAs in the region for which wigeon are part of the qualifying assemblage: Montrose Basin and Firth of Forth SPA & Ramsar.

Flight height

Observations made from site specific boat-based and land-based surveys recorded all but one wigeon as flying below 30 m in flight.

Elsewhere data from other offshore wind farms on flight heights for wigeon are limited with only 60 recorded flight heights from surveys undertaken at ten offshore wind farms. The few records recorded 38% of flights at rotor height.

Collision risk

Evidence from site specific monitoring indicate wigeon are regular in Aberdeen Bay but in relatively low numbers. Evidence from other offshore wind farms indicate that the majority of wigeon fly below 30 m. At Nysted offshore wind farm where 1% of all records were of wigeon and passage rates of up to 20 birds per hour were detected no collisions were recorded (Petersen *et al*. 2006). At Kalmar Sound 25,000 wigeon were counted during migration and no collisions observed (Pettersson 2005). Based on the relatively low numbers of wigeon recorded and evidence from offshore wind farms where wigeon are relatively common it is concluded that the risk of an adverse effect on wigeon from collision mortalities arising from the proposed development is negligible.

Barrier effect

Evidence from studies undertaken at Kalmar Sound suggest that there is the potential for some barrier effects as wigeon can avoid flying through offshore wind farms. Should a barrier effect occur then wigeon will fly around the proposed development. This may incur an overall increase in flying distance of approximately 3.2 km. There is no evidence of any regular feeding or roosting flights by wigeon across Aberdeen Bay and the seasonal occurrence of wigeon recorded suggest that the majority of birds are on migration. The relatively small additional distance flown should wigeon fly around the proposed development compared to the total distance of their migration will not be significant nor have an adverse effect.

Displacement

Wigeon do not use Aberdeen Bay for feeding or roosting and therefore no displacement effects will occur.

Cumulative and in-combination

The low level of usage of the site by wigeon and the relatively few recorded from other UK developments indicate that there will not be any cumulative or in-combination impacts.

4.6.6 Conclusions

Habitats Appraisal

There are no SPAs for which wigeon is a qualifying species that will be effected by the proposed development.

Environmental Impact Assessment

Based on the relatively low numbers of wigeon recorded and their known behaviour it is predicted that there will not be a significant environment impact arising from the proposed development on wigeon.

4.7 Eurasian Teal *(Anas crecca)*

4.7.1 Protection & Conservation Status

The (Eurasian) teal is listed in Appendix II of the Bonn Convention, Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.7.2 Background

Teal		
GB Population	Summer –155 – 2,600 prs. Winter – 192,000 ind.	BTO 2011
Scottish population	Summer – 1,950 – 3,400 prs Winter – 22,500 – 125,000 ind.	Forrester *et al.* 2007
International threshold	5,000 ind.	Calbrade *et al.* 2010
GB threshold	1,920 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Loch of Strathbeg: 504 ind.	SNH 2011 Calbrade *et al.* 2010
European population estimate	Breeding 920,000 – 120,000 ind. Wintering – >730,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'small decline'	Birdlife 2004
World population (Svalbard)	5,9 – 6,900,000 'adults'	Birdlife 2011

The teal is an uncommon breeding duck in the UK occurring on freshwater lochs and marshes. The majority of the UK population breed in Scotland where an estimated 3,400 pairs of teal breed (Forrester *et al*. 2007).

Following breeding, teal occur in both freshwater and coastal habitats feeding on seeds and grasses. There is a substantial increase in the numbers of teal in winter as migrants from northern Europe and Russia arrive during September and October and remain until March and April. About 6% of Scotland's wintering population of teal occur in North-east Scotland with most birds occurring on freshwater Lochs, e.g. Loch of Strathbeg and Loch of Skene. Elsewhere teal occur on the river Don where there may be up to 100 birds present.

Passage of teal past Peterhead occurs throughout the year but with a very distinct autumn passage with up to 550 birds during September. A smaller spring passage occurs during April and May. All sightings of teal made at Peterhead were of birds within a few hundred metres from the shore (Innes 1996).

Boat-based surveys

Three teal were seen from boat-based surveys with one in October and two in November.

Vantage Point surveys

Teal were infrequently recorded during the three years of Vantage Point surveys with a total of 43 birds recorded of which 26 were in September.

Bird Detection Radar

During the five days of observations undertaken at Easter Hatton and Drums during October 2005 as part of the Bird Detection Radar studies, 187 teal were recorded in seven flocks, all at Drums. (Walls *et al.* 2005). Additional radar studies undertaken over seventeen days in April 2007 recorded seven teal at Blackdog (Simms *et al.* 2007).

4.7.3 Summary of Results

Aside from birds recorded from land-based counts at Drums in October 2005 relatively few teal were recorded during surveys undertaken in Aberdeen Bay.

4.7.4 Initial Assessment of Significance

Teal	Overall sensitivity	Magnitude	Significance
Collision	Medium	Negligible	Negligible
Barrier	High	Negligible	Negligible
Displacement	Medium	Negligible	Negligible

4.7.5 Species Sensitivities

Qualifying species

The Loch of Strathbeg is the only SPA in the vicinity of the proposed development for which teal is a qualifying species.

Flight height

The only flight height recorded was of one bird flying at an altitude of greater than 30 m.

Elsewhere data from other offshore wind farms on flight heights for teal is very limited with records from a number of other offshore wind farms but the flight heights not being reported. There was one flock of 11 teal recorded at Beatrice Demonstration Project and all were flying at rotor height.

Collision risk

Teal were recorded across Aberdeen Bay in low numbers with peak counts occurring during periods of migration. Evidence from other offshore wind farms on the potential of collision risk is limited but a total of 2,300 teal were recorded during studies in Kalmar Sound and none were reported to collide. Evidence for other species of wildfowl indicate that wildfowl have high avoidance rates. Based on the low numbers of teal recorded within the proposed development area and the predicted high avoidance rates it is concluded that the risk of an adverse effect or significant environmental impact on teal from collision mortalities arising from the proposed development is negligible.

Barrier effect

Evidence from studies undertaken at Kalmar Sound suggest that there is the potential for some barrier effects as wildfowl avoid flying through wind farms. Teal may avoid flying through offshore wind farms and if so may incur an overall increase in flying distance of approximately 3.2 km. There is no evidence of any regular feeding or roosting flights by teal across Aberdeen Bay and the seasonal occurrence of teal recorded suggest that the majority of birds are on migration. The relatively small additional distance flown should teal fly around the proposed development compared to the total distance of their migration will not be significant nor have an adverse effect.

Displacement

Teal do not use Aberdeen Bay for feeding or roosting and therefore no displacement effects will occur.

Cumulative and in-combination

The low level of usage of the site by teal and the relatively few recorded from other UK developments indicate that there will not be any cumulative or in-combination impacts.

4.7.6 Conclusions

Habitats Appraisal

There are no SPAs for which teal is a qualifying species that will be adversely effected by the proposed development.

Environmental Impact Assessment

Based on the relatively low numbers of teal recorded and their known behaviour it is predicted that there will not be a significant environmental impact arising from the proposed development on teal.

4.8 Mallard (*Anas platyrhynchos*)

4.8.1 Protection & Conservation Status

The mallard is listed in Appendix II of the Bonn Convention Appendix III of the Bern Convention and is on the Green List of Species of Conservation Concern.

4.8.2 Background

Mallard		
GB Population	Summer – 48,000 – 114,000 prs. Winter – 352,000 ind.	BTO 2011
Scottish population	Summer – 17,000 – 43,000 prs Winter – 65,000 – 90,000 ind.	Forrester *et al.* 2007
International threshold	20,000 ind.	Calbrade *et al.* 2010
GB threshold	3,520 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Firth of Forth 2,546 ind (91/92-95/96)	SNH 2011
European population estimate	Breeding 920,000 – 120,000 ind. Wintering – >730,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'small decline'	Birdlife 2004
World population (Svalbard)	5,900,000 – 6,900,000 'adults'	Birdlife 2011

Mallard is the most common and widespread duck in Britain with a breeding population of up to 114,000 pairs and wintering population of approximately 352,000 individuals.

Mallard breed primarily on freshwater habitats but in winter occur widely on estuaries and shallow lochs (Forrester *et al.* 2007). Although the Scottish population is largely semi-resident, with only relatively localised movements, the wintering population is increased by migrants from Europe and Russia, which arrive during the autumn (Wernham *et al.* 2002). In North-east Scotland the main wintering areas are the Loch of Strathbeg and Loch of Skene with relatively small numbers of a hundred or less occurring on the Ythan Estuary (NESBR). Mallard were recorded throughout the year at Peterhead with a distinct peak in October and November when up to 500 birds were recorded (Innes 1996).

Boat-based surveys

Two mallard were recorded in January 2008, two in September 2010 and one in November 2010.

Vantage Point surveys

Mallard were infrequently recorded in Aberdeen Bay during the three years the Vantage Point surveys were undertaken with a total of 52 birds counted. There was no obvious seasonal variation in the small numbers of counts made, with 33 birds in June being the biggest count.

Bird detection Radar

No mallard were recorded from radar studies in October 2005 but nine were recorded at Blackdog during the radar surveys undertaken in April 2007 (Simms *et al.* 2007).

4.8.3 Summary of Results

Mallard were infrequently recorded in Aberdeen Bay with most sightings from Vantage Point surveys.

4.8.4 Initial Assessment of Significance

Mallard	Overall sensitivity	Magnitude	Significance
Collision	Medium	Negligible	Negligible
Barrier	High	Negligible	Negligible
Displacement	Medium	Negligible	Negligible

4.8.5 Species Sensitivities

Qualifying species

There is one SPA in the region for which mallard is part of the qualifying assemblage: Firth of Forth SPA.

Flight height

Very few records of mallard were made from site specific boat-based or land-based surveys and no records of their of flight heights were made.

Elsewhere there is very limited data from other offshore wind farms on flight heights for mallard with only six recorded flight heights from surveys undertaken at ten offshore wind farms. Of those recorded 33% of flights were at rotor height.

Collision risk

Evidence from site specific monitoring indicated that mallard are scarce in Aberdeen Bay and primarily occur in near-shore waters. Evidence from other offshore wind farms indicated that mallard are at low risk of collision from offshore wind farms. A total of nearly 5,500 mallard were recorded during studies undertaken in Kalmar Sound and no collisions were recorded (Pettersson 2005). Based on the relatively low numbers of mallard recorded and evidence of a potentially high avoidance rate from other developments where mallard are relatively more common, it is predicted that the risk of an adverse or significant environmental effect on mallard from collision mortalities arising from the proposed development is negligible.

Barrier effect

Evidence from studies undertaken at Kalmar Sound suggests that there is the potential for some barrier effects as mallard may avoid flying through offshore wind farms. Should a barrier effect occur then mallard will fly around the proposed development. This may incur an overall increase in flying distance of approximately 3.2 km. There is no evidence of any regular feeding or roosting flights by mallard across Aberdeen Bay nor any regular usage of the site itself. Any additional distance flown should mallard fly around the proposed development will be small compared to the total distance of their migration and will not be significant nor have an adverse effect.

Displacement

Mallard do not use Aberdeen Bay for feeding or roosting and therefore no displacement effects will occur.

Cumulative and in-combination

The low level of usage of the site by mallard and the relatively few recorded from other UK developments indicate that there will not be any cumulative or in-combination impacts.

4.8.6 Conclusions

Habitats Appraisal

There are no SPAs for which mallard is a qualifying species that will be effected by the proposed development.

Environmental Impact Assessment

Based on the relatively low numbers of mallard recorded and their known behaviour it is predicted that there will not be a significant environmental impact arising from the proposed development on mallard.

4.9 Common eider (Somateria mollissima)

4.9.1 Protection & Conservation Status

The (common) eider is listed in Appendix II of the Bonn Convention, Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.9.2 Background

Eider		
GB Population	Summer – 31,000 pairs Winter 73,000 ind.	BTO 2011
Scottish Population	Summer - 20,000 nesting females Winter – 64,500 ind.	Forrester *et al.* 2007
International threshold	12,850 ind.	Calbrade *et al.* 2010
GB threshold	730 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Ythan Estuary Montrose Basin Firth of Tay & Eden Firth of Forth	SNH 2011 JNCC 2011a
European population estimate	Breeding 840,000 – 1,200,000 prs Wintering – 1,700,000 individuals	Birdlife 2004
European population trend	Status 'secure' Trend 'small decline'	Birdlife 2004
World population	3.1 – 3,800,000 'adults'	Birdlife 2011

Eiders occur in coastal waters throughout northern Britain, particularly in areas where suitable prey of molluscs and crustaceans occur in shallow water of usually less than 3 metres. Breeding colonies are often large and flocks of many thousands of birds can occur in suitable nearshore areas. It is the commonest breeding seaduck in the UK with a breeding population of 31,000 pairs of which approximately 20,000 occur in Scotland.

Following breeding, eiders can congregate into large moulting flocks in specific areas with main areas being Firth of Forth, Shetland, Ythan, Aberdeen Bay and Montrose Basin (Cork Ecology 2004a). The largest moulting flock occurs off Murcar, in Aberdeen Bay, where up to 9,000 have been recorded (Forrester *et al.* 2007).

Although eiders in the UK are largely non-migratory there is some winter dispersal away from the breeding areas with a proportion of birds from North-east Scotland wintering in the Tay Estuary. The east coast of Scotland holds a substantial proportion of the UK wintering population with approximately 59,000 birds. The major wintering areas along the east coast of Scotland are the Tay Estuary, Firth of Forth, Montrose Basin, Orkney, Ythan and the Moray Firth (Cork Ecology 2004a). First winter birds remain near the Ythan Estuary (Baillie & Milne 1988).

The most important areas for eider in North-east Scotland are the Ythan Estuary, where up to 1,500 eider breed, and Aberdeen Bay where a large flock occurs during July and August when they undergo a post-breeding moult. Peak counts at the Ythan Estuary occur during May with maximum counts of up to 4,952 in 2004 and a five year peak mean of 3,333 individuals (NESBR, Calbrade *et al.* 2010). This is lower than the numbers present on the estuary during the 1980's when between 6,000 and 7,000 eider were recorded (Buckland, Bell & Picozzi 1990). Peak numbers in Aberdeen Bay are generally lower with generally between 1,000 – 2,000 birds present although a maximum count in recent years of 3,500 was in August 2002. However, numbers of eider present in Aberdeen Bay have also decreased since the peak counts in the 1980's when over 9,000 were recorded there every August (Buckland, Bell & Picozzi 1990; NESBR) (Figure 4-5).

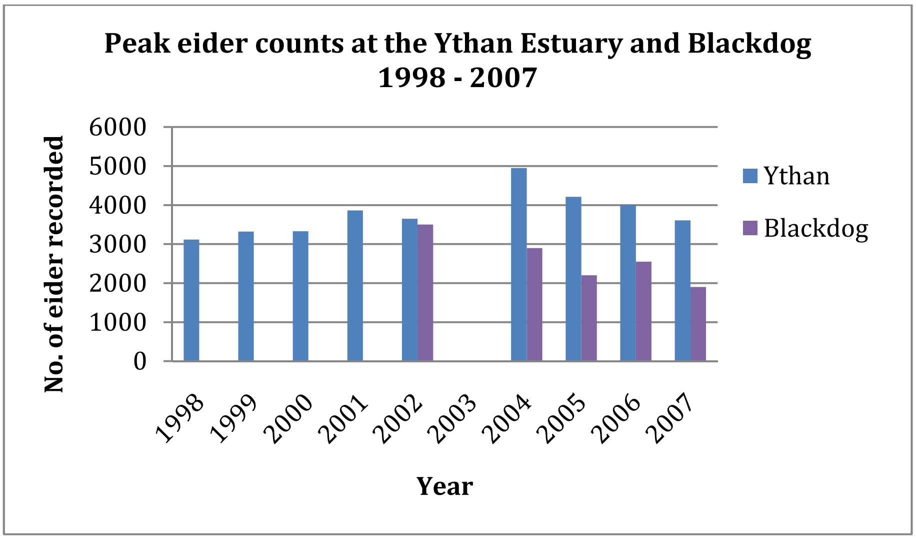


Figure 4-5: Peak eider counts at Ythan Estuary and Blackdog

Eiders are recorded passing Peterhead throughout the year but there is a strong seasonal variation with a marked spring passage of birds moving north of up to 175 birds per hour in March. The peak count was of 3,000 birds over three hours in April 1982 a year when over 30,000 eider were counted flying north between February and April (Buckland, Bell & Picozzi 1990; Innes 1996). There is a smaller movement of birds in the autumn of up to 100 birds per hour during October. Although eider occurred out to 3 km from shore, the majority of sightings were within several hundred metres from shore (Innes 1996).

Boat-based surveys

Common eiders were recorded throughout the year in inshore shallow waters predominantly in water depths of less than 10 metres (Figure 4-6, Figure 4-7, Figure 4-8). The majority of sightings were of birds outwith the 300 metre transect with only 77 birds ‘in transect’ and no records of eider ‘in transect’ during June, July and August. Consequently, the population estimates are under-representative to the total number of birds that may be present in the area. Maximum counts of common eider outwith the survey area were at Blackdog where 450 birds were present in September 2007 and 434 in September 2010 (SMRU 2011b).

The boat-based survey data indicate that the majority of eider occur in waters less than 20 m deep and in particular less than 10 m. There were no records of eider within the proposed development area with the majority of eider to the south-west in near-shore waters approximately 1 km from the nearest potential turbine location.

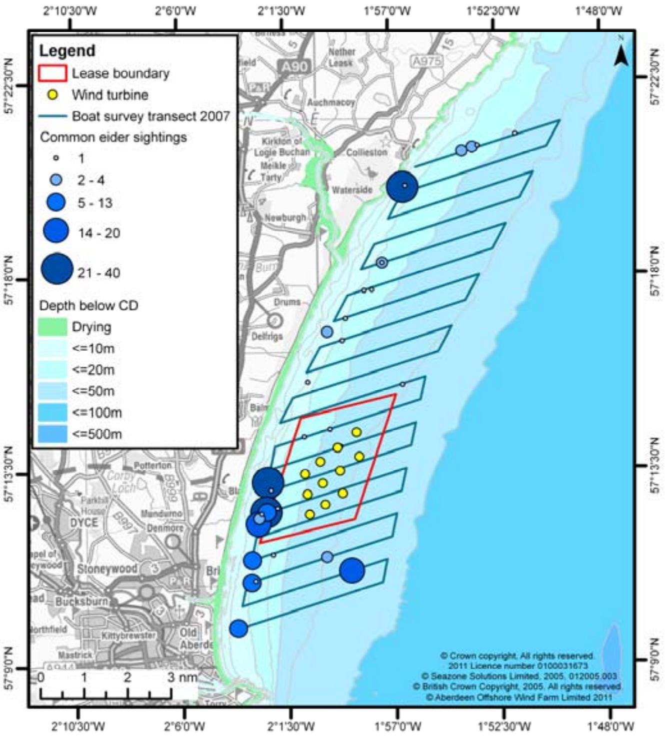


Figure 4-6: Common eider distribution in Aberdeen Bay during winter period: November to March (all sightings).

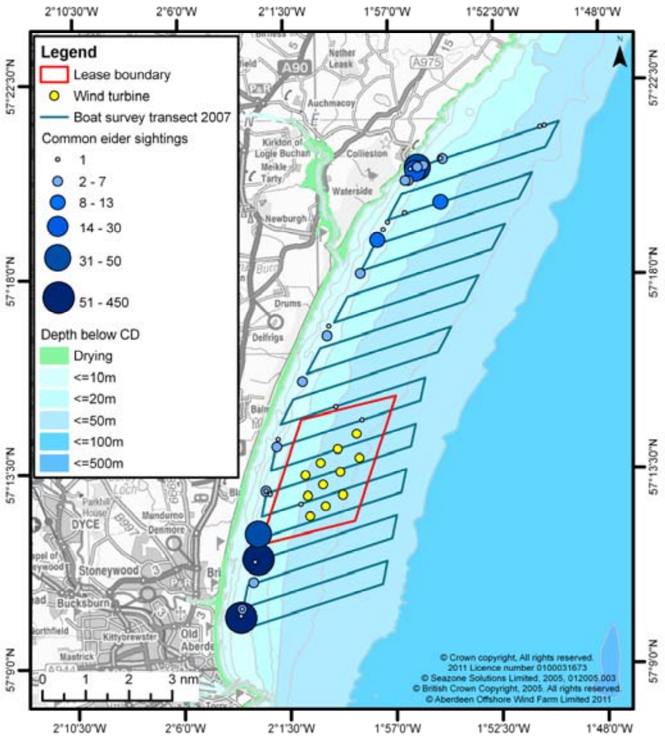


Figure 4-7: Common eider distribution in Aberdeen Bay during spring and autumn periods: April, May, September and October (all sightings).

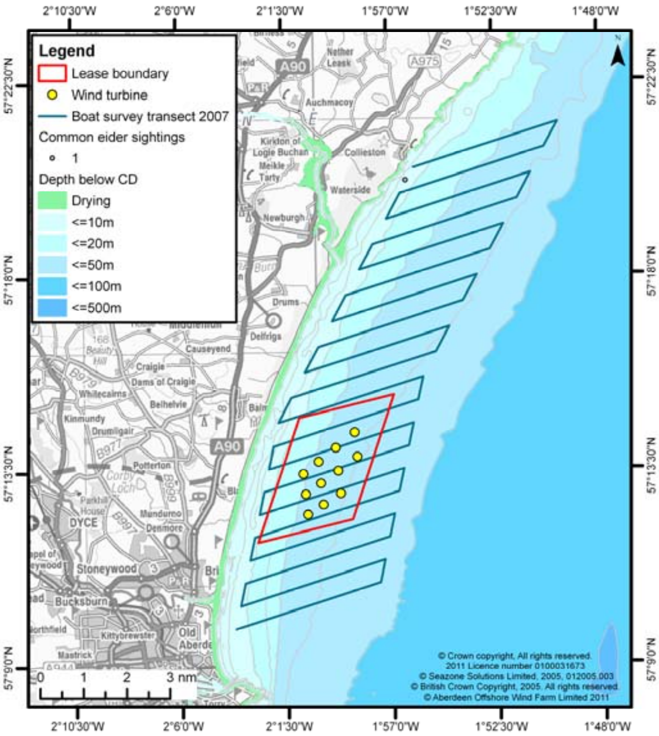


Figure 4-8: Common eider distribution in Aberdeen Bay during summer period: June, July, August (all sightings).

Table 4-7: Seasonal estimates of density and abundance of eider in the EOWDC and 'control' Areas.

	Density Estimate (km^2)	S.E	Estimated Abundance	SE	Number of observation
Development - winter	10.95	35.08	556	1.78	3
Control -winter	0.31	0.19	16	10	5
Development - Spring	0.12	0.07	6	3.8	6
Control - Spring	0.00	0.00	0	0.0	0
EOWDC - Summer	0.00	0.00	0	0	0
Control - Summer	0.00	0.00	0	0.0	0
EOWDC - Autumn	0.03	0.00	2	0.2	1
Control - Autumn	0.36	0.29	19	14.8	2

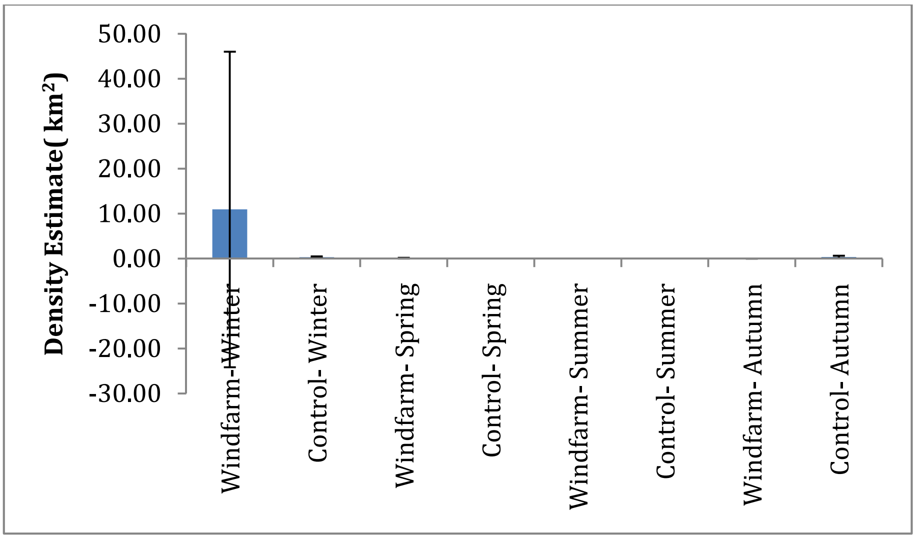


Figure 4-9: Seasonal estimates (+/- SE) of density of eiders in the proposed EOWDC and 'control' Areas.

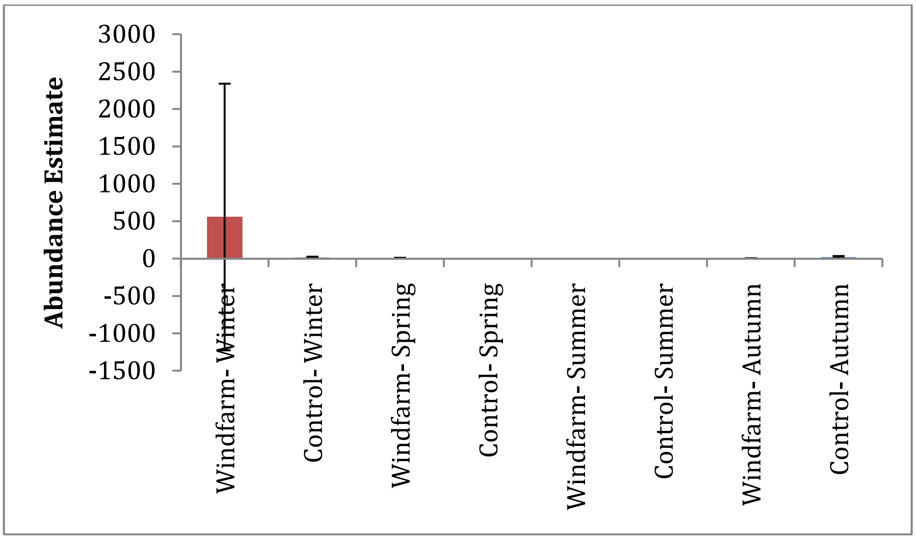


Figure 4-10: Seasonal estimates (+/- SE) of abundance of eiders in the proposed EOWDC and 'control' Areas.

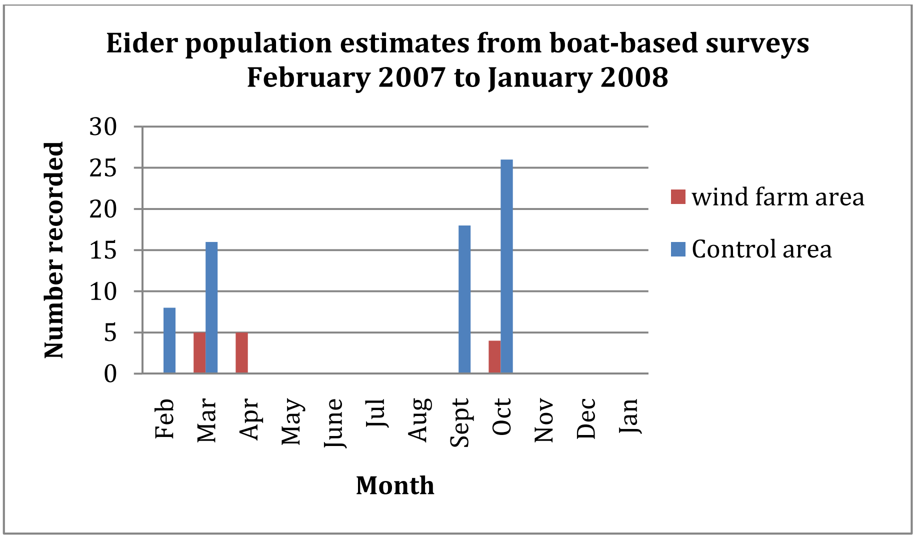


Figure 4-11: Common eider monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

Table 4-8: Common eider monthly population estimates in Aberdeen Bay: Boat-based surveys 2007 – 2008.

Month	On water estimate	In flight estimate	Total estimate
February	8	0	8
March	0	21	21
April	5	0	0
May	0	0	0
June	0	0	0
July	0	0	0
August	0	0	0
September	18	0	18
October	27	3	30
November	0	0	0
December	0	0	0
January	0	0	0

Vantage Point surveys

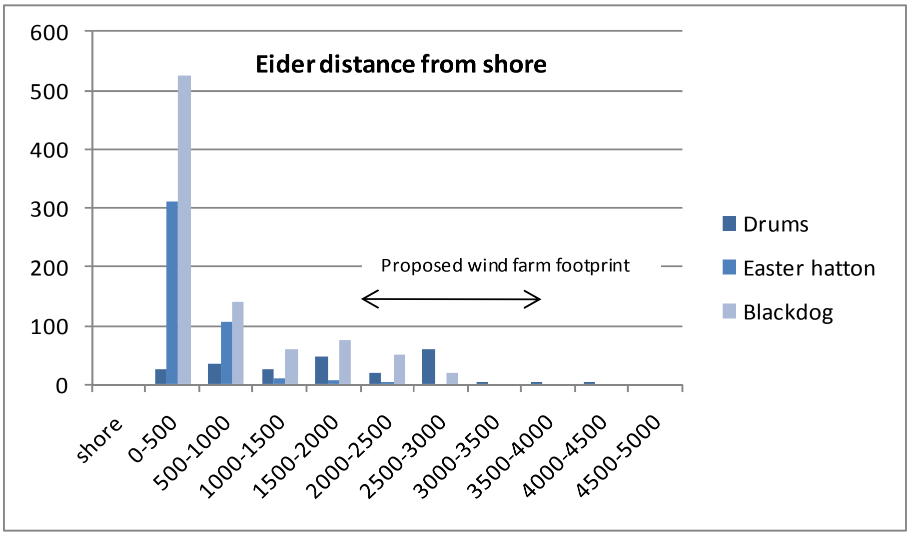
Peak movements of eider in Aberdeen Bay occurred during dawn and dusk with up to 10 birds per hour between December and March and increasing up to 32 birds per hour passing in April 2007 before decreasing to mainly less than 10 birds per hour from June through to August (EnviroCentre 2007a,b; Alba Ecology 2008a,b).

Between 96% and 98% of all flights were below 30 m with the majority of observations within 2 km of the coast and fewer between 2 km and 3 km away. Highest numbers were consistently recorded at Balmedie and Drums, which were the two closest Vantage Point sites to the Ythan Estuary.

Bird Detection Radar

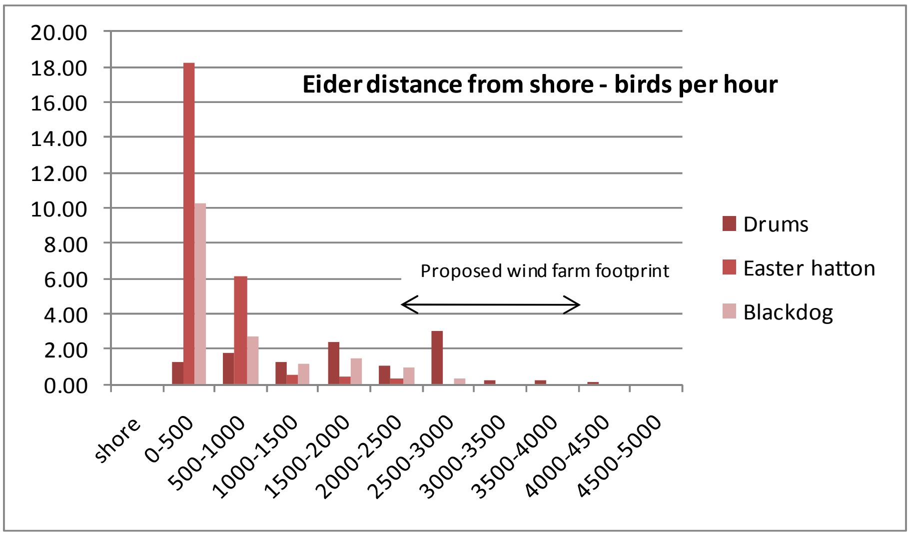
Eider were frequently recorded during the Bird Detection Radar studies undertaken in October 2005. A total of 680 birds were recorded, of which 449 were at Easter Hatton and 231 at Drums. Of those recorded in flight the maximum flight height was 10 m with the mean flight height of between 2 m and 3 m (Walls *et al*. 2006).

Additional radar studies undertaken in April 2007 recorded 855 eider at Backdog and of those recorded in flight, all were below 30 m. All sightings were of birds within 3 km from shore with the majority being within 500 m (Figure 4-12) (Simms *et al.* 2007).



(Adapted from Walls *et al.* 2006, Simms *et al.* 2007)

Figure 4-12: Distances from shore for common eider from three locations in Aberdeen Bay during surveys undertaken in October (Drums & Hatton) and April (Blackdog).



(Adapted from Walls *et al*. 2006, Simms *et al*. 2007).

Figure 4-13: Number of common eider per hour and distance from shore from three locations in Aberdeen Bay during surveys undertaken in October (Drums & Hatton) and April (Blackdog).

4.9.3 Summary of Results

The Ythan Estuary and Aberdeen Bay are both important areas for eider throughout the year. The Ythan Estuary is the largest breeding colony of eider in the UK and Aberdeen Bay holds nationally important numbers, particularly during the post-breeding period of July and August.

The results from boat-based surveys recorded relatively few eider with peak numbers during the winter and autumn periods. No eider were recorded within transect in either the proposed EOWDC area or the 'control' area between May and August. Data from land-based observations also recorded peak numbers of eider between December and April with a peak, in April, of up to 32 birds per hour. Eider were recorded out to at least 3 km from shore but as significant majority of sightings were within 1 km from shore.

All those recorded in flight from boat-based surveys were flying below 25 m and of those recorded from shore 96% and 98% were below 30 metres.

The breeding population on the Ythan Estuary and the number of birds using Aberdeen Bay are of national importance.

4.9.4 Initial Assessment of Significance

Eider	Overall sensitivity	Magnitude	Significance
Collision	Very High	Negligible	Minor
Barrier	High	Medium	Moderate
Displacement	High	High	Major

4.9.5 Species Sensitivities

Qualifying species

There are four SPAs in the region for which eider is a qualifying species as part of waterfowl assemblages: Ythan Estuary, Sands of Forvie and Meikle Loch SPA, Montrose Basin SPA & Ramsar, Firth of Forth SPA and Firth of Tay and Eden Estuary SPA.

Flight height

Flight heights obtained from boat-based surveys undertaken in Aberdeen Bay recorded all eiders in flight as being below 25 m and therefore not at risk of collision. Data obtained from land-based vantage point surveys recorded between 96% and 98% as being below 30 m.

Elsewhere in the UK there is very limited data from other offshore wind farms on flight heights for eider. Extensive studies undertaken in Denmark and Sweden have recorded significant numbers of eider. The proportion flying at rotor height is overall 26% with a mean flight height of 13.7 m (n=34,857).

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that eider are widespread and frequent within Aberdeen Bay. They occur widely with the majority of sightings occurring in nearshore waters within 1 km of the shore and in water depths of <20 m.

Studies undertaken in Denmark indicate that eider have a very high avoidance rate and that the majority of birds will detour around the wind farm. Birds flying within wind farms are unusual and when doing so 89% of all flights are below turbine height. Modelling undertaken for the significantly larger Nysted Offshore wind farm predicted that out of 235,000 passing eiders that between 0.018 and 0.02 birds might collide with a turbine (Petersen *et al*. 2006).

In Sweden at the two wind farms in the Kalmar Sound eiders are the most abundant species and over 1.2 million eider were recorded during the study period of which three were seen to collide with the turbines (Pettersson 2006).

Consequently there is substantial volume of evidence to indicate that the risk of collision by eider is extremely low.

The numbers of eider recorded in Aberdeen Bay are significantly lower than those studied in Denmark and Sweden and in neither of these studies was there any evidence of a significant impact from collision. Furthermore, site specific data indicates that relatively few eider in Aberdeen Bay occur beyond 2 km of the coast and therefore within the potential area of risk from the proposed development. Radar studies indicated up to six times more eider passing within 500 metres from shore compared to between 2.5 km and 3 km from shore.

Based on the results from other offshore wind farms that have demonstrated significant avoidance rate and very low risk of collision as well as the relatively low usage of the site due to its distance from shore it is concluded that the potential effect from collision risk is negligible.

Barrier effect

Studies undertaken in Sweden and Denmark have shown that there is the potential for significant barrier effect, with eiders changing flight directions at least 1 km from offshore wind turbines and flying around them. At Nysted offshore wind farm in Denmark radar studies undertaken tracked over 300,000 eider each autumn. The results indicated that there was a significant decrease in the proportion of flocks entering the wind farm from between the pre-construction period and the operational period. It was found that post construction, 9% of the birds entered the turbines compared with 40% crossing the same location before construction, i.e. there was a clear tendency for flocks to alter course and avoid the wind farm. Flocks that did continue into the wind farm adjusted their flight trajectories and tended to fly down the visually clear corridors between the rows of turbines (Deshom & Kahlert 2005). Further monitoring at Nysted reported a reduction of between 63%and 83% in the use of the wind farm airspace by migrating birds post construction compared to preconstruction (Petersen 2006), therefore providing evidence of large-scale avoidance behaviour of migrating birds.

Therefore it is predicted that the proposed development may cause a barrier effect to eiders in Aberdeen Bay.

There is no evidence of regular daily movements of eider within Aberdeen Bay to and from feeding or roosting areas. Should it occur with eider making daily movements from the Ythan Estuary to Aberdeen Bay to the south of the proposed development and the birds select to fly around the turbines up to 1 km away then they may incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.0% and 2.5% (Caldrow, Stillman & West 2007; Speakman, Gray & Furness 2009). This is a relatively small increase in daily energy expenditure and is unlikely to have an adverse effect on eiders in Aberdeen Bay.

The peak numbers of eider in Aberdeen Bay occur during July and August when the adult eider undergo a complete wing moult over a period of four weeks, during which time they become flightless. The daily energetic costs during this period increase but the birds remain within certain areas where they can forage and cannot undergo daily flight movements (Guillemette *et al.* 2007) Consequently, there is no incremental increase in daily energy expenditure due to the barrier effect during this period of higher energy expenditure.

Data obtained from three years of Vantage Point surveys did not detect any evidence to suggest that there are regular daily flights by eider across the proposed development area and so a regular barrier effect that may cause a long-term increase in daily energetic costs is not predicted. There is the potential for a relatively small *ad hoc* increase as birds move around the bay but as most movements are within 1 km of the coast regular barrier effects are unlikely. It is predicted that the possible impacts arising from a potential barrier effect will be minor and there will be no adverse effect or significant environmental impact.

Displacement

Based on the results from the monitoring data, the worst-case scenario is that should displacement occur, that no eider will be within the proposed development area and there will be 80% displacement out to a distance of 1 km and a further 50% decrease in abundance out to 2 km from the wind farm.

Based on the peak density obtained from boat-based surveys of 10.9 birds/km^2 during the winter period, should there be a total displacement of eider from within the proposed development area then it is predicted that up to 47 eider may be displaced during periods of peak density. Based on an 80% displacement out to 1 km (a total surface area of 12.3 km^2) from the proposed development area then it is predicted that a total of 154 eider may be displaced with a further 44 out to 2 km should there be 20% displacement. Therefore, the maximum number of eider potentially displaced is up to 198 birds based on the highest densities recorded from any survey within Aberdeen Bay and at least some displacement out to 2 km.

Based on the estimated total of 198 potentially displaced eider out of a peak reported count of 3,500 eider at Blackdog (Figure 4-5), it is predicted that up to 6% of the eider within Aberdeen Bay may be displaced. However, the distribution of eider within Aberdeen Bay is clustered with peak numbers occurring at various sites across the bay during different seasons (Sohle *et al*. 2006). The area off Blackdog regularly records the peak counts of eider in Aberdeen Bay (NESBR) and should displacement occur a greater proportion of eider might be affected than is estimated using densities obtained from boat-based surveys.

The Tuno Knob offshore wind farm in Denmark is a relatively small wind farm of ten turbines in an area that holds up to 5,800 eider. Post-construction monitoring at Tuno Knob has indicated that the distribution of eider is closely related to their prey and although there may be some displacement immediately post-construction there is unlikely to be any significant displacement of eider from the proposed development area as long as their prey remain available (Guillemette *et al.* 1999). Evidence from studies undertaken at Nysted offshore wind farm have indicated that although there was an avoidance of the area during construction there was a subsequent increase of 48% within the wind farm area post-construction but a decrease in numbers out to 2 and 4 km (Zucco *et al.* 2006).

These two studies demonstrate that eiders do not avoid wind farms post-construction and their distribution is closely aligned to the availability of prey. The main prey items for eider are mussels (*mytilus edulus*). Evidence from constructed wind farms indicates that there is likely to be an increase in mussels around the base of turbines and that no significant impacts have been detected on mussels from the construction of wind farms. Consequently, there is unlikely to be a negative impact on prey availability for eiders within Aberdeen Bay.

Based on the evidence from existing offshore wind farms it is predicted that the potential impact from displacement is minor.

Calculations used for displacement	
Area	*Peak density of eider – 10.9 birds/km^2*
Area of EOWDC – 4.3 km^2	4.3 * 10.9 = 47
Area of EOWDC 1 km buffer – 12.3 km^2 @ 80%	(12.3 * 10.9)*0.8 = 107
Area of EOWDC 2 km buffer – 20.3 km^2 @ 20%	(20.3 * 10.9)*0.2 = 44
Total predicted displacement	47+107 + 44 = 198

Disturbance

Eiders may be disturbed by vessels both during the construction phase and during operations from maintenance vessels. Studies have indicated that there may be displacement from large vessels out to 1,000 m (Larsen & Laubek 2005).

During construction there may be a number of vessels operating within the area but they will likely be focussed around a single point where the turbine is being installed. Consequently, eider may be displaced from within 1 km radius of the installation; an area of 3 km^2. Based on the highest recorded density of 10.9 birds/km^2, it is therefore predicted that up to 33 eider may be displaced from the vicinity during construction. This equates to approximately 1% of the peak eider population within Aberdeen Bay based on the peak estimated figure of 3,500 individuals. The construction period will be of short duration and the impacts from construction vessels temporary. Consequently, any potential impact is predicted to be negligible.

Displacement by service boats may diminish the re-population potential of the EOWDC. It is not known how many service vessels may be required but based on the scale of the proposed development there is unlikely to be frequently more than one vessel on any one occasion. The presence of the proposed development in the vicinity of the intensively used Aberdeen Harbour means that the potential increase of one vessel movement on a regular basis will not have any noticeable difference to the number of vessels already using Aberdeen Bay. Any specific displacement caused by the service or construction boats will be temporary as eiders will be able to move into the area once the vessels leave.

It is concluded that the effect of disturbance from construction or service boats is negligible.

Cumulative and in-combination

The potential future Ocean Pod will require additional vessel movements within the proposed development area. Should this occur then there is the potential for a cumulative effect on eider. It is not yet known what type of structure the Ocean Pod may be or how it will be installed or the number of vessel movements will be required. However, it is a single structure and it is predicted that the level of disturbance will be no greater than that arising from the installation of a single wind turbine. The scale of disturbance is therefore predicted to be localised and of short duration.

Aside from the historical and on-going levels of shipping, there are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts. The eiders present are known to travel to the Tay during the winter and have the potential to interact with other offshore wind farm planned in the area. However, the location of the wind farms in the Firth of Forth area, in particular their distance from shore, are such that eiders are unlikely to be frequently recorded in any of the areas of the proposed developments. Consequently there are unlikely to be any cumulative or in-combination impacts.

4.9.6 Conclusions

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating both a very low collision risk and little, if any, displacement and that there are not expected to be any significant barrier effects; it is predicted that there will not be any adverse effects on the SPAs for which eider is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on eider.

4.10 Long-tailed duck (*Clangula hyemalis*)

4.10.1 Protection & Conservation Status

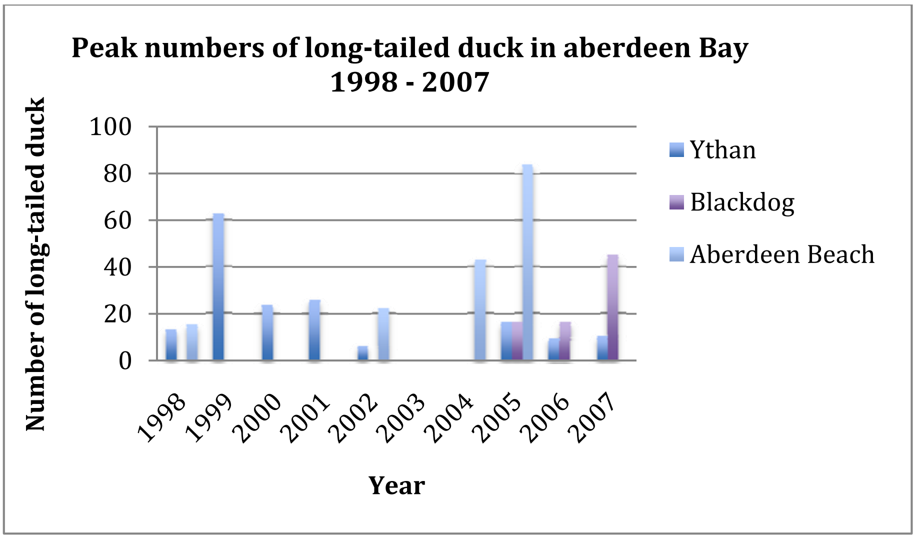
Long-tailed duck is listed in Appendix II of the Bonn Convention, Appendix III of the Bern Convention and is on the Green List of Species of Conservation Concern.

4.10.2 Background

Long-tailed duck		
GB Population	Winter – 16,000 ind.	BTO 2011
Scottish Population	Winter – 15,000 ind.	Forrester *et al* 2007
International threshold	20,000 ind.	Calbrade *et al.* 2010
GB threshold	160 ind.	1% of GB Pop[n]
Designated east coast sites where species is a noted feature	Firth of Forth Firth Tay & Eden	SNH 2011
European population estimate	Breeding 7,669 – 17,294 pairs Wintering – 4,700,000 individuals	Hagemeijer & Blair 1997
European population trend	Status 'decreasing' Trend 'moderate decline	Birdlife 2004
World population	6.2 to 6,800,000 ind.	Birdlife 2011

Long-tailed duck breed in the high Arctic with significant breeding population in Russia where up to 5 million pairs are estimated to breed. In north-west Europe, breeding populations are considerably smaller with less than 18,000 pairs in Sweden, Iceland and Finland. Long-tailed duck do not breed in the UK but an estimated 16,000 winter in the UK of which 15,000 winter in Scottish waters, primarily in Shetland, Orkney and the Moray Firth (Forrester *et al.* 2007). Outwith the breeding season long-tailed duck occur along sheltered coasts, often with soft sandy sediments and can dive to depths of up to 60 metres so can occur further offshore than many other species of seaduck.

In North-east Scotland long-tailed duck are an uncommon winter visitor with most sightings and peak numbers occurring in Aberdeen Bay where less than a hundred birds may occur (Figure 4-14). Passage of birds passing Peterhead occurred from September to May with peak counts of up to 14 birds per hour during March. Although most sightings at Peterhead were within a few hundred metres from the shore long-tailed duck were seen as far out as 3 km (Innes 1996).



(Source NESBR)

Figure 4-14: Peak numbers of long-tailed duck recorded at the Ythan, Blackdog and Aberdeen Beach 1998 – 2007.

Boat-based surveys

A total of 33 long-tailed duck were recorded from ship-based surveys in January, April, October, and November. All sightings were of birds close inshore, flying parallel to the coast (Figure 4-15) (IECS 2008, SMRU 2011b).

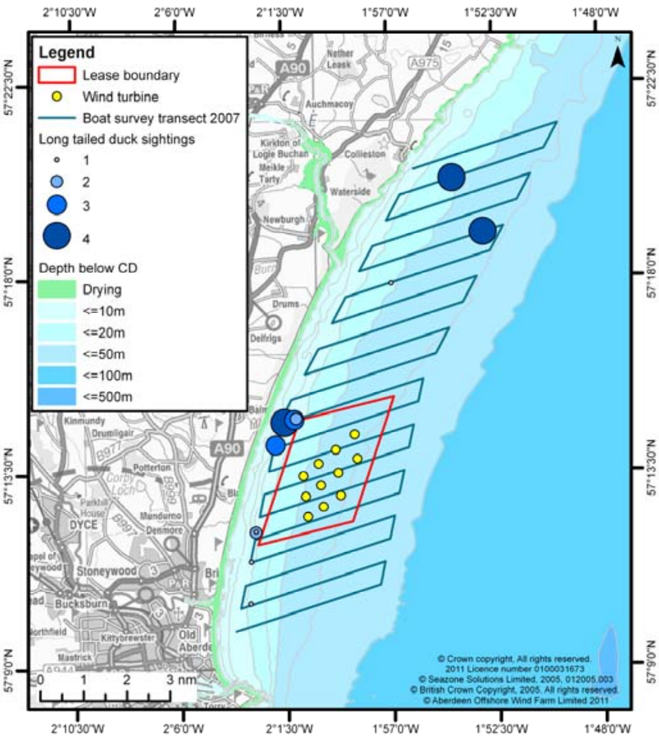


Figure 4-15: Long-tailed duck distribution in Aberdeen Bay (all sightings).

Point surveys

Long-tailed duck were regularly recorded in low numbers within Aberdeen Bay, primarily between December and March with a peak count of up to 25 birds per hour passing Blackdog in November 2007. However, numbers passing were usually less than five birds per hour at other sites (Alba Ecology 2008b). All birds were recorded flying below 30 metres with the majority of sightings between 1 km to 3 km from shore.

Bird Detection Radar

A total of 17 long-tailed duck were recorded during the radar studies in October 2005 with seven at Drums and ten at Easter Hatton. Although long-tailed duck were recorded out to 2.7 km from shore the majority of sightings were within 2 km from the coast. The mean flight heights were 2 m above sea surface with the maximum height of 4 m (Walls *et al.* 2005). Forty-seven birds were recorded during radar studies undertaken at Blackdog in April 2007. All birds were flying below 30 m and 90% of sightings were within 1.5 km of the coast (Simms *et al.* 2007).

4.10.3 Summary of Results

Relatively small numbers of long-tailed duck occur in Aberdeen Bay with peak counts of usually less than 50 birds, occurring in any month between November and March. Although long-tailed duck can occur throughout the bay the main areas are the Ythan mouth, Blackdog and the Donmouth. The majority of sightings are of birds within 2 km of the shore and at least 90% of the birds recorded in flight were flying below 30 m.

No counts of long-tailed duck within Aberdeen Bay were of national importance.

4.10.4 Initial Assessment of Significance

Long-tailed duck	Overall sensitivity	Magnitude	Significance
Collision	Medium	Negligible	Negligible
Barrier	High	Low	Minor
Displacement	Very High	Low	Moderate

4.10.5 Species Sensitivities

Qualifying species

There are two SPAs in the region for which long-tailed duck is a qualifying species as part of waterfowl assemblages: Firth of Forth SPA and Firth of Tay and Eden Estuary SPA.

Flight height

Flight heights obtained from boat-based surveys undertaken in Aberdeen Bay recorded all seventeen long-tailed ducks for which flight heights were recorded as flying below 25 m. Data from site specific radar studies recorded a mean flight height of 2 m and a maximum of 4 m.

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that long-tailed duck occur in relatively low numbers within Aberdeen Bay. Studies undertaken in Sweden indicate that long-tailed duck have a very high avoidance rate and that the majority of birds will either detour around the wind farm or fly below turbine height (Pettersson 2006). Consequently, there is evidence to indicate that the risk of collision by long-tailed duck is extremely low.

The numbers of long-tailed duck recorded in Aberdeen Bay were significantly lower than those studied in Denmark and Sweden and in neither of these studies was there any evidence of a significant impact from collision.

Based on the results from site specific study indicating the low altitude at which long-tailed duck fly and evidence from other offshore wind farms it is predicted that there is a very low risk of collision and that the potential effect from collision is negligible.

Barrier effect

Studies undertaken in Sweden and Denmark have shown that there is the potential for a barrier effect, with long-tailed duck changing flight directions at least 1 km from offshore wind turbines and flying around them. Therefore, it is predicted that the proposed development may cause a barrier effect to long-tailed duck in Aberdeen Bay.

Data obtained from nearly three years of Vantage Point surveys plus additional radar studies and boat-based surveys did not detect any evidence to suggest that there are regular daily flights by long-tailed duck across the proposed development area and so a regular barrier effect that may cause a long-term increase in daily energetic costs is not predicted. There is the potential for a relatively small *ad hoc* increase as birds move around the bay but as most movements are within 2 km of the coast regular barrier effects are unlikely. It is predicted that the potential impacts arising from barrier effect will be minor and there will be no adverse effect or significant environmental impact.

Displacement

Based on the results from the monitoring data, the worst-case scenario is that should displacement occur, that no long-tailed duck will be within the proposed development area out to a distance of 1 km and a further 50% decrease in abundance occurs out to 2 km from the wind farm. However, very few long-tailed duck were recorded from any surveys and any displacement will impact on a relatively low number of birds and any that are displaced will be able to re-locate if needed to alternative areas. Data from aerial surveys identify Cruden Bay to the North and Bridge of Don to the south of the proposed development as being the main areas for long-tailed duck (Sohle *et al*. 2006).

Based on the low numbers of long-tailed duck recorded in the vicinity of the proposed development and that alternative areas of Aberdeen Bay are known to be suitable for long-tailed it is predicted that the potential impact from displacement is negligible.

Disturbance

Long-tailed ducks may be disturbed by vessels both during the construction phase and during operations from maintenance vessels. Studies have indicated that there may be displacement from supply vessels (Pettersson 2006).

During construction there may be a number of vessels operating within the area but will likely be focussed around a single point where the turbine is being installed. The numbers of long-tailed duck present in the vicinity of the proposed development are relatively low. Evidence from existing wind farms indicates that long-tailed duck may fly up to 2 km from the vessel once disturbed and return once the vessel departs (Pettersson 2006).

It is not known how many service vessels may be required but based on the scale of the proposed development there is unlikely to be frequently more than one vessel on site at any one time. The presence of the proposed development in the vicinity of the intensively used Aberdeen Harbour means that the potential increase of one vessel movement on a regular basis will not make any noticeable difference to the number of vessels already using Aberdeen Bay. Any specific displacement caused by the service boats will be temporary as long-tailed duck will be able to move into the area once the vessels leave.

It is concluded that the effect of disturbance from construction or service boats is negligible.

Cumulative and in-combination

The potential future Ocean Pod will require additional vessel movements within the proposed development area. Should this occur then there is the potential for a cumulative effect on long-tailed duck. It is not yet known what type of structure the Ocean Pod may be or how it will be installed or the number of vessel movements will be required. However, it is likely to be a single structure and it is predicted that the level of disturbance arising from the installation of it will be no greater than that arising from the installation of a single wind turbine. The scale of disturbance is therefore predicted to be localised and of short duration.

Aside from the historical and on-going levels of shipping, there are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts. Based on the numbers present and the low risk of any adverse effect from the proposed development on its own there are no known potential cumulative or in-combination impacts.

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating both a very low collision risk, little displacement and that there are not expected to be any significant barrier effects; it is predicted that there will not be any adverse effects on the SPAs for which long-tailed duck is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on long-tailed duck.

4.11 Common scoter (*Melanitta nigra*)

4.11.1 Protection & Conservation Status

Common scoter is listed in Schedule I of the Wildlife and Countryside Act, Appendix II of the Bonn Convention Appendix III of the Bern Convention and is on the Red List of Species of Conservation Concern for a breeding species and Amber List for wintering species.

4.11.2 Background

Common scoter		
GB Population	Breeding 9 – 52 pairs Winter – 50 – 65,000 ind.	Holling 2010 Cranswick 2001
Scottish Population	Breeding – 9 – 52 pairs Winter – 25,000 – 30,000 ind.	Holling 2010 Forrester *et al.* 2007
International threshold	16,000 ind.	Calbrade *et al*. 2010
GB threshold	500 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Firth of Forth Firth of Tay & Eden	SNH 2011
European population estimate	Breeding 100,000 – 130,000 pairs Wintering – 610,000 individuals	Birdlife 2004
European population trend	Status 'secure' Trend 'small decline'	Birdlife 2004
World population	2,100,000 – 2,400,000 'adults'	Birdlife 2011

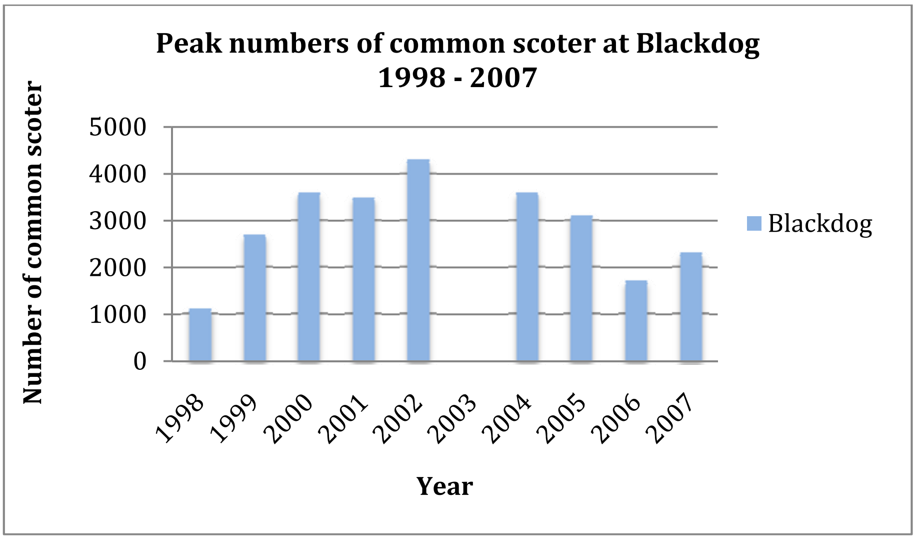
Common scoter breeds across the boreal and subarctic zones of Eurasia and has a European breeding population of up to 130,000 pairs. There is a small breeding population in the UK with between 9 and 52 pairs breeding in Scotland (Holling 2010).

Common scoter is a common winter visitor occurring in waters predominantly less than 20 m deep where they forage on benthic mussels and crustaceans. They are generally gregarious and form large flocks in suitable areas. In eastern Scotland the main wintering areas are the Moray Firth, Firth of Forth, St Andrews Bay, Carnoustie, Lunan Bay and Aberdeen Bay where a combined total of c.9,000 individuals winter (based on 5 year peak mean counts) (Calbrade *et al.* 2010).

Common scoters also occur during the summer months at regular 'moult' sites where flocks of up to 3,000 individuals may occur (Cork Ecology 2004a). The main summering sites are Aberdeen Bay, Firth of Forth, St Andrew's Bay, St Cyrus and Lunan Bay where a combined total across all sites total of c.6,500 birds may summer (Cork Ecology 2004a)

In North-east Scotland common scoter occur regularly in large numbers in a few preferred areas; particularly Aberdeen Bay. Numbers are lowest during the winter months when there are usually less than 200 birds present (Wilson *et al*. 2006). During the summer months a 'moult' flock of common scoter is present in Aberdeen Bay, primarily between the Donmouth and Balmedie to the south and west of the proposed development, with peak counts of up to 4,750 birds occurring (Buckland, Bell & Picozzi 1990; NESBR) (Figure 4-16).

Common scoter were recorded passing Peterhead throughout the year with a strong seasonal variation. Numbers passing Peterhead were generally low during the winter months with less than four birds per hour. There is a peak spring passage during April when up to 13 birds per hour were recorded with a decrease thereafter. Most sightings were of birds between 300 to 500 metres from shore but some were out to 3 km (Innes 1996).



(Source NESBR)

Figure 4-16: Peak numbers of common scoter recorded at Blackdog between 1998 and 2007.

Boat-based surveys

Common scoters were recorded in coastal waters of Aberdeen Bay throughout the year with peak counts during June and July. All records were of birds in water depths of less than 20 m with the majority of sightings within 2 km of the coast and in water depths of less than 10 m. There were relatively few records of common scoter within the proposed development area with small numbers present during the spring and autumn migration periods. The largest flocks were recorded between Donmouth and Balmedie with a cluster of flocks totalling 1,200 common scoter in July 2007 (Figure 4-17, Figure 4-18, Figure 4-19) (IECS 2008).

Additional surveys undertaken between August 2010 and January 2011 recorded common scoter within the proposed development area. Peak totals occurred in September and January when approximately 100 birds were present (Figure 4-20) (SMRU 2011b).

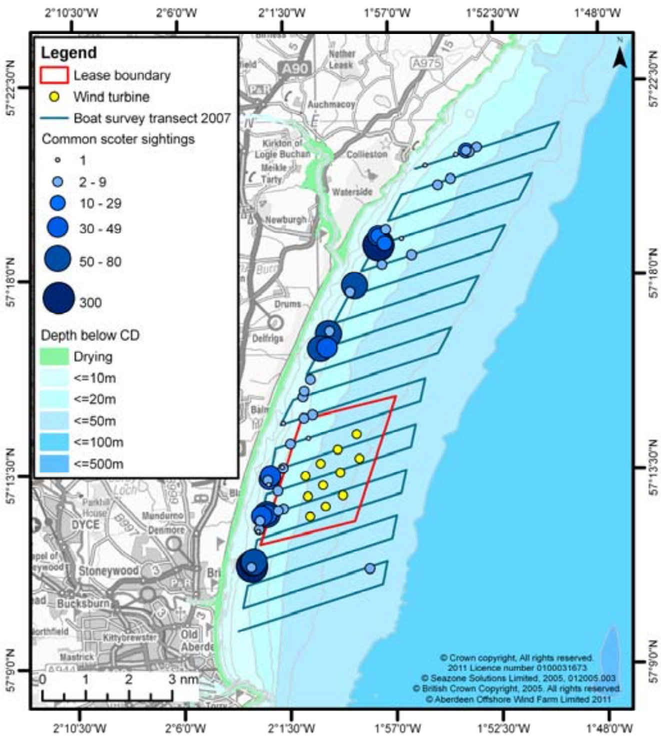


Figure 4-17: Common scoter distribution in Aberdeen Bay during winter period: November to March (all sightings).

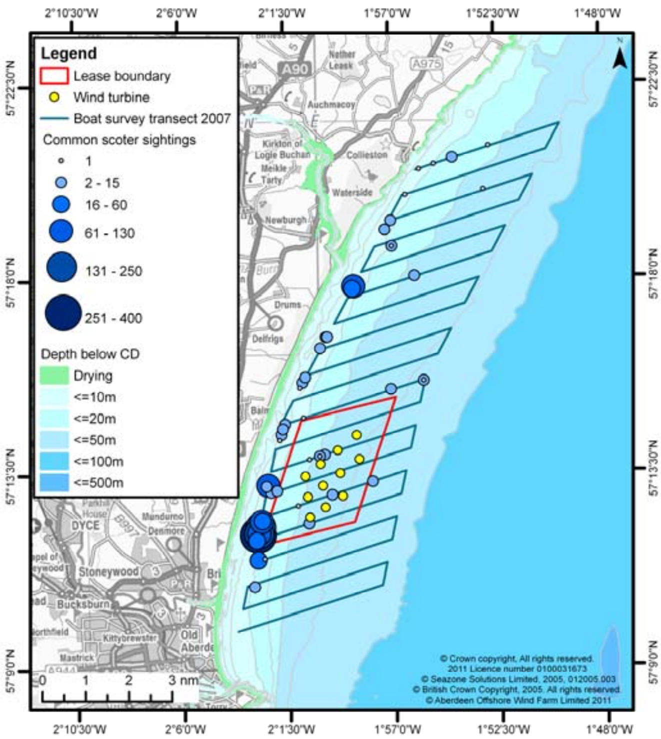


Figure 4-18: Common scoter distribution in Aberdeen Bay during spring and autumn periods: (all sightings).

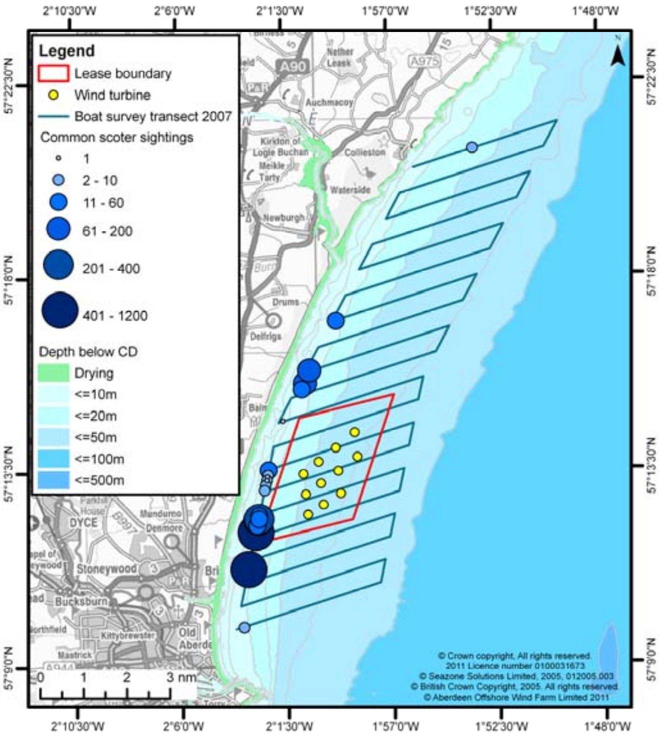


Figure 4-19: Common scoter distribution during summer period: June to August (all sightings).

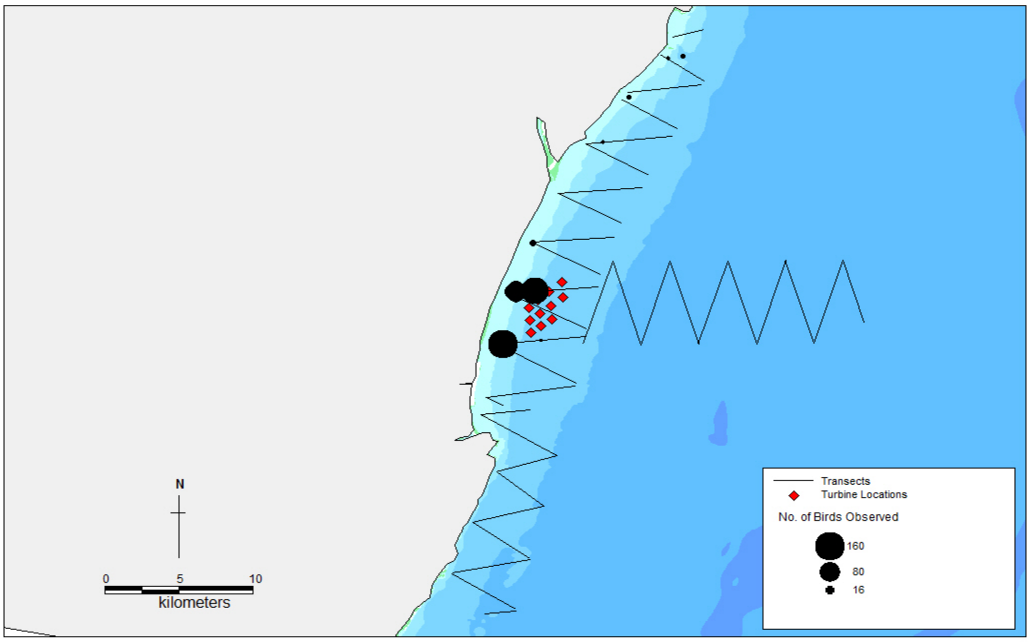


Figure 4-20: On-effort observations of all species of seaduck (Common Scoter, Unidentified Scoter species, Common Eider and Long-tailed Duck) along transects during August, September and November 2010 and January 2011.

Most sightings from boat-based surveys were of birds when not on transect and outwith the 300 m transect width. Consequently, the number of birds recorded for population estimates were relatively low. Greatest numbers were recorded within the wider proposed EOWDC development area but not within the footprint of the proposed development; with seasonal estimates using *Distance* sampling indicating peak numbers in the proposed EOWDC development area of 1,175 individuals and 442 individuals in the summer period (Table 4-9, Figure 4-21,Figure 4-22).

Table 4-9: Seasonal estimates of density and abundance of Common Scoters in the proposed EOWDC and 'control' Areas

	Density Estimate (km^2)	S.E	Estimated Abundance	SE	Number of Observations
EOWDC - winter	0.23	0.15	12	7.7	4
Control -winter	0.09	0.09	5	4.6	2
EOWDC - Spring	23.1	45.48	1,157	2,310	4
Control - Spring	0.39	0.11	20	5.9	5
EOWDC - Summer	8.69	18.62	442	946	5
Control - Summer	1.55	1.58	79	80	1
EOWDC - Autumn	0.02	0.02	1	1.4	1
Control - Autumn	0.10	0.08	5	4.2	4

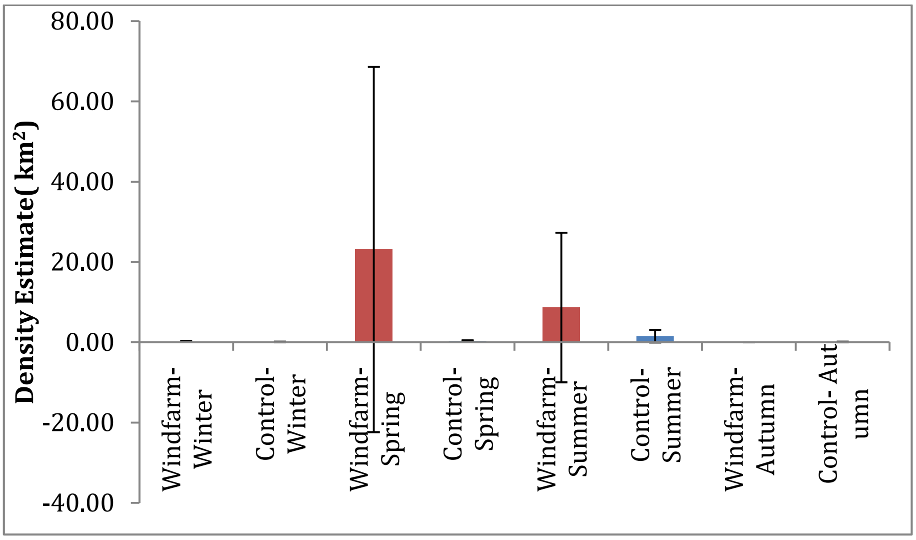


Figure 4-21: Seasonal estimates (+/- SE) of density of Common Scoters in the proposed EOWDC and 'control' Areas.

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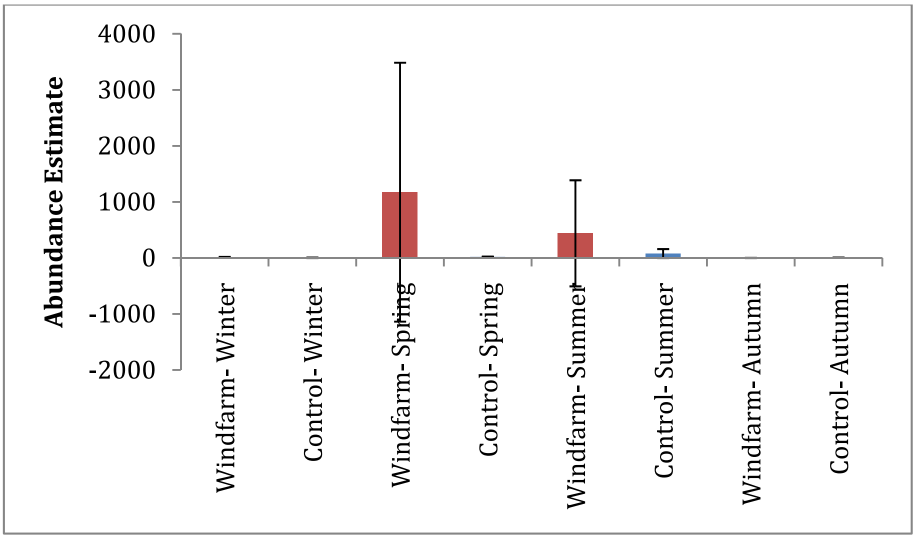


Figure 4-22: Seasonal estimates (+/- SE) of abundance of Common Scoters in the proposed EOWDC and 'control' Areas.

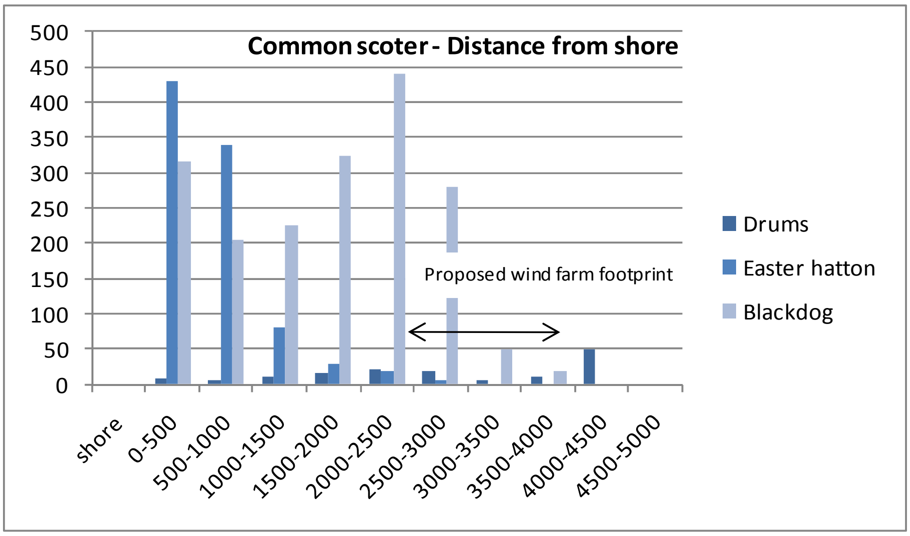
Vantage Point surveys

Results from monthly vantage point counts undertaken in Aberdeen Bay throughout the year recorded relatively low numbers of common scoter between December and February with numbers increasing from March onwards and peak movements between June and September when up to nearly 200 birds per hour were recorded passing in July 2007 (Alba Ecology 2008a,b). This is in contrast to the records from Peterhead where most sightings occurred during the spring and relatively few sightings during the summer. Birds were recorded at all Vantage Point sites with peak numbers at Balmedie, Murcar and the Promenade during June. Of those for which flight heights were recorded at least 95% were flying below 30 m with the majority of those recorded at greater than 30 m being at Donmouth. Most records were within 1 km and 2 km from shore, with relatively few between 2-3 km.

Bird Detection Radar

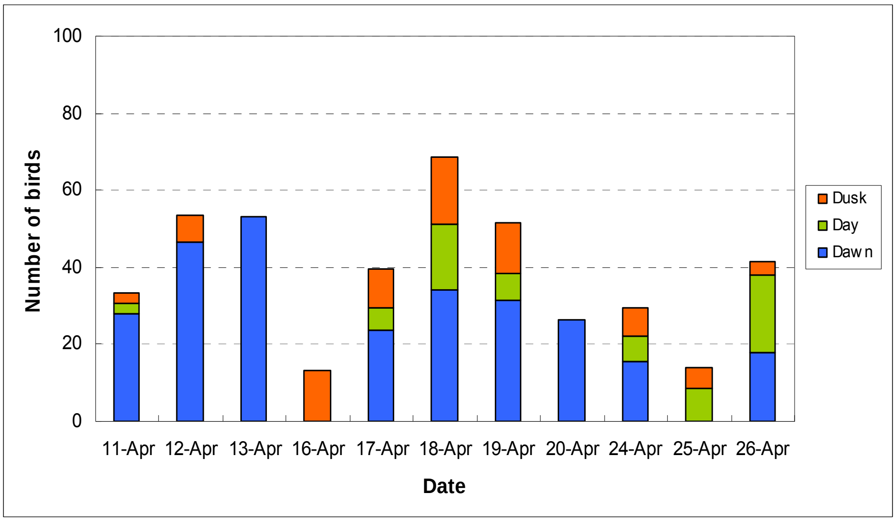
Common scoter were frequently recorded during the Bird Detection Radar studies undertaken during October 2005 with a total of 1,054 sightings of which 911 were at Easter Hatton and 143 at Drums. Common scoter recorded at Easter Hatton were generally less than 2 km from shore with those at Drums between 4 km and 4.5 km from shore. Of those recorded in flight all were flying below 5 m. (Walls *et al.* 2006).

A seventeen day radar study was undertaken at Blackdog between 11 and 26 of April 2007. During this survey a total of 1,872 common scoter were recorded in relatively small flocks of no more than 60 birds (Simms *et al.* 2007). Unlike the surveys undertaken in October 2005, approximately 50% of all common scoter were between 2 km and 4 km from shore (Figure 4-23). Although April is a period of spring migration for common scoter, there was no clear difference between the numbers of birds heading north as opposed to flying south, which indicates that the movements of birds during this period may have related to foraging movements as opposed to migrating individuals. As the majority of sightings were during the first two hours of dawn the movements recorded may also relate to birds redistributing after night time drifting (Figure 4-24).



(Adapted from Walls *et al* 2006, Simms *et al* 2007)

Figure 4-23: Distance from shore for common scoter from three locations in Aberdeen Bay during surveys undertaken in October (Drums & Hatton) and April (Blackdog).



(Source Simms *et al.* 2007)

Figure 4-24: The diurnal flight behaviour of common scoter at Blackdog.

4.11.3 Summary of Results

Common scoters were frequently recorded throughout the year during surveys undertaken across Aberdeen Bay. Peak numbers recorded during boat-based surveys were during the spring and summer months with most records from within the proposed EOWDC survey area. Land based surveys recorded peak numbers of common scoter during the summer months with most birds being recorded off Blackdog. Most common scoter were recorded with 2 km of the coast and in waters of less than 10 m. However, a survey undertaken in April recorded the majority of common scoter off Blackdog as being between 1 km and 3 km from shore.

Of those recorded in flight at least 95 of common scoter were recorded flying below 30 m.

Peak counts of common scoter recorded within Aberdeen Bay are of national importance but are not of international importance.

4.11.4 Initial Assessment of Significance

Common scoter	Overall sensitivity	Magnitude	Significance
Collision	Medium	Negligible	Negligible
Barrier	High	Medium	Moderate
Displacement	Very High	High	Major

4.11.5 Species Sensitivities

Qualifying species

There are two SPAs in the region for which common scoter is a qualifying species as part of waterfowl assemblages: Firth of Forth SPA and Firth of Tay and Eden Estuary SPA.

Flight height

Flight heights obtained from boat-based surveys undertaken in Aberdeen Bay recorded 377 common scoter in flight of which 1% were recorded as flying above 25 m and therefore at risk of collision.

Extensive studies undertaken, particularly in the East Irish Sea have recorded large numbers of common scoter of which 4.0% have been recorded at rotor height and mean flight height of 9.3 m.

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that common scoter are widespread and frequent within Aberdeen Bay and occur in large flocks in certain areas. They occur widely with the majority of sightings occurring in nearshore waters within 3 km of the shore and in water depths of <20 m.

Collision Risk Modelling undertaken for common scoter is based on:

- Body length of 49 cm
- Wingspan of 84 cm
- Flight speed of 20.9 $m.s^{-1}$

Avoidance rates ranging from between 98%, 99% and 99.5% have been used.

As no common scoters were recorded in flight from boat-based surveys undertaken within the proposed development area, the collision risk calculation is based on the maximum number of birds recorded in flight from within the 'control' area to the north. This is a precautionary assumption as the proposed development area is in water depths greater than typical foraging depths for common scoter and is therefore infrequently used but it does take into account the possibility that birds may potentially fly through the area to other feeding locations.

Table 4-10: Predicted number of potential collisions for common scoter.

Collision probability	Avoidance rate (%)		
	98	99	99.5
6.6	0.27	0.13	0.06

Based on the precautionary avoidance rate of 98% it is predicted that a total of 0.27 collisions per year may occur (Table 4-10).

The annual mortality rate for common scoter is 22.7% (BTO 2011). Consequently, out of a peak regional population of 4,300 individuals an annual mortality of 976 common scoter, may be predicted. Therefore, 1% of the baseline mortality is 10 birds per year.

Based on the results from collision risk modelling, which predicts a total of 0.27 collisions per year there will not be a significant impact on the common scoter due to collisions.

The Firth of Forth SPA is approximately 134 km away and has a five year peak mean population of 1,070 individuals. Therefore an annual mortality rate of 243 scoter. Should the whole of the wintering population in the Firth of Forth SPA fly through the proposed development area then the collision risk modelling predicts there will not be an adverse effect on the population due to collision.

The Firth of Tay & Eden Estuary SPA lies approximately 96 km away from the proposed development and has a five year peak mean population of 1,037 scoters. Therefore, an annual mortality rate of 235. Should the whole of the wintering population in Firth of Tay & Eden Estuary SPA fly through the proposed development area the collision risk modelling predicts that there will not be an adverse effect on the population due to collision.

No collisions have been reported from post-construction monitoring studies undertaken in Denmark and Sweden indicating that common scoter have a very high avoidance rate and that the majority of birds will detour around the proposed development.

Based on the results the very low risk of collision and results from operating wind farms that have demonstrated significant avoidance rates by common scoter it is concluded that the potential effect from collision risk is negligible.

Barrier effect

Studies undertaken in Sweden and Denmark have shown that there is the potential for a barrier effect on common scoter with changes flight directions up to 1 km from offshore wind turbines and flying around them (Christensen & Hounisen 2004, 2005). Therefore it is predicted that the proposed development may cause a barrier effect to common scoter in Aberdeen Bay.

There is no evidence of regular daily movements of common scoter within Aberdeen Bay to and from feeding or roosting areas. However, most flight activity at Blackdog was recorded at dawn and these may be birds moving from a roost site to feeding areas (Figure 4-24). Should a barrier effect occur with common scoter making daily movements from one location to another around the proposed development area then they may incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.2% and 2.6% (Speakman, Gray & Furness 2009). This is a relatively small increase in daily energy expenditure and is unlikely to have an adverse effect on common scoter in Aberdeen Bay.

As with eider, the peak numbers of common scoter in Aberdeen Bay occur during July and August when the adults undergo a complete wing moult over a period of four weeks, during which time they become flightless. The daily energetic costs during this period may increase but the birds remain within certain areas where they can forage and cannot undergo daily flight movements, consequently, there is no incremental increase in daily energy expenditure due to the barrier effect during this period of higher energy expenditure.

Data obtained from nearly three years of Vantage Point surveys did not detect any evidence to suggest that there are regular daily flights by common scoter across Aberdeen Bay, although the increased frequency in flights at dawn indicates that these may occur. Should they do so then there may be a relatively small increase in energetic expenditure.

The incremental increase in the distance migrating common scoter from their breeding grounds in Scandinavia or Russia may incur should they be displaced during their migration to or from the Firth of Forth or Firth Tay & Eden Estuary SPAs will be negligible and not cause an adverse effect.

Displacement

Based on the results from the monitoring data, the worst-case scenario is that should displacement occur, that no common scoter will be within the proposed development area and there will be 80% displacement out to a distance of 1 km and a further 50% decrease in abundance out to 2 km from the proposed development.

Based on the peak density obtained from boat-based surveys of 23.1 birds/km^2 during the spring period, should there be a total displacement of common scoter from within the proposed development area then it is predicted that up to 99 common scoter may be displaced during periods of peak density. Based on an 80% displacement out to 1 km from the proposed development area it is predicted that up to a further 227 common scoter may be displaced and an additional 94 out to 2 km should there be 20% displacement between 1 km and 2 km from the proposed development. Therefore, the maximum number of common scoter potentially displaced is up to 420 birds based on the highest densities recorded from any survey within Aberdeen Bay and displacement out to 2 km.

Based on the estimated total of 420 potentially displaced common scoter out of a peak reported count of 4,300 common scoter at Blackdog (Figure 4-16), it is predicted that up to 10% of the common scoter within Aberdeen Bay may be displaced. However, the distribution of common scoter within Aberdeen Bay is clustered with peak numbers occurring at various sites across the bay during different seasons (Sohle *et al*. 2006). The area off Blackdog regularly records the peak counts of common scoter in Aberdeen Bay (NESBR) and should displacement occur, a greater proportion of common scoter may be affected than is estimated using densities obtained from boat-based surveys alone.

However, intensive post-construction monitoring undertaken at Horns Rev offshore wind farm has indicated that displacement of common scoter may not occur and that birds will occur within an operating wind farm with a similar frequency as outwith (Petersen & Fox 2007). Similar results have suggested that this may also be the case at UK wind farms, e.g. Rhyl Flats.

These studies indicate that common scoter do not avoid wind farms post-construction.

Based on the evidence from existing offshore wind farms it is predicted that the potential impact from displacement is minor.

Calculations used for displacement	
Area	*Peak density of common scoter – 23.1 birds/km^2*
Area of EOWDC – 4.3 km^2	4.3 * 23.1 = 99
Area of 1 km buffer at 80% displacement = 12.3 km^2	(12.3 * 23.1)*0.8 = 227
Area of 2 km buffer at 20% displacement = 20.3 km^2	(20.3 * 23.1)/0.2 = 94
Total displaced	99+227+94 = 420

Disturbance

Common scoter may be disturbed by vessels, both during the construction phase and during operations from maintenance vessels. Studies have indicated that there may be displacement from large vessels out to 1,000 m (Larsen & Laubek 2005).

During construction there may be a number of vessels operating within the area but these will likely be focussed around a single point where the turbine is being installed. Consequently, common scoter may be displaced from within 1 km radius of the installation; an area of 3 km^2. Based on the highest recorded density of 23.1 birds/km^2, it is predicted that up to 69 common scoter may be displaced from the vicinity during the construction period. This equates to approximately 1.5% of the peak common scoter population within Aberdeen Bay based on the peak estimated figure of 4,300 individuals. The construction period will be of short duration and the displacement impacts from construction vessels temporary. Consequently, any potential impact is predicted to be negligible.

Displacement by service boats may reduce the re-population potential of the proposed development area. It is not known how many service vessels may be required but based on the scale of the proposed development there is unlikely to be more than one vessel at the site on any one occasion. The presence of the proposed development in the vicinity of the intensively used Aberdeen Harbour means that the potential increase by vessel movement will not have any noticeable difference to the number of vessels already using Aberdeen Bay. Any specific displacement caused by the service or construction boats will be temporary as common scoter will be able to move into the area once the vessels leave.

It is concluded that the effect of disturbance from construction or service boats is negligible.

Cumulative and in-combination

The potential future Ocean Pod will require additional vessel movements within the proposed development area during the installation and maintenance of it. Should this occur then there is the potential for a cumulative effect to common scoter. It is not yet known what type of structure the Ocean Pod may be or how it will be installed or the number of vessel movements will be required. However, it is a single structure and it is predicted that the level of disturbance will be no greater than that arising from the installation of a single wind turbine. The scale of disturbance is therefore predicted to be localised and of short duration.

Aside from the historical and on-going levels of shipping, there are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts. There is not predicted to be any cumulative or in-combination impacts arising at other planned developments as their locations offshore and their water depths indicate that common scoter may not regularly occur in these areas. Studies undertaken at the Beatrice demonstrator wind farm have recorded one flock of 13 common scoter (Talisman 2005). Consequently there are unlikely to be any cumulative or in-combination impacts.

4.11.6 Conclusions

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating both a very low collision risk and little, if any, displacement and that there are not expected to be any significant barrier effects; it is predicted that there will not be any adverse effects on the SPAs for which common scoter is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on common scoter.

4.12 Velvet scoter (*Melanitta fusca*)

4.12.1 Protection & Conservation Status

Velvet scoter is listed in Appendix II of the Bonn Convention, Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

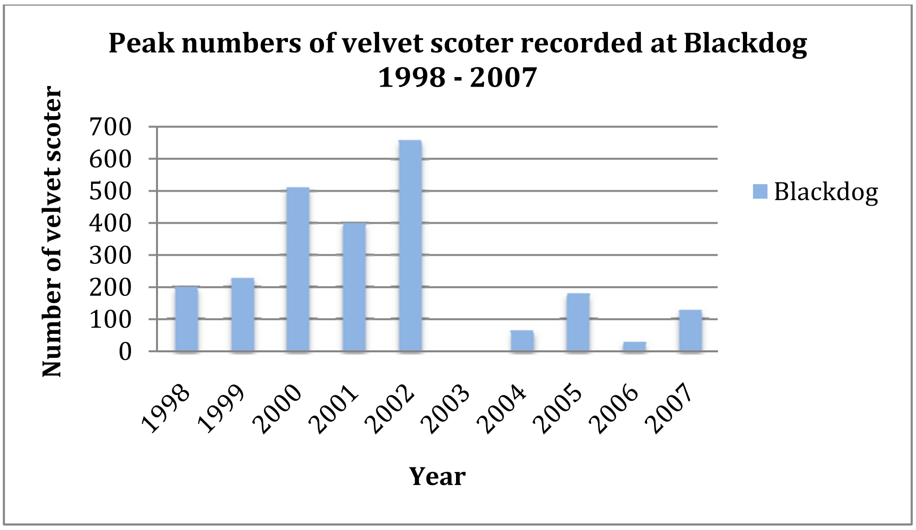
4.12.2 Background

Velvet scoter		
GB Population	Winter – 3,000 ind.	BTO 2011
Scottish Population	Winter – 2,500 – 3,500	Forrester *et al*. 2007
International threshold	10,000 ind.	Calbrade *et al.* 2010
GB threshold	30 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Firth of Forth Forth of Tay & Eden Estuary	SNH 2011
European population estimate	Breeding 85,000 – 100,000 pairs Wintering – >140,000 individuals	Birdlife 2004
European population trend	Status 'declining' Trend 'moderate decline'	Birdlife 2004
World population	1,700,000 – 3,000,000	Birdlife 2011

Velvet scoters do not breed in the UK but are a regular but uncommon winter visitor with an estimated wintering population of approximately 3,000 individuals along the east coast of the UK (Wernham *et al*. 2002). The main areas for velvet scoter along the east coast of Scotland are the Moray Firth, St Andrew's Bay and the Firth of Forth with a total of about 2,000 birds wintering (Calbrade *et al.* 2010).

During the late summer, small numbers of velvet scoter occur amongst the larger flocks of moulting common scoter and numbers increase for the rest of the year with peak wintering numbers in February.

During the winter months velvet scoter are uncommon in North-east Scotland with ones and twos being reported around the coasts. Peak numbers occur during July and August when velvet scoter occur amongst the moulting common scoter flock in Aberdeen Bay. Peak numbers vary considerably across years but up to 600 individuals have been recorded (Buckland, Bell & Picozzi 1990; NESBR) (Figure 4-25).



(Source NESBR)

Figure 4-25: peak numbers of velvet scoter recorded at Blackdog between 1998 and 2007.

Passage of velvet scoter past Peterhead occurs during spring and autumn with peak counts of up to 300 birds occurring in October and evidence of a small spring passage when up to 150 birds were recorded during April (Innes 1996).

Boat-based surveys

Four sightings of velvet scoter were made from boat-based surveys totalling 14 birds. Two singles in February, a flock of five in July and seven in November (IECS 2008).

Vantage Point surveys

In Aberdeen Bay low numbers of velvet scoter were recorded during the winter months with an increase in numbers during the year and a peak passage of velvet scoter of usually less than one bird per hour during June. Results from all the Vantage Point counts undertaken recorded only two velvet scoter flying above 30 m. Most birds were recorded between 1 km and 3 km from shore (EnviroCentre 2007a, 2007b, Alba Ecology 2008b).

Bird Detection Radar

A total of 28 velvet scoter were recorded during radar surveys in October 2005. Numbers were split fairly evenly between the two sites at which surveys were undertaken with 13 at Drums and 15 at Easter Hatton. All sightings were within 2.5 km from shore and all birds recorded in flight were flying below 10 m (Walls *et al* 2005).

Six velvet scoter were recorded at Blackdog within 1 km of the coast between 11 and 26 April 2007 (Simms *et al.* 2007).

4.12.3 Summary of Results

Velvet scoter were only occasionally recorded throughout the year during surveys undertaken across Aberdeen Bay. A total of fourteen velvet scoter were recorded from boat-based surveys and a peak from shore-based counts occurred in June. Most velvet scoter were recorded between 1 km and 3 km off the coast

Of those recorded in flight all but one were recorded flying below 30 m.

Although no counts during surveys undertaken across Aberdeen Bay were of national importance peak counts from Blackdog have, in the past, been of national importance.

4.12.4 Initial Assessment of Significance

Velvet scoter	Overall sensitivity	Magnitude	Significance
Collision	Medium	Negligible	Negligible
Barrier	High	Medium	Moderate
Displacement	Very High	High	Major

4.12.5 Species Sensitivities

Qualifying species

There are two SPAs in the region for which velvet scoter is a qualifying species as part of waterfowl assemblages: Firth of Forth SPA and Firth of Tay and Eden Estuary SPA.

Flight height

The small number of flight heights obtained from boat-based surveys undertaken in Aberdeen Bay reported all flights as flying below 25 m and therefore not at risk of collision. There was one record of a velvet scoter flying above 30 m.

Elsewhere in the UK small numbers (<20) of velvet scoter have been recorded all of which have been flying below rotor height with a mean flight height of less than 1 m.

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that velvet scoter are generally uncommon in Aberdeen Bay, occurring within the larger common scoter flocks. They occur mainly within 3 km of the coast and in waters less than 20 metres.

Evidence from elsewhere indicates that velvet scoter detour around wind farms and are at low risk of collision. A total of nearly 1,600 velvet scoters were recorded in the Kalmar Sound and no collisions were recorded (Petterrson 2006).

Consequently, the risk of an impact arising due to collisions is low and significance should it occur negligible.

The two SPAs in the region for which velvet scoter is a qualifying species as part of an assemblage are both over 90 km away. The probability of birds from these SPA populations flying through the proposed development area at turbine height is low and consequently the risk of collision is also very low. Therefore there will not be an adverse effect on the population due to collision.

Barrier effect

Studies undertaken in Sweden and Denmark have shown that there is the potential for a barrier effect on velvet scoter with changes in flight directions of up to 1 km from offshore wind turbines and birds seen flying around wind farms. Therefore, it is predicted that the proposed development may cause a barrier effect to common scoter in Aberdeen Bay.

There is no evidence of regular daily movements of velvet scoter within Aberdeen Bay to and from feeding or roosting areas. However, velvet scoter frequently mix in flocks of common scoter and should a barrier effect occur for common scoter then it may also do so for velvet scoter. As with common scoter, the potential additional increase in daily energy expenditure due to possible displacement may be between 2.2% and 2.6% (Speakman, Gray & Furness 2009). This is a relatively small increase in daily energy expenditure and is unlikely to have an adverse effect or significant impact on velvet scoter in Aberdeen Bay.

The incremental increase in the distance migrating velvet scoter from their breeding grounds in Scandinavia or Russia may incur should they be displaced during their migration to or from the Firth of Forth or Firth Tay & Eden Estuary SPAs will be negligible and not cause an adverse effect.

Displacement

Based on the results from the monitoring data, the worst-case scenario is that, should displacement occur, there will be 100% displacement of velvet scoter within the proposed development area and out to a distance of 1 km. A further 50% decrease in abundance occurs out to 2 km from the wind farm. However, very few velvet scoter were recorded during site specific surveys undertaken within the bay and peak counts from Blackdog have, in recent years, been below 200 individuals (Figure 4-25). There are no reports on whether velvet scoter are displaced by offshore wind farms but evidence of little or no displacement to the closely related common scoter indicate that displacement is unlikely to occur. Based on this assumption then it is predicted that there will not be an adverse effect or significant impact from the proposed development on velvet scoter.

Disturbance

Disturbance effects on velvet scoter will be similar to those identified for common scoter and they may be disturbed by vessels, both during the construction phase and during operations from maintenance vessels. The numbers of velvet scoter recorded within the proposed development area were very low and it is therefore predicted that disturbance from either construction or service vessels will have a negligible impact and not cause an adverse effect.

Cumulative and in-combination

Aside from the historical and on-going levels of shipping, there are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on velvet scoter present within Aberdeen Bay. There is not predicted to be any cumulative or in-combination impacts arising at other planned developments as their locations offshore and their water depths indicate that velvet scoter may not regularly occur in these areas. No velvet scoter were reported during studies undertaken at the Beatrice demonstrator wind farm (Talisman 2005). Consequently there are unlikely to be any cumulative or in-combination impacts.

4.12.6 Conclusions

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating a very low collision risk, potentially little or no displacement and no significant barrier effects; it is predicted that there will not be any adverse effects on the SPAs for which velvet scoter is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on velvet scoter.

4.13 Common goldeneye (*Bucephala clangula*)

4.13.1 Protection & Conservation Status

The (Common) goldeneye is listed in Appendix II of the Bonn Convention, Appendix III of the Bern Convention and is on the Green List of Species of Conservation Concern.

4.13.2 Background

Goldeneye		
GB population	Breeding – 200 pairs Winter – 25,000 ind	BTO 2011
Scottish population	Breeding: 120 - 150 prs Winter: 10,000 – 12,000 ind.	Holling *et al*. 2010 Forrester *et al.* 2007
International threshold	11,500 ind.	Calbrade *et al*. 2010
GB threshold	249 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Firth of Forth: 581 ind. (08/09) Firth of Tay & Eden Estuary: 255 ind	Calbrade *et al.* 2010 SNH 2011
European population estimate	Breeding 490 – 590,000 prs Wintering – >310,000 ind	Birdlife 2004
European population trend	Status 'secure' Trend 'small increase'	Birdlife 2004
World population	2,5 – 4,600,000 'adults'	Birdlife 2011

Goldeneye breed beside freshwater habitats across northern Europe with a total breeding population of up to 590,000 pairs primarily in Sweden, Finland and Russia. There is a small and localised breeding population in the UK with approximately 120 to 150 pairs nesting in Scotland (Holling *et al.* 2010).

During the winter goldeneye move away from the breeding sites and move onto both fresh and salt water bodies. In eastern Scotland the Firth of Forth holds the largest wintering population in the UK with a peak mean of 581 over the last five years. This is considerably lower than recent historical counts at the site where over 2,000 goldeneye used to be regularly recorded (Cork Ecology 2004a).

In North-east Scotland goldeneye has only recently colonised the region as a scarce breeding bird with a small but increasing population of about 30 nests, inland with relatively small numbers wintering along the coasts and inland freshwater. The main areas are Loch of Skene and Loch of Strathbeg where peak numbers of up to 100 to 200 birds may occur (Buckland, Bell & Picozzi 1990; NESBR).

On the coast goldeneye are rarely recorded between June and September with birds present from October onwards when numbers passing Peterhead peak with up to 2 birds per hour between November and January (Innes 1996). All sightings of goldeneye at Peterhead were of birds within 1 km of the shore.

Boat-based surveys

Five goldeneye were recorded from boat-based surveys with three in April and two in November.

Vantage Point surveys

Small numbers of goldeneye were recorded passing through Aberdeen Bay with a total of 41 records between November and April over the three years of data collection.

Five goldeneye were recorded from boat-based surveys with three in April and two in November.

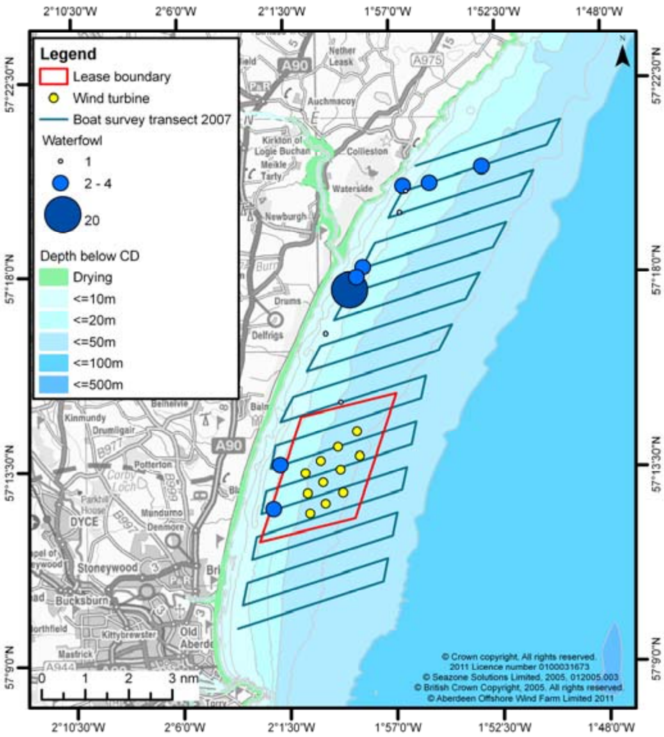


Figure 4-26: Waterfowl distribution in Aberdeen Bay - February 2007 to April 2008 (all sightings).

Bird Detection Radar

No goldeneye were recorded during the radar studies undertaken at Easter Hatton and Drums during October 2005 but three were recorded at Blackdog during the additional radar surveys undertaken at Blackdog during April 2007 (Simms *et al.* 2007).

4.13.3 Summary of Results

Goldeneye were infrequently recorded in Aberdeen Bay with most sightings from Vantage Point surveys between November and April.

4.13.4 Initial Assessment of Significance

Goldeneye	Overall sensitivity	Magnitude	Significance
Collision	Medium	Negligible	Negligible
Barrier	High	Negligible	Negligible
Displacement	Medium	Negligible	Negligible

4.13.5 Species Sensitivities

Qualifying species

There are two SPAs for which goldeneye are part of the qualifying assemblages: Firth of Forth SPA and Firth of Tay & Eden Estuary SPA. Goldeneye was also listed as part of the qualifying assemblages in original citation for the Loch of Strathbeg but is not so for subsequently updated ones.

Flight height

Very few records of goldeneye were made from site specific boat-based or land-based surveys and only two records of their of flight altitudes were made. Both were of birds flying below 25 m.

Elsewhere there is very limited data from other offshore wind farms on flight heights for goldeneye.

Collision risk

Evidence from site specific monitoring indicated that goldeneye are scarce in Aberdeen Bay and primarily occur in near-shore waters. Evidence from other offshore wind farms indicated that goldeneye are at low risk of collision from offshore wind farms. A total of nearly 3,100 goldeneye were recorded during studies undertaken in Kalmar Sound and no collisions were recorded (Pettersson 2005). Based on the relatively low numbers of goldeneye recorded and evidence from other wildfowl of a potentially high avoidance rate it is predicted that the risk of an adverse or significant environmental effect on goldeneye from collision mortalities arising from the proposed development is negligible.

Barrier effect

Evidence from studies undertaken at Kalmar Sound suggests that there is the potential for some barrier effects as goldeneye may avoid flying through offshore wind farms. Should a barrier effect occur then goldeneye will fly around the proposed development. This may incur an overall increase in flying distance of approximately 3.2 km. There is no evidence of any regular feeding or roosting flights by goldeneye across Aberdeen Bay nor any regular usage of the site itself. Any additional distance flown should goldeneye fly around the proposed development will be small compared to the total distance of their migration and will not be significant nor have an adverse effect.

Displacement

Goldeneye do not use Aberdeen Bay for feeding or roosting and therefore no displacement effects will occur.

Cumulative and in-combination

The low level of usage of the site by goldeneye and the relatively few recorded from other UK developments indicate that there will not be any cumulative or in-combination impacts.

4.13.6 Conclusions

Habitats Appraisal

There are no SPAs for which goldeneye is a qualifying species that will be effected by the proposed development.

Environmental Impact Assessment

Based on the relatively low numbers of goldeneye recorded and their known behaviour it is predicted that there will not be a significant environmental impact arising from the proposed development on goldeneye.

4.14 Red-breasted merganser (*Mergus serrator*)

4.14.1 Protection & Conservation Status

Red-breasted merganser is listed in Appendix II of the Bonn Convention, Appendix III of the Bern Convention and is on the Green List of Species of Conservation Concern.

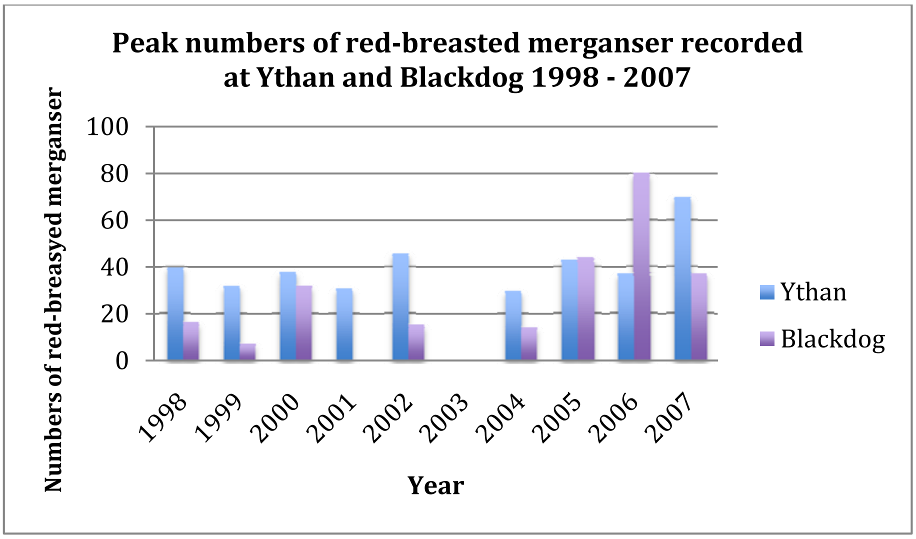
4.14.2 Background

Red-breasted merganser		
GB Population	Breeding: 2,400 prs. Winter: 10,200 ind.	Birdlife 2004
Scottish population	Breeding: 2,000 prs Winter: 8,500 ind	Forrester *et al*. 2007.
International threshold	1,700 ind.	Calbrade *et al.* 2010
GB threshold	98 ind	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Firth of Forth	SNH 2011
European population estimate	Breeding 59,818 – 84,484 pairs Wintering – 89,000 ind.	Hagemeijer & Blair 1997 Birdlife 2004
European population trend	Status 'secure' Trend 'small decline'	Birdlife 2004
World population	510,000 – 610,000	Birdlife 2011

Red-breasted merganser breed across northern Europe with the largest populations occurring in Scandinavia. In Scotland there is an estimated 2,000 pairs. The UK wintering population is estimated to 10,200 individuals, of which 8,500 occur in Scotland; dispersed around the coasts with the main wintering areas in the Moray Firth, Firth of Forth, St Cyrus and Montrose Basin and the Scottish west coast. During August and September adult red-breasted mergansers undergo a wing moult and become flightless for a period. During this period they congregate in flocks in regular areas including the Cromarty Firth, Inner Moray Firth and in Aberdeen Bay. There is evidence of migration during the spring and autumn with peak passage during March/April and October (Forrester *et al*. 2007).

Outwith the breeding season between 85% and 90% of red-breasted merganser occur along coasts and estuaries feeding on a variety of fish species (Cork Ecology 2004a).

In North-east Scotland red-breasted merganser is a scarce and possibly irregular breeder but is widespread in generally low numbers along the coasts during the winter. Peak numbers occur at Loch of Strathbeg, Ythan Estuary and in Aberdeen Bay primarily between November and February.



(Source NESBR)

Figure 4-27: Peak numbers of red-breasted merganser in Aberdeen Bay between 1998 and 2007.

Peak numbers pass Peterhead throughout the year but highest numbers occur during March and April with up to 2.4 birds per hour with most sightings within a few hundred metres from shore and nearly all sightings within 1 km from shore (Innes 1995).

Boat-based surveys

During boat-based surveys, one red-breasted merganser was recorded in March at the Donmouth (IECS 2008).

Vantage Point surveys

Data from Vantage Point Counts undertaken between March 2005 and March 2008 recorded peak numbers of red-breasted merganser in October and November when up to four birds per hour were recorded passing the Donmouth in October 2007. Up to nineteen birds were recorded in April 2006 and ten off the Promenade during March 2005 (EnviroCentre 2007a).

Out of the 84 sightings of birds in flight there was only one record of a bird flying above 30 metres. At Blackdog most sightings were of birds between 1–2 km from the shore, whereas at the Donmouth birds were recorded out to 3 km (Alba Ecology 2008b).

Bird Detection Radar

A total of 51 red-breasted merganser were recorded during five days of surveys at Drums and Easter Hatton in October 2005. Fourteen were at Drums and 37 at Easter Hatton. Birds were recorded out to 3 km from shore but the majority were within 2 km, with peak numbers within 500 m of the coast. The mean flight height was 14 m with one record of birds at 40 m (Walls *et al.* 2006).

Red-breasted mergansers were frequently recorded during the 17 days of radar surveys undertaken at Blackdog in April 2007. A total of 31 records of 76 individuals were recorded with a mean flock size of two and a peak count of seven birds (Simms *et al.* 2007). All birds were seen flying below 30 m above sea surface and the majority, 60, of sightings were of birds flying south.

4.14.3 Summary of Results

There was one sighting of red-breasted merganser from the boat-based surveys but they were regularly recorded from land-based studies with peak numbers in October and November. The majority of birds were within 2 km of the coast with most within 500 m.

Of those recorded in flight all but two were recorded flying below 30 m.

No counts during any surveys undertaken across Aberdeen Bay were of national importance.

4.14.4 Initial Assessment of Significance

Red-breasted merganser	Overall sensitivity	Magnitude	Significance
Collision	Medium	Negligible	Negligible
Barrier	High	Low	Negligible
Displacement	High	Medium	Moderate

4.14.5 Species Sensitivities

Qualifying species

Red-breasted Merganser is a qualifying species as part of waterfowl assemblages: Firth of Forth SPA, a site with a 5 year mean peak count of 410 individuals (Calbrade *et al*. 2010).

Flight height

No flight heights were obtained from boat-based surveys undertaken in Aberdeen Bay. One was recorded as flying above 30 m from Vantage Point surveys and one from radar surveys. However, the mean flight height was recorded as being 14 m.

Elsewhere in the UK 10% of all flights have been recorded at rotor height (n=71).

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that red-breasted merganser are widespread in Aberdeen Bay and occur out to 3 km from shore. Consequently they are at risk of interacting with the proposed development.

At other offshore wind farms, over 9,000 red-breasted mergansers were recorded in the Kalmar Sound and although birds were recorded flying through the wind farms there were no recorded collisions. There was also clear evidence of avoidance behaviour with a four-fold decrease in the number of mergansers flying through zone post-construction (Petterson 2006).

The majority of red-breasted mergansers were within 2 km of the shore and therefore not at risk of collision. Furthermore most sightings were of birds flying below 25 m and evidence from operating wind farms has indicated a very high avoidance rate. Therefore, the risk of a significant impact arising due to collisions is low and the significance of any impact, should it occur, would be negligible.

The only SPA in the region for which red-breasted merganser is a qualifying species is over 130 km away. The probability of birds from this SPA flying through the proposed development area at turbine height is low and consequently the risk of collision is also very low. Therefore there will not be an adverse effect on the population due to collision.

Barrier effect

Studies undertaken in Sweden and Denmark have shown that there is the potential for a barrier effect on red-breasted merganser with changes in flight directions up to 1 km from offshore wind turbines and birds seen flying around wind farms. Therefore, it is predicted that the proposed development may cause a barrier effect to red-breasted merganser in Aberdeen Bay.

There was no evidence from Vantage Point surveys or radar studies of any regular daily movements of red-breasted merganser within Aberdeen Bay to and from feeding or roosting areas. Should a barrier effect occur it is likely to be on an occasional *Ad hoc* basis and If so then it is predicted on the occasions that it occurs the increase in flight distance will cause an increase of between 1% and 1.5% of daily energy expenditure. This is a relatively small increase in daily energy expenditure and is unlikely to have an adverse effect on or significant impact on red-breasted merganser in Aberdeen Bay.

The incremental increase in the distance migrating red-breasted merganser from their breeding grounds will incur on their way to or from the Firth of Forth SPA, should they be displaced, will be negligible and not cause an adverse effect.

Displacement

Based on the results from the monitoring data, the worst-case scenario is that should 100% displacement occur, then no red-breasted merganser will be within the proposed development area out to a distance of 1 km. There may be a gradual in the number of birds present with a further 50% decrease in abundance out to 2 km from the wind farm. Very few red-breasted merganser were recorded from the site specific surveys undertaken within the bay and peak counts from Blackdog are below 80 individuals (Figure 4-27). Evidence from Sweden also suggest that operating wind farms cause little or no displacement (Pettersson 2006). Studies undertaken at Nysted offshore wind farm recorded more red-breasted mergansers during post-construction surveys than during pre-construction including in the wider area.

Based on the distribution of red-breasted mergansers in Aberdeen Bay and evidence from other sites then it is predicted that there will not be an adverse effect or significant impact from the proposed development on red-breasted merganser due to displacement.

Disturbance

Studies undertaken in Sweden concluded that although red-breasted mergansers could be disturbed by vessels they returned to areas once the vessels departed. There will be both construction traffic and maintenance vessels associated with the proposed development. These may cause some disturbance to red-breasted mergansers when on site but this will be temporary. The numbers of red-breasted merganser recorded within the proposed development area were very low and it is therefore predicted that disturbance from either construction or service vessel will have a negligible impact and not cause an adverse effect.

Cumulative and in-combination

Aside from the historical and on-going levels of shipping, there are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on red-breasted merganser present within Aberdeen Bay. There is not predicted to be any cumulative or in-combination impacts arising at other planned developments as their locations offshore and their water depths indicate that red-breasted merganser may not regularly occur in these areas. No red-breasted mergansers were reported during studies undertaken at the Beatrice demonstrator wind farm (Talisman 2005). Consequently, there are unlikely to be any cumulative or in-combination impacts.

4.14.6 Conclusions

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating a very low collision risk potentially little or no displacement and no significant barrier effects, it is predicted that there will not be any adverse effects on the SPAs for which red-breasted merganser is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on red-breasted merganser.

4.15 Red-throated diver (*Gavia stellata*)

4.15.1 Protection & Conservation Status

The red-throated diver is listed in Annex I of the Birds Directive, Appendix II of the Bern Convention, Appendix II of the Bonn Convention, Schedule 1 under the Wildlife and Countryside Act, 1981 and is on the Amber List of Species of Conservation Concern.

4.15.2 Background

Red-throated diver		
GB Population	Breeding: 1,014 – 1,551 prs. Winter: 17,000 ind.	Calbrade *et al*. 2010
Scotland	Breeding: 1,000 – 1,500 prs. Winter: 2,270 ind.	Forrester *et al.* 2007
International threshold	3,000 ind.	Calbrade *et al*. 2010
GB threshold	170 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Firth of Forth SPA 317 ind.	SNH 2011 JNCC 2011a Calbrade *et al*. 2010
European population estimate	Breeding 32,000 – 92,000 Wintering >51,000	Birdlife 2004
European population trend	Status: 'Depleted' Trend: 'stable'	Birdlife 2004
World population	200 – 590,000 'adults'	Birdlife 2011

Red-throated divers are relatively common around the Scottish coasts and spend much of the year at sea only coming onto fresh water during the breeding season. The species is entirely coastal in its wintering distribution, often being associated with shallow coastal inshore sandy bays during the winter months (Lack, 1986). The major prey items are crustaceans, sand eels, sprat, herring, flatfish and codling and, as the name of the species suggests, these items are obtained by diving. The majority of wintering individuals are located down the east coast of Britain. Recent findings from aerial survey data have estimated the UK wintering population of this species to be now in the region of 17,000 birds (O`Brien *et al.* 2008).

Red-throated divers are a very rare breeding species in North-east Scotland but are a common wintering and passage species around all coasts.

Historically peak numbers of red-throated diver occurred during the late autumn and early winter periods with a peak count of 1,470 birds between Don Mouth and Collieston in October 1979 (Buckland, Bell & Picozzi 1990). In more recent years Aberdeen Bay has held up to 400 red-throated divers during a peak spring period between March and May. However, numbers recorded appear to have decreased (Figure 4-28). Outwith the peak spring period, red-throated diver occur in lower numbers throughout the year particularly during the summer months. There is also an increase in numbers during the autumn with birds returning from their more northerly breeding grounds. Counts of up to nearly 180 birds have been recorded in the bay during September (Lewis *et al.* 2008). Evidence from studies undertaken by JNCC in 2005/06 indicated that the distributions of red-throated diver within the bay may vary slightly across the year. However, peak counts are most frequent between the Donmouth and Balmedie and at the Newburgh Bar at the mouth of the Ythan Estuary. There are very few records of any red-throated divers in water depths of greater than 20 m (Söhle *et al.* 2006; Lewis *et al*. 2008).

Three aerial surveys undertaken by the JNCC in Aberdeen Bay between December 2005, January 2006 and May 2006 recorded a maximum of 39 red-throated divers in May (Söhle *et al.* 2006).

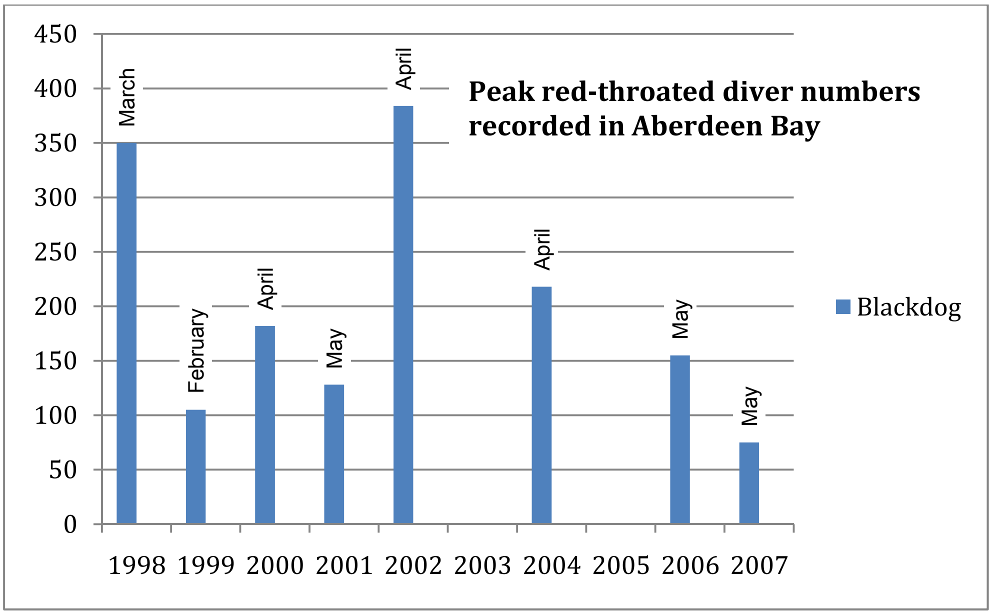


Figure 4-28: Peak numbers of red-throated diver recorded in Aberdeen Bay between 1998 and 2007. (Source NESBR).

4.15.3 Survey Results

Boat-based surveys

Boat-based surveys were undertaken on a monthly basis between February 2007 and April 2008 and from August 2010 to present. The surveys recorded red-throated divers throughout the year in Aberdeen Bay with the majority of sightings during the spring and autumn and relatively few between June, July and August. The majority of sightings were in waters less than 10 m and within 1 – 2 km of the coast. There were very few records of red-throated diver within the proposed development area. The peak in May probably reflected movement of divers heading to northern Scottish breeding sites or back across to Scandinavia, whilst the increase in winter months indicated the presence of a wintering population in Aberdeen Bay.

Based on extrapolation of overall density, including birds recorded in short-transect lengths, a total of 93 birds were estimated to be using the proposed EOWDC survey area during the passage period in May 2007. Numbers were estimated to be lower for the rest of the year with an estimated 55 birds present in December (Table 4-11). Population estimates were lower in the 'control' area, particularly during the winter months (Table 4-12).

Table 4-11: Red-throated diver monthly population estimate within the proposed EOWDC area.

Month	On water estimate	In flight estimate	Total estimate
February 2007	16	0	16
March 2007	11	3	14
April 2007	34	0	34
May 2007	88	5	93
June 2007	26	0	26
July 2007	9	0	9
August 2007	22	0	22
September 2007	7	5	13
October 2007	16	0	16
November 2007	26	0	26
December 2007	52	3	55
January 2008	33	0	33

Table 4-12: Red-throated diver monthly population estimate within the 'control' survey area.

Month	On water estimate	In flight estimate	Total estimate
February 2007	4	0	4
March 2007	29	0	29
April 2007	7	0	7
May 2007	0	0	0
June 2007	41	0	41
July 2007	13	0	13
August 2007	0	0	0
September 2007	13	3	15
October 2007	13	0	13
November 2007	7	0	7
December 2007	9	3	11
January 2008	10	0	10

Further analysis of the data collected between February 2007 and January 2008, undertaken by the Sea Mammal research Unit (SMRU) using Distance Sampling techniques, recorded peak estimated abundance during the winter months with an estimated abundance within the proposed EOWDC survey area of 38 birds in December and January and 47 birds in February and relatively lower numbers of less than 30 birds in spring. Densities were also higher in the winter with up to 0.9 birds/km^2 in the proposed EOWDC area (Table 4-13, Figure 4-30) (SMRU 2011a).

Table 4-13: Monthly estimates of density and abundance of Red-throated diver in the proposed EOWDC and 'control' areas (using Distance sampling).

Month	Location	Density Estimate (km^2)	SE	Estimated Abundance	SE	No. Observations
January	EOWDC	0.744	0.354	38	18.0	15
	Control	0.134	0.072	7	3.6	3
February	EOWDC	0.927	0.302	47	15.3	26
	Control	0.238	0.119	12	6.0	11
March	EOWDC	0.178	0.112	9	5.7	4
	Control	0.399	0.218	20	11.1	9
April	EOWDC	0.404	0.150	21	7.6	19
	Control	0.272	0.121	14	6.1	12
May	EOWDC	0.482	0.490	25	24.9	6
	Control	0.045	0.045	2	2.3	1
June	EOWDC	0.385	0.262	20	13.3	6
	Control	0.456	0.270	23	13.7	9
July	EOWDC	0.134	0.102	7	5.2	2
	Control	0.128	0.112	6	5.7	3
August	EOWDC	0.268	0.271	14	13.8	1
	Control	0.000	0.000	0	0.0	0
September	EOWDC	0.089	0.061	5	3.1	2
	Control	0.152	0.094	8	4.8	4
October	EOWDC	0.178	0.091	9	4.6	4
	Control	0.179	0.103	9	5.2	4
November	EOWDC	0.277	0.140	14	7.1	6
	Control	0.089	0.090	5	4.6	2
December	EOWDC	0.749	0.311	38	15.8	16
	Control	0.149	0.078	8	4.0	3

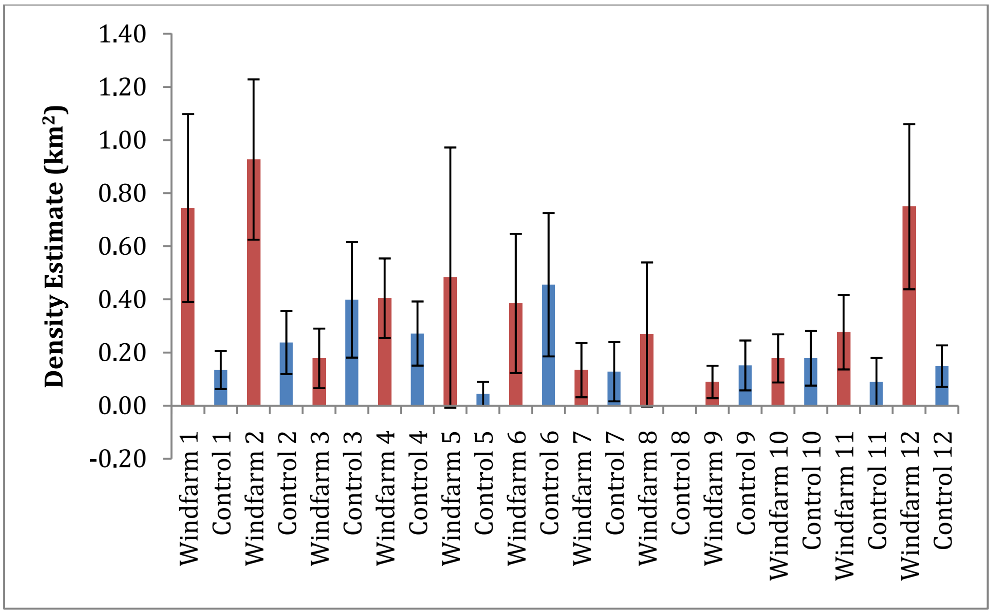


Figure 4-29: Monthly estimates (+/- SE) of density of red-throated divers in the proposed EOWDC and 'control' Areas. February 2007 – January 2008 (Wind farm 1-12 and 'control' 1-12 refers to months).

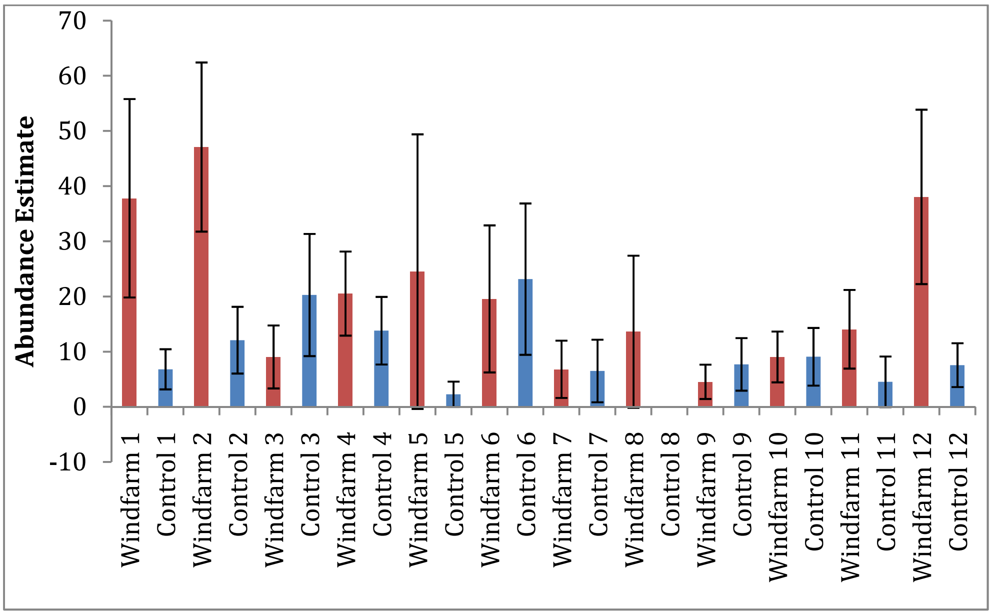


Figure 4-30: Monthly estimates (+/- SE) of abundance of red-throated Divers in the proposed EOWDC and 'control' Areas; February 2007 – January 2008 (Wind farm 1-12 and 'control' 1-12 refers to months).

Distribution maps from boat-based surveys indicate that red-throated divers exhibit a preference for water shallower than 20 m, but with concentrations observed on the 'short legs' of the survey, around the 5 m to 10 m depth contour line (Figure 4-31, Figure 4-32, Figure 4-33).

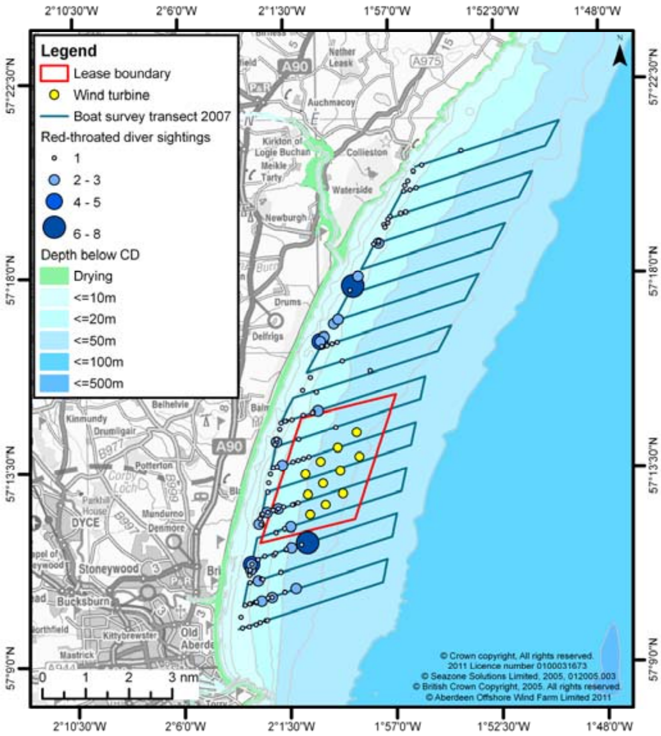


Figure 4-31: Red-throated diver distribution during winter period: November to March; 2007 – 2008 (all sightings).

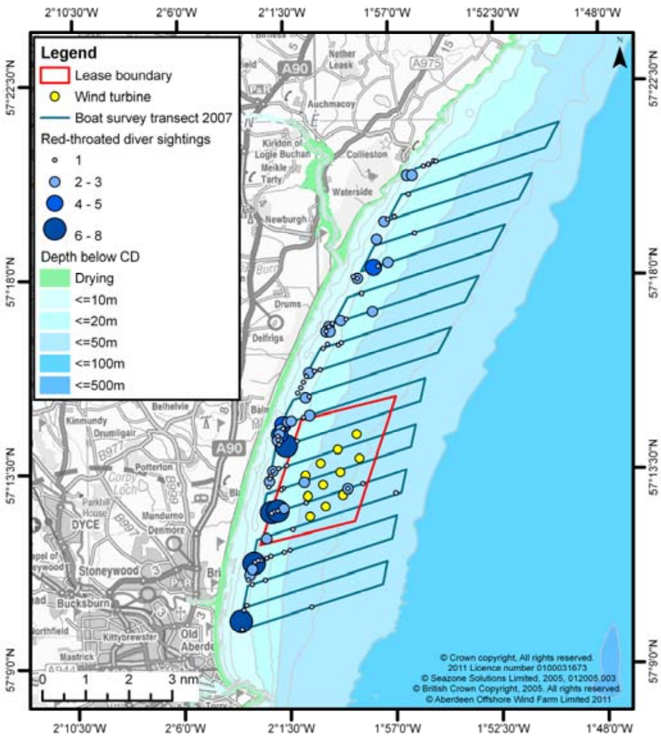


Figure 4-32: red-throated diver distribution during passage: April, May and September, October; 2007 (all sightings).

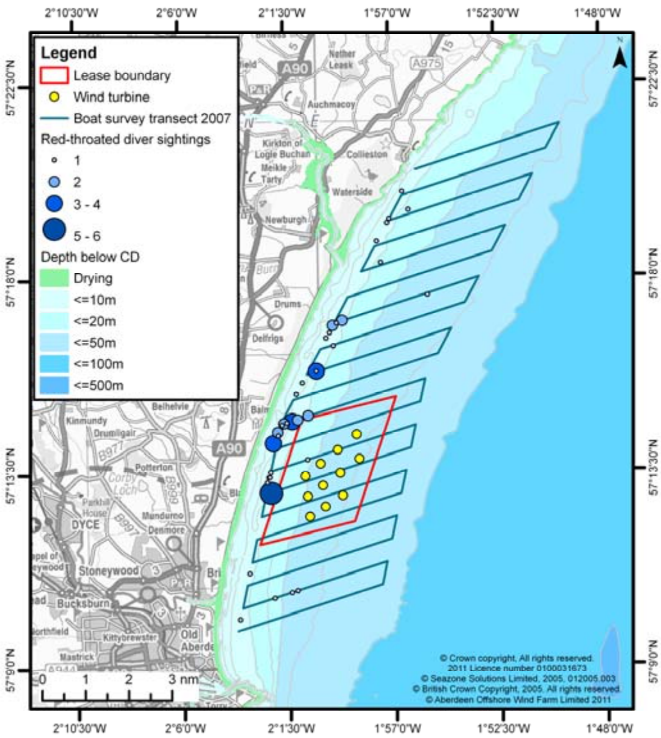


Figure 4-33: red-throated diver distribution during summer period: June, July and August 2007- (all sightings).

Additional boat-based data collected between August 2010 and January 2011 recorded a peak abundance estimate using *Distance* sampling techniques of 697 red-throated diver at a density of 4.9 birds/km^2 in the northern survey area during November 2010 with very low abundances to the south or offshore (Figure 4-34, Figure 4-35) (SMRU 2011b).

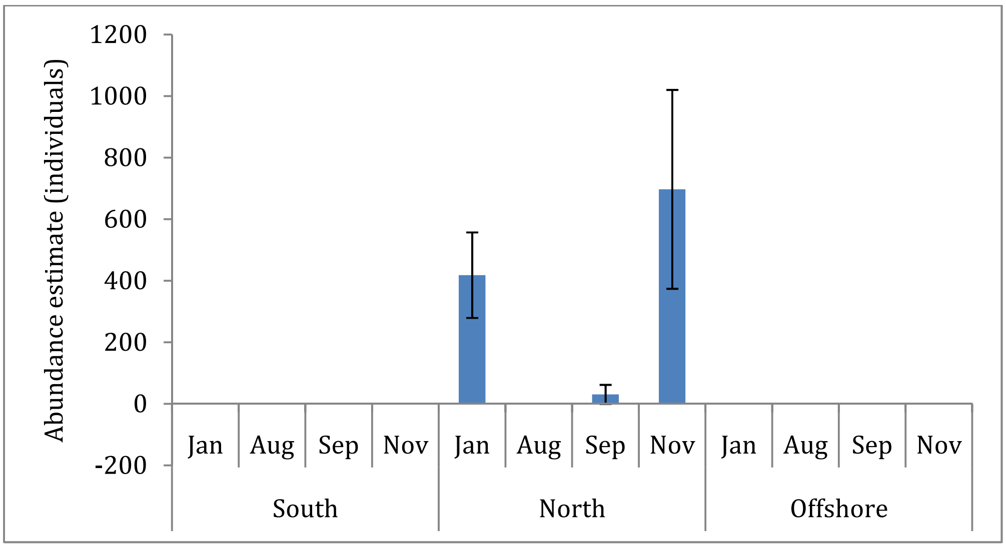


Figure 4-34: Abundance estimates for red-throated diver between August 2010 and January 2011.

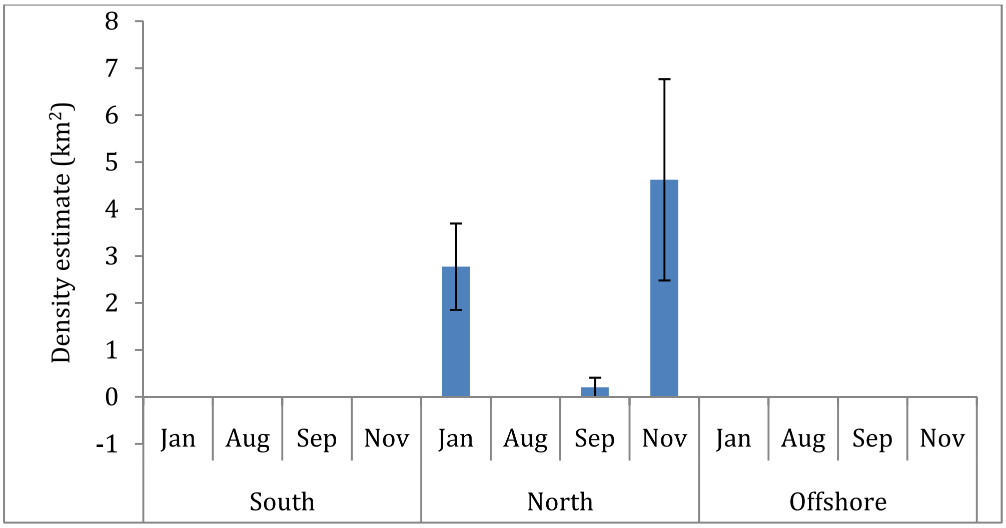


Figure 4-35: Density estimates for red-throated diver between August 2010 and January 2011.

Most sightings during this period were to the north of the proposed development area with less than five red-throated diver recorded from all surveys within the footprint of the proposed development (Figure 4-36).

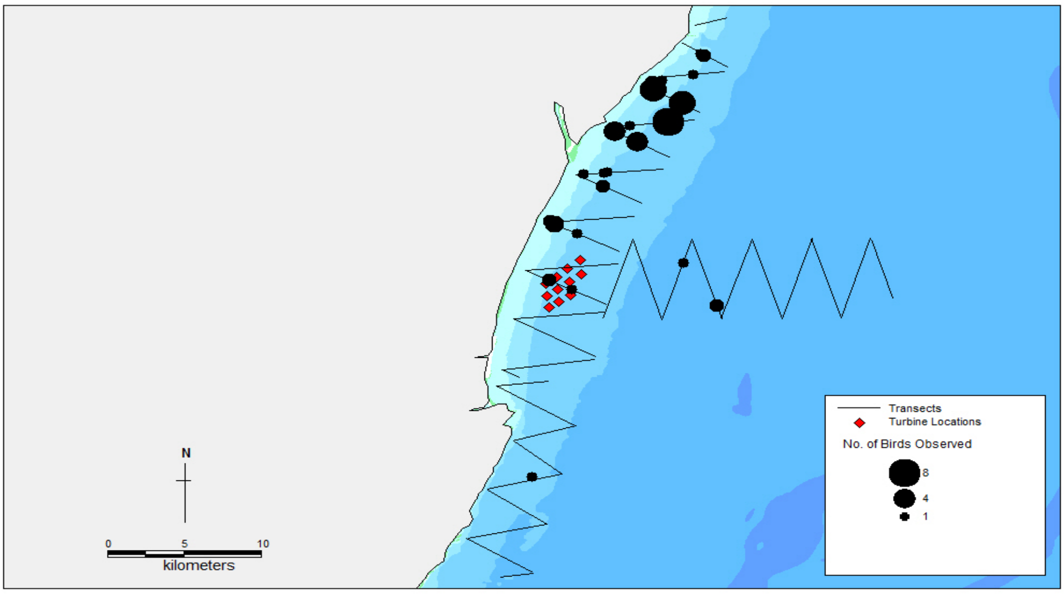


Figure 4-36: On-effort observations of all Diver species (Red-throated and Unidentified Diver species) along transects during August, September and November 2010 and January 2011

Vantage Point surveys

Data from vantage point surveys were collected in Aberdeen Bay between March 2005 and October 2005 and also from April 2006 to March 2008.

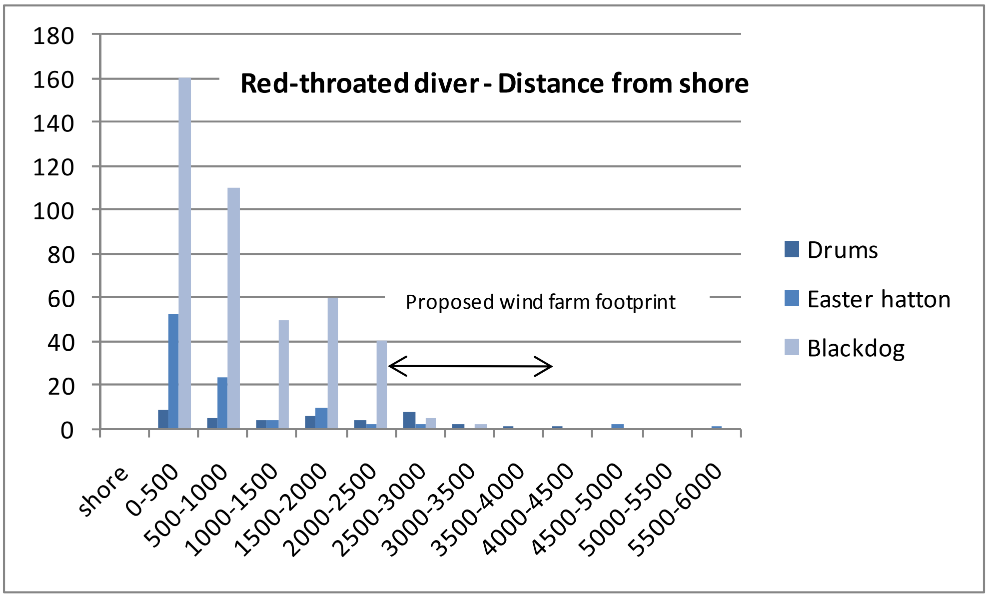
The results indicate a strong seasonal variation across the year with peak numbers occurring in the bay during April and May with a mean of up to 40 birds/hour passing in April 2007 and peak counts of 28 birds off Murcar, over four hours of observation, during May 2005 (Alba Ecology 2008a). Red-throated divers were seen at all vantage point locations, mainly within 1 km or out to 2 km from shore with most records from Murcar, Drums and Balmedie and generally lower numbers at Blackdog and Donmouth.

Of those recorded in flight between 3% and 16% were between 30 to 150 metres above the sea suface, i.e at potential rotor height.

Bird Detection Radar

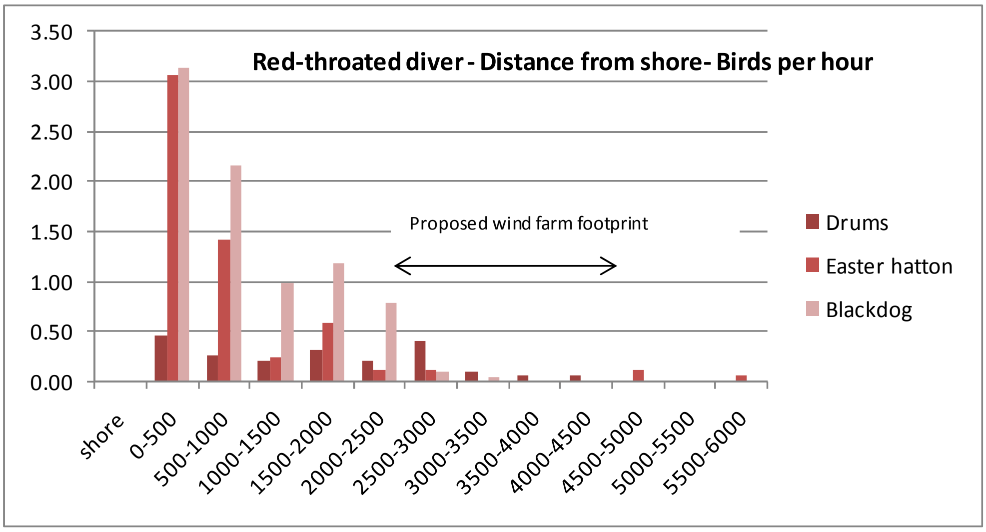
During radar studies undertaken in October 2005 a total of 157 red-throated divers were recorded, of which 65 were at Drums and 95 were at Easter Hatton (Walls *et al* 2005). Peak numbers were recorded within 500 m from shore although small numbers were recorded out to 5.5 km. Of those recorded in flight the mean height was 5 m with a maximum height of 40 m (Walls *et al.* 2006).

In April 2007, further Bird Detection Radar surveys were undertaken at Blackdog for a period of 17 days. During this time a total of 427 birds were recorded usually as singles with a maximum flock size of four birds (Simms *et al.* 2007). The majority of sightings were of birds within 1.5 km of the coast, although birds further offshore may have been missed (Figure 4-37, Figure 4-38).



(Adapted from Walls *et al.* 2006, Simms *et al.* 2007)

Figure 4-37: Distances from shore for red-throated diver from three locations in Aberdeen Bay during surveys undertaken in October 2005 (Drums & Hatton) and April 2007 (Blackdog).



(Adapted from Walls *et al.* 2006, Simms *et al.* 2007)

Figure 4-38: Number of red-throated diver per hour and distance from shore from three locations in Aberdeen Bay during surveys undertaken in October 2005 (Drums & Hatton) and April 2007 (Blackdog).

4.15.4 Summary of Results

Red-throated diver occur throughout the year in Aberdeen Bay with peak numbers occurring during the winter and spring periods. Peak numbers of red-throated diver recorded within the proposed EOWDC survey area was 93 in May 2007 and peak density of 0.9 birds/km^2 in February 2007. Further surveys identified potentially main areas for red-throated diver to the north of the proposed development where densities of up to 4.9 birds/km^2 were recorded during November 2010. Evidence from boat-based surveys supports the findings from the Vantage Point and radar studies that most red-throated diver occur within 2 km of the shore and in water depths of less than ten metres. Estimated numbers of red-throated diver recorded in Aberdeen Bay were below the threshold for a site of international importance but the bay may, on occasions, hold nationally important numbers.

The number of red-throated diver flying above 30 m and therefore at risk of potential collision varied from between 0% and 16%.

4.15.5 Initial Assessment of Significance

Red-throated diver	Overall sensitivity	Magnitude	Significance
Collision	High	Negligible	Negligible
Barrier	Very High	Medium	Major
Displacement	Very High	Medium	Major

4.15.6 Species Sensitivities

Qualify species

There are no SPAs for red-throated diver that are within the area of potential impact from the proposed development. It is recognised that currently Aberdeen Bay is an area of search with respect to becoming a potential SPA and could include red-throated diver as a qualifying species. However, it is understood that it is currently unlikely to become an SPA in the foreseeable future.

Flight height

Red-throated diver typically fly low and just above wave height. Site specific data obtained from boat-based surveys recorded 55 red-throated divers in flight all of which were recorded as flying below 25 m. Evidence from other locations have recorded 99.6% of red-throated divers as flying below 30 m (LAL 2005, RBA 2005).

Collision risk

Evidence from site specific monitoring from boat-based and land-based surveys and other data sources indicate that red-throated diver are widespread and frequent within Aberdeen Bay.

In order to determine potential effects of collision mortality on red-throated diver a collision risk assessment has been undertaken based on a collision probability of 9% and over a range of possible avoidance rates of 98%, 99% and 99.5%.

In order to determine whether any potential increase in mortality is significant the assessment is based on the precautionary figure of 1% of the baseline mortality rate for the population as has previously been considered for other offshore developments and based on EC Guidance (EC 2000).

The peak population estimate for red-throated diver recorded in Aberdeen Bay from any source is an estimated 697 individuals in November 2010 at a density of 4.9 birds/km^2. (SMRU 2011).

The annual mortality rate for red-throated diver is 16% (BTO 2011).

Consequently, out of a population of 697 individuals in Aberdeen Bay an annual mortality of 111 red-throated divers may be predicted. Therefore, 1% of the baseline mortality is 1.1 birds per year, i.e. an increase in mortality rate of more than 1 bird per year caused by collisions may be considered significant.

The Firth of Forth SPA has a wintering population of 317 individuals and therefore an annual mortality rate of 51 birds per year and a baseline mortality rate of 0.5 birds per year.

Table 4-14: Predicted number of collisions for various avoidance rates for red-throated diver

Collision probability	Avoidance rate (%)		
	98	99	99.5
9%	0.08	0.04	0.02

Based on the various scenarios and using a precautionary avoidance rate of 98% it is predicted that a total of 0.08 collisions per year may occur (Table 4-14) this is lower than the 1% baseline mortality rate of 1.1 birds per year for Aberdeen Bay and 0.5 birds per year for the Firth of Forth SPA.

Evidence from other offshore wind farms indicates that red-throated diver are at low risk of collision. Studies undertaken at Horns rev and Nysted offshore wind farms in Denmark indicate that red-throated divers avoid wind farms. Sixty-one Divers were tracked using radar none of which were recorded flying into the wind farm. Instead they were recorded as being deflected westward and flying around the wind farm (Petersen *et al*. 2006). Red-throated divers are therefore unlikely to come into direct contact with them (Petersen *et al*. 2006).

Based on the results from the Collision Risk Modelling and evidence from other sites it is concluded that the potential impact of collision risk is negligible.

Barrier effect

Evidence from studies undertaken in Denmark indicate that red-throated divers may avoid flying through wind farms; consequently, there may be a barrier effect on red-throated divers within Aberdeen Bay. Should a barrier effect occur out to a distance of 1km from the proposed development then a Diver may detour around the wind turbines causing it to increase its flight by a total of 3.2 km. Energetics modelling predicts that by flying around the proposed development the additional 3.2 km will cause an increase in energy usage of 8.5 Kj or 1% of daily energy expenditure (Speakman, Gray & Furness 2009).

There is no evidence of any regular daily movement in the form of feeding or roosting movements across Aberdeen Bay by red-throated diver and so any increase in energy expenditure due to the avoidance of the wind turbines should it occur is not predicted to be on daily basis and consequently any incremental increase in energy expenditure is likely to be *Ad hoc* and not a regular event. An increase in potential daily energy expenditure of 1% is small and likely to within the range of natural daily variations and it is therefore not considered to be significant and consequently based on current evidence the likely predicted effects from potential barrier impacts are considered to be negligible.

Displacement

Evidence from post-construction monitoring undertaken in the UK and Denmark suggests that red-throated divers may avoid wind farms (Ecology Consulting 2009, 2010; Petersen *et al.* 2006). The results from the monitoring undertaken at the Kentish Flats Offshore Wind Farm do not show 100% avoidance but do indicate a reduced usage of the site out to 1 km. Based on the results from the monitoring data, the worst-case scenario is that there is a 100% displacement of red-throated divers from the proposed development out to 1 km and a further 50% decrease out to 2 km from the area.

Based on the peak density of 4.9 birds/km^2, should there be a total displacement of red-throated diver from within the proposed development then it is predicted that up to 21 red-throated diver may be displaced during periods of peak density. Based on a 100% displacement out to 1 km (a total surface area of 12.3 km^2) from the proposed development then it is predicted that up to 60 red-throated diver may be displaced and a further 50 out to 2 km should there be 50% displacement between 1 km and 2 km from the proposed development. Therefore, the maximum number of red-throated diver potentially displaced is up to 131 birds based on the highest densities recorded from any survey within Aberdeen Bay and displacement out to 2 km.

Evidence from boat based surveys suggest that peak densities occur to the north of the proposed development area and outwith the immediate zone of displacement effect (Figure 4-31, Figure 4-32, Figure 4-33, Figure 4-36) and that densities within the vicinity of the development are typically much lower at below 1 bird/km^2 (Figure 4-29, Figure 4-30). Consequently, it is predicted that should displacement occur, the number of Divers typically displaced will be between 16 individuals (with 1 km of displacement) and 26 birds (with up to 2 km of displacement). Furthermore, the distribution of divers across Aberdeen Bay is largely within 3 km of the shore and therefore densities to the east of the proposed development, i.e. within the proposed development area, will be lower than has been used for this assessment which has not taken this decrease in offshore red-throated diver density into account.

Based on the maximum estimated population of 697 birds at a density of 4.9 birds/km^2, it is predicted that up to 19% of the red-throated diver population of Aberdeen Bay may be displaced. Based on site specific numbers from the proposed development area 4% may be displaced. Should red-throated divers be displaced then they are predicted to relocate to other suitable foraging areas. Evidence from surveys indicates that areas to the north of the proposed development area are preferred over areas within the vicinity of the proposed development.

Red-throated diver numbers within Aberdeen Bay vary across seasons and years and there is no evidence of the population of red-throated divers within Aberdeen Bay being at carrying capacity as numbers fluctuate considerably across years. Consequently, should displacement occur it is not predicted to, nor is there any evidence for, any increase in the mortality rate of red-throated diver.

Based on site specific data and results from other sites it is concluded that the potential impact of displacement is at worst moderate and most likely minor.

Calculations used for displacement		
Area	*Peak density of red-throated diver – 4.9 birds/km^2*	*Typical density of red-throated diver – 1 bird/km^2*
Area of EOWDC – 4.3 km^2	4.3 * 4.9 = 21	4.3 * 1 = 4
Area of 1 km buffer = 12.3 km^2 (100% displacement)	(12.3 * 4.9) =60	12.3 * 1 = 12
Area of 2 km buffer – 20.3 km^2 (50% displacement)	(20.3 * 4.9)*0.5 = 50	(20.3 * 1)/2 = 10
Total number potentially displaced	21 + 60 + 50 = 131	4+ 12 + 10 = 26

Disturbance

Red-throated divers are predicted to be disturbed by vessels both during construction and during operation from maintenance vessels. Previous studies have indicated that there may be total displacement from within 100 m of a vessel and varying degrees of displacement at distances up to 1,000 m. Some displacement may occur beyond 1,000 m but this is not reliably quantified or attributed to the survey vessel. The average displacement recorded is 82% of all birds within 1 km (Norman & Ellis 2005). When disturbed divers respond to approaching vessels by low, direct flights usually perpendicular to the line of approach and that these flights are generally below 15 m (Norman and Ellis 2005)

During construction there may be a number of vessels operating within the area but will likely be focussed around a single point where the turbine is being installed. Consequently, up to 82% of the Divers may be displaced from within 1 km radius of the installation; an area of 3 km^2. Based on the highest recorded density of 4.9 birds/km^2, it is therefore predicted that up to 15 red-throated diver may be displaced from the vicinity during construction. This equates to approximately 2% of the red-throated diver population within Aberdeen Bay based on the peak estimated figure of 697 individuals recorded in November 2010. The construction period will be of short duration and the impacts of construction vessels temporary. Consequently, any potential impact is predicted to be negligible.

Displacement by service boats within the EOWDC area assumes that red-throated divers are not already deterred by the turbines. If that is the case, then the presence of service boats may diminish the re-population of the site. It is not known how many service vessels may be required but based on the scale of the proposed development it is unlikely to be more than one vessel on any one occasion. The presence of the proposed development in the vicinity of the intensively used Aberdeen Harbour means that the potential increase of one vessel movement on a regular basis will not have any noticeable difference to the number of vessels already using Aberdeen Bay. Any specific displacement caused by the service boats will be temporary as Divers will be able to move into the area once the vessels leave. In addition the wide distribution of Divers is such that there are alternative suitable sites that displaced Divers could utilise.

It is concluded that the effect of service boats is much smaller than assuming total displacement from the EOWDC area and the potential impact from disturbance is minor.

Cumulative Impacts

There is the potential for cumulative impacts with other offshore wind farms, planned or proposed and other activities such as shipping.

With respect to other wind farms, three occur in the Firth of Forth (Inch Cape, Neart na Gaoithe and Firth of Forth) in an area not known to hold significant numbers of red-throated diver. Consequently there is not predicted to be any cumulative impact from these three wind farms.

Evidence from aerial surveys and site specific data at Beatrice indicate that the two wind farms planned in the Moray Firth (Beatrice and Moray Firth Offshore Wind Farms) are also in areas where red-throated diver may not occur (Söhle *et al*. 2006; Lewis *et al.* 2008; Brookes 2009). Consequently, the likelihood of a cumulative impact arising is considered to be low.

There is the potential for a cumulative impact with respect to disturbance arising from other activities, notably vessel activities in the area. Although there will be an increase in vessel movements during the construction period, post-construction it is likely that there will be less than one vessel per day. This increase is within the day-to-day variation in the number of vessels operating in and out of Aberdeen Harbour and is therefore unlikely to be noticeable.

The potential future Ocean Pod will require additional vessel movements within the proposed development area during its construction and operation. Should this occur then there is the potential for a cumulative effect on red-throated diver. It is not yet known what type of structure the Ocean Pod may be or how it will be installed or the number of vessel movements will be required. However, it is a single structure and it is predicted that the level of disturbance will be no greater than that arising from the installation of a single wind turbine. The scale of disturbance is therefore predicted to be localised and of short duration.

It is concluded that the cumulative effect of service boats is much smaller than assuming total displacement from the proposed development area and the potential cumulative impact is negligible.

4.15.7 Conclusions

Habitats Appraisal

No designated sites for which red-throated diver is a qualifying species have been identified as being at risk of a potential adverse effect.

Environmental Impact Assessment

Red-throated divers are widely distributed in Aberdeen Bay and in varying numbers. The assessment has been based on the peak densities and maximum counts recorded within the bay and is based on a series of worst-case assumptions.

Based on the low numbers of Divers recorded flying at turbine height, either within Aberdeen Bay or at other offshore wind farms, the collision risk for red-throated diver is very low and there is not likely to be a significant effect on the population arising from collision mortality rates.

There is the potential for up to 19% of the red-throated diver population within Aberdeen Bay to be displaced based on there being total avoidance of the EOWDC site out to 1 km and a further 50% decrease out to as far as 2 km. However, evidence from post construction monitoring at other offshore wind farms indicates that following construction total displacement will not occur. Furthermore, evidence from boat-based and land-based surveys indicate that the proposed development is not a major area for red-throated divers in Aberdeen Bay and alternative areas to the north are favoured. Therefore, the percentage of the population potentially displaced will be lower than has been used in this assessment. There is no evidence to suggest that, should displacement occur that any displaced red-throated divers will be at increased risk of mortality.

Disturbance from construction and maintenance vessels will occur but the impact will be localised and temporary. The number of predicted vessel movements associated with the proposed development are within the variable range of vessel activity associated with the intensively used Aberdeen harbour and unlikely to be noticed above the existing activities.

It is predicted that, although there may be some displacement of red-throated divers away from the proposed EOWDC area, there will not be a significant environmental impact arising from the proposed development on red-throated diver.

4.16 Northern Fulmar (*Fulmaris glacialis*)

4.16.1 Protection & Conservation Status

The (northern) fulmar is listed in Appendix II of the Bonn Convention, Schedule 1 under the Wildlife and Countryside Act, 1981 and is on the Amber List of Species of Conservation Concern.

4.16.2 Background

Fulmar		
GB Population	538,000 nests	Mitchell *et al* 2004
Scottish population	486,000 AoS	Forrester *et al.* 2007
International threshold	Unknown	-
GB threshold	5,000	1% of GB Pop[n]
Designated east coast sites where species is a noted feature	Fowlsheugh: 246 prs Buchan Ness to Collieston: 1,370 prs Troup Pennan and Lion's Heads: 636 prs Forth Islands: 402 prs	JNCC (2011)
European population estimate	Breeding: 2.8 – 4.400,000 Wintering: 1,500,000	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	15 – 30,000,000 'adults'	Birdlife 2011

Fulmars are one of the most abundant pelagic birds in the North Atlantic with a global population of up to 30 million individuals and a UK breeding population of over 500,000 individuals. The fulmar population has increased dramatically during the last couple of centuries and numbers in Britain doubled between 1969 – 1970 and 1985 – 1987 (Wernham *et al.* 2002).

After fledging, young fulmars spend up to four years at sea, during which time they are thought to disperse widely and rarely visit land (Wernham *et al*. 2002). They feed at sea often scavenging behind fishing vessels.

The UK population is estimated to be 538,000 apparently occupied nests (AoN) and therefore in excess of a million birds, of which approximately 80% are in Scotland (Mitchell *et al*. 2004).

In North-east Scotland the fulmar population has increased with over a 118% increase in the number of breeding bird in Moray, 136% increase between Banff and Buchan and 167% increase in Kincardine and Deeside (Mitchell *et al*. 2004).

During a ten year study of seabird movements at Peterhead, fulmars passed along the north-east coast throughout the year but were scarcest in winter, with a general pattern of a modest southward movement. In spring numbers increase with the majority of birds heading north. In the autumn numbers of fulmars passing Peterhead decreased with the majority of birds still heading north (Innes 1992). During periods of poor weather the number of fulmars passing along the coast can be large with regular counts of over a 1,000 birds per hour during these periods (Buckland, Bell & Picozzi 1990).

4.16.3 Survey Results

Boat-based surveys

Fulmars were recorded widely across Aberdeen Bay throughout the year from boat-based surveys. However, population estimates were relatively low, particularly in the proposed EOWDC survey area where there were no records of fulmars in transect between October 2006 and January 2007. Peak numbers were recorded within the 'control' survey area to the north where up to 45 birds were recorded during December (Figure 4-41, Table 4-15). Numbers of fulmar within Aberdeen Bay were lowest from August through to November with no fulmars recorded within transect during October and November (IECS 2008) (Figure 4-39). There were very few records of fulmar recorded in proposed development area throughout the year.

Table 4-15: Fulmar monthly population estimates in Aberdeen Bay: Boat-based surveys 2007 – 2008.

Month	On water estimate	In flight estimate	Total estimate
	No.	No.	No.
February	8	24	32
March	3	3	6
April	9	10	19
May	0	21	21
June	6	6	12
July	8	6	14
August	6	3	9
September	6	0	6
October	0	0	0
November	0	0	0
December	3	42	45
January	0	8	8

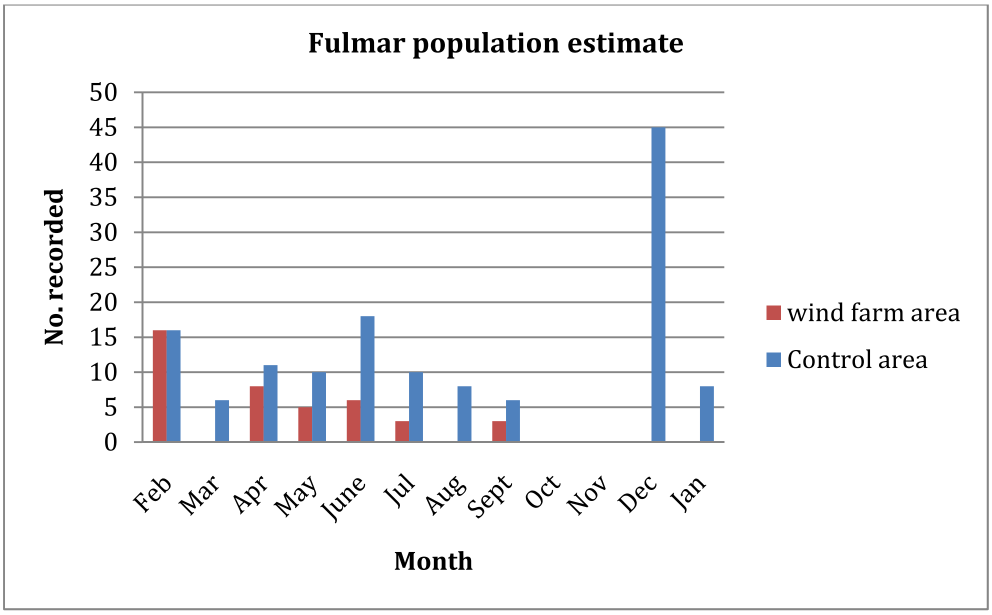


Figure 4-39: Fulmar monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

Additional data collected between August 2010 and January 2011 recorded a total of 178 fulmars in September 2010 and lower numbers less than 50 individuals, during the rest of the period (Figure 4-40) (SMRU 2011b). There was insufficient detections to undertake *Distance* sampling analysis on any of the fulmar data.

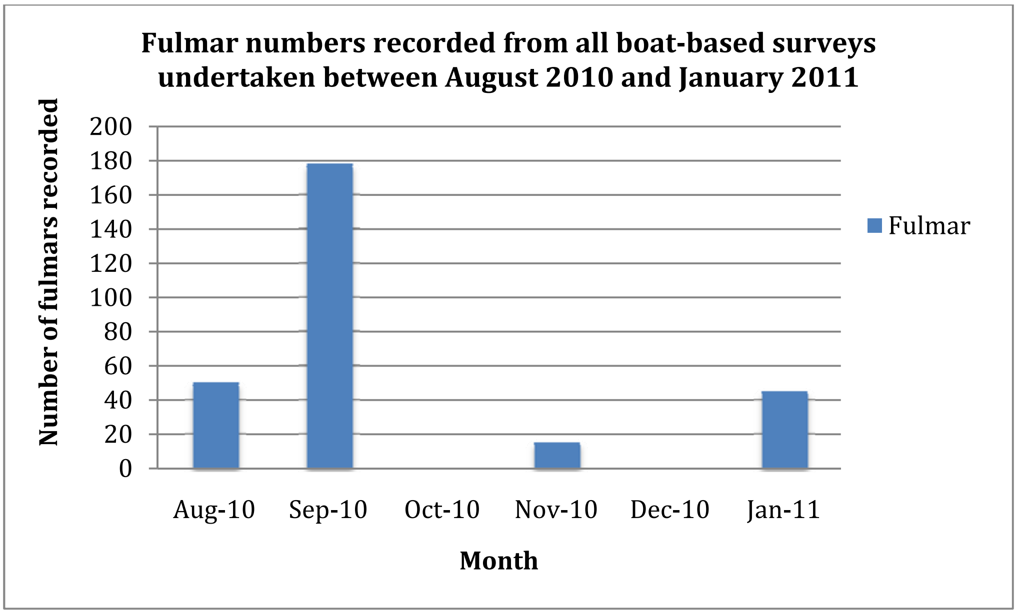


Figure 4-40: Numbers of fulmar recorded from boat-based surveys undertaken in Aberdeen Bay between August and January 2011. (Note no counts were made in October or December 2010).

Fulmar distribution within Aberdeen Bay was widespread, particularly during the breeding season. During the winter period there were fewer records and a cluster of observations to the north of the survey area near to breeding colonies. During post-breeding season the majority of fulmar sightings were further offshore with relatively few recorded in nearshore waters. (Figure 4-41, Figure 4-42, Figure 4-43, Figure 4-44). Flight height data from boat-based surveys recorded <0.5% of flights below 15 m.

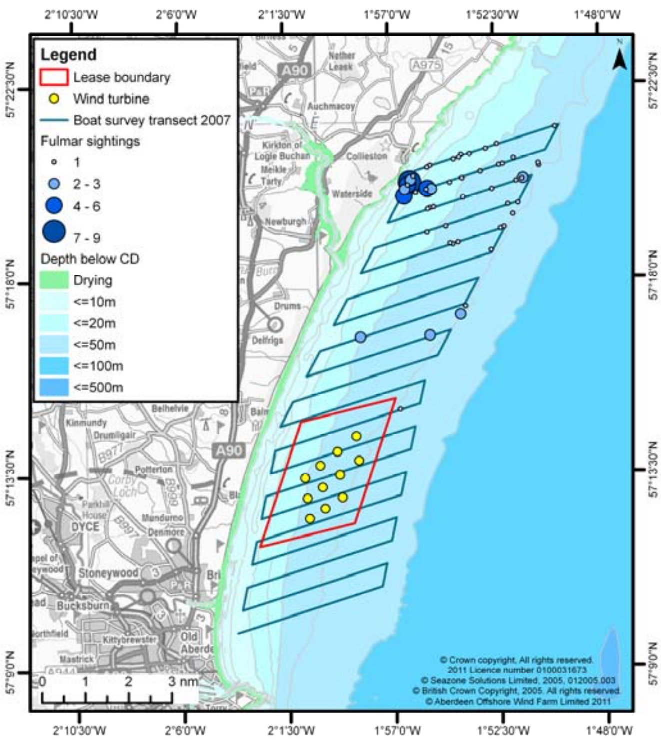


Figure 4-41: Fulmar distribution during winter period: November to February (all sightings).

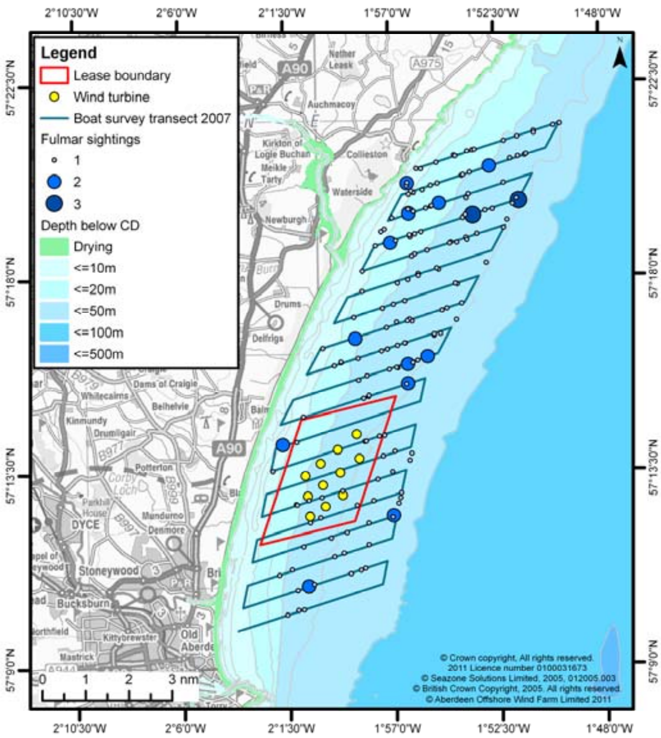


Figure 4-42: Fulmar distribution during breeding season: March to August (all sightings).

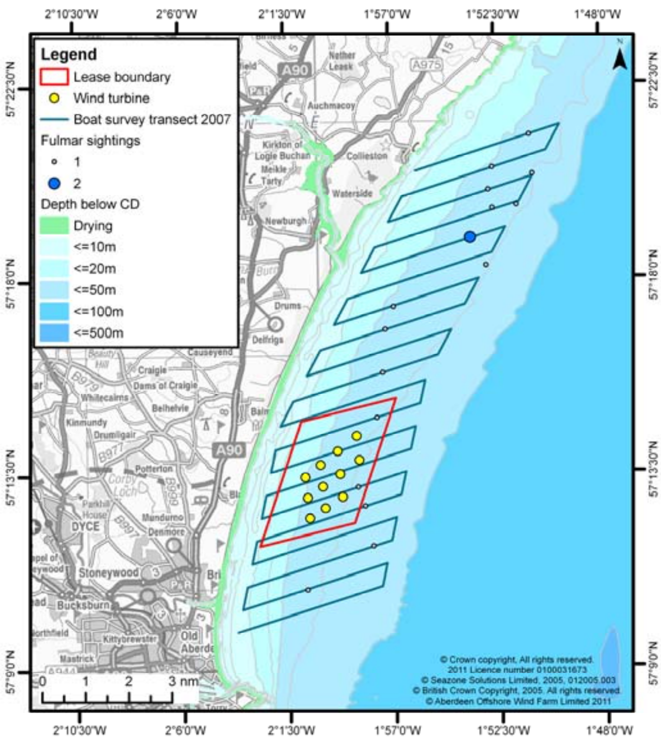


Figure 4-43: Fulmar distribution during post-breeding: September and October (all sightings).

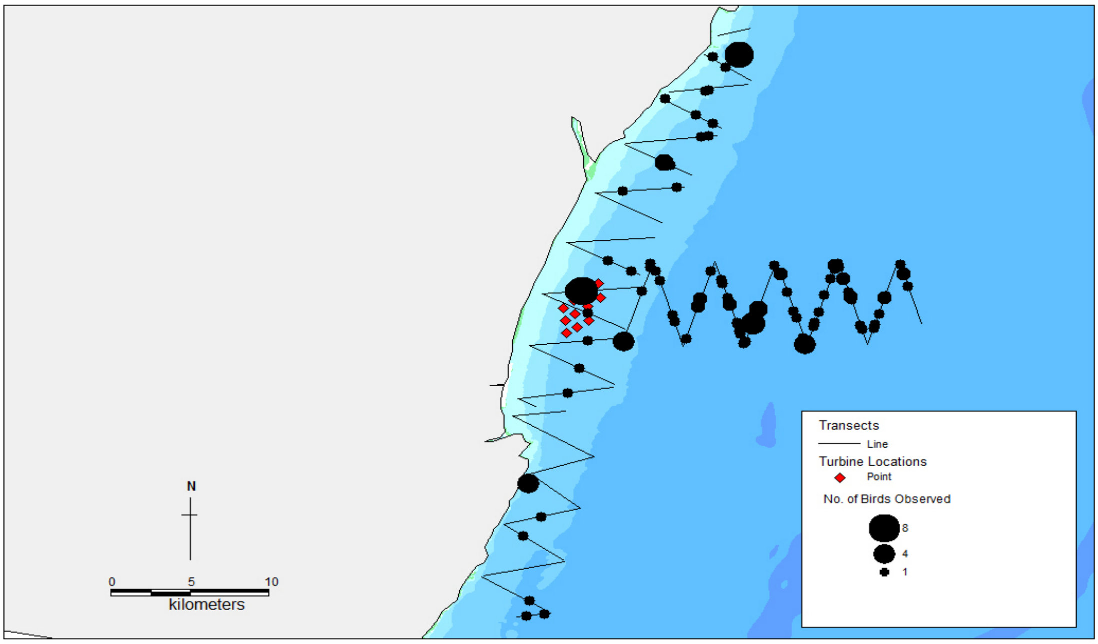


Figure 4-44: On-effort observations of Fulmar along transects during August, September and November 2010 and January 2011.

Vantage Point surveys

In Aberdeen Bay fulmars were present during peak dawn and dusk activity periods between April and September in numbers generally less than 20 birds per hour but occasionally up to 75 birds per hour during peak periods in June (Alba Ecology 2008a). This is considerably lower than the number of birds recorded at Peterhead during the same seasonal period where between 300 to 400 birds per hour were recorded (Innes 1992).

Numbers of fulmar sighted within Aberdeen Bay decreased during the winter months with less than three birds per hour passing through any one Vantage Point site in Aberdeen Bay between October 2006 and March 2007. Twenty-five fulmars were recorded during a hundred hours of observations between October 2006 and March 2007 (EnviroCentre 2007b) and twenty-four between October 2007 and March 2008 (Alba Ecology 2008b).

Most records during the winter months were of birds at least 1 km from the shore, with the majority being between 2 km and 3 km offshore. Of those recorded in flight at least 80% of all flights were below 30 m.

Bird Detection Radar

No fulmars were recorded during five days of observations undertaken at Easter Hatton and Drums during October 2005. Further radar studies undertaken at Blackdog over a seventeen day period in April 2007 recorded 158 fulmars at a rate of three birds per hour during April (Simms *et al.* 2007).

4.16.4 Summary of Results

Fulmars occur throughout the year in Aberdeen Bay with peak numbers during the late summer, late winter and spring periods. Very few fulmars were recorded in nearshore waters during the post-breeding and early winter periods. Fulmars were more frequently recorded within the ‘control’ survey to the north and in offshore waters than within the proposed offshore EOWDC survey area, where there was a peak count of sixteen birds in February 2006. Results from the Vantage Point and radar studies suggest that the majority of fulmars occur between 2–3 km offshore and between 0.5% and 20% of all flights were below 30 m. The numbers recorded from boat-based and Vantage Point land based surveys were lower than the peak counts reported for Aberdeen Bay from other land based counts.

Numbers of fulmar recorded in Aberdeen Bay were below the threshold for a site of international importance.

4.16.5 Initial Assessment of Significance

Fulmar	Overall sensitivity	Magnitude	Significance
Collision	Very High	Negligible	Minor
Barrier	Medium	Medium	Minor
Displacement	Medium	Negligible	Negligible

4.16.6 Species Sensitivities

Qualify species

There are twenty-five SPAs for which fulmar is a qualifying species all of which are within the potential foraging range from the proposed development of 664 km. However, for the purposes of this assessment four colonies have been identified as being within close enough proximity for there to be a potential significant effect:

- Buchan Ness - Collieston SPA (9.5 km).
- Fowlsheugh SPA (31.1 km).
- Forth Islands SPA (124.4 km).
- Troup, Pennan and Lion’s Heads SPA (74.3 km).

Fulmar populations at the time of designation or at the time of last review at each of the sites were:

- Buchan Ness to Collieston SPA held 1,765 apparently occupied nest (AoN). Recent counts indicate a slight decline to 1,370 AoN;
- Fowlsheugh SPA held 1,170 AoN. Recent counts indicate a decline to 246 AoN.
- Forth Islands held 1,600 AoN. Recent counts indicate a decline to 402 AoN.
- Troup, Pennan and Lion’s Head SPA held 4,400 AoN.

  Note – the ‘recent counts’ may not be complete and therefore the declines suggested may not be genuine decreases.

Flight height

Data obtained from boat-based surveys did not record any fulmars flying above 25 m and less than 0.5% were flying above 15 m (n=214).

Elsewhere data from other offshore wind farms have recorded less than 1% at rotor height and a mean flight height 17 metres (n=1,734).

Collision risk

Evidence from site specific monitoring from boat-based and land-based surveys indicate that fulmars are widespread across Aberdeen Bay with increasing numbers offshore including within the proposed development area (Figure 4-41 to Figure 4-44). All sightings within Aberdeen Bay were of birds flying below 25 m and therefore not at risk of collision.

There is only one record of a fulmar collision with an offshore wind farm with one recorded at Blyth (Zucco *et al*. 2006). Evidence from other offshore wind farms indicate that fulmars fly predominantly below turbine height and are therefore not at significant risk of collision.

Based on the evidence from existing offshore wind farms and site specific data indicating a very low level of flight height, predominantly below turbine height, it is concluded that the risk of any significant impact or adverse affect on fulmars from collision is negligible.

Collision Risk Modelling undertaken for fulmar is based on:

- Body length of 52 cm
- Wingspan of 117 cm
- Flight speed of 13 $m.s^{-1}$

Modelling has been undertaken based on a collision probability of 9.8% and over a range of possible avoidance rates of 98%, 99% and 99.5%.

Table 4-16: Predicted number of collisions for various avoidance rates for fulmar.

Collision probability	Avoidance rate (%)		
	98	99	99.5
9.8%	0.08	0.04	0.02

Based on the various scenarios and using a precautionary avoidance rate of 98% it is predicted that a total of 0.08 collisions per year may occur (Table 4-16). The current SPA population across all four SPAs is 6,418 AoN; approximately 12,836 adults.

The annual mortality rate for fulmar is 3% (BTO 2011). Consequently, out of a population of 12,836 individuals an annual mortality of 385 fulmars may be predicted. Therefore, 1% of the baseline mortality is 3.8 birds per year, i.e. an increase in mortality rate of more than 3 birds per year caused by collisions may be considered significant.

For the individual SPAs the increase in mortality which could cause an adverse effect is lower.

- Fowlsheugh has the lowest currently reported population for a SPA of 246 AoN (492 individuals) then an increase in mortality of more than 0.1 bird per year could be adverse.

- Buchan Ness to Collieston SPA has a current population of 2,740 individuals (1,370 AoN) and an annual mortality of 82 birds per year. Therefore 1% of baseline mortality is 0.8 birds per year.
- Recent counts at the Forth Islands SPA are of 804 individuals (402 AoN). An annual mortality of 24 birds per year. 1% of baseline mortality is therefore 0.2 birds per year.
- Troup, Pennan and Lion's Head SPA held 4,400 AoN, 8,800 individuals. An annual mortality of 264 birds per year. 1% of baseline mortality is therefore 3 birds per year.

Site specific data and results from other offshore wind farm locations indicate that less than 1.0% of fulmars fly at above 20 – 25 m and consequently the risk of collision is very remote. The results from the collision risk modelling also indicate that the risk of a collision is very low and that it is predicted that 0.08 fulmar per year may collide with the wind turbines when 1% of flights are at rotor height. This is lower than 1% baseline mortality rates for any of the SPAs identified as being at potential risk from the proposed development.

Based on the site specific evidence and the results from collision risk modelling it is concluded that the risk of a significant environmental impact is negligible and an adverse effect minor.

Barrier effect

The number of fulmars reported at operating wind farms is very low consequently there is little or no evidence of any barrier effect. The few records from Danish studies suggest that fulmars may avoid flying through the operating wind farm and consequently there may be a barrier effect.

In order to avoid the turbines the birds may incur additional energetic expenditure. The proposed EOWDC is at its longest point approximately 4 km and at its widest 2 km. Assuming birds avoid the proposed development area at 1,000 m then they may incur an overall increase in flight distance of 3.2 km.

Fulmars are extremely efficient fliers and during the breeding season can travel many hundreds of kilometres in single feeding trips up to 580 km (Roos *et al.* 2010) and outwith the breeding season forage widely across the North Sea and North Atlantic. Consequently, any additional increase in foraging distance due to avoidance of flying through the proposed development and its significance will be minor.

Displacement

Fulmars are primarily an aerial species spending relatively little time on the sea surface and do so primarily when preening or feeding or during periods of calm weather. There are no data available from constructed wind farms to determine whether fulmars are displaced from wind farms.

Data from boat-based surveys undertaken between 2007 and 2008 recorded a peak count of 16 fulmars in the proposed EOWDC survey area during February (Figure 4-39). This is less than 0.3% of the SPA fulmar population. There is no evidence from the surveys that the area is used extensively by fulmars and should there be total displacement that the displaced fulmars will not find other suitable areas. Fulmars forage over a wide area in search of small fish (sandeels), crustaceans and squid. They also scavenge extensively around fishing vessels (Phillips *et al*. 2009). Consequently, it is predicted that should displacement occur the magnitude of the effect and its significance will be negligible.

Cumulative and in-combination

The very large range that fulmars can fly suggest that any individual fulmar may interact with any of the proposed offshore wind farms in Scottish waters and elsewhere. Consequently, there is the potential for cumulative and in-combination effects. The closest constructed offshore wind farm is the Beatrice demonstrator project in the Moray Firth. Collision Risk Modelling undertaken for that project suggested that one fulmar every three years may collide with the turbines (Talisman 2005). However, there is no evidence to suggest any likely significant impact on fulmar from collision risks; nor any impact from barrier effect or displacement. The relatively low level of usage of the site indicates the potential for a cumulative or in-combination effect to be low and the magnitude negligible.

4.16.7 Conclusions

Habitats Appraisal

Based on the available evidence from site specific surveys undertaken at the proposed development area, in particular the relatively low usage of the site along with evidence from existing wind farms it is concluded that the proposed development will not have an adverse effect on fulmars as qualifying features for Buchan Ness - Collieston SPA, Fowlsheugh SPA, Forth Islands SPA, Troup, Pennan and Lion’s Heads SPA.

Environmental Impact Assessment

Based on the very low usage of the site and the known behaviour of fulmar it is predicted that there will not be a significant environment impact arising from the proposed development on fulmars.

4.17 Northern Gannet (*Morus bassanus*)

4.17.1 Protection & Conservation Status

The (Northern) gannet is listed in Appendix III of the Bern Convention, and is on the Amber List of Species of Conservation Concern.

4.17.2 Background

Gannet		
GB population	Breeding: 230,000 prs	Mitchell *et al* 2004
Scottish population	Breeding: 182,511 AoS Winter: 'a few thousand'	Forrester *et al.* 2007
International threshold	Unknown	-
GB threshold	4,600 ind.	1% of GB Pop[n]
Designated east coast sites where species is a noted feature	Forth Islands: 44,000 prs	JNCC
European population estimate	Breeding 300,000 – 310,000 prs Wintering – unknown	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	950,000 – 1,200,000 'adults'	Birdlife 2011

Gannets are widespread across the whole of the North Sea but breed at relatively few but typically large colonies. They have a prolonged breeding season with adults attending colonies from January through to November with chicks fledging from August to October. During the breeding season adults will forage up to 500 km from the breeding colony, although more typically it is within 100 km from the colony. Gannets recorded in Aberdeen Bay during the breeding season are likely to be from the colony at Troup head or potentially Bass Rock as opposed to those from Fair Isle or further afield.

Once fledged, chicks move predominantly southwards wintering between the Bay of Biscay and Senegal. However, many gannets may also spend at least part of the winter in the North Sea.

The gannet population has increased in recent decades with up to 230,000 pairs recorded during the Seabird 2000 censuses (Mitchell *et al*. 2004).

In North-east Scotland gannets occur throughout the year in variable numbers. During a ten year study of seabird movements at Peterhead, gannets were scarcest during the winter, but numbers increased in the spring from April onwards, peaking in May. During the summer and early autumn numbers recorded passing Peterhead remained relatively high before decreasing from October onwards (Buckland, Bell & Picozzi 1990; Innes 1991).

Boat-based surveys

Gannets were recorded throughout Aberdeen Bay from boat-based surveys with no areas identified as being of particular importance but with the majority of sightings in water depths of between 20 m and 50 m (Figure 4-45, Figure 4-46, Figure 4-47). Numbers of gannets recorded were lowest between November and March and highest during the breeding season from April to August when gannets were widespread throughout the area.

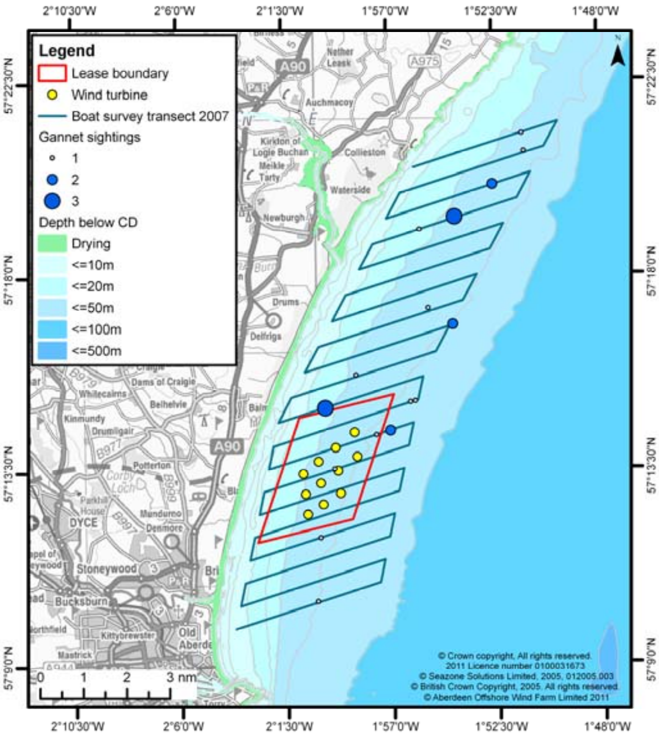


Figure 4-45: Gannet distribution during winter period: November to March (all sightings)

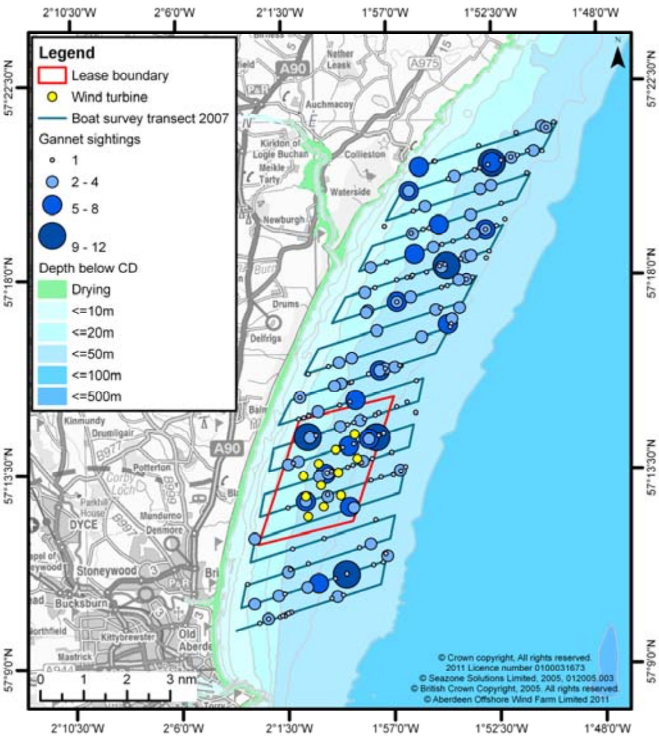


Figure 4-46: Gannet distribution during breeding season: April to August (all sightings).

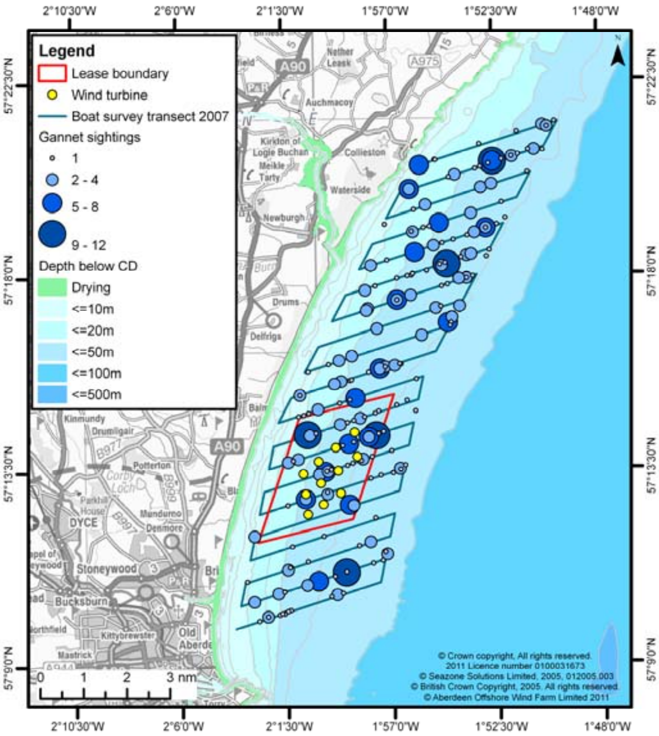


Figure 4-47: Gannet distribution during post-breeding: September and October (all sightings).

Additional surveys undertaken between August 2010 and January 2011 recorded gannets in low numbers in offshore waters with clusters to the north of the Ythan Estuary and relatively few within the proposed development area (Figure 4-48).

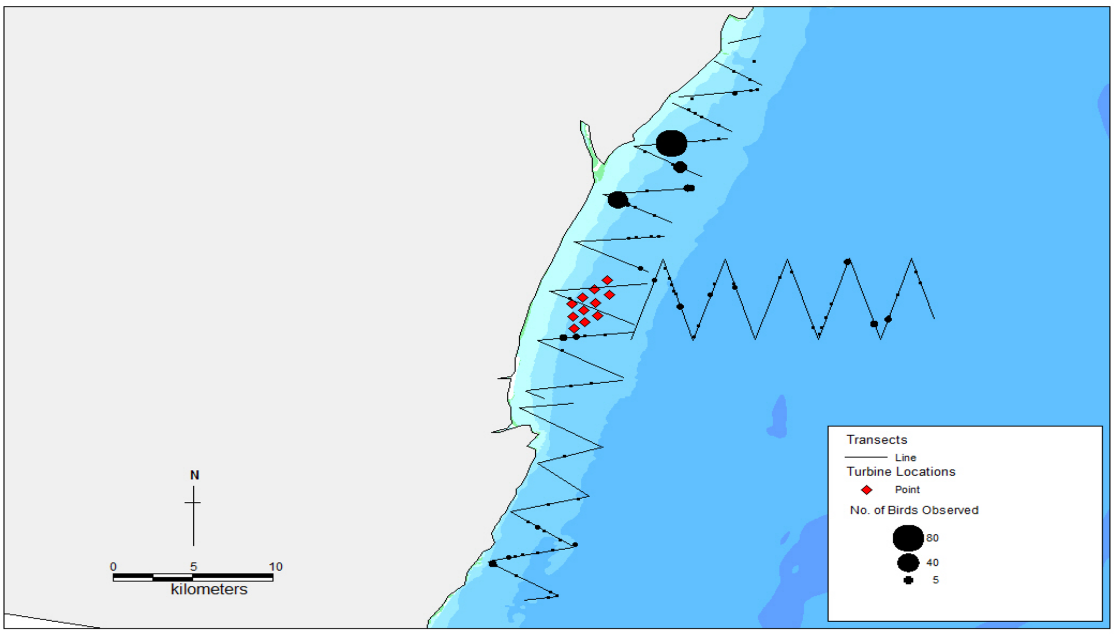


Figure 4-48: On-effort observations of Northern Gannet along transects during August, September and November 2010 and January 2011.

Relatively few gannets were recorded from boat-based surveys during the winter months with an increase in numbers in June and a peak in July, August and September (Figure 4-49).

Distance analysis of the first year's data estimated a peak density of 3.1 birds/km^2 during July within the 'control' area when none were recorded within the proposed EOWDC survey area. Within the EOWDC area peak numbers were estimated to be in June and August (Figure 4-50 Figure 4-52). Additional *Distance* sampling analysis undertaken on the data collected between August 2010 and January 2011 estimated significantly higher numbers during September primarily in areas that had not previously been surveyed to the north of the proposed development area, with an abundance estimate of 642 birds in September and a density of 4.26 birds/km^2 (Figure 4-51, Figure 4-53).

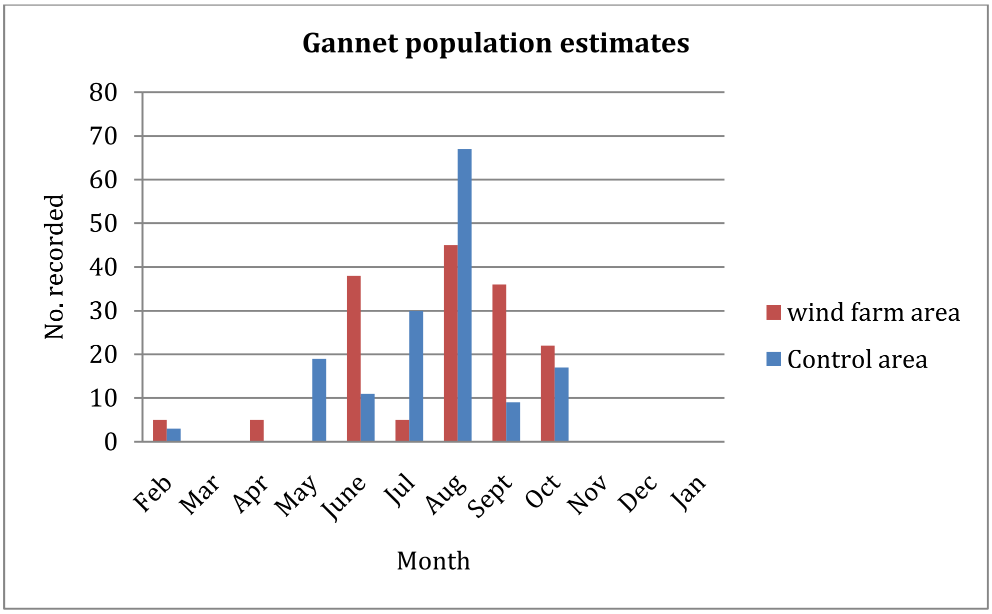


Figure 4-49: Gannet monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

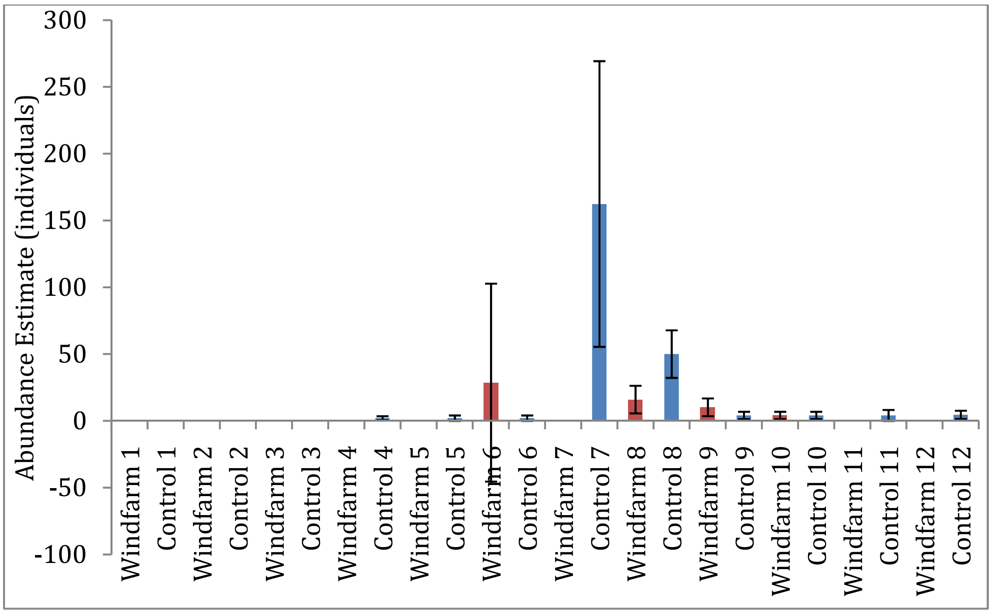


Figure 4-50: Monthly estimates (+/- SE) of abundance of gannets in the wind farm and 'control' Areas; February 2007 – January 2008 ('windfarm' 1-12 and 'control' 1-12 refers to months).

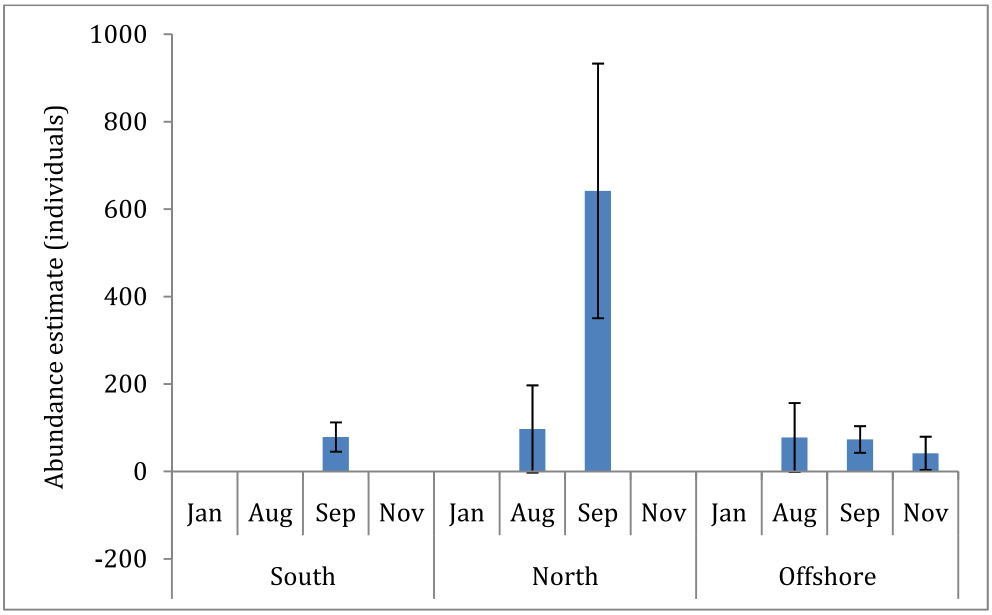


Figure 4-51: Monthly estimates (+/- SE) of abundance of gannet in the South, North and Offshore Strata between August 2010 and January 2011.

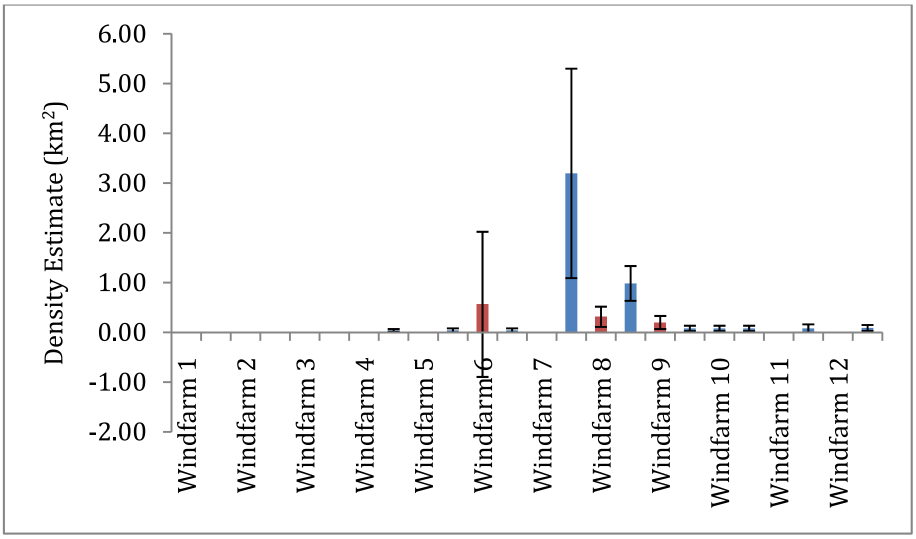


Figure 4-52: Monthly estimates (+/- SE) of density of gannets in the proposed EOWDC and 'control' Areas (wind farm 1-12 and 'control' 1-12 refers to months).

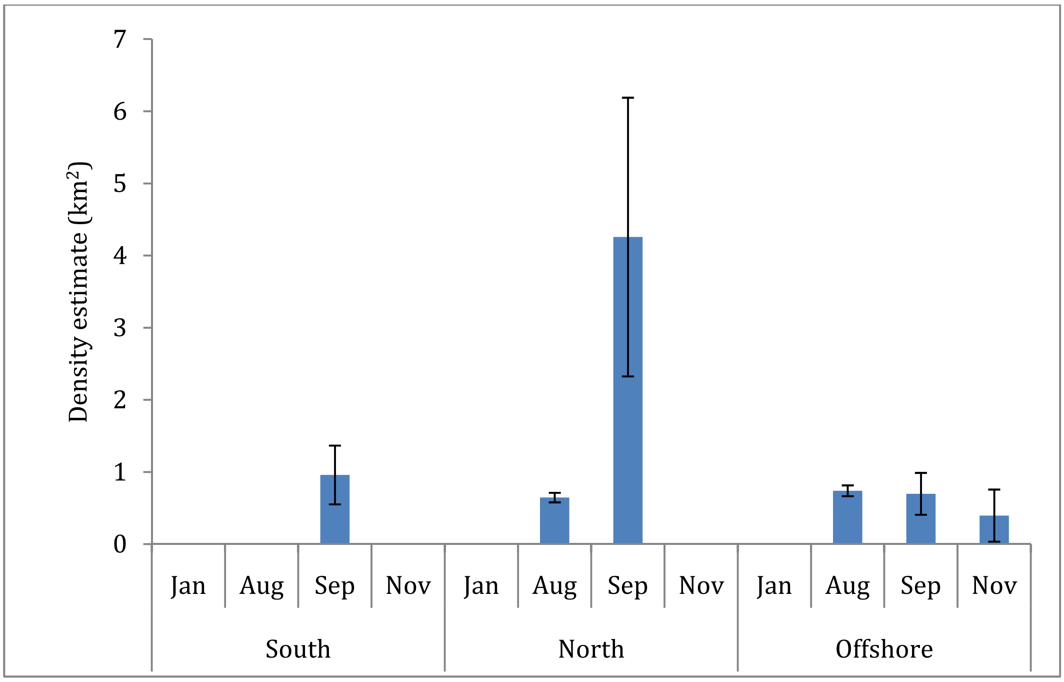


Figure 4-53: Monthly estimates (+/- SE) of density of gannet in the South, North and Offshore Strata between August 2010 and January 2011.

Flight heights of gannets recorded during the boat-based surveys indicated that 29% of all flights were above 15 m and 17% were above 25 m.

Vantage Point surveys

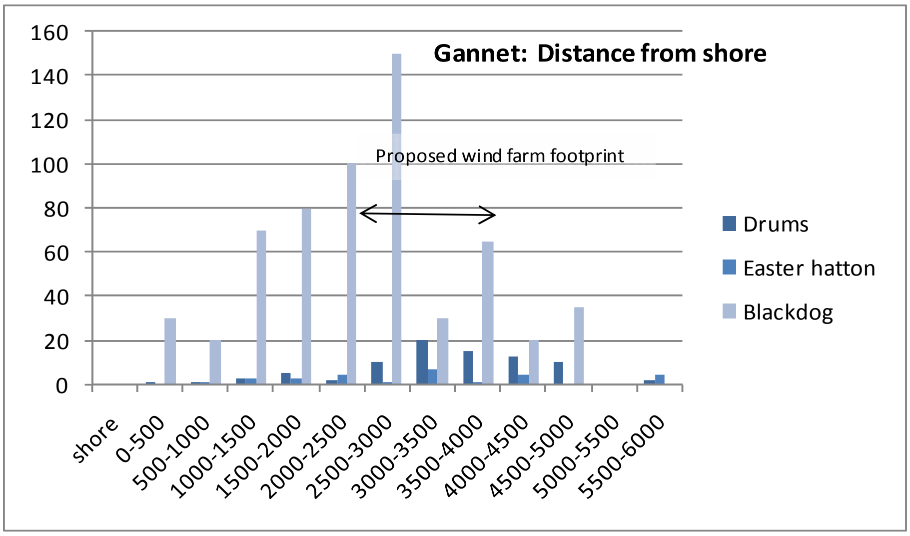
Gannets were observed from all Vantage Point sites, with a peak count of up to 120 birds per hour in July 2007 and 90 birds per hour in September 2006 (Alba Ecology 2008a, EnviroCentre 2007a) which is similar to the numbers recorded at

Peterhead during this period (Innes 1991). Numbers of gannets in Aberdeen Bay decreased after October with typically less than five birds per hour passing (EnviroCentre 2007b) and typically lower numbers during the winter with less than ten birds per hour between October and March (EnviroCentre 2007b, Alba Ecology 2008b).

Flight heights recorded between April and September 2006 from Vantage Point surveys recorded 25% of all gannets between 30–150 metre height across all Vantage Point Sites but between 40% and 50% were recorded within the same height bands between April to September 2007 (Alba Ecology 2008a). Gannets were recorded out to at least 3 km from shore with the majority of sightings between 2 and 3 km.

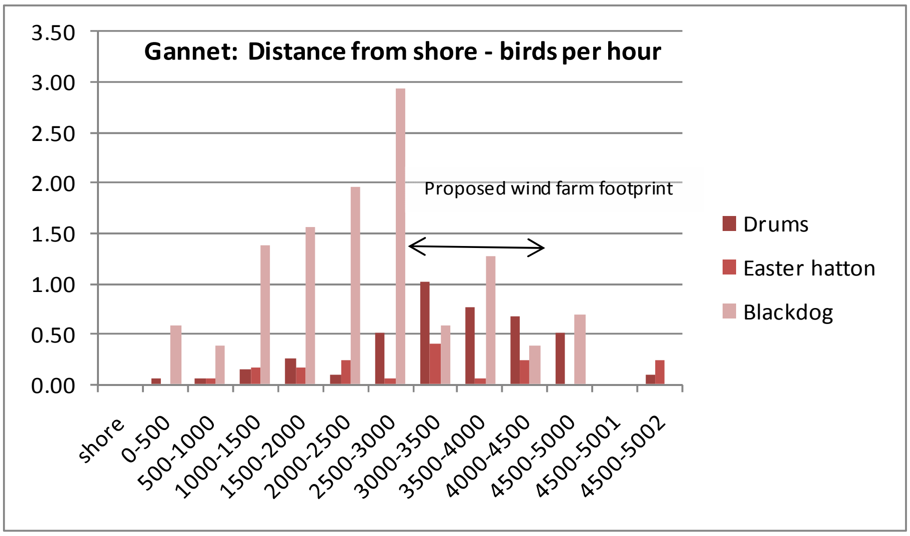
Bird Detection Radar

A total of 110 gannets were recorded during the radar studies undertaken in October 2005. Sightings were of birds out to 6 km from shore with peak numbers recorded at between 3 km and 5 km (Figure 4-54). Of those recorded in flight the mean height was 8 m above the sea surface with a maximum height of 30 m (Walls *et al.* 2006). A total of 633 gannets were recorded at a mean rate of 12.4 birds per hour at Blackdog during radar studies undertaken in April 2007. During this period the maximum flock size was of 64 birds but the mean flock size was of three (Simms *et al.* 2007). The majority of sightings were of birds flying between 1 km and 3 km offshore with a peak monthly rate of 2.9 birds per hour between 2.5 km and 3.0 km (Figure 4-55). All those recorded in flight were flying below 30 m.



(Adapted from Walls *et al.* 2006, Simms *et al.* 2007)

Figure 4-54: Distances from shore for gannet from three locations in Aberdeen Bay during surveys undertaken in October (Drums & Hatton) and April (Blackdog).



(Adapted from Walls *et al.* 2006, Simms *et al.* 2007)

Figure 4-55: Number of gannets per hour and distances from shore from three locations in Aberdeen Bay during surveys undertaken in October (Drums & Hatton) and April (Blackdog).

4.17.3 Summary of Results

Gannet occur throughout the year in Aberdeen Bay with peak numbers between June and September and relatively few records between November and April. Gannets were more frequently recorded within the 'control' area and to the north of the Ythan compared to the proposed development area where there was a peak estimated abundance of 45 birds in August compared to 642 birds in September 2010 to the north. Results from the Vantage Point and radar studies suggest that the majority of gannets occur between 2–3 km offshore. Of those recorded in flight 83% of all flights were below 25 m.

Numbers of gannet recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.17.4 Initial Assessment of Significance

Gannet	Overall sensitivity	Magnitude	Significance
Collision	Very High	Low	Moderate
Barrier	Medium	Low	Minor
Displacement	Medium	Negligible	Negligible

4.17.5 Species Sensitivities

Qualify species

There are two SPAs for which gannet is a qualifying species both of which may be within foraging range from the proposed development

- Fair Isle SPA (*c*. 253 km)
- Forth Islands SPA (124.4 km).

Gannet populations at the time of designation or at the time of last review at each of the sites were:

- Fair Isle SPA held 1,166 apparently occupied nest (AoN). Recent counts indicate a an increase to 3,582 AoN (2009).
- Forth Islands SPA held 21,600 pairs. Recent counts indicate an increase of 48,065 AoN (2004).

Flight height

Data obtained from boat-based surveys recorded 404 gannets in flight of which 17% were recorded flying above 25 m.

Elsewhere published data from other offshore wind farms have recorded 14% of gannets flying at rotor height with a mean flight height of 10.25m (n=9,154).

Collision risk

Evidence from site specific monitoring from boat-based and land-based surveys indicate that gannets are widespread across Aberdeen Bay with peak numbers of passing birds between 1 km and 3 km from shore (Figure 4-45 to Figure 4-48). 17% of all sightings of flying birds were of birds flying greater than 25 m above sea surface. Consequently, gannets are at risk of collision with the proposed development.

Collision Risk Modelling undertaken for gannet is based on:

- Body length of 94 cm
- Wingspan of 180 cm
- Flight speed of 15 $m.s^{-1}$

The Collision Risk Modelling is based on a collision probability of 12% and a range of potential avoidance rates from 98%, 99% and 99.5% have been used.

Table 4-17: Predicted number of collisions for various avoidance rates for gannet.

Collision probability	Avoidance rate (%)		
	98	99	99.5
12%	1.66	0.83	0.41

Based on the various scenarios and using a precautionary avoidance rate of 98% it is predicted that a total of 1.6 collisions per year may occur. The current SPA population in the region is 51,647 pairs.

The annual mortality rate for gannet is 8.1% (BTO 2011). Consequently, out of a population of 51,647 pairs (103,294 adults) an annual mortality of 8,367 gannets may be predicted. Therefore, 1% of the baseline mortality is 84 birds per year, i.e. an increase in mortality rate of more than 84 birds per year caused by collisions may be considered significant.

For the two individual SPAs the increase in mortality that could cause an adverse effect is lower:

- Fair Isle SPA has a current population of 3,582 AoN (5,164 adults); therefore an annual mortality rate of 418 adults. 1% of baseline mortality is therefore 4 individuals.

- Forth Islands SPA has a current population of 48,065 AoN (96,130 adults); therefore an annual mortality rate of 7,786 adults. 1% of baseline mortality is therefore 78 individuals.

The results from the collision risk modelling indicate that between 1 and 2 gannets per year may collide with the proposed development. This is lower than either of the baseline mortality rates used to indicate whether the potential impact is will have an adverse effect.

There is no evidence that gannets from Fair Isle occur within the region during the breeding season. Foraging activity will likely remain within the waters around Shetland and therefore it is not predicted that there will be any impact on gannets associated with the Fair Isle SPA during the breeding season.

Tagging data of birds from the Bass Rock colony indicates that they forage widely and are potentially at collision risk with the proposed development (Hamer *et al.* 2000). Based on the collision risk modelling undertaken, should all the potential collisions be of birds arising from the Bass Rock colony in the Forth SPA, 124 km away, then there will be a very small increase in the baseline mortality rate and below the level that may be of concern.

The regional population of gannet include a colony at Troup Head to the north of the proposed development, where a total of 1,810 AoN were counted in 2007 (JNCC 2011a). Therefore, the breeding population is 3,620 individuals and will have an annual mortality of 434 birds. The 1% baseline mortality will therefore be 4 birds per year. Based on the collision risk modelling which predicts an annual collision mortality of between 1 and 2 birds per year it is predicted that even if all the gannets within the EOWDC development area are from Troup Head the potential impact will not be significant and its effects will be negligible.

Evidence from existing wind farms indicates that gannets avoid flying through wind farms and may have a significant far field avoidance rate; this behaviour will further reduce the risk of potential collision.

Barrier effect

The number of gannets reported at operating wind farms is low consequently there is limited evidence of any barrier effect. However, studies undertaken at Danish offshore wind farms indicates that gannets avoid flying through operating wind farms and consequently there may be a barrier effect (Zucco *et al*. 2006).

In order to avoid the turbines gannets may incur additional energetic expenditure. The proposed EOWDC is at its longest point approximately 4 km and at its widest 2 km. Assuming birds avoid the proposed development area at 1,000 m then they may incur an overall increase in flight distance of 3.2 km.

Gannets are extremely efficient fliers and during the breeding season can travel many hundreds of kilometres in single feeding trips up to 364 km from the colony and over 900 km in a single trip (Hamer *et al.* 2007). The additional distance of up to 3.2 km an individual gannet may have to fly in order to detour around the proposed development is therefore negligible. Furthermore, there is no evidence that the area is used as regular flyway or feeding location consequently the significance of any potential impact arising from a barrier effect is also negligible.

Displacement

Although gannets are primarily an aerial species evidence from tracking studies indicate that they may spend up to half their time away from colonies on the sea surface (Lewis *et al*. 2001). Consequently, gannets may be displaced from an area if they avoid entering wind farms.

Data from boat-based surveys undertaken between 2007 and 2008 recorded a peak count of 29 gannets in June at a density of 0.5 birds/km^2 in the proposed EOWDC survey area (SMRU 2011a); this is less than 0.02% of the SPA population. Gannet distribution was generally spread evenly across the bay with higher densities recorded to the north of the proposed development area. There is no evidence from the surveys that the area is used extensively by gannets and should there be total displacement that the displaced gannets will not find other suitable areas. Evidence from tracking studies indicate that gannets can forage across a very wide area and that the potential loss of 4 km^2 of sea surface is very small compared to the total area in which they forage. Consequently, it is concluded that any potential impact due to displacement, should it occur, will be negligible.

Cumulative and in-combination

The theoretical very large foraging range that gannets can fly suggest that any individual gannet may interact with a number of the proposed offshore wind farms in Scottish waters. Published data elsewhere indicates that gannets from colonies in Shetland or eastern England are unlikely to occur in Aberdeen Bay during the breeding season (Langston 2011), although they may occur during periods of passage.

Consequently, there is low potential for cumulative or in-combination effects with respect to gannets from Fair Isle SPA or Bempton Cliffs SPA. However, there is evidence to suggest that the gannets from the Forth Island SPA may occur within the Aberdeen Bay area. Populations from this SPA may also interact with potential offshore wind farm developments currently proposed the Firth of Forth area, namely: Neart na Gaoithe, Inch Cape and Firth of Forth offshore wind farms. There is currently very limited information on the proposed developments as decisions on the location, scale and numbers of turbines are still to be decided. Based on the scoping reports it is currently predicted that there may be an additional 526 turbines within the Firth of Forth area (Table 4-18). Information on the use of these areas by gannets is limited with no published information currently available from on-going studies being undertaken for the proposed wind farms. It is therefore not possible to undertake cumulative/in-combination collision risk assessment based on collision risk modelling or an assessment on possible cumulative displacement or barrier impacts.

Table 4-18: Predicted wind farms that may have an in-combination impact on gannets in the Firth of Forth.

Project	Estimated no. of turbines	Area (km^2)	Predicted Application date
Inch Cape	181	151	2012
Neart Na Gaoithe	130	105	2012
Firth of Forth (phase I)	215	597	2013

There is a magnitude difference in scale between the proposed development and those planned in the Firth of Forth area and it is a significantly greater distance from the Forth SPA. Any potential incremental increase arising from the proposed development will likely be minor by comparison and therefore not have a significant cumulative or in-combination impact.

Collision Risk Modelling undertaken for Beatrice offshore wind farm predicted a total of five gannets per year may collide with the Beatrice demonstrator project development based on a 98% avoidance rate (Talisman 2005). The additional mortality from the proposed development may increase this by one or two birds per year. Based on a population of 3,620 adults at Troup Head the potential increase in mortality will be above the 1% of baseline mortality. This increase in mortality is considered to be of moderate significance but does not take into account the reported far field avoidance rates.

There are two planned offshore wind farms within the Moray Firth that could potentially have a cumulative impact on the gannets at Troup head (Table 4-19). There is little information on the number or scale of turbines and there is no published information currently available from on-going studies being undertaken for the proposed wind farms. It is therefore not possible to undertake cumulative collision risk assessment based on collision risk modelling or an assessment on possible cumulative displacement or barrier impacts. The scale of the proposed development is significantly smaller than those proposed in the Moray Firth and consequently based on the current information on gannet distribution the scale of potential impact significantly lower.

Table 4-19: Predicted wind farms that may have a cumulative impact on gannets in the Moray Firth.

Project	Estimated no. of turbines	Area (km^2)	Predicted Application date
Moray Firth (phase 1)	200	296	2012
Beatrice	184	131	2012

4.17.6 Conclusions

Habitats Appraisal

Based on the available evidence from site specific surveys undertaken at the proposed development area, tagging studies undertaken at the relevant SPA and collision risk modelling it is concluded that the proposed development will not have an adverse effect on gannets as qualifying species for Fair Isle SPA or Forth Islands SPA. There is the potential for a cumulative impact but there are no data available to undertake such an assessment. However, the distance and scale of the proposed development from other projects is such that any in-combination impact will likely be relatively small and of minor or negligible significance.

Environmental Impact Assessment

Based on the site specific data and the known behaviour of gannets it is predicted that there will not be a significant environmental impact arising from the proposed development on gannets. However, there is the potential for a moderate cumulative impact with gannets associated with the Troup Head gannet colony and the existing Beatrice demonstrator project.

4.18 Manx shearwater (*Puffinus puffinus*)

4.18.1 Protection & Conservation Status

The Manx shearwater is listed in Appendix II of the Bern Convention, and is on the Amber List of Species of Conservation Concern.

4.18.2 Background

Manx shearwater		
GB Population	277,803 - 312,263 prs	Mitchell *et al* 2004
International threshold	Unknown	-
GB threshold	5,400 ind.	1% of GB Pop[n]
Designated east coast sites where species is a noted feature	None	JNCC
European population estimate	Breeding 350,000 – 390,000 Wintering – unknown	Birdlife 2004
European population trend	Status 'localised' Trend 'unknown'	Birdlife 2004
World population	340,000 – 410,000 ind.	JNCC 2011

Most of the world population of Manx shearwaters breed in Britain and Ireland. The world population is estimated to be between 338,000 and 411,000 pairs of which up to 374,000 pairs nest in Britain and Ireland (Mitchell *et al.* 2004).

There are no breeding colonies in the North Sea but outwith the breeding season Manx shearwaters disperse widely and migrate south to winter in waters off South America (Wernham *et al*. 2002).

In North-east Scotland Manx shearwaters occur in relatively low numbers from late spring through to the autumn. Studies undertaken off Peterhead identified a passage of Manx shearwaters from April through to November with peak numbers passing in June and July with up to ten birds per hour. The number of birds passing varies considerably with the majority of sightings occurring in periods of rain or sea mist and fewer records during periods of bright fine whether (Innes 1992).

Boat-based surveys

A total of 40 Manx shearwaters were recorded from all boat-based surveys between May and November with sightings scattered across Aberdeen Bay (Figure 4-56). Ninety percent of all records were of birds in flight with the majority heading north (IECS 2008).

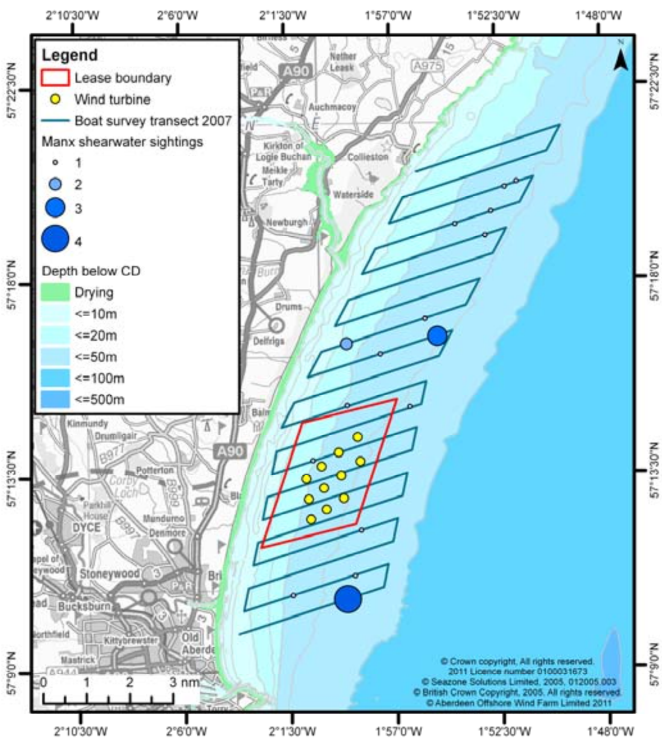


Figure 4-56. Shearwater distribution in Aberdeen Bay February 2007 to April 2008 (all sightings).

Vantage Point surveys

Manx shearwaters were observed in Aberdeen Bay from vantage point surveys between April and November with a peak of up to five birds per hour during June 2006 and one bird per hour during August 2005. Only one bird seen in October (EnviroCentre 2007a,b; Alba Ecology 2008a,b).

Bird Detection Radar

There were five sightings of Manx shearwaters during the seventeen days of observations undertaken in April 2007 (Simms *et al.* 2007).

4.18.3 Summary of Results

Manx shearwaters were recorded in low numbers from between April and November with a peak in June. Of those recorded in flight from boat based surveys all flights were below 30 m and most sightings were of birds approximately 1 km from shore.

Numbers of Manx shearwater recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.18.4 Initial Assessment of Significance

Manx shearwater	Overall sensitivity	Magnitude	Significance
Collision	High	Negligible	Negligible
Barrier	Low	Negligible	Negligible
Displacement	Low	Negligible	Negligible

4.18.5 Species Sensitivities

Qualifying species

There are no SPAs in the North Sea for which Manx shearwater is a qualifying species. Of the four UK SPAs for which Manx shearwater is a qualifying species, two are in Wales and the other two are off western Scotland.

Flight height

Of those recorded in flight and for which flight heights were recorded all Manx shearwaters were flying below 15 m.

Elsewhere data from other offshore wind farms have recorded all Manx shearwater as flying below turbine height. Data from Walney offshore wind farm reported 5,999 sightings of which 99% were flying below 5 m (Dong 2006).

Collision risk

Evidence from site specific monitoring and elsewhere indicate that Manx shearwaters rarely fly at turbine height and therefore are not at risk of collision.

Barrier effect

The number of Manx shearwaters reported at operating wind farms is very low consequently there is little or no evidence of any barrier effect.

Should a barrier effect occur then the Manx shearwaters will fly around the proposed development. This would incur an overall increase in flying distance of approximately 3.2 km. Manx shearwaters are a highly pelagic species spending a significant proportion of their time in flight and travelling vast distances. The additional energetic cost that may be incurred if a barrier effect occurs will be negligible and not have any significant impact on Manx shearwaters.

Displacement

Relatively few Manx shearwaters were recorded from either the boat-based or the land-based surveys. Of those recorded over 90% were of birds in flight, indicating that Aberdeen Bay is not used as an area for birds to settle on the sea surface.

There are currently no constructed wind farms anywhere in the world where Manx shearwater regularly occur from which conclusions can be drawn to assess whether or not there may be a displacement effect. However, the relatively low usage of Aberdeen Bay by Manx shearwaters and the observation that over 90% of Manx shearwaters recorded were only in flight indicates that there will not be a significant impact should displacement occur and the significance of any potential impact will be negligible.

Cumulative and in-combination

The very low level of usage of the site by Manx shearwater indicates that there will not be any cumulative or in-combination impacts.

4.18.6 Conclusions

Habitats Appraisal

There are no SPAs for which Manx shearwater is a qualifying species that will be adversely affected by the proposed development.

Environmental Impact Assessment

Based on the relatively low numbers of Manx shearwaters recorded and their known behaviour it is predicted that there will not be a significant environmental impact arising from the proposed development on Manx shearwaters.

4.19 Great cormorant (*Phalacrocorax carbo*)

4.19.1 Protection & Conservation Status

The (great) cormorant is listed in Annex III of the Bern Convention and is on the Green List of Species of Conservation Concern.

4.19.2 Background

Cormorant		
GB population	Breeding: 8,400 prs Winter: 23,000 ind.	BTO 2011
Scottish population	Breeding: 3,600 AoN Winter: 9,000 – 11,000 ind.	Forrester *et al.* 2007
International threshold	1,200 ind.	Calbrade *et al.* 2010
GB threshold	230 ind	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Forth Islands: 198 prs Firth of Forth: wintering assemblage Firth of Tay & Eden Estuary: wintering assemblage	SNH 2011 JNCC 2011a
European population estimate	Breeding: 310 – 370,000 prs Wintering: unknown	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	1,4 – 2,900,000 ind.	Birdlife 2011

Cormorants occur widely across the UK breeding and wintering on both freshwater bodies inland and also at coastal locations. Breeding occurs in colonies from April through to September when coastal breeding birds remain largely within nearshore waters. Following breeding, there is some dispersal away from the breeding areas with many birds moving south during the winter. The population of cormorant has increased across the whole of the UK but has decreased in certain localised areas. In North-east Scotland the number of breeding cormorants has recently increased with new colonies being formed to the north of Aberdeen Bay.

Results from ten years of observations undertaken at Peterhead indicate strong seasonal differences with peak numbers of cormorant occurring during the autumn and winter and relatively low numbers between May and August. Peak counts of up to 20 birds per hour were recorded in October with the majority of sightings shortly after dawn. Nearly all observations were within 500 metres of the coast (Innes 1991). Elsewhere cormorants occur widely along the coast with up 150 birds being recorded on the Ythan Estuary (NESBR).

Boat-based surveys

Cormorants were recorded in low numbers from boat-based surveys throughout the year. With the exception of one record of 25 birds nearly all sightings were of birds in nearshore waters and in water depths of less than 20 m. Concentrations were recorded in the shallow waters from the Ythan Estuary to Collieston (Figure 4-57) (IECS 2008). Peak numbers of cormorant were recorded during September and October with a population estimate of up to 20 birds in the 'control' area and 17 birds within the survey area for the proposed EOWDC during October (Figure 4-59). Data collected between August 2010 and January 2011 recorded low numbers of cormorants during August with a total of 8 birds seen throughout the surveyed area and peak numbers of cormorants during September when a total of 32 were recorded (Figure 4-58) (SMRU 2011b).

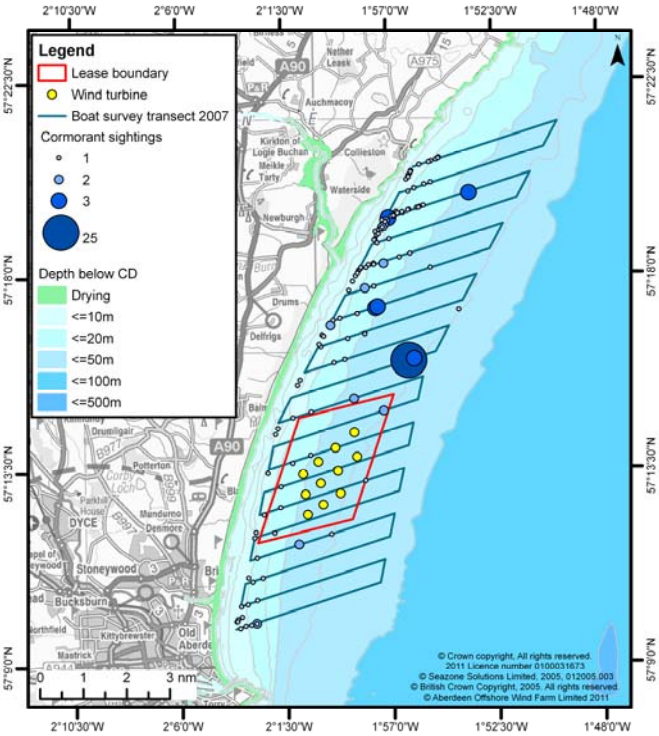


Figure 4-57: Cormorant distribution February 2007 to January 2008 (all sightings).

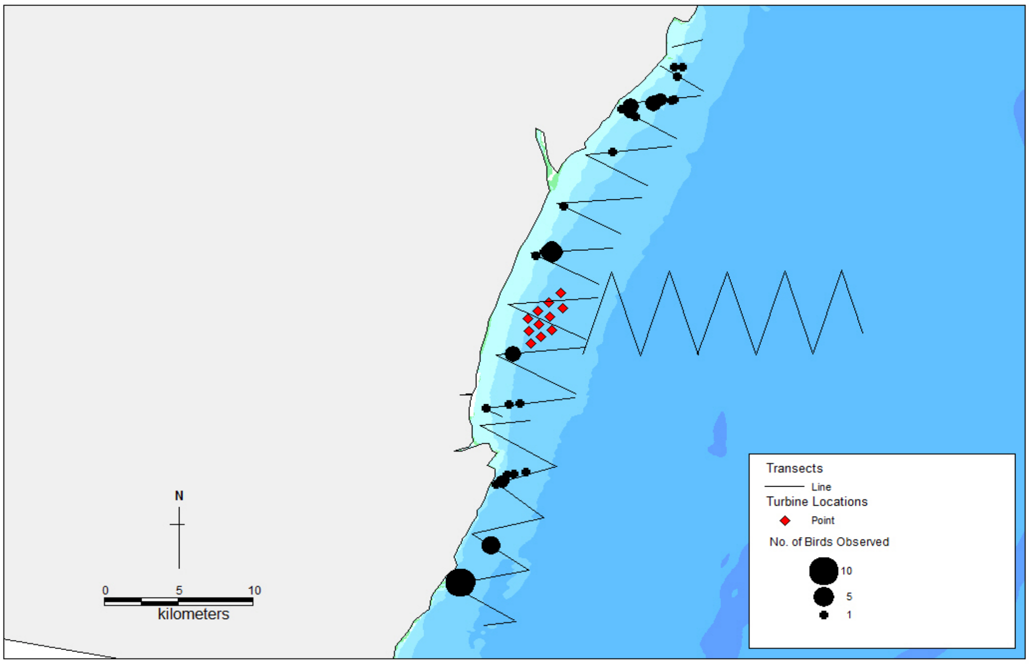


Figure 4-58: On-effort observations of all cormorant species (great cormorant and shag) along transects during August, September and November 2010 and January 2011.

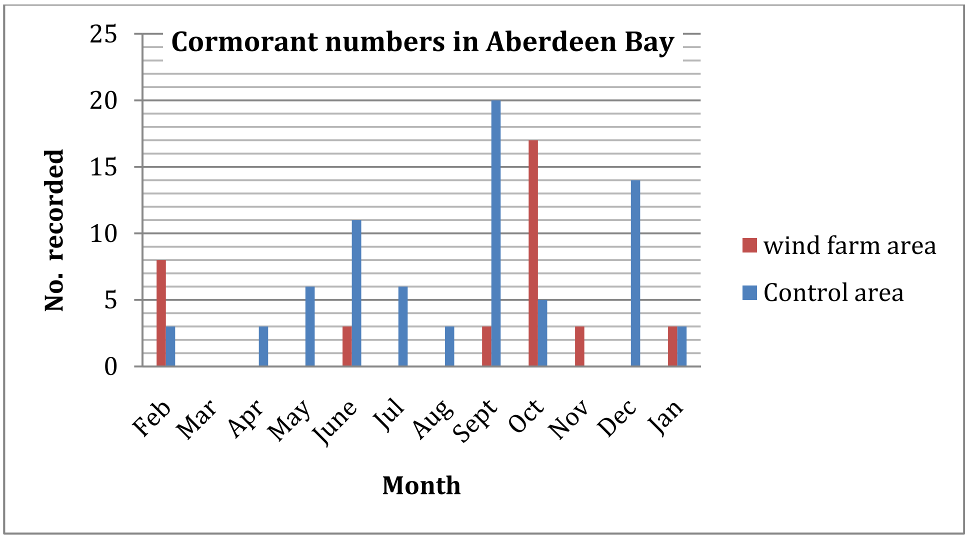


Figure 4-59: Cormorant monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

There were not enough records to undertake *Distance* sampling on a monthly basis. However, *Distance* sampling was possible on seasonal data. Peak overall estimated abundances were during the spring and autumn periods with the majority of sightings within the 'control' area. Throughout the year, the numbers of cormorant estimated to be in the 'control' area were higher than within the proposed EOWDC area (Table 4-20, Figure 4-60, Figure 4-61).

Table 4-20: Seasonal estimates of density and abundance of cormorants in the proposed EOWDC and 'control' Areas

	Density Estimate (km^2)	SE	Estimated Abundance	SE	No. Observations
EOWDC- Winter	0.177	0.075	9	3.8	6
Control- Winter	0.268	0.134	14	6.8	9
EOWDC- Spring	0.000	0.000	0	0.0	0
Control- Spring	0.616	0.221	31	11.2	24
EOWDC- Summer	0.039	0.040	2	2.0	1
Control- Summer	0.358	0.223	18	11.3	9
EOWDC- Autumn	0.348	0.180	18	9.1	6
Control- Autumn	0.472	0.200	24	10.1	10

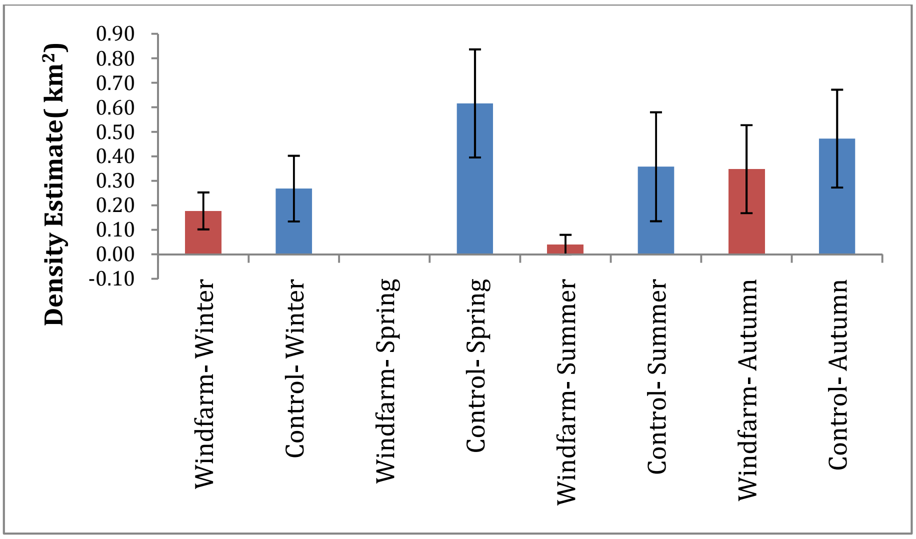


Figure 4-60: Seasonal estimates (+/- SE) of density of cormorants in the proposed EOWDC and 'control' Areas.

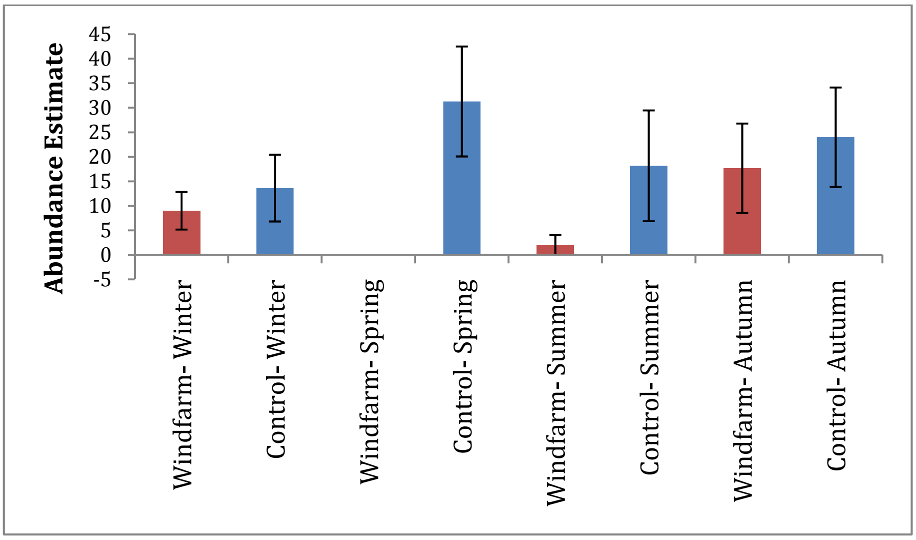


Figure 4-61: Seasonal estimates (+/- SE) of abundance of cormorants in the proposed EOWDC and 'control' Areas.

Vantage Point surveys

Cormorants were present during peak dawn and dusk activity periods in Aberdeen Bay throughout the year with peak numbers between June and September. Up to 15 birds per hour passed during peak periods. During the winter months the number of cormorants within Aberdeen Bay was lower with less than five birds per hour passing any one Vantage Point (EnviroCentre 2007b). Of those recorded in flight, 8% of cormorants were flying between 30 m and 150 m above sea surface with 0.5 birds per hour doing so during the winter months and up to one per hour during summer months (EnviroCentre 2007b). The majority of sightings were within 2 km of the coast (Alba Ecology 2008b).

Bird Detection Radar

A total of 96 cormorants were recorded during Bird Detection Radar studies undertaken during October 2005. The number of observations made between the two sites from which the surveys were undertaken was similar, with 47 cormorants recorded at Drums and 49 at Easter Hatton (Walls *et al*. 2006). Forty-three cormorants were recorded off Blackdog over a seventeen day period in April 2007. Most sightings were of single birds but a flock of three was recorded (Simms *et al.* 2007).

4.19.3 Summary of Results

Cormorants were regularly recorded in Aberdeen Bay throughout the year. Peak numbers occurred in the spring and autumn with most sightings within the 'control' area. Peak abundance of 31 birds and a density of 0.61 birds/km^2 occurred in the 'control' area during the spring. The majority of sightings were within 2 km of the coast and of those recorded in flight, 92% of all flights were below 30 m.

Numbers of cormorant recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.19.4 Initial Assessment of Significance

Cormorant	Overall sensitivity	Magnitude	Significance
Collision	Very High	Negligible	Minor
Barrier	Medium	Low	Minor
Displacement	Very High	Low	Moderate

4.19.5 Species Sensitivities

Qualifying species

The nearest SPA to the proposed development for which cormorant is a qualifying breeding species is the Forth Islands SPA. The cormorant is also a qualifying species for the Firth of Forth SPA and Firth of Tay & Eden Estuary SPA for which the species is listed under Article 4.2 as part of wintering waterfowl assemblage (SNH 2011).

Flight height

Of those recorded in flight from boat-based surveys and for which flight heights were recorded all were flying below 25 m and 7% were flying between 15 m and 25 m. Data obtained from Vantage Point counts indicated that 8% were flying between 30 m and 150 m.

Data from other offshore wind farms have recorded overall 4% of cormorant as flying at rotor height with a mean flight height of 8.6 m (n=20,416).

Collision risk

Evidence from site specific monitoring from boat-based and land-based surveys indicate that cormorants are widespread in nearshore waters across Aberdeen Bay (Figure 4-57, Figure 4-58). There were no records of cormorants flying at rotor height from boat-based surveys and therefore a figure of 4% based on data from other offshore developments has been used for the Collision Risk Modelling.

Collision with offshore wind turbines have been reported (Zucco *et al.* 2006)

Collision Risk Modelling undertaken for cormorant is based on:

- Body length of 84 cm

- Wingspan of 160 cm
- Flight speed of 19.4 m.s^{-1}

(Koffijberg & Mennobart 1995; Gremillet, Schmid & Culik 1995)

Table 4-21: Predicted number of collisions for various avoidance rates for cormorant.

Collision probability	Avoidance rate (%)		
	98	99	99.5
8.9%	1.23	0.62	0.31

Based on the various scenarios and using a precautionary avoidance rate of 98% it is predicted that a total of 1.23 collisions per year may occur (Table 4-21).

The annual mortality rate for cormorant is 12% (BTO 2011). Consequently, out of a population of 198 pairs (396 individuals) at the Forth Islands SPA an annual mortality of 47 cormorants may be predicted. Therefore, 1% of the baseline mortality is 0.5 birds per year.

However, the Forth Islands SPA is 124 km away and the maximum reported foraging distance for breeding cormorants is 35 km (Roos 2010). Therefore, the proposed development is outwith the range of potential adverse effect on the breeding cormorants at the Forth Islands SPA.

Cormorants associated with the non-breeding wintering assemblages at the Firth of Forth and Firth of Tay & Eden Estuary SPA will remain within or in the vicinity of those sites during the non-breeding seasons. Both sites are in excess of 90 km away from the proposed development and therefore not at risk of an adverse effect from the proposed development.

Within North-east Scotland cormorants breed to the north of the proposed development with colonies on the Forvie National Nature reserve (NNR), Boddam area and Loch of Strathbeg. The majority of birds recorded from boat-based and land-based surveys were recorded in the ‘control’ area to the north and therefore are likely to be birds associated with these colonies. Based on an estimated breeding population of 150 pairs (300 individuals) an increase in mortality of 0.3 birds per year could be significant.

Results from collision risk modelling indicate that should all the cormorants at risk of collision be from colonies to the north of the proposed development, in order for less than 0.3 birds per year to collide with the turbines an avoidance rate of more than 99.5% is required. This is significantly lower than the precautionary 98% avoidance rate predicted.

Evidence from existing wind farms indicate that cormorants take avoidance behaviour and that up to 43% will do so before being at risk of collision. Furthermore studies undertaken at Ronland Offshore wind farm in Denmark recorded only one observation of cormorant at risk of collision after 560 hours of observations (Jensen 2006). Data from Sweden also indicates a significant reduction in the number of cormorants flying through the wind farm site once in operation compared to pre-construction (Zucco *et al.* 2006).

Based on the site specific evidence and the results from collision risk modelling it is concluded that risk of a significant environmental impact is minor and any possible adverse affect negligible.

Barrier effect

Although cormorants are regularly recorded within operating wind farms there is also evidence of a barrier effect with birds detouring around turbines (Petersen *et al*. 2006).

Should a barrier effect occur then cormorants will fly around the proposed development. By doing so this could cause an overall increase in flying distance of up to approximately 3.2 km. For a bird foraging at the maximum recorded foraging range from a colony of 35 km this additional distance would equate to an additional 10% of flight distance and add between 1% and 2% to the daily energy expenditure (Speakman, Gray & Furness 2009).

Foraging ranges of up to 35 km have been reported as unusual with only 5% of flights being of that distance and typical foraging range being of 5 km or less (Roos 2010). The additional 1 – 2% of daily energy expenditure that could be incurred by avoiding the proposed development area will not on an *ad hoc* basis have a significant effect and as foraging flights of that distance are unusual and not predicted to take place on a daily basis there will not be any detrimental cumulative impact caused by regular flights around the proposed development. Based on the evidence from existing offshore wind farms and site specific data it is concluded that the potential barrier effect will have a minor impact of cormorants

Displacement

Although cormorants may fly around wind farms they have also been regularly recorded within constructed offshore wind farms where they use the turbine structures for perches and have been recorded feeding within arrays of wind turbines (Petersen 2004). Consequently, although there may be an effect to flying birds cormorants do occur within wind farms and there is not total displacement and it is not predicted that there will be a significant effect arising from the proposed development on cormorants from displacement effects.

Cumulative and in-combination

The three closest SPAs for which cormorant is a qualifying species are all over 90 km away. The proposed offshore wind farms within the Firth of Forth area or the Moray Firth are all in waters largely in excess of 20 m water depth and therefore in areas where cormorants are unlikely to regularly occur. For example, only two cormorants were recorded over a year of surveys at the Beatrice Offshore wind farm demonstrator project (Talisman 2005). There is therefore no evidence of a likely adverse or significant effect on cormorants from either the proposed development on its own or in combination with other plans or programmes.

4.19.6 Conclusions

Habitats Appraisal

There are no SPAs for which cormorant is a qualifying species that will be adversely affected by the proposed development.

Environmental Impact Assessment

Based on the site specific data and data from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on cormorants.

4.20 European shag (*Phalacrocorax aristotelis*)

4.20.1 Protection & Conservation Status

The (European) shag is included in annex I of the Wild Birds Directive and Annex II of the Bern Convention. It is included on the Amber List of Species of Conservation Concern.

4.20.2 Background

Shag		
GB Population	Summer: 27,000 prs	BTO 2011
Scottish population	Summer: 21,500 – 30,000 prs Winter: 60,000 – 80,000 ind.	Forrester *et al.* 2007
International threshold	2,000 ind	Calbrade *et al.* 2010
GB threshold	540 ind	1% of GB population
Designated east coast sites where species is a noted feature	Buchan Ness – Collieston Coast: 331 prs Forth Islands: 480 prs	SNH 2011 JNCC 2011a
European population estimate	Breeding 75,000 – 81,000 pairs Wintering – >92,000	Birdlife 2004
European population trend	Status 'secure' Trend 'moderate decline'	Birdlife 2004
World population	230 – 240,000 'adults'	Birdlife 2011

The (European) shag occurs widely along rocky coastal areas of the UK where they breed in loose colonies along suitable rocky shores and forage typically within approximately 4 km of the shore. Outwith the breeding season, shags disperse locally up to 100 km away from their breeding colonies and are not strongly migratory. They remain within nearshore coastal waters often around rocky coasts or in large shallow sandy bays feeding, primarily, on a variety of fish species. The breeding population in the UK has increased substantially during the 20th century from 34,000 pairs in 1969/1970 to 43,000 pairs in 1985-1988.

In North-east Scotland, shags occur widely along all coasts and regular daily movements to and from roosting sites have been recorded at Peterhead. Peak counts at Peterhead occurred from October through to March where up to 1,200 birds per hour have been recorded flying north at dawn and counts of 3,000 to 4,000 birds have been recorded (Buckland, Bell & Picozzi 1990). During the breeding season the numbers of birds at Peterhead were considerably lower with less than 200 birds per hour passing (Innes 1991).

Boat-based surveys

Only fourteen shags were recorded 'in transect' during boat-based surveys with all but one within approximately 2 km of the coast and in water depths of less than 20 m Further records of birds detected but not in transect are included in Figure 4-62 and indicate that occasional records may occur further offshore.

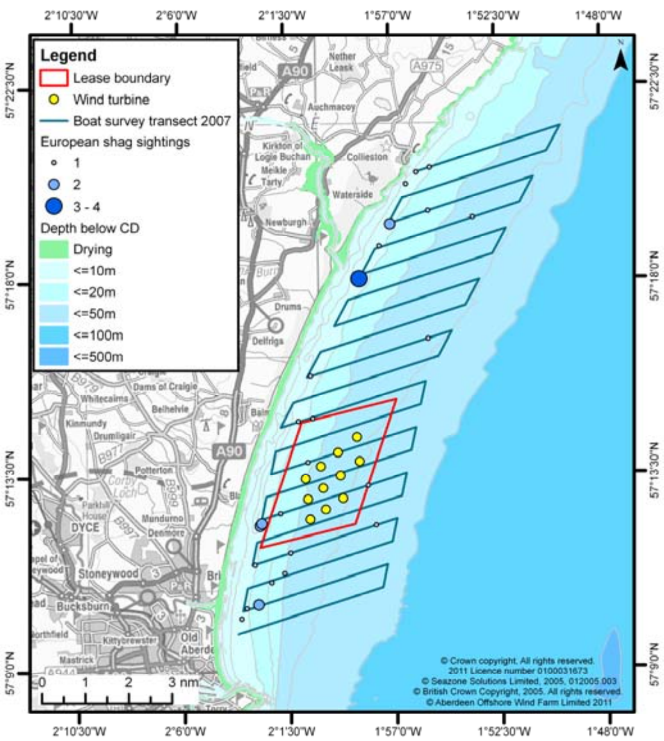


Figure 4-62: Shag distribution in Aberdeen Bay - February 2007 to April 2008 (all sightings).

Vantage Point surveys

In Aberdeen Bay shags were recorded in low numbers throughout the area. Peak numbers occurred in April with three birds per hour during April 2006 and eight birds per hour in April 2007 (EnviroCenrtre 2007a, Alba Ecology 2008a). Numbers decreased to less than one bird per hour during the winter months (EnviroCentre 2007b, Alba Ecology 2008b). Most shags were recorded between 1 km and 3 km from shore and at least 93% were flying below 30 m (EnviroCentre 2007a).

Bird Detection Radar

One shag was recorded at Easter Hatton during the five days of observations undertaken at both Drums and Easter Hatton in October 2005 (Walls *et al.* 2005). A further 14 birds were recorded during the 17 days of surveys undertaken in April 2007 (Simms *et al.* 2007).

4.20.3 Summary of Results

Although shags were recorded regularly in Aberdeen Bay throughout the year numbers were generally low. Peak numbers occurred in the spring and autumn with most sightings within 2 km from the shore. Of those recorded in flight, 93% of all flights were below 30 m.

Numbers of shag recorded in Aberdeen Bay were below the threshold for a site of national importance.

4.20.4 Initial Assessment of Significance

Shag	Overall sensitivity	Magnitude	Significance

Collision	Very High	Negligible	Minor
Barrier	Medium	Low	Minor
Displacement	Very High	Low	Moderate

4.20.5 Species Sensitivities

Qualifying species

The shag is a qualifying species for Buchan Ness to Collieston Coast SPA which lies approximately 9.5 km to the north of the proposed development and also the Forth Islands SPA which lies approximately 124 km to the south of the proposed development. (SNH 2011).

Flight height

Of those recorded in flight from boat-based surveys and for which flight heights were recorded all were flying below 15 m.

Data from other offshore wind farms have recorded 12% of shags as flying at rotor height (n=230).

Collision risk

Evidence from site specific monitoring from boat-based and land-based surveys indicate that shags are uncommon within the area of the proposed development. All sightings from boat-based surveys were of birds flying below rotor height and therefore not at risk from collision with the turbines. Further evidence from other offshore wind farms further indicates that shags flying at rotor height are unusual (ERM 2005).

Based on the relatively low numbers of shags recorded within the area of the proposed development and evidence indicating that shags rarely fly at rotor height it is predicted that very few collisions will occur and any impacts will be negligible and not cause an adverse effects on shag as qualifying species for either the Buchan Ness to Collieston Coast SPA and Forth Islands SPA.

Barrier effect

There is little or no evidence from existing offshore wind farms to determine whether or not a barrier effect may occur. However, should it do so then shags will fly around the proposed development. By doing so this could cause an overall increase in flying distance of up to approximately 3.2 km. For a bird foraging at the maximum recorded foraging range from a colony of 17 km (Roos 2010) this additional distance would equate to an additional 18% of flight distance and add between 1% and 2% to the daily energy expenditure (Speakman, Gray & Furness 2009).

Foraging ranges of up to 17 km are unusual and mean foraging ranges are less than 7 km from the colony consequently the majority of foraging being undertaken by shags associated with the SPA will be out with the proposed development area and there will not be a barrier effect. The additional 1 to 2% of daily energy expenditure that may be incurred on the occasions that shags do forage further and maybe avoid the proposed EOWDC area will not on an *ad hoc* basis have a significant effect and as foraging flights of that distance are unusual and not predicted to take place on a daily basis there will not be any detrimental cumulative impact caused by regular flights around the proposed development. Based on the evidence from existing offshore wind farms and site specific data it is concluded that the potential barrier effect will have a negligible impact on shags.

Displacement

There is limited data from existing offshore wind farms that shags occur within operating wind farms (Christensen & Hounisen 2005). However, should displacement occur then an area of approximately 4 km^2 may not be utilised by shags. Data from boat-based surveys indicate that shags are relatively uncommon within the vicinity of the proposed development and that the area is not an important location for shags. Even if displacement does occur the number of birds potentially displaced will be small and that their displacement into other areas will not have a detrimental effect. Based on the evidence from site specific surveys it is predicted that there will not be any significant environmental or adverse effects on shags from displacement impacts.

Cumulative and in-combination

Of the two SPAs for which shag is a qualifying species: the Forth Islands SPA is 124 km away and will not be impacted by the proposed development and the Buchan Ness to Collieston Coast SPA is 9.5 km away. No adverse effects are predicted upon either of these sites from the proposed development on its own. The proposed offshore wind farms within the Firth of Forth area and the Moray Firth are in deeper waters but may still be in areas where shags can forage. No data are available as to whether shags are being recorded at any of the planned wind farm locations. However, the distance from shore for all the planned Round 3 and Scottish Territorial Water wind farms locations indicate that they are unlikely to be frequently used as areas of importance for shags. The Beatrice demonstrator project recorded just 63 shags over a 12 month period indicating that the area is not extensively used by this species (Talisman 2005).

There is therefore no evidence of a likely adverse or significant effect on shags from either the proposed development on its own or in combination with other plans or programmes.

4.20.6 Conclusions

Habitats Appraisal

There are no SPAs for which the shag is a qualifying species that will be adversely effected by the proposed development.

Environmental Impact Assessment

Based on the site specific data and data from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on shags.

4.21 Great crested grebe (*podiceps cristatus*)

4.21.1 Protection & Conservation Status

The great crested grebe is listed in Annex I of the Birds Directive, Appendix II of the Bern Convention, Appendix II of the Bonn Convention, Schedule 1 under the Wildlife and Countryside Act, 1981 and is on the Green List of Species of Conservation Concern.

4.21.2 Background

The great-crested grebe is a widespread breeding species in the UK with an estimated breeding population of 8,000 pairs. They breed on freshwater habitats but can winter on along estuaries with an estimated 1,800 out of the UK wintering population of 16,000 doing so.

The main wintering area along the east coast of Scotland is the Firth of Forth where a mean peak of 156 great-crested grebe has been recorded over the last five years (Calbrade *et al*. 2010). In North-east Scotland great-crested grebes are an uncommon breeding and wintering species.

Great crested grebe		
GB population	Summer: 8,000 prs Winter: 16,000 ind.	BTO 2011
Scottish population	Summer: 240 – 365 prs Winter: 900 – 1,500 ind.	Forrester *et al*. 2007
International threshold	3,600 ind.	Calbrade *et al.* 2010
GB threshold	159 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Firth of Forth	SNH 2011 JNCC 2011a
European population estimate	Breeding 300, – 450,000 prs Wintering >240,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'moderate decline'	Birdlife 2004
World population	920,000 – 1,400,000 'adults'	Birdlife 2011

Vantage Point surveys

There was one record of a great-crested grebe from the Vantage Point surveys in October 2007 (Alba Ecology 2008b).

4.21.3 Initial Assessment of Significance

Great-crested grebe	Overall sensitivity	Magnitude	Significance
Collision	Medium	Negligible	Negligible
Barrier	High	Negligible	Negligible
Displacement	Very High	Negligible	Minor

4.21.4 Species Sensitivities

Qualify species

The nearest SPA for which great-crested grebe is a qualifying species is the Firth of Forth SPA, *c*134 km to the south of the proposed development. Great-crested grebe qualifies under Article 4.2 as part of a wintering waterfowl assemblage and the population at the time of citation was 720 individuals, 7% of GB population (SNH 2011).

Status

Great-crested grebes are rarely recorded within Aberdeen Bay and there was only one sighting from any of the project specific surveys. Records from other sources support the finding that great-crested grebes are infrequent in the bay (NESBR).

Cumulative

The very low level of usage of the site indicates that there will not be any cumulative or in-combination impact.

4.21.5 Conclusions

Habitats Appraisal

Based on the available evidence from site specific surveys undertaken at the proposed development area, in particular the very low usage of the site by great-crested grebes and the distance the site is from the Firth of Forth SPA, it is concluded that the proposed development will not have an adverse effect on great-crested grebe as qualifying species.

Environmental Impact Assessment

Based on the very low usage of the site it is predicted that there will not be a significant environment impact arising from the proposed development on great-crested grebe.

4.22 Great skua (*Stercorarius skua*)

4.22.1 Protection & Conservation Status

The great skua is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.22.2 Background

Great skua		
GB population	Breeding: 9,650 prs	Mitchell *et al* 2004
Scottish population	Breeding: 9,650 prs	Forrester *et al.* 2007
International threshold	Unknown	-
GB threshold	192 ind.	1% of GB Pop^{n}
Designated east coast sites where species is a noted feature	None	SNH 2011 JNCC 2011a
European population estimate	Breeding 16,000 pairs Wintering – unknown	Birdlife 2004
European population trend	Status 'secure' Trend 'Large increase'	Birdlife 2004
World population	16,000 pairs	Mitchell *et al* 2004

Approximately 60% of the world population of great skua nest in the UK, all of which nest in north and north-west Scotland. They are summer migrants to the UK arriving at their breeding colonies in April and May and departing primarily during August and September. During the breeding season non-breeding immature birds may also be present at the colonies. Following breeding, birds disperse into the North Sea and Atlantic and migrate southwards to their wintering grounds in the Bay of Biscay and West Africa. Autumn passage of great skuas is estimated to be between 2,000 to 10,000 birds when they remain largely offshore occurring in relatively low densities across the North Sea (Forrester *et al.* 2007).

During the breeding season they feed on fish, often following fishing vessels or by kleptoparasitising fish from other seabirds but they will also kill smaller seabirds.

In North-east Scotland great skuas occur between April and November with peak numbers in July and August with up 10 birds per hour past Peterhead (Innes 1993).

Boat-based surveys

Great skua were recorded from July to September with 27 sightings from the whole survey area. Sightings were recorded throughout the bay with no areas of significant concentrations recorded and very records were from within the proposed EOWDC development area (Figure 4-63).

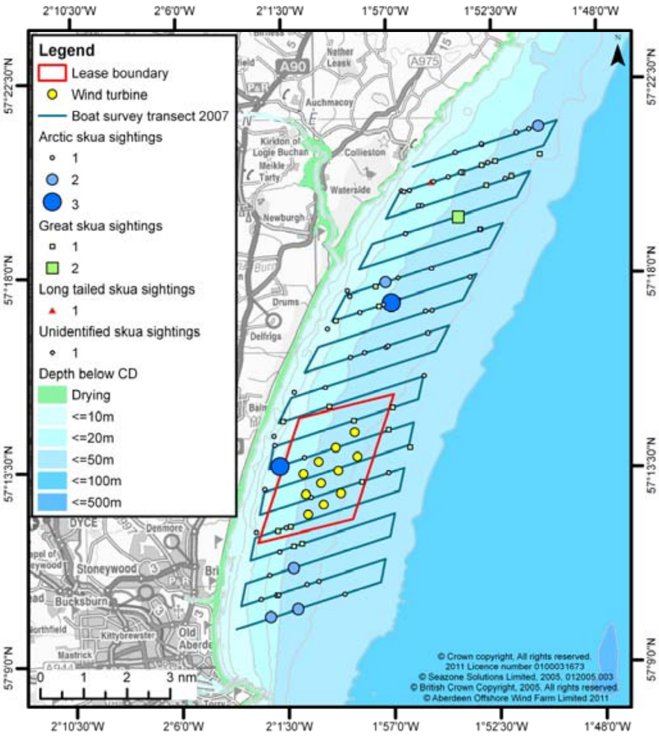


Figure 4-63: Skua distribution February 2007 to April 2008 (all sightings).

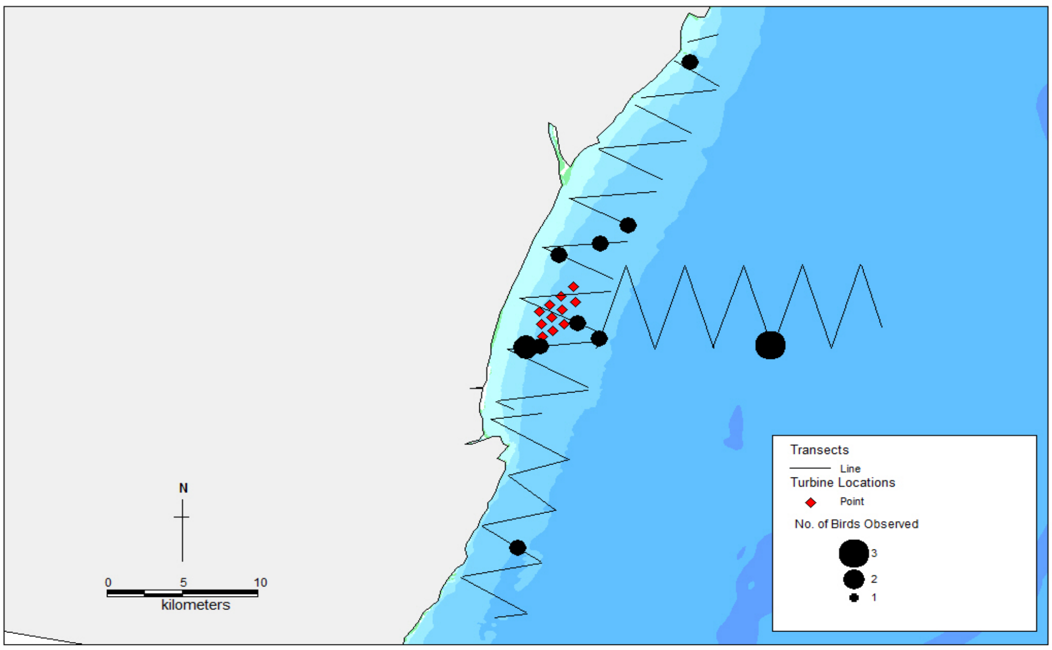


Figure 4-64: On-effort observations of all Skua species (great, Arctic and pomarine) along transects during August, September and November 2010 and January 2011.

Vantage Point surveys

Great skuas were recorded in relatively low numbers from Vantage Point counts from April and October with peak counts during August and September when up to three birds per hour were recorded. Most observations of birds were between 1–3 km from shore and between 84% and 87% were flying below 30 m.

Bird Detection Radar

Ten great skuas were recorded during the radar studies in October 2005 and seven during April 2007. All but one of the sightings was of single birds (Walls *et al* 2005, Simms *et al.* 2007).

4.22.3 Summary of Results

Great skuas were widely recorded across Aberdeen Bay in relatively low numbers from all surveys from between April and October. Peak counts were during the period of autumn migration when up to three birds per hour were recorded in August and September. There were also a smaller number of sightings during the spring migration with most records from April.

Of those recorded in flight, during boat-based surveys, 25% were recorded flying above 25 m and between 13% and 16% were recorded above 30 m from land-based surveys.

No counts of great skua from any of the surveys undertaken within Aberdeen Bay were of national importance.

4.22.4 Initial Assessment of Significance

Great skua	Overall sensitivity	Magnitude	Significance
Collision	High	Negligible	Negligible
Barrier	Low	Low	Negligible
Displacement	Low	Negligible	Negligible

4.22.5 Species Sensitivities

Qualifying species

There are no SPAs in the region for which the great skua is a qualifying species but over 73% of the UK breeding population of great skuas do occur in SPAs in northern Scotland.

Flight height

Observations from boat-based surveys undertaken in Aberdeen Bay reported two out of the eight great skuas for which flight heights were recorded as being above 25 m, i.e. 25% of flights were at rotor height..

Elsewhere in the UK out of 239 recorded flight heights of great skua obtained from boat-based surveys, 4% were recorded as being at rotor height.

Collision risk

Data obtained from boat-based and land-based surveys recorded great skuas across Aberdeen Bay in relatively low numbers particularly during the autumn passage periods. There is relatively little data from other constructed offshore wind farms to determine possible avoidance rates but these are assumed to be relatively high and 96% of flights are below rotor height.

Based on the relatively low usage of the site, the broad distribution of great skua across Aberdeen Bay and the high percentage of birds recorded as flying below rotor height it is concluded that there is a low risk of collision and that should it occur its significance on the species will be negligible.

Barrier effect

There are no data from any constructed wind farms to determine whether or not a barrier effect may occur. Should it do so, there will be an incremental increase in energy expenditure as the bird flies around the wind turbines. However, the increase in flight distance caused by doing so will be insignificant for a bird flying to or from its wintering grounds in the Bay of Biscay (or further south) and its breeding grounds in northern Scotland. The significance of any increase in energy expenditure will, if it occurs, be negligible.

Displacement

There are no data available to determine whether great skuas may be displaced from the proposed development area. Should they do so then they will forage elsewhere for their prey whether that is from scavenging behind fishing vessels, stealing it from other birds or catching it themselves. There is no indication that the proposed area is of any significant importance for great skua and therefore any displacement, should it occur, will be negligible.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on great skuas.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available is that from the Beatrice Demonstrator Project which recorded 51 great skuas over a period of 12 months pre-construction surveys (Talisman 2005). The size, scale and exact locations of the Round 3 and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of great skuas that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from the proposed plans. However, although great skuas will be recorded within the area, the relatively far distance the proposed development is from the other planned offshore wind farms and its relatively small scale reduces the risk of a potentially significant cumulative or in-combination effect.

4.22.6 Conclusions

Habitats Appraisal

There are no SPAs in the region for which great skua is a qualifying species.

Environmental Impact Assessment

Based on the relatively low densities of great skuas recorded in Aberdeen Bay and their broad distribution it is predicted that there will not be a significant impact arising from the proposed development on great skuas.

4.23 Arctic skua (*Stercorarius parasiticius*)

4.23.1 Protection & Conservation Status

The Arctic skua is listed in Appendix III of the Bern Convention and is on the Red List of Species of Conservation Concern.

4.23.2 Background

Arctic skua		
GB Population	Breeding: 2,100 prs	Mitchell *et al* 2004
Scottish population	Breeding 2,100 prs	Forrester *et al*. 2007
International threshold	Unknown	-
GB threshold	50	Minimum
Designated east coast sites where species is a noted feature	None	SNH 2011 JNCC 2011a
European population estimate	Breeding 40,000 – 140,000 pairs Wintering – unknown	Birdlife 2004
European population trend	Status 'secure' Trend 'unknown'	Birdlife 2004
World population	85,000 – 340,000 pairs	Mitchell *et al* 2004

Within the UK Arctic skuas only nest in north and western Scotland where they are a summer migrant arriving on their breeding grounds during April and May and departing primarily in August and September. They feed on fish, primarily sandeels, that they often obtain from other seabirds as they enter the seabird colonies.

During migration from August to October Arctic skua occur widely offshore in low densities across the North Sea but may favour inshore waters where they can scavenge food from other seabirds, particularly Terns. In North-east Scotland peak passage occurs during August with a maximum of 326 Arctic skuas over a four hour period in August 1983 passing Peterhead (Buckland, Bell & Picozzi 1990).

Boat-based surveys

A total of 64 Arctic skuas were recorded from ship-based surveys undertaken between June and November 2007 and a further 16 were recorded between September and November 2010. Arctic skuas were recorded widely throughout the bay with no concentrations identified (Figure 4-63).

Vantage Point surveys

In Aberdeen Bay Arctic skuas were recorded between April and October with peak numbers of up to five birds per hour in July (EnviroCentre 2007a,b). Birds were recorded out to 3 km from shore with at least 78% of the sightings below turbine height.

Bird Detection Radar

Fourteen Arctic skuas were recorded by visual observations undertaken during Bird Detection radar studies in October 2005 and a further single observation was made at Blackdog in April 2007 (Walls *et al* 2006, Simms *et al.* 2007).

4.23.3 Summary of Results

Arctic skuas were widely recorded across Aberdeen Bay in relatively low numbers from all surveys from between April and October. Peak count numbers were during July when up to five birds per hour were recorded from land-based observations.

There was also a number of sightings during the spring and autumn migration periods.

Of those recorded in flight, 19% were recorded flying above 25 m from boat-based surveys and 22% above 30 m from land-based surveys.

No counts of Arctic skua from any of the surveys within Aberdeen Bay were of national importance.

4.23.4 Initial Assessment of Significance

Arctic skua	Overall sensitivity	Magnitude	Significance
Collision	High	Negligible	Negligible
Barrier	Low	Low	Negligible
Displacement	Low	Negligible	Negligible

4.23.5 Species Sensitivities

Qualifying species

There are no SPAs in the region for which the Arctic skua is a qualifying species but over 24% of the UK breeding population of Arctic skuas do occur in seven SPAs in Orkney and Shetland.

Flight height

Observations from boat-based surveys undertaken in Aberdeen Bay reported 16% of all flights above 25 m.

Elsewhere in the UK out of 50 recorded flight heights for Arctic skua four, i.e. 8%, were at rotor height.

Collision risk

Data obtained from boat-based and land-based surveys recorded Arctic skuas across Aberdeen Bay in relatively low numbers particularly during the autumn passage periods. There is relatively little data from other constructed offshore wind farms to determine possible avoidance rates but it is assumed to be relatively high and 92% of flights are below rotor height.

Based on the relatively low usage of the site, the broad distribution of Arctic skua across Aberdeen Bay and the high percentage of birds recorded as flying below rotor height it is concluded that there is a low risk of collision and that should it occur its significance on the species will be negligible.

Barrier effect

Data from post-construction monitoring studies undertaken in Denmark indicate that Arctic skua do not avoid entering wind farms consequently there is not thought to be a significant barrier effect (Zucco *et al*. 2006).

Displacement

There are no data available to determine whether Arctic skuas may be displaced from the proposed development area. However, they are known to follow Gulls, which may enter the proposed development area and Arctic skuas have been shown not to avoid wind farms. There is no indication any potential displacement effect but should it occur its significance is predicted to be negligible.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on Arctic skuas.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available is that from the Beatrice Demonstrator Project which recorded 16 Arctic skuas over a period of 12 months pre-construction surveys (Talisman 2005). The size, scale and exact locations of the Round 3 and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of Arctic skuas that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from the proposed plans. However, although great skuas will be recorded within the area, the relatively far distance the proposed development is from the other planned offshore wind farms and its relatively small scale reduces the risk of a potentially significant cumulative or in-combination effect.

4.23.6 Conclusions

Habitats Appraisal

There are no SPAs in the region for which Arctic skua is a qualifying species.

Environmental Impact Assessment

Based on the relatively low numbers of Arctic skuas recorded in Aberdeen Bay and their broad distribution it is predicted that there will not be a significant impact arising from the proposed development on Arctic skuas.

4.24 Golden plover (*Pluvialis apricaria*)

4.24.1 Protection & Conservation Status

Golden plover is listed in Annex I of the Birds Directive, Schedule II of the Wildlife & Countryside Act, Appendix II of the Bonn Convention. Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.24.2 Background

Golden plover		
GB Population	Summer: 23,000 prs Winter: 250,000 nd.	BTO 2011
Scottish Population	Summer – 15,000 prs Autumn – 20,000 – 60,000 ind Winter: 25,000 – 35,000 ind.	Forrester *et al* 2007
International threshold	9,300 ind.	Calbrade *et al.* 2010
GB threshold	4,000 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	Firth of Forth: 2,970 ind.	SNH 2011 JNCC 2011
European population estimate	Breeding 436,000- 740,000 prs Wintering – 820,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'unknown breeding moderate increase wintering	Birdlife 2004
World population	640,000 to 1,200,000 ind.	Birdlife 2011

Golden plover breed on upland moorlands in northern Britain and Europe with the largest European populations in Iceland where up to 310,000 pairs (BirdLife 2004).

The UK holds 80% of the breeding population of the southern race of golden plover *P. apricaria apricaria* which has undergone a significant decline of 20% between the 1960's and 1980's (EC 2009). The breeding population occurs widely across the uplands of northern Britain and particularly Scotland where 15,000 pairs occur (Forrester *et al*. 2007).

In winter the UK population increases with birds arriving from Iceland and the Continent where they spend the winter on arable land, often winter crops, and open grassland. Birds return to the same areas and often same fields each year. Golden plover recorded in eastern Britain are thought to be predominantly birds from Scandinavia or further east whereas those from Iceland occur predominantly in western Britain and Ireland. Birds occurring in North-east Scotland are therefore most likely to be local breeding birds and from populations to the north and east (Wernham *et al*. 2002).

In North-east Scotland golden plover are a decreasing breeding species inland but occur widely during the winter at a few favoured locations near the coast each winter. Peak numbers in the region occur on the Ythan Estuary during the autumn as migrants. Maximum counts in recent years have been up to 9,000 birds but more often peak numbers are between 3,000 to 4,000 individuals (Buckland Bell & Picozzi

1990; NESBR). Birds forage and roost on the Ythan at low tide but move away as far as 10 km during high tides (Buckland Bell & Picozzi 1990).

Boat-based surveys

No golden plover were recorded from boat based surveys.

Vantage Point surveys

No golden plover were recorded from Vantage Point surveys

Bird Detection Radar

Golden plover were observed on three occasions but in large numbers during radar and visual surveys undertaken in October 2005. A total of 2,170 golden plover were recorded in three flocks along the shoreline and out to 3,300 m. Their mean flight height was 35 m and therefore at potential risk of collision (Walls *et al.* 2006)

Summary of Results

Golden plover were only recorded during land-based surveys undertaken on October 2005. The majority of sightings were of birds along the shore, although one flock occurred out as far as 3,300 metres offshore.

4.24.3 Initial Assessment of Significance

Golden plover	Overall sensitivity	Magnitude	Significance
Collision	Medium	Negligible	Negligible
Barrier	Medium	Low	Minor
Displacement	Low	Negligible	Negligible

4.24.4 Species Sensitivities

Qualifying species

Golden plover is a qualifying species as part of an assemblage for the Firth of Forth SPA.

Flight height

Flight heights recorded from land based surveys undertaken in October 2005 recorded a mean flight height of 35 m. Elsewhere very few golden plover have been recorded at offshore wind farms and all have been below turbine height.

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that golden plover are rarely recorded offshore in Aberdeen Bay. However, flocks of golden plover can occur. However, the only flock recorded offshore was to the north of the proposed development and were of birds likely associated with the Ythan Estuary also to the north, therefore golden plover are not at risk of collision. It is possible that golden plover may cross Aberdeen Bay during periods of passage. However, there is no indication that there are any regular movements across the bay nor that there is a flyway across the proposed development area.

Studies undertaken in Denmark have also indicated that golden plover fly above the turbine height during passage and are not at risk of collision and that other species of wader flying at rotor height demonstrated effective avoidance behaviour when near to offshore wind turbines (Petersen *et al.* 2006). Consequently, there is evidence to indicate that the risk of collision to golden plover in Aberdeen Bay is low and that the potential effect from collision is negligible.

Barrier effect

Data obtained from nearly three years of Vantage Point surveys plus additional radar studies and boat-based surveys did not detect any evidence to suggest that there are regular daily flights by golden plover across the proposed development area and so a regular barrier effect that may cause a long-term increase in daily energetic costs is not predicted. There is the potential for a relatively small *ad hoc* increase if golden plover cross the bay during migration but this would cause a very small incremental increase in energetic costs. It is predicted that the potential impacts arising from barrier effect will at worst be minor but most likely be negligible due to the relatively small incremental increase in flight distance compared to the likely total length of migration.

Displacement

No golden plover were recorded at the proposed development area and therefore no displacement effects will occur.

Cumulative and in-combination

It is possible that birds migrating long distances from Scandinavia or Russia may interact with one or more wind farm. However, it is not known where the golden plover recorded at the Ythan Estuary originate from or where they may migrate to and therefore it is not possible to undertake an evidence based cumulative or in-combination impact assessment.

The only data available that may be of relevance is from the Beatrice demonstrator project which did not record any golden plover during its surveys. Data from other proposed projects in the Moray Firth and the Firth of Forth are not currently available.

Habitats Appraisal

Based on the very low usage of the proposed development area by golden plover and some evidence from existing offshore wind farms indicating a low collision risk, it is predicted that there will not be any adverse effects on the Firth of Forth SPA for which golden plover is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on golden plover.

4.25 Black-legged kittiwake (*Rissa tridactyla*)

4.25.1 Protection & Conservation Status

The (black-legged) kittiwake is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.25.2 Background

Kittiwake		
GB population	Breeding: 370,000 prs	Mitchell *et al* 2004
Scottish population	Breeding: 282,200 AoN Winter: est. 10,000 ind	Forrester *et al*. 2007
GB threshold	?	Calbrade *et al*. 2010
International threshold	20,000 ind	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Buchan Ness to Collieston Coast: 12,542 AoN (2007) Fowlsheugh: 11,140 AoN (2006) Forth Islands: 2,316 AoN (2009) Troup Pennan & Lion's Head: 14,896 AoN (2007)	SNH 2011 JNCC 2011a
European population estimate	Breeding 24,000 – 58,000 pairs Wintering – >11,000	Birdlife 2004
European population trend	Status 'depleted' Trend 'moderate increase'	Birdlife 2004
World population	97,000 – 270,000 'adults'	Birdlife 2011

Kittiwakes are the most numerous species of gull in the world and highly pelagic. It is the most abundant breeding gull in the UK nesting in often very large colonies on coastal cliffs. Kittiwakes start arriving back at their colonies during March and April and depart during August and September. During the breeding season they can forage widely with adults flying in excess of 100 km to suitable foraging sites.

Post-breeding, both adults and juveniles disperse across the North Sea and the north Atlantic with a greater proportion of unsuccessful breeders wintering off eastern Canada compared to those that have been successful that winter largely in the eastern Atlantic (Bogdanova *et al*. 2011).

In North-east Scotland kittiwakes are recorded throughout the year but with lowest numbers between November and March and peak numbers generally during July and August. On occasions there are records of exceptionally large movements of kittiwakes along Aberdeenshire coast. In April 1978 over 44,000 kittiwakes were recorded flying past Collieston and over 80,000 are estimated to have flown past Aberdeenshire on 29 October 1969 (Buckland, Bell & Picozzi 1990).

Observations off Peterhead occur out to 3 km with most records of birds closest to shore during poor weather (Innes 1991).

Boat-based surveys

Kittiwakes were the most frequently recorded Gull from boat-based surveys. They were recorded throughout Aberdeen Bay with the majority of sightings in water depths of between 10 m and 20 m and between 1 km and 3 km from the shore. Year 1 data indicated significantly more kittiwakes in to the north compared to those within the proposed EOWDC survey area. Relatively low numbers were recorded during the winter period and none within the footprint of the proposed development area (Figure 4-65)

Peak numbers occurred during the breeding season between April and July, with highest numbers to the north (Figure 4-66). Post-breeding, the numbers of kittiwake recorded decreased with low numbers recorded within the proposed development area (Figure 4-67).

Data collected from between August 2010 and January 2011 have indicated greater numbers within the vicinity of the proposed development compared to elsewhere (Figure 4-68).

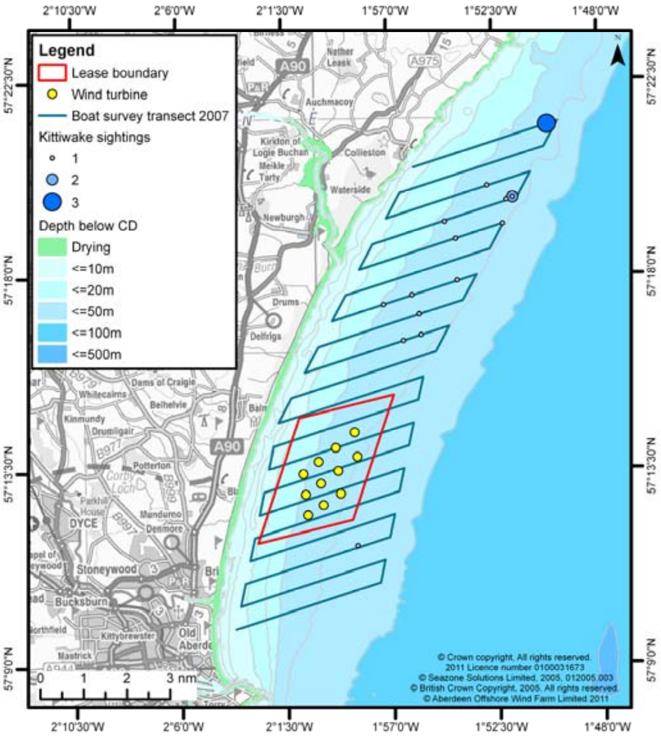


Figure 4-65: Kittiwake distribution in Aberdeen Bay during winter period: November to March (all sightings).

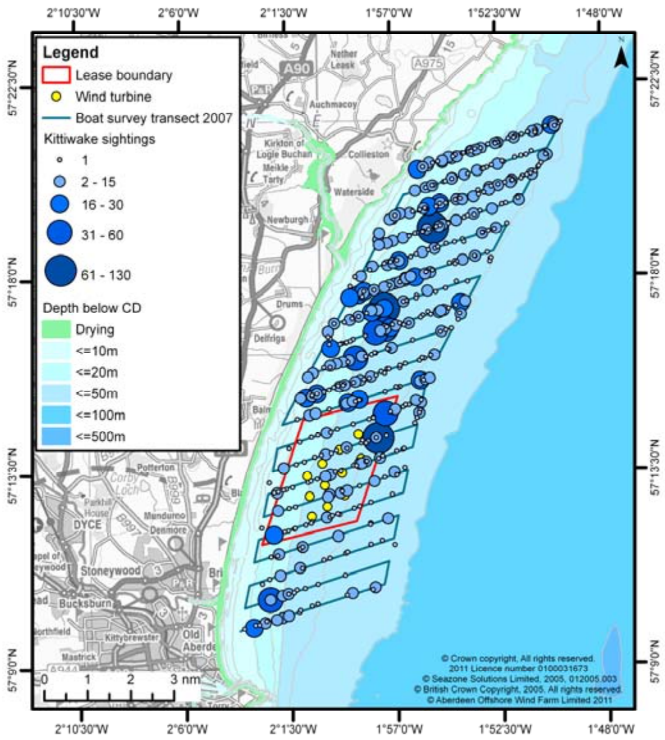


Figure 4-66: Kittiwake distribution in Aberdeen Bay during breeding season: April – July (all sightings).

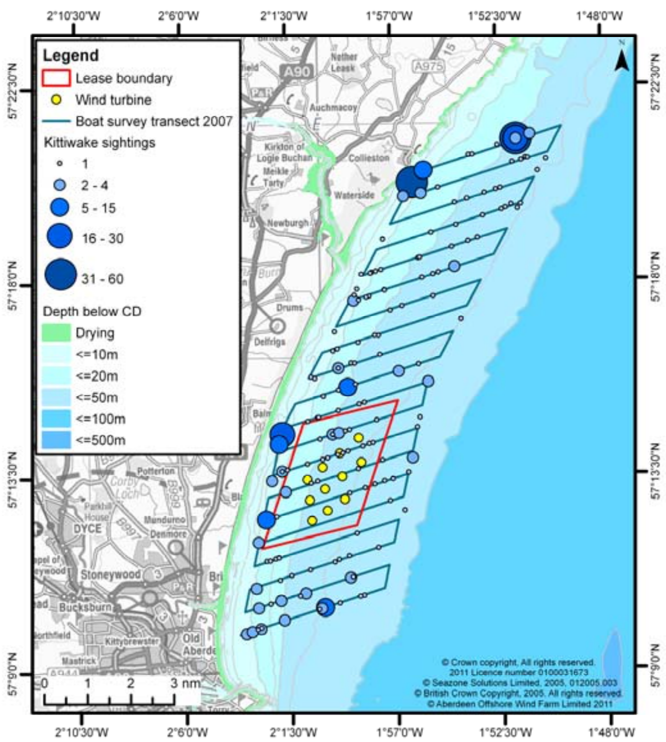


Figure 4-67: Kittiwake distribution in Aberdeen Bay during post-breeding: August - October (all sightings).

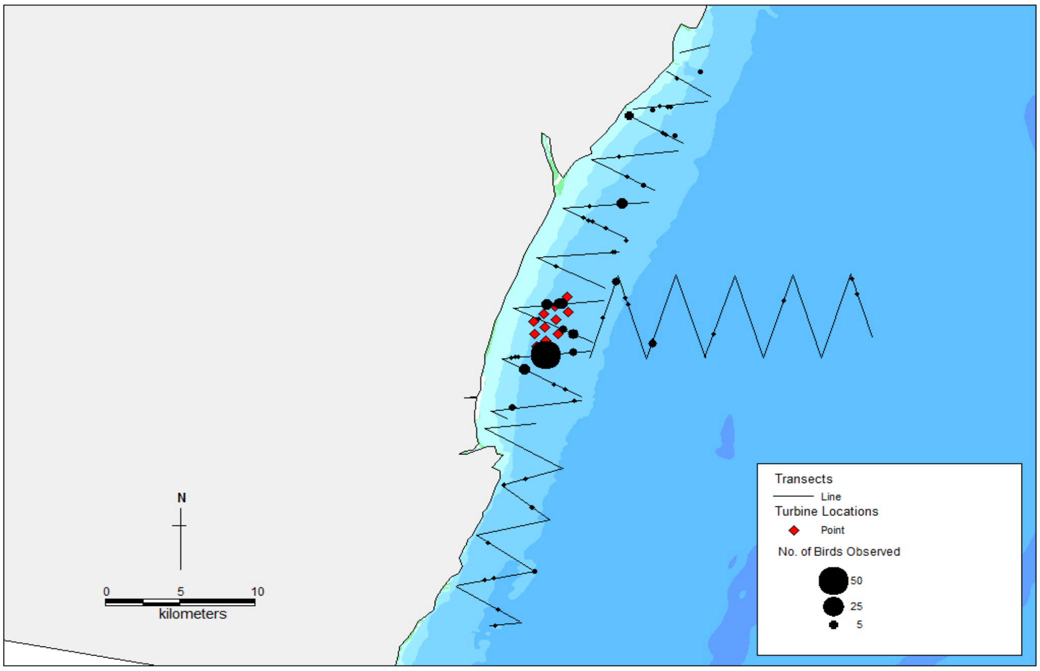


Figure 4-68: On-effort observations of kittiwake along transects during August, September and November 2010 and January 2011.

There was a strong seasonal variation in the frequency of sightings with relatively high numbers in June and July when there was a peak of *c.*2,300 kittiwakes within the surveyed area. Outwith the peak period numbers of kittiwakes recorded were relatively low with an estimated abundance of less than 14 birds in the proposed EOWDC development area during the autumn and only one bird during the winter period (

Table 4-22). Peak density estimates occurred during the spring and summer when up to 33 birds/km^2 were recorded.

Monthly data collected from between August 2010 and January 2011 recorded peak abundance estimate of 870 birds in the northerly survey area during September with relatively few birds to the south or offshore (Figure 4-71). Densities of kittiwakes during September were 5.7 birds/km^2 (Figure 4-72).

Table 4-22: Seasonal estimates of density and abundance of kittiwakes in the proposed EOWDC and 'control' areas.

Season	Density Estimate (km^2)	SE	Estimated Abundance	SE	No. Observations
EOWDC- Winter	0.025	0.025	1	1.3	1
Control- Winter	0.049	0.050	3	2.5	2
EOWDC- Spring	0.453	0.229	23	11.6	12
Control- Spring	21.383	15.748	1,086	800.0	16
EOWDC- Summer	13.046	6.251	663	317.6	33
Control- Summer	33.000	11.277	1,676	572.9	60
EOWDC- Autumn	0.276	0.206	14	10.5	7
Control- Autumn	0.332	0.149	17	7.5	9

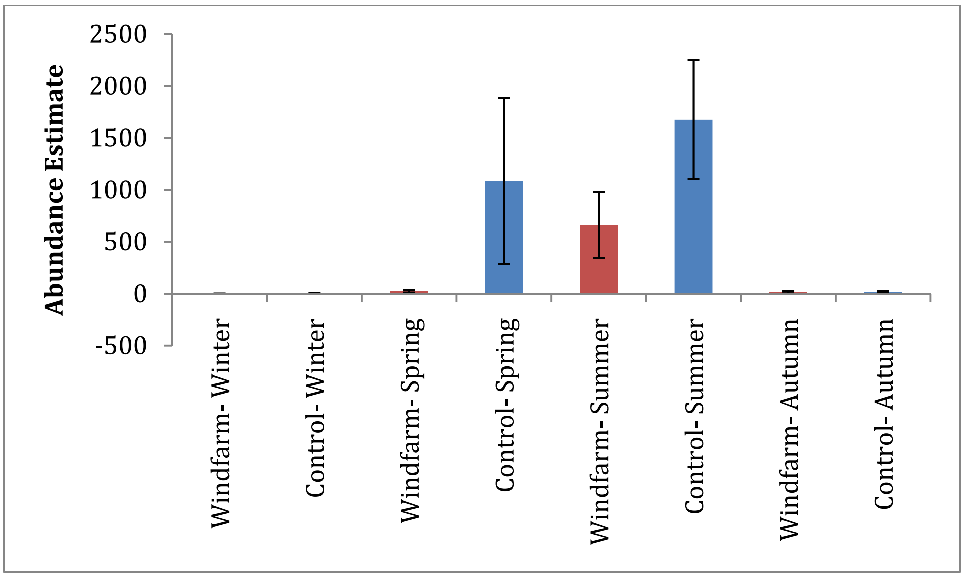


Figure 4-69: Seasonal estimates (+/- SE) of abundance of kittiwakes in the proposed EOWDC and 'control' areas; February 2007 – January 2008.

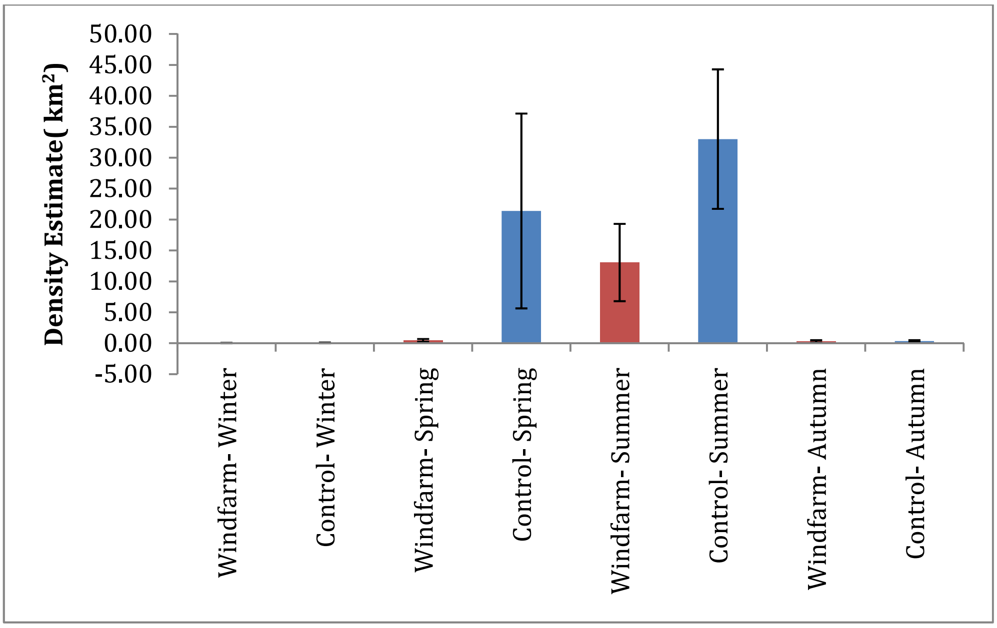


Figure 4-70: Seasonal estimates (+/- SE) of density of kittiwakes in the proposed EOWDC and 'control' areas.

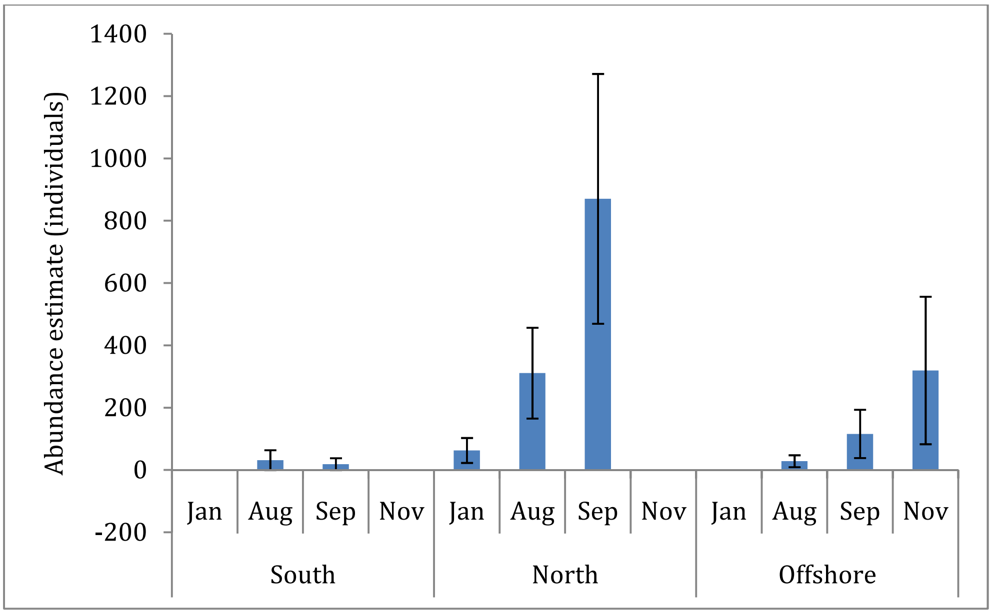


Figure 4-71: Monthly estimates (+/- SE) of abundance of Black-legged Kittiwake in the South, North and Offshore Strata; August 2010 to January 2011.

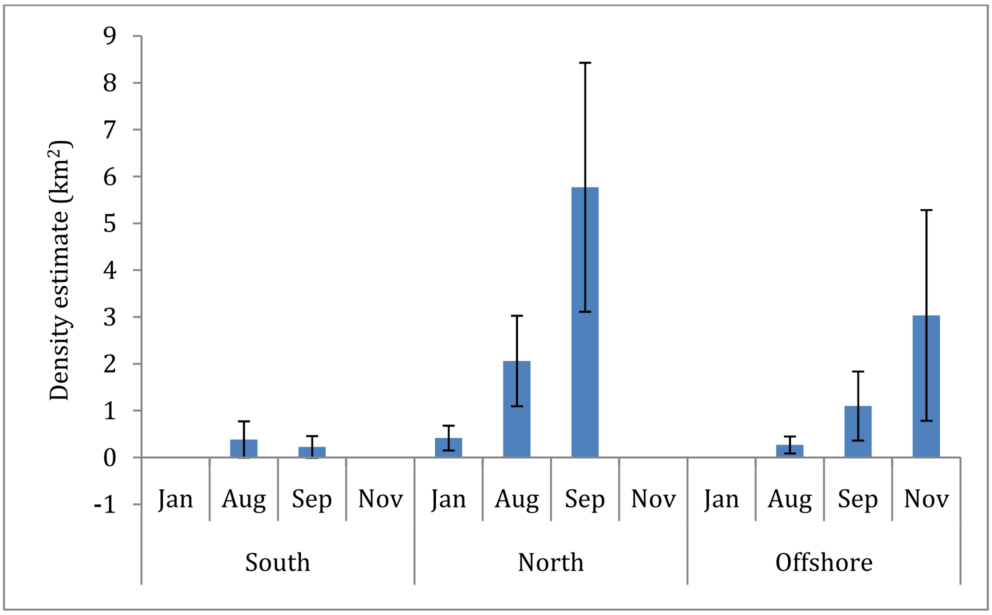


Figure 4-72: Monthly estimates (+/- SE) of density of Black-legged Kittiwake in the South, North and Offshore Strata; August 2010 to January 2011.

Vantage Point surveys

Vantage Point counts at four locations within Aberdeen Bay recorded kittiwakes throughout the year. Peak numbers were of up to 160 birds per hour during August 2005 and 200 birds per hour in July 2006 but numbers of passing birds were more frequently at <100 birds per hour (EnviroCentre 2007a, Alba Ecology 2008a). During the winter months there were considerably fewer kittiwakes present in Aberdeen Bay with less than 10 birds per hour recorded (Alba Ecology 2008b) Birds were recorded out to 3 km from shore with peak numbers within 1-3 km and at least 42% of sightings were of birds flying between 30-150 m from the sea surface.

Bird Detection Radar

One kittiwake was recorded at Easter Hatton during the Radar studies undertaken in October 2005 (Walls *et al*. 2005) and 26 were recorded during April 2007 radar surveys at a rate of 0.5 birds per hour (Simms *et al.* 2007).

4.25.3 Summary of Results

Kittiwakes were recorded throughout Aberdeen Bay in highly seasonally variable numbers. During the winter periods very few kittiwakes were recorded. However during the breeding season kittiwakes were frequently recorded with estimated populations within the 'control' area during this period of 1,676 birds and 663 birds in the proposed EOWDC development area. Peak densities of 33 birds/km^2 were recorded to the north of the proposed development during the summer months. Land-based observations also recorded peak numbers during the summer months with a peak in July. Of those for which flight height was recorded, 22% were greater than 25 m above the sea surface.

The majority of sightings were between 1 km and 3 km from the coast.

4.25.4 Initial Assessment of Significance

Kittiwake	Overall sensitivity	Magnitude	Significance
Collision	Medium	Medium	Minor
Barrier	Very High	Low	Minor
Displacement	Medium	Low	Negligible

4.25.5 Species Sensitivities

Qualifying species

Kittiwake is a qualifying species for four SPAs within the region: Buchan Ness to Collieston, Fowlsheugh, Troup, Pennan & Lion's Head and Forth Islands SPAs.

Flight height

Flight altitude data obtained from boat-based surveys reported 22% of flights at above 25 m.

Elsewhere out of over 14,000 recorded flight altitudes for kittiwake 13% were at rotor height.

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that kittiwakes are widespread and frequent within Aberdeen Bay and with a distinct seasonal peak during the summer months.

Collision Risk Modelling undertaken for kittiwake is based on:

- Body length of 39 cm
- Wingspan of 108 cm

- Flight speed of 10.5 $m.s^{-1}$

The Collision Risk Modelling is based on a collision probability of 11.9% and been undertaken over a range of avoidance rate from 98%, 99% and 99.5% have been used.

Table 4-23: Predicted number of collisions per year for kittiwake

Collision probability	Avoidance rate (%)		
	98	99	99.5
11.9%	3.6	1.8	0.9

Based on the precautionary avoidance rate of 98% it is predicted that a total of four collisions per year may occur (Table 4-23).

The annual mortality rate for kittiwake is 6% (BTO 2011). Consequently, out of a peak local population of 2,339 individuals in both the 'control' and EOWDC areas during summer 2007 an annual mortality of 140 kittiwakes may be predicted. Based on the regional SPA population of kittiwakes of 83,156 individuals, the annual mortality rate will be 4,989 individuals and therefore the 1% baseline mortality rate is 50 birds per year. The results from the Collision Risk Modelling predict a total of four kittiwakes per year may collide with the wind turbines.

The Buchan Ness to Collieston Coast SPA lies approximately 9.5 km away from the proposed development and holds approximately 25,000 breeding kittiwakes, based on the latest available counts in 2007. The colony will therefore have an annual mortality of 1,505 birds. It is likely that many of kittiwakes recorded within Aberdeen Bay during the breeding period are associated with this colony. The results from the collision risk modelling which predict a mortality of four kittiwakes per year, indicate that there will not be an adverse effect on the population of kittiwakes associated with the SPA based on the precautionary assumption that an increase of 1% above baseline mortality could be adverse, i.e. more than 15 kittiwakes a year collide with the turbines.

The Fowlsheugh SPA lies 31 km away from the proposed development and holds 11,140 breeding pairs of kittiwake based on latest counts. Therefore, the annual mortality rate from this colony is 1,337 birds per year. Based on the results from the collision risk modelling it is concluded that if all the kittiwakes at risk of collision are from Fowlsheugh then there is unlikely to be an adverse effect on the SPA population.

The Troup Pennan & Lion's Head SPA lies 74.3 km to the north of the proposed development and holds 29,792 breeding kittiwakes. The annual mortality is estimated to be 1,787 birds per year and consequently, based on a 1% of annual mortality threshold, an adverse effect on kittiwakes from this colony is not predicted.

The Forth Islands SPA is approximately 124 km to the south and holds 4,632 breeding kittiwakes. However, the maximum foraging range for kittiwakes reported is 83 km (Roos 2010) and therefore the SPA is outwith the maximum foraging range for breeding kittiwakes and there will not be an adverse effect on the population due to collision.

Based on the results of the Collision Risk Modelling and the current regional and SPA populations, it is predicted that that the potential population affect caused by collision impacts with the proposed development on kittiwakes is negligible.

Barrier effect

Data from post-construction monitoring studies undertaken in Denmark indicate that although kittiwakes may make some avoidance response they are generally not affected by offshore wind turbines and do not avoid entering wind farms.

Consequently, there is not thought to be a significant barrier effect on kittiwakes from the proposed development (Zucco *et al*. 2006).

Displacement

Although during periods of construction the number of kittiwakes present in the area may be reduced once in operation evidence to suggest that kittiwakes may be attracted to the area. Therefore no displacement is predicted.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on kittiwakes.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth all of which have the potential to contribute to a possible cumulative and in-combination effects. The only data available is that from the Beatrice Demonstrator Project which recorded 2,943 kittiwakes over a period of 12 months of pre-construction surveys (Talisman 2005). Collision Risk Modelling undertaken for the Beatrice Demonstrator Project predicted up to 9 kittiwakes per year may collide with the two turbines. The effect from the potential collisions was concluded not to be significant.

The size, scale and exact locations of the Round 3 wind farms and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of kittiwakes that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from the proposed plans. However, based on the known distribution and behaviour of kittiwakes it is predicted that they will be widespread across many of the possible areas at which wind farms may, in the future, be constructed.

4.25.6 Conclusions

Habitats Appraisal

There are four SPAs for which kittiwakes are a qualifying species in the region and based on the results from the Collision Risk Modelling which predicts an annual collision mortality rate of four birds per year and the likely foraging ranges kittiwakes it is predicted that there will not be an adverse effect on the SPAs.

Environmental Impact Assessment

Based on the results from Collision Risk Modelling undertaken and the potential number of kittiwakes, which may collide with the proposed development. It is predicted that there will not be a significant impact arising from the proposed development on regional population of kittiwakes.

4.26 Black-headed gull (*Larus ridibundus*)

4.26.1 Protection & Conservation Status

The black-headed gull is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.26.2 Background

Black-headed gull		
GB population	Breeding: 130,000 prs Wintering: 2.1 – 2,200,000 ind	Mitchell *et al* 2004 BTO 2011
Scottish population	Breeding: 43,200 AoN Wintering: 155,500 ind.	Forrester *et al*. 2007
International threshold	20,000 ind.	Calbrade *et al*. 2010
GB threshold	19,000 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	None	SNH 2011 JNCC 2011a
European population estimate	Breeding 1.5 – 2,200,000 pairs Wintering – >3,200,000 individuals	Birdlife 2004
European population trend	Status 'secure' Trend 'moderate decline'	Birdlife 2004
World population	2.1 – 2,800,000 pairs	Mitchell *et al* 2004

Black-headed gulls are the most widespread seabird breeding in Britain and Ireland with similar numbers nesting inland as on the coast. The majority of the breeding population is semi-resident with the majority of the UK population undertaking only localised seasonal movements. However, the UK wintering population is bolstered by birds from northern and eastern Europe.

Outside the breeding season black-headed gulls occur in inshore tidal waters largely avoiding rocky or exposed coasts, preferring inlets, bays and estuaries with sandy or muddy beaches (Snow & Perrins 1998). Black-headed gulls are primarily a coastal species and are scarce offshore.

In North-east Scotland black-headed gulls occur throughout the year with peak numbers at Peterhead between July and February with nearly all sightings of birds passing Peterhead within 200 m of the coast (Innes 1994). The number of wintering black-headed gulls is 13,500 individuals of which nearly 12,000 are found along the coast (Forrester *et al*. 2007).

Boat-based surveys

Nine sightings of black-headed gulls were made from boat-based surveys undertaken between February 2007 and January 2008. Eight of the nine sightings were made in November and all were inshore (IECS 2008).

Vantage Point surveys

Black-headed gulls occur throughout the year in Aberdeen Bay but there were large variations in numbers between years. In 2006, peak numbers occurred in June with up to 5 birds per hour passing all within 2 km of the coast and the majority within 1 km (EnviroCentre 2007a). However, in 2007 peak counts occurred in July and August when up to 90 birds per hour passed the Donmouth (Alba Ecology 2008a). During the winter months numbers of black-headed gulls recorded were much lower with a peak count of less than 30 birds per hour in February 2008 (Alba Ecology 2008b). In 2006, 48% of sightings were within the 30-150 m height band across all vantage point sites and in 2007, 9% were within the same height band (Alba Ecology 2008a).

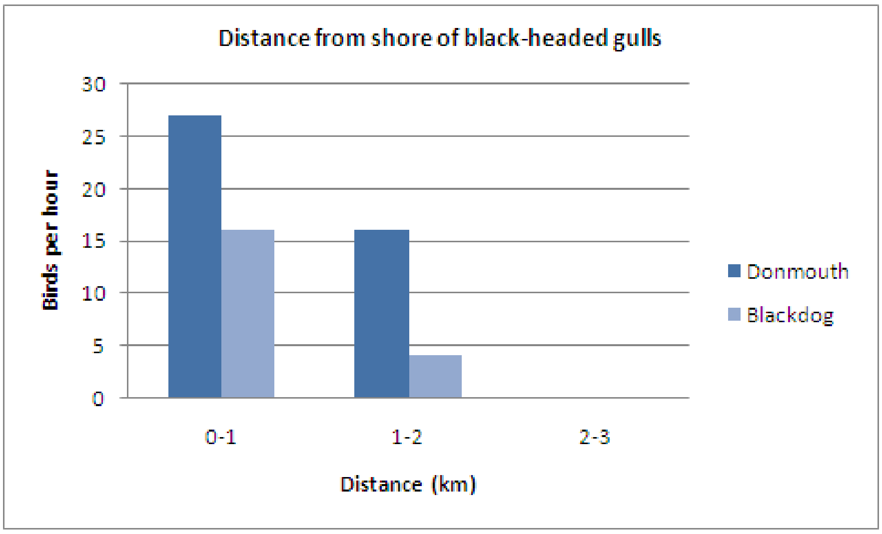


Figure 4-73: Number of black-headed gulls per hour recorded off Aberdeen Bay from Vantage Point Counts April 2006 – March 2008 and their distance from shore.

Bird detection Radar

One-hundred and forty-three black-headed gulls were recorded from observations undertaken during Bird Detection Radar surveys in October 2005 (Walls *et al.* 2006). Fourteen were recorded at Blackdog over a seventeen day period in April 2007 (Simms *et al.* 2007).

4.26.3 Summary of Results

Black-headed gulls were rarely recorded from boat-based surveys with most observations made from Vantage Point surveys. Numbers of black-headed gulls varied between years and across the seasons. Lowest numbers were during the winter months and peak counts from between June and August. Peak counts were of up to 90 birds per hour passing the Donmouth during July and August.

The majority of sightings were within 1 km of the coast there were very few records beyond 2 km from the shore. Of those recorded in flight up to 48% were recorded flying between 30 m and 150 m but numbers at these heights varied considerably.

No counts of black-headed gulls from any of the surveys were of national importance.

4.26.4 Initial Assessment of Significance

Black-headed gull	Overall sensitivity	Magnitude	Significance
Collision	High	Negligible	Negligible
Barrier	Low	Low	Negligible
Displacement	Low	Negligible	Negligible

4.26.5 Species Sensitivities

Qualifying species

There are no SPAs in the region for which black-headed gull is a qualifying species.

Flight height

Only four observations of flight altitudes were obtained from boat-based surveys. All were of birds flying below 25 m.

Elsewhere, out of 16,358 recorded flight altitudes for black-headed gull 13% were at rotor height.

Collision risk

Data obtained from boat-based and land-based surveys recorded black-headed gulls mainly within 1 km of the coast with most records during the summer months and lower numbers during the winter. Data from coastal wind farms have recorded relatively low avoidance behaviour towards wind turbines by black-headed gulls and they are known to collide with turbines. However, nearly all the sightings of black-headed gull were within 2 km of the coast and the majority were within 1 km (Figure 4-73). Boat-based surveys recorded very few black-headed gulls offshore.

Based on the very few records of black-headed gull in the vicinity of the proposed development there is considered to be a very low risk of collision and, should it occur, its significance on the species will be negligible.

Barrier effect

Data from post-construction monitoring studies undertaken in Denmark indicate that black-headed gulls are generally not affected by offshore wind turbines and do not avoid entering wind farms. Consequently, there is not thought to be a significant barrier effect (Zucco *et al*. 2006).

Displacement

Very few black-headed gulls were recorded within the area of the proposed development and black-headed gulls are not known to show any significant displacement effects. There is no indication of any potential displacement effect but should it occur its significance is predicted to be negligible.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on black-headed gulls.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available is that from the Beatrice Demonstrator Project which recorded six black-headed gulls over a period of 12 months pre-construction surveys (Talisman 2005). The size, scale and exact locations of the Round 3 and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of black-headed gulls that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from the proposed plans. However, based on the known behaviour of black-headed gulls, in particular their coastal distribution it is predicted that the risk of any cumulative or in-combination effects is low and the consequences negligible.

4.26.6 Conclusions

Habitats Appraisal

There are no SPAs in the region for which black-headed gull is a qualifying species.

Environmental Impact Assessment

Based on the relatively low numbers of black-headed gulls recorded in Aberdeen Bay and that were not recorded in the proposed development area it is predicted that there will not be a significant impact arising from the proposed development on black-headed gulls.

4.27 Common gull (*Larus canus*)

4.27.1 Protection & Conservation Status

The common gull is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.27.2 Background

Common gull		
GB Population	Breeding: 48,000 prs Winter: 620 – 721,000 ind.	BTO 2011
Scottish population	Breeding: 48,100 AoN Winter: 79,700 ind.	Forrester *et al*. 2007
International threshold	20,000 ind.	Calbrade *et al*. 2010
GB threshold	9,000 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	None	SNH 2011 JNCC 2011a
European population estimate	Breeding 590,000 – 1,500,000 pairs Wintering – >910,000	Birdlife 2004
European population trend	Status 'depleted' Trend 'unknown'	Birdlife 2004
World population	2,500,000 – 3,700,000 pairs	Birdlife 2011

Common gulls occur throughout much of Scotland breeding in colonies usually inland and foraging in fields, estuaries and nearshore waters. During the autumn the UK population is augmented by migrants from northern Europe that winter in the UK. In Scotland an estimated 100,000 to 200,000 common gulls occur during the spring and autumn passage (Forrester *et al.* 2007).

During the breeding season common gulls remain close to shore with relatively few sightings of common gulls from offshore waters. Outwith the breeding season common gulls disperse southward to southern Scotland and England but wintering birds remain largely in nearshore waters often occurring in large numbers in river estuaries where large roosts can occur. Spring passage occurs during March and April across a broad front.

In North-east Scotland peak numbers occur on the Ythan Estuary during October and November and there is some evidence of a spring and autumn passage of birds past Peterhead. Relatively few common gulls nest along the coast although an increasing population have nested on the flat roofs of nearby industrial estates since 1984. Historically there were large breeding colonies inland up Deeside where there were up to 17,000 pairs in the Coreen Hills up Deeside Up to 900 birds per month were recorded passing Peterhead during July and August (Buckland, Bell & Picozzi 1990).

Boat-based surveys

Common gulls were recorded throughout the year in Aberdeen Bay from boat-based surveys. Numbers were highest during the autumn, particularly November and February and March. Very few common gulls were recorded during June and July (Figure 4-77). Although common gulls were widely recorded throughout the surveyed area the majority of records during the winter were off Balmedie between 2 km and 3 km from shore and within the northern part of the proposed development area

During the breeding season significantly fewer common gulls were recorded and most records were in nearshore waters with few birds recorded within the footprint of the proposed development (Figure 4-75).

Post-breeding, the numbers of common gulls within Aberdeen Bay increased with widely scattered records in predominantly nearshore waters (Figure 4-76)

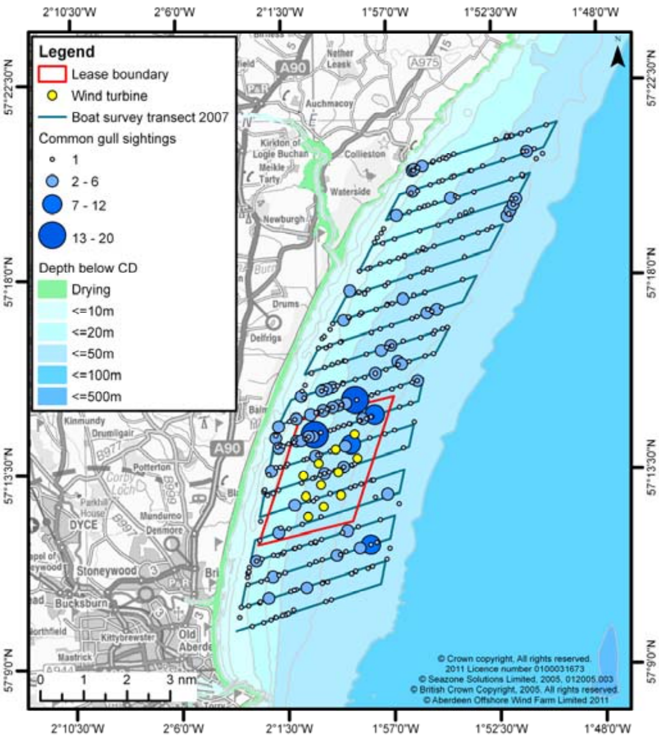


Figure 4-74: Common gull distribution in Aberdeen Bay during winter period: November to March (all sightings).

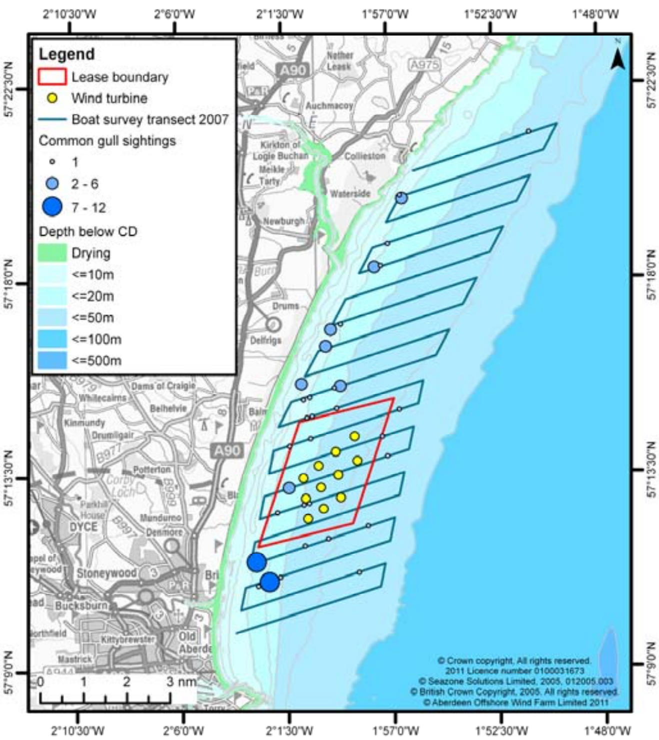


Figure 4-75: Common gull distribution during breeding season: April to July (all sightings).

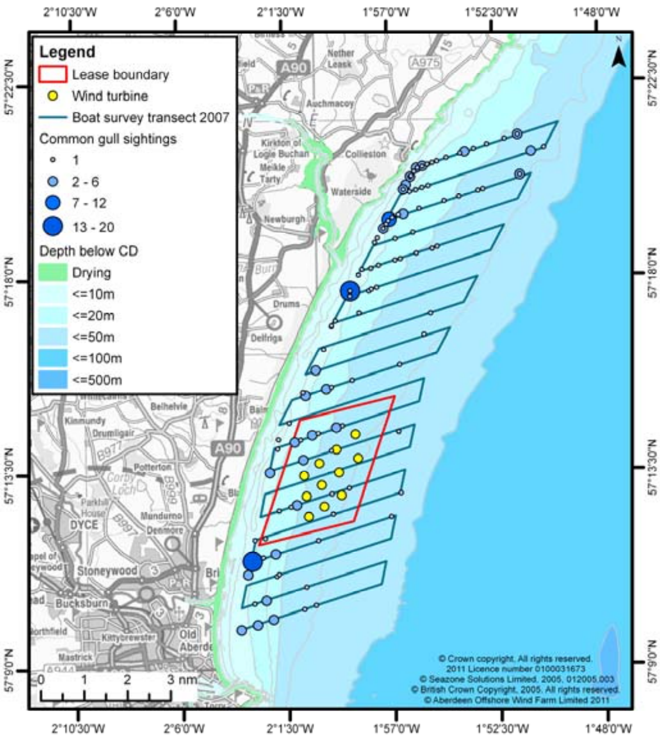


Figure 4-76: Common gull distribution during post-breeding: August to October (all sightings).

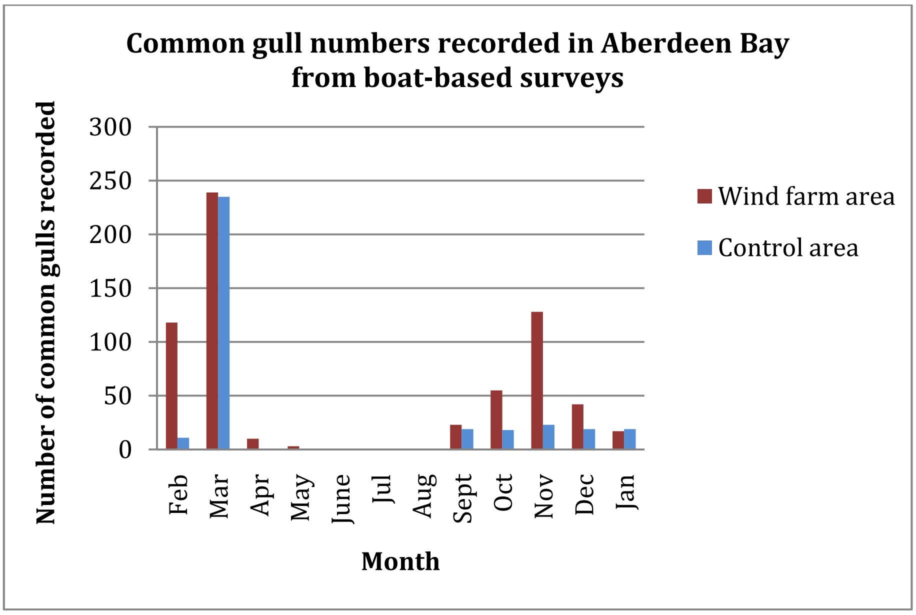


Figure 4-77: Common gull monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

There were not enough sightings to undertake a monthly assessment using *Distance*. However, estimated densities on seasonal basis were able to be calculated and estimated peak autumn and spring abundances of 128 and 187 birds respectively. During the autumn and spring peak numbers occurred in the 'control' survey area whilst in the winter peak numbers occurred in the proposed development area (Table 4-24, Figure 4-78).

Table 4-24: Seasonal estimates of density and abundance of Common gulls in the proposed EOWDC and 'control' areas.

Season	Density Estimate (km^2)	SE	Estimated Abundance	SE	No. Observations
EOWDC - Winter	3.300	1.071	168	54.4	47
Control- Winter	0.832	0.239	42	12.1	24
EOWDC - Spring	0.535	0.529	27	26.9	9
Control- Spring	3.673	2.193	187	111.4	16
EOWDC - Summer	0.000	0.000	0	0.0	0
Control - Summer	0.000	0.000	0	0.0	0
EOWDC- Autumn	1.365	0.630	69	32.0	15
Control - Autumn	2.510	1.772	128	90.0	9

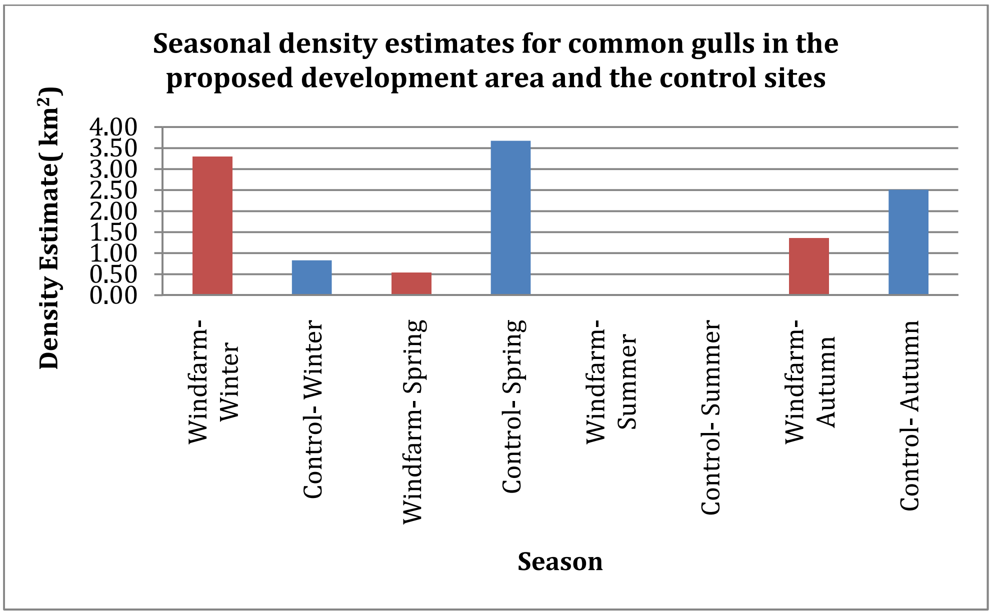


Figure 4-78: Seasonal estimates of density (+/- SE) of Common Gulls in the proposed EOWDC and 'control' areas

Vantage Point surveys

In Aberdeen Bay common gulls were recorded throughout the year with peak numbers during periods of passage when up to 130 birds per hour passed Balmedie in April 2007, 150 birds per hour in February 2008 and up to 60 birds per hour passing during August 2006 (Alba Ecology 2008a,b; EnviroCentre 2007a). The majority of sightings were within 0-2 km of the coast with up to 50% of birds flying between 30-150 m.

Bird Detection Radar

A total of 490 common gulls were recorded during the Bird Detection Radar studies undertaken at Drums and Easter Hatton during October 2005. Eighty per-cent of sightings were made at Drums (Walls *et al.* 2006).

In April 2007, 336 common gulls were recorded over a seventeen day period at Blackdog at a rate of 6.5 birds per hour. The mean flock size was of six birds but a maximum flock of 68 was recorded (Simms *et al.* 2007).

4.27.3 Summary of Results

Common gulls were recorded throughout the year with peak numbers during early spring and early autumn with peak counts of up to 150 birds per hour in February 2008. There were relatively few sightings during the breeding season and no sightings from boat-based surveys in August when up to 60 birds per hour were recorded from Vantage Point surveys.

The majority of sightings were within 2 km of the coast with relatively few records beyond 2 km from the shore. Of those recorded in flight up to 50% were recorded flying between 30 m and 150 m.

No counts of common gull from any of the surveys within Aberdeen Bay were of national importance.

4.27.4 Initial Assessment of Significance

Common gull	Overall sensitivity	Magnitude	Significance
Collision	Medium	Negligible	Negligible
Barrier	Low	Low	Negligible
Displacement	Low	Negligible	Negligible

4.27.5 Species Sensitivities

Qualifying species

There are no SPAs in the region for which common gull is a qualifying species.

Flight height

Observations from boat-based surveys recorded 33% of flight at above 25 m (n=494). Data from onshore surveys recorded up to 30% of flight heights as being above 30 m.

Elsewhere, out of 5,074 recorded flight altitudes for common gull, 21% were at rotor height.

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that common gulls are widespread throughout Aberdeen Bay, particularly between November and March (Figure 4-74).

Collision Risk Modelling undertaken for common gull is based on

- Body length of 41 cm
- Wingspan of 120 cm

- Flight speed of 13.4 $m.s^{-1}$

Collision Risk Modelling was undertaken based on a collision probability of 9.6% and across various avoidance rates of 98%, 99% and 99.5%.

Table 4-25: Predicted number of collisions per year for common gull.

Collision probability	Avoidance rate (%)		
	98	99	99.5
9.6%	4.9	2.4	1.2

Based on the precautionary avoidance rate of 98% it is predicted that a total of 4.9 collisions per year may occur (Table 4-25).

The annual mortality rate for common gull is 14% (BTO 2011). Consequently, out of a peak Aberdeen Bay population of 474 individuals in both the 'control' and potential development areas during March (Figure 4-77), an annual mortality of 66 common gulls may be predicted. Therefore, 1% of the baseline mortality is <1 bird per year. The regional coastal breeding population comprising of roof nesting birds in and around Aberdeen is estimated to be 1,240 breeding adults (Calladine *et al*. 2006) which will therefore have an annual mortality of 174 birds per year and a 1% baseline mortality of 2 birds. Should all the birds at risk of collision during the breeding season be from these colonies then it is predicted that at a 98% avoidance rate the effects from collision risk may be significant.

Based on the results from collision risk modelling, which predicts a total of nearly 5 collisions per year there may be a significant impact on common gull due to collisions.

However, studies relating to other species of gull have reported avoidance rates at greater than 99% and therefore it is predicted that the number of common gulls will be lower than has been indicated by the Collision Risk Modelling and is likely to be one to two birds per year.

Barrier effect

Evidence from existing offshore wind farms indicate that offshore wind farms do not have a significant barrier effect on Gulls and there is no evidence for any potential barrier effect to common gulls (Zucco *et al.* 2006). However, should it occur, the relatively short increase in distance, estimated to be at most 3.2 km, that common gulls may have to fly is predicted not to be significant in terms of increased energetic expenditure. Consequently, the potential impact from the barrier effect is predicted to be negligible.

Displacement

There is no evidence from any offshore wind farm that there will be any displacement effect on common gulls from offshore wind farms but should it occur its significance is predicted to be negligible.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on black-headed gulls.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available is that from the Beatrice Demonstrator Project which did not record any common gulls over a period of 12 months pre-construction surveys (Talisman 2005). The size, scale and exact locations of the Round 3 and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of common gulls that may be present in the planned development areas. However, the location of the proposed developments are further offshore and common gulls are not predicted to occur in significant numbers within these areas. Consequently, it is predicted that the risk of any cumulative or in-combination effects is low and the consequences negligible.

4.27.6 Conclusions

Habitats Appraisal

There are no SPAs within the region for which common gulls are listed as a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on breeding common gulls.

4.28 Lesser black-backed gull (*Larus fuscus*)

4.28.1 Protection & Conservation Status

The Lesser-black backed gull is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.28.2 Background

Lesser black-backed gull		
GB population	Breeding: 110,000 prs Winter: 118 – 131,000 ind.	BTO 2011
Scottish population	Breeding: 25,000 AoN Winter: 200 – 600 ind.	Forrester *et al*. 2007
International threshold	5,500 ind.	Calbrade *et al*. 2008
GB threshold	500 ind.	Calbrade *et al* 2008
Designated east coast sites where species is a noted feature	Forth Islands 2,920 prs	JNCC 2011a
European population estimate	Breeding 300,000 – 350,000 pairs Wintering – >130,000	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	910,000 – 1,100,000 'adults'	Birdlife 2011

The lesser black-backed gull breeds in colonies located around the UK coastline. There are approximately 110,000 breeding pairs in the UK, of which 21% occur in Scotland. In Scotland this species is principally a summer migrant with a small but increasing wintering population.

Lesser black-backed gulls occur in both inshore and offshore waters, often further offshore than many other species of gull during the breeding season. They are both scavengers and, offshore, fish often from fishing vessels.

In North-east Scotland the species is predominantly a summer migrant and is scarce during the winter months. At Peterhead passage of lesser black-backed gulls occurred between March and May with a peak in April with no records between October and February. The majority of sightings were within close proximity of the coast (Innes 1994).

Boat-based surveys

Only two sightings of lesser black-backed gulls were made during boat-based surveys undertaken between February 2007 and January 2008. Both were in June of birds within the proposed EOWDC survey area (IECS 2008).

A further 40 lesser black-backed gulls were recorded throughout the surveyed area during September 2010.

Vantage Point surveys

Lesser black-backed gulls were recorded in relatively low numbers at all Vantage Point sites between April and September. Peak counts occurred in June and July with up to two birds per hour recorded. Although lesser black-backed gulls were recorded out to 3 km from the shore, the vast majority were within 0-2 km from the shore. 40% of all flights were within the 30 -150 m height band. During the winter period, lesser black-backed gulls were scarce in Aberdeen Bay with nineteen records between October 2007 and March 2008 (Alba Ecology 2008b).

Bird Detection Radar

Six lesser black-backed gulls were recorded during the radar studies undertaken in October 2005 and three at Blackdog during April 2007 (Walls *et al.* 2005, Simms *et al.* 2007).

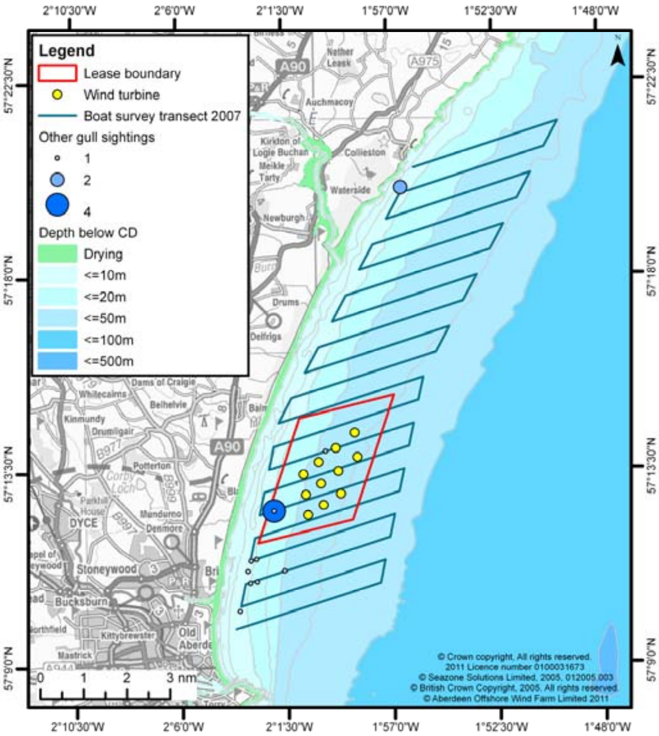


Figure 4-79: Other Gull distribution in Aberdeen Bay - February 2007 to April 2008 (all sightings).

4.28.3 Summary of Results

Lesser black-backed gulls were recorded in relatively low numbers between April and September with only two sightings from boat-based surveys and small numbers from land-based observations. Of those for which flight height was recorded, 40% were within 30 – 150 m of the sea surface.

The majority of sightings were within 2 km of the coast with relatively few records beyond 2 km from the shore.

No counts of lesser black-backed gull from any of the surveys within Aberdeen Bay were of national importance.

4.28.4 Initial Assessment of Significance

Lesser black-backed gull	Overall sensitivity	Magnitude	Significance
Collision	Very High	Low	Moderate
Barrier	Medium	Low	Minor
Displacement	Medium	Negligible	Negligible

4.28.5 Species Sensitivities

Qualifying species

The only SPA in the region for which lesser black-backed gull is a qualifying species is Forth Islands SPA where 2,920 pairs nest.

Flight height

Observations of flight altitudes were obtained from Vantage Point surveys which recorded 40% of lesser black-backed gulls as flying between 30 m and 150 m.

Elsewhere, out of 24,481 recorded flight altitudes for lesser black-backed gull, 22% were at rotor height.

Collision risk

Data obtained from boat-based and land-based surveys recorded relatively few lesser black-backed gulls nearly all within 2 km of the coast and all but one during the summer months. Data from coastal wind farms have recorded relatively low avoidance behaviour towards wind turbines by lesser black-backed gulls and they are known to collide with turbines. However, as nearly all the sightings of lesser black-backed gull were within 2 km of the coast and therefore not at risk of collision with the proposed development and there were relatively few sightings it is considered that there is a very low risk of collision and, should it occur, its significance on the species will be negligible.

Although lesser black-backed gulls are known to forage up to 300 km from their colonies and therefore those from the Forth Islands SPA may be at risk of collision with the proposed development. The majority of foraging trips are considerably smaller and therefore not at risk (Camphuysen 1995; Ens *et al.* 2008).

Barrier effect

Data from post-construction monitoring studies undertaken in Denmark and Sweden indicate that lesser black backed gulls are generally not affected by offshore wind turbines and do not avoid entering wind farms. Consequently, there is not thought to be a significant barrier effect (Zucco *et al*. 2006).

Displacement

Very few lesser black-backed gulls were recorded within the area of the proposed development and they are not known to show any significant displacement effects. There is no indication of any potential displacement effect but should it occur its significance is predicted to be negligible.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on black-headed gulls.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available is that from the Beatrice Demonstrator Project which did not record any lesser black-backed gulls over a period of 12 months pre-construction surveys (Talisman 2005). The size, scale and exact locations of the Round 3 and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of gulls that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from the proposed plans. However, based on the known behaviour of lesser black-backed gulls they may occur in the areas of the proposed developments but are predicted to be in relatively low densities it is therefore predicted that the risk of any cumulative or in-combination effects is low and the consequences negligible.

4.28.6 Conclusions

Habitats Appraisal

The only SPA for which lesser black-backed gull is a qualifying species is the Forth Islands SPA, which is 124 km away. Although within the potential foraging range of lesser black-backed gull, the numbers recorded from boat-based and land-based surveys were low and consequently it is predicted that there not be an adverse effect on the SPA.

Environmental Impact Assessment

Based on the relatively low numbers of lesser black-backed gulls recorded in Aberdeen Bay it is predicted that there will not be a significant impact arising from the proposed development on lesser black-backed gulls.

4.29 Herring gull (*Larus argentatus*)

4.29.1 Protection & Conservation Status

The herring gull is listed in Appendix III of the Bern Convention and is on the Red List of Species of Conservation Concern.

4.29.2 Background

Herring gull		
GB Population	Breeding: 131,000 pairs	BTO 2011
Scottish population	Breeding: 72,000 AoN Wintering: 91,000 ind.	Forrester *et al* 2007
International threshold	5,900 ind	Calbrade *et al*. 2010
GB threshold	4,500 ind	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Buchan Ness to Collieston – 3,079 AoN (2007) Fowlsheugh – 122 AoN (2008) Forth Islands – 6,600 prs Troup Pennan & Lion's Heads – 4,200 prs	SNH 2011 JNCC 2011a
European population estimate	Breeding 764,000 – 1,400,000 prs Wintering – >800,000	Birdlife 2004
European population trend	Status 'secure' Trend 'overall increase'	Birdlife 2004
World population	2,700,000 – 5,700,000 'adults'	Birdlife 2011

Herring gulls are widespread around the British coasts with largest concentrations along rocky coastlines of northern and western Scotland and north-west England. Following breeding, there is a general southerly movement of herring gulls with breeding birds at any one area replaced by birds from more northerly colonies. They are opportunistic feeders, scavenging and predating a wide range of foods. At sea, herring gulls forage extensively around fishing vessels.

In North-east Scotland the breeding population has decreased since the 1960's when 42,500 apparently occupied nests were recorded to 15,000 in 2002. They occur throughout the year in North-east Scotland and a spring passage has been recorded past Peterhead between March and June and peak numbers occur from July and August (Innes 1994).

Boat-based survey

Herring gulls were recorded throughout the year within Aberdeen Bay but there was distinct seasonal variations in the numbers of herring gull present with relatively low numbers present between November and March (Figure 4-81), with a significant increase in the number of birds during the breeding season, particularly in June and July (Figure 4-82; Figure 4-80). Following breeding the number of herring gulls decreased with just a few birds recorded offshore (Figure 4-83). Peak population estimates within the wider proposed EOWDC development area occurred during June and July with up to 456 birds recorded during July. Of those recorded in flight 40% of herring gulls were flying above 25 m.

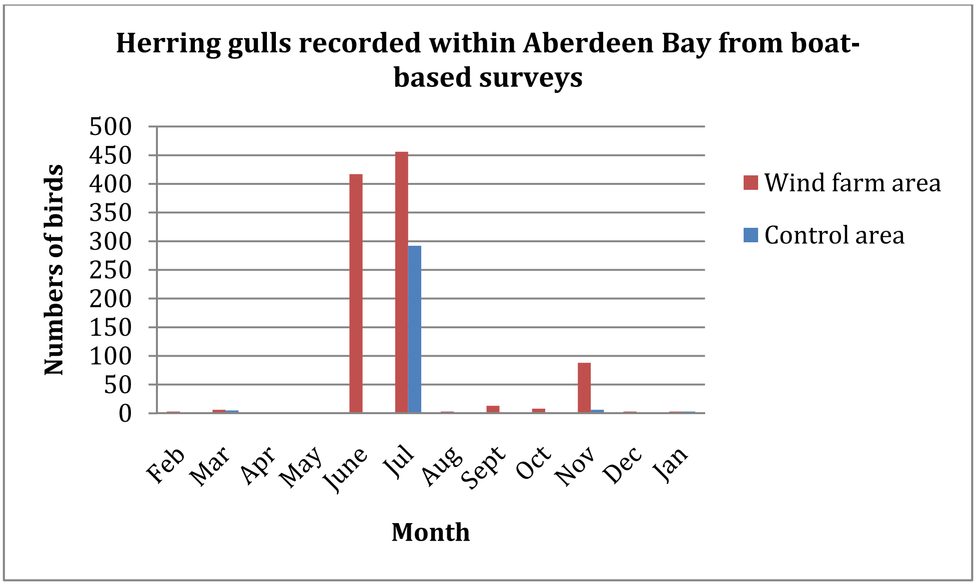


Figure 4-80: Herring gull monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

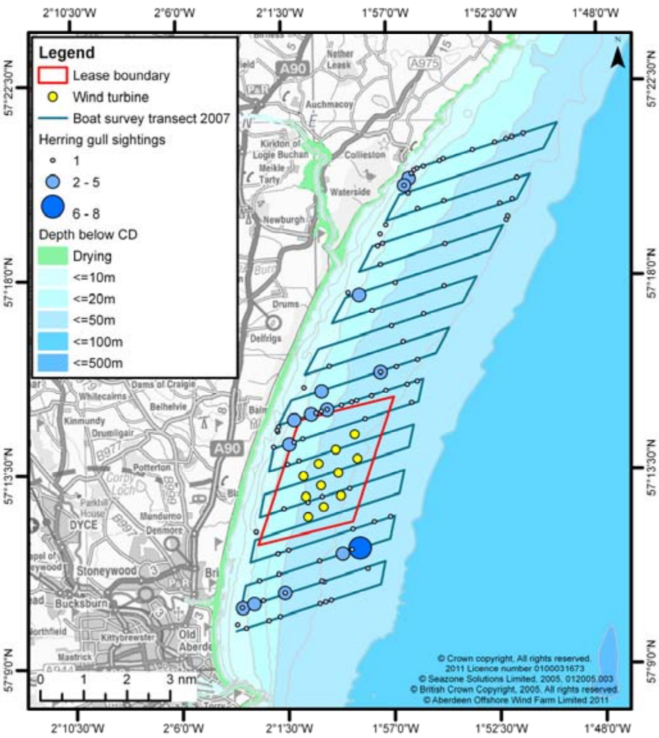


Figure 4-81: Herring gull distribution during winter period: November to March (all sightings).

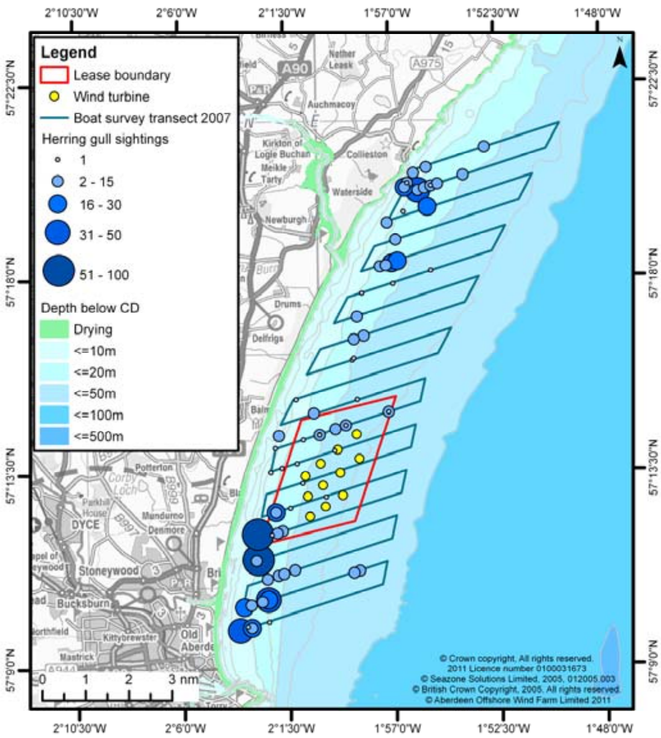


Figure 4-82: Herring gull distribution during breeding season: April, May, September and October (all sightings).

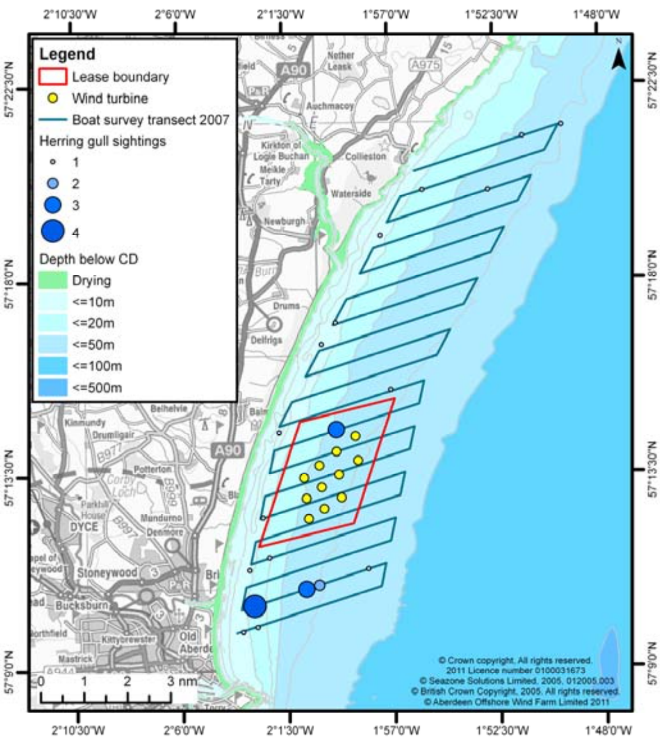


Figure 4-83: Herring gull distribution during post-breeding: June to August (all sightings).

Vantage Point surveys

Vantage point counts undertaken in Aberdeen Bay between March 2005 and October 2005 and again from April 2006 to March 2008 recorded herring gulls during every month and across all four survey sites. Peak numbers occurred during June when up to 240 birds per hour were recorded with 50% of all records within the 30-150 m height band (Alba Ecology 2008a, EnviroCentre 2007a). During the winter months herring gulls were still regularly recorded with generally less than 100 birds per hour, with a peak of 180 birds per hour at the Donmouth in March 2008 (Alba Ecology 2008b). The majority of all sightings were within 2 km of the coast with considerably fewer sightings beyond 2 km (Figure 4-84). Of those in flight 48% of herring gulls were recorded as flying between 30-150 m.

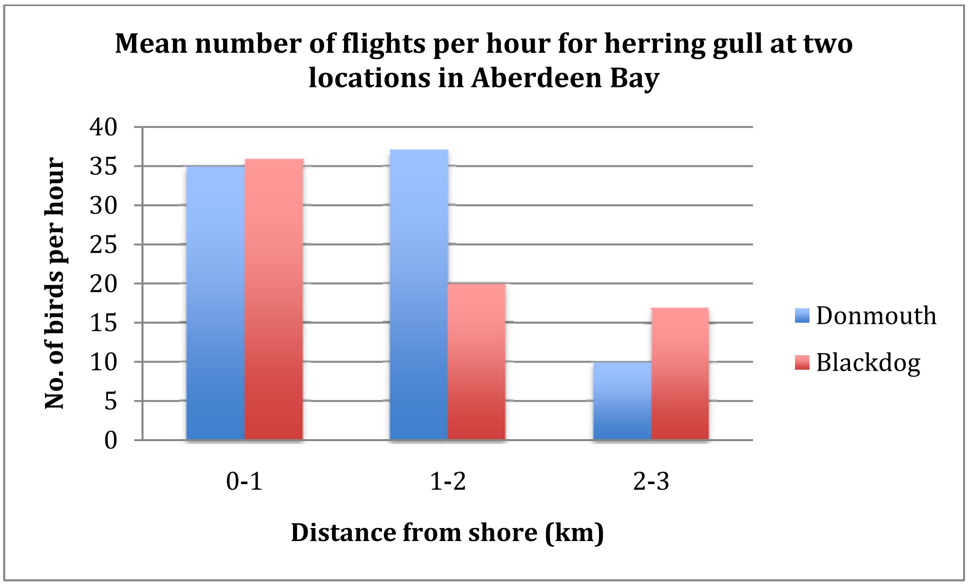


Figure 4-84: Mean number of herring gulls per hour passing two Vantage Points in Aberdeen Bay and their distance from shore.

Bird Detection Radar

Three hundred and eighty herring gulls were recorded during the Radar studies in October 2005. The majority of birds were recorded at Drums where 86% of all sightings occurred (Walls *et al.* 2005).

A total of 34 herring gulls were recorded during seventeen days of observations undertaken at Blackdog during April 2007 (Simms *et al.* 2007).

4.29.3 Summary of Results

Herring gulls were recorded throughout the year with peak numbers from boat-based surveys during June and July and relatively few records during other times of year. Land-based observations recorded higher numbers of herring gulls than the boat-based surveys in particular during the winter and spring periods when few if any were seen offshore.

The majority of sightings were within 2 km of the coast with relatively few records beyond 2 km from the shore. Of those recorded in flight up to 50% were recorded flying between 30 m and 150 m.

No counts of herring gull from any of the surveys within Aberdeen Bay were of national importance.

4.29.4 Initial Assessment of Significance

Herring gull	Overall sensitivity	Magnitude	Significance
Collision	Very High	Low	Moderate
Barrier	Medium	Medium	Minor
Displacement	Medium	Negligible	Negligible

4.29.5 Species Sensitivities

Qualifying species

Herring gull is a qualifying species for four SPAs that could potentially interact with the proposed development: Buchan Ness to Collieston, Fowlsheugh and Forth Islands SPAs, Troup Pennan & Lion's Heads.

Flight height

Flight altitude data obtained from boat-based surveys reported 40% of flights at above 25 m.

Elsewhere, out of nearly 15,000 recorded flight altitudes for herring gull 24% were at rotor height.

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that herring gulls are widespread and frequent within Aberdeen Bay and with a distinct seasonal peak during the summer months.

Collision Risk Modelling undertaken for herring gull is based on:

- Body length of 60 cm
- Wingspan of 144 cm
- Flight speed of 13.4 $m.s^{-1}$

The Collision Risk Modelling is based on a collision probability of 11% and been undertaken over a range of avoidance rate from 98%, 99% and 99.5% have been used.

Table 4-26: Predicted number of collisions per year for herring gull.

Collision probability	**Avoidance rate (%)**		
	98	99	99.5
11%	7.2	3.6	1.8

Based on the precautionary avoidance rate of 98% it is predicted that a total of 7.2 collisions per year may occur (Table 4-26).

Based on the regional SPA population of herring gulls of 19,562 individuals, the annual mortality rate will be 2,347 individuals and therefore the 1% baseline mortality rate will be 235 birds per year. The results from the Collision Risk Modelling predict a total of 7 herring gulls per year may collide with the turbines.

The Buchan Ness to Collieston Coast SPA lies approximately 9.5 km away from the proposed development and holds approximately 6,158 breeding herring gulls. Based on the latest available counts in 2007. The colony will therefore have an annual mortality of 739 birds. It is likely that many of herring gulls recorded within Aberdeen Bay during the breeding period are associated with this colony. The results from the collision risk modelling predict an annual mortality of 7 herring gulls per year indicating that there will not likely be an adverse effect on the population of herring gulls associated with the SPA based on the precautionary assumption that an increase of 1% above baseline mortality could be adverse, i.e. more than 8 herring gulls a year collide with the turbines. However, the predicted mortality of 7 birds per year is close but it is based on a series of precautionary figures that assume the peak numbers recorded within the development area are constant throughout the year. It is therefore predicted that the number estimated to collide each year is precautionary as is the avoidance rates which have been reported as being greater than 99%.

The Fowlsheugh SPA lies 31 km away from the proposed development and holds 122 breeding pairs of herring gull based on latest counts. Therefore, the annual mortality rate from this colony is 14 birds per year. Based on the results from the collision risk modelling it is concluded that if all the herring gulls at risk of collision are from Fowlsheugh then there is the potential for an adverse effect on the SPA population

The Forth Islands SPA is approximately 124 km away and holds 13,200 herring gulls. However, the SPA is too far away for breeding herring gulls from the SPA to occur regularly, if at all, within the proposed development area during the breeding season. Therefore, there will not be an adverse effect on the population due to collision.

The number of herring gulls recorded within the proposed development area was lower than elsewhere, with the majority of sightings within 2 km of the coast (Figure 4-84). Data from tagging studies confirms that although maximum foraging distances may mean that birds from the SPAs could occur within the proposed development area they also show that the majority of foraging is very coastal and within the tidal zones. Consequently, it is predicted that that the potential affect from collision risk on herring gulls is moderate to minor.

Barrier effect

Data from post-construction monitoring studies undertaken in Denmark and Sweden indicate that although herring gulls may make some avoidance response they are generally not affected by offshore wind turbines and do not avoid entering wind farms. Consequently, there is not thought to be a significant barrier effect on herring gulls from the proposed development (Zucco *et al*. 2006).

Displacement

There have been no reported displacement effects on herring gulls from offshore wind farms but some evidence of an increase in numbers within the constructed offshore wind farm areas. No displacement is predicted.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on herring gulls.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available is that from the Beatrice

Demonstrator Project which recorded 193 herring gulls over a period of 12 months of pre-construction surveys (Talisman 2005). The size, scale and exact locations of the Round 3 and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of gulls that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from the proposed plans. However, based on the known behaviour of herring gulls and that they remain largely within coastal waters it is predicted that the risk of any cumulative or in-combination effects is low and the consequences negligible.

4.29.6 Conclusions

Habitats Appraisal

There are three SPAs for which herring gulls are a qualifying species in the region and based on the results from the Collision Risk Modelling which predicts an annual collision mortality rate of up to seven birds per year and the likely foraging ranges herring gulls it is predicted that there will not be an adverse effect on the Forth Islands SPA but may be one for Fowlsheugh SPA.

Environmental Impact Assessment

Based on the results from Collision Risk Modelling undertaken and the potential number of herring gulls, which may collide with the proposed development and the likely foraging ranges of the herring gulls present in the region it is predicted that there will not be a significant impact arising from the proposed development on regional population of herring gulls.

4.30 Great black-backed gull (*Larus marinus*)

4.30.1 Protection & Conservation Status

The great-black backed gull is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.30.2 Background

Great black-backed gull		
GB population	Breeding: 17,000 prs Winter: 71 – 81,000 ind	Mitchell *et al* 2004 BTO 2011
Scottish population	Breeding: 14,800 AoN Winter: 7,500 – 10,000 ind	Forrester *et al*. 2007
International threshold	4,400 ind.	Calbrade *et al 2010*
GB threshold	400 ind.	Calbrade *et al.* 2010
Designated east coast sites where species is a noted feature	None	SNH 2011 JNCC 2011a
European population estimate	Breeding 110,000 – 180,000 pairs Wintering – >150,000	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	540 – 750,000 'adults'	Birdlife 2011

The great black-backed gull is Britain's largest breeding gull. It occurs widely around UK coast, particularly in areas of rocky coastlines. It is an opportunistic feeder being a predator, scavenger and food pirate and frequently occurs around fishing vessels.

The UK population is approximately 17,000 pairs of which 14,800 are in Scotland and of those, the majority are in the north and west of Scotland. In North-east Scotland the great black-backed gull is a scarce breeding species with 72 pairs in 2002 (Forrester *et al.* 2007). The UK population is largely sedentary with some localised winter movements and migrants from northern Europe arriving during the winter.

In North-east Scotland great black-backed gulls occur around all coasts with numbers increasing from July and August onwards. No obvious passage of birds was detected at Peterhead during the ten years of observations undertaken between 1978 and 1988 (Innes 1994).

Boat-based surveys

Great black-backed gulls were recorded widely across Aberdeen Bay, predominantly within 1 to 2 km form the coast, throughout the year in relatively low numbers (Figure 4-85). Peak counts from boat-based surveys were during June with 127 birds in transect with relatively lower numbers during other months. The peak count in June included 123 birds within the EOWDC area that were associated with a fishing vessel and therefore causing a potentially inflated number of birds in a localised area. Aside from the peak count in June there was a notable increase in numbers during the autumn from September to December (Figure 4-86). Additional surveys undertaken between August 2010 and January 2011 recorded only five birds in August and increased up 19 birds across the whole surveyed area during November and January (SMRU 2011b).

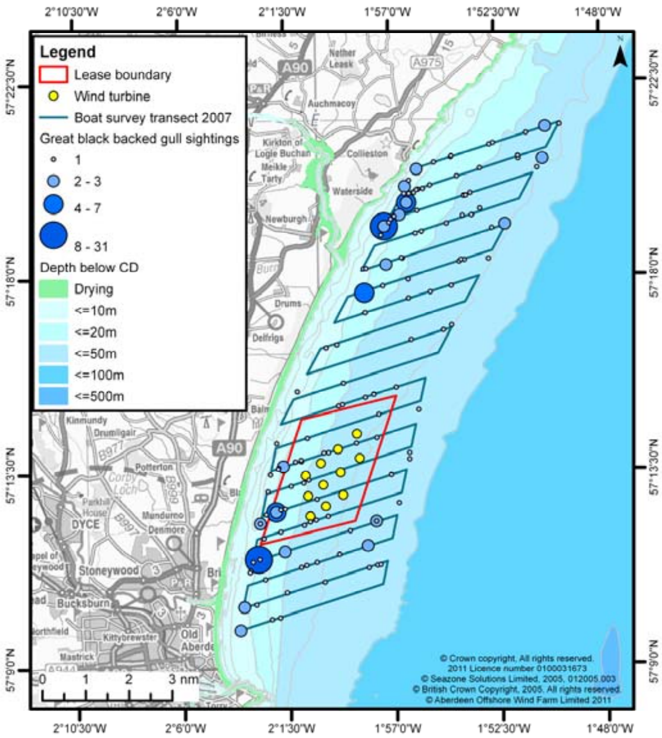


Figure 4-85: Great black-backed gull distribution in Aberdeen Bay February 2007 to January 2008 (all sightings).

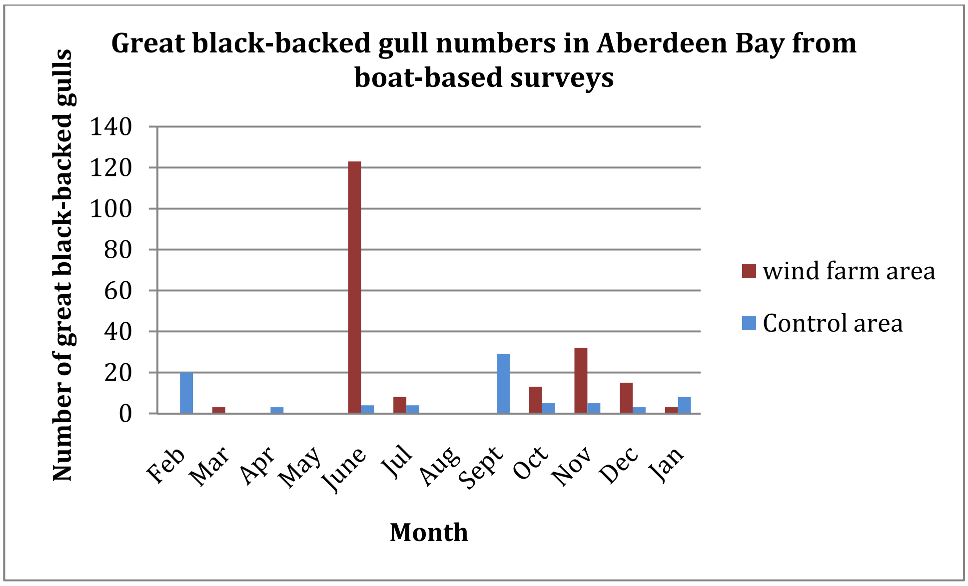


Figure 4-86: Great black-backed monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

Vantage Point surveys

Great black-backed gulls were recorded in Aberdeen Bay throughout the year with peak counts of up to 15 birds per hour in June 2006 and eight birds per hour in August 2007 (Alba Ecology 2008a, EnviroCentre 2008a). Relatively low numbers of six or less birds per hour were recorded during the rest of the year (EnviroCenter

2007b, Alba Ecology 2008b). Recorded flight heights of 'black-backed gulls' (both lesser and great-black-backed) indicate that 40% of all flights occur within 30-150 m from sea surface and the majority of flights are within 1 km of the coast.

Bird Detection Radar

A total of 41 great-black-backed gulls were recorded during Bird Detection Radar studies in October 2005 (Walls *et al*. 2005) and one bird was recorded during 17 days of observations in April 2007 (Simms *et al.* 2007).

4.30.3 Summary of Results

Great black-backed gulls were recorded in relatively low numbers throughout the year. Peak counts occurred in June when a flock was recorded associating with a fishing vessel. Land-based observations also recorded peak numbers during June and August. Outwith the breeding season the numbers of great black-backed gulls were lower. Of those for which flight height was recorded, 40% were within 30 - 150 m of the sea surface.

The majority of sightings were within 1 km of the coast with relatively few records beyond 1 km from the shore.

No counts of great black-backed gull from any of the surveys within Aberdeen Bay were of national importance.

4.30.4 Initial Assessment of Significance

Great black-backed gull	Overall sensitivity	Magnitude	Significance
Collision	High	Low	Minor
Barrier	Low	Low	Negligible
Displacement	Low	Negligible	Negligible

4.30.5 Species Sensitivities

Qualifying species

There are no SPAs in the region for which great black-backed gull is a qualifying species.

Flight height

Observations of flight altitudes were obtained from boat-based Surveys recorded 60% of great black-backed gulls as flying above 25 m.

Elsewhere 28% of great black-backed gulls have been recorded at rotor height.

Collision risk

Data obtained from boat-based and land-based surveys recorded relatively few great black-backed gulls with nearly all sightings within 2 km of the coast. Consequently, it is considered that there is a very low risk of collision and, should it occur, its significance on the species will be negligible.

Barrier effect

Data from post-construction monitoring studies undertaken in Denmark indicate that there is no barrier effect on great black backed gulls from constructed wind farms (Zucco *et al*. 2006).

Displacement

Data from operating wind farms indicate that great black-backed gulls may be attracted to offshore wind farms and that there are no displacement effects.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause a cumulative impact on black-headed gulls.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available is that from the Beatrice Demonstrator Project which recorded 424 great-black backed gulls and predicted six collisions per year (Talisman 2005). The size, scale and exact locations of the Round 3 and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of gulls that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be a cumulative impact arising from the proposed plans. Based on the known behaviour of great black-backed gulls they may occur in the areas of the proposed developments and be at risk of collision. However, based on the location and scale of the proposed development any cumulative impact will be relatively small and predicted to be negligible.

4.30.6 Conclusions

Habitats Appraisal

There are no SPAs in the region for which great black-backed gull is a qualifying species.

Environmental Impact Assessment

Based on the low numbers of great black-backed gulls recorded and that most sightings were within 2 km from the coast it is predicted that there will not be a significant impact arising from the proposed development on great black-backed gulls.

4.31 Little tern (*Sterna albifrons*)

4.31.1 Protection & Conservation Status

The Little tern is listed in Annex I of the Birds Directive, Schedule I of the Wildlife and Countryside Act, Appendix II of the Bonn Convention, Appendix II of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.31.2 Background

Little tern		
GB population	Breeding: 1,900 prs	Mitchell *et al* 2004
Scottish population	Breeding: 331 AoN	Forrester *et al.* 2007
International threshold	490 ind.	Calbrade *et al*. 2010
GB threshold	50 ind	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Ythan Estuary Sands of Forvie and Meikle Loch – 36 pairs (2009) Firth of Tay & Eden Estuary (0 pairs)	SNH 2011 JNCC 2011a
European population estimate	Breeding 35,000 – 55,000 Wintering – none	Birdlife 2004
European population trend	Status 'declining' Trend 'moderate decline'	Birdlife 2004
World population	190,000 – 410,000	Birdlife 2011

The little tern is the smallest of Britain's terns, nesting in small colonies along sand and shingle beaches where they often suffer from disturbance and predation.

They arrive from their West African wintering grounds from April onwards and depart in August and September. They feed on small fish, foraging in close in-shore waters.

In North-east Scotland only sixteen little terns were recorded during ten years of observations at Peterhead. All were recorded between May and August and were within a few hundred metres of the shore. Little terns breed in the region at the Ythan Estuary where they return from their wintering grounds at the end of April. The numbers nesting varies considerably across years with many years having only a few pairs and others occasionally over 70 pairs nesting. The number of young fledged also varies considerably with most years producing only a few young due to predation and weather. During years where nests fail early on birds may leave the region by the end of June and early July but in years where nesting has been successful birds may remain in the area through to August or early September (Buckland, Bell & Picozzi 1990; NESBR).

Boat-based surveys

No little terns were recorded from any of the boat-based surveys.

Vantage Point surveys

Nine little terns were recorded during May 2005 but none from Vantage Point counts between May and August 2006 and only 11 during the same period in 2007 (Alba Ecology 2008a). The only sighting in 2006 was of six birds in September 2006 (EnviroCentre 2007a). All sightings were within 1 – 2 km of the coast and flying below 30 m.

Bird Detection Radar

There were no records of little tern from surveys undertaken during the radar studies.

4.31.3 Summary of Results

Very few little terns were recorded from any of the surveys undertaken during the study. There were no sightings from boat-based surveys and only 11 little terns over nearly three years of Vantage Point surveys undertaken between May and August 2006 and 2007. There were six birds in September 2006. All sightings were of birds flying below 30 m.

No counts of little tern from any of the surveys within Aberdeen Bay were of national importance.

4.31.4 Initial Assessment of Significance

Little tern	Overall sensitivity	Magnitude	Significance
Collision	Very High	Negligible	Moderate
Barrier	Medium	Low	Minor
Displacement	Medium	Negligible	Negligible

4.31.5 Species Sensitivities

Qualifying species

The little tern is a qualifying species for the Ythan Estuary, Sands of Forvie and Meikle Loch SPA where 36 pairs nested in 2009 and Firth of Tay and Eden Estuary where they last bred in 2007 and now no pairs breed.

Flight height

The only records of little tern were from Vantage Point surveys, which recorded a total of 18 little terns, all of which were flying below 30 m.

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that relatively few little terns occur in Aberdeen Bay and when they do they remain within 2 km of the coast and below turbine height. Consequently, it is predicted that the risk of a collision by little tern with the proposed development is extremely low.

Little terns typically forage between 3 m – 8 m above the surface and are therefore at low risk of collision (ECON 2006). Collisions of turbines by little terns have been reported from Zeebrugge harbour where an array of turbines are lined up along the harbour wall across which little terns fly to and from their colonies (Everaert & Stienen 2006). There have been no other collisions reported from other offshore wind farms where little terns occur.

Based on the small number of little terns potentially occurring within the proposed development area and the low flight heights it is predicted that the risk of collision is low.

Barrier effect

Studies undertaken in UK and Belgium have shown that there is unlikely to be a barrier effect with little terns recorded foraging within operating wind farms and no evidence of any strong avoidance behaviour. As little terns forage predominantly within 2 km of the coast there will not be a barrier effect.

Displacement

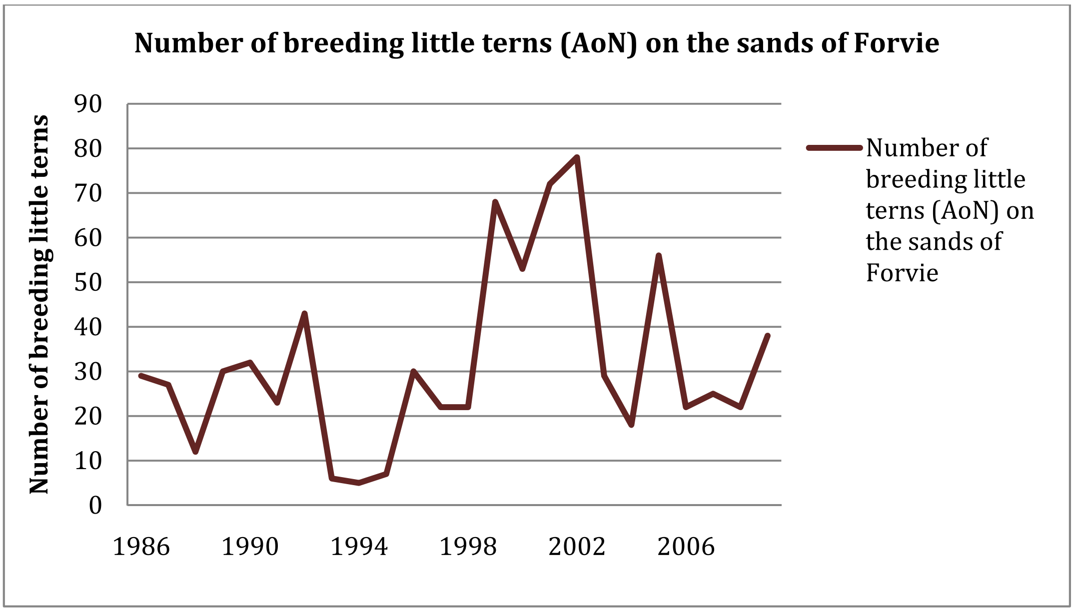
Evidence from studies undertaken in Belgium and the UK have not shown any evidence of a displacement effect. Four years of intensive studies undertaken at Scroby sands offshore wind farm reported that following construction there was a greater use of the area than there had been previously. This increase in use was thought to be due to the formation of a new sand bar within the wind farm thus providing better foraging opportunities (ECON 2008). Consequently, it is predicted that there will be no displacement effects on little terns due to potential development.

Disturbance

Little terns may not be impacted directly by activities associated with the proposed development. i.e. vessel movements, but evidence from monitoring undertaken at Scroby Sands indicates that there is the potential for a secondary impact should the prey of little terns be affected (ECON 2008). Little terns forage on small fish often, young clupeids. Monitoring undertaken at Scroby Sands recorded a reduction in the availability of young herring following the construction of a wind farm by pile-driving and a subsequent breeding failure of little terns (ECON 2008). The little terns were able to compensate for the reduction in available prey by foraging further afield and changing prey items and there has not been any evidence of an overall population decline in the number of little terns in the area but the locations where the terns foraged and the sizes of colonies have varied. Breeding success varies considerably across years and the size of the colonies may change significantly from one year to the next. Consequently, the link between the decline in young herring, and subsequent localised reduction in tern breeding success, being caused by the construction of the wind farm has not been confirmed. However an effect on little tern breeding success could not be discounted.

The significance of any potential effect depends on the scale of displacement and its duration. It also depends on whether other suitable foraging areas can be located. Although these are difficult to predict any potential impacts upon prey are expected to be relatively short-term as they should affect only one or two breeding seasons depending on whether significant pile-driving takes place and whether construction is undertaken over one or two years. Following cessation of construction new juvenile fish will be available the season following construction.

The numbers of breeding little terns breeding at the Sands of Forvie each year is highly variable as is their breeding success with many years where they fail to produce many, if any young (Figure 4-87).



AoN = Apparently Occupied Nest (Adapted from JNCC 2011b and NESBR)

Figure 4-87: Numbers of breeding little terns at the Sands of Forvie since 1986.

Based on the evidence from studies undertaken at Scroby Sands, there is the potential for a moderate effect on little terns should the construction of the proposed development cause a significant decline in potential prey items of little terns during the breeding season. However, should it occur it is predicted that the duration of impact would last no longer than one or two seasons as juvenile fish will be available the following season.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts.

Although there are other planned offshore wind farms none are in areas where little terns will likely occur and therefore no cumulative or in-combination impacts are predicted.

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating both a very low collision risk, little or no displacement and that there are not expected to be any barrier effects; it is predicted that there will not be any adverse effects on the SPA for which little tern is a qualifying species. However, should pile-driving be undertaken, there is the potential for an impact on the prey of little terns during the construction period. If this occurs there is the potential for a localised adverse effect during the construction periods but thereafter breeding success would not be affected by the proposed development. Little terns regularly have unsuccessful breeding seasons and therefore the population can withstand one or two poor breeding seasons should they occur without having an adverse effect on the population.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on little tern. Although impacts arising from the potential reduction in the availability of suitable prey species during the breeding season could have a temporary impact.

4.32 Sandwich tern (*Sterna sandvicensis*)

4.32.1 Protection & Conservation Status

The Sandwich tern is listed in Annex I of the Birds Directive, Appendix II of the Bonn Convention, Appendix II of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.32.2 Background

Sandwich tern		
GB population	Breeding: 11,000 prs	Mitchell *et al* 2004
Scottish population	1,100 AoN	Forrester *et al*. 2007
International threshold	1,700 ind.	Calbrade *et al*. 2010
GB threshold	200 ind.	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Ythan Estuary, Sands of Forvie and Meikle Loch: 645 prs (2009) Loch of Strathbeg: 1 pr (2010) Firth of Forth: 1,617 ind. (passage) Forth Islands: 0 prs (2010)	SNH 2011 JNCC 2011a
European population estimate	Breeding 82 – 130,000 pairs Wintering – unknown	Birdlife 2004
European population trend	Status 'depleted' Trend 'small decline'	Birdlife 2004
World population	490 – 640,000 individuals	Birdlife 2011

Sandwich terns are regular summer migrants to UK waters and breed at coastal colonies on undisturbed beaches. They regularly move colonies and numbers at each colony can vary considerably across years.

Birds return to their breeding grounds during April and remain in the area until the autumn. The number of terns breeding is highly variable and their success depends on the availability of suitable prey, predation and weather. Sandwich terns forage offshore for small fish species, particularly sandeels and clupeids. The distance that they forage varies depending on prey availability with distances of up to 67 km reported.

The British breeding population is approximately 11,000 pairs of which 1,100 pairs breed in Scotland.

In North-east Scotland Sandwich terns breed at the Sands of Forvie where up to 1,800 pairs have bred although recent counts have been lower and occasionally at the Loch of Strathbeg where recently very small numbers have attempted to breed.

At Peterhead Sandwich terns have been recorded from March to October with peak numbers of up to three birds per hour in May and June.

Boat-based surveys

Although Sandwich terns are a common breeding species at the nearby Sands of Forvie, relatively few were recorded from boat-based surveys undertaken in the proposed development area. A total of five Sandwich terns were recorded within the proposed EOWDC survey area, all in May. Larger numbers were recorded in the area to the north of the proposed EOWDC area where a total of 43 birds were recorded between May and July (Figure 4-88; Figure 4-89). Nearly all sightings were of birds inshore and in water depths of less than 10 m (IECS 2008).

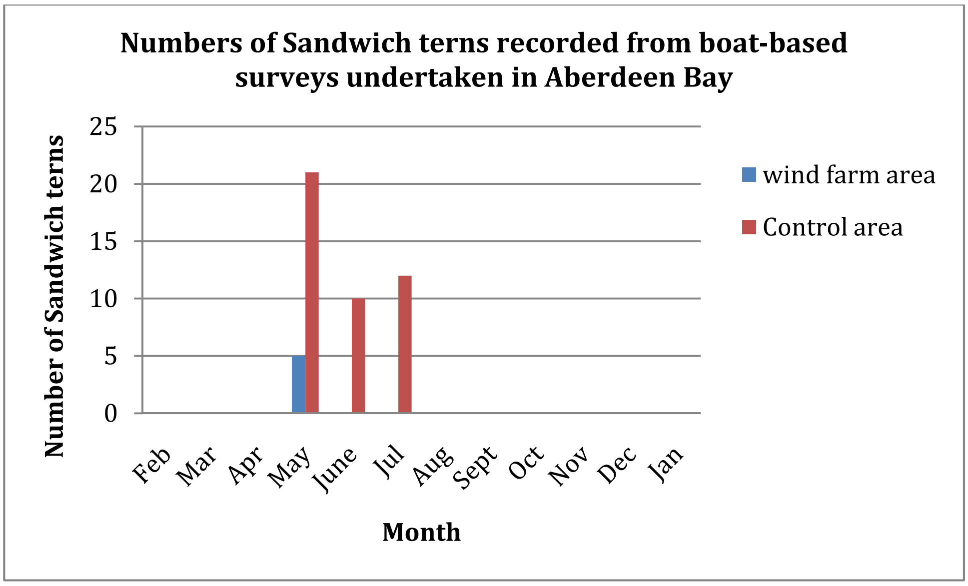


Figure 4-88: Sandwich tern monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

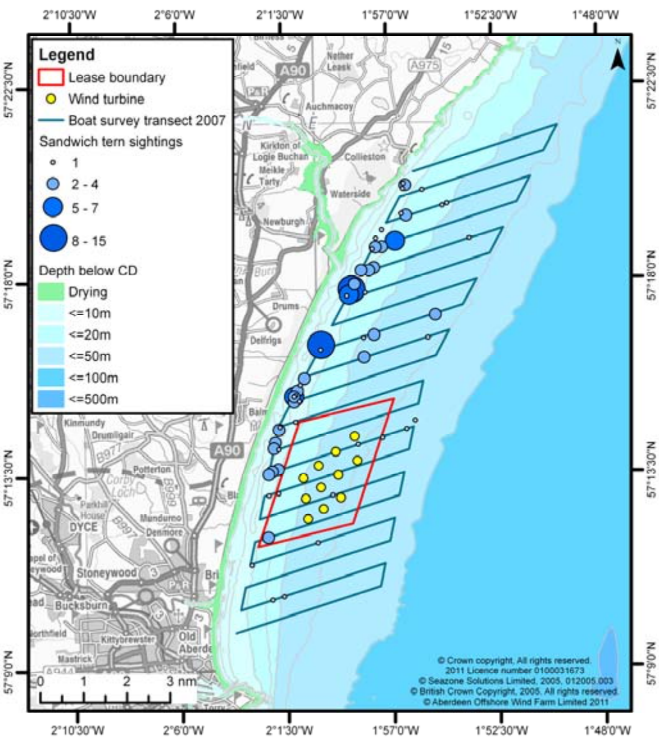


Figure 4-89: Sandwich tern distribution in Aberdeen Bay during breeding season: April – August (all sightings).

Vantage Point surveys

Sandwich terns occur in Aberdeen Bay from March through to October with peak counts in May when up 100 birds per hour were recorded, and August 2007 when up to 300 birds per hour were recorded (Alba Ecology 2008a). A significant decrease in the number of birds was recorded in Aberdeen Bay during the breeding season of June and July with generally less than 50 birds per hour passing. Birds were recorded predominantly within the 0-2 km of the shore with few records beyond 2 km

(Figure 4-90). Of those for which flight height was recorded at least 44% were recorded at between 30-150 m above the sea surface.

Bird Detection Radar

There were no sandwich terns recorded during the radar surveys undertaken at Drums and Easter Hatton during October 2005. In April 2007 a total of 298 Sandwich terns were recorded from Blackdog at a rate of nearly six birds per hour (Simms *et al*. 2007). All sightings were within 2 km from shore but this may in part be due to birds being missed further offshore.

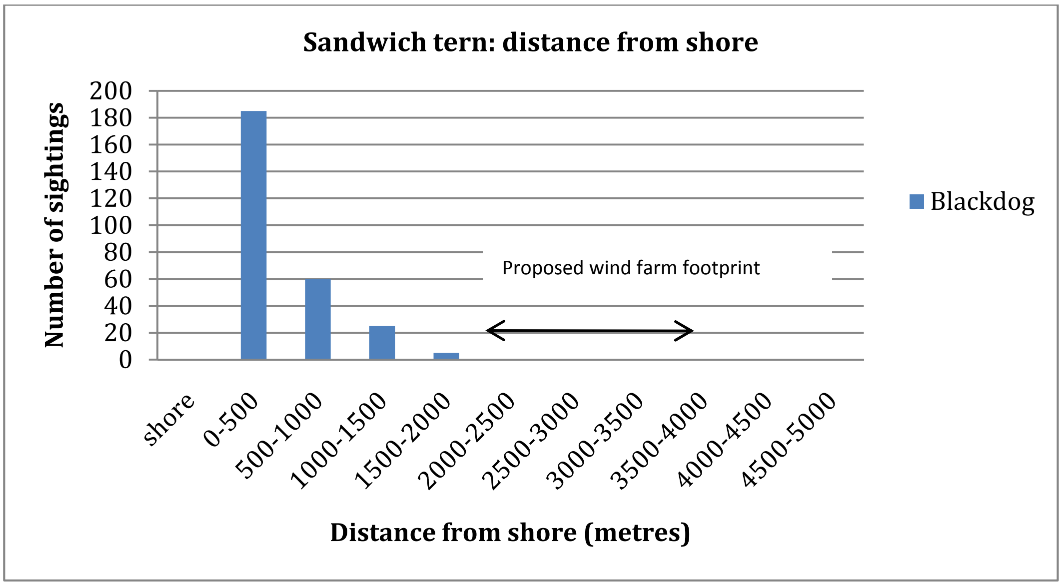


Figure 4-90: Distances from shore for Sandwich terns from Blackdog (April 2007).

4.32.3 Summary of Results

Relatively few Sandwich terns were recorded from boat-based surveys undertaken in Aberdeen Bay. Peak numbers were in May and August with lower numbers during the period of chick rearing in June and July. The majority of sightings were within 500 m from shore with few sightings of birds beyond 2 km. Of those recorded in flight, 44% of Sandwich terns were flying between 30 – 150 m.

No counts of Sandwich tern from any of the surveys within Aberdeen Bay were of national importance.

4.32.4 Initial Assessment of Significance

Sandwich tern	Overall sensitivity	Magnitude	Significance
Collision	Very High	Low	Moderate
Barrier	Medium	Medium	Minor
Displacement	Medium	Medium	Minor

4.32.5 Species Sensitivities

Qualifying species

The Sandwich tern is a qualifying species for the Ythan Estuary, Sands of Forvie and Meikle Loch SPA & Ramsar where 645 pairs nested in 2009; Loch of Strathbeg where 1 – 2 pairs nested in 2010, Forth Islands where no Sandwich terns now breed and the Firth of Forth which supports a post-breeding (passage) population of 1,617 individuals.

Flight height

Data from boat-based surveys recorded 4% of all flights at above 25 m, whereas 44% of those from Vantage Point Counts were reported as being at rotor height. Elsewhere, 12% of all flights have been reported as being at rotor height (n=5,080).

Collision risk

Collision Risk Modelling undertaken for sandwich tern is based on:

- Body length of 38 cm
- Wingspan of 100 cm
- Flight speed of 10.5 $m.s^{-1}$

The Collision Risk Modelling is based on a collision probability of 11.8% and been undertaken over a range of avoidance rate from 98%, 99% and 99.5% have been used.

Table 4-27: Predicted number of collisions per year for Sandwich tern.

Collision probability	Avoidance rate (%)		
	98	99	99.5
11.8%	0.4	0.2	0.1

Based on the precautionary avoidance rate of 98% it is predicted that a total of 0.4 collisions per year may occur (Table 4-27).

The annual mortality rate for Sandwich tern is 11% (BTO 2011).

Based on the regional SPA population of Sandwich tern of 645 breeding pairs the annual mortality rate will be 142 individuals and therefore the 1% baseline mortality rate is 1.4 birds per year. The results from the Collision Risk Modelling predict a total of less than 1 bird per year may collide with the wind turbines.

Collision Risk Modelling has been undertaken based on the higher 12% of all flights at rotor height as reported from other offshore wind farms. The results from the modelling indicate an annual mortality rate of 1.2 birds per year, which is similar to the 1% baseline mortality rate.

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that relatively few Sandwich terns occur in area of the proposed development with nearly all sightings within 2 km of the coast and the majority within 1 km.

Data from existing offshore wind farms have reported relatively high number of collisions of sandwich tern with wind turbines (e.g. Everaert & Stienen 2006). However they have also demonstrated high avoidance rates of more than 99%. The number of collisions recorded has been largely due to the high number of transits made by the Sandwich terns at the sites. Site specific data indicates a low usage of the proposed development area and low numbers of transits across the site consequently a low risk of collision.

Based on the small numbers of sandwich terns recorded within the proposed development area and the relatively high avoidance rates reported for Sandwich terns, it is predicted that the risk of collision is low and the significance negligible.

Barrier effect

Studies undertaken in UK and Belgium have shown that there is unlikely to be a barrier effect with sandwich terns recorded foraging within operating wind farms and no evidence of any strong avoidance behaviour. As the Sandwich terns in Aberdeen Bay forage predominantly within 2 km of the coast and there will not be a barrier effect.

Displacement

Evidence from studies undertaken in Belgium and the UK have not shown any evidence of a displacement affect on Sandwich terns with birds entering operating wind farms. Therefore, predicted that any potential impact from displacement will be negligible.

Disturbance

As with little terns, Sandwich terns are not predicted to be impacted directly by disturbance from construction or operating vessels. However, they could, in theory, be impacted indirectly if the construction of the proposed project has an impact on the availability of their prey. However, unlike with little terns this potential impact has not been reported from any offshore wind farm.

Sandwich terns feed predominantly on sandeels and clupeids (young herring) and should they be impacted by construction activities in the vicinity of the proposed development then Sandwich terns may have to either forage more widely or find alternative prey. It is not possible to determine whether either possible impacts are potentially likely but Sandwich terns do forage widely in the coastal waters of Aberdeen Bay and appear not to occur in the EOWDC area so those that are effected may be able to relocate should their be a localised effect.

There is no evidence of an indirect impact on breeding Sandwich terns from other constructed offshore wind farms but there is the potential for a temporary moderate effect on Sandwich terns should the construction of the proposed development cause a significant decline in the prey of Sandwich during the breeding season. If this effect occurs it is predicted that it would last no longer than a single season before fish numbers returned back to the population levels prior to construction.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts.

Outwith Aberdeen Bay there are further planned wind farms in the Moray Firth and Firth of Forth areas. The exact locations, size and type of turbines are unknown and no site specific data are available to inform the cumulative or in-combination assessment.

Surveys undertaken at the Beatrice Demonstrator Project located in the Moray Firth did not record any Sandwich terns and there are no Sandwich tern colonies in the Moray Firth area. Therefore, Sandwich terns are unlikely to occur regularly in the Moray Firth. Sandwich tern is a qualifying species for its post-breeding passage population in the Firth of Forth SPA and as breeding species in the Forth Islands SPA. The SPA citation for the Forth Islands states 22 pairs of Sandwich tern but no pairs have nested there in recent years.

The detailed distribution of Sandwich terns in the Firth of Forth is unknown and there are no site specific data available to indicate whether Sandwich terns occur in the vicinity of the planned offshore wind farms. However, published seabirds at sea data indicate low densities occurring in the Firth of Forth area during the summer months with no records offshore during September or October (Stone *et al.* 1995). The Firth of Firth SPA is also approximately 124 km away from the proposed development and therefore the risk of any cumulative or in-combination impacts are low.

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating both a very low collision risk, little or no displacement and that there are not expected to be any barrier effects; it is predicted that there will not be any adverse effects on the SPA for which Sandwich tern is a qualifying species. However, should there be an impact on the prey items of Sandwich terns during the construction period then there is the potential for a short-term adverse effect for a single season but after which no adverse effects are predicted.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on sandwich tern. Although impacts arising from the potential reduction in the availability of suitable prey species during the breeding season could be possible.

4.33 Common tern (*Sterna hirundo*)

4.33.1 Protection & Conservation Status

The common tern is listed in Annex I of the Birds Directive, Appendix II of the Bonn Convention, Appendix II of the Bern Convention and is on the Green List of Species of Conservation Concern.

4.33.2 Background

Common tern		
GB population	10,000 prs	BTO 2011
Scottish population	4,800 AoN	Forrester *et al.* 2007
International threshold	1,900 ind	Calbrade *et al*. 2010
GB threshold	200 ind	Calbrade *et al*. 2010
Designated east coast sites where species is a noted feature	Ythan Estuary, Sands of Forvie and Meikle Loch – 6 pairs (2006). Forth Islands 378 prs	SNH 2011 JNCC 2011a
European population estimate	Breeding 270 – 570,000 pairs Wintering – unknown	Birdlife 2004
European population trend	Status 'secure' Trend 'stable'	Birdlife 2004
World population	1.6 – 4,600,000 individuals	Birdlife 2011

Common terns are a widespread summer visitor to the UK, arriving from their wintering grounds off West Africa during April and May and departing in August and September. They nest colonially along coasts and inland along rivers and freshwater bodies. Coastal breeders feed predominantly on small fish, which are caught by plunge diving in nearshore waters, shallow bays and lagoons. They have however been reported to forage up to 34 km from their breeding sites.

There are approximately 10,000 pairs in Britain of which approximately 4,800 nest in Scotland. In North-east Scotland common terns are found along all the region's coasts with the largest coastal breeding colonies at the Sands of Forvie. They also breed inland of Aberdeen and birds from these colonies may forage offshore. Peak numbers arrive during May and the birds remain in the region until August and September.

The identification of common and Arctic tern is difficult at any range and consequently records of distant passing birds are not assigned to either species and are recorded as 'commic' terns.

Passage of 'commic' terns past Peterhead occurs from April to September with peak numbers of up to 40 birds per month during July. Most records were of birds within several hundred metres from the shore.

Boat-based survey

Common terns were recorded from boat-based surveys between May and September. Peak counts occurred in June with a population estimate of 264 birds in the 'control' area and 55 birds in the proposed development area (IECS 2008). There were no records of common terns from boat-based surveys between October and March in the first year of data collection but eight were recorded during September 2010. There were no confirmed sightings of common tern within the proposed development area although two birds were recorded as either common or Arctic tern. The majority of sightings were to the north near the Ythan Estuary (Figure 4-92 and Figure 4-93).

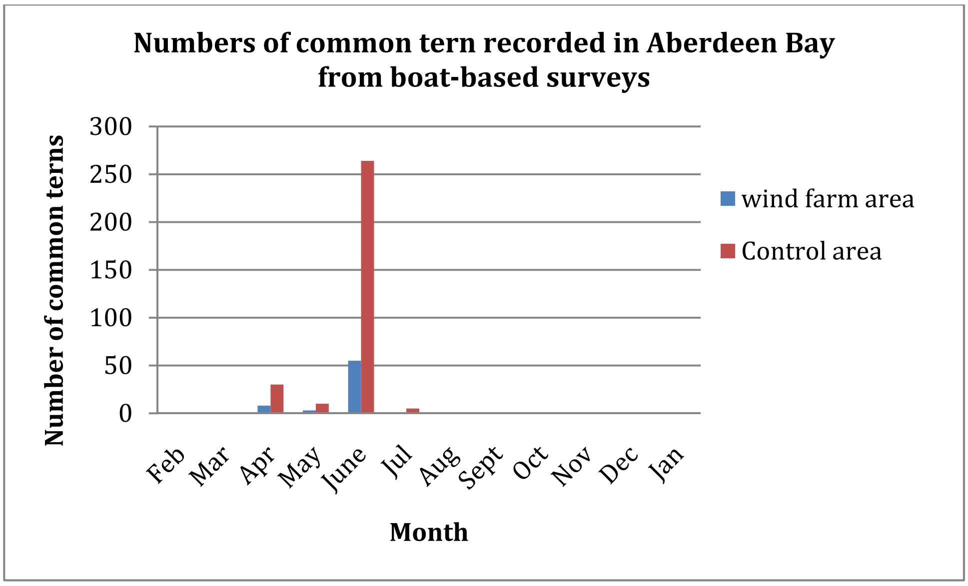


Figure 4-91: Common tern monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

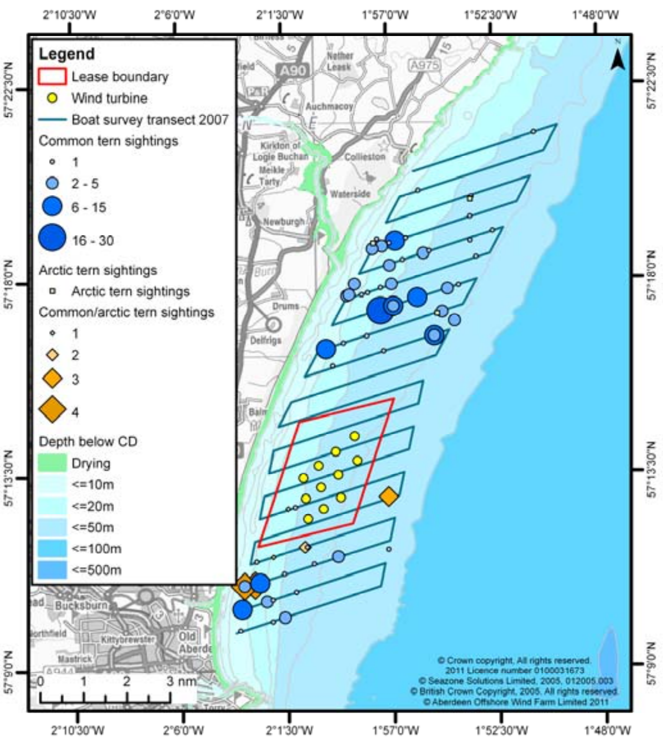


Figure 4-92: Common tern and Arctic tern distribution in Aberdeen Bay during breeding season: April – July (all sightings).

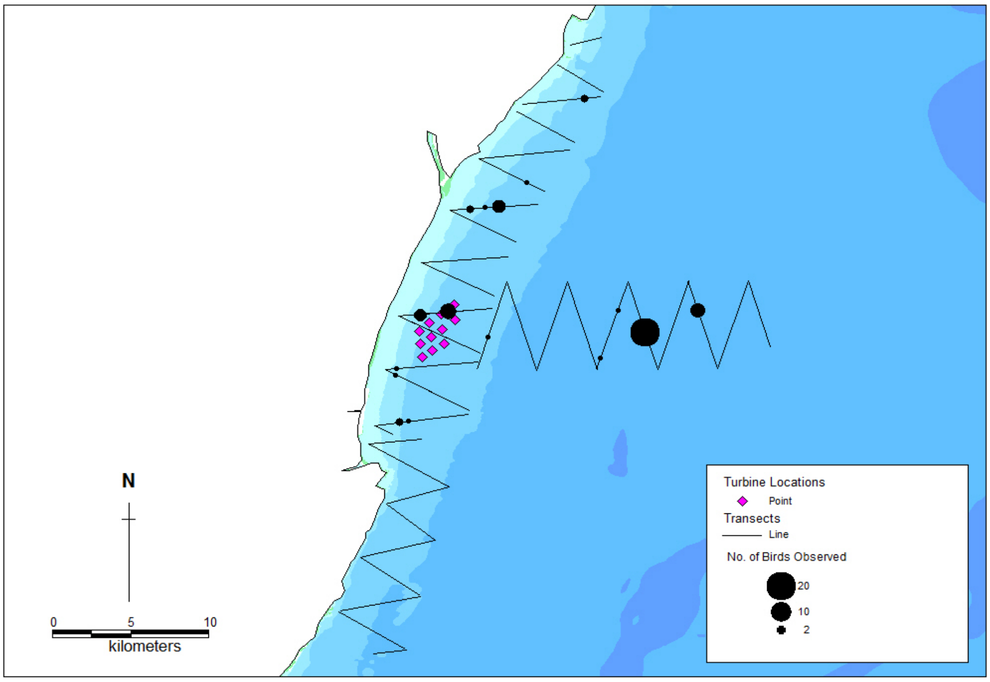


Figure 4-93: On-effort observations of Tern species (Common, Arctic Sandwich and Unidentified Tern species) along transects during August, September and November 2010 and January 2011.

Vantage Point surveys

In Aberdeen Bay common terns were recorded from April through to September with peak counts varying across years. In 2006 peak counts occurred during July and August when up to 50 birds per hour were recorded compared to a peak of less than 10 birds per hour in August 2005 and five birds per hour during the same period in 2007 (EnviroCentre 2007a, Alba Ecology 2008a). In 2008, the peak counts occurred in May when up to ten birds per hour passed the Donmouth. Relatively low numbers were recorded during June when birds were breeding.

The majority of sightings were of birds between 0–2 km from the coast and at least 83% of sightings were of birds flying below 30 m.

Bird Detection Radar

There were no common terns recorded during the radar surveys undertaken at Drums and Easter Hatton during October 2005. In April 2007 a total of 14 common terns were recorded from Blackdog at a rate of 0.27 birds per hour (Simms *et al*. 2007).

4.33.3 Summary of Results

Numbers of common terns from boat-based surveys peaked during June when up to 264 birds were present in the 'control' area. The timing of peak counts varied between years with some occurring in May and others in July and August when up to 50 birds per hour were recorded. The majority of sightings were within 2 km of the coast and at least 83 of sightings were of birds flying below 30 m.

The peak count of estimated abundance in June was greater than the threshold of national importance.

4.33.4 Initial Assessment of Significance

Common tern	Overall sensitivity	Magnitude	Significance
Collision	Very High	Low	Moderate
Barrier	Medium	Low	Minor
Displacement	Medium	Low	Minor

4.33.5 Species Sensitivities

Qualifying species

The common tern is a qualifying species for the Ythan Estuary, Sands of Forvie and Meikle Loch SPA where six pairs nested in 2009 and the Forth Islands SPA where 378 pairs nest.

Flight height

Out of 22 recorded flight heights for common tern obtained from site specific boat-based surveys, 14% of flights were above 25 m.

Elsewhere, out of 2,060 recorded flight heights, 11% have been recorded as being at rotor height.

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that common terns may occur within the proposed development area but in lower numbers than areas to the north. A peak estimated population of 55 birds occurred in the proposed EOWDC survey area during June when 264 birds were in the 'control' area to the north.

Collision Risk Modelling undertaken for common tern is based on:

- Body length of 33 cm
- Wingspan of 88 cm
- Flight speed of 10.9 $m.s^{-1}$

The Collision Risk Modelling is based on a collision probability of 11.8% and been undertaken over a range of avoidance rate from 98%, 99% and 99.5%.

Table 4-28: Predicted number of collisions per year for common tern

Collision probability	**Avoidance rate (%)**		
	98	99	99.5
11.8%	3.5	1.7	0.8

Based on the precautionary avoidance rate of 98% it is predicted that a total of 3.5 collisions per year may occur (Table 4-28).

The annual mortality rate for common tern is 10% (BTO 2011). Based on the regional SPA population of 768 breeding adults, the annual mortality rate will be 77 individuals and therefore the 1% baseline mortality rate is less than one bird per year. The results from the Collision Risk Modelling predict a total of 3.5 common terns per year may collide with the wind turbines.

Six pairs of common tern nest on the Sands of Forvie and consequently an increase in adult mortality could have an adverse effect. The Sands of Forvie lies approximately 7.2 km away from the proposed development and therefore may be within the potential foraging range of breeding common terns, which although have been estimated to forage less than 25 km away from their nests are more likely to be within 4 km and 6 km (Roos 2010).

A total of 378 pairs of common tern nest at the Firth of Forth, which lies approximately 124 km away and therefore outwith the maximum foraging range recorded for common terns.

Data obtained from Zeebrugge, where common terns frequently pass across an array of turbines, have reported relatively high collision mortalities although very low collision probabilities of 0.1% for birds flying at rotor height and 0.007% for birds at all altitudes (Everaert & Stienen 2006). Consequently the use of a 98% avoidance rate is very precautionary and it is predicted that avoidance of greater than 99% is likely. Based on this the number of potential collisions by common terns may be between one to two birds per year.

Based on the results from the collision risk modelling and the relatively small number of common terns potentially occurring within the proposed development area it is predicted that the risk of collision is low but the significance may be moderate or minor.

Barrier effect

Studies undertaken in UK, Belgium Denmark and Sweden have shown that there is unlikely to be a barrier effect, with common (or common/Arctic) terns recorded foraging within operating wind farms and no evidence of any strong avoidance behaviour. Post-construction monitoring undertaken at Kentish Flats have shown a potential barrier effect with fewer common terns flying through the operating wind farm than compared to prior construction (Gill *et al*. 2008). The location of the proposed development to the south of the tern colony on the Sands of Forvie and that site specific monitoring indicates that areas to the north of the proposed development are preferred indicates that there are unlikely to be any significant or adverse effects to common terns caused by the potential barrier effect.

Displacement

Evidence from studies undertaken in Denmark where common terns were seen to enter operating wind farms indicates that there may be little or no displacement. Should displacement occur, site specific data indicates that common terns may forage elsewhere, particularly to the north where then numbers of common terns present were higher.

Disturbance

Common terns may not be impacted directly by activities associated with the proposed development, i.e. vessel movements, but there is the potential for a secondary impact should the prey of common terns be affected by construction activities, particularly pile driving. Common terns forage on small fish, young clupeids, and crustaceans (shrimps). Should the construction of the proposed development cause a reduction in the availability of prey to breeding terns then this cause an adverse effect.

The location of nearest tern colonies 7 km away and that more common terns were recorded to the north of the development area indicate that should there be a reduction of suitable prey in the vicinity of the proposed development from pile driving, then there are other areas where common terns may forage, e.g. in the Ythan Estuary. Any potential impact will likely last for no more than the one or two seasons during construction as juvenile fish will be available as prey following cessation of construction.

The significance of any potential effect depends on the type of installation technique used the subsequent scale of disturbance and its duration. It also depends on whether other suitable foraging areas are available. Although these are difficult to predict any potential impacts upon prey are expected to be relatively short-term as they should only effect one or two breeding seasons, as new juvenile fish will become available the season following construction. Post construction monitoring undertaken at Kentish Flats did not record any reduction in the number of terns using the area and noted an increase in overall numbers indicating no significant effect from construction on Terns (Gill *et al*. 2008).

Based on the results from site specific surveys and evidence from studies undertaken at other constructed wind farms it is predicted that any potential impact may be of moderate significance.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts.

Outwith Aberdeen Bay there are further planned wind farms in the Moray Firth and Firth of Forth areas. The exact locations, size and type of turbines are unknown and no site specific data are available to inform the cumulative or in-combination assessment.

Collision Risk Modelling undertaken for all species of tern recorded at the Beatrice Demonstrator Project located in the Moray Firth predicted an annual mortality rate of less than 1 bird per year. The additional mortality rate is therefore low and of minor significance.

The detailed distribution of common terns in the Firth of Forth is unknown and there are no site specific data available to indicate whether common terns occur in the vicinity of the planned offshore wind farms. However, published seabirds at sea data indicate low or very densities occurring in the Firth of Forth area with no records in the area where wind farms may in the future be developed (Stone *et al.* 1995). The Firth of Firth SPA is also approximately 124 km away from the proposed development and therefore the risk of any cumulative or in-combination impacts are low.

Habitats Appraisal

Based on the evidence from existing offshore wind farms indicating both a very low collision risk, little or no displacement or barrier effects; it is predicted that there will not be any adverse effects on the SPA for which common tern is a qualifying species. However, should there be an impact on the prey species for common tern during the construction period then there is the potential for a localised impact.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on common tern, although there may be a temporary moderate impact if the construction of the proposed development causes a displacement of fish species.

4.34 Arctic tern (*Sterna paradisaea*)

4.34.1 Protection & Conservation Status

The Arctic tern is listed in Annex I of the Birds Directive, Appendix II of the Bonn Convention, Appendix II of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.34.2 Background

Arctic tern		
GB Population	52,600 pairs	BTO 2011
Scottish population	47,300	Forrester *et al*. 2007
International threshold	Unknown	Calbrade *et al*. 2010
GB threshold	1,000	1% of UK breeding pop$^{\underline{n}}$
Designated east coast sites where species is a noted feature	Forth Islands: 908 prs	SNH 2011 JNCC 2011a
European population estimate	Breeding 500,000 – 900,000 pairs Wintering – none	Birdlife 2004
European population trend	Status 'secure' Trend 'unknown'	Birdlife 2004
World population	2,000,000 mature individuals	Birdlife 2011

Arctic terns are a summer migrant to the northern Europe and winter in the Antarctic. They arrive on their breeding grounds during April and May and depart during August and September. They breed in colonies on undisturbed beaches and islands and numbers in colonies varies considerably across years with birds regularly switching colonies. They forage in mainly coastal waters feeding predominantly on small fish by plunge diving to just below the surface.

An estimated passage of up to 200,000 Arctic terns may occur in Scotland. In North-east Scotland Arctic terns occur from April through to September with peak numbers in July when up to 40 birds per month were recorded past Peterhead (Innes 1994).

Boat-based surveys

Three Arctic terns were recorded in July 2007 from boat-based surveys (IECS 2008).

Vantage Point surveys

Arctic terns were regularly recorded in Aberdeen Bay from April through to October with a distinct peak in numbers between June and August. Peak numbers varied considerably across years with up to 150 birds per hour passing Drums in July 2008 but a peak of only up to ten birds per hour in June 2007 (EnviroCentre 2007a, Alba Ecology 2008a). Birds were recorded less than 2 km from shore and up to 36% of sightings were greater than 30 m above sea surface.

Bird Detection Radar

There were no Arctic terns recorded during the radar surveys undertaken at Drums and Easter Hatton during October 2005. In April 2007, 2 Arctic terns were recorded from Blackdog (Simms *et al*. 2007).

A further 23 common/Arctic terns were recorded during the April 2007 radar surveys (Simms *et al*. 2007). All terns recorded from the radar surveys were seen flying below 30 m.

4.34.3 Summary of Results

Numbers of Arctic terns recorded from boat-based surveys was very low but they were regularly recorded from land-based counts from April through to October with peak counts during July. Numbers recorded varied but were generally less than 10 birds per hour with one exceptional count of 150 birds per hour in July. The majority of sightings were within 2 km of the coast and 36% of all sightings were of birds flying above 30 m.

There is no UK threshold but the peak count of 150 birds per hour in July 2008 was less than the 1% of the national breeding population.

4.34.4 Initial Assessment of Significance

Arctic tern	Overall sensitivity	Magnitude	Significance
Collision	Very High	Low	Moderate
Barrier	Medium	Low	Minor
Displacement	Medium	Low	Minor

4.34.5 Species Sensitivities

Qualifying species

The Arctic tern is a qualifying species for the Forth Islands SPA where 908 pairs nest.

Flight height

There were no species specific flight heights recorded for Arctic terns from site specific boat-based surveys. Out of the 24 flights for 'commic' (common/Arctic) terns none were above 25 m.

Elsewhere, very few Arctic terns have been reported from other offshore wind farm surveys (n= 122) but for those that have, 24% have been recorded at rotor height.

Collision risk

Only three Arctic terns were recorded from site specific boat-based surveys undertaken in Aberdeen Bay but more were recorded from Vantage Point Counts with up to 36% of flight altitudes above 30 m. Nearly all sightings were of birds within 2 km of the coast, indicating that there is a low risk of collision with the proposed development. Avoidance rates for Arctic terns are unknown but based on the similar common tern results from Zeebrugge it is predicted that should Arctic terns occur in the vicinity of the proposed development they will have a high avoidance rate and the risk of collision low and any potential impacts negligible.

Barrier effect

Studies undertaken in Denmark and Sweden have shown that there is unlikely to be a barrier effect with common/Arctic terns recorded foraging within operating wind farms and no evidence of any strong avoidance behaviour. And there are unlikely to be any significant or adverse effects to Arctic terns caused by the potential barrier effect.

Displacement

Evidence from studies undertaken in Denmark where common/Arctic terns were seen to enter operating wind farms indicates that there may be little or no displacement. As very few Arctic terns were recorded beyond 2 km the use of the site by Arctic tern appears to be very low and therefore it is predicted that there will be little or no displacement effect.

Disturbance

Arctic terns may not be impacted directly by activities associated with the proposed development, i.e. vessel movements but there is the potential for a secondary impact should the prey of Arctic terns be affected by construction activities. Arctic terns are opportunistic feeders foraging on small fish and crustaceans. Should the construction of the proposed development cause a reduction in the availability of prey to Arctic terns then this could cause an adverse effect.

However, very few Arctic terns were recorded and there is no evidence to suggest that the proposed development area and the surrounds are particularly important for Arctic terns and that should their prey be displaced that they would not be able to find alternative areas to forage. Any potential impact will likely last for no more than one or two seasons as juvenile fish will be available as prey the following year.

Based on the results from site specific surveys and evidence from studies undertaken at other constructed wind farms it is predicted that any potential impact on Arctic tern will be low and of minor significance.

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts.

Outwith Aberdeen Bay there are further planned wind farms in the Moray Firth and Firth of Forth areas. The exact locations, size and type of turbines are unknown and no site specific data are available to inform the cumulative or in-combination assessment.

The detailed distribution of Arctic terns in the Firth of Forth is unknown and there are no site specific data available to indicate whether Arctic terns occur in the vicinity of the planned offshore wind farms. However, published seabirds at sea data indicate low or very densities occurring in the Firth of Forth area with no records in the area where wind farms may in the future be developed (Stone *et al.* 1995). The Forth Islands SPA is also approximately 124 km away from the proposed development and therefore the risk of any cumulative or in-combination impacts are low.

Habitats Appraisal

The only SPA in the region for which Arctic tern is listed as a qualifying species is the Forth Islands SPA, which is approximately 124 km to the south. The risk of an adverse effect on the qualifying species is therefore low and its significance should there be one, is negligible.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on Arctic tern. However, there may be a temporary minor impact if there is disturbance to prey during construction.

4.35 Common Guillemot (*Uria aalge*)

4.35.1 Protection & Conservation Status

The (common) guillemot is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.35.2 Background

Guillemot		
GB Population	Breeding: 1,300,000 ind.	BTO 2011
Scottish population	Breeding: 780,000 prs Winter: 750,000 ind.	Forrester *et al.* 2007
International threshold	Unknown	-
GB threshold	13,000 ind.	1 of GB Pop^{n}
Designated east coast sites where species is a noted feature	Buchan Ness to Collieston Coast – 19,296 ind. (2007) Fowlsheugh 50,566 ind. (2009) Troup, Pennan and Lion's head – 16,325 ind. (2007) Forth Islands 16,000	SNH 2011 JNCC 2011a
European population estimate	Breeding 2,000,000-2,700,000 prs. Wintering – 4,300,000 ind.	Birdlife 2004
European population trend	Status 'secure' Trend 'large increase'	Birdlife 2004
World population	7,300,000 – 7,400,000	Mitchell *et al* 2004

The guillemot is one the most abundant seabirds in the northern hemisphere with a large population in the Atlantic. Numbers in Britain and Ireland have increased substantially during the last 30 years. Guillemots breed at most locations around the coast of Britain and Ireland where there is suitable cliff nesting habitat. The species is extremely gregarious, colonial nesting is the norm and colonies can contain tens of thousands of individuals (Wernham *et al*. 2002).

Birds may start to return to the colonies from their offshore wintering areas as early as October although many do not return until the spring. During the breeding season birds remain in proximity of their colonies but may forage in excess of 100 km from their breeding sites. The chick leaves the colony with the male when about three weeks old and still flightless. The male accompanies the chick for a further six to eight weeks while it develops and the adult undergoes a complete moult during which time it has a period that it becomes flightless.

Guillemots feed on a variety of small pelagic shoaling fish, especially lesser sandeels, sprats and members of the family Gadidae, which they catch by underwater pursuit after diving from the surface.

Guillemots feed mainly close offshore and are numerous around Britain and Ireland throughout the year. The species is dispersive, rather than migratory with many adults remaining within a few hundred kilometres of their colonies throughout the year. During late summer and early autumn the adults undergo a period of moult during which time they become flightless for a period. They are also accompanied by their flightless chicks during this period.

There is an estimated 1,000,000 pairs of guillemots nesting in Britain of which 75% are in Scotland, the majority in Shetland, Orkney, Caithness, Sutherland and Western Isles (Mitchell *et al*. 2004).

In North-east Scotland the guillemot occurs widely throughout the region and there are number of significant breeding colonies with a population of 150,000 individuals.

The region therefore holds approximately 10% of the UK and Scottish breeding populations.

A distinct passage of guillemots has been recorded off Peterhead with a northerly passage of birds in the spring when up to 24,000 birds per hour have been recorded. A smaller passage of birds occurs in the autumn with up to 400 birds per hour passing.

The passage of birds recorded past Peterhead extended from a few hundred metres from the shore to over 3 km (Innes 1990).

Boat-based surveys

Guillemot was the most frequently recorded species from boat-based surveys between February 2007 and January 2008. Guillemots were recorded throughout the year and throughout the surveyed area with birds recorded in shallow nearshore waters and further offshore in deeper waters of 30 m or more. Although the distribution of guillemots was fairly even across the surveyed area, more guillemots were recorded to the north and offshore of the proposed EOWDC area than within the proposed development area outwith the breeding season (Figure 4-94).

During the breeding season the numbers of guillemot present across the whole of the survey area were relatively low but evenly distributed in water depths of between 20 m and 50 m (Figure 4-95, Figure 4-96).

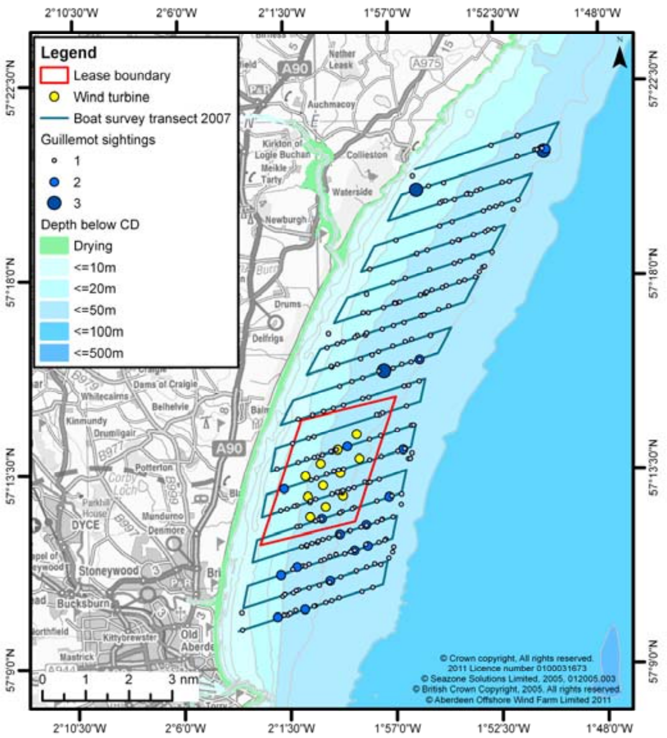


Figure 4-94: Guillemot distribution in Aberdeen Bay during winter period: November to February (all sightings).

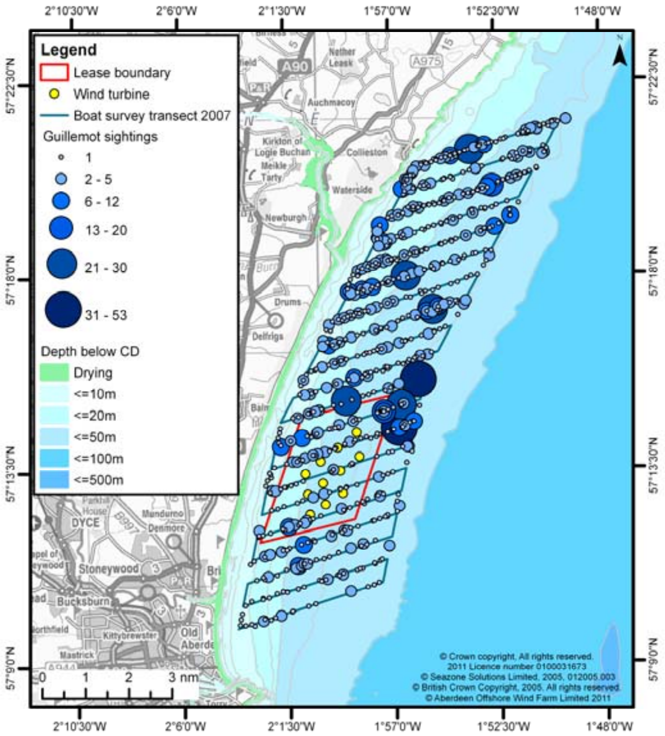


Figure 4-95: Guillemot distribution in Aberdeen Bay during breeding season: March to June (all sightings).

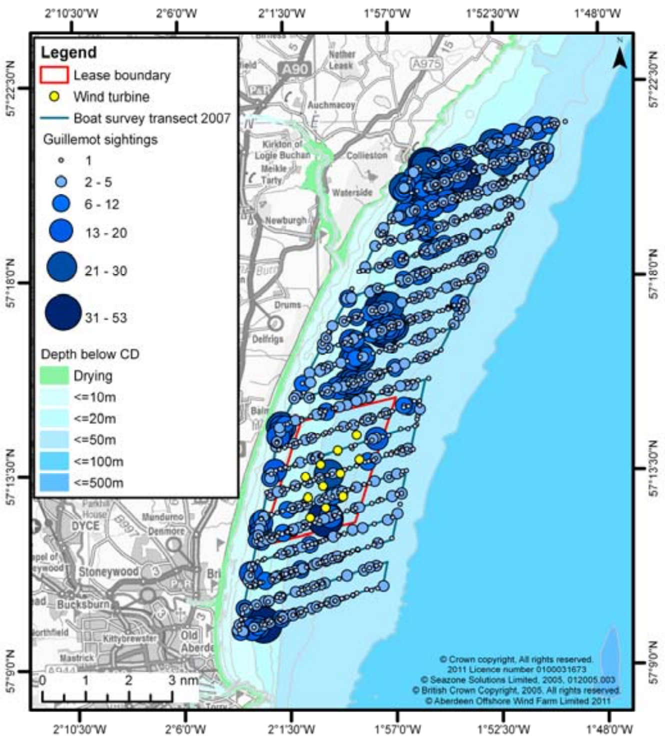


Figure 4-96: Guillemot distribution during post-breeding: July to October (all sightings).

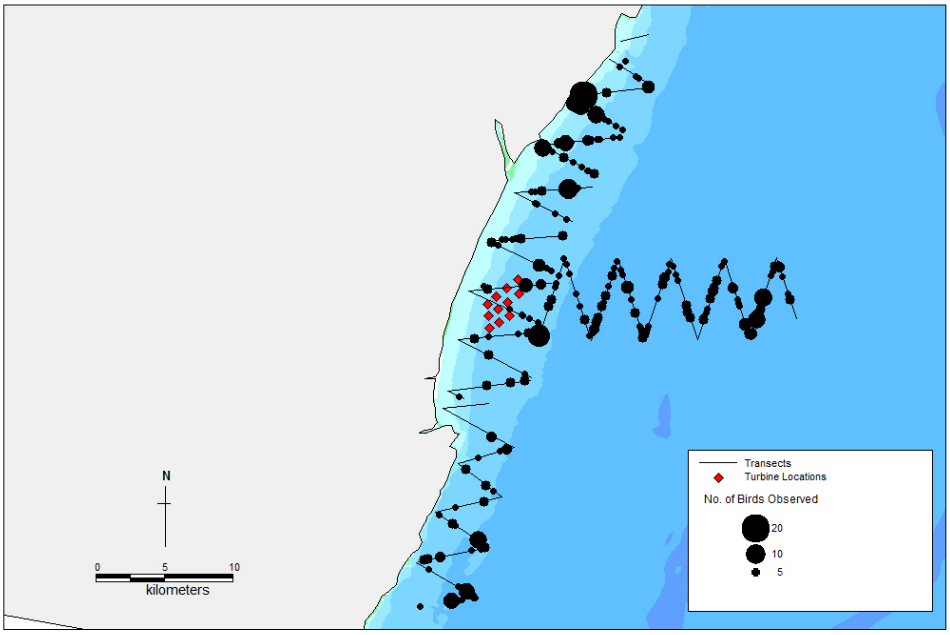


Figure 4-97: On-effort observations of Auk species (guillemot, razorbill and Puffin) along transects during August, September and November 2010 and January 2011.

Numbers of guillemot in the winter period were lower than during the summer months when numbers peaked in July (Figure 4-98). Estimated monthly numbers using *Distance* analysis indicate a population of up to 2,578 guillemots within the 'control' area during July and a further 1,511 in the proposed EOWDC survey area. Densities of up to 51 birds/km^2 and 30 birds/km^2 were estimated during this period (Figure 4-101, Figure 4-99). The highest abundance estimates were from the northern survey area with estimated abundances of nearly 5,500 individuals during September and a density of 36 birds/km^2 (SMRU 2011b).

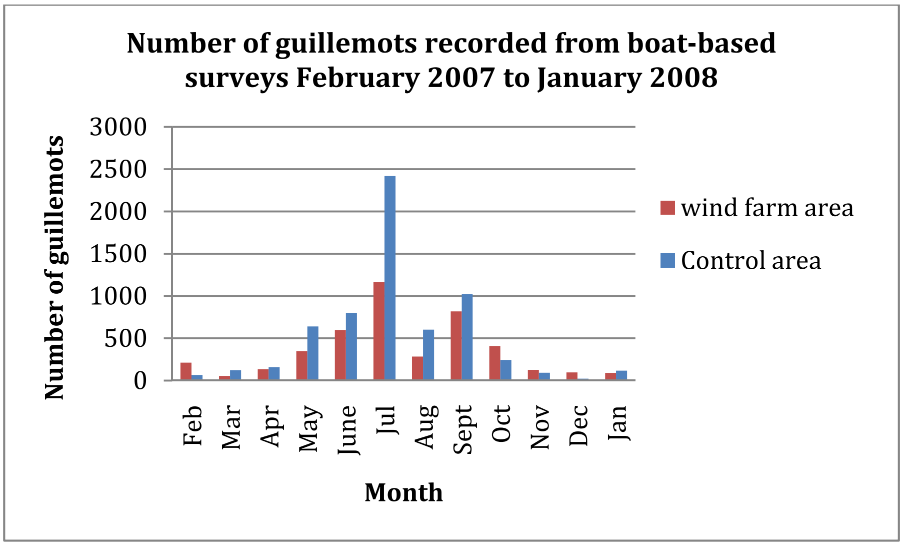


Figure 4-98: Guillemot monthly population estimates in proposed EOWDC and 'control' areas: Boat-based surveys 2007 – 2008.

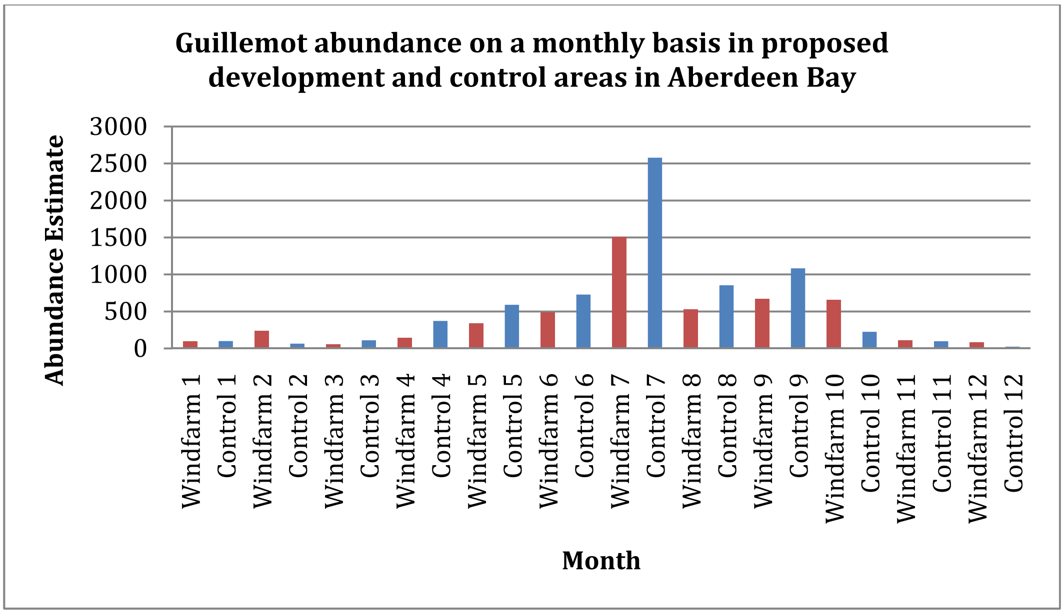


Figure 4-99: Monthly estimates of abundance of guillemots in the proposed EOWDC and 'control' areas from February 2007 to January 2008.

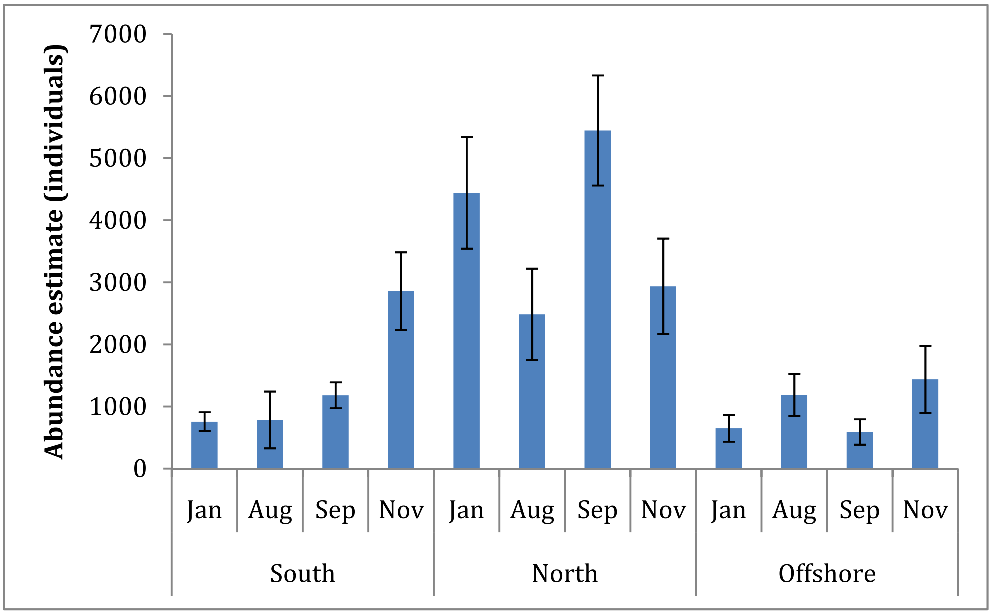


Figure 4-100: Monthly estimates (+/- SE) of abundance of guillemot in the South, North and Offshore Strata between August 2010 and January 2011.

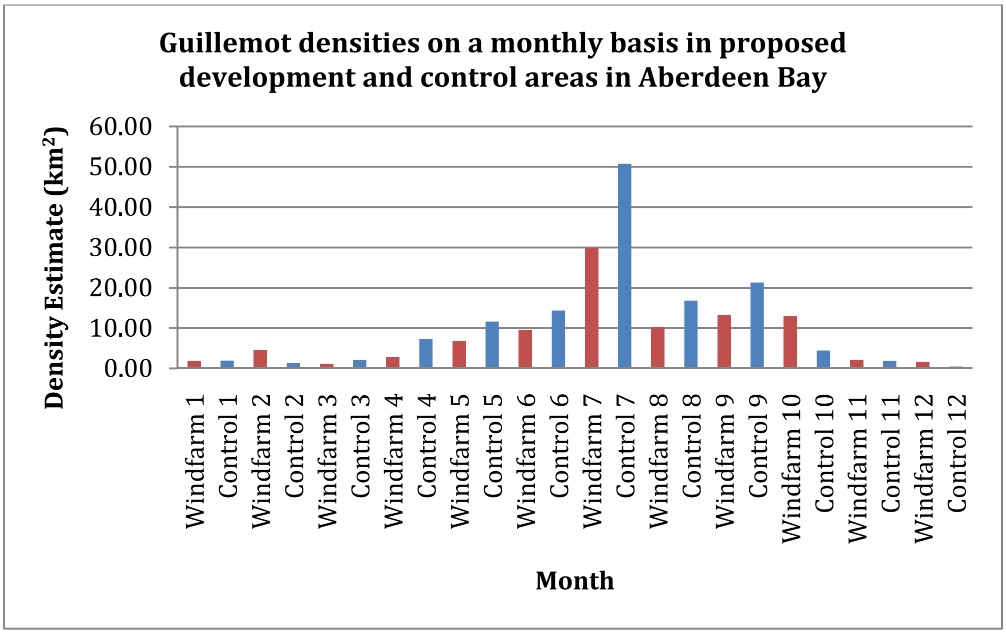


Figure 4-101: Monthly estimates of density of guillemots in the proposed EOWDC and 'control' areas; February 2007 – January 2008 ('Windfarm' 1-12 and 'control' 1-12 refers to months).

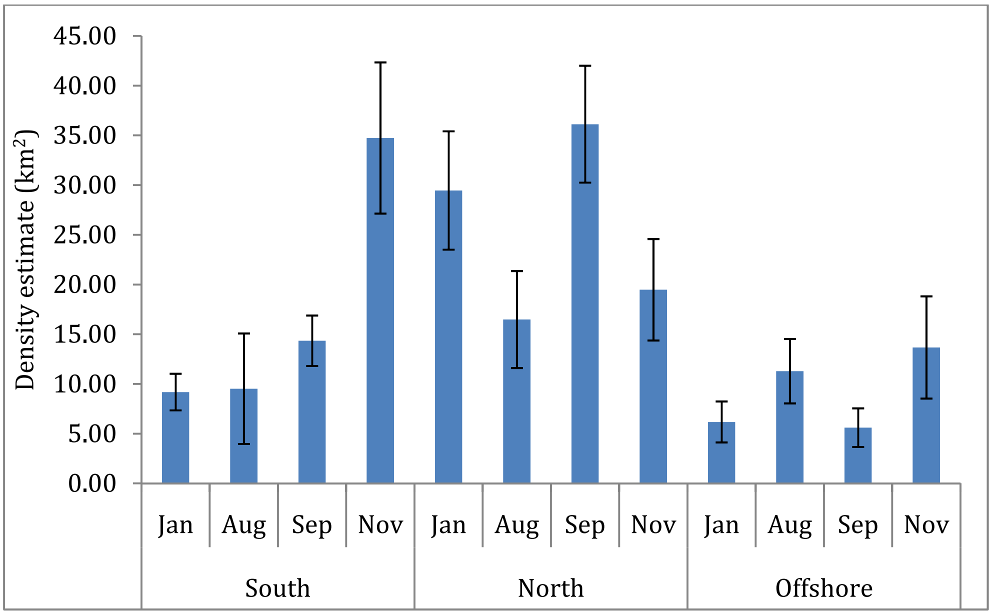


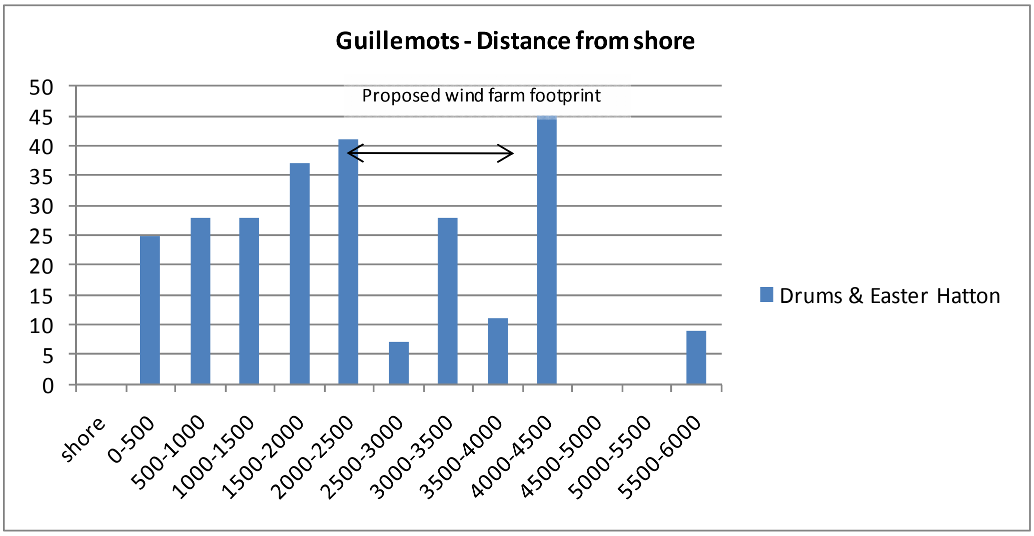
Figure 4-102: Monthly estimates (+/- SE) of density of Common Guillemot in the South, North and Offshore Strata.

Vantage Point surveys

Guillemots were present in Aberdeen Bay throughout the year. Relatively low numbers were present between December and February with numbers increasing from March onwards. Up to 250 birds per hour were recorded flying past in March 2007, increasing to up to 400 birds per hour during April 2007. (EnviroCentre 2007a,b). At least 98% of all flights were below 30 m. Relatively few birds were recorded within 1 km of the coast with most between 1 km and 3 km; (Alba Ecology 2008a,b).

Bird Detection Radar

A total of 259 guillemots were recorded during the Bird Detection Radar studies undertaken in October 2005. The numbers recorded between the two survey sites were broadly similar with 108 at Drums and 151 at Easter Hatton. The distribution of guillemots was different between the two sites, with a larger proportion of birds at Easter Hatton recorded within 2.5 km from shore compared to Drums where a greater proportion were recorded out to 4.5 km. Combining observations from both sites suggests a generally broad distribution of guillemots (Walls *et al.* 2006).



(Adapted from Walls *et al.* 2006, Simms *et al.* 2007)

Figure 4-103: Guillemot distribution from shore from observation at Drums and Easter Hatton in October 2005.

4.35.3 Summary of Results

Guillemots were recorded widely across Aberdeen Bay from all surveys. Data from boat-based surveys indicate peak counts in the bay occur during the post-breeding period, particularly in July with more birds recorded within the 'control' site than within the proposed EOWDC development area. Relatively high numbers remain within the area until November after which numbers of guillemots in the area decrease. Land based observations recorded peak numbers during April. Data from boat-based surveys recorded guillemots widely across the surveyed areas and land-based observations recorded most guillemots from between 1.5 km and 4.5 km from the coast.

No counts during any surveys undertaken across Aberdeen Bay were of national importance.

4.35.4 Initial Assessment of Significance

Guillemot	Overall sensitivity	Magnitude	Significance
Collision	Very High	Negligible	Minor
Barrier	Medium	Medium	Minor
Displacement	High	Low	Minor

4.35.5 Species Sensitivities

Qualifying species

There are four SPAs in the region for which guillemot is a qualifying species: Buchan Ness to Collieston Coast, Fowlsheugh, Troup, Pennan and Lion's Head and Forth Islands SPA.

Flight height

Flight heights obtained from boat-based surveys undertaken in Aberdeen Bay recorded 271 guillemots in flight of which 1% were recorded as flying above 25 m and therefore at risk of collision.

Elsewhere in the UK out of over 6,000 guillemots for which flight heights have been recorded less than 1% have been recorded at rotor height.

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that guillemots are widespread and frequent within Aberdeen Bay and occur throughout the area.

Collision Risk Modelling undertaken for guillemot is based on:

- Body length of 40 cm
- Wingspan of 70 cm
- Flight speed of 16.5 $m.s^{-1}$

Collision Risk Mortality has been based on a collision probability of 7% and a range of avoidance rates of 98%, 99% and 99.5% have been used.

Table 4-29: Predicted number of collisions per year for guillemot.

Collision probability	**Avoidance rate (%)**		
	98	99	99.5
7%	0.04	0.02	0.01

Based on the precautionary avoidance rate of 98% it is predicted that a total of 0.04 collisions per year may occur (Table 4-29).

The annual mortality rate for guillemot is 5.4% (BTO 2011). Consequently, out of a peak regional population of 5,447 individuals (Figure 4-100) an annual mortality of 294 guillemot, may be predicted. Therefore, 1% of the baseline mortality is 3 birds per year.

Based on the results from collision risk modelling, which predicts a total of 0.04 collision per year there will not be a significant impact on the guillemot due to collisions.

The Buchan Ness to Collieston Coast SPA lies approximately 9.5 km away from the proposed development and holds 19,296 individual guillemots on the latest counts in 2007. The colony has an annual mortality of 1,041 guillemots. It is likely that the majority of guillemots within Aberdeen Bay during the breeding period are associated with this colony. The results from the collision risk modelling which predict an annual mortality of 0.04 guillemots per year indicate that there will not be an adverse effect on guillemot associated with the SPA based on the precautionary assumption that an increase of 1% above baseline mortality could be adverse, i.e. more than ten guillemots a year collide with the turbines.

The Fowlsheugh SPA lies 31 km away from the proposed development and holds 50,566 guillemots based on latest counts. Therefore, the annual mortality rate is 2,730 birds per year. Based on the results from the collision risk modelling it is concluded that even if all the guillemots at risk of collision are from Fowlsheugh there will not be an adverse effect.

Troup Pennan and Lion's Heads SPA is 74 km to the north of the proposed development and, based on the latest counts holds 16,325 guillemots and therefore an annual mortality rate of 881 guillemots. The results of the collision risk modelling indicate that there not be an adverse effect on guillemots associated with this SPA.

The Forth Islands SPA is approximately 124 km away and holds 16,888 guillemots therefore an annual mortality rate of 912 guillemots. Should the whole of the population in the Firth of Forth SPA fly through the proposed development area then the collision risk modelling predicts there will not be an adverse effect on the population due to collision.

Based on the results the very low risk of collision it is concluded that the potential effect from collision risk is negligible.

Barrier effect

Studies undertaken in Sweden and Denmark indicate that there is some potential for a barrier effect to occur with a reduced number of birds crossing the constructed wind farms.

During the breeding season it is predicted that there may be regular flights to and from colonies some of which will intersect the proposed development area. The distance guillemots forage varies depend upon the availability of suitable prey and at what stage during the breeding season they are. Maximum foraging ranges are up to 123 km but the median range is 38 km during incubation and 5 km during chick rearing (Roos 2010). Should a barrier effect occur with guillemots from either Fowlsheugh or Buchan Ness to Collieston Coast SPAs making daily movements from one location to another around the proposed development area then they may incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.0% and 2.5% (Speakman, Gray & Furness 2009).

The location and size of the proposed development is such that it will only occupy a relatively small zone through which birds may avoid flying. No significant concentrations of guillemots were recorded in the vicinity of the proposed development and therefore it is not considered to be a particularly favourable area for foraging. Regular daily movements by individual birds that could cause an incremental increase in distance of foraging flights on a daily basis is not predicted to occur, i.e. birds from colonies will forage over a wider area and will not need to detour around the proposed development on a regular daily basis.

Based on the above it is concluded that the potential incremental increases in foraging distances are unlikely to cause an adverse effect or significant impact on guillemots.

Displacement

Based on the results from the monitoring data, the worst-case scenario is that should displacement occur, no guillemots will be within the proposed development area out to a distance of 1 km and a 50% decrease in abundance occurs between 1 km and 2 km from the proposed development.

Based on the peak density obtained from boat-based surveys of 50.7 birds/km^2 in the 'control' area during July, should there be a total displacement of guillemot from within the proposed development area then it is predicted that up to 218 guillemot may be displaced during periods of peak density. Based on a 100% displacement out to 1 km (a total surface area of 12.3 km^2) from the proposed development area then it is predicted that up to 623 guillemot may be displaced and a further 515 out to 2 km should there be 50% displacement. Therefore, the maximum number of guillemot potentially displaced is up to 1,355 birds based on the highest densities recorded from any survey within Aberdeen Bay and displacement out to 2 km.

Based on the estimated total of 1,355 potentially displaced guillemots out of a peak reported count of 5,447 guillemot, it is predicted that up to 25% of the guillemots within Aberdeen Bay may be displaced. This is based on a peak density obtained from the 'control' area to the north, the peak density from within the EOWDC area was lower at 30 birds/km^2; consequently, the figure used in this assessment is therefore precautionary.

Based on the regional population estimate of 88,737 guillemots obtained from the regional SPA counts then approximately 1.5% of the regional population may be displaced.

Site specific surveys recorded guillemots throughout the survey area and no specific concentrations were detected, although densities tended to be higher to the north of the proposed development area. However, should there be a displacement effect there is no evidence to suggest that the loss of the area of the proposed development will be significant and that individuals displaced will not be able to find suitable foraging areas elsewhere. Therefore, there is no evidence to suggest that any displacement will have a negative impact on guillemots.

Post-construction monitoring undertaken at Horns Rev offshore wind farm has indicated that displacement of guillemots can occur. However, results from other operating wind farms have not shown a total displacement of guillemots. Guillemots have been recorded at the constructed Kentish Flats offshore wind farm but in reduced numbers (Gill *et al.* 2008). Counts from surveys undertaken during construction at Lynn and Inner Dowsing recorded on average more guillemots during construction than pre-construction but this also included the 'control' areas and more guillemots were also recorded during post-construction surveys at Egmond aan Zee offshore wind farm than were counted prior to construction. There is therefore some evidence to suggest that total displacement of guillemots from within the EOWDC area will not occur.

Based on the evidence from existing offshore wind farms it is predicted that the potential impact from displacement may be moderate.

Calculations used for displacement	
Area	*Peak density of guillemot – 50.7 birds/km^2*
Area of EOWDC – 4.3 km^2	4.3 * 50.7 = 218
Area of 1 km buffer – 12.3 km^2	12.3 * 50.7 = 623
Area of 2 km buffer – 20.3 km^2 at 50% displacement.	(20.3 * 50.7)/2 = 515
Total potentially displaced	218 + 623 + 515 = 1,355

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on guillemots.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available is that from the Beatrice Demonstrator Project which recorded 19 guillemots over a period of 12 months pre-construction surveys (Talisman 2005). The size, scale and exact locations of the Round 3 and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of guillemots that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from the proposed plans. However, although the developments are within the potential foraging ranges of guillemots from a number of SPAs the, relatively far, distance the proposed development is from the other planned offshore wind farms and its relatively small scale reduces the risk of a potentially significant cumulative or in-combination effect.

4.35.6 Conclusions

Habitats Appraisal

Based on site specific data and the broad distribution of guillemots in Aberdeen Bay plus evidence from existing offshore wind farms indicating a very low collision risk and recognising that there is potential for some but not total avoidance and potentially some displacement it is predicted that there will not be any adverse effects on the SPAs for which guillemot is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on guillemots.

4.36 Razorbill (*Alca torda*)

4.36.1 Protection & Conservation Status

The razorbill is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.36.2 Background

Razorbill		
GB population	Breeding: 110,000 prs.	BTO 2011
Scottish population	Breeding: 93,300 prs Winter: 50,000 – 250,000 ind.	Forrester *et al.* 2007
International threshold	Unknown	-
GB threshold	2,200 ind	1% of GB Pop[n]
Designated east coast sites where species is a noted feature	Buchan Ness to Collieston Coast: 4,179 ind. (2007) Fowlsheugh: 4,632 ind. (2009) Firth of Forth: 3,464 ind Troup Pennan & Lion's Heads	SNH 2011 JNCC 2011a
European population estimate	Breeding 430,000 – 770,000 pairs Wintering – >500,000 individuals	Birdlife 2004
European population trend	Status 'secure' Trend 'unknown'	Birdlife 2004
World population	610 – 630,000	Mitchell *et al* 2004

The global distribution of razorbill is restricted to the North Atlantic and adjacent waters of the Arctic. In the breeding season, adult razorbills concentrate in shallow coastal waters at or near breeding colonies, which are usually situated on steep cliffs, often in the vicinity of guillemots. Relatively little is known about movements of razorbills away from their breeding colonies, although they are believed to be more southerly than guillemots (Wernham *et al*. 2002). During the winter razorbills can occur in Firths and larger estuaries and shallow marine areas such as St. Andrews Bay (Forrester *et al.* 2007). Razorbills feed chiefly on fish, with some invertebrates. Sandeel are a favoured prey item, which they catch by underwater pursuit after diving from the surface.

There is an estimated 110,000 pairs of razorbill nesting in Britain of which 93,000 pairs occur in Scotland and approximately 9,000 individuals within the two main colonies in North-east Scotland.

In North-east Scotland razorbills occur widely across the region, particularly during the breeding season. Peak passage occurs during April with a smaller autumn passage recorded.

Boat-based surveys

Razorbills were recorded throughout the year and across the whole of the surveyed area. Peak numbers occurred during post-breeding surveys between June and September, particularly to the north of the proposed development area. Relatively lower numbers were recorded between November and February (Figure 4-104, Figure 4-105, Figure 4-106). Razorbills were recorded within the footprint of the proposed development with peak numbers during the breeding season.

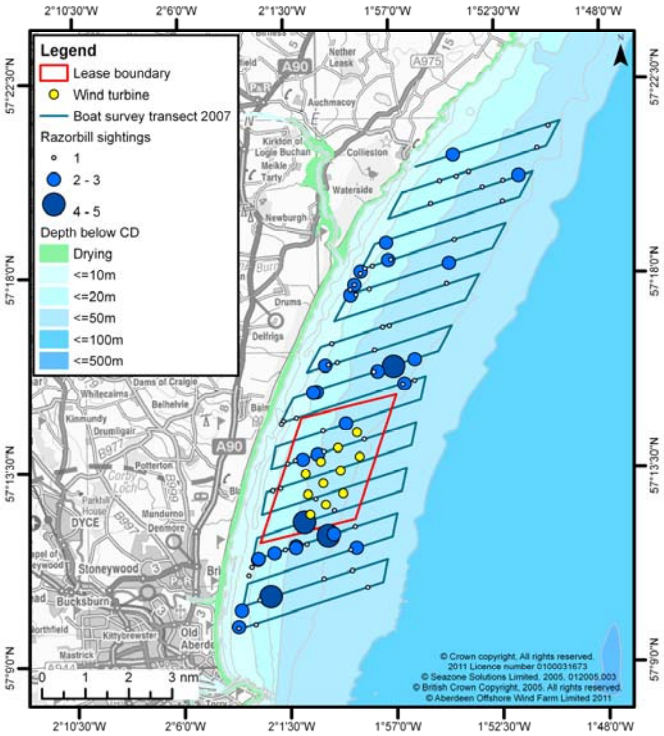


Figure 4-104: Razorbill distribution in Aberdeen Bay during winter period: November to February (all sightings).

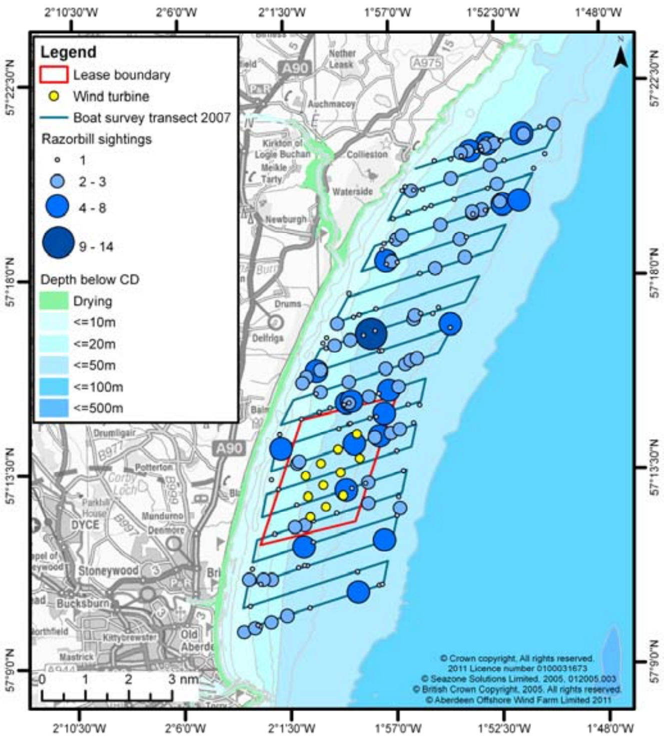


Figure 4-105: Razorbill distribution in Aberdeen Bay during breeding season: March to June (all sightings).

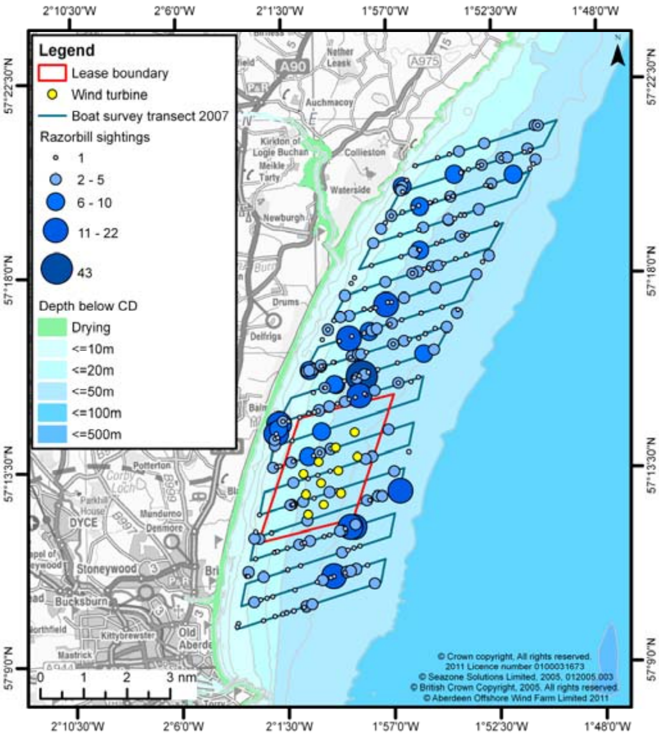


Figure 4-106: Razorbill distribution in Aberdeen Bay during post-breeding: July to October (all sightings).

Peak counts were of 378 birds in the ‘control’ area during July and 273 birds in the proposed EOWDC development area during in August (Figure 4-107).

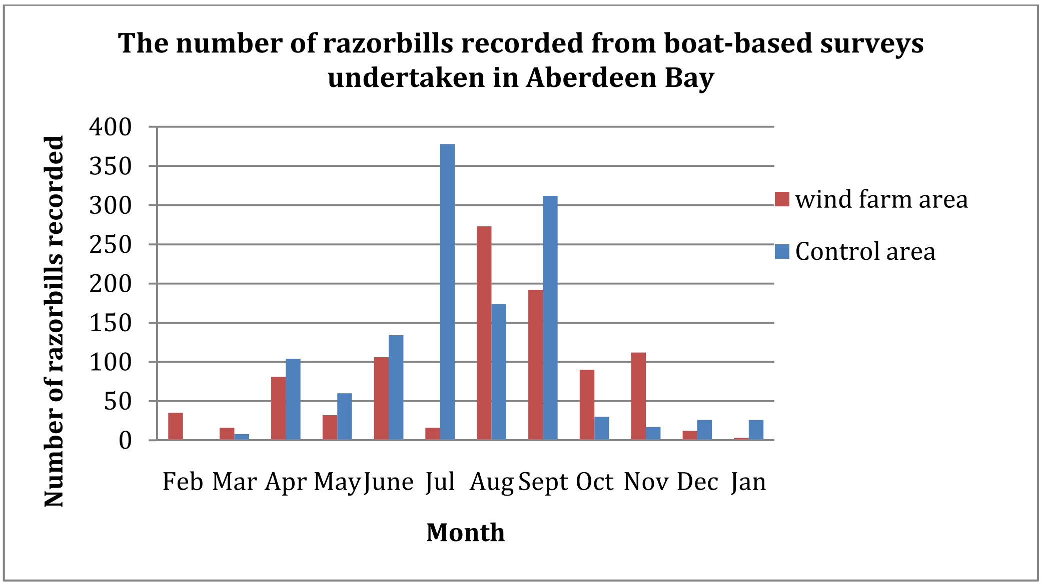


Figure 4-107: Razorbill monthly population estimates in proposed EOWDC and ‘control’ areas: Boat-based surveys 2007 – 2008.

Estimated abundances using *Distance* sampling on the first years of data, estimated peak abundance of razorbill within the proposed development during August with an estimated abundance of 359 birds. The highest abundance was within the ‘control’ area to the north with a total of 421 birds in October. Very low numbers were recorded throughout the area between January and March (Figure 4-108). Data obtained from between August 2010 and January 2011 recorded peak abundance in the northern survey area of 1,370 razorbills during August with decreasing numbers in most areas during the autumn and winter periods (Figure 4-109).

Peak densities of razorbills were 8.3 birds/km^2 within the ‘control’ area during October and 9 birds/km^2 in the southern and northern areas during August (Figure 4-109, Figure 4-110) (SMRU 2011b).

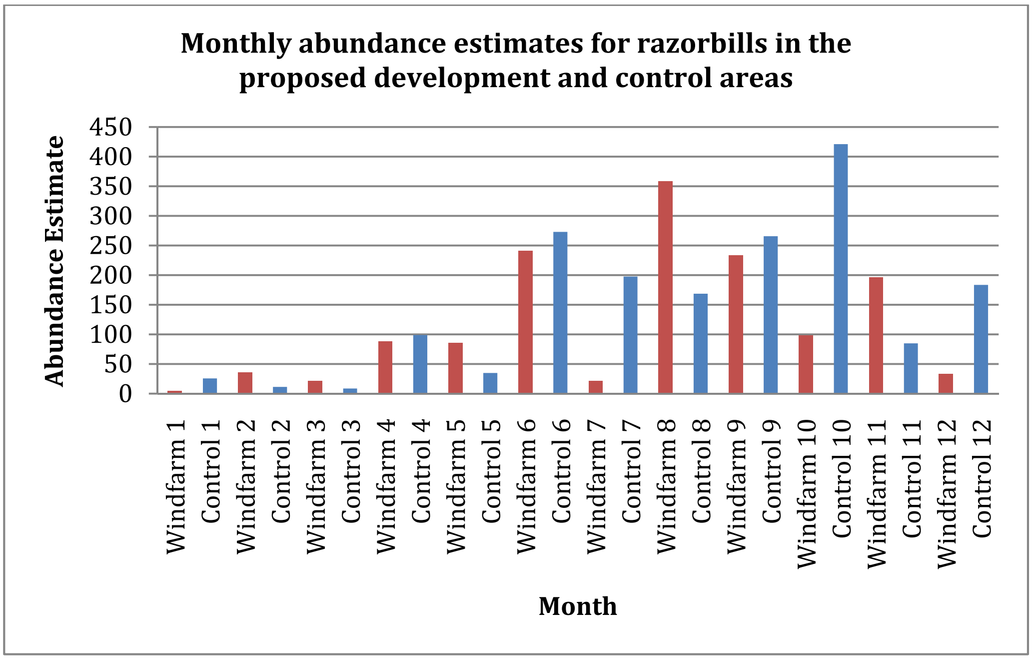


Figure 4-108: Monthly estimates (+/- SE) of abundance of razorbills in the proposed EOWDC and ‘control’ areas (Wind farm 1-12 and ‘control’ 1-12 refers to months).

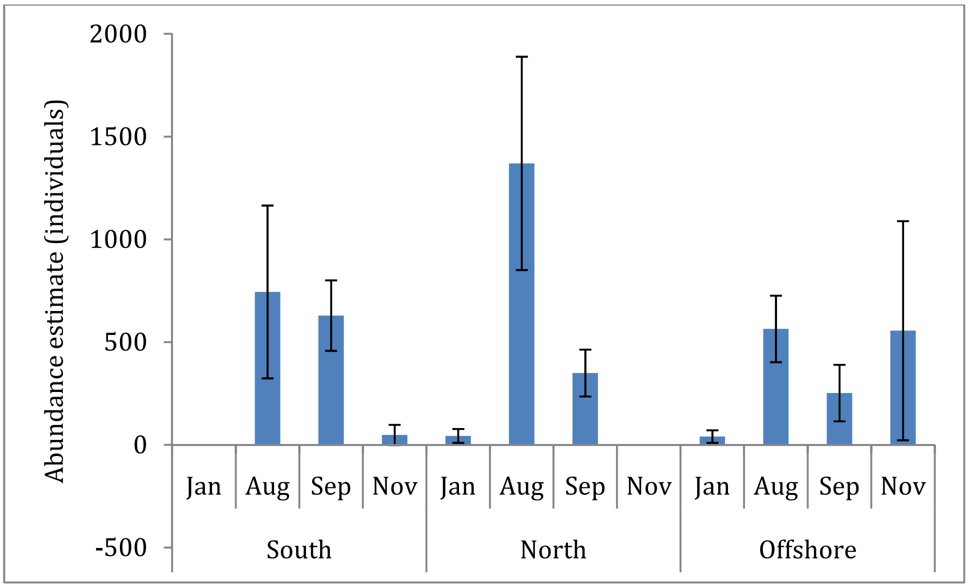


Figure 4-109: Monthly estimates (+/- SE) of abundance of Razorbill in the South, North and Offshore Strata.

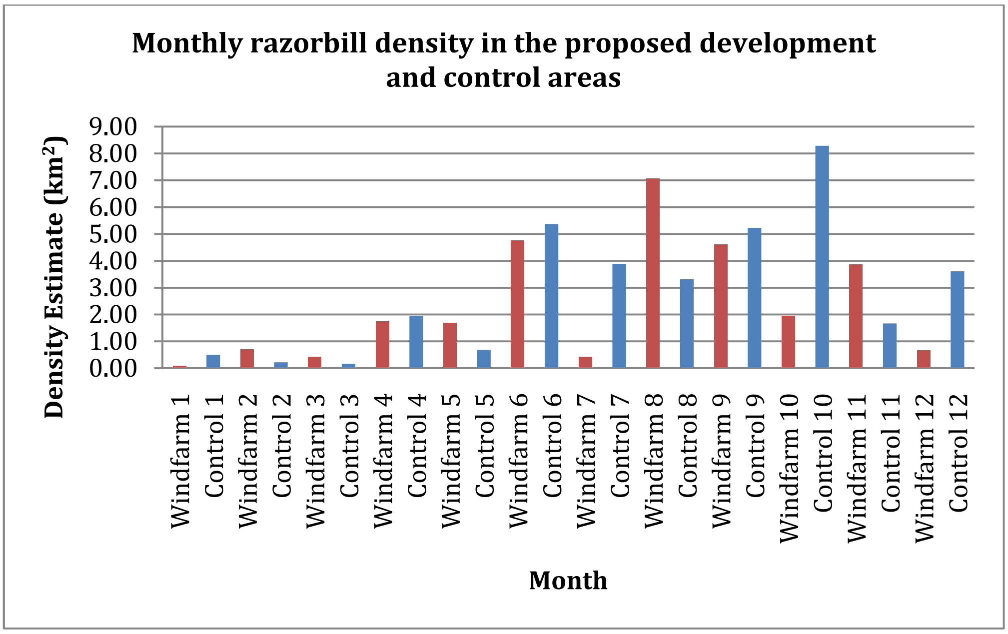


Figure 4-110: Monthly estimates (+/- SE) of density of razorbills in the proposed EOWDC and 'control' areas (Wind farm 1-12 and 'control' 1-12 refers to months).

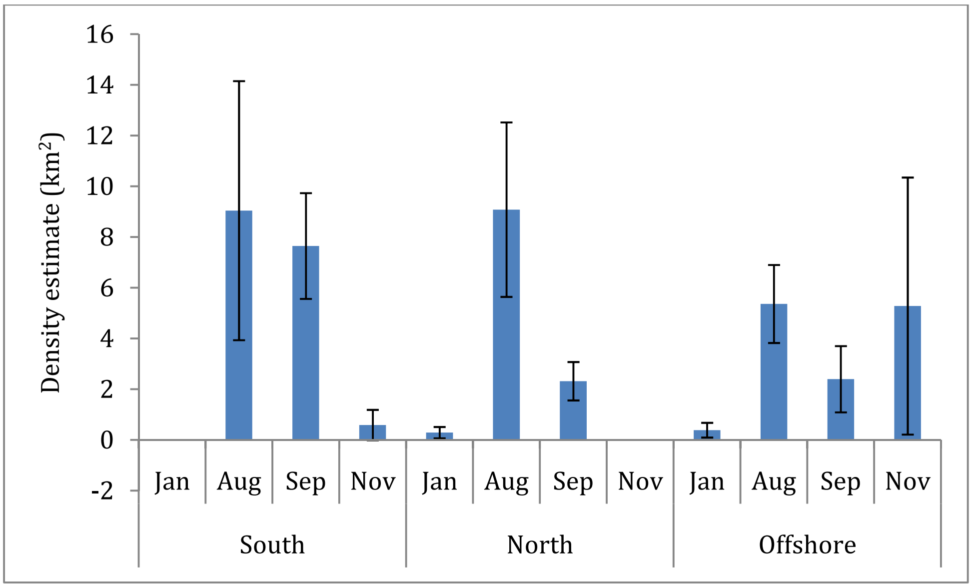


Figure 4-111: Monthly estimates (+/- SE) of density of Razorbill in the South, North and Offshore Strata.

Although birds were recorded in all water depths the majority of sightings were in areas where water depth was 20 m or below (IECS 2008). All those recorded in flight flew below 25 m.

Vantage Point surveys

Razorbills were recorded significantly less frequently in Aberdeen Bay than guillemots with a peak of up to seven birds per hour in March 2006 and five birds per hour during September 2007 (EnviroCentre 2007a,b; Alba Ecology 2008a). All birds recorded were flying below 30 m and unlike guillemot, most were flying between 1 and 2 km from shore.

Bird Detection Radar

There were no razorbills recorded during the radar surveys undertaken at Drums and Easter Hatton during October 2005. In April 2007 a total of 12 razorbills were recorded from Blackdog (Simms *et al*. 2007).

4.36.3 Summary of Results

Razorbills were widely recorded across Aberdeen Bay from all surveys. Low numbers were present at the beginning of the year but increased from April onwards. Data from boat-based surveys indicate peak counts in the bay between July and September but also a high count in October. Birds were recorded in relatively equal numbers across both the ‘control’ site and the proposed EOWDC survey area. Land based observations recorded peak numbers during April and September.

Data from boat-based surveys recorded razorbills widely across the surveyed areas and land-based observations recorded most birds from between 2.0 km and 4.0 km from the coast.

All those recorded in flight were seen to be flying below 25 m.

No counts during any surveys undertaken across Aberdeen Bay were of national importance.

4.36.4 Initial Assessment of Significance

Razorbill	Overall sensitivity	Magnitude	Significance
Collision	Very High	Negligible	Minor
Barrier	Medium	Medium	Minor
Displacement	High	Low	Minor

4.36.5 Species Sensitivities

Qualifying species

There are four SPAs in the region for which razorbill is a qualifying species: Buchan Ness to Collieston Coast, Fowlsheugh, Troup, Pennan and Lion's Head and Forth Islands SPA.

Flight height

Flight heights obtained from boat-based surveys undertaken in Aberdeen Bay recorded 354 razorbills in flight of which none were recorded as flying above 25 m and therefore at risk of collision.

Elsewhere out of 3,299 razorbills for which flight heights have been recorded 4% have been at rotor height.

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that razorbills are widespread and frequent within Aberdeen Bay and occur in relatively low densities throughout the area.

No razorbills have been reported as flying at rotor height within Aberdeen Bay or from other wind farms and no reports of collisions by razorbills have been found. Consequently, it is concluded that the risk of a collision with a turbine is very small and that collision mortality will not cause an adverse effect or significant impact to razorbills.

Barrier effect

As with guillemots, studies undertaken in Sweden and Denmark indicate that there is some potential for a barrier effect to occur with a reduced number of guillemots/razorbill crossing the constructed wind farms.

During the breeding season it is predicted that there may be regular flights to and from colonies some of which will intersect the proposed development area. The distance razorbills forage varies depending upon the availability of suitable prey and at what stage during the breeding season they are. Maximum foraging ranges are up to 150 km but most foraging occurs within 10 km of the colony (Roos 2010; Thaxter *et al*. 2010). Should a barrier effect occur with razorbills from either Fowlsheugh or Buchan Ness to Collieston Coast SPAs making daily movements from one location to another around the proposed development area then they may incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.0% and 2.5% (Speakman, Gray & Furness 2009).

The location and size of the proposed development is such that it will only occupy a relatively small zone through which birds may avoid flying. No significant concentrations of razorbills were recorded in the vicinity of the proposed development and therefore it is not considered to be a particularly favourable area for foraging. Regular daily movements by individual birds that could cause an incremental increase in distance of foraging flights on a daily basis is not predicted to occur, i.e. birds from colonies will forage over a wider area and will not need to detour around the proposed development on a regular daily basis.

Based on the above it concluded that the potential incremental increases in foraging distances are unlikely to cause an adverse effect or significant impact on razorbills.

Displacement

Based on the results from the monitoring data, the worst-case scenario is that should displacement occur, no razorbill will be within the proposed development area out to a distance of 1 km and a further 50% decrease in abundance occurs out to 2 km from the proposed development area.

Based on the peak density obtained from boat-based surveys of 9.0 birds/km^2 in the 'control' area during August, should there be a total displacement of razorbills from within the proposed development area it is predicted that up to 39 razorbills may be displaced during periods of peak density. Based on a 100% displacement out to 1 km from the proposed development area then it is predicted that up to 111 razorbills may be displaced and a further 91 out to 2 km should there be 50% displacement from between 1 km and 2 km. Therefore, the maximum number of razorbill potentially displaced is up to 241 birds based on the highest densities recorded from any survey within Aberdeen Bay and displacement out to 2 km.

Based on the estimated total of 241 razorbills potentially displaced out of a peak reported count of 1,369 razorbills (Figure 4-109), it is predicted that up to 18% of the razorbills within Aberdeen Bay may be displaced. This is based on a peak density obtained from surveys to the north of the development area and are therefore unlikely to be impacted by displacement effects; consequently the figure used is precautionary.

Based on the regional SPA population of 12,175 razorbills then approximately 1.9% of the regional population may be displaced.

Site-specific surveys recorded razorbills throughout the survey area and no specific concentrations were detected; although densities tended to be higher to the north of the proposed development area. However, should there be a displacement effect there is no evidence to suggest that the loss of the area of the proposed development will be significant and that individuals displaced will not be able to find suitable foraging areas elsewhere. Therefore, there is no evidence to suggest that any displacement will have a negative impact on razorbills.

Post-construction monitoring undertaken at Horns Rev offshore wind farm has indicated that displacement of razorbills occur. However, results from other operating wind farms suggest that this may not be the case and that total displacement from the are of the proposed development may not occur. Densities of razorbills within the area were not higher than elsewhere and consequently it is not thought that the proposed location is of particular importance, particularly as densities of razorbills tended to be higher to the north. Consequently, should displacement occur there are other areas where razorbills could relocate and it is predicted that any potential impact caused by displacement will be minor.

Calculations used for displacement	
Area	*Peak density of razorbill – 9.0 birds/km^2*
Area of EOWDC – 4.3 km^2	4.3 * 9.0 = 39
Area of 1 km buffer – 12.3 km^2	12.3 * 9 = 111
Area of 2 km buffer – 20.3 km^2 (50% displacement)	(20.3 * 9)/2 = 91
Total number at potential displacement	39+111+91 = 241

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on razorbills.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available is that from the Beatrice Demonstrator Project which recorded one razorbill over a period of 12 months pre-construction surveys (Talisman 2005). The size, scale and exact locations of the Round 3 and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of razorbills that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from the proposed plans. However, although the developments are within the potential foraging ranges of razorbills from a number of SPAs the relatively far distance the proposed development is from the other planned offshore wind farms and it's relatively small scale reduces the risk of a potentially significant cumulative or in-combination effect.

4.36.6 Conclusions

Habitats Appraisal

Based on site specific data and broad distribution of razorbills in Aberdeen Bay plus evidence from existing offshore wind farms indicating a very low collision risk and recognising that there is potential for some but not total avoidance and potentially some displacement it is predicted that there will not be any adverse effects on the SPA for which razorbill is a qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on razorbills.

4.37 Guillemot/Razorbill (*Uria alage/Alca torda*)

4.37.1 Background

Guillemot and razorbill can be difficult to separate in the field and consequently a proportion of birds are not identified to either species but are instead recorded as either guillemot or razorbill.

Boat-based surveys

Data from boat-based surveys undertaken between February 2007 and January 2008 indicate a similar pattern of distribution for guillemot/razorbill as was found for each individual species. Peak numbers occurred during July with an estimated 4,058 birds recorded in the 'control' area to the north and 1,620 in the wider proposed development area. Outwith the peak post-breeding period there was an estimated density of less than 6 birds/km^2 from November through to March. Throughout the year densities and abundance were greater within the 'control' area than within the proposed development area (Table 4-30, Figure 4-110, Figure 4-108).

Within the footprint of the proposed development relatively low numbers of guillemots/razorbills were recorded particularly during the breeding and post-breeding seasons.

Table 4-30: Monthly estimates of density and abundance of guillemots, razorbills and individuals not identified to either species in the proposed EOWDC and 'control' areas.

Month	Location	Density Estimate (km^2)	SE	Estimated Abundance	SE	No. Observations
January	EOWDC	2.154	0.509	109	25.9	30
	Control	2.908	0.546	148	27.7	45
February	EOWDC	6.135	0.751	312	38.2	169
	Control	1.662	0.285	84	14.5	52
March	EOWDC	1.486	0.389	75	19.7	23
	Control	3.262	0.598	166	30.4	43
April	EOWDC	5.147	0.790	261	40.2	138
	Control	10.377	1.481	527	75.2	260
May	EOWDC	8.001	1.147	406	58.2	85
	Control	12.646	1.856	642	94.3	151
June	EOWDC	14.219	2.607	722	132.4	109
	Control	20.070	2.828	1,020	143.7	180
July	EOWDC	31.882	4.153	1620	211.0	192
	Control	79.886	10.083	4,058	512.2	330
August	EOWDC	20.613	3.916	1047	198.9	104
	Control	29.480	5.655	1,498	287.2	178
September	EOWDC	17.920	2.500	910	127.0	180
	Control	26.274	2.410	1,335	122.4	221
October	EOWDC	17.839	1.854	906	94.2	187
	Control	6.010	0.867	305	44.0	77
November	EOWDC	5.447	0.602	277	30.6	55
	Control	2.659	0.515	135	26.2	29

Month	Location	Density Estimate (km^2)	SE	Estimated Abundance	SE	No. Observations
December	EOWDC	2.585	0.714	131	36.3	38
	Control	1.635	0.362	83	18.4	14

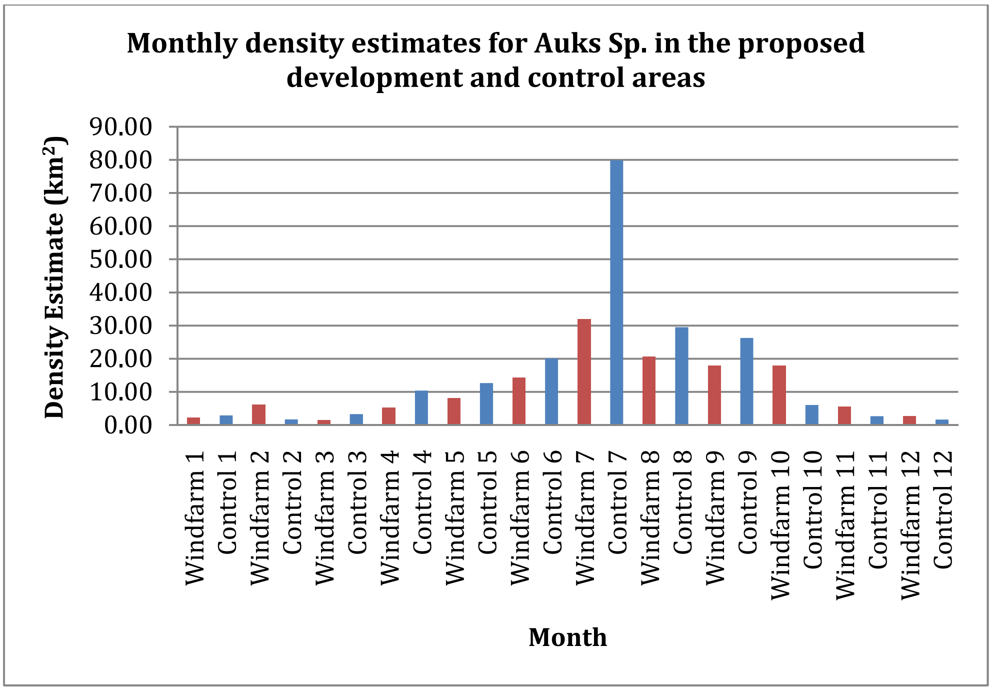


Figure 4-112: Monthly estimates (+/- SE) of density of guillemots, razorbills and individuals not identified to species in the proposed EOWDC and 'control' areas ('Windfarm' 1-12 and 'control' 1-12 refers to months).

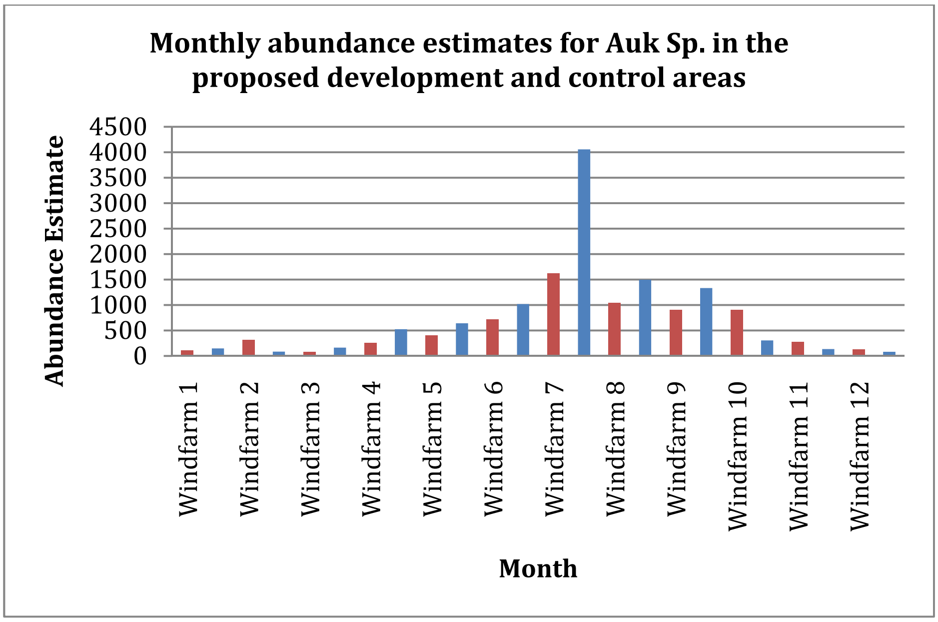


Figure 4-113: Monthly estimates (+/- SE) of abundance of guillemots, razorbills and individuals not identified to species in the 'wind farm' and 'Control' areas (Wind farm 1-12 and 'control' 1-12 refers to months).

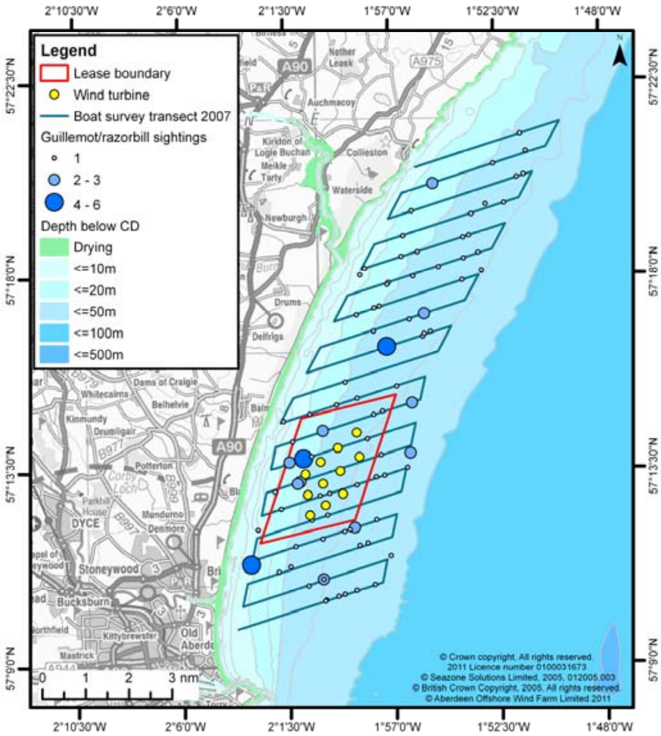


Figure 4-114: Guillemot/Razorbill distribution in Aberdeen Bay during winter period: November to February (all sightings).

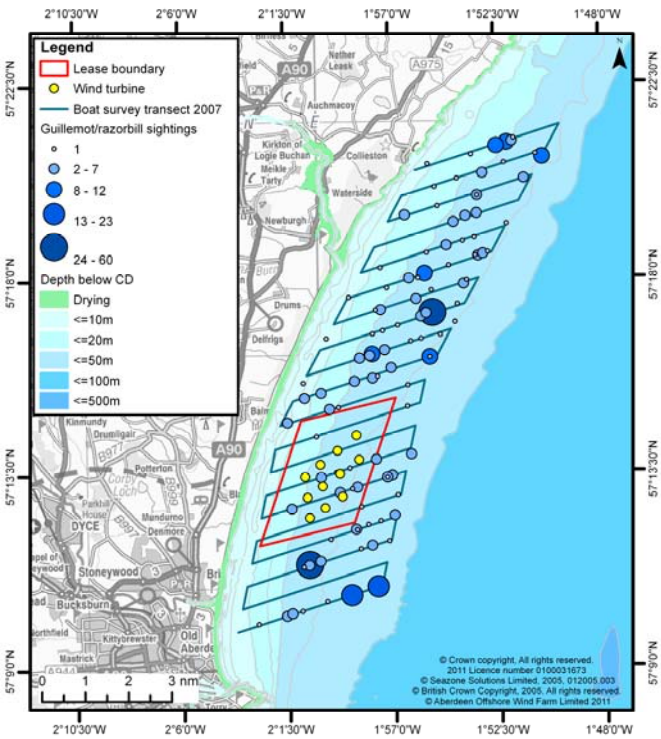


Figure 4-115: Guillemot/Razorbill distribution in Aberdeen Bay during breeding season: March to June (all sightings).

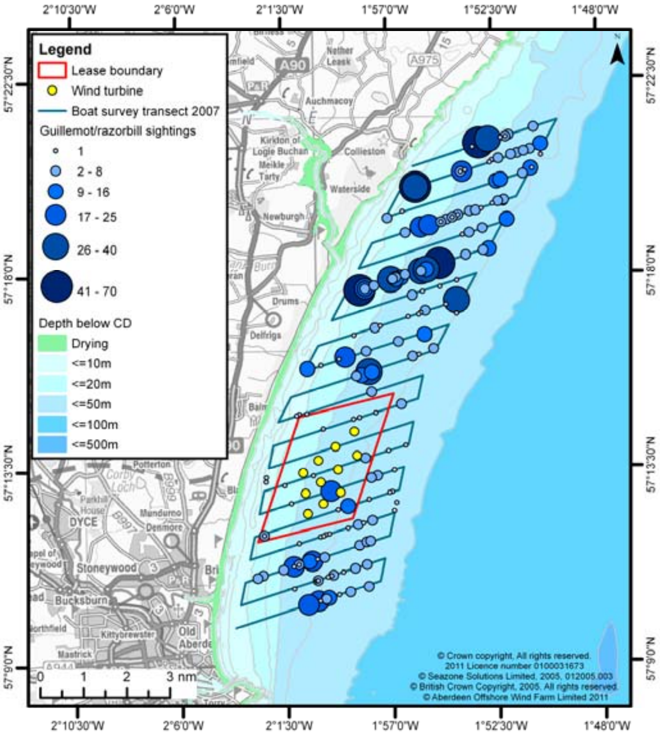


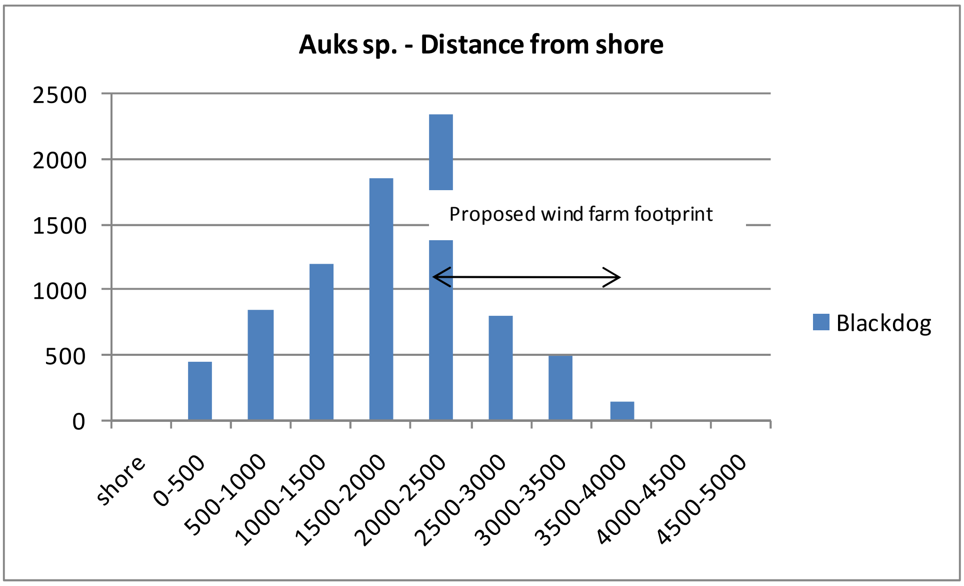
Figure 4-116: Guillemot/Razorbill distribution in Aberdeen Bay during post-breeding: July to October (all sightings).

Vantage Point surveys

Unidentified Auks were recorded throughout the year during Vantage Point surveys. Peak numbers occurred during April when up to 600 birds an hour were recorded passing Drums and November when up to 120 birds per hour were recorded passing Balmedie. Aside from these two peak counts numbers passing all Vantage Point sites were considerably lower and often less than 10 birds per hour at other sites during the same period (Alba Ecology 2008a). During the breeding season the numbers of unidentified Auks was lower than during the post-breeding season.

Bird Detection Radar

A total of 38 Auks were not identified to species level during surveys undertaken at Drums and Easter Hatton during October 2005. During the seventeen days of radar surveys undertaken in April 2007, a total of 7,787 unidentified Auks were recorded with a mean passage rate of 153 birds per hour making this the most frequently recorded 'species' during the April surveys. There was a distinct peak of up to 2,500 birds passing per hour on the evening of 12 April (Simms *et al*. 2007). The majority of sightings were within 1.5 km and 3 km from the coast (Figure 4-117)



(Adapted from Simms *et al*. 2007)

Figure 4-117: Distances from shore for Auks Sp. from Blackdog (April 2007).

4.37.2 Summary of Results

Unidentified Auks were widely recorded across Aberdeen Bay from all surveys. Relatively low numbers were present at the beginning of the year but increased from April onwards. Data from surveys indicate peak numbers in the bay during July with a decrease in numbers from August onwards. Significantly more birds were recorded in the 'control' area than within the proposed development area.

Data from boat-based surveys recorded unidentified Auks widely across the surveyed areas and land-based observations recorded most from between 2.0 km and 4.0 km from the coast.

4.37.3 Initial Assessment of Significance

Guillemot/Razorbill	Overall sensitivity	Magnitude	Significance
Collision	Very High	Negligible	Minor
Barrier	Medium	Medium	Minor
Displacement	High	Low	Minor

4.37.4 Species Sensitivities

Qualifying species

There are four SPAs in the region for which both guillemots and razorbills are a qualifying species: Buchan Ness to Collieston Coast, Fowlsheugh, Troup, Pennan and Lion's Head and Forth Islands SPA.

Flight height

Flight heights for both guillemots and razorbill are discussed previously and both species show that between 96% and 100% of flights are below turbine height.

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that both guillemots and razorbill are widespread and frequent within Aberdeen Bay and occur throughout the area.

Collision Risk Modelling undertaken for guillemot has indicated a very low risk of collision and it is likely that the majority of unidentified guillemot/razorbills will be of this species. The number of birds recorded in flight was very similar to guillemot and it is therefore predicted that the total number of birds at risk of collision is very low and that there will not be a significant impact on the guillemot/razorbill due to collisions.

Barrier effect

The potential barrier effect for guillemot/razorbill has been addressed previously under the respective species sections.

Displacement

To determine the potential impacts on guillemots/razorbill from displacement it is assumed that there will be total displacement within the proposed development area and out to a distance of 1 km and then a further 50% decrease in abundance out to 2 km from the proposed development area.

Based on the peak density obtained from boat-based surveys of 79.8 birds/km^2 in the 'control' area during July, should there be a total displacement of guillemot/razorbills from within the proposed development area it is predicted that up to 2,133 birds may be displaced out to 2 km during periods of peak density. Based on peak densities recorded within the proposed development area, which were lower, 850 guillemots/razorbill may be displaced.

Based on the regional population 101,000 guillemot and razorbills obtained from the regional SPA counts then between 1% and 2% of the regional population may be displaced. However, as previously discussed, total avoidance is not considered likely and any displaced birds will be able to find other alternative foraging areas based on the broad distribution of guillemots in the area and their wide foraging areas. Consequently it is not thought any significant impact or adverse effect will occur.

Calculations used for displacement	'control'	EOWDC
Area	*Peak density of guillemot/razorbill – 79.8 birds/km^2*	*Peak density of guillemot/razorbill –31.8 birds/km^2*
Area of EOWDC – 4.3 km^2	4.3 * 79.8 = 343	4.3 * 31.8 = 137
Area of 1 km buffer – 12.3 km^2	12.3 * 79.8 = 981	12.3 * 31.8= 391
Area of 2 km buffer – 20.3 km^2 (50% displacement)	(20.3 * 79.8)/2 = 809	(20.3 * 31.8)/2 = 322
Total potential displacement	343 + 981 + 809 = 2,133	137 + 391 + 322 = 850

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on either guillemots or razorbills. Information required to inform potential cumulative impacts from possible future offshore wind farm projects outwith Aberdeen Bay is currently unavailable. However, the relative distance the proposed development is from the other planned offshore wind farms and its relatively small scale reduces the risk of a potentially significant cumulative or in-combination effect.

4.37.5 Conclusions

Habitats Appraisal

Based on site specific data and broad distribution of both guillemots and razorbills in Aberdeen Bay plus evidence from existing offshore wind farms indicating a very low collision risk and recognising that there is potential for some but not total avoidance and, potentially, some displacement it is predicted that there will not be any adverse effects on the SPAs for which either guillemot or razorbill are qualifying species.

Environmental Impact Assessment

Based on evidence from existing offshore wind farms it is predicted that there will not be a significant environmental impact arising from the proposed development on guillemots or razorbills.

4.38 Atlantic Puffin (*Fratecula arctica*)

4.38.1 Protection & Conservation Status

The (Atlantic) puffin is listed in Appendix III of the Bern Convention and is on the Amber List of Species of Conservation Concern.

4.38.2 Background

Puffin		
GB Population	Breeding: 579,000 prs	BTO 2011
Scottish population	Breeding: 493,000 prs Winter: est. 20,000 ind	Forrester *et al.* 2007
International threshold	Unknown	-
GB threshold	10,400 ind.	1% of GB Pop[n]
Designated east coast sites where species is a noted feature	Firth of Forth (58,867 AoN)	SNH 2011 JNCC 2011a
European population estimate	Breeding 5,700,000 – 7,300,000 pairs Wintering – unknown	Birdlife 2004
European population trend	Status 'depleted' Trend 'unknown'	Birdlife 2004
World population	5,500,000 – 6,600,000 pairs	Mitchell *et al* 2004

Puffins are restricted to the North Atlantic and adjacent waters of the Arctic, with the species main stronghold in Iceland and north Norway. Puffins remain offshore until the breeding season when they move inshore and start attending colonies during early spring. The species is highly colonial, with pairs typically nesting in underground burrows dug in the soil of offshore islands. Following breeding, puffins leave the colonies and disperse widely to offshore waters. Puffins mainly feed on fish with sandeels a favoured prey item that they catch by underwater pursuit after diving from the surface.

The UK breeding population is estimated to be approximately 600,000 pairs of which 493,000 are in Scotland and 2,500 nest in North-east Scotland.

In North-east Scotland puffins are rarely recorded outwith the breeding season with peak counts past Peterhead of up to 15 birds per hour in June and July.

Boat-based survey

Unlike guillemots and razorbills, puffins were recorded predominantly in water depths of 30 m or more, with relatively few birds in near-shore waters. There were very few records of puffin between November and February with numbers increasing from March onwards. However, numbers in Aberdeen Bay were still relatively low with peak concentrations during the breeding season near Collieston where small numbers breed. Peak numbers occurred in the post-breeding season between August and October with the majority of birds to the north and very few records within the footprint of the proposed development area (Figure 4-118, Figure 4-119, Figure 4-120).

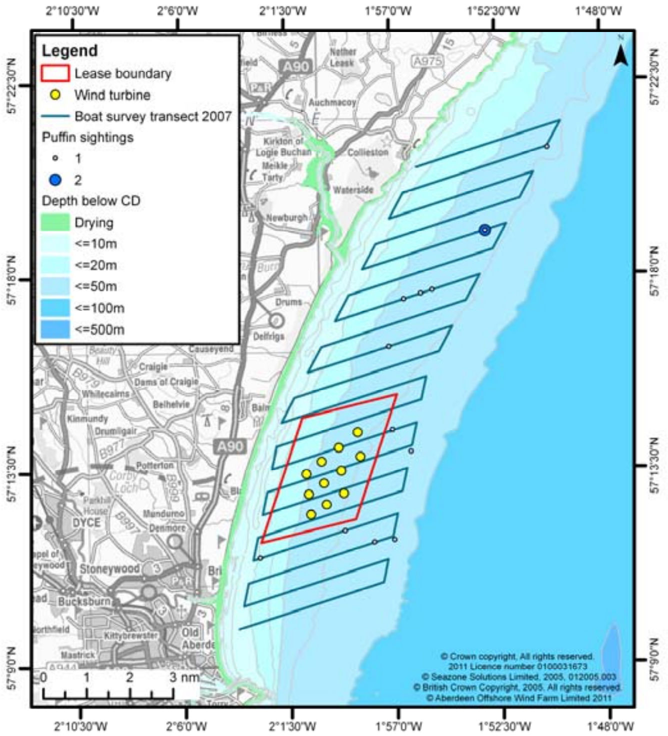


Figure 4-118: Puffin distribution in Aberdeen Bay during winter period: October to February (all sightings).

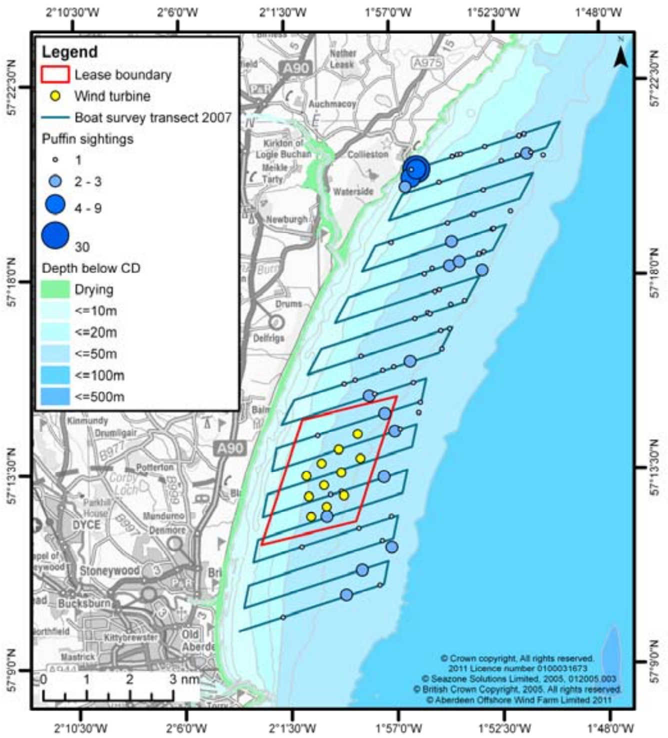


Figure 4-119: Puffin distribution in Aberdeen Bay during breeding season: March to July (all sightings).

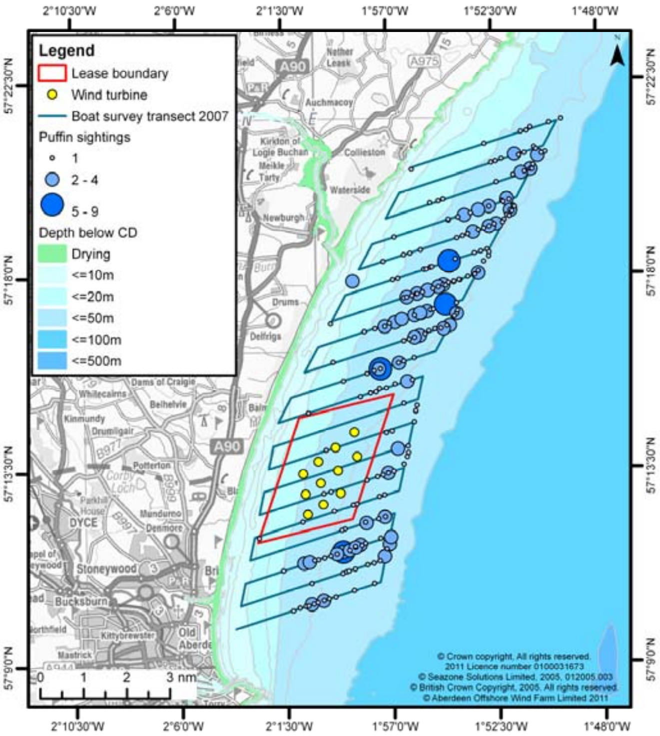


Figure 4-120: Puffin distribution in Aberdeen Bay during post-breeding: August to September (all sightings).

Puffins were only recorded between May and November with peak counts in the post-breeding season with an estimated population of 700 and 800 birds in the northern survey area during August and September 2010 and 1,347 individuals in offshore waters during August. Within the 'control' area peak abundance was during September when 357 individuals were estimated within the 'control' area and 48 were present in the proposed EOWDC development area. Within the proposed EOWDC development area peak numbers of puffin occurred during August and October when peak counts of 175 and 163 respectively were recorded (Figure 4-123, Figure 4-121).

Peak densities also occurred between August to October when 12.8 birds/km^2 were recorded in offshore areas during August and 7 birds/km^2 during October in the 'control' area. Within the proposed development area a peak density of 3.4 birds/km^2 was recorded in August.

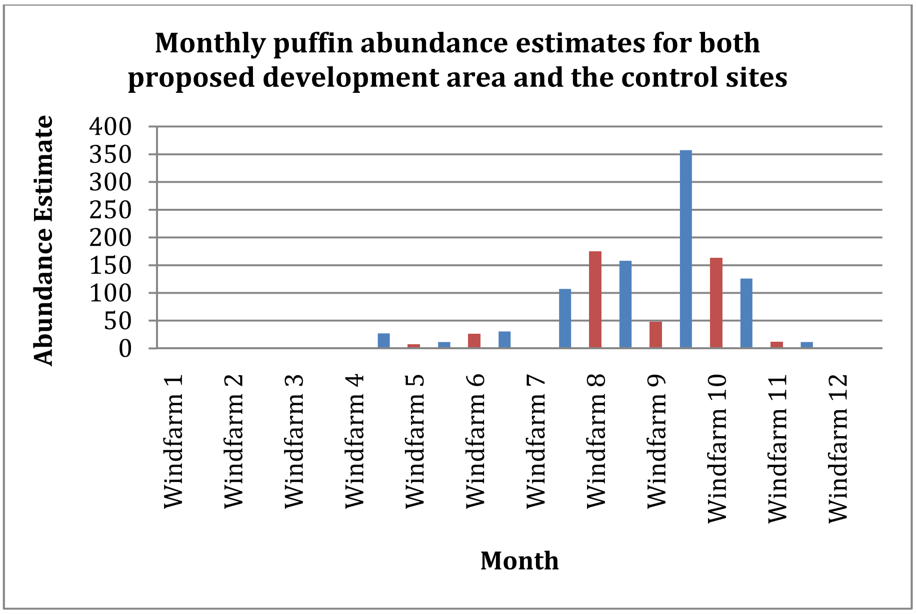


Figure 4-121: Monthly estimates (+/- SE) of abundance of puffins in the proposed EOWDC and 'Control' areas; February 2007 to January 2008 ('Windfarm' 1-12 and 'Control' 1-12 refers to months).

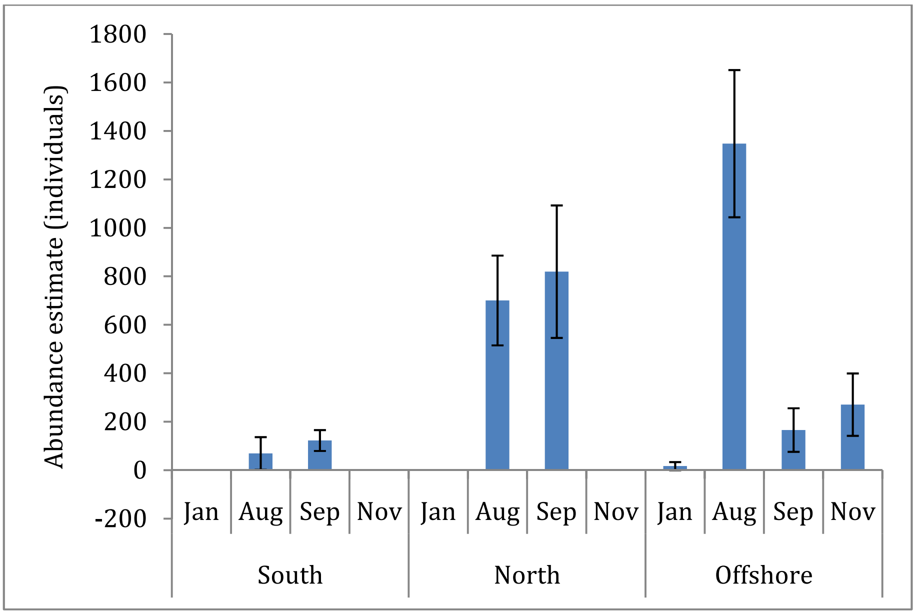


Figure 4-122: Monthly estimates (+/- SE) of abundance of Atlantic Puffin in the South, North and Offshore Strata; August 2010 to January 2011.

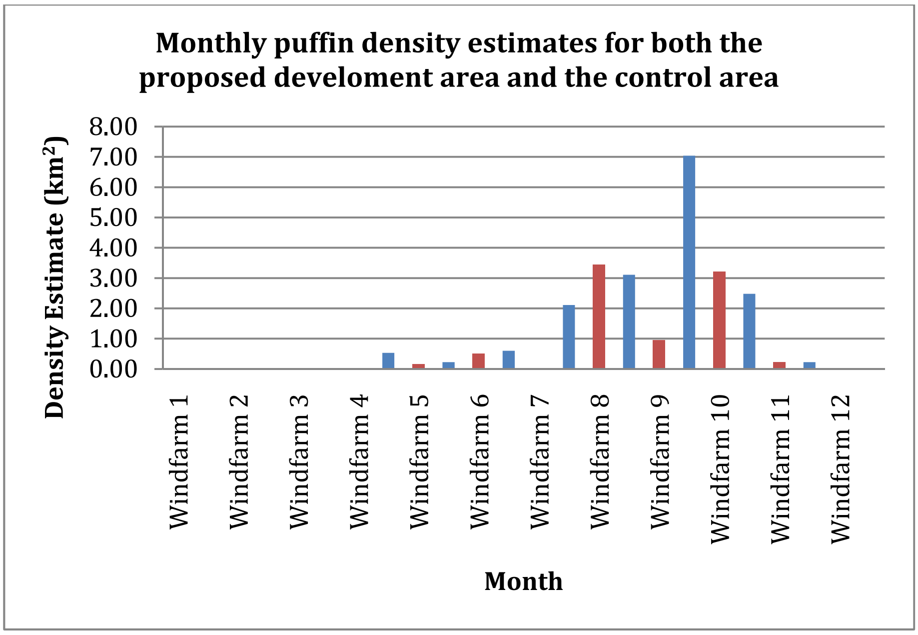


Figure 4-123: Monthly estimates (+/- SE) of density of puffins in the proposed EOWDC and 'control' areas February 2007 to January 2008 ('Windfarm' 1-12 and 'Control' 1-12 refers to months).

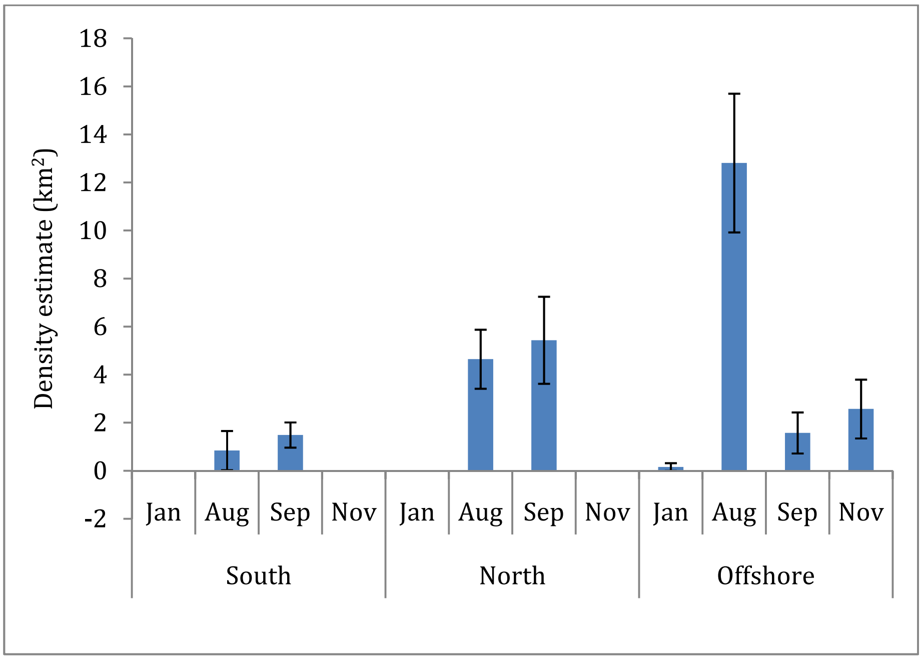


Figure 4-124: Monthly estimates (+/- SE) of density of Atlantic Puffin in the South, North and Offshore Strata; August 2010 to January 2011.

Vantage Point surveys

In Aberdeen Bay puffins were scarce during the winter period with only one sighting between October 2006 and March 2007. Between April and September low numbers of puffin were recorded with a passage of two birds per hour and a peak of three birds per hour in April. All sightings were of birds flying below 30 m and between 1 km and 3 km from shore.

Bird Detection Radar

One puffin was recorded during radar studies in October 2005 (Walls *et al* 2005).

4.38.3 Summary of Results

Puffins were widely recorded across Aberdeen Bay from all surveys. No puffins were recorded between December and March and relatively low numbers were recorded until July when the number of puffins recorded increased with a peak during the post-breeding period. Peak numbers of puffins during July and September were recorded within the 'control' area whereas in August and October peak numbers were within the proposed development area.

Of those recorded in flight, all puffins recorded during boat-based and land-based surveys were recorded as flying below 30 m.

No counts of puffin from any of the surveys undertaken within Aberdeen Bay were of national importance.

4.38.4 Initial Assessment of Significance

Guillemot	Overall sensitivity	Magnitude	Significance
Collision	Very High	Negligible	Minor
Barrier	Medium	Medium	Minor
Displacement	Medium	Low	Minor

4.38.5 Species Sensitivities

Qualifying species

The only SPA in the region for which puffin is a qualifying species is the Forth Islands SPA where 58,867 pairs of puffins nest on the Isle of May.

Flight height

Flight heights obtained from boat-based surveys undertaken in Aberdeen Bay recorded 32 puffins in flight none of which were recorded as flying above 25 m and therefore at risk of collision.

Elsewhere in the UK very few puffins have been recorded in flight and all have been below turbine height (n=35).

Collision risk

Evidence from site specific monitoring using boat-based and land-based surveys and other data sources indicate that puffins are widespread and frequent within Aberdeen Bay and occur in relatively low densities throughout the area.

No puffins were recorded as flying at rotor height within Aberdeen Bay or from other wind farms and no reports of collisions of puffins have been found. Consequently, it is concluded that the risk of a collision with a turbine is very small and that any collision mortality, should it occur, will not cause an adverse effect or significant impact to puffins

Barrier effect

There is no data available to determine whether puffins may be impacted by a barrier effect as very few puffins have been reported near to constructed offshore wind farms.

During the breeding season it is predicted that there may be regular flights to and from colonies some of which will intersect the proposed development area. The distance puffins' forage varies depending upon the availability of suitable prey and at what stage during the breeding season they are. Maximum foraging ranges are up to 137 km away from the colony although most foraging ranges will be considerably closer than this (Roos 2010; Thaxter *et al*. 2010). Should a barrier effect occur with birds from Fowlsheugh or to the north of Collieston making daily movements from one location to another around the proposed development area then they may incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.0% and 2.5% (Speakman, Gray & Furness 2009).

The location and size of the proposed development is such that it will only occupy a relatively small zone through which birds may avoid flying. No significant concentrations of puffins were recorded but they did tend to occur further offshore than either guillemot or razorbill and therefore have a higher potential to interact with the proposed development. However, puffins had a wide distribution offshore and regular daily movements by individual birds that could cause an incremental increase in the length of foraging flights on a daily basis is not predicted to occur, i.e. birds from colonies will forage over a wider area and will not need to detour around the proposed development on a regular daily basis.

Based on the above it is concluded that the potential incremental increases in foraging distances are unlikely to cause an adverse effect or significant impact on puffins.

Displacement

The worst-case scenario is that should 100% displacement occur, no puffin will be within the proposed development area out to a distance of 1 km and then a further 50% decrease in abundance occurs out to 2 km from the proposed development area.

Based on the peak density obtained from boat-based surveys of 12.8 birds/km^2 in the offshore area during August, should there be a total displacement of puffins from within the proposed development area it is predicted that up to 55 puffins may be displaced during periods of peak density. Based on a 100% displacement out to 1 km from the proposed development area then it is predicted that up to 157 puffins may be displaced and a further 130 out to 2 km should there be 50% displacement from between 1 km and 2 km. Therefore, the maximum number of puffin potentially displaced is up to 342 birds based on the highest densities recorded from any survey within Aberdeen Bay and displacement out to 2 km.

Based on the estimated total of 342 puffins potentially displaced out of a peak reported count of 1,347 (Figure 4-121), it is predicted that up to 25% of the puffins within Aberdeen Bay may be displaced. However, this is based on a peak density obtained from surveys further offshore from the development and densities within the proposed development area were significantly lower at between 3 and 5 birds per/km^2.

Based on the regional SPA population 117,734 puffins and the highest densities recorded from site specific surveys approximately 0.3% of the regional population may be displaced.

Site specific surveys recorded puffins throughout the survey area and no specific concentrations were detected; although densities tended to be higher further offshore compared to those recorded from the proposed development area. Should there be a displacement effect there is no evidence to suggest that the loss of the area of the proposed development will be significant and that individuals displaced will not be able to find suitable foraging areas elsewhere. Therefore, there is no evidence to suggest that any displacement will have a negative impact on puffins.

Densities of puffins within the proposed development area were not higher than elsewhere and consequently it is not thought that the proposed location is of particular importance for puffin, particularly as densities tended to be higher further offshore and in the 'control' area. Consequently, should displacement occur there are other areas where puffins could relocate and it is predicted that any potential impact caused by displacement will be minor.

Calculations used for displacement	
Area	*Peak density of puffin – 12.8 birds/km^2*
Area of EOWDC – 4.3 km^2	4.3 * 12.8 = 55
Area of 1 km buffer – 12.3 km^2	12.3 * 12.8 = 157
Area of 2 km buffer = 20.3 km^2. Area of 50% displacement	(20.3 * 12.8)/2 = 130
Total potential displacement	55 + 157 + 130 = 342

Cumulative and in-combination

There are no other additional activities within Aberdeen Bay that may cause either cumulative or in-combination impacts on puffins.

Outwith Aberdeen Bay there are a number of planned offshore wind farms in the Firth of Forth and the Moray Firth. The only data available is that from the Beatrice Demonstrator Project which recorded 16 puffins over a period of 12 months pre-construction surveys (Talisman 2005). The size, scale and exact locations of the Round 3 and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of puffins that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be a cumulative or in-combination impact arising from the proposed plans. However, although the developments within the Firth of Forth area are within foraging ranges of puffins from the Isle of May the relatively large distance the proposed development is from the other planned offshore wind farms and its relatively small scale reduces the risk of a potentially significant cumulative or in-combination effect.

4.38.6 Conclusions

Habitats Appraisal

Based on the distance the relevant SPA is from the proposed development site and the broad distribution of puffins in Aberdeen it is predicted that there will not be an adverse effect on the SPA for which puffin is a qualifying species.

Environmental Impact Assessment

Based on the numbers and distribution of puffins in Aberdeen Bay and their predicted behaviour towards wind farms it is concluded that there will not be a significant environmental impact arising from the proposed development on puffins.

5 OTHER SPECIES

The following bird species were recorded during the surveys undertaken within Aberdeen Bay, including radar studies and Vantage Point Counts. The numbers recorded for the following species were either low or they are not qualifying species for any SPAs likely to be affected by the proposed development.

Further detailed assessment for these species has not been undertaken as either the numbers recorded were very low or, as was the case for most waders, the majority of records were of birds within very close proximity to shore or even, on occasions, overland. Consequently, the risk of an interaction with the proposed development is negligible.

5.1 Mute swan

Four mute swans were recorded during the Vantage Point surveys with three in April 2007 and one in December 2006 (AlbaEcology 2008a, EnviroCenter 2007b).

5.2 Brent goose

Twenty Brent geese were recorded of Murcar in September 2005 and a further 19 from visual observations undertaken at the same time as the Bird Detection Radar studies in October 2005. A further skein of five birds was recorded in during further radar studies in April 2007 (Walls *et al.* 2006, Simms *et al.* 2007).

5.3 Tufted duck

A pair of tufted duck were recorded flying north in April 2007 from boat-based surveys and 11 were recorded at Blackdog during the radar surveys undertaken in April 2007 (Simms *et al.* 2007).

5.4 Black-throated diver

A single black-throated diver was recorded heading south past Blackdog in September 2006 it was recorded flying between, 0-30 m above sea level and between 1-2 km offshore (EnviroCentre 2007a). A further black-throated diver was seen flying past Blackdog in January 2007 and two past Don Mouth in February 2007 (EnviroCentre 2007b). One black-throated diver was recorded at Blackdog during the April 2007 radar surveys (Simms *et al.* 2007).

5.5 Great northern Diver

One great northern diver was recorded from boat-based surveys in January 2011.

Seven great northern divers were recorded from Vantage Point surveys undertaken between March 2005 and March 2008. Singles were recorded in June, July, August, and December and three in September. All were recorded flying below 30 m (Alba Ecology 2008a, EnviroCenter 2007b).

5.6 Sooty shearwater

A single sighting in November 2010 was the only record from boat-based surveys (SMRU 2011b). During Vantage Point surveys undertaken between April and October 2006 a total of 12 sooty shearwaters were recorded and a further 15 between April 2007 and November 2007 (EnviroCentre 2007a, Alba Ecology 2008a,b). All sightings were of birds flying below 30 metres and predominantly more than 2 km from shore. One sooty shearwater was recorded flying north in October and one was recorded at Drums, during the radar studies in October 2005. (IECS 2008; Walls *et al*. 2005).

5.7 European Storm petrel

One record from Vantage Point surveys was of a single bird in October 2007.

5.8 Grey Heron

Singles at Murcar in August 2005, Drums in October 2005, Donmouth in June 2006 and Balmedie in August 2006 were the only records. One was seen from boat-based surveys undertaken in August 2010.

5.9 Sparrowhawk

One was recorded during radar surveys in April 2007.

5.10 Kestrel

One kestrel was recorded at the Donmouth in March 2007.

5.11 Buzzard

One was recorded during radar surveys undertaken in April 2007.

5.12 Osprey

A single osprey was seen at the Donmouth in July 2007.

5.13 Oystercatcher

Small numbers recorded from land based observations with maximum counts of 10 in August 2006 and 11 in April 2006 at Drums and 43 at Blackdog in April 2007.

5.14 Ringed plover

Fifteen ringed plover were recorded at Drums in October 2005.

5.15 Northern Lapwing

A total of 930 lapwing were recorded at Drums in October 2005.

5.16 Knot

15 at Balmedie in August 2005 and Four in January at the Donmouth were the only records.

5.17 Sanderling

Small numbers of sanderling were regularly recorded along the beach of Aberdeen Bay. Peak totals were of 110 at Blackdog in April 2007, 49 at Easter Hatton in October 2005 and 12 at Blackdog during September 2006.

5.18 Dunlin

Small numbers of dunlin were recorded during land-based counts with four at Drums and 11 at Blackdog in June 2006. Two dunlin were recorded from boat-based surveys both flying below 30 m.

5.19 Black-tailed godwit

Eighteen black-tailed godwits in April at Blackdog in 2007 was the only record.

5.20 Bar-tailed godwit

Six at Balmedie in April 2005, one at Drums in October 2005, one in September 2006 and two in April 2006 both at Blackdog were the only sightings.

5.21 Whimbrel

Singles at Drums in April 2005 June 2006 at Blackdog and Drums in April 2006 were the only records.

5.22 Curlew

Curlew were generally regularly recorded in small numbers of less than 40 birds throughout the year from land-based observations. One exception was of counts undertaken in October 2005 when 941 were recorded at Drums and 235 at Easter Hatton.

5.23 Redshank

Three sightings of redshank were all from Blackdog where there were 25 in April 2006, seven in June 2006 and 27 in April 2007. There were no other sightings of redshank from other land-based or boat-based surveys.

5.24 Turnstone

Three turnstone were recorded from land-based counts in October 2005.

5.25 Long-tailed skua

There was one record, in May, of an adult long-tailed skua flying north from boat-based surveys.

5.26 Pomarine skua

In Aberdeen Bay, Pomarine skuas were recorded in very small numbers between June and September with 2 in June and one in August. All records were of birds flying below 30 m. A further 12 Pomarine skuas were recorded during radar studies undertaken in October 2005. Six were at Drums and six at Easter Hatton (Walls *et al* 2005).

5.27 Glaucous gull

A total of seven glaucous gulls were recorded from the surveys. All were made during Vantage Point counts with a total of six records at Blackdog between November 2007 and March 2008 and one at the Donmouth in February 2008.

5.28 Little gull

In Aberdeen Bay little gulls are scarce with four at drums in May 2005 and a total of twenty recorded between April and July 2006 with a peak count in May 2006 of up to 2 birds per hour (EnviroCentre 2007a). There were no records of little gulls during 2007 surveys and only one record in March 2008.

There was one further record in August 2010 (SMRU 2011b).

Little gulls were recorded out to 3 km from shore and half of all sightings were of birds flying between 30-150 m.

One little gull was recorded at Easter Hatton during the radar studies in October 2005. (Walls *et al* 2005).

5.29 Sabine's gull

One was seen from Easter Hatton during radar studies in October 2005 (Walls *et al*. 2006).

5.30 Black guillemot

There were two records of black guillemot from Vantage Point surveys: four birds of Drums in November 2007 and one there in March 2008.

5.31 Little auk

The majority of records of little auk were from surveys undertaken in November 2007 when up to 194 little auks were recorded from land-based observations. Boat-based records were during October and November with a total of 12 birds seen. A further five were recorded in April 2007. All sightings were of birds in flight, flying below 15 m.

5.32 Woodpigeon

A single woodpigeon was seen in April 2007.

5.33 Swift

Two in June 2007 at the Donmouth.

5.34 Skylark

Two skylark were seen in April 2007.

5.35 Swallow

There were only a few sightings of swallows reported from land-based observations with a maximum 8 at Blackdog in April 2007 and ones or twos from other observation points during the summer months.

5.36 Sand martin

A single sand martin was recorded during April 2007 at Blackdog.

5.37 Meadow pipit

A single meadow pipit was recorded in March 2007 at the Donmouth.

5.38 Redstart

Two redstarts were recorded at Easter Hatton during October 2005.

5.39 Blackbird

A flock of 25 blackbirds were recorded from land-based observations undertaken at Drums during November 2007.

5.40 Redwing

A single redwing was recorded in October 2005.

5.41 Carrion Crow

Four carrion crows were recorded from land-based observations in April 2007. One at the Donmouth, two at Blackdog and one at Balmedie.

5.42 Linnet

Four linnets were recorded from land-based counts in April 2007.

5.43 Snow bunting

A flock of thirteen were recorded at Blackdog during November 2007.

6 SUMMARY

For the main species recorded from surveys undertaken within the proposed development area the results from the Impact Assessment presented in Section 4, are summarised in Table 6-1. The results presented do not take into account any specific mitigation measures that may be developed in the future that would further reduce the risks and remove or remedy any significant or adverse impacts that may arise (see Section 7).

The results of the assessment identified 36 species of bird that due to either their conservation status, i.e. are a qualifying species for an SPA or due to the numbers recorded within the proposed development area could be impacted by the proposed development.

Three potential impacts were identified: Collision, Displacement and Barrier effects. The potential for both direct and indirect disturbance has also been considered as part of the displacement assessment.

Following the use of a series of matrices to indicate the significance of a potential impact arising from the construction, operation and decommissioning of the proposed development an evidence based assessment has been undertaken to determine the overall significance of the potential impacts.

The results indicate that for most species the proposed development is only likely to have a negligible or at worse a minor effect on the species present.

The impact assessment has identified the potential for impacts of moderate significance on four species of bird: red-throated diver, little tern, Sandwich tern and common tern.

Red-throated diver may be displaced from the area of the proposed development during construction, operation and decommissioning phases. Site specific data indicate that although the higher numbers of red-throated diver occur to the north of the proposed development area a proportion of the local regional population may be displaced. The effects of the possible displacement on red-throated divers are unknown but could be significant were all those displaced not to survive. However, this scenario is considered improbable as the proposed development is in an area not favoured by red-throated diver and any Divers that may be displaced will be able to move to other suitable foraging areas. Therefore, although the impact may be moderate in terms of displacement the actual impact on the Diver population within Aberdeen Bay will be negligible or minor.

Three species of Tern were identified as being at potential risk of a moderately significant impact due to possible indirect impact on their prey should pile driving occur during the construction period. However, it is also considered that any displacement of prey would be temporary as fish would return to the area following cessation of piling. Consequently, the possible impacts were considered to be of a temporary nature and would not have a long-term effect.

Table 6-1: Summary of Species Impact Assessment.

Species	Collision Risk	Barrier	Displacement	Overall Assessment
Whooper swan	Negligible	Negligible	Negligible	**Negligible**
Pink-footed goose	Negligible	Negligible	Negligible	**Negligible**
Greylag goose	Negligible	Negligible	Negligible	**Negligible**
Barnacle goose	Minor	Negligible	Negligible	**Minor**
Shelduck	Negligible	Negligible	Negligible	**Negligible**
Eurasian wigeon	Negligible	Negligible	Negligible	**Negligible**
Eurasian Teal	Negligible	Negligible	Negligible	**Negligible**
Mallard	Negligible	Negligible	Negligible	**Negligible**
Common eider	Negligible	Minor	Minor	**Minor**
Long-tailed duck	Negligible	Minor	Negligible	**Negligible**
Common scoter	Negligible	Negligible	Minor	**Minor**
Velvet scoter	Negligible	Negligible	Minor	**Minor**
Goldeneye	Negligible	Negligible	Negligible	**Negligible**
Red-Brst Merganser	Negligible	Negligible	Negligible	**Negligible**
Red-throated diver	Negligible	Negligible	Moderate	**Moderate**
Fulmar	Negligible	Minor	Negligible	**Minor**
Manx shearwater	Negligible	Negligible	Negligible	**Negligible**
Northern gannet	Negligible	Negligible	Negligible	**Negligible**
Great cormorant	Negligible	Minor	Negligible	**Minor**
European shag	Negligible	Negligible	Negligible	**Negligible**
Great-crested grebe	Negligible	Negligible	Negligible	**Negligible**
Arctic skua	Negligible	Negligible	Negligible	**Negligible**
Great skua	Negligible	Negligible	Negligible	**Negligible**
Golden plover	Negligible	Minor	Negligible	**Minor**
Kittiwake	Negligible	Negligible	Negligible	**Negligible**
Black-headed gull	Negligible	Negligible	Negligible	**Negligible**
Common gull	Minor	Negligible	Negligible	**Minor**
Herring gull	Minor	Negligible	Negligible	**Minor**
Lsr black-backed gull	Negligible	Negligible	Negligible	**Negligible**
Grt black-backed gull	Negligible	Negligible	Negligible	**Negligible**
Little tern	Negligible	Negligible	Moderate	**Moderate**
Sandwich tern	Negligible	Negligible	Moderate	**Moderate**
Common tern	Minor	Negligible	Moderate	**Moderate**
Arctic tern	Minor	Negligible	Minor	**Minor**
Guillemot	Negligible	Negligible	Minor	**Minor**
Razorbill	Negligible	Negligible	Minor	**Minor**
Atlantic puffin	Negligible	Negligible	Minor	**Minor**

7 MITIGATION & MONITORING

Detailed mitigation and monitoring measures aimed to avoid, remove or reduce any potentially significant impacts will be developed more fully during consultation with the Regulator and their statutory advisors and other stakeholders.

The main potential impacts arising from the proposed development relate primarily to direct or indirect displacement effects on Divers and Terns. Mitigation measures that may be considered as measures to help avoid, remove or reduce them include:

Minimising the proposed development area: By reducing as far as practicable the overall area of the proposed development, the total area and consequently the total number of red-throated divers that may be displaced will be minimised. A number of factors need to be taken into consideration when identifying the location of turbines, including the minimum distance turbines may be able to operate effectively. The current lay out is based on the minimum practical distance possible between turbines, taking into account the physical properties of the likely turbines, features of the seabed, water depth, other sea users as well as comments received during the consultations undertaken during the development of this project. Subject to further consultation, it is currently predicted that there will not be any significant change in the positions of the currently planned wind turbine locations, which covers an area of 4.3 km^2.

Vessel management plans: The potential disturbance of seaduck and Divers and other seabirds from the proposed development area by construction, maintenance or decommissioning vessels may be reduced by minimising the number vessels used during any of phases of the proposed project. Furthermore, ensuring that all vessels use the existing shipping lanes within Aberdeen Bay for as much time as possible will minimise the number of birds potentially displaced.

Foundation types: The use of monopiles as a type of foundation requires the use pile-driving to install them, which may cause an indirect effect on prey species. By selecting alternative foundation types, e.g. gravity based structures or jackets that require smaller piles, there is the potential to reduce the risk of an impact on the prey species and therefore reduce the possibility of a displacement effect being caused by construction activities. Further consideration of the foundation types used by the proposed project will be made during the consenting process. Means to minimise the potential effects of noise generated by pile-driving, should it occur, would be considered in line with the latest relevant guidance and would for example include ‘soft-start’.

Timing and duration of installation: The timing and duration of installation have still to be determined. Site-specific data indicate that there are birds present in Aberdeen Bay throughout the year with peak numbers occurring at different times of year depending on the species. Therefore, it may not be possible to select a period for construction activities to take place at a specific time of year that has relatively lower bird numbers present and therefore less sensitive. It is also recognised that there may be other environmental and project aspects, e.g. fish spawning periods or vessel availability that will need to be considered when identifying potential development construction periods. The timing of possible construction would be further considered during the consenting process when details on the potential project schedule are developed.

Minimising aviation and navigation lighting: Birds can be attracted to bright lights, e.g. lighthouses, particularly during poor weather conditions. In order to reduce the risk of birds being attracted to the proposed development all lighting will be kept as far as practicable to a minimum but still kept within the requirements to ensure safety.

Discussions with the relevant authorities on minimum lighting requirements to ensure safety would be held.

It is essential that any monitoring undertaken is designed to address specific concerns or potential impacts identified during the EIA process. Poorly designed *ad hoc* monitoring is likely to be inefficient and not provide useful or meaningful results. It is therefore important that any monitoring programme is developed in collaboration with the Regulator and statutory advisors and takes note of key stakeholders comments arising from the consultation period.

A detailed monitoring programme aimed at specific issues or concerns would be developed with the Regulator and advisors should consent be granted.

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8 APPENDIX A

8.1 Collision risk modelling

The following section describes and defines the key terms used in the collision risk modelling, following the recommendations made in the SNH approach and also to that having been used in previous offshore wind farm assessments.

The *risk area* is the two-dimensional window facing a bird approaching the proposed development from any given direction. It is defined here as the width of the application area multiplied by the height of the proposed turbine rotors.

Birds may face a wider span of turbines if they approach from other directions (east to west) across the proposed development but, the assumption of this particular flight path is precautionary, since this approach direction has the highest *rotor-swept area* to risk-area ratio and so the highest potential collision risk of any approach path.

The number of birds that are expected to pass through the airspace that would actually be swept by the rotors (the "rotor swept area") was calculated using the following equation:

- *total passing through the risk area * ratio of the rotor swept area to the risk area.*

The proposed development design is planned to use a number of yet undeveloped turbine types with the exact detail of these machines not yet known. The maximum turbine that is expected to be deployed could be up to 10MW. In order to make predictions for the worst-case scenario, the turbines were assumed to be 11, 10MW machines, because these machines result in a greater rotor-swept area than the alternative machines.

Any birds that were recorded as flying through the proposed development at Potential Collision Height was considered to be "at risk" of passing through the airspace swept by a turbine rotor (a rotor transit). Potential Collision Height was defined as a height band between 25-150m. Bird flight height information was used to calculate the portion of flying birds expected to be at potential collision height.

The directional modelling process is described below and illustrated using the real data for gannet. The following steps relate to the steps set out in the collision risk calculations for each species, given in the results section.

Step 1:

The peak totals of each key species seen flying at the EOWDC within the 300m transect during the snapshot scans were calculated. In order to build a degree of precaution into the model, the month with the highest peak total of birds detected in flight was used. In order to calculate the % of birds at collision risk height taken as birds flying 25m – 150m, both site specific survey data was used (where available) and generic information on flight height information (Cook, Wright & Burton *in prep*.). The rate at which birds were detected during the surveys was calculated by dividing the species total by the total number of survey minutes.

<u>Example</u>:

- *29 Gannets recorded in flight during the September survey.*
- *Total gannets flying at Potential Collision Height (using 17 site specific collision height value) = 4.93*
- *Total gannets flying at potential collision height (using 14% site specific collision height value) = 4.06*

Step 2:

The rate at which birds were detected during the survey was calculated by dividing the species totals by the total number survey minutes.

Example:

- *Gannets recorded during the IECS survey (361 minutes of survey effort in the EOWDC area) = R = 0.0136 birds per minute, (or 0.011 using 14% generic collision height)*

Step 3:

The bird detection rates collected in survey areas (e.g. 'control' or EOWDC) were scaled down to the size of the proposed development licence area. This was accomplished by multiplying the survey detection rate by the ratio of the transect area to the proposed development area.

Example:

- For gannet R_{SITE} = ratio EOWDC transect to survey area (0.393) x survey detection rate (0.0136) = 5.34×10^{-3}

Step 4

The number of birds flying through the Risk Area during an average year was then extrapolated from the overall detection rate. This was calculated by multiplying the rate per minute (R_{SITE}) by the total number of minutes that the species was considered to be potentially active during the year. In the absence of good information on the potentially active periods of any of the key species, it was assumed, as a precaution, that all could fly at any time of the day. Thus the potentially active period was taken to be 365 days x 24 hours, or 525,600 minutes for all.

Example:

- *The average number of gannets flying through the EOWDC Risk Area was estimated to be 0.0136 x 525,600 = 7,148 birds (or 5,781 birds using 14% of birds at collision height)*.

Step 5

The size of the *risk area*, which is defined as the width of the proposed development area multiplied by the height of the proposed turbine rotors was = 540,000 m^2.

Example:

- *The risk area at EOWDC was calculated by: Width of EOWDC area (2,600 m) * Height of turbines (10MW 150 m)*.

Step 6

The total rotor swept area was calculated using the following equation: total passing through the risk area * ratio of the *rotor swept area* to the *risk area*.

Example: The areas swept by one 10MW turbine rotor of up to 150 m diameter was $\pi \times 75^2$ = 17,671. With their being potentially up to 11 of these turbines at the EOWDC, the total *rotor swept area* was taken to be 11 * 17,671 = 194,161.

Step 7

The ratio of the rotor-swept area to the risk area was calculated by dividing the rotor swept area by the risk area.

Example:

- *rotor swept area (194, 161) / 540,000 = 0.35*

Step 8

The annual number of birds flying through the rotor swept area was calculated from the annual numbers through the risk area by direct proportion.

Example:

*At the EOWDC the rotor swept area formed 0.35 of the risk area, so the estimated number of gannets through the rotor swept area is 7,148 * 0.35 = 2,501 birds (or 2,023 birds using 14% flying at collision height)*.

Step 9

The probability of collision was calculated for each key species, using the spreadsheet supplied by SNH for this purpose. The input parameters relating to the species were sourced from Snow and Perrins (1998) (length and wingspan) and Alerstom *et al*., (2007) (average flight speed). The parameters for the likely turbine specifications for a 10 MW machine were provided by AOWFL and are outlined in the Project Description (Chapter 3).

Example:

- *The probability of collision for the gannet was calculated as 12, or 0.12*

Gannet											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	□	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
Bird Length	0.94	m	0.025	0.575	3.78	10.84	0.73	0.00091	9.12	0.61	0.00077
Wingspan	1.8	m	0.075	0.575	1.26	4.19	0.28	0.00212	2.46	0.17	0.00124
F: Flapping (0) or gliding (+1)	1		0.125	0.702	0.76	3.30	0.22	0.00278	1.19	0.08	0.00100
			0.175	0.860	0.54	3.12	0.21	0.00367	0.70	0.05	0.00083
Bird speed	15	m/sec	0.225	0.994	0.42	3.52	0.24	0.00533	1.35	0.09	0.00204
RotorDiam	150	m	0.275	0.947	0.34	3.21	0.22	0.00594	1.51	0.10	0.00280
Rotation Period	2.97	sec	0.325	0.899	0.29	2.97	0.20	0.00650	1.61	0.11	0.00352
			0.375	0.851	0.25	2.77	0.19	0.00701	1.66	0.11	0.00419
			0.425	0.804	0.22	2.61	0.18	0.00747	1.68	0.11	0.00481
			0.475	0.756	0.20	2.46	0.17	0.00788	1.68	0.11	0.00538
Bird aspect ratio: □	0.52		0.525	0.708	0.18	2.33	0.16	0.00825	1.67	0.11	0.00591
			0.575	0.660	0.16	2.21	0.15	0.00857	1.65	0.11	0.00638
			0.625	0.613	0.15	2.10	0.14	0.00884	1.62	0.11	0.00681
			0.675	0.565	0.14	1.99	0.13	0.00906	1.58	0.11	0.00719
			0.725	0.517	0.13	1.89	0.13	0.00923	1.54	0.10	0.00752
			0.775	0.470	0.12	1.79	0.12	0.00936	1.50	0.10	0.00781
			0.825	0.422	0.11	1.70	0.11	0.00944	1.45	0.10	0.00804
			0.875	0.374	0.11	1.61	0.11	0.00947	1.40	0.09	0.00823
			0.925	0.327	0.10	1.52	0.10	0.00945	1.34	0.09	0.00837
			0.975	0.279	0.10	1.43	0.10	0.00938	1.29	0.09	0.00846
				Overall p(collision) =			**Upwind**	**14.1%**		**Downwind**	**10.1%**
								Average	**12%**		

Step 10

The estimated number of turbine collisions each year, assuming no avoiding action and that the turbines were operating 85% of the time to take account of periods when the winds would be inefficient to operate, was calculated as the estimated annual numbers of birds flying through the rotor swept area, multiplied by the probability of collision, multiplied by 0.85.

Example:

- *For the gannet, 2,501 (estimated number of bird collisions per year) *0.12 (probability of collision) * 0.85 (time that turbines were operating) = 255 birds per year (or 206 when applying 14% flying at collision height)*.

These values are both precautionary as it assumes birds are active 24 hours a day and do not avoid the turbines.

Various plausible avoidance rates were then applied to this estimate to give a more realistic range of collisions. The avoidance rates applied were 98% (assumed to be the worst case scenario) 98% and 99%.

98% avoidance 255 (or 206) birds * 0.02 = 5.1 (or 4.1*) gannet collisions annually,

99 % avoidance 255 (or 206) birds * 0.01 = 2.55 (or 2.06*) gannet collisions annually,

99.5% avoidance 255 (or 206) birds * 0.005 = 1.27 (1.03*) gannet collisions annually,

*Uses 14% of birds in flight flying at collision height

Goose collision risk methodology

In the absence of site specific survey data that was suitable to estimate collision risk for the pink-footed goose and barnacle goose a different approach was applied based on the assumption that the whole UK wintering populations of pink-footed goose and Svalbard population of Barnacle goose undertake a twice yearly migration across the proposed development area in a 10 km band.

Pink footed geese:

The proposed development risk area in a north south direction has a length of 3.6 km and it was assumed that 244,800 pink footed geese would migrate through the risk area every year. The number of birds flying across the risk window at potential collision height was calculated as 46% of 244,800 = 112,608 individuals. The rotor swept area is 194,161 m^2 and the proportion of the rotor swept area to the risk window is 0.35. The number of birds calculated to fly across the rotor swept area is 39,412.

Barnacle goose:

The proposed development risk area in a north south direction has a length of 3.6 km and it was assumed that 32,000 barnacle geese would migrate across a 10 km band of the offshore area, twice a year. The number of birds potentially flying through the risk area is 23,040 birds per year. The number of birds flying across the risk area at potential collision height was calculated as 46% of 23,040 = 10,958. The rotor swept area is 194,161 m^2 and the proportion of the rotor swept area to the risk window is 0.35. The number of birds calculated to fly across the rotor swept area is 3,709.

8.2 Summary of the collision risk outputs

Table 8-1: Pink-footed goose Collision Risk Calculations

Step in collision risk Process	Peak numbers of flying birds (applying generic flight height information 46%)
Step 1: Number of birds in transect at Potential Collision Height	Used proportion of UK population of pink footed geese migrating along a 10km band
Step 2: Rate at which birds detected at PCH	Not applicable
Step 3: Rate of bird detections scaled to EOWDC area	Not applicable
Step 4: Estimated annual total of birds through the risk area	112,608.0000
Step 5: Size of the risk area	540,000.0000
Step 6: Total rotor swept area	194,161.0000
Step 7: Ratio of rotor swept area to the risk area	0.3500
Step 8: Annual number of birds flying through the rotor area	39412.8000
Step 9: Probability of collision (Band Model)	8.4%
Step 10: Estimated number of collisions per year assuming no avoidance and 100% operational time	3,310.6752
Assuming an operational time of 85%	2,814.0739
Assuming a 98% avoidance rate	56.2815
Assuming a 99% avoidance rate	28.1407
Assuming a 99.5% avoidance rate	14.0704

Table 8-2: Barnacle goose Collision Risk Calculations

Step in collision risk Process	Peak numbers of flying birds (applying generic flight height information 46%)
Step ,: Number of birds in transect at Potential Collision Height	Used proportion of UK population of barnacle geese migrating along a 10km band
Step 2: Rate at which birds detected at PCH	Not applicable
Step 3: Rate of bird detections scaled to EOWDC area	Not applicable
Step 4: Estimated annual total of birds through the risk area	10,598.00
Step 5: Size of the risk area	540000.00
Step 6: Total rotor swept area	194,161.00
Step 7: Ratio of rotor swept area to the risk area	0.35
Step 8: Annual number of birds flying through the rotor area	3709.30
Step 9: Probability of collision (Band Model)	8.5
Step 10: Estimated number of collisions per year assuming no avoidance and 100% operational time	315.29
Assuming an operational time of 85%	268.00
Assuming a 98% avoidance rate	5.36
Assuming a 99% avoidance rate	2.68
Assuming a 99.5% avoidance rate	1.34

Table 8-3: Common scoter Collision Risk Calculations

Step in collision risk Process	Peak numbers of flying birds (applying generic flight height information 46%)
Step 1: Number of birds in transect at Potential Collision Height	1.04
Step 2: Rate at which birds detected at PCH	0.034
Step 3: Rate of bird detections scaled to EOWDC area	0.0013
Step 4: Estimated annual total of birds through the risk area	699.7499
Step 5: Size of the risk area	540,000.0000
Step 6: Total rotor swept area	194,161.0000
Step 7: Ratio of rotor swept area to the risk area	0.3500
Step 8: Annual number of birds flying through the rotor area	244.9125
Step 9: Probability of collision (Band Model)	0.066
Step 10: Estimated number of collisions per year assuming no avoidance and 100% operational time	16.1642
Assuming an operational time of 85%	13.7396
Assuming a 98% avoidance rate	0.2748
Assuming a 99% avoidance rate	0.1374
Assuming a 99.5% avoidance rate	0.0687

Table 8-4: Gannet Collision Risk Calculations

Step in collision risk Process	Peak numbers of flying birds (applying site specific flight height 17%)	Peak numbers of flying birds (applying generic flight height information 14%)
Step 1: Number of birds in transect at Potential Collision Height	4.93	4.06
Step 2: Rate at which birds detected at PCH	0.01	0.01
Step 3: Rate of bird detections scaled to EOWDC area	0.01	0.00
Step 4: Estimated annual total of birds through the risk area	2,820.90	2323.09
Step 5: Size of the risk area	540,000.00	540,000.00
Step 6: Total rotor swept area	194,161.00	194,161.00
Step 7: Ratio of rotor swept area to the risk area	0.35	0.35
Step 8: Annual number of birds flying through the risk area	987.31	813.08
Step 9: Probability of collision (Band Model)	12%	12%
Step 10: Estimated number of collisions per year assuming no avoidance and 100% operational time	118.48	97.57
Assuming an operational time of 85%	100.71	82.93
Assuming a 98% avoidance rate	2.01	1.66
Assuming a 99% avoidance rate	1.01	0.83
Assuming a 99.5% avoidance rate	0.50	0.41

Table 8-5: Cormorant Collision Risk Calculations

Step in collision risk Process	Peak numbers of flying birds (applying site specific flight height 0%)	Peak numbers of flying birds (applying generic flight height information 4%)
Step 1: Number of birds in transect at Potential Collision Height	Not applicable	4.06
Step 2: Rate at which birds detected at PCH	Not applicable	0.01
Step 3: Rate of bird detections scaled to EOWDC area	Not applicable	0.00
Step 4: Estimated annual total of birds through the risk area	Not applicable	2323.09
Step 5: Size of the risk area	Not applicable	540000.00
Step 6: Total rotor swept area	Not applicable	194161.00
Step 7: Ratio of rotor swept area to the risk area	Not applicable	0.35
Step 8: Annual number of birds flying through the risk area	Not applicable	813.08
Step 9: Probability of collision (Band Model)	Not applicable	8.9%
Step 10: Estimated number of collisions per year assuming no avoidance and 100% operational time	Not applicable	72.36
Assuming an operational time of 85%	Not applicable	61.51
Assuming a 98% avoidance rate	Not applicable	1.23
Assuming a 99% avoidance rate	Not applicable	0.62
Assuming a 99.5% avoidance rate	Not applicable	0.31

Table 8-6: Fulmar Collision Risk Calculations

Step in collision risk Process	Peak numbers of flying birds (applying site specific flight height)	Peak numbers of flying birds (applying generic flight height information
Step 1: Number of birds in transect at Potential Collision Height	N/A	0.4200
Step 2: Rate at which birds detected at PCH	N/A	0.0007
Step 3: Rate of bird detections scaled to EOWDC area	N/A	0.0003
Step 4: Estimated annual total of birds through the risk area	N/A	147.0433
Step 5: Size of the risk area	540000.0000	540,000.0000
Step 6: Total rotor swept area	194,161.0000	194,161.0000
Step 7: Ratio of rotor swept area to the risk area	0.3500	0.3500
Step 8: Annual number of birds flying through the risk area	N/A	51.4651
Step 9: Probability of collision (Band Model)	0.0940	0.0940
Step 10: Estimated number of collisions per year assuming no avoidance	N/A	4.8377
Assuming an operating time of 85%	N/A	4.1121
Assuming a 98% avoidance rate	N/A	0.0822
Assuming a 99% avoidance rate	N/A	0.0411
Assuming a 99.5% avoidance rate	N/A	0.0206

Table 8-7 Red-throated diver collision risk calculations

Step in collision risk Process	Peak numbers of flying birds No site specific flight height data available	Peak numbers of flying birds (applying generic flight height information 4%)
Step 1: Number of birds in transect at Potential Collision Height	N/A	0.2500
Step 2: Rate at which birds detected at PCH	N/A	0.0007
Step 3: Rate of bird detections scaled to EOWDC area	N/A	0.0003
Step 4: Estimated annual total of birds through the risk area	N/A	150.9947
Step 5: Size of the risk area	540,000.0000	540,000.0000
Step 6: Total rotor swept area	194,161.0000	194,161.0000
Step 7: Ratio of rotor swept area to the risk area	0.3500	0.3500
Step 8: Annual number of birds flying through the risk area	N/A	52.8482
Step 9: Probability of collision (Band Model)	0.0900	0.0900
Step 10: Estimated number of collisions per year assuming no avoidance	N/A	4.7563
Assuming an operating time of 85%	N/A	4.0429
Assuming a 98% avoidance rate	N/A	0.0809
Assuming a 99% avoidance rate	N/A	0.0404
Assuming a 99.5% avoidance rate	N/A	0.0202

Table 8-8 Guillemot collision risk calculations

Step in collision risk Process	Peak numbers of flying birds (applying site specific flight height 1%)	Peak numbers of flying birds (applying generic flight height information 1%)
Step 1: Number of birds in transect at Potential Collision Height	0.1400	0.1400
Step 2: Rate at which birds detected at PCH	0.0005	0.0005
Step 3: Rate of bird detections scaled to EOWDC area	0.0002	0.0002
Step 4: Estimated annual total of birds through the risk area	93.5874	93.5874
Step 5: Size of the risk area	540,000.0000	540,000.0000
Step 6: Total rotor swept area	194,161.0000	194,161.0000
Step 7: Ratio of rotor swept area to the risk area	0.3500	0.3500
Step 8: Annual number of birds flying through the risk area	32.7556	32.7556
Step 9: Probability of collision (Band Model)	0.0770	0.0770
Step 10: Estimated number of collisions per year assuming no avoidance	2.5222	2.5222
Assuming an operating time of 85%	2.1439	2.1439
Assuming a 98% avoidance rate	0.0429	0.0429
Assuming a 99% avoidance rate	0.0214	0.0214
Assuming a 99.5% avoidance rate	0.0107	0.0107

Table 8-9: Common gull collision risk calculations

Step in collision risk Process	Peak numbers of flying birds (applying site specific flight height 33%)	Peak numbers of flying birds (applying generic flight height information 22%)
Step 1: Number of birds in transect at Potential Collision Height	12.8700	8.1900
Step 2: Rate at which birds detected at PCH	0.0419	0.0267
Step 3: Rate of bird detections scaled to EOWDC area	0.0165	0.0105
Step 4: Estimated annual total of birds through the risk area	8,659.4055	5,510.5308
Step 5: Size of the risk area	540,000.0000	540,000.0000
Step 6: Total rotor swept area	194,161.0000	194,161.0000
Step 7: Ratio of rotor swept area to the risk area	0.3500	0.3500
Step 8: Annual number of birds flying through the risk area	3030.7919	1928.6858
Step 9: Probability of collision (Band Model)	0.0960	0.0960
Step 10: Estimated number of collisions per year assuming no avoidance	290.9560	185.1538
Assuming an operating time of 85%	247.3126	157.3808
Assuming a 98% avoidance rate	4.9463	3.1476
Assuming a 99% avoidance rate	2.4731	1.5738
Assuming a 99.5% avoidance rate	1.2366	0.7869

Table 8-10: Herring gull collision risk calculation

Step in collision risk Process	Peak numbers of flying birds (applying site specific flight height 42%)	Peak numbers of flying birds (applying generic flight height information 24%)
Step 1: Number of birds in transect at Potential Collision Height	16.8000	10.0800
Step 2: Rate at which birds detected at PCH	0.0538	0.0323
Step 3: Ratio of survey area to EOWDC area	0.0212	0.0127
Step 4: Estimated annual total of birds through the risk area	11122.5046	6673.5028
Step 5: Size of the risk area	540,000.0000	540,000.0000
Step 6: Total rotor swept area	194,161.0000	194,161.0000
Step 7: Ratio of rotor swept area to the risk area	0.3500	0.3500
Step 8: Annual number of birds flying through the risk area	3,892.8766	2,335.7260
Step 9: Probability of collision (Band Model)	0.1100	0.1100
Step 10: Estimated number of collisions per year assuming no avoidance	428.2164	256.9299
Assuming an operating time of 85%	363.9840	218.3904
Assuming a 98% avoidance rate	7.2797	4.3678
Assuming a 99% avoidance rate	3.6398	2.1839
Assuming a 99.5% avoidance rate	1.8199	1.0920

Table 8-11: Kittiwake collision risk calculations

Step in collision risk Process	Peak numbers of flying birds (applying site specific flight height 22%)	Peak numbers of flying birds (applying generic flight height information 13%)
Step 1: Number of birds in transect at Potential Collision Height	7.4800	4.4200
Step 2: Rate at which birds detected at PCH	0.0249	0.0147
Step 3: Ratio of survey area to EOWDC area	0.0098	0.0058
Step 4: Estimated annual total of birds through the risk area	5,133.1388	3,033.2184
Step 5: Size of the risk area	540,000.0000	540,000.0000
Step 6: Total rotor swept area	194,161.0000	194,161.0000
Step 7: Ratio of rotor swept area to the risk area	0.3500	0.3500
Step 8: Annual number of birds flying through the risk area	1,796.5986	1,061.6264
Step 9: Probability of collision (Band Model)	0.1190	0.1190
Step 10: Estimated number of collisions per year assuming no avoidance	213.7952	126.3335
Assuming an operating time of 85%	181.7259	107.3835
Assuming a 98% avoidance rate	3.6345	2.1477
Assuming a 99% avoidance rate	1.8173	1.0738
Assuming a 99.5% avoidance rate	0.9086	0.5369

Table 8-12: Sandwich tern collision risk calculations.

Step in collision risk Process	Peak numbers of flying birds (applying site specific flight height 4%)	Peak numbers of flying birds (applying generic flight height information 12%)
Step 1: Number of birds in transect at Potential Collision Height	0.8400	2.5200
Step 2: Rate at which birds detected at PCH	0.0028	0.0084
Step 3: Ratio of survey area to EOWDC area	0.0011	0.0033
Step 4: Estimated annual total of birds through the risk area	576.4487	1729.3462
Step 5: Size of the risk area	540,000.0000	540,000.0000
Step 6: Total rotor swept area	194,161.0000	194,161.0000
Step 7: Ratio of rotor swept area to the risk area	0.3500	0.3500
Step 8: Annual number of birds flying through the risk area	201.7571	605.2712
Step 9: Probability of collision (Band Model)	0.1180	0.1180
Step 10: Estimated number of collisions per year assuming no avoidance	23.8073	71.4220
Assuming an operating time of 85%	20.2362	60.7087
Assuming a 98% avoidance rate	0.4047	1.2142
Assuming a 99% avoidance rate	0.2024	0.6071
Assuming a 99.5% avoidance rate	0.1012	0.3035

Table 8-13: Common tern collision risk calculations

Step in collision risk Process	Peak numbers of flying birds (applying site specific flight height 14%)	Peak numbers of flying birds (applying generic flight height information 8%)
Step 1: Number of birds in transect at Potential Collision Height	7.7000	4.4000
Step 2: Rate at which birds detected at PCH	0.0247	0.0141
Step 3: Ratio of survey area to EOWDC area	0.0097	0.0055
Step 4: Estimated annual total of birds through the risk area	5097.8146	2913.0369
Step 5: Size of the risk area	540,000.0000	540,000.0000
Step 6: Total rotor swept area	194,161.0000	194,161.0000
Step 7: Ratio of rotor swept area to the risk area	0.3500	0.3500
Step 8: Annual number of birds flying through the risk area	1,784.2351	1,019.5629
Step 9: Probability of collision (Band Model)	0.1180	0.1180
Step 10: Estimated number of collisions per year assuming no avoidance	210.5397	120.3084
Assuming an operating time of 85%	178.9588	102.2622
Assuming a 98% avoidance rate	3.5792	2.0452
Assuming a 99% avoidance rate	1.7896	1.0226
Assuming a 99.5% avoidance rate	0.8948	0.5113

8.3 Band model collision risk calculations

Table 8-14: Red-throated diver Band model collision risk calculations

Red-throated diver											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	□	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.66	m	0.025	0.575	4.33	10.39	0.61	0.00076	8.66	0.51	0.00064
Wingspan	1.11	m	0.075	0.575	1.44	4.04	0.24	0.00178	2.31	0.14	0.00102
F: Flapping (0) or gliding (+1)	1		0.125	0.702	0.87	3.24	0.19	0.00238	1.14	0.07	0.00084
			0.175	0.860	0.62	3.11	0.18	0.00320	0.53	0.03	0.00054
Bird speed	17	m/sec	0.225	0.994	0.48	3.39	0.20	0.00449	0.91	0.05	0.00120
RotorDiam	150	m	0.275	0.947	0.39	3.05	0.18	0.00493	1.11	0.07	0.00180
RotationPeriod	3.00	sec	0.325	0.899	0.33	2.79	0.16	0.00533	1.23	0.07	0.00235
			0.375	0.851	0.29	2.58	0.15	0.00568	1.30	0.08	0.00286
			0.425	0.804	0.25	2.40	0.14	0.00599	1.33	0.08	0.00333
			0.475	0.756	0.23	2.24	0.13	0.00626	1.35	0.08	0.00376
Bird aspect ratio: □	0.59		0.525	0.708	0.21	2.10	0.12	0.00649	1.34	0.08	0.00415
			0.575	0.660	0.19	1.97	0.12	0.00668	1.33	0.08	0.00449
			0.625	0.613	0.17	1.85	0.11	0.00682	1.30	0.08	0.00479
			0.675	0.565	0.16	1.74	0.10	0.00692	1.27	0.07	0.00505
			0.725	0.517	0.15	1.64	0.10	0.00698	1.24	0.07	0.00527
			0.775	0.470	0.14	1.53	0.09	0.00700	1.19	0.07	0.00544
			0.825	0.422	0.13	1.44	0.08	0.00697	1.15	0.07	0.00558
			0.875	0.374	0.12	1.34	0.08	0.00691	1.10	0.06	0.00567
			0.925	0.327	0.12	1.25	0.07	0.00680	1.05	0.06	0.00572
			0.975	0.279	0.11	1.16	0.07	0.00665	1.00	0.06	0.00572
				Overall p(collision) =			**Upwind**	**10.9%**		**Downwind**	**7.0%**
								Average	**9.0%**		

Table 8-15: Cormorant – Band model collision risk calculations.

Cormorant											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	□	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.84	m	0.025	0.575	4.94	13.27	0.68	0.00086	11.55	0.60	0.00074
Wingspan	1.6	m	0.075	0.575	1.65	5.00	0.26	0.00193	3.27	0.17	0.00127
F: Flapping (0) or gliding (+1)	1		0.125	0.702	0.99	3.86	0.20	0.00249	1.75	0.09	0.00113
			0.175	0.860	0.71	3.59	0.18	0.00323	1.01	0.05	0.00091
Bird speed	19.4	m/sec	0.225	0.994	0.55	3.47	0.18	0.00402	0.63	0.03	0.00073
RotorDiam	150	m	0.275	0.947	0.45	3.36	0.17	0.00477	1.16	0.06	0.00164
RotationPeriod	3.00	sec	0.325	0.899	0.38	3.08	0.16	0.00515	1.30	0.07	0.00218
			0.375	0.851	0.33	2.85	0.15	0.00550	1.39	0.07	0.00268
			0.425	0.804	0.29	2.65	0.14	0.00581	1.44	0.07	0.00315
			0.475	0.756	0.26	2.48	0.13	0.00608	1.46	0.08	0.00358
Bird aspect ratio: □	0.53		0.525	0.708	0.24	2.34	0.12	0.00632	1.47	0.08	0.00398
			0.575	0.660	0.21	2.20	0.11	0.00652	1.46	0.08	0.00433
			0.625	0.613	0.20	2.07	0.11	0.00668	1.44	0.07	0.00465
			0.675	0.565	0.18	1.96	0.10	0.00681	1.42	0.07	0.00494
			0.725	0.517	0.17	1.84	0.10	0.00689	1.39	0.07	0.00518
			0.775	0.470	0.16	1.74	0.09	0.00695	1.35	0.07	0.00539
			0.825	0.422	0.15	1.64	0.08	0.00696	1.31	0.07	0.00557
			0.875	0.374	0.14	1.54	0.08	0.00694	1.26	0.07	0.00570
			0.925	0.327	0.13	1.44	0.07	0.00688	1.22	0.06	0.00580
			0.975	0.279	0.13	1.35	0.07	0.00679	1.17	0.06	0.00586
				Overall p(collision) =			**Upwind**	**10.8%**		**Downwind**	**6.9%**
								Average	**8.9%**		

Table 8-16: Gannet – Band model collision risk calculations.

Gannet											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.94	m	0.025	0.575	3.82	10.95	0.73	0.00091	9.22	0.61	0.00077
Wingspan	1.8	m	0.075	0.575	1.27	4.22	0.28	0.00211	2.50	0.17	0.00125
F: Flapping (0) or gliding (+1)	1		0.125	0.702	0.76	3.32	0.22	0.00277	1.22	0.08	0.00101
			0.175	0.860	0.55	3.13	0.21	0.00366	0.70	0.05	0.00081
Bird speed	15	m/sec	0.225	0.994	0.42	3.53	0.24	0.00529	1.34	0.09	0.00200
RotorDiam	150	m	0.275	0.947	0.35	3.21	0.21	0.00589	1.51	0.10	0.00276
RotationPeriod	3.00	sec	0.325	0.899	0.29	2.97	0.20	0.00645	1.60	0.11	0.00347
			0.375	0.851	0.25	2.78	0.19	0.00695	1.65	0.11	0.00413
			0.425	0.804	0.22	2.61	0.17	0.00741	1.68	0.11	0.00475
			0.475	0.756	0.20	2.47	0.16	0.00782	1.68	0.11	0.00532
Bird aspect ratio: β	0.52		0.525	0.708	0.18	2.34	0.16	0.00818	1.67	0.11	0.00584
			0.575	0.660	0.17	2.22	0.15	0.00849	1.65	0.11	0.00631
			0.625	0.613	0.15	2.10	0.14	0.00876	1.62	0.11	0.00673
			0.675	0.565	0.14	2.00	0.13	0.00898	1.58	0.11	0.00711
			0.725	0.517	0.13	1.89	0.13	0.00915	1.54	0.10	0.00744
			0.775	0.470	0.12	1.79	0.12	0.00927	1.49	0.10	0.00772
			0.825	0.422	0.12	1.70	0.11	0.00935	1.45	0.10	0.00795
			0.875	0.374	0.11	1.61	0.11	0.00938	1.40	0.09	0.00814
			0.925	0.327	0.10	1.52	0.10	0.00936	1.34	0.09	0.00828
			0.975	0.279	0.10	1.43	0.10	0.00929	1.29	0.09	0.00837
				Overall p(collision) =			**Upwind**	**13.9%**		**Downwind**	**10.0%**
								Average	**12.0%**		

Table 8-17: Fulmar – Band model collision risk calculations.

Fulmar											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.52	m	0.025	0.575	3.57	8.84	0.63	0.00079	7.12	0.51	0.00064
Wingspan	1.17	m	0.075	0.575	1.19	3.52	0.25	0.00189	1.80	0.13	0.00096
F: Flapping (0) or gliding (+1)	1		0.125	0.702	0.71	2.88	0.21	0.00257	0.78	0.06	0.00069
			0.175	0.860	0.51	2.81	0.20	0.00351	0.53	0.04	0.00066
Bird speed	14	m/sec	0.225	0.994	0.40	3.03	0.22	0.00488	0.99	0.07	0.00159
RotorDiam	150	m	0.275	0.947	0.32	2.74	0.20	0.00538	1.14	0.08	0.00224
RotationPeriod	3.00	sec	0.325	0.899	0.27	2.51	0.18	0.00582	1.23	0.09	0.00285
			0.375	0.851	0.24	2.32	0.17	0.00622	1.27	0.09	0.00341
			0.425	0.804	0.21	2.16	0.15	0.00657	1.29	0.09	0.00391
			0.475	0.756	0.19	2.02	0.14	0.00686	1.29	0.09	0.00436
Bird aspect ratio: β	0.44		0.525	0.708	0.17	1.89	0.14	0.00710	1.27	0.09	0.00476
			0.575	0.660	0.16	1.78	0.13	0.00730	1.24	0.09	0.00511
			0.625	0.613	0.14	1.67	0.12	0.00744	1.21	0.09	0.00541
			0.675	0.565	0.13	1.56	0.11	0.00753	1.17	0.08	0.00566
			0.725	0.517	0.12	1.46	0.10	0.00757	1.13	0.08	0.00586
			0.775	0.470	0.12	1.36	0.10	0.00756	1.08	0.08	0.00600
			0.825	0.422	0.11	1.27	0.09	0.00749	1.03	0.07	0.00610
			0.875	0.374	0.10	1.18	0.08	0.00738	0.98	0.07	0.00614
			0.925	0.327	0.10	1.09	0.08	0.00721	0.93	0.07	0.00613
			0.975	0.279	0.09	1.00	0.07	0.00700	0.87	0.06	0.00607
				Overall p(collision) =			**Upwind**	**11.8%**		**Downwind**	**7.9%**
								Average	**9.8%**		

Table 8-18: Pink-footed goose Band model collision risk calculations

Pink-footed goose											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	□	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.65	m	0.025	0.575	4.79	15.34	0.82	0.00102	13.61	0.72	0.00091
Wingspan	1.53	m	0.075	0.575	1.60	5.69	0.30	0.00227	3.96	0.21	0.00158
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.96	4.26	0.23	0.00283	2.16	0.11	0.00143
			0.175	0.860	0.68	3.86	0.21	0.00360	1.28	0.07	0.00120
Bird speed	18.8	m/sec	0.225	0.994	0.53	3.68	0.20	0.00440	0.93	0.05	0.00111
RotorDiam	150	m	0.275	0.947	0.44	3.16	0.17	0.00462	1.02	0.05	0.00149
RotationPeriod	3.00	sec	0.325	0.899	0.37	2.86	0.15	0.00494	1.14	0.06	0.00197
			0.375	0.851	0.32	2.63	0.14	0.00525	1.22	0.06	0.00244
			0.425	0.804	0.28	2.44	0.13	0.00552	1.27	0.07	0.00287
			0.475	0.756	0.25	2.28	0.12	0.00576	1.29	0.07	0.00326
Bird aspect ratio: □	0.42		0.525	0.708	0.23	2.13	0.11	0.00595	1.29	0.07	0.00361
			0.575	0.660	0.21	2.00	0.11	0.00611	1.28	0.07	0.00393
			0.625	0.613	0.19	1.87	0.10	0.00623	1.26	0.07	0.00420
			0.675	0.565	0.18	1.76	0.09	0.00631	1.24	0.07	0.00444
			0.725	0.517	0.17	1.65	0.09	0.00635	1.20	0.06	0.00464
			0.775	0.470	0.15	1.54	0.08	0.00636	1.17	0.06	0.00481
			0.825	0.422	0.15	1.44	0.08	0.00633	1.12	0.06	0.00493
			0.875	0.374	0.14	1.34	0.07	0.00626	1.08	0.06	0.00502
			0.925	0.327	0.13	1.25	0.07	0.00615	1.03	0.05	0.00507
			0.975	0.279	0.12	1.16	0.06	0.00600	0.98	0.05	0.00508
				Overall p(collision) =			**Upwind**	**10.2%**		**Downwind**	**6.4%**
								Average	**8.3%**		

Table 8-19: Barnacle Goose Band model collision risk calculations

Barnacle Goose											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	□	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.64	m	0.025	0.575	4.58	14.08	0.78	0.00098	12.36	0.69	0.00086
Wingspan	1.39	m	0.075	0.575	1.53	5.27	0.29	0.00220	3.54	0.20	0.00148
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.92	4.00	0.22	0.00278	1.89	0.11	0.00131
			0.175	0.860	0.65	3.66	0.20	0.00356	1.08	0.06	0.00105
Bird speed	18	m/sec	0.225	0.994	0.51	3.52	0.20	0.00439	0.88	0.05	0.00110
RotorDiam	150	m	0.275	0.947	0.42	3.08	0.17	0.00471	1.04	0.06	0.00158
RotationPeriod	3.00	sec	0.325	0.899	0.35	2.81	0.16	0.00508	1.16	0.06	0.00210
			0.375	0.851	0.31	2.59	0.14	0.00540	1.24	0.07	0.00259
			0.425	0.804	0.27	2.41	0.13	0.00569	1.28	0.07	0.00303
			0.475	0.756	0.24	2.25	0.12	0.00593	1.30	0.07	0.00343
Bird aspect ratio: □	0.46		0.525	0.708	0.22	2.10	0.12	0.00614	1.30	0.07	0.00379
			0.575	0.660	0.20	1.97	0.11	0.00630	1.29	0.07	0.00412
			0.625	0.613	0.18	1.85	0.10	0.00643	1.27	0.07	0.00440
			0.675	0.565	0.17	1.74	0.10	0.00651	1.24	0.07	0.00464
			0.725	0.517	0.16	1.63	0.09	0.00656	1.20	0.07	0.00485
			0.775	0.470	0.15	1.52	0.08	0.00657	1.16	0.06	0.00501
			0.825	0.422	0.14	1.43	0.08	0.00653	1.12	0.06	0.00514
			0.875	0.374	0.13	1.33	0.07	0.00646	1.07	0.06	0.00522
			0.925	0.327	0.12	1.23	0.07	0.00635	1.02	0.06	0.00527
			0.975	0.279	0.12	1.14	0.06	0.00619	0.97	0.05	0.00527
				Overall p(collision) =			**Upwind**	**10.5%**		**Downwind**	**6.6%**
								Average	**8.5%**		

Table 8-20: Common scoter Band model collision risk calculations

Common Scoter											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	□	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.49	m	0.025	0.575	5.32	13.28	0.64	0.00079	11.56	0.55	0.00069
Wingspan	0.84	m	0.075	0.575	1.77	5.00	0.24	0.00180	3.28	0.16	0.00118
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.06	3.89	0.19	0.00232	1.78	0.09	0.00107
			0.175	0.860	0.76	3.63	0.17	0.00304	1.05	0.05	0.00088
Bird speed	20.9	m/sec	0.225	0.994	0.59	3.52	0.17	0.00379	0.53	0.03	0.00057
RotorDiam	150	m	0.275	0.947	0.48	3.10	0.15	0.00408	0.72	0.03	0.00095
RotationPeriod	3.00	sec	0.325	0.899	0.41	2.79	0.13	0.00435	0.88	0.04	0.00137
			0.375	0.851	0.35	2.55	0.12	0.00458	0.98	0.05	0.00176
			0.425	0.804	0.31	2.35	0.11	0.00478	1.04	0.05	0.00212
			0.475	0.756	0.28	2.17	0.10	0.00494	1.07	0.05	0.00244
Bird aspect ratio: □	0.58		0.525	0.708	0.25	2.02	0.10	0.00507	1.09	0.05	0.00273
			0.575	0.660	0.23	1.88	0.09	0.00517	1.08	0.05	0.00298
			0.625	0.613	0.21	1.75	0.08	0.00523	1.07	0.05	0.00320
			0.675	0.565	0.20	1.63	0.08	0.00525	1.05	0.05	0.00339
			0.725	0.517	0.18	1.51	0.07	0.00525	1.02	0.05	0.00354
			0.775	0.470	0.17	1.40	0.07	0.00521	0.98	0.05	0.00365
			0.825	0.422	0.16	1.30	0.06	0.00513	0.95	0.05	0.00373
			0.875	0.374	0.15	1.20	0.06	0.00502	0.90	0.04	0.00378
			0.925	0.327	0.14	1.10	0.05	0.00488	0.86	0.04	0.00380
			0.975	0.279	0.14	1.01	0.05	0.00470	0.81	0.04	0.00378
				Overall p(collision) =			**Upwind**	**8.5%**		**Downwind**	**4.8%**
								Average	**6.6%**		

Table 8-21: Guillemot Band model collision risk calculations

Guillemot											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.4	m	0.025	0.575	4.20	10.08	0.61	0.00076	8.36	0.51	0.00063
Wingspan	0.7	m	0.075	0.575	1.40	3.94	0.24	0.00179	2.21	0.13	0.00100
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.84	3.17	0.19	0.00240	1.07	0.06	0.00081
			0.175	0.860	0.60	3.05	0.18	0.00324	0.47	0.03	0.00050
Bird speed	16.5	m/sec	0.225	0.994	0.47	3.10	0.19	0.00422	0.69	0.04	0.00093
RotorDiam	150	m	0.275	0.947	0.38	2.76	0.17	0.00460	0.88	0.05	0.00147
RotationPeriod	3.00	sec	0.325	0.899	0.32	2.50	0.15	0.00493	0.99	0.06	0.00196
			0.375	0.851	0.28	2.30	0.14	0.00522	1.06	0.06	0.00240
			0.425	0.804	0.25	2.12	0.13	0.00546	1.09	0.07	0.00281
			0.475	0.756	0.22	1.97	0.12	0.00567	1.10	0.07	0.00317
Bird aspect ratio: β	0.57		0.525	0.708	0.20	1.83	0.11	0.00582	1.09	0.07	0.00348
			0.575	0.660	0.18	1.70	0.10	0.00594	1.08	0.07	0.00375
			0.625	0.613	0.17	1.59	0.10	0.00601	1.05	0.06	0.00398
			0.675	0.565	0.16	1.48	0.09	0.00604	1.02	0.06	0.00417
			0.725	0.517	0.14	1.37	0.08	0.00602	0.98	0.06	0.00431
			0.775	0.470	0.14	1.27	0.08	0.00596	0.94	0.06	0.00441
			0.825	0.422	0.13	1.17	0.07	0.00586	0.89	0.05	0.00447
			0.875	0.374	0.12	1.08	0.07	0.00572	0.84	0.05	0.00448
			0.925	0.327	0.11	0.99	0.06	0.00553	0.79	0.05	0.00445
			0.975	0.279	0.11	0.90	0.05	0.00530	0.74	0.04	0.00437
				Overall p(collision) =			**Upwind**	**9.6%**		**Downwind**	**5.8%**
								Average	**7.7%**		

Table 8-22: Guillemot / Razorbill Band model collision risk calculations

Guillemot											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	□	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.4	m	0.025	0.575	4.20	10.08	0.61	0.00076	8.36	0.51	0.00063
Wingspan	0.7	m	0.075	0.575	1.40	3.94	0.24	0.00179	2.21	0.13	0.00100
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.84	3.17	0.19	0.00240	1.07	0.06	0.00081
			0.175	0.860	0.60	3.05	0.18	0.00324	0.47	0.03	0.00050
Bird speed	16.5	m/sec	0.225	0.994	0.47	3.10	0.19	0.00422	0.69	0.04	0.00093
RotorDiam	150	m	0.275	0.947	0.38	2.76	0.17	0.00460	0.88	0.05	0.00147
RotationPeriod	3.00	sec	0.325	0.899	0.32	2.50	0.15	0.00493	0.99	0.06	0.00196
			0.375	0.851	0.28	2.30	0.14	0.00522	1.06	0.06	0.00240
			0.425	0.804	0.25	2.12	0.13	0.00546	1.09	0.07	0.00281
			0.475	0.756	0.22	1.97	0.12	0.00567	1.10	0.07	0.00317
Bird aspect ratio: □	0.57		0.525	0.708	0.20	1.83	0.11	0.00582	1.09	0.07	0.00348
			0.575	0.660	0.18	1.70	0.10	0.00594	1.08	0.07	0.00375
			0.625	0.613	0.17	1.59	0.10	0.00601	1.05	0.06	0.00398
			0.675	0.565	0.16	1.48	0.09	0.00604	1.02	0.06	0.00417
			0.725	0.517	0.14	1.37	0.08	0.00602	0.98	0.06	0.00431
			0.775	0.470	0.14	1.27	0.08	0.00596	0.94	0.06	0.00441
			0.825	0.422	0.13	1.17	0.07	0.00586	0.89	0.05	0.00447
			0.875	0.374	0.12	1.08	0.07	0.00572	0.84	0.05	0.00448
			0.925	0.327	0.11	0.99	0.06	0.00553	0.79	0.05	0.00445
			0.975	0.279	0.11	0.90	0.05	0.00530	0.74	0.04	0.00437
				Overall p(collision) =			**Upwind**	**9.6%**		**Downwind**	**5.8%**
								Average	**7.7%**		

Table 8-23: Common gull Band model collision risk calculations

Common gull											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.41	m	0.025	0.575	3.41	10.05	0.75	0.00094	8.33	0.62	0.00078
Wingspan	1.2	m	0.075	0.575	1.14	3.93	0.29	0.00220	2.20	0.16	0.00123
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.68	3.12	0.23	0.00291	1.01	0.08	0.00094
			0.175	0.860	0.49	2.96	0.22	0.00387	0.79	0.06	0.00103
Bird speed	13.4	m/sec	0.225	0.994	0.38	2.93	0.22	0.00491	0.97	0.07	0.00162
RotorDiam	150	m	0.275	0.947	0.31	2.59	0.19	0.00532	1.07	0.08	0.00219
RotationPeriod	3.00	sec	0.325	0.899	0.26	2.37	0.18	0.00575	1.15	0.09	0.00278
			0.375	0.851	0.23	2.19	0.16	0.00613	1.18	0.09	0.00331
			0.425	0.804	0.20	2.03	0.15	0.00645	1.20	0.09	0.00379
			0.475	0.756	0.18	1.90	0.14	0.00672	1.19	0.09	0.00422
Bird aspect ratio: β	0.34		0.525	0.708	0.16	1.77	0.13	0.00694	1.17	0.09	0.00460
			0.575	0.660	0.15	1.66	0.12	0.00710	1.15	0.09	0.00492
			0.625	0.613	0.14	1.55	0.12	0.00721	1.11	0.08	0.00519
			0.675	0.565	0.13	1.44	0.11	0.00727	1.07	0.08	0.00540
			0.725	0.517	0.12	1.34	0.10	0.00727	1.03	0.08	0.00556
			0.775	0.470	0.11	1.25	0.09	0.00722	0.98	0.07	0.00567
			0.825	0.422	0.10	1.16	0.09	0.00712	0.93	0.07	0.00572
			0.875	0.374	0.10	1.07	0.08	0.00696	0.88	0.07	0.00572
			0.925	0.327	0.09	0.98	0.07	0.00675	0.82	0.06	0.00567
			0.975	0.279	0.09	0.89	0.07	0.00649	0.76	0.06	0.00557
				Overall p(collision) =			**Upwind**	**11.6%**		**Downwind**	**7.6%**
								Average	**9.6%**		

Table 8-24: Herring Gull Band model collision risk calculations

Herring Gull											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	□	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.6	m	0.025	0.575	3.41	10.87	0.81	0.00101	9.15	0.68	0.00085
Wingspan	1.44	m	0.075	0.575	1.14	4.20	0.31	0.00235	2.47	0.18	0.00139
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.68	3.28	0.24	0.00306	1.17	0.09	0.00110
			0.175	0.860	0.49	3.08	0.23	0.00402	0.90	0.07	0.00118
Bird speed	13.4	m/sec	0.225	0.994	0.38	3.07	0.23	0.00516	1.11	0.08	0.00187
RotorDiam	150	m	0.275	0.947	0.31	2.78	0.21	0.00571	1.26	0.09	0.00258
RotationPeriod	3.00	sec	0.325	0.899	0.26	2.56	0.19	0.00621	1.34	0.10	0.00324
			0.375	0.851	0.23	2.38	0.18	0.00666	1.37	0.10	0.00384
			0.425	0.804	0.20	2.22	0.17	0.00705	1.39	0.10	0.00440
			0.475	0.756	0.18	2.09	0.16	0.00740	1.38	0.10	0.00490
Bird aspect ratio: □	0.42		0.525	0.708	0.16	1.96	0.15	0.00768	1.36	0.10	0.00534
			0.575	0.660	0.15	1.85	0.14	0.00792	1.34	0.10	0.00573
			0.625	0.613	0.14	1.74	0.13	0.00810	1.30	0.10	0.00607
			0.675	0.565	0.13	1.63	0.12	0.00823	1.26	0.09	0.00636
			0.725	0.517	0.12	1.53	0.11	0.00830	1.22	0.09	0.00659
			0.775	0.470	0.11	1.44	0.11	0.00832	1.17	0.09	0.00677
			0.825	0.422	0.10	1.35	0.10	0.00829	1.12	0.08	0.00689
			0.875	0.374	0.10	1.26	0.09	0.00820	1.07	0.08	0.00696
			0.925	0.327	0.09	1.17	0.09	0.00806	1.01	0.08	0.00698
			0.975	0.279	0.09	1.08	0.08	0.00787	0.95	0.07	0.00695
				Overall p(collision) =			**Upwind**	**13.0%**		**Downwind**	**9.0%**
								Average	**11.0%**		

Table 8-25: Kittiwake Band model collision risk calculations

Kittiwake											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	□	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.39	m	0.025	0.575	2.67	7.74	0.74	0.00092	6.02	0.57	0.00072
Wingspan	1.08	m	0.075	0.575	0.89	3.16	0.30	0.00225	1.43	0.14	0.00102
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.53	2.60	0.25	0.00310	0.66	0.06	0.00078
			0.175	0.860	0.38	2.56	0.24	0.00426	0.85	0.08	0.00142
Bird speed	10.5	m/sec	0.225	0.994	0.30	2.65	0.25	0.00568	1.11	0.11	0.00239
RotorDiam	150	m	0.275	0.947	0.24	2.41	0.23	0.00631	1.21	0.12	0.00317
RotationPeriod	3.00	sec	0.325	0.899	0.21	2.22	0.21	0.00687	1.26	0.12	0.00389
			0.375	0.851	0.18	2.06	0.20	0.00736	1.27	0.12	0.00455
			0.425	0.804	0.16	1.92	0.18	0.00779	1.27	0.12	0.00513
			0.475	0.756	0.14	1.80	0.17	0.00814	1.25	0.12	0.00564
Bird aspect ratio: □	0.36		0.525	0.708	0.13	1.69	0.16	0.00843	1.22	0.12	0.00609
			0.575	0.660	0.12	1.58	0.15	0.00865	1.18	0.11	0.00647
			0.625	0.613	0.11	1.48	0.14	0.00881	1.14	0.11	0.00678
			0.675	0.565	0.10	1.38	0.13	0.00889	1.09	0.10	0.00702
			0.725	0.517	0.09	1.29	0.12	0.00891	1.04	0.10	0.00720
			0.775	0.470	0.09	1.20	0.11	0.00886	0.99	0.09	0.00730
			0.825	0.422	0.08	1.11	0.11	0.00874	0.93	0.09	0.00734
			0.875	0.374	0.08	1.03	0.10	0.00855	0.88	0.08	0.00731
			0.925	0.327	0.07	0.94	0.09	0.00829	0.82	0.08	0.00721
			0.975	0.279	0.07	0.86	0.08	0.00797	0.76	0.07	0.00704
				Overall p(collision) =			**Upwind**	**13.9%**		**Downwind**	**9.8%**
								Average	**11.9%**		

Table 8-26: Sandwich tern Band model collision risk calculations

Sandwich tern											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	□	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.38	m	0.025	0.575	2.67	7.53	0.72	0.00090	5.81	0.55	0.00069
Wingspan	1	m	0.075	0.575	0.89	3.09	0.29	0.00220	1.36	0.13	0.00097
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.53	2.56	0.24	0.00305	0.61	0.06	0.00073
			0.175	0.860	0.38	2.53	0.24	0.00421	0.82	0.08	0.00136
Bird speed	10.5	m/sec	0.225	0.994	0.30	2.64	0.25	0.00566	1.10	0.11	0.00237
RotorDiam	150	m	0.275	0.947	0.24	2.40	0.23	0.00628	1.20	0.11	0.00315
RotationPeriod	3.00	sec	0.325	0.899	0.21	2.21	0.21	0.00684	1.25	0.12	0.00386
			0.375	0.851	0.18	2.05	0.20	0.00733	1.26	0.12	0.00451
			0.425	0.804	0.16	1.91	0.18	0.00775	1.26	0.12	0.00509
			0.475	0.756	0.14	1.79	0.17	0.00810	1.24	0.12	0.00560
Bird aspect ratio: □	0.38		0.525	0.708	0.13	1.68	0.16	0.00838	1.21	0.12	0.00604
			0.575	0.660	0.12	1.57	0.15	0.00860	1.17	0.11	0.00641
			0.625	0.613	0.11	1.47	0.14	0.00875	1.13	0.11	0.00672
			0.675	0.565	0.10	1.37	0.13	0.00883	1.08	0.10	0.00696
			0.725	0.517	0.09	1.28	0.12	0.00884	1.03	0.10	0.00713
			0.775	0.470	0.09	1.19	0.11	0.00878	0.98	0.09	0.00723
			0.825	0.422	0.08	1.10	0.10	0.00866	0.92	0.09	0.00726
			0.875	0.374	0.08	1.02	0.10	0.00846	0.87	0.08	0.00723
			0.925	0.327	0.07	0.93	0.09	0.00820	0.81	0.08	0.00712
			0.975	0.279	0.07	0.85	0.08	0.00787	0.75	0.07	0.00695
				Overall p(collision) =			**Upwind**	**13.8%**		**Downwind**	**9.7%**
								Average	**11.8%**		

Table 8-27: Common Tern Band model collision risk calculations.

Common tern											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	3	m	r/R	c/C	□	collide		contribution	collide		contribution
Pitch (degrees)	30		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.33	m	0.025	0.575	2.78	7.76	0.71	0.00089	6.03	0.55	0.00069
Wingspan	0.99	m	0.075	0.575	0.93	3.16	0.29	0.00217	1.44	0.13	0.00099
F: Flapping (0) or gliding (+1)	0		0.125	0.702	0.56	2.61	0.24	0.00300	0.59	0.05	0.00068
			0.175	0.860	0.40	2.57	0.24	0.00412	0.80	0.07	0.00128
Bird speed	10.9	m/sec	0.225	0.994	0.31	2.62	0.24	0.00540	1.02	0.09	0.00212
RotorDiam	150	m	0.275	0.947	0.25	2.37	0.22	0.00598	1.13	0.10	0.00285
RotationPeriod	3.00	sec	0.325	0.899	0.21	2.18	0.20	0.00649	1.18	0.11	0.00352
			0.375	0.851	0.19	2.02	0.18	0.00694	1.20	0.11	0.00412
			0.425	0.804	0.16	1.88	0.17	0.00732	1.19	0.11	0.00466
			0.475	0.756	0.15	1.75	0.16	0.00763	1.18	0.11	0.00513
Bird aspect ratio: □	0.33		0.525	0.708	0.13	1.64	0.15	0.00788	1.15	0.11	0.00553
			0.575	0.660	0.12	1.53	0.14	0.00806	1.11	0.10	0.00587
			0.625	0.613	0.11	1.43	0.13	0.00818	1.07	0.10	0.00615
			0.675	0.565	0.10	1.33	0.12	0.00823	1.03	0.09	0.00636
			0.725	0.517	0.10	1.23	0.11	0.00821	0.98	0.09	0.00650
			0.775	0.470	0.09	1.14	0.10	0.00813	0.93	0.08	0.00658
			0.825	0.422	0.08	1.06	0.10	0.00799	0.87	0.08	0.00659
			0.875	0.374	0.08	0.97	0.09	0.00777	0.81	0.07	0.00654
			0.925	0.327	0.08	0.88	0.08	0.00750	0.76	0.07	0.00642
			0.975	0.279	0.07	0.80	0.07	0.00715	0.70	0.06	0.00623
				Overall p(collision) =			**Upwind**	**12.9%**		**Downwind**	**8.9%**
								Average	**10.9%**		

European Offshore Wind Deployment Centre

Environmental Statement

Appendix 11.1: Bats Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

1 BATS ENVIRONMENTAL IMPACT ASSESSMENT TECHNICAL REPORT

1.1 Introduction

1 This section will review the information available for bats that are present in the Aberdeen Bay area with the focus being on bats that could be present in the offshore area beyond the high water mark. All bat species found in Scotland are classified as European Protected Species and are fully protected under the Conservation (Natural Habitats) Regulations 1994 as amended. This lists a number of offences in relation to bats and the places which they live.

2 Surveys for any bat roosts and feeding areas will be carried out to inform the onshore environmental impact assessment. These surveys will be conducted using qualified surveyors at the proposed substation and cable landfall and the results will be presented in the onshore Environmental Statement.

3 The impacts considered in this report are all related to the operational phase and are listed as:

- physical impacts from direct collision or flying close proximity to wind turbine blades
- indirect impacts, changing foraging behaviour of bats by attraction to lights and increased risk of physical impacts from collision.

1.1.1 Consultation

4 During meetings with SNH bats occurring in offshore were not raised as being a particular cause for concern.

1.2 Baseline Information

5 Seventeen species of bat are found in the UK, six of which are known to occur in north-east Scotland. Three of these species are considered to occur commonly (common pipistrelle, Soprano pipistrelle and the Brown long-eared bat) one species (Daubenton's bat) fairly common and two are considered uncommon (Natterer's bat and Whiskered bat) (SNH, 2009). A brief description of the six species found in Scotland is given below. A single sighting in the north-east Scotland of the Nathusiu's pipistrelle has also been recorded hence a brief description of this species is also given.

6 **Common pipistrelle (*Pipistrellus pipistrellus*) and Soprano pipistrelle (*Pipistrellus pigmaeus*)** - Due to the similarity of the two species Soprano pipistrelle was not discovered until the 1990s but has since been found to be common and widespread throughout the UK, including north-east Scotland. Both species occur throughout mainland Britain and some inner Hebridean Islands. They occur in most habitats but particularly riparian woodland and parkland. Both species will forage up to 5 km from their roosts and are the most frequently recorded species along the Aberdeenshire coast.

7 **Nathusiu's pipistrelle (*Pipistrellus nathusii*)** - A previous migrant species. It has only been classified as a resident in the UK since 1996. To date only one recorded sighting has been made in the in north-east Scotland. Two

recorded sightings from oil platforms suggest that this species may be a very scarce migrant. The range and status of this species is current unclear.

8 **Brown long-eared bat** (***Plecotus auritus***) - This species is widespread in mainland Britain and also occurs in some inner Hebridean Islands, the species of bat is less common than the pipistrelles particularly along the coast. Brown long-eared bats roost in old houses and forage within 1.5 km from their roosts which are invariably near to thick woodland. Consequently they are scarce along the coast.

9 **Daubenton's bat** (***Myotis daubentonii***) - Occur throughout mainland Britain as far north as Sutherland and possibly on some of the larger Inner Hebridean islands. Although widespread in north-east Scotland, Daubenton's bats are closely associated with fresh water and avoid urban habitats. Roosts are in mature deciduous trees and rarely in houses. In the north-east of Scotland the species occurs along the Ythan as well as Deeside and Donside, however, the species is rare or scarce near the coast.

10 **Natterer's bat** (***Myotis nattereri***) - Natterer's bats are found throughout most of the British Isles. Recent records have extended its range in Scotland north to the Great Glen fault. This is a very rare bat in north-east Scotland with few records reported. It does forage widely and over a wide variety of habitats including grassland, but it prefers semi-open woodland often coniferous.

11 **Whiskered bat** (***Myotis mystacinus***) - Very rare with just one record in north-east Scotland. It is found throughout England and Wales and even in southern Scotland and throughout Ireland.

1.3 Impact Assessment

12 It is recognised that bats may be impacted by wind farms; with evidence from a number of onshore wind farms indicating that bats have a higher mortality rate due to wind farms than birds do. Although direct collisions with the wind turbines do occur, a higher mortality rate arises due to barotraumas caused by sudden changes in air pressure causing lethal lung damage. The impacts considered in this report are all related to the operational phase and are listed as:

- physical impacts from direct collision or flying close proximity to wind turbine blades
- indirect impacts, changing foraging behaviour of bats by attraction to lights and increased risk of physical impacts from collision

13 Bats have been recorded foraging around offshore wind farms. Studies undertaken in Sweden to explore potential impacts on migrating bats discovered that non migratory bats also occurred foraging around the wind turbines as far as 10 km from shore (Ahlén et al., 2007).

14 There is no evidence to suggest the offshore area of Aberdeen Bay is used by bats, the decreasing availability of insect prey with increasing distance from the shore reduces the likelihood of bats foraging beyond the coastal environment.

15 Although there are a number of species that are likely to be found in the terrestrial environments of north-east Scotland, there is no evidence to

suggest that any of these bat species currently utilise the offshore areas for foraging or migration corridors. There are no known flyways across Aberdeen Bay and there is no evidence to suggest migration of Scottish bats to, or from other European countries.

16 Unlike other offshore areas where bats have been found to forage offshore, such as Sweden, Aberdeen Bay does not have any known migration corridors or flyways that are actively used by bats to travel across Aberdeen or to migrate to other parts of Europe, such as Scandinavia.

17 It is only when the EOWDC has been built and is operational that there would be any risk to bats that are flying in, or through, the development area. From a the results of literature review there was a lack of any studies which have identified the presence of bats in Aberdeen Bay beyond the high water mark.

18 The threat to populations of bat species present in the north-east Scotland from collisions is shown in Table 1. Both species of pipistrelle (common and soprano) are ranked as having a medium collision risk, all the other four species were considered to have a low risk of collision. The population threat from collisions to all bat species found in the north-east Scotland is low. Although this threat may be revisited by the UK statutory nature conservation agencies depending upon the scale of future wind farm developments particularly those situated onshore.

Table 1 The risk of collision fatalities affecting bat populations (table adapted from Natural England 2009

Species	Relative Population Size and Status	Risk of Collision	Population Threat
Common pipistrelle	Common	Medium	Low
Soprano pipistrelle	Common	Medium	Low
Brown long-eared bat	Common	Low	Low
Daubenton's bat	Common	Low	Low
Natterer's bat	Fairly common	Low	Low
Whiskered bat	Locally distributed	Low	Low

19 During the operational phase of the proposed EOWDC the addition of aviation and navigational safety aids such as lights could act as attractants to insects which in turn may attract predators such as bats from the mainland, however it is known that bats generally avoid artificial lighting (Boshamer and Bekker 2008). Also Aberdeen Bay is frequently used for mooring vessels used to supply the oil and gas industry. These vessels are lit by powerful lights and easily visible from the shore and there have not been any records of bats foraging around the lights of these boats.

20 The addition of permanent lights offshore may influence the foraging flights of bats, although there is no evidence to suggest that lights that are currently present offshore Aberdeen Bay have attracted bats.

21 There are no foreseeable impacts from the construction phases or decommissioning phases.

22 The risk of collision is considered to be negligible once the EOWDC has been constructed and is operational. Although there have been reports of bats discovered on oil and gas infrastructure offshore, there is no evidence for any significant movement, or permanent distribution, of bats in offshore waters in the Aberdeen Bay area and therefore the impact of the EOWDC on the bats is considered to be negligible.

1.4 Mitigation and Monitoring

23 No additional mitigation for the offshore works is planned for bats.

24 If any environmental risk to bats is identified in any subsequent land-based surveys and following the advice of SNH, post monitoring surveys could monitor the EOWDC area to assess if there are any bats that are foraging or moving through the site.

1.5 Summary

25 Six species of bats are thought to occur in north-east Scotland, although only three of them are common species. The bats are not expected to use the waters of Aberdeen Bay for feeding and there are no known flyways or migration corridors in the area. Once the proposed EOWDC is operational there is the small possibility that the EOWDC could attract insects and bats offshore due to the small lights required for safety reasons on the wind turbines. The evidence suggests a lack of bats in the offshore waters of Aberdeen Bay. Impacts from the construction, operation and subsequent decommissioning of the EOWDC on bat species are considered to be negligible.

26 A thorough survey for bat species and their associated roosts will be undertaken as part of the environmental surveys carried out for the onshore Environmental Impact Assessment to look at the impact of the onshore works.

1.6 References

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European Offshore Wind Deployment Centre

Environmental Statement

Appendix 12.1: Marine Mammals Baseline Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

European Offshore Wind Deployment Centre

Marine Mammal Environmental Baseline

Genesis Job Number J-71666/A

June 11

CLIENT:	**Aberdeen Offshore Wind Limited**
PROJECT/JOB TITLE:	**Wind farm FEED Support**
DOCUMENT TYPE:	**Report**
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GENESIS JOB NUMBER:	**J-71666/A**
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Rev	**Date**	**Description**	**Issued By**	**Checked By**	**Approved By**	**Client Approval**

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1. INFORMATION FOR THE NON-TECHNICAL SUMMARY

The marine mammal environmental baseline drew upon existing research surveys conducted on marine mammals in the wider area as well as several years of land based and boat surveys of the wider EOWDC development area. Several marine mammal species have been recorded (sighting and/or stranding) in Aberdeen Bay and the surrounding area; including 12 odontocete species, three mysticete species and three pinniped species. Of these, bottlenose dolphins, harbour porpoises, white-beaked dolphins, minke whales, Risso's dolphins, harbour seals and grey seals occur regularly in the area, with other species only being recorded occasionally or rarely.

Bottlenose dolphins in the Aberdeen area are part of the resident population from the Moray Firth Special Area of Conservation (SAC), which have a range extending from the Moray Firth to the Firth of Forth. There appears to be sub-groups within the population with one group spending most of their time within the inner Moray Firth (SAC) and the other group having a wider range and spending less time in the inner Moray Firth area.

The bottlenose dolphin population of the Moray Firth has recently been expanding its range in a southerly direction, beyond the boundaries of the Moray Firth SAC, with an increase in sightings and identified individuals along the east coast of Scotland as far as St Andrews and the Firth of Forth. Although Aberdeen is recognised as an important area for bottlenose dolphins, further studies are required to more accurately determine the proportion of the population that utilises this area throughout the year.

Bottlenose dolphins are generally found within coastal waters, although have been observed in offshore areas off north-east Scotland. Bottlenose dolphins have been observed off Aberdeen throughout the year, although there appears to be an increase in occurrence between November and May.

Bottlenose dolphin were the second most frequently sighted cetacean species during the surveys carried out as part of the EOWDC, with a total of 200 individuals being detected. The majority of the sightings occurred in the spring and summer months. A higher number of bottlenose dolphins were recorded in the wind farm area in comparison to the control site and in the vicinity of the entrance to Aberdeen harbour, which is a known hotspot for dolphin sightings. Their presence at this site has been linked to salmon migration up the river.

Young bottlenose dolphin calves have been observed in the Aberdeen area during spring and early summer, indicating a possible increased sensitivity to any potential disturbance during this time.

From the available information it is apparent that the Aberdeen area is important for bottlenose dolphins, however it is unclear how reliant they are on the area as they are regularly observed, both feeding and with calves, at various locations along the north-east coast of Scotland.

Harbour porpoises are the most common species of cetacean in the North Sea and have a wide range and distribution in both coastal and offshore areas. Harbour porpoises regularly occur in the Aberdeen area throughout the year, with peak occurrence during August and September.

The diet of harbour porpoises is varied and they have been recorded to take a wide range of prey items. In Scottish waters their diet is primarily whiting, sandeels, haddock/saithe/Pollock and *Trisopterus* spp. It is unclear if porpoises in the Aberdeen area are attracted to a specific prey species.

The calving period for harbour porpoises in Scottish waters is estimated to be between April and June, and calves have been observed off Aberdeenshire between May and September, indicating a possible increased sensitivity to any potential disturbance during this time.

Harbour porpoises were the most recorded cetacean species during the EOWDC boat surveys with over 420 individuals detected. The harbour porpoise was the only species that was detected in sufficient numbers to allow a detection function to be applied that would allow for abundance and density estimates to be generated. The density of harbour porpoises was higher in the control area in all seasons except summer. Lowest densities occurred during May and June. The density estimates produced for harbour porpoise all show considerable error margins which is a reflection of the sampling effort, further surveys would reduce this. In the four surveys carried out during 2010-2011 the northern transect had the highest proportion of harbour porpoises, except in January when highest densities were recorded in the southern transect.

The harbour porpoise, as expected, was the most frequently detected cetacean species during the acoustic surveys. In agreement with the results of the visual surveys the control area recorded more acoustic detections than the wind farm survey area. In the acoustic surveys carried out during 2010-2011 higher numbers of detections were made in the offshore survey area during the August and September surveys, although it is too early to conclude whether this represents a movement of animals further offshore during the summer months.

White-beaked dolphins are present in the central and northern North Sea throughout most of the year. Sightings data suggests their presence in the coastal waters off Aberdeenshire is seasonal, with sightings recorded between June and August; however strandings data indicate they may be present in the area between February and October.

The movement of white-beaked dolphins into coastal waters during summer months is thought to relate to the calving period, with calves being observed off Aberdeenshire in all three months that the species has been observed.

The seasonal movement may also be related to the seasonal abundance or movement of prey species, such as herring or mackerel. It is hoped that the marine ecology and fisheries studies will provide more information on potential prey in the area.

Along the Aberdeenshire coast, white-beaked dolphins appear to have a preference for sections of the coast adjacent to deeper waters, with a higher incidence of sightings between Aberdeen and Stonehaven compared to the area between Aberdeen and Collieston.

White beaked dolphins have been detected during the EOWDC surveys over the course of several years during the month of August, this data supports the occurrence of this dolphin as a seasonal summer visitor that possibly moves to coastal waters following prey such as mackerel and for calving purposes. Although white-beaked dolphins are found throughout the central North Sea and generally in more offshore areas, it is apparent that the coastal waters off Aberdeen could be important during the summer/calving period.

Minke whales occur throughout the central and northern North Sea, particularly during summer months. They are generally observed in offshore deeper waters, but appear to move into coastal waters along the north-east coast of Scotland from July.

Minke whales have been recorded off the Aberdeenshire coast primarily during summer months (July – August); although observations and strandings indicate they may be present in the area throughout the year.

The seasonal movement of minke whales into coastal waters during the summer is thought to be related to prey availability. Minke whales generally feed on a small pelagic fish, such as sandeels, herring and sprat.

Six minke whales have been observed as part of the EOWDC surveys. Minke whales are thought to have a preference for water depths of 38m or deeper, these depths are generally found further offshore and beyond the EOWDC crown estate lease, although one minke whale was detected within the lease area during the boat based surveys.

Although minke whales occur regularly in the area off Aberdeen, especially during summer, it is unclear how important the area is relative to other areas.

In the northern and central North Sea, Risso's dolphins are primarily observed around Shetland and Orkney. However, there has been an increase in reported sightings along the north-east coast in recent years. Risso's dolphins have been recorded off Aberdeenshire since 2005 at various times of the year.

The increase in recent sightings in the Aberdeen Bay area may indicate that Risso's dolphins are using the area more frequently, and although occasionally recorded in the area this may change and should be monitored. Possible reasons for the apparent recent increase in observations in the area are unclear, but could be related to prey availability, Risso's dolphins feed primarily on cephalopods, and/or climate change.

Risso's dolphins were observed during vantage point surveys, but not during any of the EOWDC boat surveys. The increase in sightings of Risso's dolphins may point towards an increase in the use of the Aberdeen area in comparison to historic levels.

Harbour seals are widely distributed along the east coast of Scotland. They are present in the Aberdeen area throughout the year. Their occurrence at the estuaries of the Rivers Dee and Don is seasonal with an increase in numbers during the winter and early spring.

Harbour seals use haul-out sites at the Donmouth, at the mouth of the Ythan River and at Catterline. Harbour seals have been observed feeding on salmonids and flatfish at the estuaries of the Rivers Dee and Don, as well as other marine prey species.

The pupping period for harbour seals occurs from June to July and moulting occurs from June to September, during these times they spend a higher proportion of their time ashore and in coastal waters.

Both species of seal grey and harbour seals are regularly present and frequently sighted in Aberdeen bay, especially at the entrances to the rivers Dee and the Don. Grey seals were the most frequently observed seal species recorded during the boat surveys carried out between 2007-2007. Almost equal proportions of grey and common seals were recorded during boat surveys carried out during 2010-2011.

Designated coastal SACs for harbour seals are present along the east coast of mainland Scotland, these are situated in the Dornoch Firth and Morrich Moore in the Moray Firth and Firth of Tay and Eden estuary.

Grey seals are also found along the east coast of Scotland. They are present in the Aberdeen area throughout the year. Grey seals use haul-out sites at the Donmouth, at the mouth of the Ythan River, outside Peterhead harbour, Cruden Bay, Boddom and at Catterline.

The most well established colony in the area is at Catterline, where up to five pups may be born each year. The pupping period for grey seals occurs from October to November and moulting occurs from February to April, during these times they spend a higher proportion of their time ashore and in coastal waters.

Grey seals have been observed feeding on salmonids and flatfish at the estuaries of the Rivers Dee and Don, as well as other marine prey species.

Designated SAC's for grey seals along the east coast of Scotland include the Isle of May at the entrance of the Firth of Forth, and it can be expected that individual seals from these colonies may be passing through and the EOWDC development area.

For species such as white-sided dolphins, killer whales, common dolphins, striped dolphins, long-finned pilot whales, sperm whales, humpback whales, fin whales, northern bottlenose whales, Sowerby's beaked whales and other pinniped species, although present in the area off north-east Scotland this is only a marginal part of their habitat, and is likely to be inhabited only during a restricted part of the year by relatively few individuals.

2. INTRODUCTION

Genesis Oil and Gas Consultants (GOGC) have been commissioned by AOWFL to undertake a marine mammal impact assessment of the EOWDC. The structure of the assessment can be summarised as follows:

- **Baseline Report** (this document) – this provides a summary of the existing information relating to the distribution and abundance of marine mammals in Scotland with a focus on Aberdeen Bay. This report draws on the findings of a desk based study and marine mammal research studies and also dedicated marine mammal surveys carried out for the purpose of supplementing the baseline for the EOWDC.
- **EIA Technical Report** – an assessment of the impact of the project on marine mammals in the study area.
- **Non-Technical Summary Chapter for the Environmental Statement** – a summary of findings from the Baseline Report and EIA Technical Report.

In order to assess the importance of the proposed EOWDC and surrounding area for marine mammals and the potential impacts associated with the project, it is necessary to understand the occurrence and distribution of marine mammals in the area and understand why they are there.

The main aim of the baseline study is to provide detailed information on marine mammals that may be present in the crown estate licence area and also the surrounding area to inform the EIA technical report. The baseline report provides information on the following:

- Marine mammals present in Aberdeen Bay and Scottish coastal waters
- Abundance and distribution of marine mammals, and seasonal patterns of distribution and migration
- Usage of the Aberdeen Bay by marine mammals (feeding, passage area, calving)
- Identification of any potential seasonal sensitivities (e.g. calving period)
- knowledge/data gaps relating to marine mammals in Aberdeen Bay

3. DATA SOURCES

The following key data sources have been used to inform the baseline assessment:

- Boat based surveys of the EOWDC and wider area carried out by Institute of Estuarine and Coastal Studies (IECS) (2007-2008) and the Sea Mammal Research Unit (SMRU) 2010-2011 (Section 3.1)
- Land based Vantage Point surveys carried out as part of the baseline surveys of EOWDC March 2005-2007 Section 3.2
- Joint Nature Conservation Committee (JNCC) aerial survey data of Aberdeen Bay 2005-2006 (Section 3.3)
- Marine mammals present along the Scottish coastline were assessed as part of Strategic Environmental Assessment (SEA) area 5 as part of the oil and gas licensing programme (Section 3.4)
- Northern North Sea Cetacean Ferry Surveys (NORCET) cetacean survey information (Section 3.5)
- Moray Firth cetacean study 2009-2011 into the effects of proposed oil and gas exploration (Section 3.6)
- Cetacean stranding data (Section 3.7)

A full list of documents referenced in the baseline assessment is provided in the reference section.

3.1 BOAT SURVEYS

The aim of all of the boat based surveys was to collect marine mammal data to generate density and abundance estimates by year, month/season and stratified for the wind farm and control site. The passive acoustic monitoring element allowed for the acoustic analysis of marine mammal data to generate detection rates for harbour porpoise and delphinids.

Marine mammal and seabird surveys were carried out on behalf of AOWL by the Institute of Estuarine and Coastal Studies (IECS), University of Hull from February 2007 – April 2008, inclusive.

SMRU Ltd were contracted to undertake 12 monthly surveys for marine mammals and seabirds. Included in the baseline report are provisional survey data collected from the initial four surveys completed in August, September and November 2010 and January 2011.

For all the marine mammals surveys conducted as part of the EOWDC baseline marine mammal observers followed standard survey transect procedures to collect data on marine mammals, and the surveys occurred in a Beaufort sea state 4, or less.

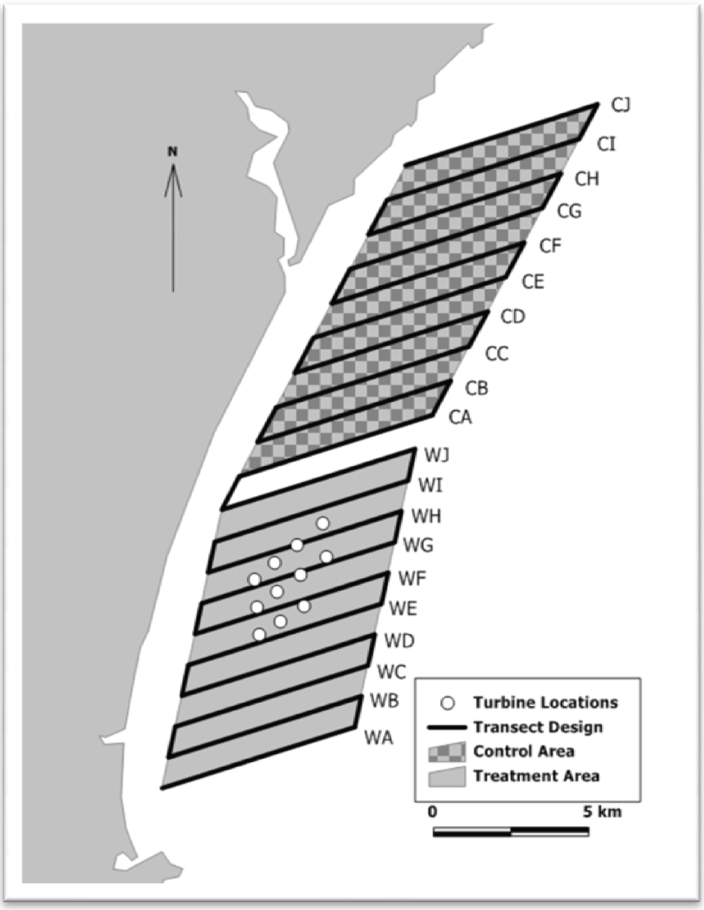
The vessel used for the IECS surveys and the initial 4 SMRU surveys was an ex-Clyde class lifeboat *Gemini Explorer*. It had an observation platform 5.1 m above sea level, cruising speed of 8-9 knots and a clean electronic footprint which was required for the acoustic survey component.

3.1.1 IECS boat based surveys 2007-2008

The survey approach used in the IECS boat based surveys was a Before-After-Control Impact design (BACI) and the scope was for a significantly larger wind farm. The survey approach was developed in consultation with the Joint Nature Conservation Committee (JNCC) and Scottish Natural Heritage (SNH) in 2006. Two survey areas were defined; the ‘wind farm’ area and a ‘control area’, immediately to the north (Figure 1). The terminology control area has been used to define one of the survey areas, however, it is accepted that establishing a true control area with equivalent environmental conditions to the wind farm area is difficult, if not impractical for a coastal environment.

In each area (50.8 km^2), parallel line transect surveys were completed across two survey strata (Wind farm and Control). During each survey month, ten transects of 6.5 km length were surveyed in each of the two areas giving a total survey effort of 130 km per survey month. Surveys were undertaken during a total of 15 months between February 2007 and April 2008 (Table 1), giving 1,950 km of survey effort during this phase of data collection (Travers, *et al*., 2008).

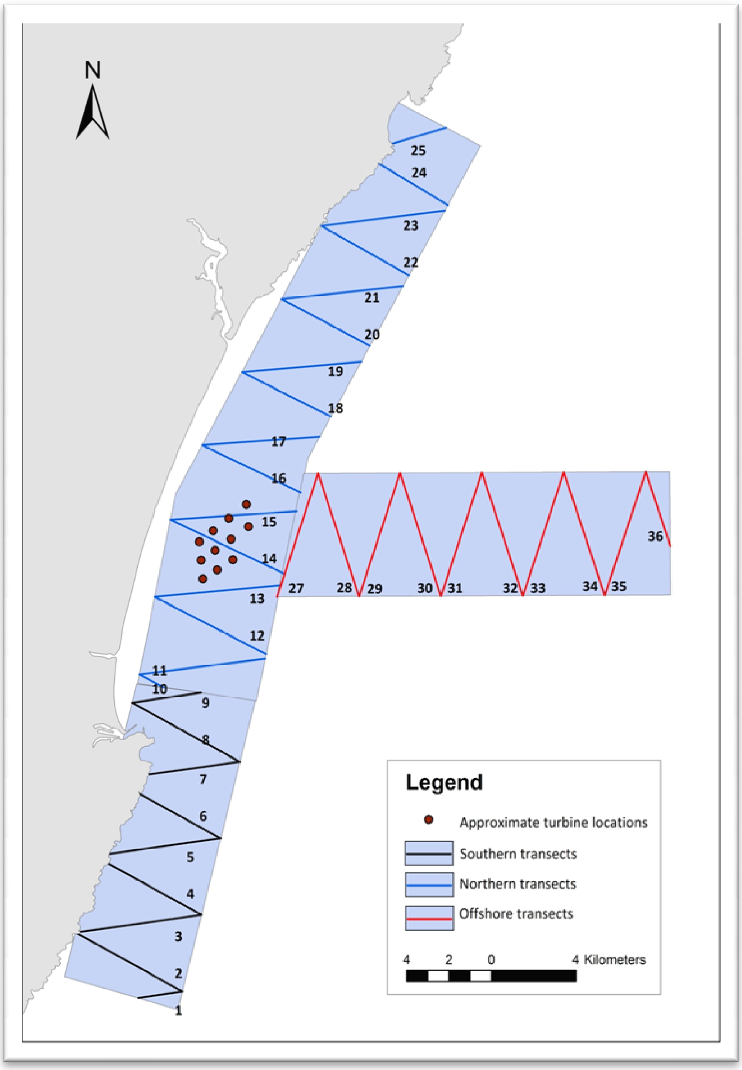
Figure 1 Boat based survey transects 2007-2008 (IECS), the grey area with the turbine locations is the wind farm area and the cross-hatched area is the control area (Travers, *et al*., 2008)



3.1.2 SMRU Ltd boat based surveys 2010-2011

SMRU Ltd were contracted to undertake an additional 12 months of surveys for marine mammals and seabirds. The survey design differed to that used by IECS and is based on zigzag line transects and the survey area is extended into the South, North and Offshore survey areas which were 82.8 km^2, 150.8 km^2 and 105.2 km^2 in area respectively (Figure 2) (SMRU Ltd, 2011a). The North survey area encompassed the Wind farm and 'Control' areas surveyed between February 2007 and April 2008. During each survey , 9, 16 and 10 transects were undertaken in the South, North and Offshore areas respectively, giving a total survey effort of approximately 40 km, 75 km and 60 km per survey block. For each survey a total of 36 transects were therefore surveyed, providing a total of 175 km of survey effort.

Figure 2 The boat based survey areas covered during 2010-2011; the southern area, (survey transects shown in black), the northern area, (survey transects shown in blue), and the offshore area, (survey transects shown in red). The survey transects are also labelled 1-36 (SMRU Ltd, 2011a).



The survey is based on a gradient design and the shortfalls of the 'Before and After Controlled Impact' (BACI) approach used in the first phase of data collection are avoided. The data collected using this gradient approach is compatible, and can be analysed in conjunction with the first phase of boat based surveys. Where sufficient observations of marine mammals have been collected this will allow pooled density estimates and abundances of marine mammals to be generated. The survey results will enable a repeatable baseline to monitor throughout the development of the proposed EOWDC.

All observers operated from the bridge roof (approx 5 m above sea level) and followed standard line transect procedures for marine mammals and modified European Seabird At Sea (ESAS) methods for seabirds. The main change to the ESAS method was the use of a third observer to count flushed birds ahead of the vessel. There were 3 seabird and 4 cetacean observers on each survey. Surveys were carried out in Beaufort sea state 4 or below with good visibility.

Included in this baseline report are the initial results from the data collected from the initial four surveys completed in August, September and November 2010 and January 2011 (SMRU Ltd, 2011a). There have been further surveys carried out in February and March, which have not yet been analysed.

3.1.2.1 Survey Effort during IECS (2007-2008) and SMRU (2010-2011) boat based surveys

The amount of survey effort completed on each transect varied slightly between surveys due to navigational issues (i.e. shipping traffic) or avoidance of heritable fishing grounds. The GPS logger data from each survey were therefore used to provide an accurate measure of survey effort for each transect, and these effort values were used for analysis.

IECS boat based surveys were carried out from February 2007 – April 2008. April was surveyed three times, to concentrate more survey effort during the breeding season, and February was surveyed twice, all other months were only surveyed once. The seasonal survey effort was highest in the winter and spring months with, with 520 km and 650 km, respectively (Table 1).

SMRU surveys were undertaken during August, September and November 2010, and January 2011 a total survey effort of approximately 600 km during this phase of monitoring (Table 2). A survey was not possible during October 2010 due to ongoing seismic surveys and then poor weather. Due to potential access restrictions, that Marine Scotland were made aware of, it was not possible to conduct a December survey.

When the seasonal survey effort collected during the IECS and SMRU surveys are combine there is fairly even coverage during each season, the season with the highest effort is winter (696 km) and the lowest is summer (595 km) (Table 3).

Upon the completion of the final 12 months of survey effort the environmental baseline chapter will be updated and the boat based survey results will be analysed together. Both phases of boat based survey results will be combined and used to develop a spatial model of marine mammal density and abundance throughout the survey area, where sufficient data allows. The results of this further analysis will be considered in any updates necessary to the marine mammal impact assessment and any revisions to the impact assessments will be incorporated.

Table 1 Total number of EOWDC boat based surveys and survey effort between February 2007 and April 2008 (IECS)

Season	Month	Number of surveys	Year	Total Effort (km)	Seasonal effort (km)
Winter	December	1	2007	130	520
	January	1	2008	130	
	February	2	2007, 2008	260	
Spring	March	1	2007	130	650
	April	3	2007, 2008, 2008	390	
	May	1	2007	130	
Summer	June	1	2007	130	390
	July	1	2007	130	
	August	1	2007	130	
Autumn	September	1	2007	130	390
	October	1	2007	130	
	November	1	2007	130	

Table 2 Total number of EOWDC boat based surveys carried out 2010-2011 (SMRU)

Month	Number of surveys	Year	Total Effort (km)
August	1	2010	175
September	1	2010	175
October	0	2010	0
November	1	2010	175
December	0	2010	0
January	1	2011	175
*February**	1	2011	175
*March**	1	2011	175

* February and March data was not available for inclusion in the baseline report

Table 3 Total number of EOWDC surveys and survey effort completed per season between February 2007 and April 2008 (IECS) and August 2010 and January 2011 (SMRU)

Season	Number of Surveys			Effort (km)		
	Total	IECS	SMRU	Total	IECS	SMRU
Winter	5	4	1	695	520	175
Spring	5	5	0	650	650	0
Summer	3	3	1	565	390	175
Autumn	5	3	2	640	390	250

3.1.2.2 Passive Acoustic Monitoring Methods

Passive Acoustic Monitoring was used during the surveys carried out by IECS in 2007-2008 and the SMRU surveys carried out during 2010-2011; the total number of surveys and associated effort is shown in Table 4 and Table 5.

In the IECS survey a hydrophone array was towed behind the survey vessel during the line transects across both the wind farm and control area. Acoustic effort was calculated by examining the times contained within the acoustic files, and comparing these with the GPS data. If acoustic data was being recorded and the vessel was shown to be on a long transect line, the effort status was classed as being "on effort". If acoustic data was being recorded but the vessel was not sailing a transect line, or was sailing a short transect line, the effort status was classed as "opportunistic".

During the SMRU acoustic survey a hydrophone array was towed behind the survey vessel during all surveys. Acoustic effort was recorded in the field, and is defined as periods when hydrophone and associated recording equipment are operational and the survey vessel is adhering to one of the pre-designed survey transects. If the hydrophone and associated recording equipment are operational but the vessel is not sailing a transect line, the effort status was classed as "opportunistic". During the August survey, poor visibility resulted in the repetition of some of the southern transects for the visual observers and these extra transects have been included in the August acoustic analysis.

Table 4 Total number of IECS surveys with hydrophone deployed and survey effort completed per month between October 2007 and April 2008.

Month	Surveys	Effort (km)
Oct-07	1	111
Nov-07	1	102
Dec-07	1	127
Jan-08	1	88
Feb-08	1	127
March-08	0	0
April-08	2	227

Table 5 Total number of SMRU surveys with hydrophone deployed and survey effort completed per month between August 2010 and January 2011

Month	Surveys	Effort (km)
Aug-10	1	207.5
Sept-10	1	168.6
Nov-10	1	166.7
Jan-11	1	164.2

Hydrophone data were run through a harbour porpoise detection algorithm in real time in the field using the Rainbow Click software (freely available from www.ifaw.org). Rainbow click highlights porpoise-type clicks within the acoustic data, and these detections were validated manually to ascertain the number of harbour porpoise detections. Detection rates are expressed as events per kilometre.

In addition to the Rainbow Click files created during the line transect surveys; recordings were also made at a sample rate of 96 kHz. The combined data set was run through the PAMguard "whistle and moan" detector module (PAMguard software freely available from www.pamguard.org) by SMRU Ltd to identify any dolphin whistles that may have been recorded. Detections were validated manually to ascertain the number of dolphin events. Detection rates are expressed as events per kilometre.

3.1.2.3 Analysis methods for visual marine mammal data

Visual marine mammal data was analysed using conventional and multi-covariate distance sampling using Distance version 6 (Thomas et al. 2010). For the marine mammal species detected, there were only enough sightings of the harbour porpoise to enable detection function to be applied for this species only, for all other species too few observations were recorded. Only on transect effort was used in the analysis (i.e. short transit legs between transects were discarded).

The standard equations for estimating density and abundance are:

$$\hat{D} = \frac{n}{2\mathrm{L.\,esw}}$$

Where *n* is the number of sightings, *s* is the mean group size, *L* is the total length of transect surveyed and *esw* is the effective strip half width. The *esw* is a function (inverse of the detection function *f(y)*) of the perpendicular distances associated with the sighting and is modelled by fitting a key function with series expansion. The best model was primarily judged by the lowest value of the Akaike's Information Criteria (AIC) compared to others. How well the model fitted the data was judged by the Goodness of fit tests and QQ-plots.

Abundance is then simply the density estimate multiplied by the survey area. Variance was estimated empirically using the delta method (Buckland et al. 2001).

Surveys within the same month were combined to generate the density and abundance estimates. The sightings data for harbour porpoises were pooled over the entire 15 month survey period. Data were then stratified at the estimation stage to generate density and abundance estimates by month and season for each of the areas. Months were divided into four seasons: Winter (December, January, and February), Spring (March, April and May), Summer (June, July and August) and Autumn (September, October and November).

3.2 Vantage Point surveys

Shore-based vantage point bird surveys were conducted for two hours weekly at Blackdog and Donmouth and fortnightly at Drums and Balmedie covering a distance of up to 2 km from shore (Figure 10.2). These surveys were designed primarily for bird observations, but collected information on marine mammals observed. Vantage point surveys were conducted from August 2005 until March 2008 (Alba Ecology and Envirocentre 2008).

Bottlenose dolphins have been recorded at all four sites (Donmouth, Blackdog, Balmedie and Drums), with the distance from shore ranging from less than 0.5 km to greater than 3 km and the direction of travel being up and down the coast. Bottlenose dolphins have been observed throughout the year (except in June) and at various times of the day.

Harbour porpoises have been recorded at all four sites (Donmouth, Blackdog, Balmedie and Drums), with the distance from shore ranging from 0.5 km to 2 km and the direction of travel has been both up and down the coast, although the majority appeared to be heading north. Harbour porpoises have been observed in January, February, May, June, July, August, September and December and at various times of the day.

The majority of seal sightings were of individual animals, probably grey seals, although harbour seals were recorded at Blackdog in June 2007 and at the Donmouth in July 2007. Seals have been recorded at all four sites Donmouth, Blackdog, Balmedie and Drums, although there is only one recorded sighting at Drums, with the distance from shore ranging from the surf zone to 1.5 km. Seals have been observed in January, February, March, August and December, at various times of the day.

Other species recorded were Risso's dolphins in April 2006 and April 2007. Single minke whales were recorded at both Donmouth and Blackdog on 13th July 2007, although this may have been the same individual moving along the coast and a large unidentified cetacean more than 5 km from the coast was observed in December 2006.

3.3 JNCC marine mammal observations during winter aerial surveys of Aberdeen Bay

The Joint Nature Conservation Committee (JNCC) conducted aerial surveys of wintering aggregations of seaducks, divers and grebes within Aberdeen Bay in December 2004, February 2005, December 2005, January 2006, May 2006 and April 2007. Surveys were conducted from light aircraft, following a line-transect method (details of the survey methods are provided in Söhle *et al*. (2006) and Wilson *et al*. (2006). During these surveys observations of bottlenose dolphins and harbour porpoises were recorded incidentally (Table 6).

Table 6 Marine mammal observations during JNCC aerial surveys of Aberdeen Bay (2004-2007) (Söhle *et al.*,, 2006; Wilson *et al.*, 2006)

Date	Bottlenose dolphin	Harbour porpoise
11th December 2004	4	0
17th February 2005	1	0
8th December 2005	4	6
24th January 2006	0	5
10th May 2006	0	0
26th April 2007	1	0

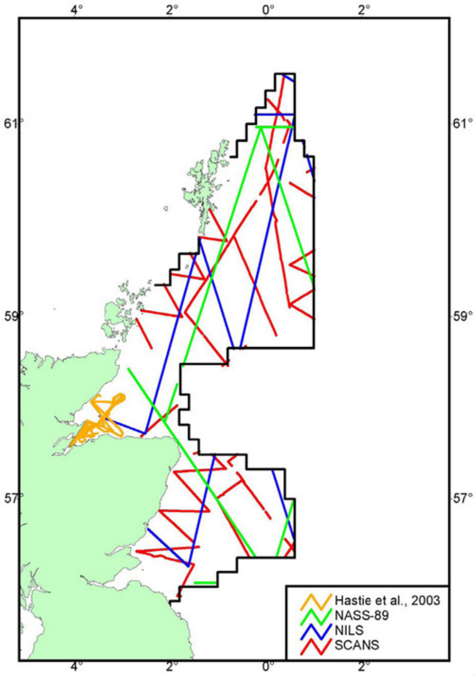
3.4 Distribution and Abundance of Cetaceans to the North and East of Scotland (SEA5)

Hammond *et al*. (2004) examined the distribution and abundance of cetaceans occurring to the north and east of Scotland during the Strategic Environmental Assessment (SEA) 5 (Figure 3). Species that are known to occur regularly in this area are the harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin, killer whale, bottlenose dolphin and minke whale. In addition there are occasional at-sea records in the area of at least eight further cetacean species: humpback whale, fin whale, sperm whale, northern bottlenose whale, long-finned pilot whale, Risso's dolphin, short-beaked common dolphin and striped dolphin.

Hammond *et al*. (2004) reviewed quantitative information for this area from a variety of sightings surveys including the Small Cetacean Abundance in the North Sea (SCANS) survey in July 1994 (Hammond *et al.* 1995; 2002), the North Atlantic Sightings Surveys (NASS) in July 1989 (Bjørge and Øien, 1995), and the Norwegian Independent Line transect Surveys (NILS) in July 1995 and 1998 (Schweder *et al.,* 1997; Skaug *et al.,* 2003). There are also published cetacean observations made during seismic surveys in 1996 to 1999 (Stone, 1997; 1998; 2000; 2001; 2003a). Acoustic recordings have also been used to determine the general distribution and seasonal patterns of movement of some cetacean species by Cornell University, Aberdeen University and the Joint Nature Conservation Committee using the US Navy's SOSUS hydrophone array and low frequency sonor buoys (Swift *et al.,* 2002).

Information from Hammond *et al*. (2004) has been included in this review, with particular reference to the north-east coast of Scotland.

Figure 3 SEA 5 Area: north and east Scotland, including cruise tracks from various surveys conducted in the SEA5 area and SCANS (Hammond *et al*., 1995; 2002: black line outlines SEA5 area)



3.5 NORTHERN NORTH SEA CETACEAN FERRY SURVEYS (NORCET)

Cetacean surveys have been conducted from the bridge of the *MV Hascosay* ferry between Aberdeen, Orkney and Shetland during daylight hours in summer months (April to September) from 2002 to 2006 (MacLeod *et al*., 2007). Data from these surveys provided important additional information on the occurrence and distribution of cetaceans in areas away from the coast that are not regularly covered by other surveys. Although the surveys have been continuing after 2006, no analysed sightings data was available.

In the first five years, surveys were been conducted on over 100 days and 383 sightings of 1,148 individual cetaceans were recorded. These sightings represent 10 different species. The most commonly sighted species was the harbour porpoise (164 sightings) which were recorded throughout the region. Minke whales were the second most commonly recorded species (55 sightings) and were most commonly sighted in deeper waters of the outer Moray Firth in early summer and in more coastal waters in later summer. The third most commonly seen species was the white-beaked dolphin (53 sightings). Again this species was recorded through out the study area, but was most commonly sighted in July and August in coastal waters. Thirty-nine groups of bottlenose dolphins were sighted, but this species was almost exclusively sighted close to shore as the ferry passed along the coast of mainland Scotland. Only harbour porpoises, minke whales and bottlenose dolphins were recorded in all summer months. The remaining species sighted were the Atlantic white-sided dolphin (10 sightings), the common dolphin (9 sightings), the Risso's dolphin (6 sightings), the killer whale (3 sightings), the fin whale (3 sightings) and the humpback whale (1 sighting).

The data collected from the NORCET ferry surveys 2002-2006 is summarised in Figure 4. The proportion of cetacean species detected during each month and year of survey effort is illustrated in Figure 5 and Figure 6.

Figure 4 Cetacean species detected along the north east coast of Scotland during NORCET Ferry crossings 2002-2006 (MacLeod *et al*., 2007)

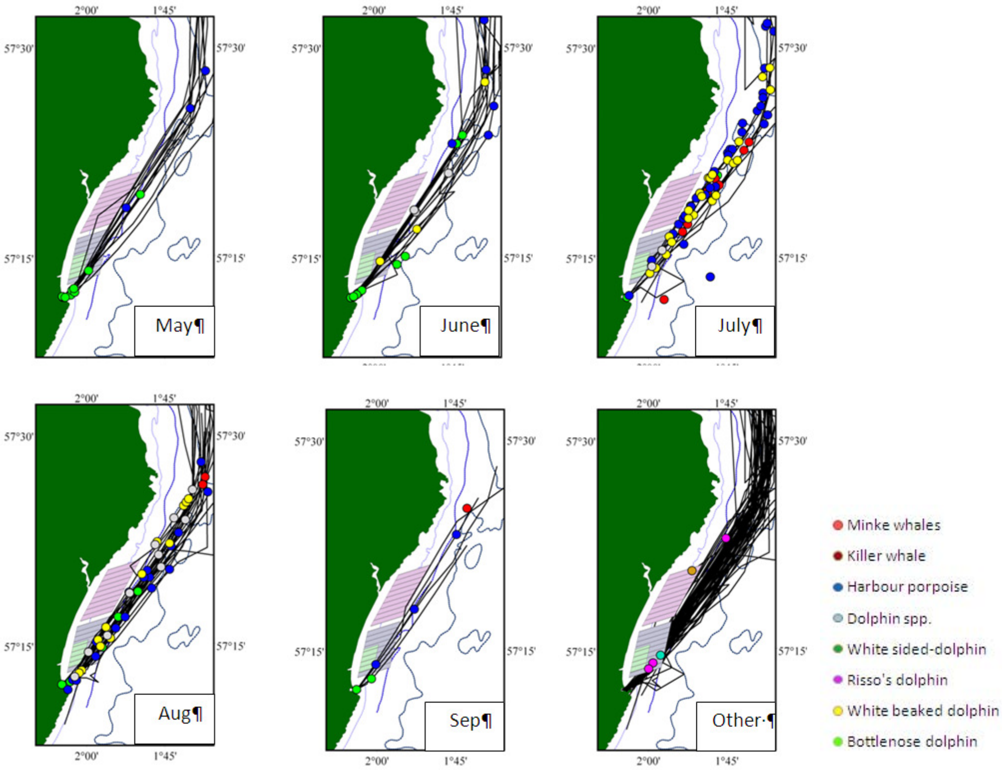


Figure 5 Proportion of cetacean sightings per month during the NORCET surveys 2002-2006(Data used from MacLeod *et al*., 2007)

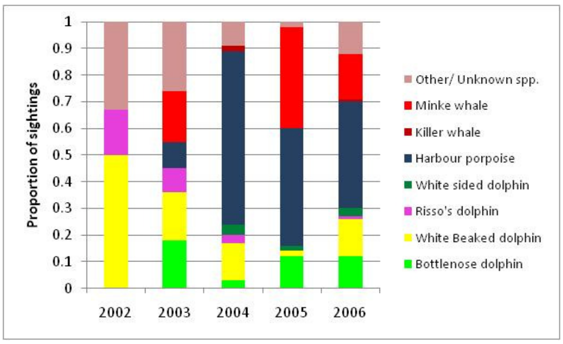
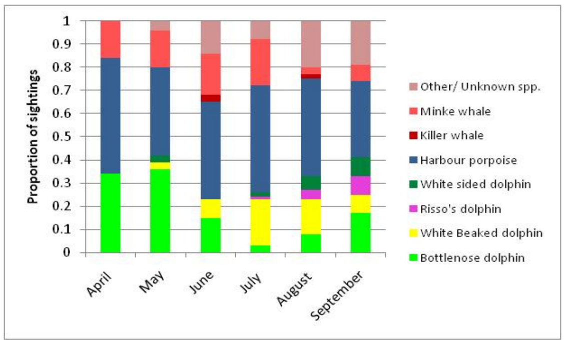


Figure 6 Proportion of cetacean sightings per year during the NORCET surveys 2002-2006(Data used from MacLeod *et al*., 2007)



3.6 Moray Firth Study Assessing Impacts of Potential Oil and Gas Seismic Surveys

The Department and Energy and Climate Change (DECC), with co-funding from the Scottish Government COWRIE and Oil and Gas UK funded a three year research programme that will finish in 2012 to assess the potential impacts of proposed oil and gas activities on cetaceans in the Moray Firth. The project involved the collection of boat based survey, aerial survey (2010) and deployment of acoustic hydrophones (C-Pods) to detect the vocalisations of cetaceans. The interim results of the first two years of surveys have been published and results applicable to the two main cetacean species observed in the Moray Firth the harbour porpoise and bottlenose dolphin will be presented (Thompsen, *et al*., 2010; Thompsen *et al*., 2011).

3.7 Cetacean Stranding Data: Fraserburgh to Inverbervie (January 1992 – March 2010)

The Scottish Agricultural College Veterinary Services at Inverness carry out necropsies on stranded and by-caught cetaceans in Scotland for the DEFRA funded Marine Mammal Strandings Program as part of the United Kingdom Government's commitment to a number of international conservation agreements. Post mortem procedures, sampling and data collection by the SAC follow the recommended procedure of the European Cetacean Society (Kuiken and Hartmann, 1991) and the UK Marine Mammal Project (Law, 1994).

Nine cetacean species have been recorded in the strandings database by the Scottish Agriculture College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and March 2010 (SAC, 2006; CSIP 2010). Of the 167 cetaceans in the strandings records for the north-east coast the majority (approximately 78%) were harbour porpoises, other species were white-beaked dolphins, sperm whales, minke whales, common dolphins, Risso's dolphins, bottlenose dolphins, long-finned pilot whale and Sowerby's beaked whale (Table 7).

Table 7 Strandings data recorded from Fraserburgh to Inverbervie 1992-2006 (SAC, 2006; CSIP 2010)

Species	Number
Harbour porpoise	130
White-beaked dolphin	14
Sperm whale	9
Minke whale	5
Common dolphin	3
Risso's dolphin	2
Bottlenose dolphin	2
Long-finned pilot whale	1
Sowerby's beaked whale	1

4. MARINE MAMMALS IN ABERDEEN BAY AND SURROUNDING AREA

The northern and central North Sea is in an important area for several marine mammal species. Minke and killer whales, white-beaked and white-sided dolphins and harbour porpoises may occur regularly in the area, of which the harbour porpoises, minke whales and white-beaked dolphins are the most abundant. Bottlenose dolphins are regularly seen in coastal waters in the Moray Firth and along the north east coast of Scotland. Long-finned pilot and sperm whales, common, striped, Risso's and bottlenose dolphins are less frequently sighted in the central and northern North Sea, while other species including northern bottlenose, Sowerby's beaked, fin and humpback whales are encountered infrequently/ rarely (Hammond *et al*., 2001, 2002, 2004; Northridge *et al*., 1995; Reid *et al*., 2003; Stone, 1997, 1998, 2000, 2001, 2003a, b; Weir and Stockin, 2001; Weir *et al*., 2007; Wilson *et al*., 2000).

There abundance of marine mammal species that are known to occur, or have been previously recorded, in Aberdeen Bay area is shown in Table 8.

Table 8 Summary of abundance of marine mammals within Aberdeen Bay

Common name	Latin name	Abundance
Bottlenose dolphins	*Tursiops truncatus*	common/regular
Harbour porpoises	*Phocoena phocoena*	common/regular
White-beaked dolphins	*Lagenorhynchus albirostris*	common/seasonal
Minke whales	*Balaenoptera acutorostrata*	common/seasonal
White-sided dolphins	*Lagenorhynchus acutus*	occasional
Killer whales	*Orcinus orca*	rare
Common dolphins	*Delphinus delphis*	infrequent/rare
Risso's dolphins	*Grampus griseus*	occasional
Striped dolphins	*Stenella coeruleoalba*	rare
Long-finned pilot whales	*Globicephala melas*	infrequent/rare
Sperm whales	*Physeter macrocephalus*	infrequent/rare
Humpback whales	*Megaptera novaeangliae*	rare
Fin whales	Balaenoptera physalus	rare
Sowerby's beaked whales	*Mesoplodon bidens*	rare
Northern bottlenose whales	*Hyperoodon ampullatus*	rare
Harbour seals	*Phoca vitulina*	common/regular
Grey seals	*Halchoerus grypus*	common/regular

Between 1999 and 2001, a total of 9 different cetacean species were reported between Peterhead and Arbroath (Weir and Stockin, 2001). The most frequently sighted cetaceans were the bottlenose dolphin and harbour porpoise. Both species were reported from all along the coastline, although the majority of bottlenose dolphin sightings were in the vicinity of Aberdeen harbour. Other species recorded include the white-beaked dolphin, minke whale, killer whale and long-finned pilot whale (Weir and Stockin, 2001). Since 2001 a further three cetacean species have been recorded for the first time in the area; these were humpback whale, northern bottlenose whale and Risso's dolphins (SGSW unpublished data).

Marine mammal surveys have been conducted along the Aberdeenshire coast from 2001 to 2005 (prior to the EOWDC marine mammal surveys), during these surveys a total of seven different species of cetacean were recorded: bottlenose dolphins, harbour porpoises, white-beaked dolphins, minke whales, long-finned pilot whales, Risso's dolphins and humpback whales (Canning, 2007). Bottlenose dolphins, harbour porpoises, minke whales, white-beaked dolphins, harbour seals and grey seals are known to occur regularly in the Aberdeen Bay area.

For cetacean species such as common dolphins, fin whales, humpback whales, northern bottlenose whales, long-finned pilot whales, sperm whales and striped dolphins the area off north-east Scotland is only a marginal part of their habitat, and is likely to be inhabited only during a restricted part of the year (Hammond *et al*., 2004).

Table 9 Summary of the presence, seasonal occurrence and seasonal sensitivities of marine mammals in the Aberdeen Bay area

Species	Presence	Seasonal Occurrence											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bottlenose dolphin	regular				*	*	*	*	*	*			
Harbour porpoise	regular				*	*	*	*	*	*			
White-beaked dolphin	regular/seasonal						*	*	*				
Minke whale	regular												
White-sided dolphin	occasional												
Killer whale	rare												
Common dolphin	occasional												
Risso's dolphin	occasional/regular												
Striped dolphin	rare												
Long-finned pilot whale	occasional												
Sperm whale	rare												
Humpback whale	rare												
Fin whale	rare												
Northern bottlenose whale	rare												
Sowerby's beaked whale	rare												
Harbour seal	regular						*	*	*	*			
Grey seal	regular		*	*	*						*	*	
Hooded seal	rare												

Key
- Present in area (sighting and/or stranding)
- Peak abundance
- Potential to be present in area
- * Seasonal sensitivities (e.g. calving period, moulting period)

5. CETACEANS

5.1 BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*)

5.1.1 Distribution

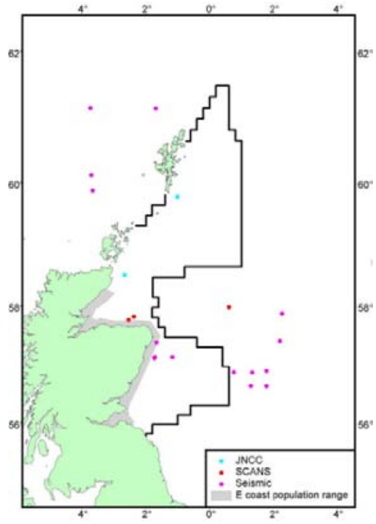
Bottlenose dolphins occur world-wide; they are found in virtually all tropical and temperate seas and occupy most marine habitats from the open ocean to coastal lagoon. Bottlenose dolphins occur in European waters along the Atlantic shores from Portugal to the Faroe Islands. Their distribution appears to be linked to sea temperature; in the north-east Atlantic resident coastal populations extend only as far north as Scotland. However, the species is caught in the Faroes drive fishery, suggesting that it may be more abundant and widespread than is generally thought (Hammond *et al*., 2001). Bottlenose dolphins are not particularly common in the north-eastern area of the North Atlantic but there are a number of well-documented and, in some cases, well-studied coastal populations along the Atlantic margin of Europe (Hammond *et al*., 2004).

There are two main areas of UK territorial waters where there are semi-resident groups of bottlenose dolphins: Cardigan Bay in Wales and the Moray Firth on the north-east coast of Scotland. Both of these areas have been designated Special Areas of Conservation (SAC) for bottlenose dolphins. There are also smaller populations of bottlenose dolphins off south Dorset, around Cornwall and in the Sound of Barra in the Outer Hebrides. Other bottlenose dolphin groups, presumed to be of transients, have been recorded further offshore in deeper water to the west of Scotland.

Figure 9 shows the locations of bottlenose dolphin sightings made during systematic surveys and some platforms of opportunity off north-east Scotland (Hammond *et al*., 2004). The few observations offshore in the North Sea may indicate that animals from the Moray Firth population could be distributed offshore at least for part of the year (Hammond *et al*., 2004).

During the SCANS II surveys in July 2005, bottlenose dolphins were encountered around the coasts of Britain, Ireland, France, Spain and Portugal. They were also sighted in outer shelf waters off Scotland and Ireland and in the Celtic Sea. The total abundance of bottlenose dolphins for the entire SCANS II survey area is estimated to be 12,645 (CV=0.27) (SCANS II, 2008).

Figure 7 Scottish east coast range and sightings of bottlenose dolphins from various sources (Hammond *et al*., 2004)



5.1.2 Occurrence in Aberdeen Bay and surrounding area

Bottlenose dolphins are known to occur regularly in the Aberdeen Bay area. Observations indicate they are present in the area throughout the year, with a peak occurrence during the winter and spring months (November-May), when they can be observed almost daily feeding at Aberdeen Harbour (Canning, 2007; Stockin *et al*., 2006).

The habitation of Aberdeenshire's coastal waters by bottlenose dolphins appears to have increased since the early 1990s and they are now the most frequently reported cetacean species in the area (Stockin *et al*., 2006; Weir and Stockin, 2001). There has been a recent increase in sightings along the east coast of Scotland as far south as St Andrews (Wilson *et al*., 2004).

Analysis of cetacean distribution and habitat use along the Aberdeenshire coast, indicate that the entrance to the River Dee (Aberdeen harbour) is an important feeding area for bottlenose dolphins, especially during the winter and spring when dolphins are most abundant (Canning, 2007). The majority of sightings away from Aberdeen were of groups travelling while those sighted at Aberdeen generally exhibited foraging behaviours (Canning, 2007).

Bottlenose dolphin presence at Aberdeen harbour showed a strong correlation with tidal height and river flow. These factors are also known to influence salmon migration up river, suggesting that salmon presence is the factor attracting these dolphins to this site. The seasonal pattern in the age of salmon that move upstream (with the older, multi-winter fish coming inshore during the winter and spring), matches the seasonal pattern in the bottlenose dolphin sightings suggesting they could be targeting these older fish (Canning, 2007).

The importance of the Aberdeen harbour area during the winter is the opposite of what has been observed within the Moray Firth, where the majority of sightings are during the summer (Wilson *et al.*, 1997a). Bottlenose dolphins are now also regularly recorded off St Andrews (70 miles south of Aberdeen) and again the sightings here are mainly during the summer, with peak sightings occurring between June and August (N. Quick, Pers. Comm.; Hammond *et al*., 2004).

Bottlenose dolphin sightings recorded during targeted project Vantage Point surveys (August 2005 – March 2008) are summarised in Table 10 .

Table 10 Bottlenose dolphin sightings recorded during Vantage Point surveys (August 2005 – March 2008)

VP site	Observations
Donmouth	April 2006, May 2006, March 2007, April 2007, July 2007, August 2007, September 2007 and March 2008
Blackdog	April 2006, May 2006, July 2006, August 2006, January 2007, and July 2007
Balmedie	December 2005, August 2007 and April 2007
Drums	August 2005, November 2005, August 2006, December 2006, February 2007 and July 2007.

During the JNCC aerial survey of Aberdeen Bay, bottlenose dolphins were recorded in December 2004, February 2005, December 2005 and April 2007 (Table 2).

A number of unidentified dolphin species were detected during the four months of SMRU Ltd acoustic surveys carried out for the EOWDC, these results are presented in Appendix 8.2

5.1.2.1 Boat based survey results 2007-2008: Bottlenose dolphins

There were 200 bottlenose dolphins that were recorded during 62 observations both on and off effort during the boat based surveys carried out 2007-2008 (Figure 8). There were 10 observations of 58 bottlenose dolphins collected on effort that would have been available for distance analysis (if statistically feasible). The mean group size of all sightings both on and off effort was 5.2 individuals. The majority of sightings occurred during the spring months with sightings occurring throughout the year. A higher number of individuals were observed in the wind farm survey area in comparison to the control site (Table 11).

Figure 8 Bottlenose dolphins observed on and off effort during the 2007-2008 EOWDC boat surveys

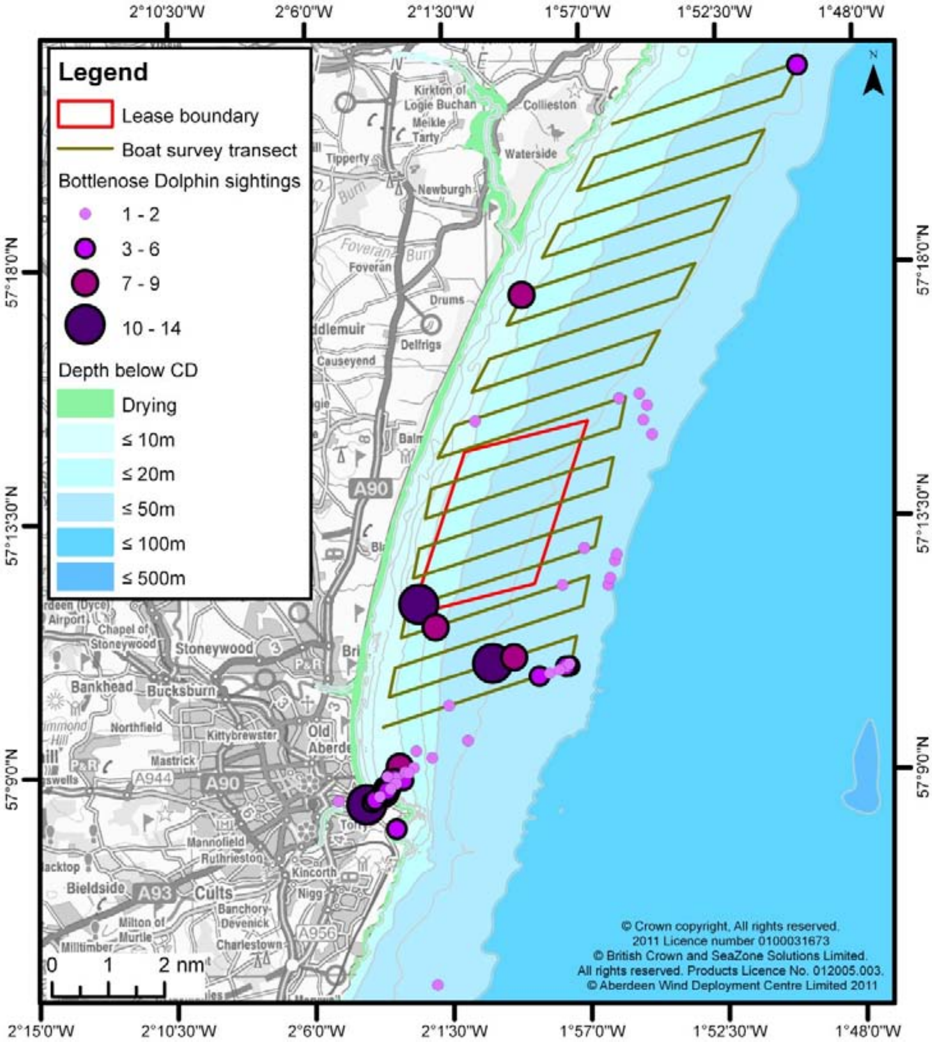


Table 11 Sightings information for bottlenose dolphins recorded during the boat based surveys 2007-2008

Common name	Winter	Spring	Summer	Autumn	Total On effort	Total Off effort	Total On /Off effort	Windfarm	Control
Bottlenose dolphin	0 (9)	20 (76)	34 (45)	3 (13)	58	142	200	46 (69)	13 (71)

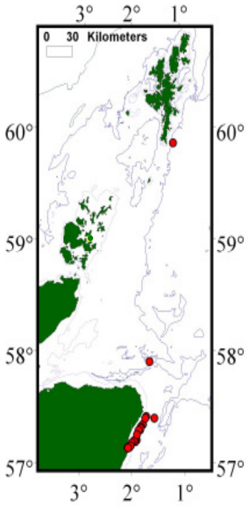
During the boat based surveys in August, September and November 2010 and January 2011 no bottlenose dolphins were recorded, although a total of 13 unidentified dolphins and dolphin vocalisations were detected during these surveys.

5.1.3 Observations from ferry surveys

Cetacean surveys were conducted from the bridge of the *MV Hascosay* ferry between Aberdeen, Orkney and Shetland during summer months (April to September) from 2002 to 2006. During these surveys, bottlenose dolphins were not sighted evenly throughout the study area, and the sightings were concentrated in the region along the coast of mainland Scotland, and particularly in the waters around Aberdeen Harbour (Figure 9). Thirty-nine sightings of bottlenose dolphins were recorded during more than 100 survey days, making it the fourth most commonly sighted species in the region. Bottlenose dolphins were recorded in all months surveyed. The average group size was five individuals, but groups ranged from one to 25 individuals (MacLeod *et al.*, 2007).

Observations during the ferry surveys are consistent with studies conducted in the outer Moray Firth and along the Aberdeenshire coast, which indicate that bottlenose dolphins primarily use coastal waters in this region, and suggest that this population of bottlenose dolphins rarely use the deeper, more open waters of the outer-most Moray Firth and the northern North Sea. In addition, observations during the ferry surveys suggest that bottlenose dolphins rarely, if ever, occur in the coastal waters around Orkney and Shetland (MacLeod *et al.*, 2007).

Figure 9 Distribution of bottlenose dolphin sightings during ferry surveys (April to September, 2002-2006)



5.1.4 Moray Firth population Bottlenose dolphin

5.1.4.1 Distribution and occurrence

In March 2005, an area of the inner Moray Firth (with an outer boundary from Helmsdale on the north coast to Lossiemouth on the south coast) was designated as a marine SAC for the conservation of the bottlenose dolphin population. In the 1980s, the core of this population's range was in the inner Moray Firth. Dolphins are distributed throughout the inner Moray Firth and there are three areas 'hotspots' where sightings are concentrated: the Kessock Channel, Channory narrows, and around the mouth of the Cromarty Firth, all of which are narrow, deep channels associated with strong tidal currents (Wilson *et al.*, 1997a; Hastie *et al.*, 2003b).

Spatial patterns of cetacean distribution within the Moray Firth have been investigated using a combination of visual and passive acoustic boat-based line-transect surveys in the inner and outer Moray Firth during the summers of 2004 and 2005. Bottlenose dolphins had a predominately near-shore distribution with a confirmed preference for hotspots within the inner Moray Firth. However, some regular, but sporadic, dolphin activity was present at the Beatrice wind farm site (offshore) during the late summer/autumn of the sampling period (Lusseau *et al.*, 2005; Talisman, 2005).

Bottlenose dolphins are observed all year round within the Moray Firth SAC, although there is a seasonal pattern to their sightings with peak sightings occurring during the summer months between May and September and lower number in winter and spring (Wilson *et al.,* 1997a).

Systematic boat surveys conducted along the southern outer Moray Firth coastline between the ports of Lossiemouth and Fraserburgh from May to October 2001 to 2005 inclusive by the Cetacean Research and Rescue Unit, found that bottlenose dolphins were only recorded in shallow waters rarely exceeding 25m depth and encounters were highly variable across all months (Robinson *et al*., 2008).

From the analysis of the acoustic data collected as part of the Moray Firth study on the potential impacts oil that and gas exploration has upon cetacean, dolphins tended to be detected most often in the inner Moray Firth and along the southern Moray Firth and less frequently in the central Moray Firth, but with detections increasing again at more offshore locations (Figure 10). Aerial survey data collected during August to November 2010 confirmed that cetacean sightings in the central and offshore waters of the Moray Firth were either the Risso's dolphin, white beaked dolphin or common dolphin and therefore indicated that most if not all of the dolphins detected in the Cpods in more offshore water represent detections of these other species (Figure 10). The 2010 results were compared with acoustic detections in 2009 and the data indicate that the spatial variation in dolphins was consistent between years (Thompsen *et al*., 2011).

Figure 10 Proportion of days that dolphin detections were recorded at the C-pod location sites (reproduced from Thompsen *et al*. 2011)

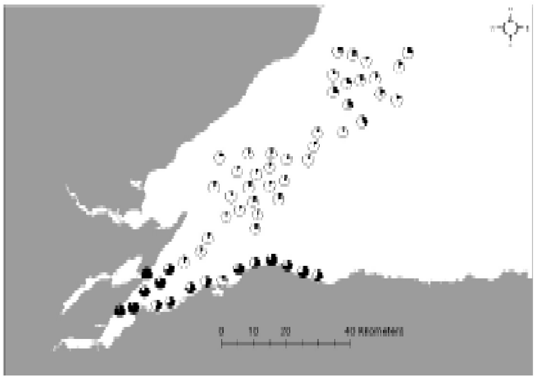
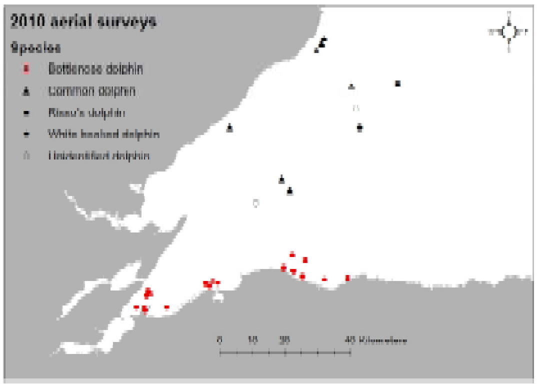


Figure 11 Dolphin observations during the aerial surveys carried out August-November 2010 (reproduced from Thompsen *et al*. 2011)



5.1.4.2 Abundance

Data collected during 1990 and 1993 estimated that 129 individuals (95% Confidence Interval (CI): 110-174) used the Moray Firth area at this time (Wilson *et al*., 1999a). Analysis of survey data between 1990 and 2002 indicated considerable variability among years, with estimates ranging between 75-200 (Thompson *et al*., 2004a) and similarly, analysis of data collected in 2001 estimated an average population size of around 85 (95% probability interval = 76-263) (Durban *et al*., 2005), although there is uncertainty about current trends in abundance (Thompson *et al*., 2004a).

Data collected up to 1997 were analysed to estimate rates of survival and reproduction, which were incorporated in a Population Viability Analysis (PVA) to predict likely future population trends (Sanders-Reed *et al*. 1999). These models predicted that, if conditions remained the same, the Scottish east coast population was likely to decline at a rate of around 5% per annum. The results of the modelling study were used to assign the bottlenose dolphin population to 'unfavourable – declining' (according to the framework categories within the Common Standards Monitoring). However, the calculated annual estimates of abundance from 1990 to 2002 showed no clear trend

(Hammond *et al*., 2004). Subsequent results from the monitoring programme that Scottish Natural Heritage established to follow changes in the number of dolphins using the SAC indicated that, whilst the numbers had declined during the 1990's, these appeared to be stabilising by 2004. As a result, the condition was assessed as "unfavourable recovering" in 2005 (Thompsen, *et al*., 2009).

5.1.4.3 Genetic and social structure

The Moray Firth bottlenose dolphin population is thought to be genetically isolated, with studies indicating a low mitochondrial genetic diversity (Parsons *et al*., 2002). From genetic studies it appears that Scottish east coast bottlenose dolphins are more closely related to the Welsh population in Cardigan Bay and to individuals stranded around the southern coast of England than to individuals encountered in the Scottish Western Isles (Parsons *et al*., 2002).

Analysis of the social structure of bottlenose dolphins along the Scottish east coast suggest that the population is composed of two social units with restricted interactions via a few common individuals (Lusseau *et al*., 2005). These two units appear to be related to known differences in the ranging pattern of individuals (Wilson *et al*., 2004). Individuals commonly seen in the inner Moray Firth were not observed in other locations and these individuals tend not to interact with individuals coming into the inner Moray Firth area during summer and mostly remained within their communities. The home ranges of the two social units largely overlap and this may be related to the presence of abundant prey in the area that allows the two communities to co-inhabit in the same area at this time (Lusseau *et al*., 2005).

5.1.4.4 Range expansion

Recent evidence suggests that the Moray Firth bottlenose dolphin population has been extending its range beyond the boundaries of the Moray Firth and associated SAC, with an increase in sightings along the east coast of Scotland as far south as St Andrews and the Firth of Forth (Wilson *et al*., 2004).

Between 1990 and 2000, photo-identification surveys were conducted within the inner Moray Firth, along the coastal waters of the outer Moray Firth and along the coasts south of Fraserburgh (Wilson *et al*., 2004). Examination of the data for 54 distinctly marked individuals (approximately 42% of the estimated population, which were identified in the inner Moray Firth between 1990 and 1992 and were known to have survived through the 1990s), found that the majority (74%) had subsequently been identified in the outer Moray Firth and 61% had been seen along the coasts south of Fraserburgh, confirming that they had come from the 'Moray Firth population' (Wilson *et al*., 2004). The animals seen in other areas continued to be seen within the inner Moray Firth, indicating an expansion, rather than shifting of their range (Wilson *et al*., 2004).

There appears to be a spatio-temporal stratification pattern within the population, with animals using areas outside the inner Moray Firth also spending less time within the inner Moray Firth. Animals that were identified in areas outside the Moray Firth also occupied the areas furthest from the head of the inner Moray Firth when identified within the inner Moray Firth, compared to animals that were predominantly sighted within the inner Moray which tended to be found most often closest to the headwaters (Wilson *et al*., 2004).

In addition, animals that used areas outside the inner Moray Firth appeared to move greater distances between sightings and moved faster during sightings. For example, one individual was identified south of Aberdeen in June 1996 and was re-identified off Burghead 52 hours later, representing a distance of 218 km and a minimum swimming speed of 4.2 km/h (Wilson *et al*., 2004). For consecutive sightings 5 or less days apart, the median rate of travel for dolphins identified primarily within the inner Moray was 0.071 km/h, whereas for dolphins observed using areas outwith the inner Moray Firth it was significantly grater at 0.22 km/h. Similarly, during sightings in the outer Moray Firth and along the coasts south of Fraserburgh the median rate of progress was 7.6 km/h, which was twice as fast as in the inner Moray Firth (3.9 km/h) (Wilson *et al*., 2004).

The reasons for the apparent range expansion appear to be related to changes in prey resources (Wilson *et al*., 2004). For example, the rapid and long-range movements observed outside the inner Moray Firth suggests that prey resources may be more widely dispersed and/or different in these areas. The stratification among individuals may indicate competition for resources (Wilson *et al*., 2004).

5.1.4.5 Diet

Bottlenose dolphins are opportunistic feeders and take a wide variety of fish and invertebrate species. Despite the large amount of information on bottlenose dolphins in the area, relatively little is known about their diet. Stomach content analysis of bottlenose dolphins (n= 10) from Scottish waters indicate that the main prey eaten were cod (*Gadus morhua*), saithe (*Pollachius virens*) and whiting (*Merlangius merlangus*) although several other fish species were also eaten, including salmon (*Salmo salar*) and haddock (*Melanogrammus aeglefinus*) and cephalopods (Santos *et al*., 2001a).

5.1.4.6 Habitat use and foraging

Bottlenose dolphin presence at the mouth of the River Dee (Aberdeen harbour) has been associated with salmon migration, suggesting that salmon presence is a factor in attracting these dolphins to this site (Canning, 2007). Although the River Dee is situated in a large bay, it flows out through a man-made harbour, the entrance to which is narrow and deeper than the surrounding waters, therefore creating a potential "bottleneck" for migrating fish (Canning, 2007).

Within the inner Moray Firth, feeding behaviour by bottlenose dolphins was significantly higher in areas used intensively by dolphins, these discrete areas occur in deep narrow entrances to coastal inlets that have steep seabed gradients and strong tidal currents (Hastie *et al*., 2004; Wilson *et al*., 1997a). Behaviours that were associated with feeding on large prey peaked in deep waters over steep seabed gradients, particularly during June and July (Hastie *et al*., 2004). It has been suggested that these areas create bottlenecks for migratory fish, most likely migrating salmonids (*Salmo salar* and *Salmo trutta*) potentially increasing foraging opportunities (Wilson *et al*., 1997a).

Passive acoustic monitoring within the deep (55m), narrow channel at the entrance to the Cromarty Firth, indicated that bottlenose dolphins used the full water column and consistently dived to depths of around 50 m, close to the seabed. However, the majority of their time appeared to be spent within the surface layers and feeding behaviour occurred primarily at depths between 20 m and 30 m (Hastie *et al*., 2006).

At the Kessock channel within the inner Moray Firth, bottlenose dolphins were most abundant during the flood tide, particularly during the stationary stage of the tidal front. They showed a spatial association with the area near the surface features of the front, which could be related to increasing foraging efficiency resulting from the accumulation of prey in the frontal region (Mendes *et al*., 2002).

During land-based observations at Aberdeen harbour between early May and late July 2002, bottlenose dolphins were found to present during all times of the day and tide, although occurred more frequently around midday and early afternoon, while their abundance was greater around high tide and late afternoon. Foraging was the most commonly observed activity (Sini *et al*., 2005).

5.1.4.7 Life history

Bottlenose dolphins are long-lived animals with life spans of up to 40-50 years. Females are sexually mature at between 5-12 years of age and can produce a calf every 2-3 years, although 3 to 6 year intervals are more common (Connor and Smolker, 1990; Scott *et al*., 1996; Connor *et al*., 2000). Calves stay with their mothers for at least 4 years (Smolker *et al*., 1992). However, studies in the Moray Firth indicate that the association between calves and mothers remains high until the calf is 8 years old (Grellier *et al*., 2003).

Immature bottlenose dolphins (juveniles/calves) have been observed off Aberdeenshire throughout the year, with an increase in the proportion of calves during the spring, between April and June (Canning, 2007; Stockin *et al*., 2006; Weir and Stockin, 2001). Very young calves have been recorded during spring and early summer (Weir and Stockin, 2001).

In surveys along the outer Moray Firth (May to October, 2001-2005), calves were recorded in 84% of all bottlenose dolphin encounters, with newborn animals being observed from July to October inclusive (Robinson *et al*., 2008).

5.1.4.8 Strandings

Two bottlenose dolphins have been recorded stranded by the Scottish Agricultural College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and March 2010 (CSIP 2010). One was a male with a body length of 267 cm recovered in December 1999 near Balmedie, the other had a body length of approximately 200 cm, the sex was not determined and it was recovered from Peterhead in December 2005 (SAC, 2006). Although there are only two stranding records of bottlenose dolphins along the north-east coast (1992-2010), this reflects the small population size in the area, rather than their low occurrence in the area.

5.1.4.9 Threats

Post-mortem analyses of stranded animals have identified that some fishery by-catch occurs and that at least some calf mortality results from infanticide (Patterson *et al*., 1998).

Bottlenose dolphins from eastern Scotland have a high prevalence of several different types of skin lesion (Thompson and Hammond, 1992; Wilson *et al*., 1997b). In comparison with similar data from other parts of the world the prevalence and severity of lesions are high but mainly related to exposure to water of low salinity and/or temperature (Wilson *et al*., 1999b). The causal links underlying these patterns remain unknown, but it is possible that they are related to an increase in physiological stress, potentially making the animals more prone to other factors, including anthropogenic agents such as contaminants (McKenzie *et al*., 1997) or infections from viruses, bacteria or fungi. Subsequent studies have shown that severity and prevalence of lesions vary among individuals in the Moray Firth and that variation patterns can be related to the behaviour of infectious diseases (Wilson *et al*., 2000).

5.2 HARBOUR PORPOISE (*PHOCOENA PHOCOENA*)

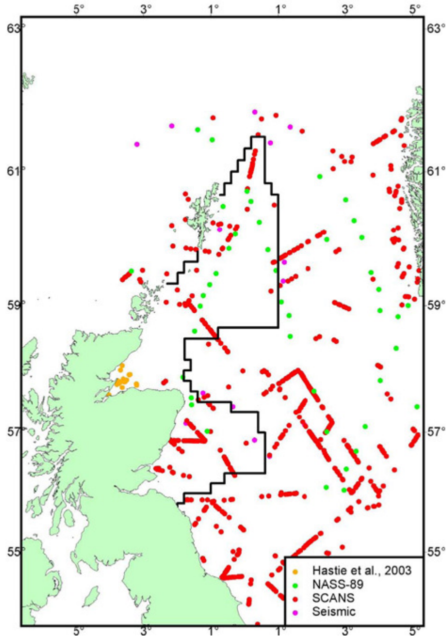
5.2.1 Distribution

Harbour porpoises are found in temperate and sub-arctic waters of the Northern Hemisphere, mainly on the continental shelves. They are distributed around the fringes of the North Atlantic Ocean basin, extending from North Carolina, off the United States, to Greenland and northern Norway and south through European waters as far as North Africa (Hammond *et al*., 2004).

The harbour porpoise is widespread throughout the cold and temperate seas of north-west Europe, including the North Sea, the Skagerrak, Kattegat, Irish Sea, west of Ireland and Scotland, northwards to Orkney and Shetland and off the coast of Norway (Jackson and McLeod, 2002). In the North Sea, sightings from shipboard and aerial surveys indicate that harbour porpoises are widely and almost continuously distributed, with important concentrations in the central North Sea, along the Danish and northern German coasts (Donovan and Bjørge, 1995; Hammond *et al.*, 2002; IWC, 1996). Harbour porpoises are highly mobile and distributed around the UK coast (Reid *et al*., 2003).

Figure 12 (taken from Hammond *et al*., 2004) shows the numerous locations of harbour porpoise sightings made during systematic surveys and some platforms of opportunity in the north and east of Scotland.

Figure 12 Harbour porpoise sightings made during various surveys. Sightings are represented by a coloured circle (Hammond *et al*., 2004).



Harbour porpoises are generally described as a shelf species that frequents relatively shallow bays, estuaries and tidal channels, generally in depths less than 200 m in continental shelf waters (Klinowska, 1991). However, they have been observed in the deep waters of the Norwegian Rinne, in deep water areas between Iceland and the Faroe Islands, and on the Rockall and Faroe Banks (Northridge *et al.*, 1995). Summer surveys in the North Sea and adjacent waters found porpoises in large numbers offshore as well as in coastal waters (Hammond *et al.*, 2002). Porpoises have also been sighted in offshore waters with depths between 953 and 1502 m off north-west Scotland (Atlantic Frontier) (MacLeod *et al.*, 2003). By-catch data from Ireland also suggest that porpoises occur regularly offshore, with records from up to 220 km from land (Rogan and Berrow, 1996). Aggregations of harbour porpoises are often associated at local sites with strong tidal features, such as headlands, and areas with upwellings, tidal races and rips, often close to reefs and small islands, where prey are probably concentrated into patches (Gaskin, 1992; Pierpoint, 2001; Read and Westgate, 1997).

Spatial patterns of cetacean distribution within the Moray Firth were investigated using a combination of visual and passive acoustic boat-based line-transect surveys in the inner and outer Moray Firth during summers 2004 and 2005. These surveys indicate that harbour porpoises tended to have a diffuse and offshore distribution (Hastie *et al.*, 2003a; Lusseau *et al.*, 2005)

During systematic boat surveys conducted along the southern outer Moray Firth coastline between the ports of Lossiemouth and Fraserburgh from May to October 2001 to 2005, harbour porpoises were encountered throughout the study area, although they were usually more abundant in deeper waters, further from shore, with sightings typically occurring along the 20-50 m isobaths. Porpoises were observed throughout the study period, with an increase in encounters from May through to October (Robinson *et al*., 2008).

During the Moray Firth surveys carried out during 2009 and 2010 as part of the research study to investigate potential impacts from oil and gas exploration on cetaceans the harbour porpoise was the most frequently observed cetacean. The results of the acoustic monitoring, using C-pods in 2009 and 2010, found that harbour porpoises were typically detected at each of the monitoring locations on most days, especially at the offshore sites (Figure 13) (Thompsen *et al*., 2011). The spatial occurrences of harbour porpoise during both 2009 and 2010 were consistent. The harbour porpoise was the most frequent cetacean detected during the aerial survey programme, a total of 230 encounters of harbour porpoise were encountered with the mean group size being 1.52 (Figure 14).

Figure 13 Proportion of days that harbour porpoise were detected by C-pods during 2010 (Thompsen *et al*., 2011)

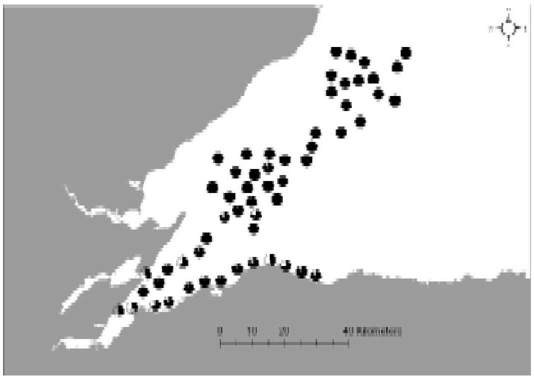
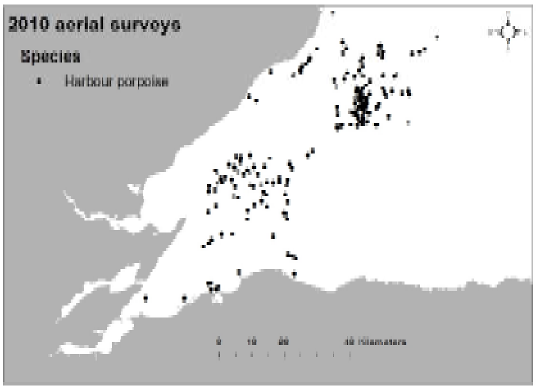


Figure 14 Observations of harbour porpoise during aerial surveys carried out in 2010 (Thompsen *et al*., 2011)



5.2.2 Seasonal movements

The seasonal movements and migratory patterns of harbour porpoises in the North East Atlantic and North Sea are not well understood. Porpoises may reside within an area for an extended period of time, however, onshore/offshore migrations and movements parallel to the shore are also thought to occur (Bjørge and Tolley, 2002). In the North Sea, there may be a general westward movement from the eastern North Sea and possibly from the very northern areas of the North Sea into the western edge of the northern North Sea (along the east coast of Scotland) during April to June and a further influx to the northern North Sea during July to September (Northridge *et al.*, 1995). These seasonal movements are thought to coincide with the calving and mating seasons, respectively.

Animals in the eastern North Atlantic are not known to perform long migrations, but satellite-tagged animals in Canada and Denmark have been shown to move some hundreds of kilometres within a year. Recent satellite-tracking data from Denmark have shown animals moving from northern Denmark to the northern North Sea and Shetland (Hammond *et al*., 2004). Satellite telemetry studies suggest that porpoises are highly mobile and capable of covering large distances in short time periods, with daily distances travelled in the Bay of Fundy varying from 14 to 58 km (Read and Westgate, 1997).

5.2.3 Abundance

The harbour porpoise is the most abundant cetacean recorded in the North Sea (Evans, 1992; Hammond *et al.*, 2002) and was the mostly commonly sighted cetacean during surveys along the southern outer Moray Firth coastline and the second most frequently sighted cetacean along the south Grampian coastline (Weir and Stockin, 2001).

The estimated summer abundance of harbour porpoises in North Sea areas during the first SCANS survey in July 1994 was 268,452 (approximate 95% confidence interval of 210,000 – 340,000). This estimate includes shelf waters to the west of Shetland and Orkney (Hammond *et al.,* 2002). Bjørge and Øien (1995) estimated that there were 82,600 porpoises in the North Sea north of 56^{o}N. This estimate is known to be biased downwards because the probability of detection on the transect line was assumed to be one (certain detection). Seabirds At Sea data from 1979 to 1991 show the highest rate of porpoise sightings in the northern North Sea is in April to June (the calving season), and July to September (Hammond *et al*., 2004).

Initial harbour porpoise abundance estimates in the entire North Sea are 231,000 from the SCANS II surveys conducted July 2005. The total abundance of harbour porpoises for the entire SCANS II survey area is estimated to be 385,616 (CV=0.20) (SCANS II, 2008). During the SCANS II surveys harbour porpoise density was highest in the south central North Sea and coastal waters of northwest Denmark (~0.6 animals/km^2), elsewhere there was relatively little variation in porpoise density (0.3-0.4 animals/km^2) (SCANS II, 2008).

Numbers of porpoises present in UK waters vary seasonally and more animals are likely to pass through UK waters than are present at any one time (Jackson and McLeod, 2002).

5.2.4 Occurrence in Aberdeen Bay and surrounding area

Harbour porpoises are known to occur regular in the Aberdeen Bay area throughout the year. Land- and vessel based sightings between March 1999 and October 2001, along the Aberdeenshire coast (between St Cyrus and Collieston, primarily between Stonehaven and Aberdeen) indicated that harbour porpoises were present throughout the year with peak occurrence during August and September (Weir *et al*., 2007).

Land based surveys carried out by the Seawatch Foundation indicated that porpoises were sighted more frequently between Stonehaven and Aberdeen, than between Aberdeen and Collieston, with the majority of sightings occurring off Cove and Girdleness to the south of Aberdeen (Weir *et al*., 2007). Tidal height and sea depth appears to have a strong influence on where and when porpoises are sighted and it is thought this is a reflection of prey behaviour (Canning, 2007).

Harbour porpoise sightings were frequently recorded during vantage point surveys of the wind farm area between August 2005 – March 2008 and the sightings are summarised in Table 12.

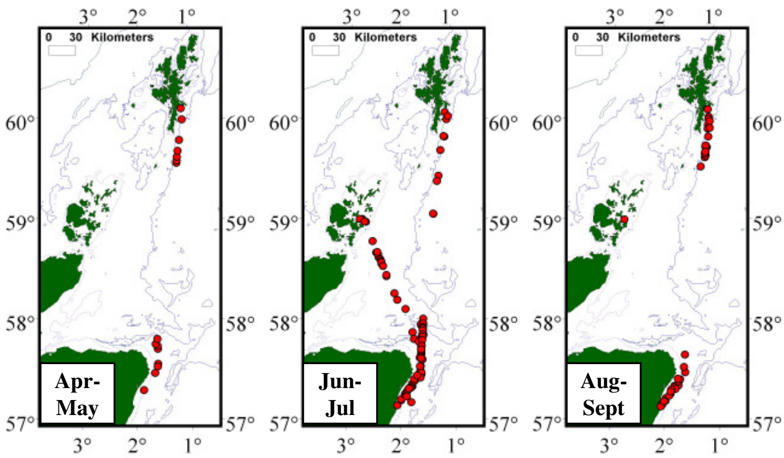
Table 12 Harbour porpoise sightings recorded during Vantage Point surveys (August 2005 – March 2008)

VP site	Observations
Donmouth	August 2006, September 2006, February 2007, September 2007, December 2007 and January 2008
Blackdog	May 2006, August 2006, September 2006, January 2007, February 2007, July 2007, August 2007 and September 2007,
Balmedie	September 2006, December 2006, January 2007, August 2007 and March 2008
Drums	December 2006, January 2007, February 2007, June 2007, August 2007, December 2007 and February 2008

During the JNCC aerial survey of Aberdeen Bay, harbour porpoises were recorded in December 2005 and January 2006 (Söhle *et al*., 2006)

Harbour porpoises were the most recorded cetacean species during over 100 days of surveys conducted from the bridge of the *MV Hascosay* ferry as it travelled between Aberdeen, Orkney and Shetland in summer months between 2002 and 2006 (MacLeod *et al.*, 2007). Porpoises were recorded through out the region and in all months surveyed with no obvious changes in distribution over time (Figure 15). Recorded group sizes ranged from one to six, with an average of two. There was no variation in average group size across the summer months, but the maximum group size peaked in August and was lowest in April and September (MacLeod *et al*., 2007).

Figure 15 Distribution of harbour porpoise sightings during ferry surveys (April-September, 2002-2006)



5.2.4.1 Boat based survey results: Harbour porpoise

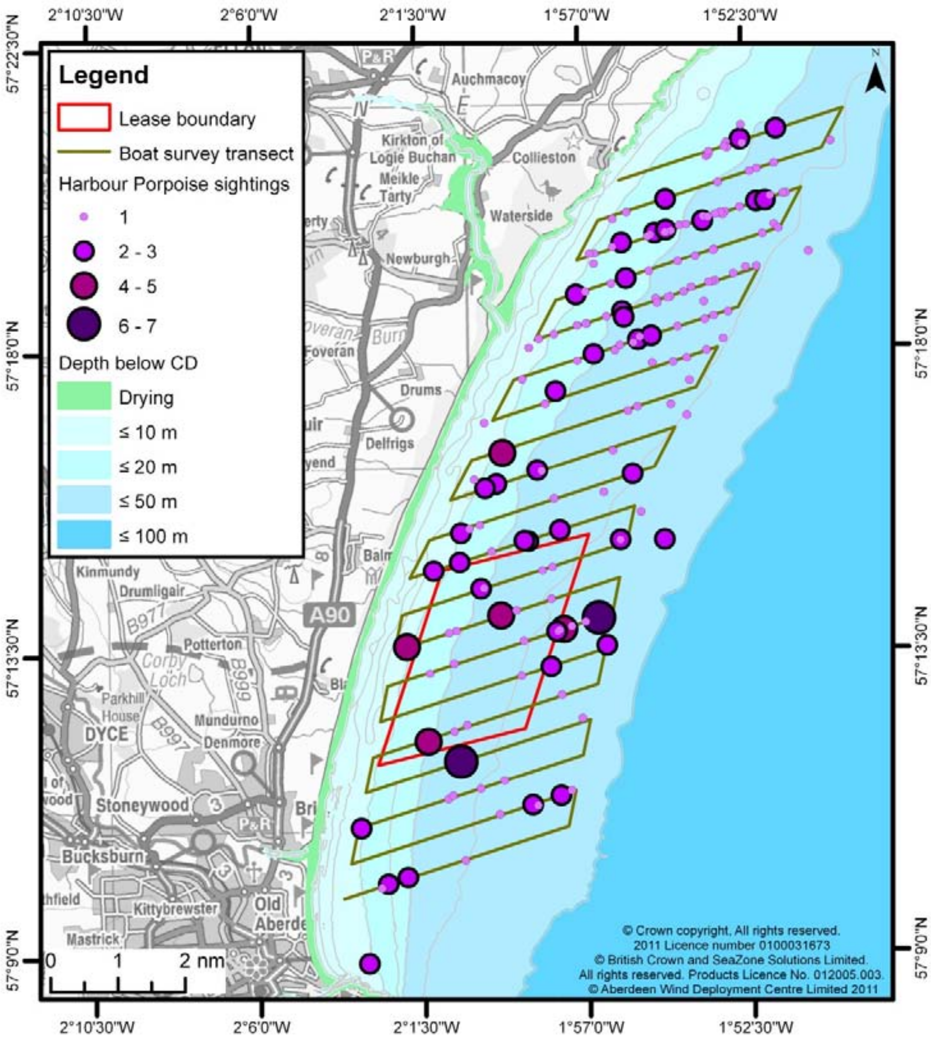
The harbour porpoise was the only species which was detected in sufficient numbers to allow a detection function to be applied. The detection function was applied to both phases of boat based surveying, the initial survey period

2007-2008 and the four months of survey carried out 2010-2011. The results of each phase of boat based surveys are discussed in the following sections.

5.2.4.2 Harbour porpoise survey results 2007-2008

There were 197 observations of 291 individuals observed during the boat based surveys carried out during 2007-2008. The distribution of all observations recorded, including those off effort are displayed in Figure 16.

Figure 16 Observations of harbour porpoise on and off effort during EOWDC boat surveys 2007-2008



5.2.4.2.1 Estimation of density using distance analysis 2007-2008

There were 175 observations of 251 individuals recorded on 1950 km of survey effort. Only on transect effort was used in the analysis (i.e. short transit legs between transects were discarded).

The radial distance and angles recorded to each sighting were converted to perpendicular distances and examined as a histogram (Figure 17). The histogram shows that there a peak in sightings within 100 m of the transect. The data are also spiked at the transect line which means that there are more sightings than would be expected on the transect line. To fit the detection function, the perpendicular distance were grouped with a wide first perpendicular distance bin, extending from the transect line to 200 m. This was done to 'force' Distance to fit a shoulder near the transect line distances rather than the reality, which is a spike. The data were also right truncated at 800 m (*n* = 167).

The best model of the detection function was a simple Hazard-rate without adjustment terms (p = 0.68) (Figure 18). The *esw* was 355m (%CV = 9.7).

Figure 17 Histogram of the perpendicular distances associated with the harbour porpoise sightings 2007-2008 data

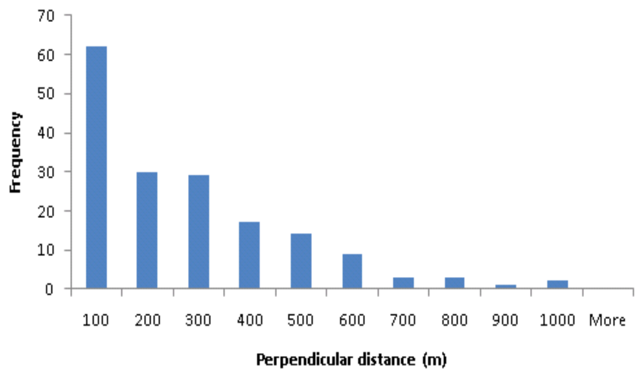
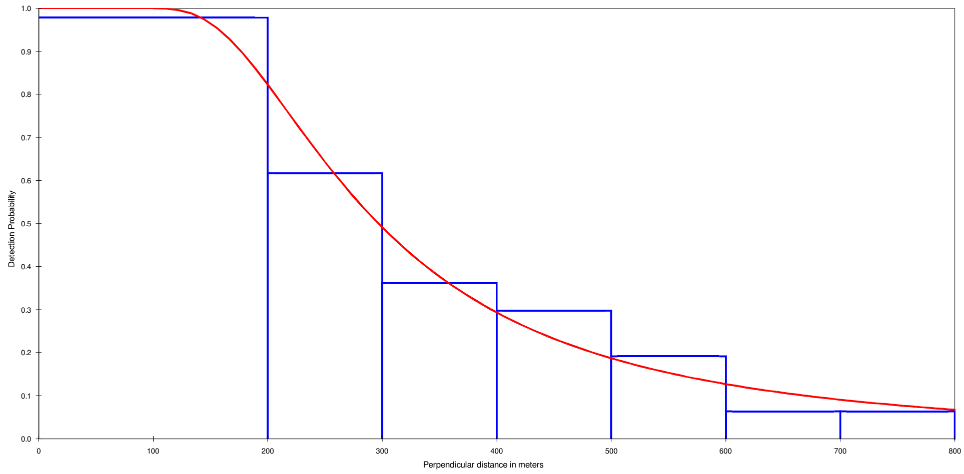


Figure 18 Detection probability fitted to perpendicular distances of harbour porpoise sightings February 2007-April 2008



The pooled detection function was then applied to the estimation of density and abundance by month and season. Multiple surveys within the same month were pooled to generate the density and abundance estimates. The mean group size was 1.42 (SE=0.07)). Density and abundance estimates by area/season and area/month are given in Table 13 and Table 14.

Density of harbour porpoise was higher in the control area in all seasons except summer (Table 14). The highest densities at both sites occurred during autumn (September-November). Lowest densities of harbour porpoises occurred during May and June at both the wind farm and control site. Peak densities were recorded during November at the wind farm site but during October and January at the control site (Figure 19).

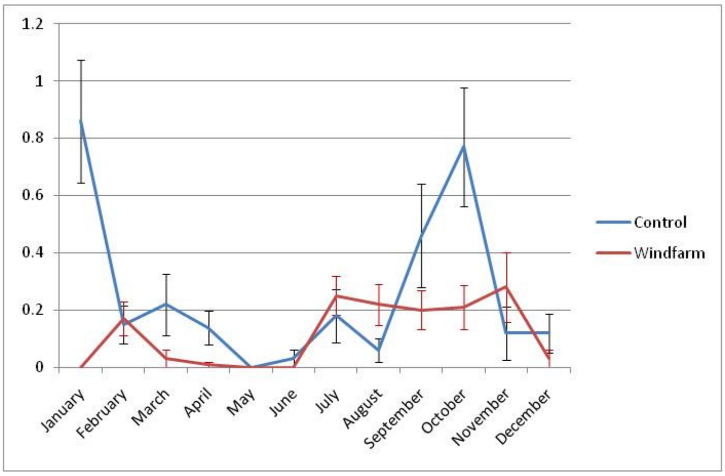
Table 13 Density and abundance of harbour porpoises by month and area estimated from year 1 survey data (February 2007 – April 2008, where n= number of sightings, DS = density of schools, D = density of animals and N = abundance. CV is the coefficient of variation and CI is the confidence interval

	CONTROL AREA				WIND FARM AREA				Area with highest animal density
Month	***n***	***DS (CV)***	***D (CV)***	***N (CV) [95% CI]***	***n***	***DS (CV)***	***D (CV)***	***N (CV) [95% CI]***	
January	29	0.6 (26.4)	0.92 (26.9)	47 (26.9) [27-83]	0	0	0	0	CONTROL
February	10	0.10 (39.1)	0.14 (39.4)	7 (39.4) [3-16]	11	0.12 (35.1)	0.18 (35.4)	9 (35.4) [4-18]	WIND FARM
March	7	0.16 (44.1)	0.22 (44.3)	11 (44.3) [4-29]	1	0.02 (100.5)	0.03 (100.6)	2 (100.6) [0-10]	CONTROL
April	14	0.10 (86.4)	0.14 (86.6)	7 (86.6) [2-33]	1	0.007 (100.5)	0.01 (100.6)	1 (100.6) [0-3]	CONTROL
May	0	0	0	0	0	0	0	0	-
June	1	0.02 (100.5)	0.03 (100.6)	2 (100.6) [0-11]	0	0	0	0	CONTROL
July	6	0.16 (57.5)	0.22 (57.7)	11 (57.7) [3-38]	8	0.18 (27.0)	0.26 (27.4)	13 (27.4) [7-23]	WIND FARM
August	5	0.10 (36.11)	0.15 (36.4)	7 (36.4) [3-16]	7	0.16 (32.1)	0.22 (32.5)	11 (32.5) [6-23]	WIND FARM
September	16	0.33 (38.9)	0.46 (39.1)	24 (39.1) [10-54]	7	0.14 (33.5)	0.20 (33.9)	10 (33.9) [5-21]	CONTROL
October	25	0.56 (26.8)	0.80 (27.2)	40 (27.2) [23-72]	6	0.12 (39.4)	0.17 (39.7)	9 (39.7) [4-20]	CONTROL
November	4	0.09 (77.1)	0.13 (77.2)	6 (77.2) [1-30]	9	0.20 (43.8)	0.29 (43.6)	15 (43.6) [6-37]	WIND FARM
December	4	0.09 (77.1)	0.13 (77.2)	6 (77.2) [1-30]	1	0.02 (100.5)	0.03 (100.6)	2 (100.6) [0-10]	CONTROL

Table 14 Density and abundance of harbour porpoises by season and area estimated from year 1 survey data (February 2007 – April 2008), where n= number of sightings, DS = density of schools, D = density of animals and N = abundance, CV is the coefficient of variation and CI is the confidence interval

	CONTROL AREA				WIND FARM AREA				Area with highest animal density
Season	***n***	***DS (%CV)***	***D (%CV)***	***N (%CV) [95% CI]***	***n***	***DS (%CV)***	***D (%CV)***	***N (%CV) [95% CI]***	
Winter	42	0.24 (27)	0.34(27.7)	17 (27.7) [10-29]	12	0.07 (35.7)	0.10 (36.0)	5 (36.0) [2-10]	CONTROL
Spring	21	0.09 (59.9)	0.13 (60.1)	6 (60.1) [2-20]	2	0.009 (70.7)	0.01 (70.9)	1 (70.9) [0-2]	CONTROL
Summer	13	0.09 (36.0)	0.13 (36.4)	7 (36.4) [3-14]	15	0.11 (25.36)	0.15 (25.8)	8 (25.8) [5-13]	WIND FARM
Autumn	45	0.35 (24.5)	0.46 (25.0)	24 (25.0) [14-39]	22	0.16 (24.1)	0.23 (24.6)	11 (24.6) [7-19]	CONTROL

Figure 19 Monthly patterns in harbour porpoise density at the wind farm and control site (vertical bars represent +- standard error)



5.2.4.3 Harbour porpoise boat based surveys results 2010-2011

A total of 134 observations of harbour porpoise were recorded, consisting of 296 individuals during the 4 months of SMRU Ltd surveys. The radial distance and angle from the transect line were converted to perpendicular distance within Distance, after truncation of sightings beyond 800 m there were a total of 132 observations of harbour porpoise available for analysis. The model chosen was a half normal key function with second order cosine adjustment terms (Figure 20). Cluster size was regressed against distance from transect and as this regression was non-significant at 0.15, mean cluster size was used throughout. The mean cluster size over all data was 2.13 (SE= 0.15) and the effective strip half width was 241.6 m (%CV=7.3). Density and abundance were estimated by month and assumed certain detection of animals on the transect line (g(0) = 1). The estimates have also been corrected using a g(0)=0.34 (which is the probability of detecting an animal on the transect line) (Hammond et al., 2002). The effects of varying g(0) and the influence that this has on the estimated abundance value is discussed in Appendix 8.1.

Figure 20 Detection probability curve for harbour porpoise observations, based on all data from the four months and three study areas, and using 100m data 'bins'

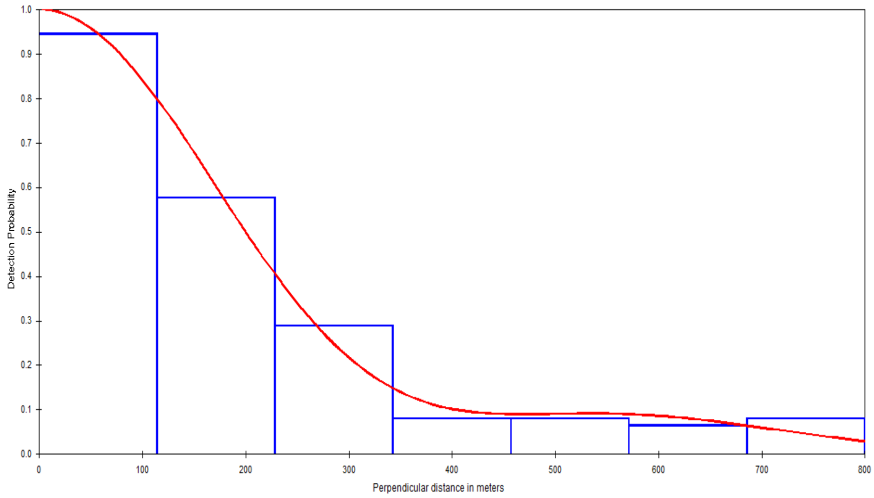


Figure 21 On-effort locations of harbour porpoise sightings during along transects during August, September and November 2010, and January 2011

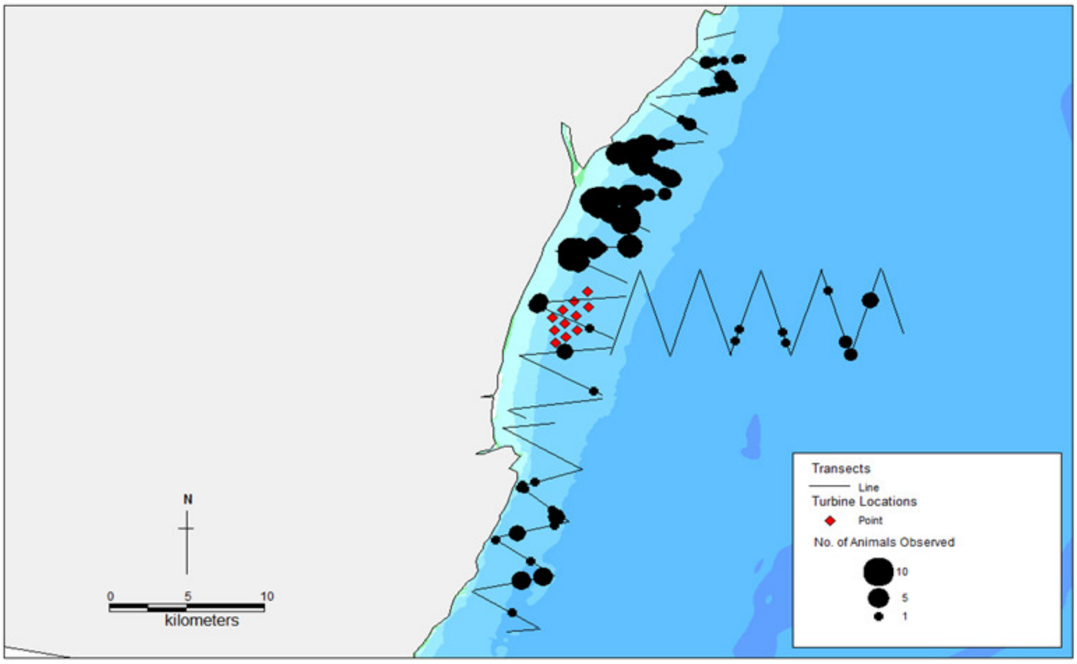
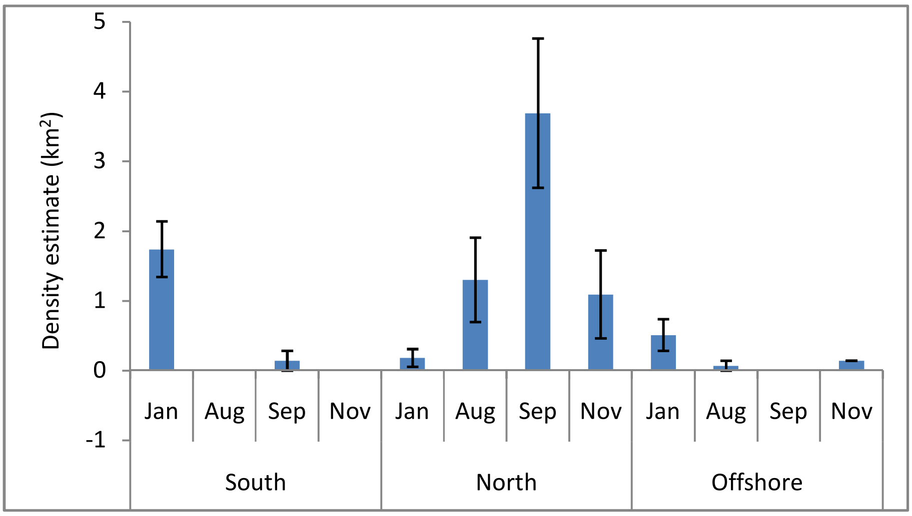


Table 15 Estimates of density (no. per km^2) and abundance (no. per survey stratum) of harbour porpoise in the South, North and Offshore Strata (corrected abundance estimates assuming g(0) = 0.34)

Site	Month	Animal Density (%CV)	Abundance (%CV)	95% Confidence intervals	Corrected abundance (%CV)
South	Aug	1.74 (23)	147 (23)	89-242	432 (22.9)
	Sept	0	0	0	0
	Nov	0.14 (100.5)	12 (100.5)	2-83	34 (100.4)
	Jan	0	0	0	0
North	Aug	0.18 (70.9)	28 (70.9)	7-109	83 (70.9)
	Sept	1.3 (46.6)	200 (46.6)	78-510	588 (46.5)
	Nov	3.69 (29)	568 (29)	314-1029	1671 (28.9)
	Jan	1.09 (57.8)	169 (57.8)	54-526	496 (57.7)
Offshore	Aug	0.51 (44.4)	55 (44.4)	21-141	161 (44.3)
	Sept	0.07 (100.5)	8 (100.5)	1-50	22 (100.5)
	Nov	0	0	0	0
	Jan	0.14 (0.67)	15 (0.67)	4-60	45 (67.4)

Figure 22 monthly estimates (+/- SE) of density of Harbour porpoise in the South, North and Offshore Strata (Assuming g(0)=1)

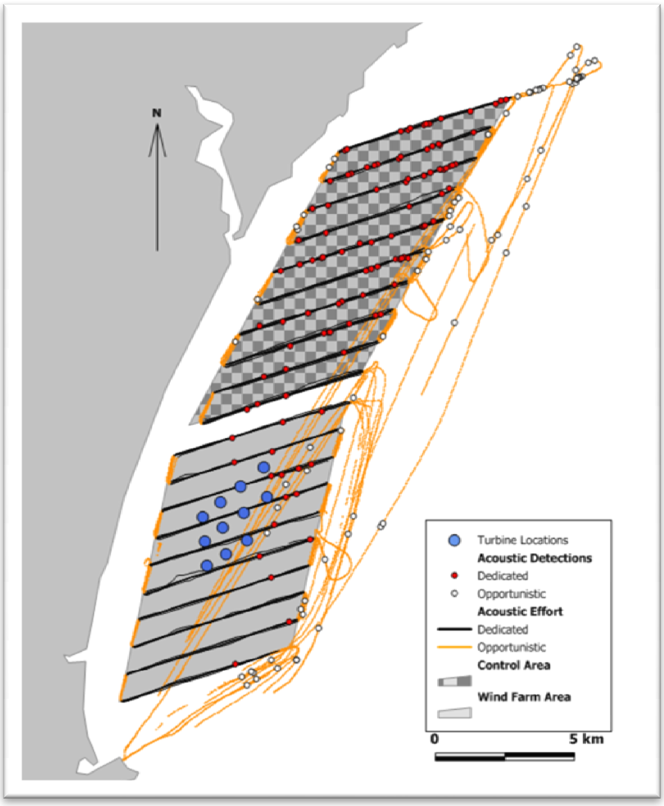


Most of the estimates produced show considerable error margins at present. These errors stem from the small number of surveys currently available for analyses, and are expected to reduce as more surveys are carried out.

5.2.4.4 Towed Passive Acoustic Monitoring (PAM) results for surveys 2007-2008

The harbour porpoise was the most frequently detected marine mammal species during the acoustic surveys. Only the dedicated acoustic effort was used to assess the acoustic detection rates of marine mammals across both the wind farm area and the control area. The harbour porpoise detections 'off effort' that were opportunistic detections are shown in Figure 23.

Figure 23 Combined acoustic effort from Oct-07 to April-08 across both the control and wind farm areas. Yellow lines show the opportunistic acoustic effort. Dedicated acoustic effort is shown by the black lines. Red circles show "on effort" acoustic detections, white circles show "opportunistic" acoustic detections (SMRU Ltd 2011b)



Harbour porpoises were detected on all seven surveys in which the hydrophone was deployed (Table 16). Combined detection rates ranged from 0.03 detections per km of dedicated effort, (early April survey, 2008) to 0.22 detections per km of dedicated effort (November survey, 2007). Detection rates were much lower in both of the April surveys than in any of the preceding five surveys.

Table 16 Number of porpoise detections and detection rate (detection/km) for each of the 7 surveys for which acoustic data were collected

Month of survey	Number of detections	Effort (km)	Detection rate (detections per km)
Oct-07	16	111	0.14
Nov-07	23	102	0.22
Dec-07	23	127	0.18
Jan-08	17	88	0.19
Feb-08	25	127	0.20
Early April-08	3	101	0.03
Late April-08	6	126	0.05

There appears to be marked differences in spatial distribution of porpoises over the areas surveyed, with more detections made in the control area than in the wind farm area. A total of 113 harbour porpoise detections were made overall, of which 96 were made within the control area (0.23) detections per km dedicated acoustic effort), and 17 were made within the wind farm area (0.05 detections per km dedicated acoustic effort) (Figure 23). Figure 24 shows the detection rate per survey in both the control and the wind farm areas. In each monthly survey the detection rate is higher in the control area.

The detection rate per transect is shown in Table 17. All transects recorded acoustic detections with the exception of transect 'WC' located in the wind farm area (Figure 1 provides details of the transect names).

Figure 24 Histogram comparing the detection rate for harbour porpoises in the control area and the wind farm area across all survey months.

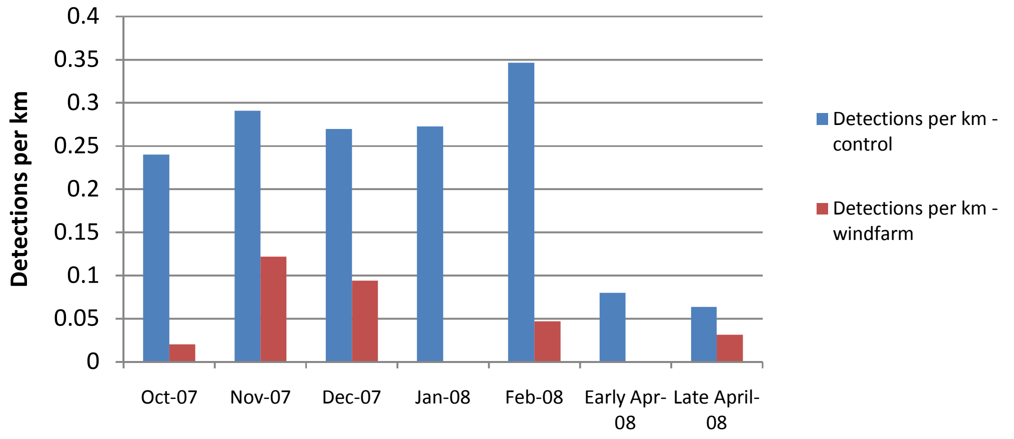


Table 17 Harbour porpoise detection rate for each individual survey transects, combined across all surveys 2007-2008

Transect ID	Number of detections	Effort (km)	Detection rate
WA	1	29.72	0.03
WB	1	33.35	0.03
WC	0	40.99	0.00
WD	1	38.57	0.02
WE	2	39.20	0.05
WF	1	38.37	0.03
WG	2	38.71	0.05
WH	4	38.48	0.10
WI	2	33.57	0.05
WJ	3	38.92	0.09
CA	3	42.03	0.07
CB	4	43.25	0.09
CC	8	44.30	0.18
CD	8	44.96	0.18
CE	9	42.51	0.21
CF	17	45.04	0.38
CG	6	36.19	0.17
CH	14	38.20	0.37
CI	13	37.78	0.34
CJ	14	39.11	0.39

5.2.4.5 Towed Passive Acoustic Monitoring (PAM) results for surveys 2010-2011

Harbour porpoises were detected acoustically on all four of the surveys (Table 18). Combined detection rates ranged from 0.08 detections per km of dedicated effort, (January 2011) to 0.15 detections per km of dedicated effort (September 2010).

A total of 85 "on effort" harbour porpoise detections were made across all three strata. Of these, 56.5% were made in the north stratum, 20% in the south stratum and 23.5% in the offshore stratum (Table 18 and Figure 29). The number of detections and detection rate per transect is shown in Table 19. Whilst all strata contained porpoise detections, 10 of the individual transects did not. The locations of harbour porpoise detections in each of the four surveys can be seen in Figure 25-Figure 28 "On effort" sightings are shown by red circles; "off effort" detections by orange circles. In some cases, due to navigational constraints, the actual sailed transects differed slightly from the pre-designed survey tracks. Designed tracks are shown in grey, actual sailed transects are shown in black. Some of the southern transects were sailed twice.

Figure 25 Locations of harbour porpoise detections during the August 2010 survey

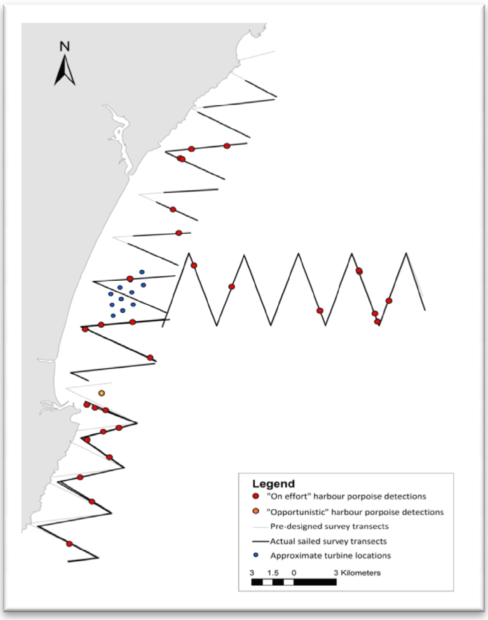


Figure 26 Locations of harbour porpoise detections during the September 2010 survey

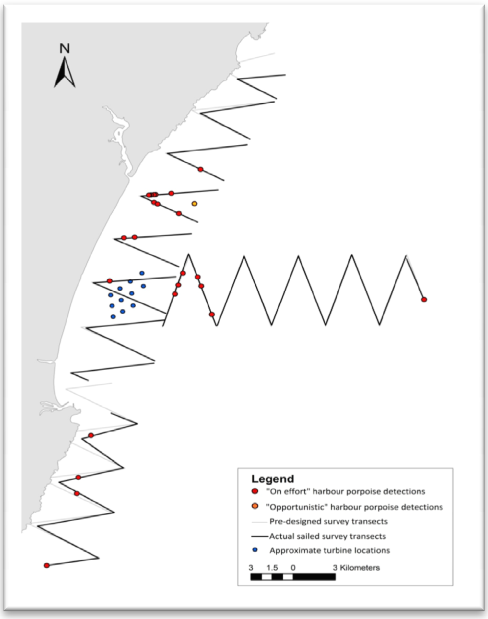


Figure 27 Locations of harbour porpoise detections during the November 2010 survey

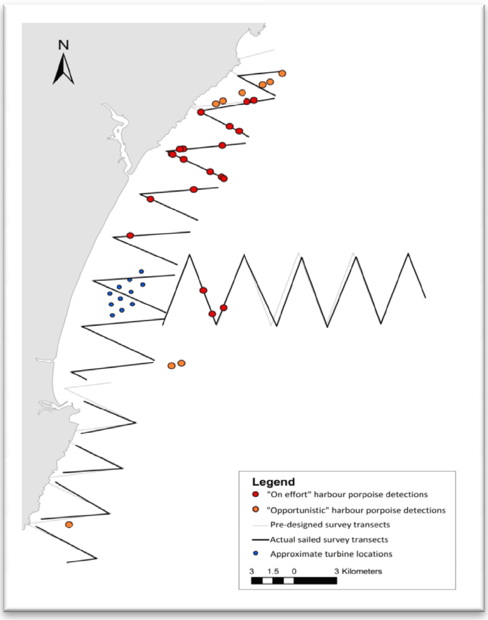


Figure 28 Locations of harbour porpoise detections during the January 2011 survey

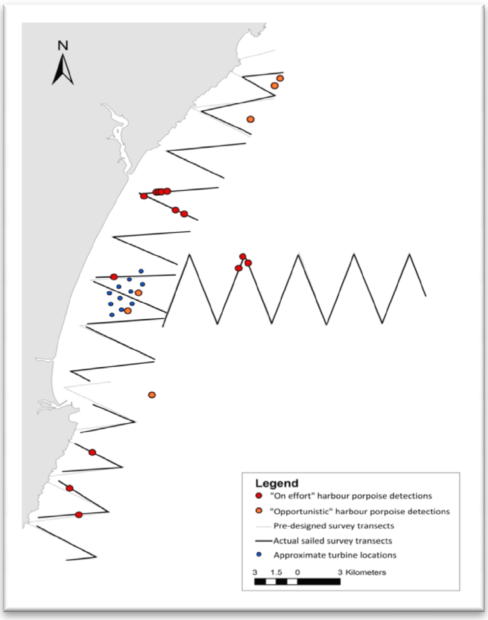


Table 18 Number of porpoise detections and detection rate (detection/km) for each of the surveys

Month of survey	Number of "on effort" detections	Kilometres of effort	Detection rate (detections per km)
Aug 2010	27	207.5	0.13
Sept 2010	26	168.6	0.15
Nov 2010	18	166.7	0.11
Jan 2011	14	164.2	0.09

Table 19 The spread of harbour porpoise detections across survey strata

Strata	Number of "on effort" porpoise detections	% total porpoise detections	Detections per km dedicated effort
South	17	23.5%	0.10
North	48	56.5%	0.15
Offshore	20	20%	0.08

Figure 29 Monthly detection rates of harbour porpoises in the South, North and Offshore Strata

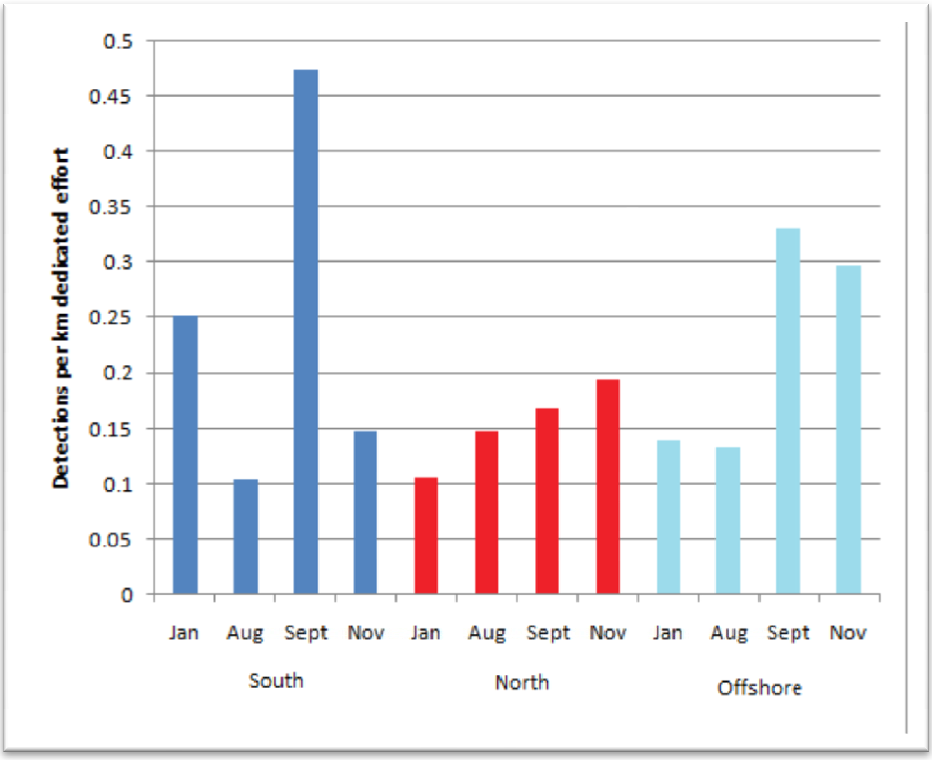


Table 20 Harbour porpoise detection rates for each individual survey transects, combined across all 4 surveys

Strata	Transect ID*	Number of detections	km of survey effort	Detection rate
South	1	1	12.3	0.08
	2	0	24.9	0.00
	3	2	26.1	0.08
	4	2	22.6	0.09
	5	1	22.7	0.04
	6	5	19.2	0.26
	7	4	20.3	0.20
	8	2	16.5	0.12
	9	Not surveyed		
North	10	0	5.6	0.00
	11	0	23.7	0.00
	12	3	28.9	0.10
	13	2	29.2	0.07
	14	0	22.9	0.00
	15	3	23.1	0.13
	16	0	19.1	0.00
	17	4	20.5	0.20
	18	8	17.1	0.47
	19	11	20.4	0.54
	20	8	18.5	0.43
	21	5	22.8	0.22
	22	2	16.4	0.12
	23	2	21.2	0.09
	24	0	11.7	0.00
	25	0	9.6	0.00
	26	Not surveyed		
Offshore	27	3	24.5	0.12
	28	6	24.2	0.25
	29	4	23.9	0.17
	30	1	23.9	0.04
	31	0	23.7	0.00
	32	1	24.0	0.04
	33	0	24.1	0.00
	34	4	23.7	0.17
	35	1	23.9	0.04
	36	0	15.8	0.00

**Locations of transits within the survey design can be seen in Figure 2*

Harbour porpoise acoustic detections appear to follow a similar pattern of distribution to the sightings of animals. The pattern of detections from the November survey most closely resembles the pattern formed from the visual data. Higher numbers of detections were made in the offshore survey area during the August and September 2010 surveys, although it is too early to conclude whether this represents a movement of animals offshore during the summer months. Acoustic detection rates were lowest during the January survey, but again, more data are required to determine if this is part of a trend.

The acoustic dolphin detections (both clicks and whistles) made during the August 2010 survey coincide both temporally and spatially with sightings of white-beaked dolphins made in the offshore strata. Additional detections in the northern stratum which do not coincide with visual observations reinforce the value of carrying out simultaneous passive acoustic data collection alongside the use of visual observers.

5.2.5 Diet

The diet of harbour porpoises in Scottish waters has been determined through stomach content analysis and, although fish from 15 taxa, cephalopods from five taxa and crustaceans from four taxa were recovered from the stomachs of harbour porpoises between 1992 and 2003, the diet is dominated by four main prey categories: (i) whiting; (ii) sandeels (Ammodytidae spp.); (iii) haddock/saithe/pollack and (iv) *Trisopterus* spp. (Norway pout and poor cod) (Santos *et al.*, 2004a). Whiting and sandeels are the most important prey types, in terms of contribution by number and mass, in the diet of harbour porpoises from Scottish waters (Santos *et al.*, 2004a).

The main fish species consumed by porpoises (identified in samples recovered mainly from fishing nets) from the Scottish east coast between 1959 and 1971 were herring, sprats, whiting, sandeels, cod, Norway pout and other gadoids, decapod shrimps were also present (Rae 1965, 1973).

5.2.6 Life history

Harbour porpoises in Scottish waters have a distinct reproductive season. Examination of the reproductive status of stranded harbour porpoises (1992-2005) indicates that conception takes place between April and September, gestation appears to last 10-11 months and the calving period is between April and June. Lactation appears to last 9 to 10 months with weaning taking place in March/April (Learmonth, 2006.).

The period of conception for harbour porpoises in Scottish waters coincides with observations of larger group sizes of porpoises in July and August off the North Sea coast (N. Quick, Pers. Comm.).

In the coastal waters off Aberdeenshire juvenile porpoises and calves have been observed between May and September, with a peak during June (Weir *et al*., 2007). Sightings suggest that calving may take place in June with the observation of very small calves during this time (Weir and Stockin, 2001).

In surveys along the southern coast of the outer Moray Firth (May to October, 2001-2005), neonatal porpoise calves were typically observed between May and July and the progressive increase in harbour porpoise encounters from May through to October was believed to result from the inshore movements of lactating females with their calves, followed thereafter by the males (Robinson *et al*., 2008).

5.2.7 Strandings

One hundred and thirty stranded harbour porpoises have been recorded by the Scottish Agricultural College along the north east coast of Scotland from Fraserburgh to Inverbervie between January 1992 and March 2010(CSIP 2010). Thirty-three were females, 51 were male and the sex was not determined for 48 individuals. Body lengths were between 76 cm and 165 cm. Harbour porpoises were recovered all along the north-east coast of Scotland throughout the year, with the majority recovered in the 1st and 2nd quarters (January-June: approximately 84%), in all years (SAC, 2006; CSIP 2009).

Stranding records indicate that harbour porpoises are regularly present in the area through out the year, with an increase in the number of stranded porpoises between January and June. Similarly, an examination of stranded harbour porpoises around Scotland between 1992 and 2004 found an increase in the number of strandings in March, April and June, with lower numbers in October, November and December, even when porpoises with body lengths less than 110 cm were removed to reduce the bias of the higher number of immature porpoises stranded during the birth and weaning periods (March to June) (Learmonth, 2006).

5.2.8 Harbour porpoises killed by bottlenose dolphins

One hundred and forty-three of the 389 harbour porpoises (37%), for which cause of death was established in Scottish waters between 1992 and 2004, died as a result of attacks by bottlenose dolphins (Learmonth, 2006). All fatal bottlenose dolphin attacks were recorded on the North Sea coast, ranging from Brora in the north to the Firth of Forth in the south, with the majority (66%) in the Moray Firth. The distribution of bottlenose dolphin attacks on harbour porpoises is consistent with an overlap in the distribution of the two species on the Scottish east coast (Wilson *et al*., 2004). The fatal attacks by bottlenose dolphins along the north east coast also indicates that bottlenose dolphins are present in the area throughout the year, despite the low number of strandings recovered.

Fatal bottlenose dolphin attacks on harbour porpoises in Scottish waters were recorded in all months of the year, with higher numbers between April and June (Learmonth, 2006). There was some evidence of a seasonal shift in bottlenose dolphin attacks on porpoises along the east coast, with 75% of bottlenose dolphin attacks within the Moray Firth occurring between April and September and 77% of bottlenose dolphin attacks outside the Moray Firth occurring between January and June (Learmonth, 2006). The increase in bottlenose dolphin attacks outside the Moray Firth between January and June is consistent with an increase in the number of sightings of bottlenose dolphins off Aberdeen between the months of February and May (Weir and Stockin 2001; Canning, 2007).

There were significant annual variations in the number of harbour porpoises that had died from fatal bottlenose dolphin attacks in Scottish waters between 1992 and 2004, although no overall trend increase or decrease in numbers was detected. However, there was evidence of an increase in the number of bottlenose dolphin attacks outside the Moray Firth in recent years. The increase in bottlenose dolphin attacks on harbour porpoises out with the Moray Firth is consistent with a recent range expansion of bottlenose dolphins (Wilson *et al.*, 2004).

Sightings reports suggest fine-scale segregation, both temporal and geographical, in the occurrence of harbour porpoises and bottlenose dolphins (Canning 2007; Thompson *et al.,* 2004b). Segregation within a small area may result from different uses of the area between the two species or could be due to avoidance behaviour by porpoises as a result of the violent attacks by bottlenose dolphins (Thompson *et al.,* 2004b).

5.3 WHITE-BEAKED DOLPHIN (*LAGENORHYNCHUS ALBIROSTRIS*)

5.3.1 Distribution

White-beaked dolphins are most commonly sighted in the central part of the North Sea between 54°N and 59°N (Hammond *et al*., 2001). White-beaked dolphins are restricted to temperate and sub-Arctic waters of the North Atlantic (Reid *et al*., 2003). They are mainly distributed over the continental shelf, usually in waters of 50-100 m depth (Reid *et al*., 2003). In the North Sea they are thought to be more numerous within about 200 nm of the Scottish and north-eastern English coasts (Northridge *et al.,* 1995). White-beaked dolphins are present year round in the North Sea, including waters of Shetland and Orkney (Northridge *et al.* 1997).

The locations of white-beaked dolphin sightings made during systematic surveys and some platforms of opportunity off north-east Scotland are presented in Figure 31 (Hammond *et al,*. 2004). During the SCANS II survey in July 2005, white-beaked dolphins were seen in the northern and central North Sea and west of Britain and Ireland (SCANS II, 2006). Analysis of the UK stranding database suggested that sea temperature influences the distribution of this species around the UK (Canning *et al*., 2008).

There has been a decline in the relative frequencies of strandings and sightings of white-beaked dolphins, a colder-water species and a relative increase in strandings and sightings of common dolphins, a warmer-water species off northwest Scotland. Theses changes in the cetacean community off northwest Scotland have been linked to climate change (MacLeod *et al*., 2005).

Figure 30 Distribution of white-beaked dolphin sightings during ferry surveys (April-September, 2002-2006

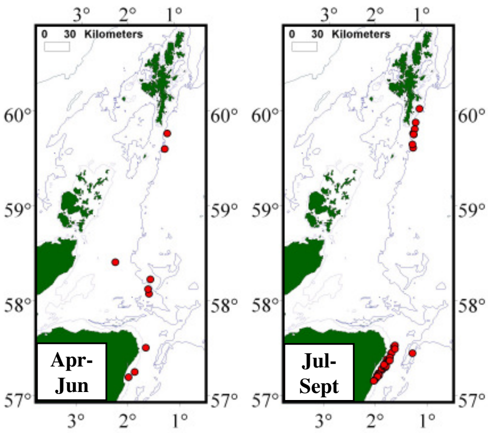
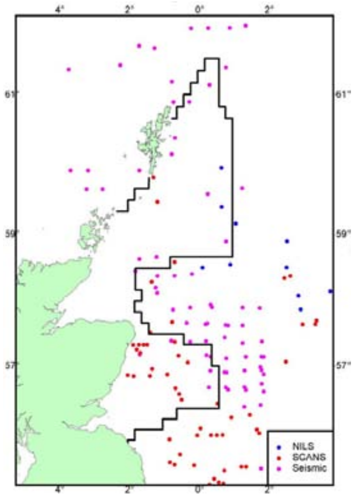


Figure 31 White-beaked dolphin sightings made during various surveys (Hammond *et al*. 2004)



5.3.2 Seasonal Movements

White-beaked dolphins are present year-round in the North Sea, with most sightings recorded between June and October (Evans, 1992; Northridge *et al*., 1995; Reid *et al*., 2003). Seasonal aggregations of white-beaked dolphins have been recorded along the north-east English coast during April and June (Northridge *et al*., 1997).

5.3.3 Abundance

The summer abundance of white-beaked dolphins in the North Sea areas during the first SCANS survey in July 1994 was 7,856 (95% confidence interval 4,000–13,300). This estimate includes shelf waters around Shetland and Orkney in which there were an estimated 1,157 animals (Hammond *et al*., 1995, 2002, 2004).

Current estimated abundance in UK and adjacent waters (shelf only) is 22,400 individuals (SCANS II, 2008). White-beaked dolphins are usually found in schools numbering less than 10 individuals, but schools of up to 50 are not uncommon, and aggregations can comprise 100-500 animals in northern parts of their range and also in the North Sea (Reid, et al. 2003).

5.3.4 Occurrence in Aberdeen Bay and surrounding area

The presence of white-beaked dolphins in the Aberdeen Bay area is seasonal. During land- and vessel based surveys between March 1999 and October 2001, along the Aberdeenshire coast (between St Cyrus and Collieston, primarily between Stonehaven and Aberdeen), white-beaked dolphins were recorded only between June and August, despite good coverage for both land- and vessel-based surveys in most other months. White-beaked dolphin calves were observed in all three months that the species was recorded (Weir *et al*., 2007).

The fine-scale distribution varied within the study area, with an apparent preference for sections of coast adjacent to deeper water. Most white-beaked dolphins were sighted along the Cove to Girdle Ness coast. During the land-based surveys, the incidence of white-beaked dolphins was significantly higher in the area between Aberdeen and Stonehaven than in area between Aberdeen and Collieston (Weir *et al*., 2007).

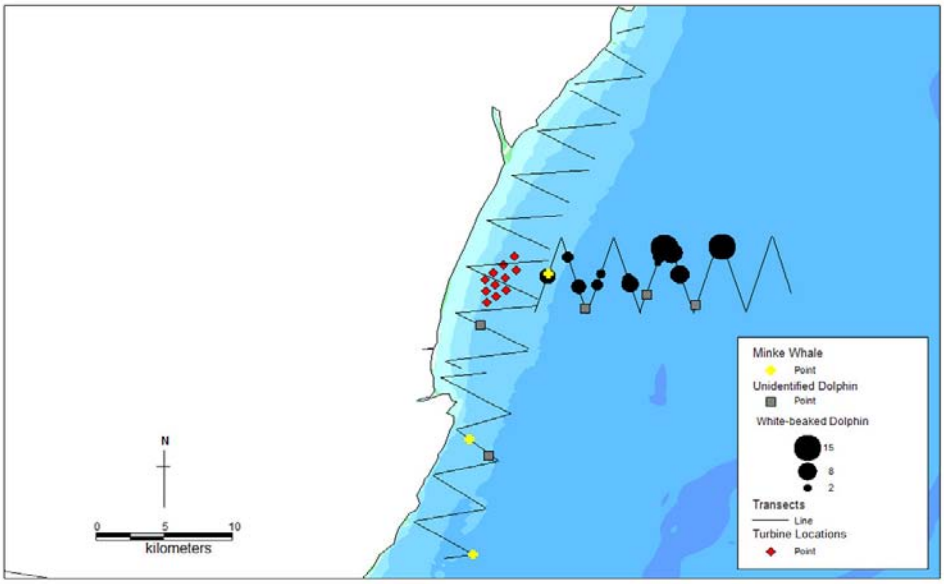
Similarly, white-beaked dolphins were only recorded during summer months during land and boat surveys along the Aberdeenshire coast (Stonehaven to Aberdeen) between 2002 and 2005. During land based surveys at Aberdeen harbour (November 2002 – April 2005), white-beaked dolphins were recorded during the summer of 2004 and during land-based surveys at Stonehaven (March 2003 – March 2005), they were observed between May and August during 2003 and in July during 2004 (Canning, 2007). Analysis of the sightings indicate that seabed depth and slope influence the distribution of white-beaked dolphins in this area and this is thought to be related to prey distribution. Sea temperature was found to influence white-beaked dolphin group size, with smaller groups being recorded at higher temperatures (Canning, 2007).

The high number of calves observed during the boat surveys off Aberdeenshire and in the stranding data during the summer, suggests the inshore movement of this species at this time of year may be related to calving. The stranding data also suggested there may be a difference in when males and females move inshore (Canning, 2007).

White-beaked dolphins were the most commonly-sighted species of dolphin during northern North Sea ferry surveys between Aberdeen, Orkney and Shetland in summer months between 2002 and 2006 (MacLeod *et al.*, 2007). White-beaked dolphins were recorded throughout the study area, but were recorded more frequently in more coastal waters, such as along the coast of mainland Scotland, in the late summer and early autumn. Group sizes ranged from one to 20, with an average of five individuals per group. White-beaked dolphins were the only species of cetacean recorded in all years when surveys were conducted. White-beaked dolphins made up the highest proportion of sightings in July, accounting for almost 20% of all sightings. White-beaked dolphins were not recorded in April (MacLeod *et al*., 2007).

During the boat based survey carried out as part of the wind farm during 2007-2008 one sighting of three individual white beaked dolphins occurred in August 2007, and this was an incidental sighting when the observers were off effort. Again during the August survey there were 14 observations of white beaked dolphins that in the offshore transect comprising a total of 88 individuals (Figure 32). The sightings data collected as part of the EOWDC marine mammal data supports other observational data records which suggests the species is a seasonal summer visitor to the Aberdeenshire coast.

Figure 32 White beaked dolphins, minke whale and unidentified dolphins detected during August, September and November 2010, and January 2011



5.3.5 Diet

White-beaked dolphins take a range of prey, including fish, cephalopods and some crustacean species (Reid *et al*., 2003). Herring and whiting have been recorded as prey items of this species in the North Sea (Fraser, 1974; Harmer, 1927). The diet of those found around Britain includes whiting, hake, herring, cod, mackerel, scad, sandeel, long rough dab, *Trisopterus sp*, and the octopus *Eledone cirrhosa* (Evans, 1992; Santos *et al.,* 1994). Stomach contents analysis of white-beaked dolphin (n=22) stranded around Scotland (1992-2003) identified a wide variety of prey species: haddock and whiting were the predominant fish species and other prey species included cod, herring and mackerel (Canning *et al*., 2008). Elsewhere in the North Atlantic herring and gadoid fishes also appear to be the main diet items (Reeves *et al.*, 1999a).

5.3.6 Life history

Little is known about the reproductive behaviour of this species but mating is thought to occur during the summer with parturition occurring the following summer (Kinze *et al.,* 1997). White-beaked dolphin calves have been observed off Aberdeenshire in all three months (June, July and August) that the species has been observed (Weir *et al*., 2007).

Information on the life history of white-beaked dolphins in Scottish waters is limited. However, the examination of the reproductive status of stranded individuals (1996-2002) suggests that mating occurs between July and August; however the majority of stranded white-beaked dolphins for which age and reproductive data are available, were sexually immature and aged four years and less.

5.3.7 Strandings

The majority of white-beaked dolphins stranded in the UK are found around Scotland and along the east coast of England (Canning *et al*., 2008). Fourteen white-beaked dolphins have been recorded by the Scottish Agricultural College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and December 2009. Seven were female and 7 were male, with body length between 119cm and 263cm (Table 21). White-beaked dolphins were recovered along the north-east coast of Scotland between February and October, with the majority in June and July, in 1992-1995 and 2001-2004 (Table 21).

Table 21 White-beaked dolphins stranded along the northeast coast of Scotland January 1992 – August 2009 (CSIP 2010)

Date Found	Location	Sex	Body length
June 1992	Aberdeen	M	132 cm
March 1993	Aberdeen	F	225 cm
September 1994	Aberdeen	M	222 cm
July 1994	Balmedie	M	119 cm
July 1994	Aberdeen	F	134 cm
April 1995	Fraserburgh	F	188 cm
July 1995	Balmedie	F	122 cm
July 2001	Forvie	F	245 cm
June 2002	Forvie	M	263 cm
June 2002	Blackdog	M	155 cm
June 2002	Collieston	F	171 cm
October 2003	Aberdeen	M	158 cm
February 2004	Fraserburgh	M	200 cm
January 2008	Collieston	F	176 cm

Stranding records suggest that white-beaked dolphins may be present in the area throughout the year, with the exception of winter (November-January). The peak occurrence appears to be in summer, especially during the months of June and July.

5.4 Minke whale (*Balaenoptera acutorostrata*)

5.4.1 Distribution

Minke whales are widely distributed in the northern hemisphere, tropical, temperate and polar seas (Reid *et al*., 2003). There are three distinct populations: Southern Hemisphere, Northern Pacific and North Atlantic. In the North Atlantic the International Whaling Commission recognises three stocks for management purposes: NE Atlantic, west Greenland and Canadian east coast. Minke whales off north-east Scotland are part of the NE Atlantic stock (Hammond *et al*., 2004).

Minke whales occur throughout the central and northern North Sea, as illustrated by the distribution of sightings during the SCANS survey and on other surveys on platforms of opportunity Figure 34 (Hammond *et al*., 2001). Minke whales are more frequently sighted inshore during summer months. The locations of minke whale sightings made during systematic surveys and some platforms of opportunity off NE Scotland are shown in Figure 35 (Hammond *et al*., 2004). Minke whales are widely distributed in the area off north-east Scotland, both in offshore and coastal areas. During the SCANS II survey in July 2005, minke whales were found in the northern and central North Sea and west of Britain and Ireland (SCANS II, 2008).

Between May and October from 2001 to 2006 inclusive, systematic boat surveys were conducted along an 83 km length of the southern coastline of the outer Moray Firth between Lossiemouth and Fraserburgh, using four dedicated survey routes positioned parallel to the shore: three outer routes, approximately 1.5 km apart in latitude, and an inner coastal route. Minke whales were encountered throughout the survey area, but were more generally distributed towards the central and eastern area of the study site, with a notable absence to the far west. A larger number of whales were also sighted on the innermost survey route, but once corrections for survey effort had been made, a considerably higher abundance of animals was shown for each of the outer survey routes, typically occurring along the 20-50 m isobaths. Whilst minke whales were recorded during all survey months (May to October inclusive), the animals were typically encountered in this region from mid June onwards, showing a peak in occurrence during July and August. In addition, the temporal distribution of whales suggested an inshore movement of animals across the summer months, with the whales being recorded in deeper, offshore waters in May and June followed by increasing numbers of encounters of animals in more shallow, inshore waters from July onwards (Robinson *et al*., 2007).

5.4.2 Migration

There is no direct evidence that minke whales in the Northern Hemisphere migrate, but in some areas there appear to be shifts in latitudinal abundance with season (Hammond *et al*., 2004). This is true for the North Sea, where minke whales appear to move into the North Sea at the beginning of May and are present throughout the summer until October (Hammond *et al*., 2004; Northridge *et al.*, 1995).

5.4.3 Abundance

A total abundance of 16,400 individuals has been estimated for UK and adjacent waters, and results from the CODA survey in 2007 estimated a total abundance in the survey area to be 6,765 [95% CI=1,239-36,925] (Macleod, *et al*., 2008). Minke whales are usually seen singly or in pairs although, when feeding, they sometimes form larger aggregations that can number 10-15 individuals (Reid, *et al*. 2003).

During the SCANS I survey, the highest densities were recorded in the northwest North Sea, particularly off the mainland coast of Scotland (Hammond *et al*., 2001). Estimates of the number of minke whales in the North Sea, north of 56°N, were 5,430 (SE=1,870) for 1989 and 20,300 (SE=5,240) for 1995. These estimates are approximately 8-18% of the estimated size of the north-east Atlantic stock of 67,000 whales in 1989 and 112,000 whales in 1995 (Hammond *et al*., 2004; Schweder *et al.*, 1997). Abundance estimates for the North Sea from the Norwegian surveys in July 1998 were 11,700 (SE=3,460) (Hammond *et al.*, 2004; Skaug *et al.*, 2003). The SCANS II survey calculated an increased abundance of minke whales for the whole of the North Sea (approximate 95% confidence interval = 10,445-33,171).

5.4.4 Occurrence in Aberdeen Bay and surrounding area

The status of minke whales in the Aberdeen Bay area is unclear. During land- and vessel based surveys along the Aberdeenshire coast (between St Cyrus and Collieston, primarily between Stonehaven and Aberdeen, from March 1999 to October 2001), minke whales were recorded only in the month of August (Weir *et al*., 2007). The five sightings all involved solitary individuals, of which three were adults and two were juveniles, which were observed only in a relatively small spatial region between Aberdeen and Stonehaven (Weir *et al*., 2007). During land-based surveys at Aberdeen harbour (November 2002 – April 2005) and Stonehaven (March 2003 – March 2005), minke whales were recorded during the summer of 2004 and August 2003, respectively (Canning, 2007). However, in recent years minke whales have been observed off the Aberdeenshire coast during most months of the year, with sightings occurring even during the winter months of December and March.

Northern North Sea ferry surveys between Aberdeen, Orkney and Shetland in summer months between 2002 and 2006 recorded minke whales throughout the region, and in all months surveyed (April to September) Figure 35 (MacLeod *et al*., 2007). Most observations of minke whales during the NORCET surveys occurred in more offshore waters in April to June and in more coastal waters in July and September (Figure 5). Minke whales were the second most commonly sighted species during the ferry surveys (MacLeod *et al*., 2007).

During bird vantage point (VP) surveys for the this project, single minke whales were recorded at both Donmouth and Blackdog on 13th July 2007, although this may have been the same individual moving along the coast.

Four minke whales have been recorded during all the boat based wind farm surveys carried out to date. One minke whale was recorded during the surveys carried out in 2007-2008 (Figure 33). Three minke whales were recorded in the four months of boat based surveys carried out during 2010-2011 (Figure 32).

Figure 33 Common dolphin, Minke whale, White beaked dolphin, unidentified dolphin and unidentified cetacean observations during the EOWDC boat based surveys 2007-2008

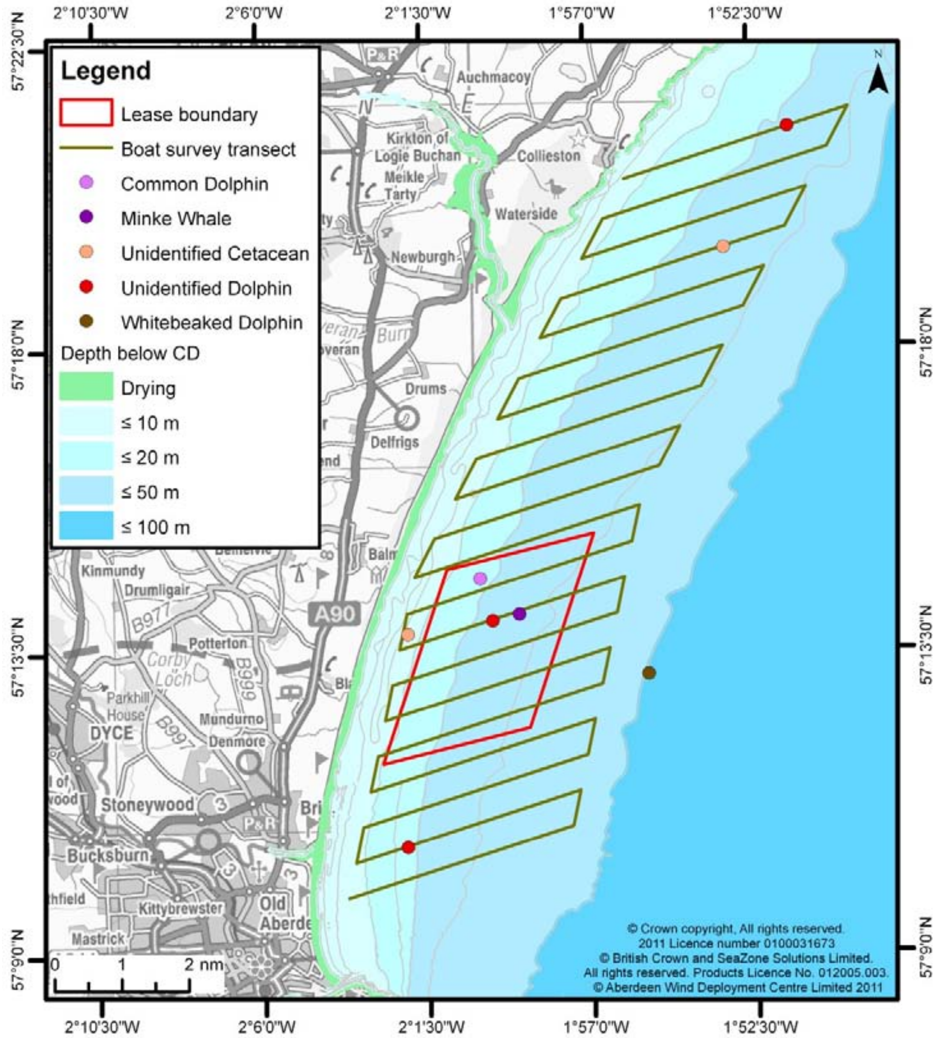


Figure 34 Minke whale sightings made during SCANS, NASS-89, NILS-95, JNCC and seismic surveys (Hammond *et al.*, 2004)

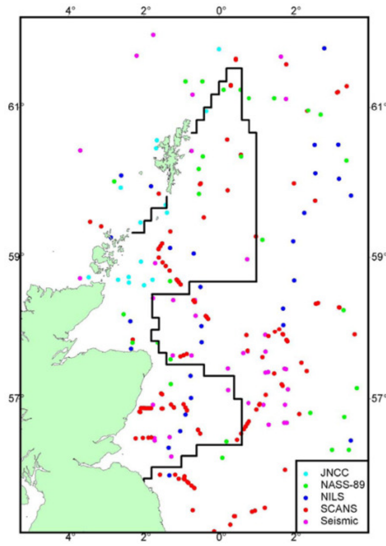
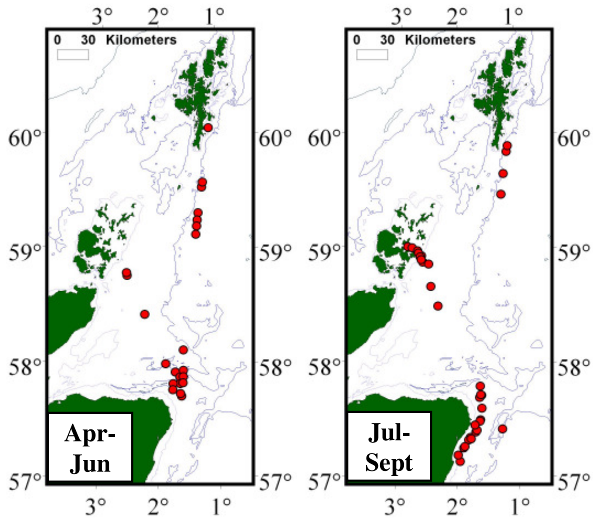


Figure 35 Distribution of minke whales sightings during ferry surveys (April-September, 2002-2006)



5.4.5 Diet

Minke whales are known to feed on a variety of fish species, including herring, cod, haddock, saithe and sandeel (Reid *et al.*, 2003). In the north-east Atlantic, minke whales feed on small pelagic fish and its distribution has been related to concentrations of sandeels and herring in Scottish waters (Evans, 1980; Macleod *et al*., 2004; Northridge, 1988). Stomach content analysis of minke whales stranded around the Scottish coast between 1992 and 2002 indicates that the diet comprised mainly sandeels, herring and sprat (Pierce *et al*., 2004).

Sightings of minke whales in the outer Moray Firth were found to be significantly higher during warm water plume events than when the colder water Dooley current was prevailing. In addition, GIS plots of the physiography of the coastal study site revealed a strong preference by the species for areas with steep, northerly-facing slopes, mean water depths of 38 m and sandy gravel sediment type. Sandy gravel sediments showed the strongest positive correlation with minke distribution, and this type of substrate is seen to be the optimal habitat utilised by burrowing sandeels (Robinson *et al.*, 2007).

5.4.6 Strandings

During 1992-2002 approximately 110 strandings of minke whales were recorded in Scotland. Most strandings were recorded between April and November, with a peak strandings of males in July and August (Pierce *et al.*, 2004).

Five stranded minke whales have been recorded by the Scottish Agricultural College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and March 2010 (SAC, 2006; CSIP 2010). The body lengths of the whales were between 585 cm and 800 cm and three of the five minke whales were identified as male. Minke whales were recovered in the months of July, September, October and November within the years 1993, 1995 and 2000 between Peterhead and Inverbervie (Table 7). Strandings records indicate that minke whales are present along the north east coast of Scotland between July and November.

Table 22 Minke whales stranded along the northeast coast of Scotland (January 1992 – August 2006)

Date Found	Location	Sex	Body length
September 1993	Near Slains Castle	M	760 cm
July 1995	Peterhead	M	585 cm
October 1995	Inverbervie	Unknown	c700 cm
November 1995	Near Catterline	M	700 cm
September 2000	Balmedie	Unknown	800 cm

5.5 ATLANTIC WHITE-SIDED DOLPHIN (*LAGENORHYNCHUS ACUTUS*)

5.5.1 Distribution

Atlantic white-sided dolphins are confined to the North Atlantic (Reeves *et al.*, 1999b). White-sided dolphins live mainly in cool waters (7-12°C), particularly along the edges of continental shelves at depths of 100-500 m, but they can be numerous in deeper waters (Reid *et al.*, 2003). The Atlantic white-sided dolphin is primarily an offshore species, but has been recorded during a number of surveys in the North Sea, especially during summer (Northridge *et al.*, 1997; Reid *et al.*, 2003). They share most of their range with the white-beaked dolphin, but in the eastern North Atlantic they adopt a mainly offshore distribution and are consequently rarer than white-beaked dolphins over shelf waters (Hammond *et al.*, 2001). Around Britain, Atlantic white-sided dolphins have been recorded mainly in the north and appear to be most common in the north-western parts of the North Sea (Hammond *et al.*, 2001, 2004). Compared to white-beaked dolphins, Atlantic white-sided dolphins are generally distributed further northwest in deeper waters. In the North Sea, their presence is seasonal, with the majority of sightings occurring between May and September (Northridge *et al.*, 1997).

5.5.2 Occurrence in Aberdeen Bay and surrounding area

Atlantic white-sided dolphins were recorded on nine occasions in groups of between one and 50 individuals during northern North Sea ferry surveys between Aberdeen, Orkney and Shetland in summer months between

2002 and 2006 (MacLeod *et al*., 2007). The majority of the sightings occurred in the more northern part of the study area around Shetland, with only one recorded sighting near the Scottish mainland coast (Figure 36). The sightings primarily occurred between July and September, with a single sighting being recorded in May. This species appears to be a seasonal but regular member of the cetacean assemblage of the northern North Sea, and primarily occurs in the more northern waters of the area (MacLeod *et al*., 2007). During surveys along the southern outer Moray Firth coast (May to October, 2001-2005), a single sighting of twelve white-sided dolphins was recorded in August 2005 (Robinson *et al*., 2008).

The locations of Atlantic white-sided dolphin sightings made during systematic surveys and some platforms of opportunity off north-east Scotland are illustrated in Figure 37. White-sided dolphins have been observed off the Aberdeen coast at Girdle Ness in June 2002 (Seawatch Foundation, 2011).

No white sided dolphins have been recorded in any of the surveys carried out as part of the EOWDC.

5.5.3 Abundance

There is no reliable total population estimate for this species at present. Abundance estimates have been difficult to obtain due to difficulties in separating white-sided dolphin and white-beaked dolphin identification at long-range (Hammond, *et al*., 2002). The white sided dolphin is known to occasionally be involved in mass stranding events, although none of these have been reported along the east coast of Scotland (Hammond *et al*., 2001).

The SCANS I survey estimated 11,760 *Lagenorhynchus* dolphins (white-beaked plus white-sided) in the North Sea (approx. 95% confidence interval 5,900 - 18,800). This estimate includes shelf waters around Shetland and Orkney (Hammond *et al*., 1995, 2002, 2004). The SCANS II survey estimated a total abundance of 27,227 (CV=0.38) for *Lagenorhynchu*s species in UK and adjacent waters (shelf only) in the summer of 2005 (Scans II, 2006). This species is very gregarious, with observed school sizes frequently numbering in the tens to hundreds, and sometimes up to 1,000, particularly offshore. Within large aggregations, clusters of 2-15 animals can often be distinguished (Reeves, *et al*., 1999a).

5.5.4 Diet

The diet of Atlantic white-sided dolphins consists of a wide variety of fish, particularly gadoids such as blue whiting, whiting, *Trisopterus* spp., cod, clupeids, particularly herring; other species recorded in the diet include hake, mackerel, salmonids and squid (Reid *et al*., 2003). Different prey species may predominate at different times of year, representing seasonal movements of prey, or in different areas, indicating prey and habitat variability in the environment (Cipriano, 2002).

The stomach contents of three white-sided dolphins stranded around Scotland between 1993 and 1995 consisted of Gadidae and cephalopods, predominately the neritic and oceanic squid *Todarodes sagittatus* (Santos *et al*., 1995).

Figure 36 Distribution of Atlantic white-sided dolphin (blue) and common dolphin (red) sightings during ferry surveys (April-September, 2002-2006)

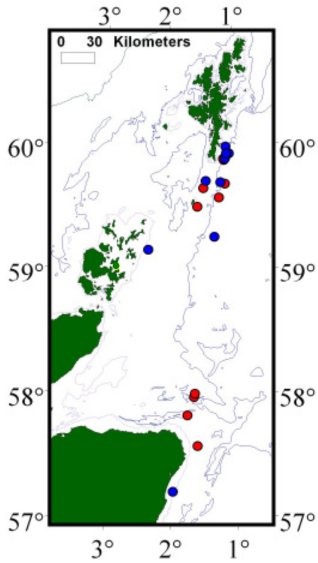
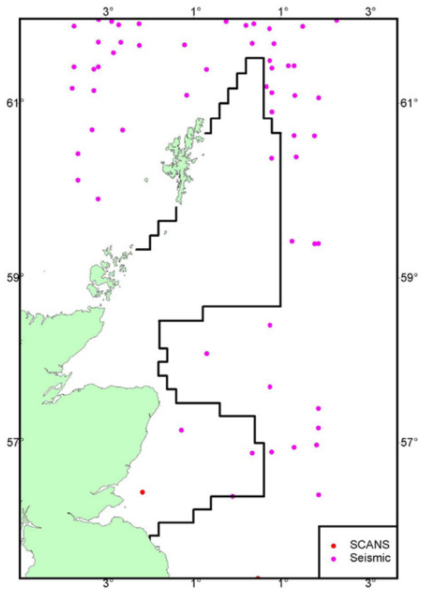


Figure 37 Atlantic white-sided dolphin sightings made during SCANS I survey and seismic surveys (Hammond *et al*., 2004)



5.6 KILLER WHALE (*ORCINUS ORCA*)

5.6.1 Distribution

Killer whales have a worldwide distribution and are found in tropical, temperate and polar waters in both the northern and southern hemisphere (Reid *et al*., 2003). In the eastern North Atlantic they occur in most areas from coastal fjords to oceanic waters. Any seasonal movements appear to be associated with prey, including seals and herring, and are region-specific (Hammond *et al*., 2001, 2004; Reid *et al.*, 2003).

Killer whales have been observed throughout the north-western North Sea in most months (Hammond *et al*., 2001, 2004; Reid *et al.*, 2003). In UK near-shore waters the species is mainly recorded between April and October (Evans, 1988, 1992; Reid *et al*., 2003). Killer whales are not numerous in the North Sea in general, although they are recorded fairly frequently around Shetland in all months (Hammond *et al*., 2004). The locations of killer whale sightings made during systematic surveys and some platforms of opportunity off north-east Scotland are illustrated in Figure 38.

During opportunistic sightings of killer whales from Scottish pelagic trawlers fishing for mackerel (October to March) and herring (June to September) off north Scotland between 2000 and 2006, encounters with recorded killer whales were recorded between January and February 2006 from pelagic trawlers fishing for mackerel to the north and east of Shetland, no killer whale encounters were recorded from vessels fishing for herring (Luque *et al*., 2006).

Individual killer whales have been documented to move over very large areas, with ranges up to tens of thousands of km^2 for animals from both resident and transient populations (Baird, 2000).

5.6.2 Abundance

The most recent sighting surveys in the eastern North Atlantic (mainly from Iceland to the Faroes) indicate a population of between 3,500 and 1,2500 individuals (Gunnlaugsson and Sigurjonsson, 1990). Most sightings in UK waters are of singles or pods of less than eight individuals (mean = 4.6), although aggregations of up to one hundred have been observed (Macleod, 2004).

5.6.3 Occurrence in Aberdeen Bay and surrounding area

Along the southern outer Moray Firth coast (May to October, 2001-2005), killer whales were only intermittently sighted between the months of June and August (*n* = 6) (Robinson *et al.*, 2008). During ferry surveys between Aberdeen, Orkney and Shetland in summer months between 2002 and 2006, killer whales were encountered on three occasions in groups ranging from one to five individuals (Figure 38). Two of these encounters were in August (2004 and 2006) and one was in June 2006. This suggests that killer whales are rare, but regular members of the cetacean community in the northern North Sea (MacLeod *et al*., 2007).

No killer whales were sighted during any of the EOWDC boat based surveys.

5.6.4 Diet

Killer whales have one of the most varied diets of all cetaceans, ranging from fish and squid to birds, turtles, seals and other cetaceans (Reid *et al*., 2003). Fish species taken in the eastern North Atlantic include herring, mackerel, cod and salmon (Evans, 1980; Reid *et al*., 2003). Little is known about the diet of killer whales in British waters (Hammond *et al*., 2001). Killer whales are thought to prey upon seals around haul outs in Shetland at least, and possibly offshore, as well as at least one porpoise, and have also been reported to feed on mackerel around Shetland (Fisher and Brown, 2001; Hammond *et al*., 2001).

The stomach contents of one killer whale stranded in Scotland between 1993 and 1995 consisted of oceanic cephalopods, including Gonatidae (*Gonatus steenstrupi*) and Histioteuthidae (Santos *et al*., 1995).

Figure 38 Distribution of killer whale (blue), Risso's dolphin (yellow) and fin whale (red) sightings during ferry surveys (April-September, 2002-2006)

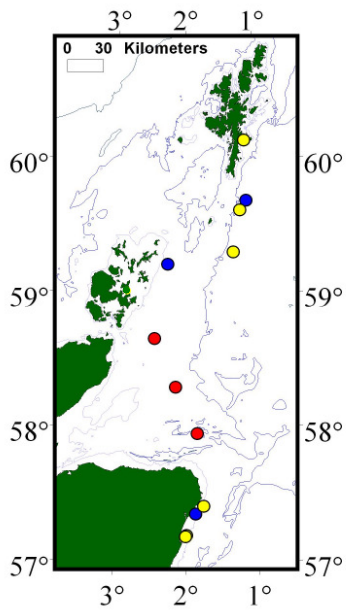
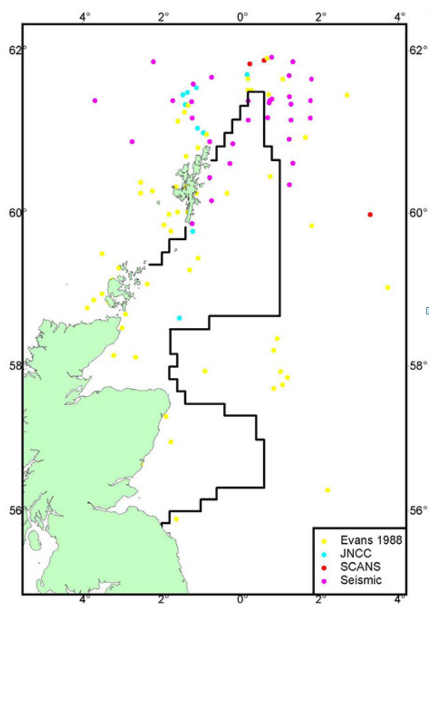


Figure 39 Killer whale sightings made during SCANS I survey, JNCC and seismic surveys and from Evans 1988 (Hammond *et al.*, 2004)



5.7 COMMON DOLPHIN (*DELPHINUS DELPHIS*)

5.7.1 Distribution

Short-beaked common dolphins have a world-wide distribution in tropical and temperate waters (Reid *et al*., 2003). They are generally found in oceanic and shelf-edge waters but do occasionally use coastal areas. Around the British Isles, the species is most often reported from the west coast, especially the Celtic Sea (Hammond *et al*., 2004; Reid *et al*., 2003).

5.7.2 Abundance

There are no known local populations in UK waters, and those animals occurring in UK waters are part of a wider north-east Atlantic population. SCANS II covered all European Atlantic continental shelf waters in June/July 2005 and estimated total abundance in the area as 63,366 (CV=0.46) (SCANS-II 2008).

5.7.3 Occurrence in Aberdeen Bay and surrounding area

There have also been infrequent sightings during surveys in the North Sea, generally during summer months (Hammond *et al*., 2001). The species is also occasionally stranded along the UK North Sea coast (Reid and Patterson, 1998). Figure 40 shows sightings records of common dolphins made during systematic surveys and some platforms of opportunity off north-east Scotland (Hammond *et al*., 2004). During the SCANS II survey in July 2005, common dolphins were sighted in the waters west of Britain and Ireland, in the channel, and in shelf waters off France, Spain and Portugal (SCANS II, 2006).

Nine groups of common dolphins, ranging in size from one to 25 animals, were recorded during NORCET surveys between Aberdeen, Orkney and Shetland in summer months between 2002 and 2006 (MacLeod *et al*., 2007). Sightings occurred from June to August and in every year except 2005. This species primarily occurred in relatively coastal waters near Shetland and north-east Scotland (Figure 40). Therefore, common dolphins appear to be a regular, if rare and seasonal, member of the cetacean assemblage of the northern North Sea (MacLeod *et al*., 2007). In the outer southern Moray Firth, along the Southern Trench, approximately 300+ common dolphins were encountered on 8th July 2007 (Earthwatch, 2011)

One solitary common dolphin was recorded during the project boat based surveys carried out during 2007-2008 (Figure 33).

5.7.4 Seasonal occurrence

Short-beaked common dolphins are occasional summer visitors to the North Sea (Hammond *et al*., 2001; 2004). Most sightings of common dolphins in the North Sea have been recorded between June and September (Reid *et al*., 2003).

5.7.5 Diet

The diet of common dolphins comprises a wide range of small fish and squid (Reid *et al*., 2003). In the North Sea, small pelagic schooling fishes and squids are the likely main food items (Hammond *et al*., 2004). An influx of the squid *Todarodes sagittatus* to the North Sea during 1937 was accompanied by an influx of common dolphins that same year, and it was assumed that the common dolphins were feeding on these squid (Fraser, 1946; Hammond *et al*., 2004).

Two common dolphins stranded in Scotland between 1993 and 1995 had eaten mainly sandeels and Gadidae (such as whiting and haddock/saithe/pollack), but also herring (Clupeidae) (Santos *et al*., 1995). Fourteen fish taxa and two cephalopod taxa were identified from the stomachs of nine common dolphins from Scottish waters between 2000 and 2003. Mackerel, followed by whiting were the main prey, other prey species included herring, sprat, *Argentine* sp., cod, haddock, blue whiting, *Trisopterus* spp., grey gurnard, scad, sandeels and plaice (Santos *et al*., 2004b).

5.7.6 Strandings

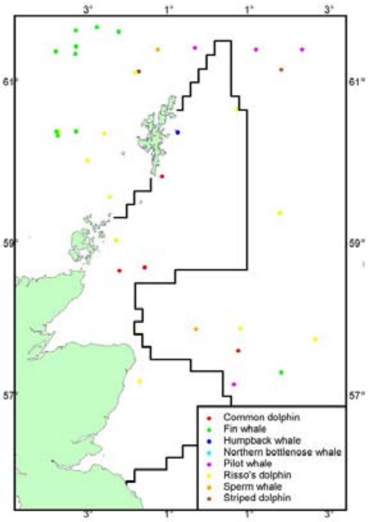
Three stranded common dolphins have been recorded by the Scottish Agricultural College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and August 2006 (SAC, 2006). The body lengths of the dolphins were between 150 cm and 220 cm, two were female and one was male. Stranded common dolphins were recorded in March, April and May in 1992 and 2005 between Fraserburgh and Aberdeen (Table 8).

Table 23 Common dolphins stranded along the northeast coast of Scotland (January 1992 – August 2006)

Date Found	Location	Sex	Body length
March 1992	Aberdeen	F	193 cm
April 2005	Aberdeen	F	151 cm
May 2005	Rattray Bay	M	219 cm

Strandings records indicate that common dolphins are present along the northeast coast of Scotland between March and May, although there occurrence in the strandings record is infrequent (SAC, 2006).

Figure 40 Sightings records of common dolphins, fin whales, humpback whales, northern bottlenose whales, pilot whales, Risso's dolphins, sperm whales and striped dolphins made during NASS-87, NILS-95 JNCC seismic and other surveys.



5.8 RISSO'S DOLPHIN (*GRAMPUS GRISEUS*)

5.8.1 Distribution

Risso's dolphins have a wide distribution and are generally found in oceanic waters. Risso's dolphins are primarily a warm water (4.5-28°C) pelagic species that is generally found in continental slope waters (Reid *et* *al*., 2003). In UK continental shelf seas, Risso's dolphins have been recorded mainly over slopes of 50-100 m depth (Reid *et al*., 2003).

Most of the sightings recorded from the northern North Sea are around Shetland, Orkney, Fraserburgh, Aberdeen and Berwick, with only a few sightings in the central North Sea (Reid *et al*., 2003; Hammond *et al*., 2001). The sightings records of Risso's dolphins made during systematic surveys and some platforms of opportunity off north-east Scotland are illustrated in Figure 40.

5.8.2 Abundance

There have been no attempts to estimate the abundance of Risso's dolphins over wide areas of the North Sea, although the animals occurring in UK waters are likely to be part of a population ranging in size from 500 animals to the low 1,000s, similar to population sizes in the north-west Atlantic (JNCC, 2010).

5.8.3 Occurrence in Aberdeen Bay and surrounding area

Sightings of Risso's dolphins in northern North Sea are mainly between July and August, although some animals were present off north-east Scotland and Shetland in winter (Reid *et al*., 2003). Along the southern outer Moray Firth coast (May to October, 2001-2005), Risso's dolphins were exclusively recorded in September and were seen in increasing abundance during the latter years of the study (Robinson *et al*., 2008).

During ferry surveys between Aberdeen, Orkney and Shetland in summer months between 2002 and 2006, Risso's dolphins were sighted on six occasions, with group size ranging from one to four individuals (MacLeod *et al*., 2007). These sightings all occurred in 2006 and were either in relatively coastal waters close to Shetland or north-east Scotland.

Risso's dolphins have been recorded off the Aberdeenshire coast since 2005, with sightings off Girdleness in September 2005 and off Cruden Bay/Bullars of Buchan in October 2005. There were several reported sightings around Aberdeen during July/August 2006 and April 2007 and another from Torry in February 2007, more recently a group of 4 Risso dolphins were observed at Longhaven Cliffs near Aberdeen in 2010 (ACC, 2008; Seawatch Foundation, 2011).

Altghough no Risso's dolphins were observed in any of the EOWDC boat based surveys, during bird vantage point (VP) surveys for this project, 20 Risso's dolphins were recorded at Blackdog on the 28th April 2006 and 10 Risso's dolphins were observed at the Donmouth on the 24th April 2007.

The increase in recent sightings in the Aberdeen Bay area may indicate that Risso's dolphins are using the area more frequently, and although occasional in the area the frequency of the utilisation of Aberdeen Bay area may change and should be monitored.

5.8.4 Diet

Risso's dolphins are capable of deep dives and are thought to specialise in catching squid (Hammond *et al*., 2001). Risso's dolphins have been reported to feed mostly on cephalopods, although small fish are also taken (Reid *et al*., 2003). Analysis of stomach contents from individuals from British waters indicated a diet of mainly octopus *Eledone cirrhosa*, also cuttlefish *Sepia officinalis*, sepioloids and squid such as *Loligo forbesi* and *Todarodes sagittatus* (Reid *et al*., 2003). Three Risso's dolphins stranded in Scotland between 1993 and 1995 had been feeding on cephalopods, primarily the octopus *Eledone cirrhosa* (Santos *et al*., 1995).

5.8.5 Strandings

Two Risso's dolphins have been recorded by the Scottish Agricultural College along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and August 2006. One was a female with a body length of 325 cm recovered in November 2004 from Blackdog, the other had a body length of approximately 250 cm, the sex was not determined, and it was recovered from Fraserburgh in January 2005 (SAC, 2006; CSIP 2009).

Strandings records suggest that although Risso's dolphins may be present in the area, their occurrence is occasional and the number of animals in the area is likely to be low.

5.9 STRIPED DOLPHIN (*STENELLA COERULEOALBA*)

5.9.1 Distribution

The striped dolphin has a worldwide distribution, occurring in both southern and northern hemispheres mainly in tropical, sub-tropical and warm-temperate oceanic waters. It tends to occur beyond the continental shelf in depths of 1,000 m or deeper, but has been occasional recorded in shelf waters and even in waters of 60 m or less (Forcada *et al*., 1990; Reid *et al*., 2003).

5.9.2 Abundance

The abundance estimate obtained from the CODA surveys is 82,585 (95% CI = 29,548 – 230,819) animals (Macleod, *et al*., 2008).

Striped dolphins were not reported in Scottish waters until 1988 (Reid *et al*., 1993). It has been suggested that *Stenella coeruleoalba*, a warm-water species, could have recently expanded its distribution northwards. Macleod *et al.* (2005) proposed that increased sea temperatures caused by climate change could explain this shift in distribution.

5.9.3 Occurrence in Aberdeen Bay and surrounding area

Striped dolphins are generally rare in UK waters, with its normal distribution reaching its nothern limit at 50^{o}N, although they have been observed in the North Sea (Reid *et al*., 2003; Stone, 2001). Most near-shore records from the UK have been recorded between July and December (Evans, 1992; Reid *et al*., 2003). Sightings records of striped dolphins made during systematic surveys and some platforms of opportunity off north-east Scotland are illustrated in Figure 38.

No stripped dolphin's were recorded in any of the project surveys.

5.9.4 Diet

The striped dolphin diet consists of a variety of mesopelagic and benthic fish, including sprat, blue whiting, *Trisopterus* spp. and whiting, as well as squid and crustaceans (Reid *et al*., 2003).

The stomach contents of four striped dolphins stranded around Scotland (1993-1995) contained mainly Gadidae (whiting and *Trisopterus* spp.), but also cephalopods, including the sepiolid *Sepietta oweniana* and the oceanic squid *Gonatus steenstrupi* (Santos *et al*., 1995). Ten fish taxa and four cephalopod taxa were identified in the stomach contents of seven striped dolphins stranded around Scotland between 2000 and 2003. Crustacean and polychaete remains were found in three and one of the stomachs, respectively. The main prey species were haddock/saithe/pollock (these species are grouped together as their otoliths are very similar and not always possible to distinguish), followed by *Trisopterus* spp. and whiting (Santos *et al*., 2004b).

5.9.5 Life History

Very little is known about the life history of striped dolphins in Scottish waters. The reproductive status was determined for 6 female and 6 male stranded striped dolphins between 2001 and 2003, with the majority being immature but the (small) sample included one pregnant female and one sexually active mature male. The pregnant female was recovered from Skye on the west coast of Scotland in September 2001 and the mature and sexually active male was recovered from the North Sea coast in May (Santos *et al*., 2008).

5.9.6 Strandings

During 1992-2003, 52 striped dolphin strandings were recorded in Scotland. Although strandings were recorded in every month of the year, highest numbers were found in January-March and August. Striped dolphins stranded all around the Scottish coast, but the majority were recovered from the west coast (Santos *et al*., 2008)

5.10 Long-finned Pilot Whale (*Globicephala melas*)

5.10.1 Distribution

Long-finned pilot whales occur in temperate and sub-Arctic regions of the North Atlantic and in the southern oceans (Reid *et al*., 2003). Long-finned pilot whales in UK waters occur mainly off the continental shelf, but their numbers and distribution seems to be highly variable both between seasons and inter-annually. Most records were from waters greater than 200 m, with relatively few occurrences in the shallower waters of the North Sea (Hammond *et al*., 2001). The sightings of pilot whales made during systematic surveys and some platforms of opportunity off north-east Scotland are illustrated in Figure 40.

5.10.2 Abundance

There is no recent population estimate for this species. The NASS-89 survey estimated 778,000 long-finned pilot whales in the eastern North Atlantic (Hammond *et al*., 2001). There has been a sustained catch of pilot whales off the Faroes for many hundreds of years, during which period more than 230,000 whales have been taken. Historically, there were enough whales around Shetland to support a drive fishery. The largest catch on record in this fishery was 1,540 animals caught in 1845 (Nature in Shetland, 2011).

5.10.3 Occurrence in Aberdeen Bay and surrounding area

Incidental sightings of pilot whales in the North Sea appear to be more numerous between November and January (Reid *et al*., 2003). There are a few sightings in the northern North Sea and there are also records from the south-western North Sea during June, July, August, and December (Reid *et al.,* 2003). Pilot whales are seen in Shetland waters in most months of the year.

During land-based surveys at Stonehaven between March 2003 and March 2005, pilot whales were observed in November 2003 (Canning, 2007). Along the southern outer Moray Firth coast (May to October, 2001-2005), pilot whales were intermittently encountered in the study area between the months of July and August (Robinson *et al*., 2008).

No long finned pilot whales were recorded in any of the EOWDC boat surveys.

5.10.4 Diet

Cephalopods generally form the majority of their diet, although they take a range of species. Twelve genera of cephalopods, as well as 15 genera of fish and crustaceans have been recorded in studies near the Faroes, with squid, especially *Todarodes sagittatus* as a key component (Desportes and Mouritsen, 1993; Reid *et al*., 2003).

5.10.5 Strandings

Strandings along the UK North Sea coast have increased since 1947; there were a number of mass strandings involving more than 150 animals in total between November 1982 and January 1985 (Hammond *et al*., 2001; Martin *et al.*, 1987; Sheldrick, 1976). Pilot whales are one of the most commonly mass-stranded whales.

One long-finned pilot whale has been recorded by the Scottish Agricultural College along the north east coast of Scotland from Fraserburgh to Inverbervie between January 1992 and March 2010. The female had a body length of 308 cm and was recovered from Fraserburgh in April 2001 (SAC, 2006; CSIP 2010).

Strandings records suggest that although long-finned pilot whales may be present in the area, their occurrence is occasional/rare and the number of animals in the area is likely to be low.

5.11 Sperm Whale (*Physeter macrocephalus*)

5.11.1 Distribution

Sperm whales have a wide distribution that includes tropical, temperate and sub-polar seas of the both the northern and southern hemispheres (Reid *et al*., 2003). Sperm whales are normally distributed to the west and north of the UK on, and beyond, the continental shelf break. They have also been recorded fairly regularly in Orkney and Shetland waters, with sightings and strandings reported in most months (Hammond *et al*., 2001). A number of sightings and strandings have been recorded from the North Sea in the last decade. Males migrate to high latitudes to feed and, as a result, all sperm whales sighted or stranded in the North Sea to date have been males (Hammond *et al*., 2001) (

Table 24).

The sightings records of sperm whales made during systematic surveys and some platforms of opportunity off north-east Scotland are illustrated in Figure 40. Sightings of sperm whales in British and Irish waters have been mainly recorded between July and December (Reid *et al*., 2003).

5.11.2 Abundance

The world population of sperm whales has been estimated at 2 million individuals, making them the most abundant species of large whale in the world (Hammond *et al*., 2001).

No sperm whales were detected in any of the project surveys.

5.11.3 Diet

Sperm whale diet is varied but primarily consists of medium to large-sized mesopelagic squid and in the North Atlantic most prey comprise mainly of Onychoteuthidae and Ommastrephidae, although other species are also taken (Reid *et al*., 2003).

Stomach contents of sperm whales stranded in Scotland and Denmark during 1990-96 were analysed (Santos *et al*., 1999). All were sub-adult or adult males and stranded between November and March. The diet of these whales was found to consist almost entirely of cephalopods, principally squid of the genus *Gonatus* (probably *G. fabricii*, an oceanic species characteristic of Arctic waters). The other prey species identified were also mostly oceanic cephalopods: the squids *Histioteuthis bonnellii*, *Teuthowenia megalops* and *Todarodes sagjttatus* and the octopus *Hahphron atlanticus*. There was little evidence of predation on fish. Remains of single individuals of the veined squid *Loligo forbesi*, the northern octopus *Eledone cirrhosa* and the saithe *Pouachius virens* provided the only possible evidence of feeding in the North Sea. The study suggested that sperm whales do not enter the North Sea to feed (Santos *et al*., 1999).

5.11.4 Strandings

Nine sperm whales have been recorded by the SAC along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and December 2009, six of which stranded together in Cruden Bay in January 1996. Nine stranded sperm whales along the north-east coast of Scotland were male during 1996, 2005, 2006 and 2009 and their body lengths ranged between 1,200cm and 1,375 cm (CSIP 2010) (

Table 24).

Table 24 Sperm whales stranded along the northeast coast of Scotland (January 1992 – March 2010)

Date Found	Location	Sex	Body length
January 1996	Cruden Bay	M	1,210 cm
January 1996	Cruden Bay	M	1,260 cm
January 1996	Cruden Bay	M	1,285 cm
January 1996	Cruden Bay	M	1,365 cm
January 1996	Cruden Bay	M	1,365 cm
January 1996	Cruden Bay	M	1,375 cm
May 2005	Cruden Bay	M	c1,350 cm
March 2006	Forvie	M	c1,200 cm
October 2009	Balmedie	M	1,400 cm

Stranding records suggest that although male sperm whales may be present in the area between January and May, their occurrence is occasional and the number of animals in the area is likely to be low (SAC, 2006).

5.12 Humpback whale (*Megaptera novaeangliae*)

5.12.1 Distribution

The humpback whale occurs globally in tropical, temperate and polar seas of the northern and southern hemispheres (Reid *et al*., 2003). It is generally found along and over the edges of continental shelves. In summer they tend to have a more coastal distribution in some areas that is largely depended on local prey availability (Reid *et al*., 2003).

5.12.2 Abundance

In the summer, a very small number of humpbacks are found in British shelf waters, particularly around the Northern Isles and also in western areas from the Hebrides to the English Channel (Evans, 2003).

5.12.3 Occurrence in Aberdeen Bay and surrounding area

Most sightings over the UK continental shelf have been made between May and September (Reid et al., 2003). The sightings records of humpback whales made during systematic surveys and some platforms of opportunity off north-east Scotland are illustrated in Figure 40.

During ferry surveys between Aberdeen, Orkney and Shetland in summer months between 2002 and 2006, one group of humpback whales, consisting of two adults and one juvenile, was seen in July 2005 (MacLeod *et al*., 2007). While this species was once almost completely absent from the North Sea due to the depletion of the North Atlantic humpback whale population by whalers, this species is now becoming regularly recorded in the North Sea in small numbers possibly as a result of a recovery in the North Atlantic population (MacLeod *et al*., 2007). Along the southern outer Moray Firth coast, humpback whales were intermittently encountered in the study area between the months of July and August (Robinson *et al*., 2008).

Humpback whales have been recorded off the Aberdeen coast in the area between Girdleness and Cove, just south of Aberdeen in February 2003 and June 2002 and off Portlethen in 2010 (Seawatch Foundation 2011).

No humpback whales were recorded during the EOWDC surveys.

5.12.4 Diet

The diet of humpback whales in the North Sea area is unknown, but elsewhere they consume planktonic crustaceans and small schooling fish. The fish species most likely to be consumed are those that form dense pelagic schools such as sandeels, herring, sprats and mackerel (Hammond *et al*., 2001, 2004; Reid *et al*., 2003).

5.13 FIN WHALE (*BALAENOPTERA PHYSALUS*)

5.13.1 Distribution

Fin whales occur in the North Atlantic and are mainly found in deep waters (400-2,000 m depth) beyond the edge of the continental shelf, but in some areas they are known to occur in shallower waters less than 200 m deep (Reid *et al*., 2003). In north-west Europe fin whales are mainly distributed along or beyond the 500 m depth contour (Reid *et al*., 2003). The sightings records of fin whales made during systematic surveys and some platforms of opportunity off north-east Scotland are shown in Figure 40.

5.13.2 Abundance

The fin whale is the most abundant large baleen whale species in the North Atlantic. The best available estimates of recent abundance accepted by the IWC Scientific Committee are 25,800 (CV= 0.13) in 2001 for the central North Atlantic (East Greenland-Iceland, Jan Mayen, Faeroes and some waters within the UK 200 nm limit) (IWC, 2007); 4,100 (CV 0.21) in 1996-2001 for the north eastern North Atlantic (North and West Norway); and 17,355 (CV 0.27) in 1989 for the Spain-Portugal-British Isles area (Buckland *et al*., 1992).

5.13.3 Occurrence in Aberdeen Bay and surrounding area

Around the British Isles, fin whales occur mainly between June and December, with most sightings in northern Britain occurring between June and August (Reid *et al*., 2003).

Three groups of fin whales were recorded during NORCET surveys, all in the outer Moray Firth region. However, these were all during a single survey in June 2006 and may represent a small number of stray animals rather than indicating the regular occurrence of this species in the northern North Sea (MacLeod *et al.*, 2007).

No fin whales were recorded during any project surveys.

5.13.4 Diet

Fin whales feed primarily on planktonic crustaceans, mainly euphausiids, but they also take a variety of fish such as herring, sandeel, mackerel and blue whiting as well as cephalopods (Reid *et al.*, 2003).

5.14 Beaked Whales

5.14.1 Distribution

Three species of beaked whale have been sighted in UK waters: northern bottlenose whale (*Hyperoodon ampullatus*), Sowerby's beaked whale (*Mesoplodon bidens*) and Cuvier's beaked whale (*Ziphius cavirostris*). Northern bottlenose whales only occur in temperate, sub-polar and polar seas in the North Atlantic (Reid *et al.*, 2003). Bottlenose whales are mostly recorded in deep water and most sightings have been made north and west of Scotland along the continental shelf edge over the 1,000 m isobath. The species is rarely seen in shelf waters of the North Sea (Reid *et al.*, 2003). Sowerby's beaked whale has the most northerly distribution of all species of *Mesoplodon* in the Atlantic and is the most frequently seen and stranded *Mesoplodon* species in the north Atlantic (Reid *et al.*, 2003). It is generally found in deep water, although has been recorded in the North Sea (Reid *et al.*, 2003). Cuvier's beaked whale, is frequently recorded in the Bay of Biscay and further south, and there have been a few confirmed sightings in UK waters (off west Scotland and in the northern North Sea), all in the summer (Reid *et al.*, 2003).

5.14.2 Abundance

In the western Atlantic several estimates have been made for Mesoplodon spp. Grouped, and Cuvier's beaked whale and these have all been in the low hundreds. However, due to the cryptic nature of these species (deep diving and occurring in small groups) these estimates carry a substantial negative bias

5.14.3 Occurrence in Aberdeen Bay and surrounding area

The sightings records suggest that beaked whales are very rare visitors to the northern and central North Sea. In summer the northern bottlenose dolphin appears to move towards north-west European shelf waters, where most records occur between April and September, peak sightings off northern Scotland have been recorded in August (Evans, 1992; Reid *et al.*, 2003).

A northern bottlenose whale was recently sighted near the entrance to Aberdeen Harbour in 2009 (C. Bloomer Pers comm.)

No beaked whale species were recorded during the project surveys.

5.14.4 Diet

Northern bottlenose whales are predominantly squid feeders. They do not appear to enter the North Sea very frequently and it is likely that when they do, they would be following squid (Hammond *et al.*, 2001). Their diet is dominated by a variety of squid species, particularly *Gonatus fabricii* and species of the genera *Histioteuthis* and *Octopoteuthis*, but also includes some fish species and crustaceans (Reid *et al.*, 2003).

Stomach content analysis of northern bottlenose whales stranded in the North Sea (Netherlands, 1993 and 1956; Denmark, 1997; Dunbar, Scotland, 1885) indicated that the food remains consisted almost entirely of cephalopod beaks, with only a few fish and crustacean remains. The cephalopod prey consisted mainly of oceanic species, in particular *Gonatus fabricii* (Santos *et al*., 2001b).

Sowerby's beaked whale diet is generally dominated by fish and squid. The stomach contents of three animals stranded in Scotland consisted of Merluccidae spp. and Gadidae spp. (MacLeod *et al*., 2003). The stomach contents of one Sowerby's beaked whale stranded in Scotland (1993-1995) had only large Gadidae otoliths (haddock/saithe/pollack) in the stomach (Santos *et al*., 1995).

5.14.5 Strandings

One Sowerby's beaked whale has been recorded by the SAC along the northeast coast of Scotland from Fraserburgh to Inverbervie between January 1992 and March 2010 (CSIP 2010). The male had a body length of 470cm and was recovered from Peterhead in January 2005 (SAC, 2006).

Strandings records suggest that although Sowerby's beaked whales may be present in the area, their occurrence is occasional/rare and the number of animals in the area is likely to be low.

6. SEALS

6.1 Harbour (or common) seal (*Phoca vitulina*)

6.1.1 Distribution

Harbour seals are one of the most widespread pinniped species and have a practically circumpolar distribution in the Northern Hemisphere. Harbour or common seals are found around the coasts of the North Atlantic and North Pacific from the subtropics to the Arctic. There are four sub-species. Only the eastern Atlantic harbour seal, *Phoca vitulina vitulina,* occurs around Britain (Hammond *et al*., 2004; SCOS, 2006).

Britain is home to approximately 40% of the world population of the European sub-species. Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast, their distribution is more restricted with concentrations in The Wash, Firth of Tay and the Moray Firth (Hammond *et al*., 2004; SCOS, 2006). The Moray Firth supports a population of approximately 1,600 harbour seals, the largest on the east coast of Scotland (Thompson *et al*., 2007).

Figure 41 depicts the distribution of harbour seals in the north-western North Sea as it was believed to be before satellite telemetry studies (after Reijnders *et al*., 1997), at-sea sightings from Pollock *et al*. (2000) are also shown (taken from Hammond *et al*., 2004).

Satellite telemetry of harbour seals found in Orkney and Shetland and seals hauling out in St Andrews Bay and the Moray Firth indicate the true distribution of seals around north-east Scotland as illustrated in Figure 42) (taken from Hammond *et al*., 2004).

Figure 41 Harbour seal distribution in the north-western North Sea after Reijnders *et al*. (1997). Also shown are haul-out sites during the moult (SMRU unpublished data) and at-sea sightings from JNCC surveys

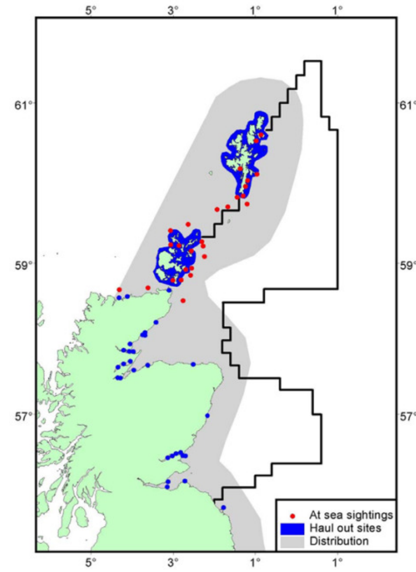
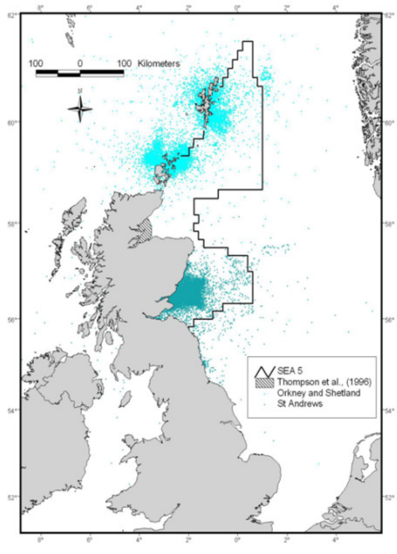


Figure 42 Locations of 55 harbour seals fitted with satellite-relay data loggers covering the period 2002-2004 (SMRU unpublished data) and the area used by VHF-tagged harbour seals in the Moray Firth



6.1.2 Occurrence in Aberdeen Bay area

Harbour seals are frequently observed in the River Don, and at least nine animals including juveniles and are often seen in the mouth of the Dee or hauled out on sand banks near the Bridge of Don. They are also recorded in Aberdeen Harbour, and may be expected to occur year-round in Aberdeen Bay. During project vantage point surveys, harbour seals were recorded at Blackdog in June 2007, Donmouth in July 2007 and at Blackdog and Donmouth in January 2008.

The SMRU data on haul out locations of harbour seals indicates the nearest harbour seal haul-out site is located 7.9 km from the proposed wind farm site during August 2005 survey (presented in Figure 48 and Figure 49).

Detailed observations of the behaviour of harbour seals at sites within the estuaries of the Rivers Dee and Don, in north-eastern Scotland, were made over two full years between 1993 and 1996 (Carter *et al*., 2001). Small numbers of grey seals were also present. The presence of seals within the estuaries was strongly related to season, with maximum numbers observed in winter and early spring; seals were virtually absent in June and July. The River Don was used largely as a haul-out site, while the River Dee was used predominantly as a foraging site, although it was not possible to determine whether the same seals were using the two estuaries. More seals were hauled-out on the River Don during twilight and dark than in daylight (Carter *et al*., 2001).

Common seals were only detected during the four months of EOWDC boat based survey 2010-2011, the results are discussed further in Section 6.3.

6.1.3 Abundance

The most recent estimate of the number of common seal in Scotland is 19,988, from surveys carried out in 2006-2008 (SCOS 2009). The abundance estimates have a degree of error as only a proportion of the individuals in the population will be hauled out and counted during. The total British population has been estimated at 40,000-46,000, and this takes into account animals missed during the counting (SCOS 2009).

Approximately 20% of the eastern Atlantic harbour seal subspecies breeds in Orkney and Shetland and along the east coast of Scotland (Hammond *et al*., 2004).

Surveys of the east coast populations in 2008 showed continuing declines in the Firth of Tay population and a continued lack of recovery in the Moray Firth; the reasons causing this recent decline are not known at present. The lack of recovery contrasts with the apparent rapid growth in populations in the nearest European populations in the Wadden Sea which increased by 15% between 2007 and 2008 and has grown by approximately 13% per annum since the 2002 PDV epidemic (SCOS 2008).

Due to declines in the numbers of harbour seals counted in Shetland, Orkney, the Moray Firth and the Firth of Tay, the Scottish Executive put in place a Conservation Order protecting harbour seals on the east coast and Northern Isles in March 2007. The Order covers the coast from Garron Point by Stonehaven to Torness Point, south of Dunbar on the south side of the Firth of Forth. Seals in the Moray Firth are already protected by a Conservation of Seals (Scotland) Order 2004.

6.1.4 Haul-out sites and breeding

Harbour seals come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. They tend to be more localised than grey seals, staying in the same general area to breed, feed and rest, and do not form as large breeding colonies. Harbour seals haul out on land regularly in a pattern that is often related to the tidal cycle (SCOS, 2006).

Pupping occurs on land from June to July during which time females and pups spend a high proportion of their time ashore. The moult is centred around August and extends into September. Moulting seals also spend a high proportion of their time ashore, so from June to September harbour seals are ashore more often than at other times of the year (Hammond *et al*., 2004).

6.1.5 Movements and foraging

The radio-tracking of adult female seals in the inner Moray Firth (1988, 1989, 1992) during the breeding season indicated that seals foraged up to 45 km from the haul-out site, but females with pups restricted their range markedly during the early part of the lactation period (Thompson *et al*., 1994).

Generally it has been thought that harbour seals forage relatively close inshore within a range of 60 km from their haul-out sites (Thompson *et al.*, 1996). However, recent information on foraging movements and the distribution at sea of harbour seals has highlighted greater travel distances, ranging from 10 km to 120 km, with a mean of 46 km (Hammond *et al*., 2004).

Data from satellite relay data loggers (SRDLs) have highlighted different foraging behaviour of harbour seals off southeast Scotland and around Orkney and Shetland. Off southeast Scotland, animals were found to be very faithful in their use of haul-out sites on land, and moderately site-faithful in the areas individuals used to forage. Duration of trips ranged from less than one day to 23 days, with a mean of 4.5 days. Foraging in the Moray Firth was mostly closer to the shore. Around Orkney and Shetland there are indications that seals tend to move between haul-outs sites within a 40 km radius of where they were captured with one animal hauling out as far as 200 km from where it was initially tagged. Foraging behaviour is also much more variable both in distance travelled and in the duration of trips. Most foraging trips are within 40 km of haul-outs but there are also longer distance trips to areas more than 200 km from haul-out sites (Hammond *et al*., 2004).

6.1.6 Diet

Harbour seals take a wide variety of prey including sandeels, whitefish, herring and sprat, flatfish, octopus and squid. Diet varies seasonally and from region to region (Hammond *et al*., 2004; SCOS, 2006). In Shetland, Brown and Pierce (1998) found that gadids accounted for an estimated 53.4% of the annual diet by weight, sandeels 28.5% and pelagic fishes 13.8%. The dominant gadid fishes were whiting and saithe. There were strong seasonal patterns in the contribution of sandeels and gadids, with sandeels being important in spring and early summer, and gadids in winter. Pelagic species (mainly herring, garfish and mackerel) were important in late summer and autumn (Hammond *et al*., 2004).

In the Moray Firth, Tollit andThompson (1996) found the key prey during 1989-1992 to be sandeels, lesser octopus, whiting, flounder, and cod. Significant between-year and seasonal fluctuations were evident. In another study in the same area between 1992 and 1994, Tollit *et al*. (1997) found the diet composition was almost totally dominated by either pelagic species or species dwelling on or strongly associated with the seabed, depending upon the relative abundance of pelagic schooling prey (Hammond *et al*., 2004).

In the Firth of Tay, unpublished SMRU data from 1998-2003 show that the diet comprised primarily sandeels, gadids and flatfish. Gadid prey was dominated by whiting, followed by cod and haddock. Plaice was the main flatfish consumed followed by dab, flounder and lemon sole. Strong seasonal patterns in prey consumption were evident (Hammond *et al*., 2004).

During observation at the estuaries of the Rivers Don and Dee, the seals were observed to eat mostly salmonids, *Salmo salar* and *S. trutta*, unidentified roundfish and founder, *Pleuronectes flesus*, there were also observations of seals taking starfish and crabs. Predation on salmonids was observed more frequently on the Dee than the Don, while the reverse was true for predation on flounder. The otoliths identified in scats collected at the mouth of the River Don belonged to marine species, including whiting, sandeels, cod, *Trisopterus* spp., haddock, plaice and lemon sole, as well as three octopus beaks, indicating that the seals were also feeding outside the estuaries (Carter *et al*., 2001).

6.1.7 Special Areas of Conservation

Designated coastal SACs for harbour seals include Yell Sound and Mousa on Shetland, Sanday on Orkney, Wash and North Norfolk coast on the east coast of England, Dornach Firth and Morrich More, in the Moray Firth, and Firth of Tay and Eden Estuary on the Scottish east coast (JNCC, 2011).

6.2 GREY SEAL (*HALICHOERUS GRYPUS*)

6.2.1 Distribution

Grey seals are restricted to the North Atlantic and adjacent seas. There are three recognised populations: the northwest Atlantic (breeding primarily on Sable Island, Canada and in the Gulf of St Lawrence); the Baltic Sea; and the northeast Atlantic (breeding primarily on offshore islands around the British Isles but also in Iceland, the Faroe Islands, France, the Netherlands, central and northern Norway, and around the Kola peninsula in Russia) (Hammond *et al*., 2004). Figure 43 shows the tracks of 108 grey seals recorded over a period of about 10 years and the locations at which it has been determined that the seals were foraging, the specific locations are shown in Figure 44 (McConnell *et al.*, 1999; taken from Hammond *et al*., 2004). More recent analysis of grey seal movements in the Pentland Firth area has been provided by SMRU Ltd, which further illustrates the large scale seasonal movements that occur between seals occurring at spatially separate haul out colonies in the North Sea.

Figure 43 Tracks of 108 grey seals fitted with satellite-relay data loggers over a period of about 10 years (McConnell *et al.,* 1999; SMRU unpublished data)

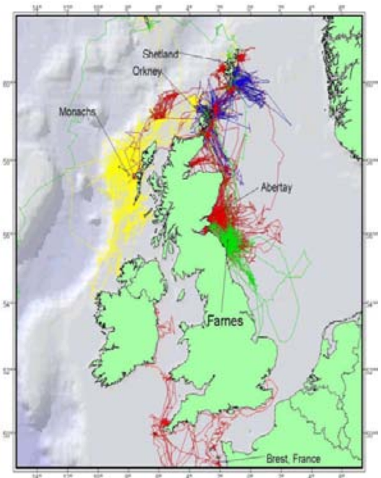


Figure 44 Locations of 108 grey seals fitted with satellite-relay data loggers over a period of about 10 years (McConnell *et al.,* 1999)

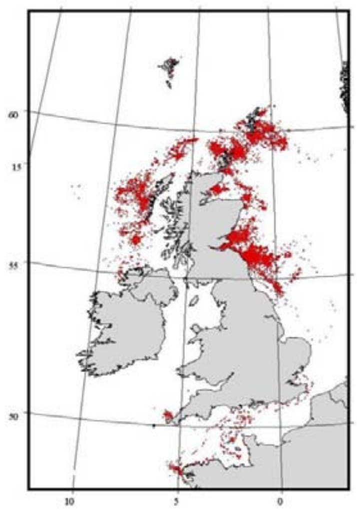
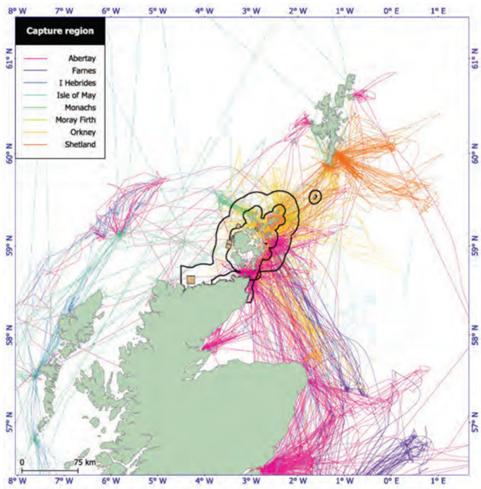


Figure 45 Grey seals tagged with SMRU Argos and SMRU GSM/GPS tags, the tracks are colour coded by capture region (SMRU 2011c)



6.2.2 Abundance

The Grey seal population of the UK is significant in a global context as the UK population represents approximately 45% of the world population on the basis of pup production (SCOS 2009). Over 90% of British grey seals breed in Scotland, the majority in the Hebrides and in Orkney (SCOS, 2006).

Combining the abundance estimates for the annually monitored seal colonies with the sites which are monitored less frequently provides an estimated seal population of 205,000, with a large confidence interval of (96,500; 405,000). A large proportion of the populations are associated with the colonies in Orkney, Shetland, and the east coast of Scotland (Hammond *et al*., 2004).

The latest population estimate has suggested an increase of around 2.8% between 2007 and 2008. The British grey seal population has been increasing by around 6% annually since the 1960s.

6.2.3 Occurrence in Aberdeen Bay area

Grey seals are frequently observed at sea during vessel-based cetacean surveys carried out by the Sea Watch Foundation, including large bulls, females and immature animals. Seals use the waters between Stonehaven and Aberdeen as a feeding area, since animals are often observed eating fish at the surface.

Grey seals are frequently observed hauled out on the Skerry just outside Peterhead harbour and may be expected to occur year-round in the area. Grey seals have important haul-out sites at Pennan Head, Rattray Head, Boddam, Catterline and Donmouth.

Grey seal sightings recorded during project VPS surveys (August 2005 – March 2008) are summarised in Table 25.

Table 25 Grey seal sightings recorded during Vantage Point surveys (August 2005 – March 2008)

VP site	Observations
Donmouth	August 2006, December 2006, March 2007, May 2007, August 2007, September 2007
Blackdog	August 2006, December 2006, January 2007, March 2007, May 2007, August 2007, December 2007
Balmedie	December 2006, February 2007, August 2007
Drums	February 2007, August 2007, September 2007

The nearest grey seal haul-out sites identified during the SMRU seal surveys in August 1997 and 2005 were located 7.9 km from the proposed wind farm site (presented in Figure 48 and Figure 49).

Grey seals were present throughout the survey area during all the boat based survey months and the results are presented in Section 6.3.

6.2.4 Haul-out sites and breeding

Grey seals haul out between foraging trips and for pupping and moulting, when they can form large colonies or aggregations (Hammond *et al*., 2004). Grey seals generally form breeding colonies on rocky shores, beaches and in caves, and on small, largely uninhabited, islands (JNCC, 2011). Large rookeries are located in the Inner and Outer Hebrides, Orkney, Isle of May, Farne Islands and Donna Nook (JNCC, 2011).

In Northern Britain, pupping occurs from October to late November and the moulting season is February-April, when they spend more time ashore than at other times of the year (Hammond *et al*., 2001).

Numbered tags attached to the flippers of pups indicate that young seals disperse widely in the first few months of life. Pups marked in the UK have, for example, been recaptured or recovered along the North Sea coasts of Norway, France and The Netherlands, mostly during their first year of life (Hammond *et al*., 2004).

6.2.5 Movements

Adult grey seals routinely move large distances. Grey seal movements have been studied in the North Sea using satellite-linked telemetry. In a study of animals at the Farne Islands and Abertay Sands, McConnell *et al.* (1999) found that movements were on two geographical scales: long and distant travel (up to 2,100 km away) to known haul-out sites; and local, repeated trips from haul-out sites to discrete offshore areas. Long-distance travel included visits to Orkney, Shetland, the Faroes, and far offshore into the Eastern Atlantic and the North Sea (Hammond *et al*., 2004). Recent telemetry studies have found that seals tagged as far south as the Farne Islands, Isle of May and Moray Firth have been found to enter the Pentland firth area (SMRU 2011c).

In 88% of trips to sea, individual seals returned to the same haul-out site from which they departed. The durations of these return trips were short (typically 2-3 days) and their destinations at sea were often localized areas characterized by a seabed of gravel/sand. This is the preferred burrowing habitat of sandeels, an important component of grey seal diet. The limited distance from a haul-out site of return trips (about 40 km) indicates that the seals were foraging within the coastal zone, rather than further offshore (Hammond *et al*., 2004).

The analysis of the seal telemetry data has shown that grey seals tagged in both the Isle of May SAC and Berwickshire and North Northumberland coast SAC appear to routinely travel past Aberdeen through the proposed location on the way to the Pentland Firth.

6.2.6 Diet

Grey seals feed mostly on fish that live on or close to the seabed. The diet is composed primarily of sandeels, whitefish (cod, haddock, whiting, ling), and flatfish (plaice, sole, flounder, dab) but varies seasonally and from region to region (SCOS, 2006).

Studies in 1985 showed that in Orkney sandeels accounted for almost 50% of the diet; the remainder was mostly cod, ling and plaice (Hammond, *et al.*, 1994). In the central North Sea, studies have shown that the diet was dominated by sandeels, cod and whiting (Hammond and Prime, 1990; Hall and Walton, 1999). Overall, grey seal diet comprises primarily sandeels, gadoids and flatfish, in that order of importance (Hammond *et al.*, 2004).

Sandeel, cod, other gadoids and plaice are the most important prey of grey seals in the North Sea (Hammond and Grellier, 2006). There were marked changes in grey seal diet composition between 1985 and 2002. In the east coast region, the percentage of gadoids in the diet was lower and the percentage of sandeels was higher in 2002 compared with 1983-88, and within the gadoids the percentage of cod in the diet overall declined almost 5-fold and the percentage of haddock increased by an order of magnitude (Hammond and Grellier, 2006).

6.2.7 Special Areas of Conservation

Designated coastal SAC sites for grey seals include the Berwickshire and North Northumberland Coast in north-east England, Faray and Holm of Faray on Orkney and the Isle of May at the entrance to the Firth of Forth (JNCC, 2011).

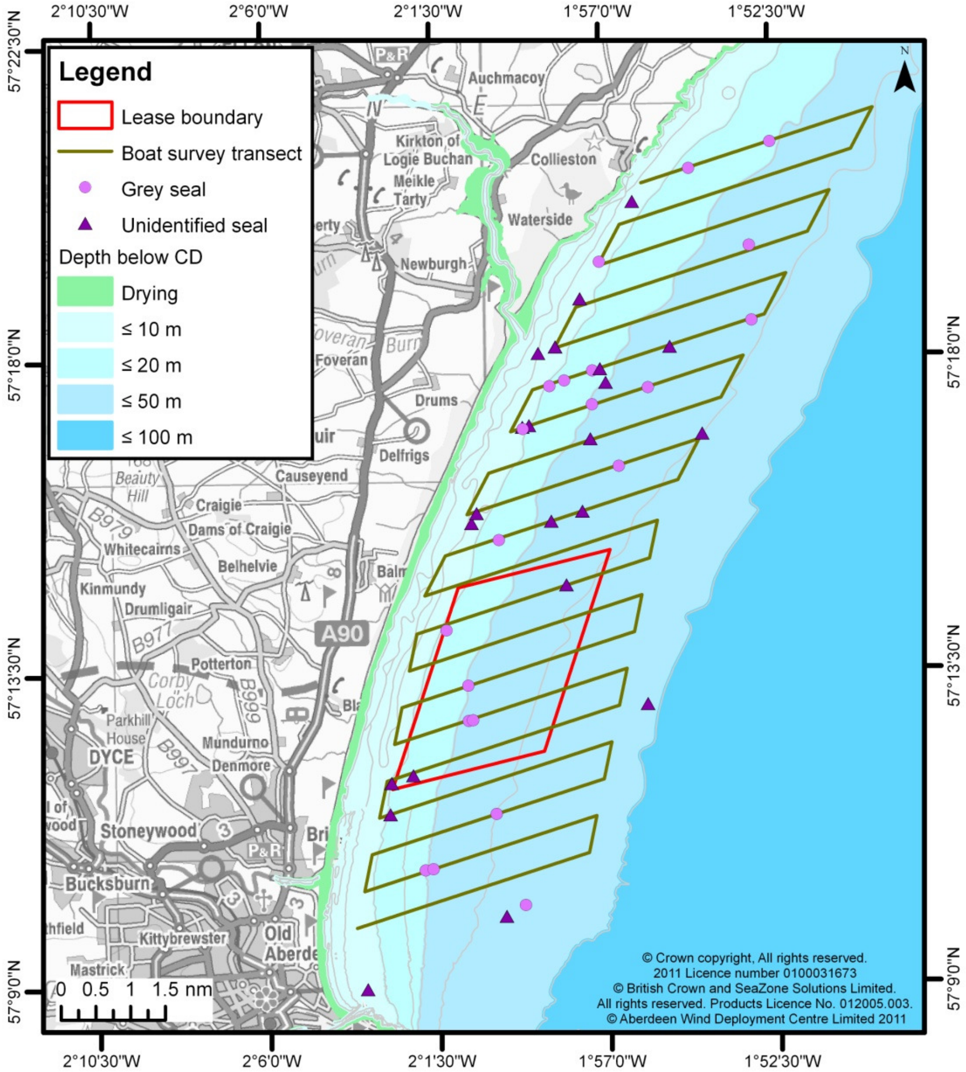
6.3 Boat Based Survey Seal Counts

A summary of the seal species that were recorded during the project boat based surveys are provided in Table 26. A total of 114 individual seals, of which a total of 44 were grey seals, 27 harbour seals and 37 were unidentified seals were observed (Figure 46 and Figure 47).

Table 26 Summary of the seal observations during the IECS (2007-2008) and SMRU Ltd (2010-2011) surveys (collected on and off effort).

Survey	Grey Seal	Harbour Seal	Unidentified
IECS -2007-2008	21	0	25
SMRU Ltd 2010-2011	23	27	18
Totals	44	27	43

Figure 46 Grey and unidentified seals observed during the EOWDC boat based surveys during 2007-2008 (collected on and off-effort)



6.3.1 Grey seals

The grey seal was the most frequently recorded species, with a total of 21 individuals recorded on effort during the boat based surveys 2007-2008 (Figure 46). The grey seal was sighted throughout the survey period with no apparent increase in frequency of sightings with any particular season. There were a higher number of grey seals (n=13) observed in the control area in comparison to the wind farm area (n=8). Despite a lower survey effort there were a higher number (n=24) of grey seals recorded during the 4 months of boat based surveys carried out during 2010-2011 (Figure 47).

6.3.2 Common seals

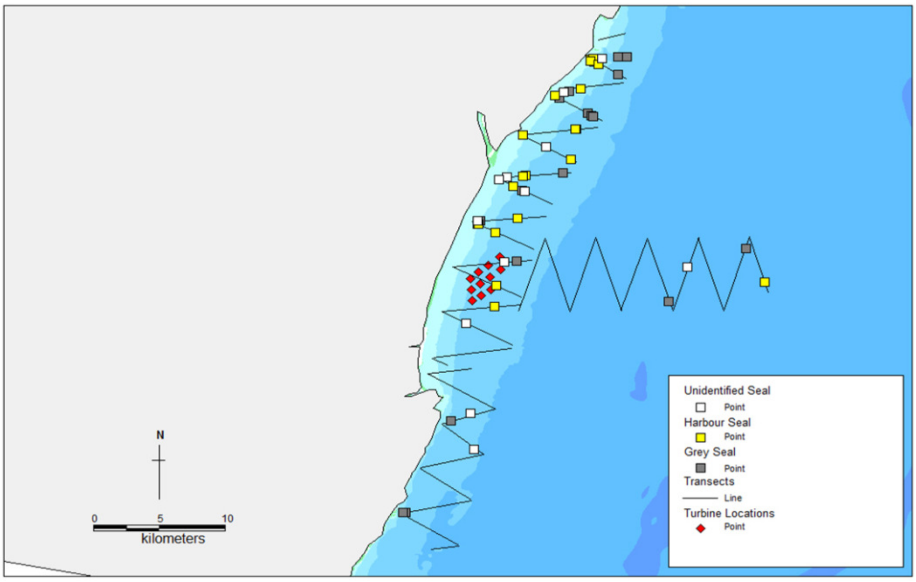
Surprisingly no harbour seals were observed during the boat based surveys carried out during 2007-2008. In the four months of boat based surveys carried out during 2010-2011 there were 27 harbour seals observed;

this suggest that either common seals were present at a lower abundance in Aberdeen Bay during this time, or a proportion of the unidentified seal species that were common seals.

6.3.3 Unidentified seals

During the boat based surveys carried out during 2007-2008 there were 25 seals observed that could not be identified to a species level, three of which were observed off transect (Figure 46). A greater number of sightings of unidentified seals (n=18) were observed in the wind farm area that the control site. There were 15 unidentified seals recorded during the boat based surveys carried out during 2010-2011.

Figure 47 On-effort observations of seals along transects during August, September and November 2010, and January 2011



6.4 Aerial Survey Data Seal Counts

The Sea Mammal Research Unit (SMRU) has surveyed harbour seals along the east coast of Scotland as part of their routine monitoring of seal populations around the UK. Surveys were carried out in 1997 and 2005, 2007 and 2008 (Figure 48 and Figure 49). The surveys were conducted during the harbour seal annual moult, in August, when the most consistent numbers of harbour seals are hauled ashore. The surveys were conducted using a helicopter equipped with a thermal imaging camera which can detect seals hauled ashore up to a 3 km distance. For consistency, surveys are restricted to within two hours either side of afternoon low tides on days with no rain.

Grey seals were also counted during these August surveys. The two species are determined using their thermal profiles and their group structure on shore and species identity is confirmed using a 'real' image from a camcorder and directly using binoculars. However, in some cases this it is not possible and the seals are classified as 'species unknown'. Additional information on grey seals is also obtained during their breeding season, September to November, using fixed wing aerial photography. Repeat surveys are made of the breeding colonies which allow subsequent estimates of pup production to be made on a colony-by-colony basis.

6.4.1 Counts and distribution of seals Fraserburgh to Montrose

The numbers of seals counted during the August thermal imaging surveys between Fraserburgh and Montrose are provided in Table 27. The sections of coast for which numbers of seals are supplied extend from Fraserburgh to Aberdeen and from Aberdeen to the mouth of the River North Esk (SMRU, 2007).

Table 27 Numbers of harbour and grey seals counted between Fraserburgh and Montrose in 1997 and 2005

Date	Region	Harbour Seals	Grey Seals	Species Unknown
Aug-97	Fraserburgh to Aberdeen	0	131	
Aug-97	Aberdeen to North Esk	15	14	
	Total	15	145	
Aug-05	Fraserburgh to Aberdeen	14	400	3
Aug-05	Aberdeen to North Esk	22	11	
Total		36	411	3

In the survey during August 2005 harbour seals were hauled out at the mouth of the River Ythan and at Catterline. Only small numbers of seals were at these haul-out sites at the time of survey. Another group of nine harbour seals were hauled out in the Montrose Basin, just outside the area covered by Table 27 (Figure 49).

Small numbers of grey seals were also hauled out at Catterline and at the mouth of the River Ythan but there were considerably more hauled out between the south end of Cruden Bay and Fraserburgh. The main haul-out sites were: The Scares at the south end of Cruden Bay; around Boddam, south of Peterhead; at the mouth (north side) of Peterhead Bay; Scotstown Head; and at Cairnbulg Point. Another group of grey seals was hauled out just outside this area, at Sandhaven, just to the east of Fraserburgh (Figure 48 and Figure 49).

Variable, but very small, numbers of grey seal pups are born at a number of sites along this section of the east coast of Scotland. The most well established colony is at Catterline, where up to five pups may be born each autumn.

6.4.1.1 Counts and distribution of seals in the wider area Nairn to Kincardine Bridge

Outside the Fraserburgh to Montrose area, but still along the east coast of Mainland Scotland, larger numbers of seals can be found. Information from at-sea tagging studies show the east coast of Scotland is used by individuals of both species which move and forage along this coast. Under the EU's Habitats Directive, the Firth of Tay has been designated a Special Area of Conservation (SAC) for harbour seals and the Isle of May in the Firth of Forth, an SAC for grey seals. Animals from these areas will potentially move along the coast between Fraserburgh and Montrose.

Consequently, survey data from a wider area (Nairn to Kincardine Bridge) is provided in Table 28, to allow the numbers of seals in the area of concern (Fraserburgh to Montrose) to be put into context.

Table 28 Numbers of harbour and grey seals counted between Nairn and the Kincardine Bridge from surveys carried out in the Augusts of 1997 and 2005 (SMRU, 2007)

Date	Region	Harbour Seals	Grey Seals	Species Unknown
Aug-97	Nairn to Fraserburgh	47	65	-
Aug-97	Fraserburgh to Aberdeen	0	131	-
Aug-97	Aberdeen to North Esk	15	14	-
Aug-97	North Esk to Buddon Ness	0	0	-
Aug-97	Buddon Ness to Newburgh	92	61	-
Aug-97	Newburgh to Tayport	56	0	-
Aug-97	Tayport to Fife Ness	485	1,849	-
Aug-97	Fife Ness to Kincardine Bridge	76	176	-
Aug-97	Isle of May	0	46	-
	Total	771	2,342	-
Aug-05	Nairn to Fraserburgh	77	245	-
Aug-05	Fraserburgh to Aberdeen	14	400	3
Aug-05	Aberdeen to North Esk	22	11	-
Aug-05	North Esk to Buddon Ness	9	0	-
Aug-05	Buddon Ness to Newburgh	92	43	-
Aug-05	Newburgh to Tayport	48	0	-
Aug-05	Tayport to Fife Ness	221	530	-
Aug-05	Fife Ness to Kincardine Bridge	176	73	8
Aug-05	Isle of May	0	18	
Total		659	1,320	-

Between Nairn and Kincardine Bridge, the main harbour seal haulout sites are at Findhorn Bay, in the Firth of Tay and the Eden Estuary and between Kirkaldy and Dalgety Bay on the Fife (north) shore of the Firth of Forth.

The main grey seal haulout sites used during August are scattered along the north Grampian coast at Findhorn Bay, Covesea and Halliman Skerries off Lossiemouth, Craigenroan Skerries near Findochty and Strahangles Point near Rosehearty. South of the North Esk, the Firth of Tay and the River Eden are the main grey seal haul out sites, with smaller numbers also using the small islands in the Firth of Forth. The Isle of May, as already mentioned, is a SAC for grey seals, which has supported a total pup production of over 1,800 seals since 1998. It should be noted that the numbers of grey seals counted here during the August surveys are very low.

6.4.1.2 Cautionary note on the counts of seals calculated from aerial surveys

These counts represent the seals that were counted ashore. They do not represent the total size of the local population, since a number of seals would have been at sea at the time of the survey.

Please note that these data refer to the numbers of seals found within these areas in August only; numbers are likely to vary at other times of the year. For instance, small numbers of harbour seals haul out during the winter on the small island at the mouth of the River Don, in Aberdeen. In addition, the numbers of grey seals ashore during the summer can be highly variable from day to day and the numbers presented above should be interpreted with caution.

Figure 48 Haul out locations of harbour and grey seals August 1997

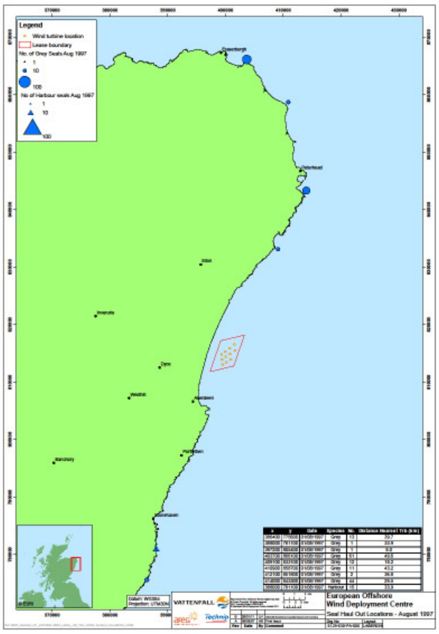
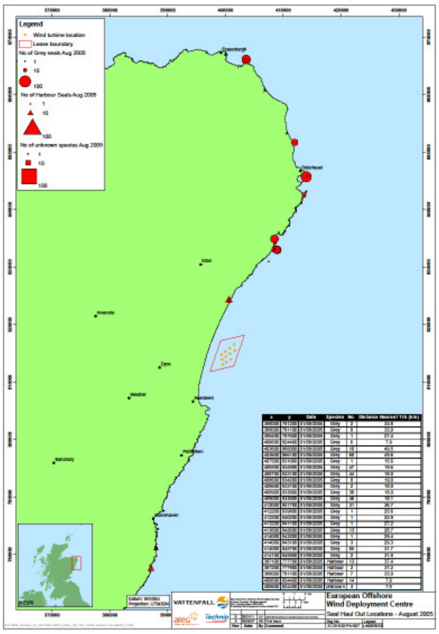


Figure 49 Haul out locations of grey and harbour seals in August 2005



6.4.2 Other seal species

There are occasional records of hooded seal, bearded seal, ringed seal and walrus in the north-east Scotland area (Hammond *et al*., 2004). All these species are considered to be rare visitors to Aberdeen bay area.

7. SUMMARY

The marine mammal environmental baseline is based on available information on marine mammals relevant to the proposed EOWDC and surrounding area, as the project develops and more information becomes available from the additional boat based surveys carried out, the marine mammal environment baseline could be updated.

The review of the distribution of each marine mammal species indicates that although several marine mammals have the potential to be in the area, for the majority of these species the area is only a marginal part of their habitat. Most species, with the exception of bottlenose dolphins, have a wide range and regularly occur throughout the northern and central North Sea, both along the coast and in offshore areas.

Sightings and strandings data provide useful information on the occurrence of marine mammals in the area and indicate that bottlenose dolphins, harbour porpoises, white-beaked dolphins, minke whales, harbour and grey seals have been regularly recorded in the area throughout most the year. Most other marine mammal species have been recorded infrequently and at certain times of the year, suggesting that the area is a small part of their range for a limited time and that relatively low numbers may be present in the area.

In order to understand why marine mammal species may be present in the area it is important to have information on their diet and examine what prey species may be attracting them to the area. The diet of marine mammal species regularly recorded in the area is varied and diverse; however, it is apparent that bottlenose dolphins are feeding on salmon at the mouth of the River Dee, harbour porpoises are probably feeding on whiting and sandeels and the seasonal occurrence of white-beaked dolphins may be linked to seasonal availability or movements of prey, such as mackerel. Harbour and grey seals have been observed feeding on salmonids and flatfish at the estuaries of the Rivers Dee and Don. Although this is a comprehensive baseline assessment, there are some areas for which there is currently limited information, such as what prey several of the marine mammal species that are regularly present in the area are feeding on. Cetacean species are particularly difficult study subjects to collect dietary information on, although strandings data has provided some useful snapshots of prey items consumed prior to beaching events, this data may not always be representative of healthy adults prey choice.

Examination of the life history of marine mammals regularly occurring in the area highlights the seasonal sensitivities, such as calving periods, of these species. Young bottlenose dolphin calves have been observed in the area during spring and early summer. The calving period of harbour porpoises in Scottish waters is estimated to be between April and June, with calves being observed in the area between May and September. White-beaked dolphin calves have been observed in the area between June and August. Seals spend a higher proportion of their time ashore and in coastal waters during the pupping and moulting seasons, for harbour seals pupping occurs from June to July and moulting occurs from June to September and for grey seals pupping occurs from October to November and the moulting season is between February and April.

The main findings from this review indicate that of the marine mammal species recorded in the area, bottlenose dolphins, harbour porpoises, white-beaked dolphins, minke whales, harbour and grey seals are regularly present in the area. Therefore, these species, could be affected by potential impacts associated with the proposed development, such as underwater noise disturbance, changes in prey availability and foraging areas, displacement and barrier effects. These potential impacts and possible mitigation measures will be addressed in the EIA technical report.

Bottlenose dolphin were the second most frequently sighted cetacean species during the surveys carried out as part of the EOWDC, with a total of 200 individuals being detected. The majority of the sightings occurred in the spring and summer months. A higher number of bottlenose dolphins were recorded in the wind farm area in comparison to the control site and in the vicinity of the entrance to Aberdeen harbour, which is a known hotspot for dolphin sightings.

The bottlenose dolphin population of the Moray Firth has recently been expanding its range in a southerly direction, beyond the boundaries of the Moray Firth SAC, with an increasing in sightings and identified individuals along the east coast of Scotland as far as St Andrews and the Firth of Forth. Although Aberdeen is recognised as an important area for bottlenose dolphins, further studies are required to more accurately determine the proportion of the population that utilises this area throughout the year.

Harbour porpoises were the most recorded cetacean species during the EOWDC boat surveys and was the only species that was detected in sufficient numbers to allow a detection function to be applied that would allow for abundance and density estimates to be generated. The density of harbour porpoises was higher in the control area in all seasons except summer. Lowest densities occurred during May and June. The density estimates produced for harbour porpoise all show considerable error margins which is a reflection of the sampling effort, further surveys would reduce this. In the four surveys carried out during 2010-2011 the northern transect had the highest proportion of harbour porpoises, except in January when highest densities were recorded in the southern transect.

The harbour porpoise, as expected, was the most frequently detected cetacean species during the acoustic surveys. In agreement with the results of the visual surveys the control area recorded more acoustic detections than the wind farm survey area. In the acoustic surveys carried out during 2010-2011 higher numbers of detections were made in the offshore survey area during the August and September surveys, although it is too early to conclude whether this represents a movement of animals further offshore during the summer months.

White beaked dolphins have been detected during the EOWDC surveys over the course of several years during the month of August; this data supports the occurrence of this dolphin as a seasonal summer visitor that possibly moves to coastal waters following prey such as mackerel and or for calving purposes.

Six minke whales have been observed as part of the EOWDC surveys. Minke whales are thought to have a preference for water depths of 38 m or deeper, these depths are generally found further offshore and beyond the EOWDC crown estate licence area, although a minke whale was detected within the EOWDC crown estate lease area during the boat based surveys.

Only one solitary short-beaked common dolphin was detected during the boat based surveys. Other cetacean species that were detected were Risso’s dolphins during vantage point surveys, but not during any of the EOWDC boat surveys. The increase in sightings of Risso’s dolphins may point towards an increase in the use of the Aberdeen area in comparison to historic levels.

Both species of seal grey and harbour seals are regularly present and frequently sighted in Aberdeen bay, especially at the entrances to the Rivers Dee and the Don. Grey seals were the most frequently observed seal species recorded during the boat surveys carried out in 2007-2008. Almost equal proportions of grey and common seals were recorded during boat surveys carried out during 2010-2011.

Designated coastal SACs for harbour seals are present along the east coast of mainland Scotland, these are situated in the Dornoch Firth and Morrich Moore in the Moray Firth and Firth of Tay and Eden estuary. Designated SAC's for coastal seals along the east coast of Scotland include the Isle of May at the entrance of the Firth of Forth, and it can be expected that individual seals from these colonies may be passing through the EOWDC development area.

8. APPENDICIES

8.1 THE EFFECTS OF G(0) < 1

This section explains the influence that defining the number of 'missed animals' has on the abundance estimates generated from transect surveys. The probability of detecting an animal on the transect line, g(0), is normally assumed to be 1 which would be for a certain detection, but for marine mammals, which spend a proportion of the time below the surface, this assumption is not generally valid. Double observer methods are needed to accurately calculate the g(0) value specific to each species and survey vessel, and thus for this study, the influence of differing g(0) values on the density and abundance estimates generated are discussed. The study are and month used to illustrate the effects of altering the g(0) <1 value was the survey occurring in the Northern transect, in November 2010).

This area and month had the highest number of observations of harbour porpoises, thus providing the most robust sub-set for demonstration. The detection probability used in they analyses will therefore have a key influence on resulting estimates as is illustrated in Table 29. Detection values that are assigned a certain probability of detection g(0) are associated with the lowest standard error (165) and also the lowest abundance estimates (568).

Table 29 Density and abundance estimates with Standard Errors, generated for the North Strata in November, when assuming a range of g(0) values.

g(0)	Density estimate	SE	Abundance estimate	SE
0.2	18.84	5.45	2841	824
0.34	11.08	3.21	1671	485
0.4	9.42	2.73	1421	412
0.6	6.28	1.82	947	275
0.8	4.71	1.36	710	206
1	3.77	1.09	568	165

8.2 DETECTION RATES OF ODONTOCETE SPECIES DURING ACOUSTIC BOAT SURVEYS

Dolphin detections were recorded on a number of occasions during the EOWDC boat based surveys. It is currently not possible to identify, to a species level, clicks and whistles of the dolphin species that are likely to present in the EOWDC area, although corroboration with observations of cetaceans during visual searches does support species identifications.

Delphinid detections were only made during one of the seven surveys in which the hydrophone array was deployed in the boat based surveys carried out during 2007-2008. This was made during the December 2007 survey on transect CA. The position of the detection is shown on Figure 23. The very low number of detections means that the detection rates for all but one of the surveys are 0. Detection rates (where available) are displayed in Table 30.

Table 30 Whistle detection rates for the survey and transect containing a single whistle detection.

Number of detections	Effort (km)	Detection rate
December survey – all transects combined		
1	127	0.008
December survey – control site transects only		
1	63	0.016
December survey – wind farm transects only		
0	64	0
Detection rates – transect CA (combined all months)		
1	42	0.024

During the four months of boat based surveys deploying a hydrophone array during August, September, November 2010 and January 2011, dolphin detections were made during all 4 surveys; although only during "off effort" sections of the September 2010 and January 2011 surveys. Most of the detections were made during August 2010 survey. Locations of dolphin detections during the August survey are shown in Figure 50 and during all other surveys are shown in Figure 51.

Figure 50 Delphinid click and whistle detections made during the August 2010 survey

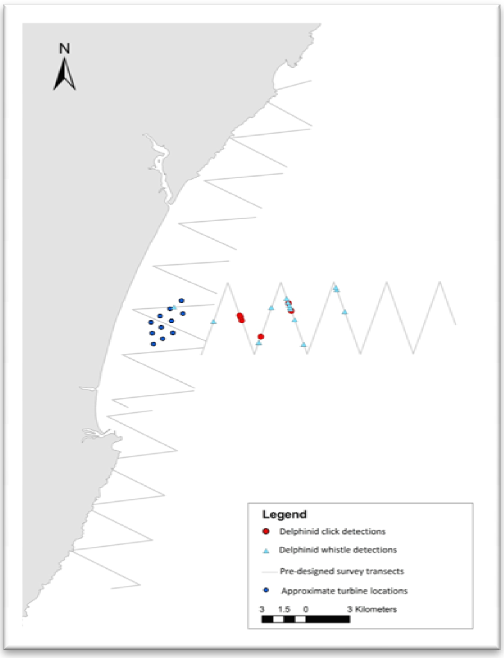
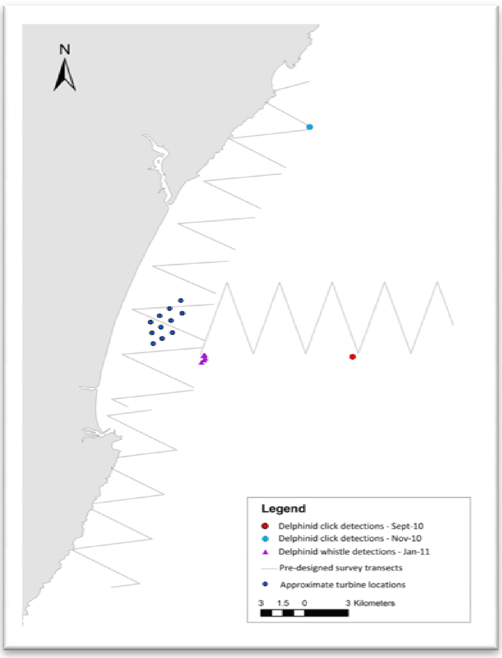


Figure 51 Delphinid click and whistle detections made during the September, November 2010 and January 2011 surveys



Only the dedicated acoustic effort (Table 6) was used to assess the acoustic detection rates of marine mammals across all three survey strata, for each of the four surveys. The September 2010 detections occurred during periods when the vessel was not sailing a pre-designed survey transect, and these have not therefore been analysed further. Detection rates (detections per km dedicated effort) have been calculated for the remaining click detections that were recorded during August and November 2010 (Table 31).

Whilst whistles were detected on both the August 2010 and January 2011 surveys, all of the January detections occurred during periods when the vessel was not sailing a pre-designed survey transect, and these have not therefore been analysed further. Due to the difficulty in meaningfully defining discrete encounters with dolphin groups when analysing whistles, the ”on effort” whistle data have been expressed as Whistle Positive Minutes”. These are defined as minutes which contain one or more whistle detections. The proportion of whistle positive minutes for each transect is shown in Table 32. It is probable that the click and whistle detections made during the August 2010 survey came from the same group of animals and it is likely that these were white beaked dolphins as they were present in the survey vicinity at the time.

Table 31 Detection rates for dolphin clicks during the August and November surveys- the only surveys on which dolphin clicks were detected during periods of dedicated effort

		August 2010			November 2010		
Strata*	Transect ID	Number of detections	km of survey effort	Detection rate	Number of detections	km of survey effort	Detection rate
North	10	0	1.422	0	0	1.234	0
	11	0	6.032	0	0	5.810	0
	12	0	5.986	0	0	5.804	0
	13	0	6.030	0	0	5.824	0
	14	0	5.749	0	0	5.767	0
	15	0	5.839	0	0	5.784	0
	16	0	3.965	0	0	5.035	0
	17	0	4.074	0	0	5.441	0
	18	0	3.279	0	0	4.573	0
	19	0	3.814	0	0	5.536	0
	20	0	4.727	0	0	4.609	0
	21	0	5.821	0	0	5.664	0
	22	0	4.208	0	0	4.108	0
	23	0	5.059	0	0	5.458	0
	24	0	2.557	0	2	3.133	0.638
	25	0	0	0	0	3262	0
	26	Not surveyed					
Offshore	27	0	6.255	0	0	5.953	0
	28	3	6.207	0.483	0	5.907	0
	29	1	6.028	0.166	0	5.966	0
	30	2	5.963	0.335	0	6.196	0
	31	0	6.143	0	0	5.807	0
	32	0	6.151	0	0	5.913	0
	33	0	6.135	0	0	6.033	0
	34	0	6.145	0	0	5.664	0
	35	0	6.187	0	0	5.957	0
	36	0	4.817	0	0	3.749	0

**the southern transects are not listed as no dolphin clicks were detected here during periods of dedicated effort*

Table 32 Proportion of dedicated effort found to be positive for dolphin whistles during the August surveys-the only survey on which dolphin whistles were detected during periods of dedicated effort

Strata*	Transect ID	Number of whistle positive minutes	Total number of minutes on transect	Proportion of whistle positive minutes
North	10	0	00:25:20	0
	11	0	00:06:10	0
	12	0	00:25:34	0
	13	0	00:25:36	0
	14	0	00:24:10	0
	15	0	00:25:02	0
	16	0	00:16:40	0
	17	0	00:17:20	0.058
	18	0	00:13:39	0
	19	0	00:16:30	0
	20	0	00:19:19	0
	21	0	00:25:00	0
	22	0	00:16:58	0
	23	0	00:21:20	0
	24	0	00:10:20	0
	25	0	0	0
	26	Not surveyed		
Offshore	27	1	00:25:12	0.04
	28	0	00:24:58	0
	29	2	00:24:00	0.08
	30	7	00:23:45	0.29
	31	0	00:26:26	0
	32	3	00:22:27	0.13
	33	0	00:22:48	0
	34	0	00:27:05	0
	35	0	00:22:27	0
	36	0	00:22:00	0

**the southern transects are not listed as no dolphin clicks were detected here during periods of dedicated effort*

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European Offshore Wind Deployment Centre

Environmental Statement

Appendix 12.2: Marine Mammals EIA Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

European Offshore Wind Deployment Centre

June 2011

EIA Technical Report Marine Mammals

Genesis Job Number J-71666/A

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1.1 INFORMATION FOR NON-TECHNICAL SUMMARY

This report follows the baseline marine mammal assessment report and provides an assessment of the potential impacts of the proposed European Offshore Wind Deployment Centre (EOWDC) upon marine mammals. In order to assess the potential effects of EOWDC relative to the baseline (existing) marine mammal environment a combination of qualitative assessments have been made that incorporate predictive modelling in order to estimate the potential magnitude and significance of any impacts. In the assessment the worst case development scenarios have been applied that are detailed in the Project Description. The impact assessment has considered the risks and impacts to marine mammals from the construction, operation and decommissioning of the EOWDC.

In the assessment of potential impacts a number of impact criteria were used for sound levels likely to cause physiological damage, audiological impact or behavioural disturbance to marine mammals. The use of multiple criteria and presentation of duplicate sets of results, such as potential ranges of impact was considered to be appropriate given the scientific uncertainty of acceptable criteria for impacts of sound upon marine mammals.

The significance of potentially killing a marine mammal during the piling of the EOWDC was assessed as being of major significance, however, with the successful adoption of the mitigation measures for piling, there are not anticipated to be any residual risks given that a marine mammal would have to be present in such close proximity to the pile driver (3 m) to be at risk.

Other forms of physical injury (non-auditory) are estimated to occur out to a greater range (60 m), and the risk of piling causing other forms of physical impacts cannot be ruled out, and has been assessed as being of major significance for all marine mammal species, the natural curiosity of seals may increase the risk of exposing both grey and common seals to sound levels capable of causing adverse physical effects.

The modelling results indicate that unless a cetacean is within the immediate vicinity of piling operations (<1.35 km) or a seal is situated within 3.6 km, the only possibility for an auditory injury to occur is during the initial piling period. It is expected that the perceived loudness of the piling activity will cause the marine mammal to exhibit an aversive behavioural reaction, with the animal moving from the area before the onset of any auditory injury can occur.

There is clearly a risk to individual marine mammals that are exposed to high sound levels in the immediate vicinity of the piling operation, given that marine mammals may be subject to sound levels that are capable of causing physical impacts, including both auditory and non-auditory impacts. Animals would have to be present within the immediate area of the pile driver to be at risk of physical effects and it is considered the risk of marine mammals receiving sound levels capable of causing their death appears to be remote.

The marine mammals which are most likely to be exposed are the more commonly sighted species within Aberdeen Bay, with the harbour porpoise, bottlenose dolphins and grey and common seals being the species most at risk from physical impacts. Given that the relatively small Moray Firth bottlenose dolphin population has been increasing its range expansion in a southerly direction, and that Aberdeen Bay frequently has bottlenose dolphins, especially during the winter and spring months, the potential impact both to the individual and population is considered to be of high magnitude and potentially of major significance. It should be considered the majority of bottlenose dolphins sightings have been observed frequenting the harbour mouth area and that the mitigation measures mentioned below they should be sufficient to ensure that no bottlenose dolphins are situated within 820 m prior to piling activities, if such measures are put in place the anticipated magnitude of the effects is expected to be negligible and thus be of minor significance to the bottlenose dolphin populations.

The range at which potential adverse behavioural responses is considerable being upto 22 km for harbour porpoise and 16 km for common and grey seals. For harbour porpoises the results of post-monitoring studies suggest that after piling stops the animals have been found to return to the area within a few hours. Therefore, behavioural disturbance, which would lead to displacement of marine mammals from the piling activities, is only expected to occur for the duration of piling activities.

The haul out locations of seals could be affected by the piling operations, which could cause the temporarily displacement of seals from such areas, the significance of this is considered to be moderate.

The potential exclusion of bottlenose dolphins through behavioural displacement for the duration of the piling activity and out to an extent of 16 km has been assessed as being of high magnitude, and therefore of potentially of major significance to the bottlenose dolphin. As bottlenose dolphins are present along the east coast of Scotland, it has been predicted that the temporary displacement of animals from the Aberdeen Bay area will be mitigated by animals moving into other areas within their natural range, this is a hypothetical assessment and is based on the available habitat range for bottlenose dolphins being extensive covering the coastal waters along the Scottish east coast.

For the other species of cetacean present in Aberdeen Bay they are not restricted to coastal areas and are present throughout a far wider area. Aberdeen Bay has not been recognised as being of particular importance for breeding or calving purposes for other cetacean species, the possible exception in that shallower coastal water of the east coast of Scotland have been speculated to have a role in breeding or calving for the white beaked dolphin during the summer period.

Any temporary exclusion of the cetacean species from Aberdeen Bay is considered to be of low to negligible magnitude, given that there is likely to be adequate areas for foraging relatively nearby. If piling occurs during summer months (July/August) the significance of this is likely to increase to moderate for the white beaked dolphins, but will still be a minor impact for all other cetacean species.

The vessels used in the construction of Aberdeen Bay may locally increase the ambient sound levels and as such may temporarily contribute to the displacement marine mammal from the vicinity of construction activities, the significance of this local displacement of marine mammals is negligible.

During the pile driving construction activities there is the potential for the sound to mask any seal vocalisations, potentially out to a distance of 80 km. Masking of biologically relevant sounds produced by high frequency cetaceans, such as the harbour porpoise, and possibly mid-frequency cetaceans, such as the bottlenose dolphin, is unlikely as the piling pulses have little high frequency energy. The pile driving pulse are of short duration, and are therefore may be below the time where full detection of signals is possible in cetaceans.

Other forms of construction sounds, such as those associated with vessel activity, are continuous type sounds, as opposed to the short duration impulsive piling sounds, and are therefore likely to be above the timeframe where full detection of the signals is possible by cetaceans, and are therefore likely to be audible. Although the vessel sounds are likely to be audible to marine mammals, they are not considered capable of masking the cetacean species that are most commonly present in Aberdeen Bay.

Marine mammals present in Aberdeen Bay are likely to be tolerant of the range of suspended sediment levels that can be present within background levels, the construction activities are not expected to generate high levels of suspended sediment other than locally elevated areas which will only exist for a short timeframe, such increases are not expected to have any form of impact upon marine mammals.

Marine mammals are highly mobile and are expected to follow their prey should they be displaced from the area during construction activities. Piling will be infrequent and temporary so that any disturbance to prey species will be intermittent and not consecutive so any foraging impacts are unlikely to be of sufficient magnitude or duration to adversely affect any life history traits of marine mammals. The marine mammals present in Aberdeen have been known to feed on varied prey species and should be adaptable should one of the more sensitive species to sound be temporarily displaced from the local area.

Increased shipping levels could be considered to increase the risk of collisions with marine mammals. Construction vessels will be transiting at slow speeds within Aberdeen Bay and are typically slow moving and generate low frequencies. It is considered that any marine mammals will be able to avoid approaching vessels. There have never been any reports of ship strikes from stranding records along the Grampian coast, which suggests the magnitude of the effect to marine mammals is negligible.

The noise from the operational wind farm is not considered to be capable of causing disturbance or displacement to marine mammals. There has been considerable variation in the reported underwater noise measurement from operational wind farms, yet all the sound levels reported thus far are relatively low.

These additional vessel arising from the maintenance of the EOWDC would not represent a significant increase on current vessel activity in this area. Aberdeen Bay is already very busy with a wide range of human activities and the small increase in vessel activity associated with the proposed wind farm is unlikely to cause any notable disturbance to marine mammals.

The worst case scenario in terms of seabed habitat lost would be through the use of gravity based structures for all eleven wind turbines; this would result in the loss of 0.03 km^2 of seabed habitat. The wind turbines are separated by a considerable distance from each other, this separation distance should not restrict the movement of marine mammals through the EOWDC. This loss of seabed habitat, in terms of similar available habitat within Aberdeen Bay is of negligible magnitude, with the significance of the impact being minor.

From the monitoring studies of constructed wind farms there is no evidence of any increases or decreases in marine mammal activity that would suggest attraction or avoidance related to magnetic fields. The information on the potential effects of EMF on marine mammals is largely unknown and further research is required to determine the potential risks this may pose to these species. The ecological significance of EMFs is an area of research which requires further study.

The Marine Mammal Protection Plan (MMPP) will be developed to address and mitigate any of the impacts identified as being of concern to marine mammals. The MMPP will outline the chosen mitigation procedures during any piling operations and construction activities to minimise the risk of impacts to marine mammals, the final MMPP will be developed in consultation with advice from statutory consultees. The programme of boat based and acoustic monitoring using C-Pods (moored hydrophones will continue throughout the development and construction of the EOWDC to enable any potential impacts upon marine mammals to be identified and recorded.

AOWFL will follow any advice provided by Marine Scotland on the European Protected Species licences to apply for, if these are required.

1.2 Introduction

Genesis Oil and Gas Consultants (GOGC) has been commissioned by AOWFL to undertake a marine mammal impact assessment of the EOWDC. The structure of the assessment can be summarised as follows:

- **Baseline Report** – this provides a summary of the existing information relating to the distribution and abundance of marine mammals in Scotland with a focus on Aberdeen Bay. This report draws on the findings of a desk based study and marine mammal research studies and also dedicated marine mammal surveys carried out for the purpose of supplementing the baseline for the EOWDC (GOGC, 2011).

- **EIA Technical Report** (this document) – an assessment of the impact of the project on marine mammals in the study area.

One of the primary issues identified at an early stage of the Impact Assessment was the potential impact of underwater sound from during both the construction, operation and decommissioning of the EOWDC. To aid the assessment Subacoustech Ltd were commissioned to provide underwater noise modelling for the installation of the foundations and determine potential impacts upon the marine mammal and other receptors within the developmental area. The impact assessment summaries the main findings of the Subacoustech report (Appendix 3.1 of the Environmental Statement for Subacoustech Ltd Report).

2. METHODOLOGY

Within the Environmental Impact Assessment Scoping Report (AOWFL, 2010) a number of marine mammal issues were raised and it is important to make due consideration of these in the impact assessment. The principal organisation which raised comments in respect of the marine mammal interests were Scottish Natural Heritage (SNH). The Joint Nature Conservation Committee (JNCC) had previously provided advice on the project, particularly the baseline survey design, as part of the originally proposed Aberdeen Offshore Wind Farm Scoping Report (AMEC, 2005).

2.1 Data Information and Sources

- DTI (2004). Guidance for the offshore windfarm consent process
- EMEC and Xodus (2010). Consenting, EIA and HRA Guidance for Marine Renewable Energy Developments in Scotland. Part one - marine renewables licensing process
- OSPAR (2008). Guidance on Environmental Considerations for Offshore Wind Farm Development. OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic
- SNH (2004). Marine renewable energy and the natural environment heritage: An overview and policy statement. Policy statement number 04/01
- Subacoustech (2011). Subsea noise modelling in support of the European Offshore Wind Deployment Centre Development
- Reports from previous studies occuring in the EOWDC development area that describe the marine mammal features of the study area have been summarised below:
    - IECS (2008). Boat based survey results for the AOWF 2007-2008
    - SMRU (2011). Boat based survey results for the EOWDC 2010-2011 (4 months of data)

2.2 Temporal Scales

There are four main phases in the development programme of the EOWDC that will be considered, these are:

- baseline (pre-construction)
- construction
- operation; and
- decommissioning

2.2.1 Baseline

The baseline or pre-construction phase considers the marine mammal abundance, distribution and seasonal occurrence within the EOWDC development area prior to any wind farm construction. The pre-construction environmental marine mammal baseline allows for a benchmark to which any changes to marine mammals can be compared. Any changes to marine mammal populations that could occur throughout the lifetime of the project that are the result of potential wide scale environmental changes such as climate change, or changes in prey availability, will also be compared to this phase. The pre-construction marine mammal baseline is discussed within the marine mammal baseline report (GOGC, 2011).

2.2.2 Construction

The construction phase considers the activities that are associated with installing the 11 foundations, wind turbines and subsea cables. A number of different foundation structures are being considered including: gravity based structure; monopiles; steel jackets; tripod on piles; and suction caisson. The final engineering for the subsea cables has yet to be completed but it is currently expected that there will be up to 4 main cables to the EOWDC and inter-array cables between the wind turbines. Potential impacts that have been assessed include:

- physical injury; including auditory and non-auditory injury;
- behavioural disturbance;
- interference with sound produced by marine mammals,
- indirect impacts of increasing suspended sediment levels; and
- displacement of prey species.

2.2.3 Operational

The operational phase will consider the impacts associated with the operational EOWDC. Potential impacts that will be assessed include: the loss of habitat as a result of the placement of the wind turbines, operational sound and Electromagnetic Fields (EMF) generated from the subsea cables.

2.2.4 Decommissioning

The decommissioning plan for the EOWDC has yet to be finalised and as such a detailed impact assessment on this section is not possible, the Description of the Proposed Project (Chapter 3 of the ES) provides an outline of the activities that are expected to be associated with the decommissioning of the EOWDC. The assumption taken in this assessment is that the wind farm and associated infrastructure, with the potential exception of the subsea cables, will be removed from the seabed as per the statutory requirements that will be in force at the time. The impacts upon marine mammals are expected to be similar to the construction activities as comparable vessels will be required. The main difference is that the removal of the foundations will not require pile driving and it is expected that impacts of underwater sound will be lower through the use of cutting techniques. The use of explosives has been ruled out. Certain foundations types will not requiring cutting and could be lifted from the seabed. The main impacts of decommissioning activities are expected to be physical and behavioural responses of marine mammals to the underwater sound levels generated.

2.3 Impact Methodology

Whilst the matrix approach has been applied as a way to categorise and assess the significance of any potential impacts to marine mammals, through discussions with SNH it has been communicated the importance of also applying rigorous professional judgement in determining significance of potential impacts. The assessment, where possible, has assessed potential impacts and the rationale behind arriving at such judgements with as much information on the reasons for arriving at a particular judgement for each of the environmental receptors involved.

For each impact, the assessment aims to describe the magnitude of effect (i.e. the change created by an activity in terms of its spatial extent, duration and scale) and the sensitivity of each receptor, that is, the resources that would be affected (based on the importance of the receptor and its recoverability). The combination of the effect and the sensitivity of the receptor are then used to derive the significance of the impact. The criteria used in the assessment are given below.

The spatial extent of effect:

- a national/international effect
- a regional effect
- a local effect (within 5 km of the site)
- a site-specific effect

The duration of effect:

- a long-term/permanent effect (more than ten years)
- a medium term effect (existing for five to ten years)
- a short-term effect (existing for one to five years)
- a temporary effect (existing for less than one year)

The scale of the effect:

- above accepted standards/guidelines
- within accepted standards/guidelines
- where no standards/guidelines available, impact relative to background conditions

The recoverability of the receptor:

- low or none
- medium
- high

The importance off the receptor (taking into account international, national and regional legislation and function within the ecosystem):

- high
- medium
- low

Impact significance is then given as Major, Moderate, Minor, or Negligible guided by the following matrix.

Table 1 Matrix used to assign level of significance of impact

Magnitude of Effect (spatial extent, duration of effect and scale)	**Sensitivity of Receptor (based on importance and recoverability)**			
	Very High	**High**	**Medium**	**Low**
Very High	Major	Major	Major	Moderate
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Moderate	Minor
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

2.3.1 Implications of Significance

Where the significance is classified as moderate to major or major this is considered to be a potentially significant effect. It should be noted that significant effects need not be unacceptable or reversible.

2.3.2 Sensitivity of Marine Mammals and their Protected Status

For the purpose of this assessment, all cetacean species and seals that are likely to be found in Aberdeen Bay are of either national or international importance due to their conservation status. All cetacean species and seals are considered to be receptors of high importance due to the national and international protection measures afforded to them which are discussed in more detail below.

The Habitats Directive is implemented in Scotland through the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) termed the 'Habitat Regulations'. The Habitat Regulations provide the protection afforded to European Protected Species (EPS) animals listed on Annex IV of the Habitats Directive which includes all species of cetacean whose natural range occurs in Great Britain.

The European Protected Species Provisions create a number of offences that relate to causing injury or disturbance to EPS species as defined in regulation 39 of the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). Before an EPS licence can be issued there are three tests which must be met by the appropriate licensing authority, which in the case of a renewable energy development would be issued by the Scottish Government. The EPS provisions do not apply to any of the seal species.

Test 1 – The licence application must demonstrably relate to one of the purposes specified in Regulation 44(2). In the case of this application any EPS licences would be issued are likely to be granted by Scottish Government on the basis of Regulation 44(2)(e) *for imperative reasons of overriding public interest including* *those of a social or economic nature and beneficial consequences of primary importance for the environment*.

Test 2 – A licence may not be granted unless Scottish Government is satisfied "*that there is no satisfactory alternative*".

Test 3- A licence cannot be issued unless Scottish Government is satisfied that the action proposed "*will not be detrimental to the maintenance of the population of the species concerned at favourable conservation status in the natural range*".

The harbour seal, common seal, the harbour porpoise and bottlenose dolphin are listed on Annex II of the Habitats Directive which require member countries to consider the designation of Special Areas of Conservation (SACs) for these animals. The cetacean species which require the designation of SACs are the bottlenose dolphin and the harbour porpoise (this is assessed separately in Chapter 29 Information to Inform the HRA).

The Marine (Scotland) Act 2010 introduces a number of measures for seal protection to update and replace the earlier Conservation of Seals Act 1970. It is now an offence to kill or take any seal at any time (with exceptions only under specific licence or for animal welfare) and it is also now an offence to harass seals at their haul-out sites.

2.4 ASSESSMENT OF CUMULATIVE IMPACTS

The cumulative assessment will address where predicted impacts of the EOWDC construction and operation could interact with impacts from other industry sectors within the same region and impact sensitive receptors. This may be through direct effects or spatially/temporally separated impacts on the same population of a receptor.

The main industries that will be considered for potential cumulative impacts are the renewable energy industry, aggregate industry, oil and gas and shipping.

A total of nine sites within Scottish Territorial Waters have been awarded for the construction of offshore wind farms. Since the announcement one of the sites, the Forth Array, has been withdrawn. Of the remaining 8 offshore wind farms the nearest three proposed wind farms are the Beatrice wind farm in the Moray Firth; approximately 150 km away and Neart na Gaiothe and Inch Cape are in the Firth of Forth, approximately 120 km to the south.

There are two Round 3 wind farms proposed off the east coast of Scotland outwith Scottish Teritorial Waters. The Moray Firth Offshore Wind Farm (eastern and western development) which is adjacent to the Beatrice offshore wind farm zone beyond the 12 nautical mile boundary, and the Firth of Forth Offshore Wind Farm which lies approximatley 70 km to the south of the proposed EOWDC.

According to the project timescales of the other foreseeable renewable energy projects, the construction of the EOWDC is planned for 2013, this is before any of the proposed renewable energy developments (Table 2). As such the assessment of cumulative impacts from construction will only assess the renewable energy developments that are already constructed, or are forecast to be constructed, within the same timeframe, not those that are planned to be developed in the future. Given the stage of development of the renewable projects yet to be constructed and the uncertainty as to the types of foundations and wind turbines that will be used, there is sparse information available to incorporate into any environmental impact assessment, which limits the effectiveness of cumulative assessments considering conceptual projects yet to be subject to a formal planning application.

This will limit the assessment of cumulative impacts from construction impacts to the Beatrice demonstrator, other operational and decommissioning impacts will make assessment, where possible, of the cumulative impacts from other yet un-consented renewable projects.

Table 2 Renewable Energy Developments that are Proposed within Scottish Territorial Waters and Beyond Territorial Waters

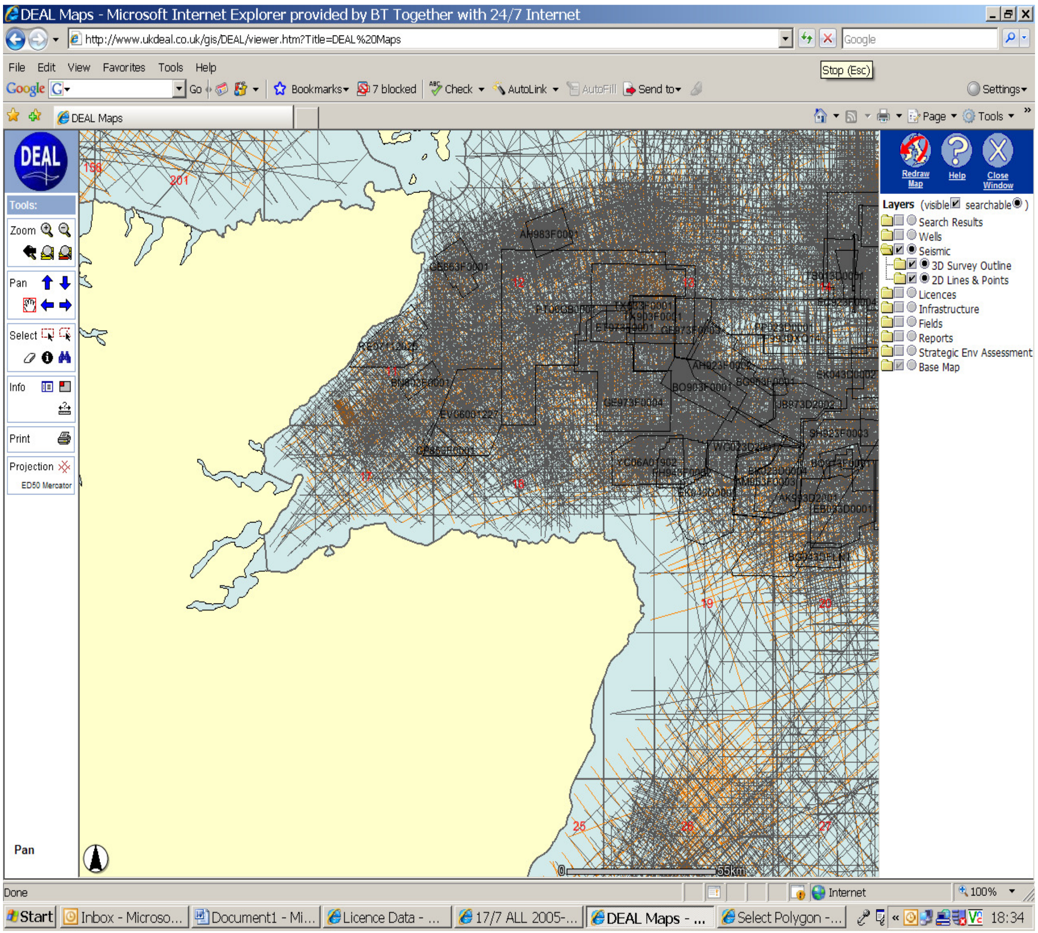
Name of development	Developer	MW	Wind turbines	Project timeframe construction
The Beatrice Demonstrator	Joint Venture Talisman and Scottish and Southern Energy	10	2	Installed operational
The Moray Firth Eastern Development	Moray Offshore Renewables Ltd	1300	67	Construction starts 2015
The Moray Firth Western Development			Not yet known	Unknown >2015 (EIA commences 2013)
Beatrice	Sea Energy Renewables Ltd & Scottish and Southern Energy	920	184	April 2014
Firth of Forth: Phase 1	Scottish and Southern Energy and Fluor	1075	215	2015
Firth of Forth: Phase 2		1435	287	Unknown >2015
Firth of Forth: Phase 3		955	191	Unknown >2015
Neart na Gaoithe	Mainstream Renewable Power	420	130	April 2014

The potential Ocean Laboratory will be considered in the assessment of cumulative impacts, although the design of the structure has yet to be completed it is possible that the foundation could be piled.

There are no known commercial aggregate dredging activities within the wider Aberdeen Bay area. Maintenance dredging does occur in the Aberdeen Harbour, with the next dredging scheduled to occur in 2012, there are no current dredging activities planned to occur during the construction phase.

The oil and gas industry has a considerable presence in the North Sea, the activities that are considered to be of most concern for marine mammals are the exploration activities including the seismic surveys and vessels used to support their activities. Seismic surveys in the North Sea are typically associated with areas of historic oil and gas activity (Figure 1).

Figure 1 Locations of previous seismic surveys in the North East of Scotland (DEAL 2011)



The locations of future seismic surveys are not yet known, as the industry is only required to submit details of the planned surveys a few months in advance of the planned operations. There are a number of seismic surveys that have been planned to in the Moray Firth but have yet to get final regulatory approval. PA Resources have proposed a 2-D seismic survey with a total duration of seven days using a 470 cubic inch array. Caithness Petroleum Ltd has submitted a proposal to undertake four exploration seismic surveys and one site survey, this is expected to last a total of 14 days, both surveys are planned to occur within the timeframe 1st August – 21st October 2011. Subject to these surveys occurring within the proposed timeframe they will both be completed in advance of any construction activities occurring in the EOWDC, as such they will not be considered as part of the in-combination assessment.

Aberdeen Harbour is an important base for the movement of vessels associated with supporting the oil and gas industry, transport of goods to the islands, and also to a lesser extent vessels used in the fishing industry. The disturbance and underwater sound produced by these vessels will be considered in the in-combination assessment.

2.5 Assessment of in-combination impacts

The term 'in-combination' will be used when considering the impacts of the proposals with other plans or projects on European sites. There is a degree of similarity and cross-over between cumulative and in-combination impacts as many of the activities that will be considered in the cumulative assessment are part of UK Government Plans or Project.

3. IMPACT ASSESSMENT

3.1 Construction Phase

3.1.1 Noise Generated during the Construction of the EOWDC May Cause Physiological Damage to Marine Mammals (Non-audiological Injury and Audiological Injury)

Worst Case Scenario: Piling of 8.5 m diameter pile at all eleven locations during one phase of installation (sequentially).

3.1.1.1 Potential Impacts

The construction activities will generate a number of sources of underwater sound, by far the loudest impulsive sound will be generated during the piling of the wind turbines. There have been several studies which have measured the underwater sound levels generated during piling of offshore wind turbines (Bailey, *et al*., 2010; Nedwell, *et al*., 2007). A general observation is that the source levels and underwater sound pressure levels have been found to increase with increasing diameter of the pile being driven, although other factors such as sediment type, energy of the pile driver have an influence on the overall sound levels generated. At the highest level, typically during underwater blast from explosives, sound has the ability to cause injury and, in extreme cases cause the death of exposed animals. Although, to date, there has never been any records of piling having caused any form of physical injury to a marine mammal.

Due to the current lack of information on potential lethal and physical injury effects from impact piling, this study has used the best available data from blast exposures to estimate impact zones. The wave forms from blast waves and piling are rather different; the transient pressure wave from an impact piling operation has roughly equal positive and negative pressure amplitude components and a relatively long duration of up to a few hundred milliseconds. By contrast, blast waves have a very high positive pressure peak followed by considerably lower amplitude, negative wave due to the momentum imparted to the water surrounding the explosive gas bubble. The pressure of a blast wave is normally quantified therefore in terms of the peak level, due to the dominance of the positive peak of the waveform. There is, therefore, a level of uncertainty as to whether a blast wave criterion can be directly applied to a transient waveform arising from an impact piling operation.

Lethal and direct physical injury from an underwater transient pressure wave are related to the peak pressure level, rise time and duration that the peak pressure acts on the body (usually measured by the impulse of the blast wave). The criteria that have been developed for assessing gross injury of this type are based on data from blast injury, at close range, to explosives. Injury has been related both to the incident peak positive pressure of the wave and to the impulse. A number of different techniques for assessing the duration of an impulsive waveform are described by Hamernik and Hsueh (1991) based on the studies by Coles, *et al*., (1968), Pfander, *et al*., (1980) and Smoorenburg (1982). The measure of impulse will, therefore, depend upon which technique is applied.

One of the challenges that AOWFL faced was determining appropriate source levels to model given that the wind turbines installed in Aberdeen Bay could potentially be the largest diameter wind turbines installed to date in offshore waters. In order to generate appropriate source levels to use, Subacoustech Ltd were commissioned to generate predictive underwater noise modelling for the pile to be installed and they used available piling measurements to derive suitable source level to model (Subacoustech, 2011 ref to Appendix 3.1).

The underwater sound modelling applied the Impulse Noise Sound Propagation and Impact Range Estimator (INSPIRE) model that has been specifically designed over five years to predict the likely level of underwater noise from impact piling operations. INSPIRE is a broadband model, that is, it does not calculate levels frequency by frequency, but in terms of the physics of the absorption of a pulse. INSPIRE uses a combination of loss caused by the spreading of the energy of the sound field (geometric loss) and loss caused by energy in the water column being absorbed in the underlying sea bed (absorption losses). This is used to estimate the likely transmission losses as the sound propagates away from the source; in this case impact piling. The model is therefore capable of estimating the effect of rapidly varying water depths that are commonly found in UK coastal waters.

The other main factor that affects the level of underwater noise is the local bathymetry, with sound attenuating at a faster rate over shallow water as opposed to deeper waters. The INSPIRE model uses digital bathymetric data provided by SeaZone Solutions Ltd, to input water depth data into the model.

3.1.1.2 Assessment of Noise Levels Capable of Causing Non-audiological Physical Impacts to Marine Mammals

A number of different impact criteria were used for the sound levels likely to cause physiological damage to marine mammals. Two of these criteria have been proposed by Parvin *et al*., (2007) and were developed to be applicable to all marine species, not just marine mammals. It should be stressed that within the scientific community there is yet no definitive accepted criteria for physical injury to marine mammals. For the assessment of physical injury to marine mammals this assessment applies a number of different impact criteria including those proposed by Parvin *et al*., (2007), and also the audiological impact criteria that have been developed by Southall *et al*., (2007). Although audiological hearing impacts are a form of physical injury they are considered in more detail in Section 3.1.1.3.

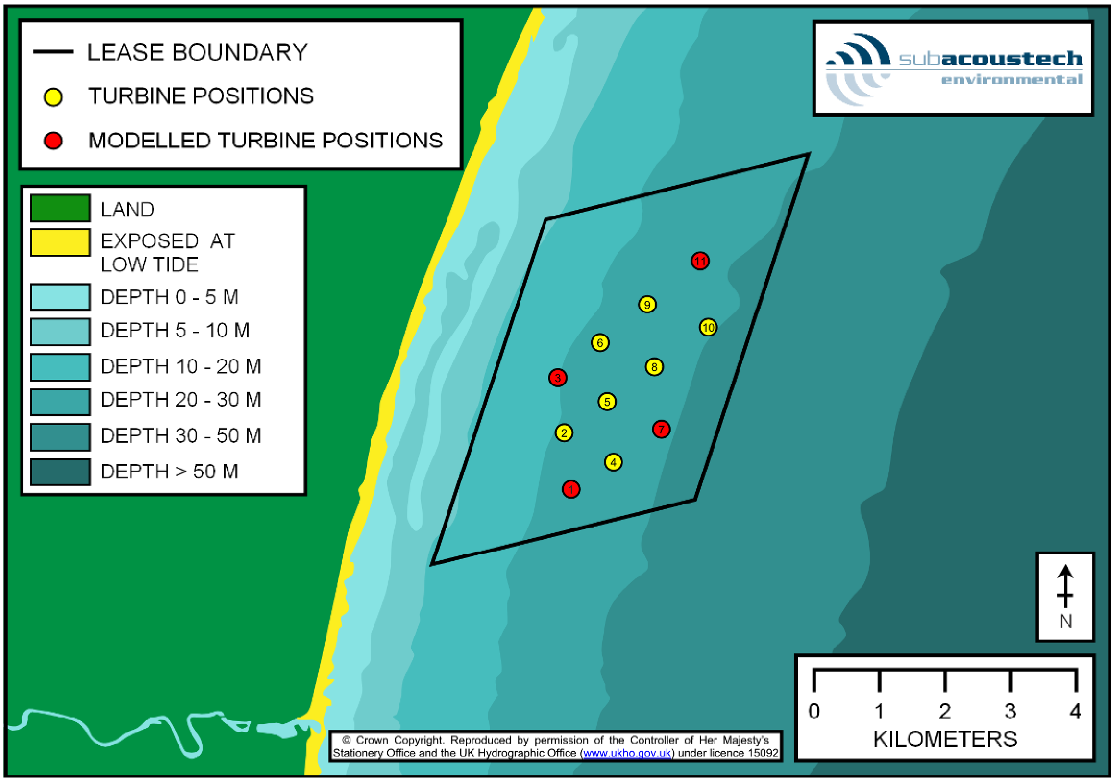
Given that the marine mammal scientific community are still actively debating appropriate impact criteria for marine mammals it was considered best practice to present a number of criteria and choose the most precautionary metric.

The sound levels that will be used in the assessment of physical impacts upon marine mammals are:

- lethal effect may occur in marine species where peak to peak levels exceed 240 dB re.1µPa
- physical injury may occur in marine species where peak to peak levels exceed 220 dB re.1µPa

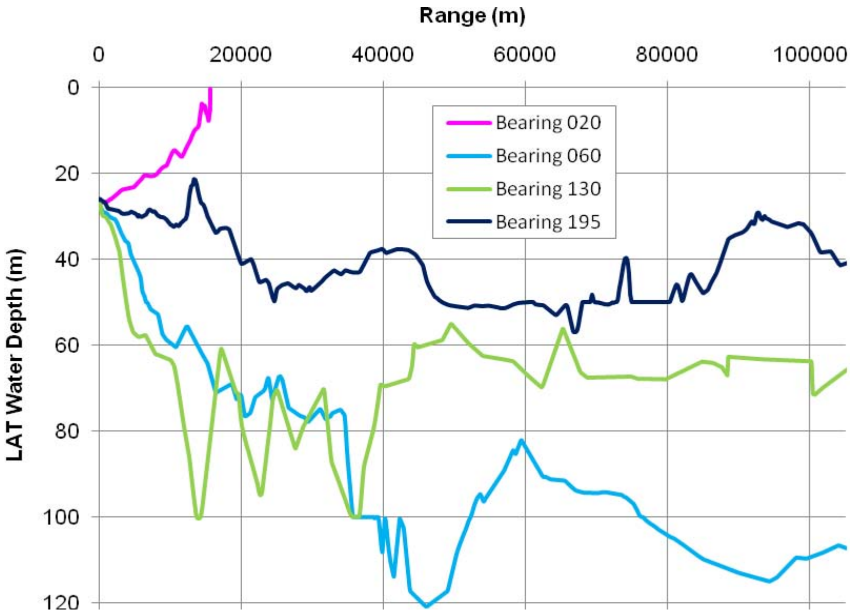
A plan of the proposed EOWDC that illustrates the four wind turbine positions that were used as the basis of the underwater noise modelling is shown in Figure 2. Wind turbine positions 1, 3, 7 and 11 were used and these locations are denoted by red circles. These four positions have been chosen to represent the greatest variation across the site in terms of location and to a lesser extent water depths, ranging from approximately 20 m Lowest Astronomical Tide (LAT) to the west to just under 30 m LAT to the east. The bathymetry is an important factor in underwater sound modelling as it influences the transmission loss that occurs to sound signals with greater losses typically occurring in shallow waters.

Figure 2 The EOWDC lease boundary area and wind turbine positions, wind turbines shown in red were used as representative modelling locations (Subacoustech, 2011)



Aberdeen Bay gradually deepens in easterly direction. In order to illustrate the varying bathymetry in the areas around the proposed EOWDC site, wind turbine number 11 has been used (Figure 3). As expected, the bearing with the shallowest water depth <20 m is bearing 20^0 (orientated towards the shoreline), whereas bearing 60^0 (heading out to the deep waters of the North Sea) encounters water depths in excess of 120 m.

Figure 3 Comparison of four representative depth profiles along transect from wind turbine position 11 indicating the varying bathymetry around the proposed EOWDC site used for the INSPIRE modelling (Subacoustech, 2011)



The underwater noise modelling was carried out at all four wind turbines locations. Shown in Figure 4 is the unweighted (unfiltered) noise generated from the piling of the 8.5 m wind turbine at wind turbine location number 11. The graph indicates that the lethal effect level (240 dB peak-peak) and the physical effect level (220 dB peak-peak) will be exceeded at 3 m and 60 m, respectively. As the environmental conditions are comparable for all the wind turbines; the modelling suggests that for physical impacts the anticipated ranges at which lethal effects and physical effects will be the same for all the wind turbine positions (Table 3).

Figure 4 Graph showing the unweighted peak to peak noise level with range for the four transects extending from wind turbine 11

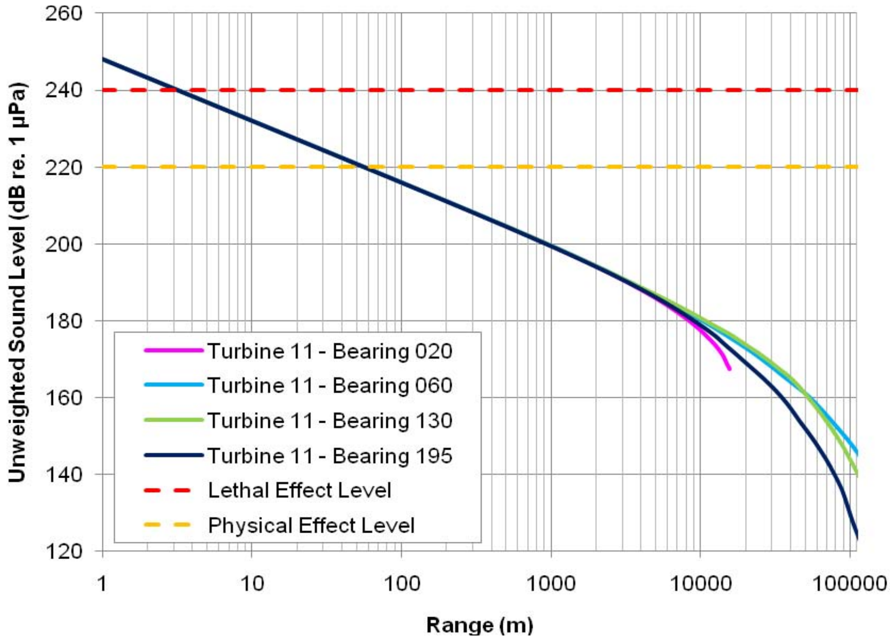


Table 3 Summary of ranges out to which lethal effect and physical injury is expected to occur in marine species using the criteria proposed in Parvin *et al.*, (2007)

Peak to Peak Levels	Wind Turbine 1	Wind Turbine 3	Wind Turbine 7	Wind Turbine 11
Lethal Effect Range to 240 dB re. 1 µPa	3 m	3 m	3 m	3 m
Physical Effect (non-auditory) Range to 220 dB re. 1 µPa	60 m	60 m	60 m	60 m

To date there has been no evidence of wind turbine installations causing any lethal, or physical injury effects upon marine mammals. It should be noted that these impact ranges are based on the extrapolation of data from measurements taken at considerably greater ranges since it is generally not possible to carry out measurements this close to impact piling operations, so the levels of underwater noise maybe lower than those estimated.

Although various species of marine mammals frequently occurring in Aberdeen Bay, some of which occur at high densities, it would still seem unlikely for any species to be present at such close proximity (3 m) to the piling location to suffer outright mortality. It is therefore thought that lethality is therefore unlikely to occur during piling.

In the context of exposure of marine mammal species to underwater sound it is very unlikely that marine mammals would experience injury unless constrained in a very high level continuous sound field for a prolonged period of time (Physical impacts from cumulative exposure are considered in Section 3.1.1.3). Other forms of physical injury (non-auditory) are estimated to occur out to a greater range (60 m), and the risk of piling causing physical impacts cannot be ruled out. However the natural curiosity of seals may increase the risk of exposing both grey and common seals to sound levels capable of causing adverse physical effects.

3.1.1.3 Assessment of Noise Levels Capable of Causing Audiological (Hearing Damage) to Marine Mammals

At a high enough level of sound, traumatic hearing injury may occur even where the time of exposure is short. Injury also occurs at lower levels of noise where the period of exposure is long. In this case, the degree of hearing damage depends on both the level of the noise and the time of exposure to it. To estimate the effect of impact piling taking place over a long period of time this concept of cumulative "Noise Dose" relationship has been used. For complex or time varying signals the degree of hearing damage has been related to the Noise Dose of the noise. The Noise Dose combines the continuous noise level containing the same sound energy as the time varying signal, and the duration of exposure.

This approach appears to translate to the underwater exposure of marine mammals, since for single exposure sounds Ward (1997) developed a level against exposure duration guide indicating that for sounds from 126 to 144 dB above hearing threshold (i.e. dB_{ht}), hearing injury can occur for exposure periods from 60 seconds to 1 second respectively. The data from Schlundt, *et al*., (2000) also indicates that this effect translates to marine mammal exposure to underwater sound. In the study, short duration sound exposures (one second continuous wave) at levels of approximately 130 dB above hearing threshold caused a small Temporary Threshold Shift (TTS) hearing injury in the bottlenose dolphin.

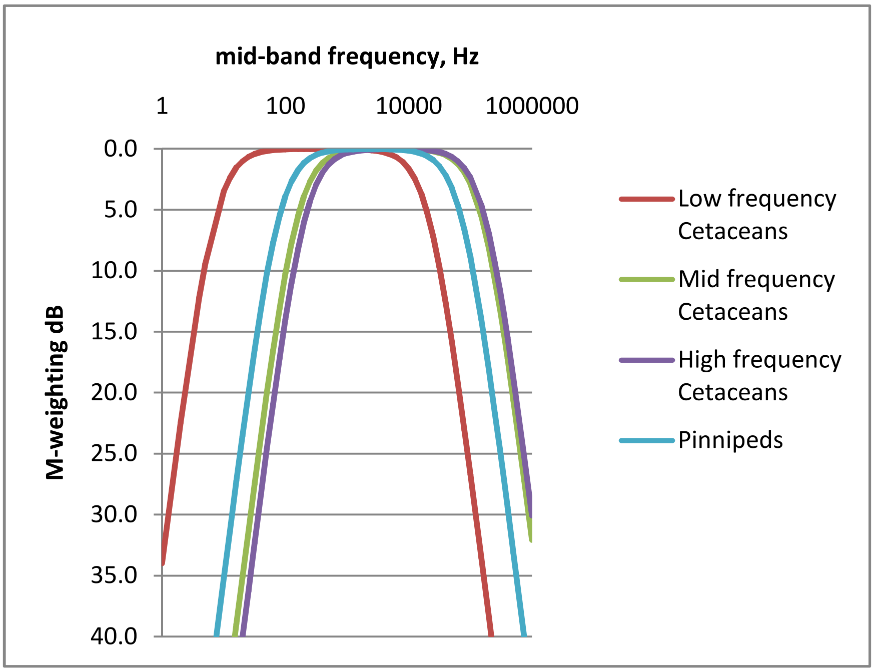
Hearing impairment in the form of a TTS in hearing may occur where an animal is exposed to a these levels, and Permanent Threshold Shift (PTS) will occur with repetitive exposure. The higher the Noise Dose above this limit, the more rapid will be the damage. It is likely that hearing impairment will occur where marine mammals are exposed to continuous or repeated high level underwater sound for relatively long periods of time; for impact piling the noise exposure can build up over many pile strikes. The Noise Dose that the animals will accumulate will depend on the received level of the underwater sound, which varies with range, and hence with the behaviour of the animal, and the time period and repetition rate of the pile strikes.

Nedwell *et al*., (2007) has suggested that the use of a 130 dB_{ht} (Decibels above hearing threshold) level, similar to that used for human exposure in air, provides a suitable criterion for predicting the onset of traumatic hearing damage (that is, where immediate traumatic and irreversible damage occurs), which recognises the varying hearing sensitivity of differing species.

The impact assessment also uses another set of exposure criteria that have been developed based on the evidence of auditory damage from numerous studies, termed the Southall criteria (Southall *et al.,* 2007). The Southall auditory injury criteria are based on both the unweighted peak pressure levels and M-weighted Sound Exposure Levels (dB re. 1 $\mu Pa^2 s$ (M)) for various groups of marine mammals. The use of a dual exposure metric is used, as it has been recognised that it is not only the exposure to peak levels of sound which is important but the total energy throughout the exposure. As a precaution for impact assessments it is recommended to apply the most conservative sound pressure level or sound exposure levels. These sound pressure level and sound exposure level recommended for marine mammals are presented in Table 4.

The sound exposure levels apply M-weighting this is essentially a simple way of applying a frequency dependant weighting to the hearing threshold of an animal, a more complex approach would be the use of the 'dBht'. There are numerous critics of the dBht approach in impact assessment, as it relies on the very few audiogram data that are available for marine mammals being correct and representative of all individuals within the population. Southall, *et al*., (2007) took account of the wide frequency dependence in the auditory response of marine species, and proposed M-Weighting frequency functions for low, mid and high frequency hearing cetaceans and pinnipeds (Figure 5). Otherwise extremely low and high frequency sounds that are detected poorly, if at all, might be subject to unrealistic criteria, for example a reduction of 10 decibels would be applied for a mid-frequency cetacean on exposure to a sound of 100 Hz.

Figure 5 M-Weighting criteria proposed for low, mid and high frequency cetaceans and pinnipeds (adapted from Southall et al., 2007)



The Southall study criteria can be used for both single pulse noise sources and multiple pulse sources (Table 4). The assessment estimated impact ranges for exposure to single pile strikes (Section 3.1.1) and also the cumulative exposure to multiple pulses over a typical installation period using the Sound Exposure Level (SEL) M-weighting metric (Section 3.1.1.3.2); threshold exposure values for single and multiple pulses using the Sound Pressure Level (SPL) and sound exposure levels are shown in Table 4.

Table 4 Proposed auditory exposure criteria for marine mammal frequency specific hearing groups: high, medium and low and seals as defined in Southall *et al.*, (2007)

Marine mammal group	Sound type	
	Single pulses	Multiple Pulses
Low Frequency Cetaceans		
Sound Pressure Level	230 dB re 1 µPa (peak)	230 dB re 1 µPa (peak)
Sound Exposure Level	198 dB re 1 $\mu Pa^2/s$ (M_{lf})	198 dB re 1 $\mu Pa^2/s$ (M_{lf})
Mid Frequency Cetaceans		
Sound Pressure Level	230 dB re 1 µPa (peak)	230 dB re 1 µPa (peak)
Sound Exposure Level	198 dB re 1 $\mu Pa^2/s$ (M_{mf})	198 dB re 1 $\mu Pa^2/s$ (M_{mf})
High Frequency Cetaceans		
Sound Pressure Level	230 dB re 1 µPa (peak)	230 dB re 1 µPa (peak)
Sound Exposure Level	198 dB re 1 $\mu Pa^2/s$ (M_{hf})	198 dB re 1 $\mu Pa^2/s$ (M_{hf})
Seals (in water)		
Sound Pressure Level	218 dB re 1 µPa (peak)	218 dB re 1 µPa (peak)
Sound Exposure Level	186 dB re 1 $\mu Pa^2/s$ (M_{pw})	186 dB re 1 $\mu Pa^2/s$ (M_{pw})

The species upon which the dB_{ht} analysis has been conducted in this study have been based upon regional significance and also crucially upon the availability of good peer-reviewed audiogram data shown in Figure 6.

The species of marine mammal considered in the impact assessment for which suitable audiogram data was available include:

- Bottlenose Dolphin: a marine mammal (toothed whale) with good high frequency hearing sensitivity. It is also used in this assessment as an indicative surrogate audiogram for Risso's Dolphin (Johnson, 1967). Although some audiogram data are available for the Risso's dolphin, it was considered that the quality of the audiogram data is not confirmed. Hence the bottlenose dolphin has been used to provide a conservative over-estimate of potential impacts;
- Harbour Porpoise: a marine mammal (toothed whale) that, based on current peer reviewed audiogram data is the most sensitive marine mammal to high frequency underwater sound (Kastelein *et al*., 2002);
- White-Beaked Dolphin: a marine mammal (toothed whale) with similar high frequency hearing to the bottlenose dolphin, but lower sensitivity to lower frequency noise (using the Striped Dolphin, *Stenella coeruleoalba*, audiogram(Kastelein, *et al*., 2003) as a surrogate as the White-Beaked Dolphin audiogram does not cover the entire audiometric range (Nachtigall, *et al*., 2007);
- Harbour (Common) Seal: a pinniped that based on current peer reviewed audiogram data is the most sensitive seal species to underwater sound (Møhl 1968; Kastak and Schusterman 1998). It is also used as a surrogate audiogram for Grey Seal.

As there is no single published dataset for seal species that covers the full audiometric range, the impact assessment is based on a weighting filter for the harbour seal that is the locus of the minimum threshold (most sensitive) data from several audiogram sources for the harbour seal. The data of Kastak and Schusterman (1998) is used for the frequency range from 100 Hz to 6.4 kHz, and the data from Mohl (1968) over the higher frequency range from 8 to 128 kHz (Figure 6).

It should also be noted that there is an absence of suitable audiogram data to use for baleen whales and there is no appropriate audiogram to use for the minke whale, the baleen whale most commonly sighted within Aberdeen Bay.

Figure 6 Audiograms applied in the marine mammal impact assessment

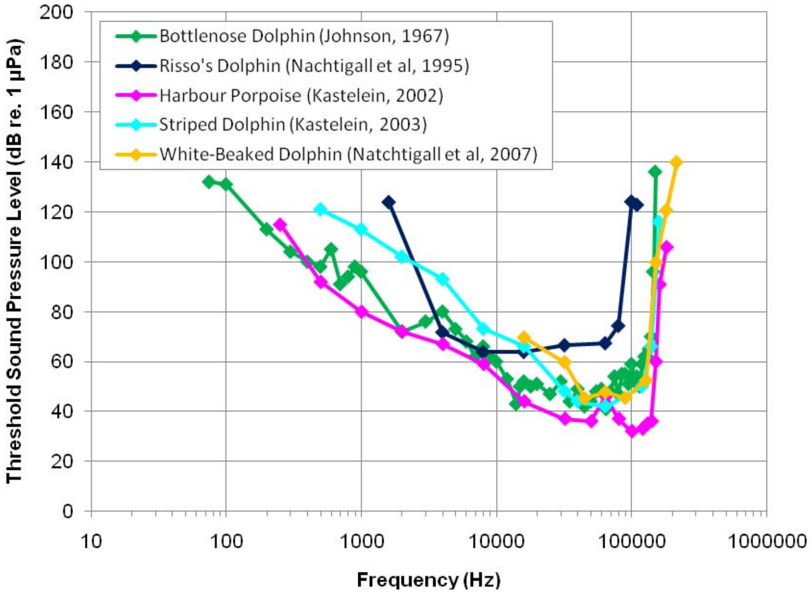


Table 5 shows the estimated impact ranges for traumatic hearing injury, using the dB_{ht} metric, for the marine species of interest, based on the 130 dB_{ht} criterion from Nedwell *et al*., (2007). The results are given for each of the four locations modelled at the proposed EOWDC site. The 130 dB_{ht} perceived level is used to indicate traumatic hearing damage over a very short exposure time of only a few pile strikes at most.

The largest estimated impact ranges out to which hearing damage may occur are for harbour porpoise (570 m; at both wind turbine positions 7 and 11). The modelling indicates that the seal species are likely to suffer these effects out to the smallest ranges (120 m) (Table 5).

Table 5 Summary of ranges out to which hearing injury is predicted to occur in various marine species using the 130 dB_{ht} (Species) criteria while piling a 8.5 m diameter pile (Nedwell *et al., 2007)*

Species	130 dB_{ht} Ranges			
	Wind turbine 1	Wind turbine 3	Wind turbine 7	Wind turbine 11
Bottlenose Dolphin Risso's Dolphin	**290 m**	**290 m**	**290 m**	**290 m**
Harbour Porpoise	560 m	550 m	**570 m**	**570 m**
White-Beaked Dolphin	240 m	240 m	**250 m**	240 m
Harbour Seal /Grey Seal	**120 m**	**120 m**	**120 m**	**120 m**

Figures in bold were the maximum impact ranges for marine mammal species assessed

Table 6 presents the injury impact ranges using the single pulse peak level criteria for species of cetacean and pinniped proposed by Southall *et al*., (2007). The modelling indicates that the range for injury (PTS) to all hearing types of cetaceans when applying the Southall criteria is 5 m at all wind turbine locations modelled. The range for physical auditory injury for seals is a greater distance of 30 m from the wind turbines, as they are considered by Southall *et al*., (2007) to have an increased sensitivity to peak levels of underwater sound in comparison to cetaceans.

Table 6 Summary of the estimated mean ranges to various unweighted peak noise levels during installation of 8.5 m diameter piles, shown are the PTS criteria for all cetaceans and seals (Southall *et al*., 2007)

Peak Levels*	Wind turbine 1	Wind turbine 3	Wind turbine 7	Wind turbine 11
Range to 230 dB re.1µPa (Cetacean Injury criteria, Southall *et al*., 2007)	5 m	5 m	5 m	5 m
Range to 218 dBre.1µPa (Pinniped Injury criteria, Southall *et al.,*2007)	30 m	30 m	30 m	30 m

*Peak levels were calculated by reducing the peak-peak levels by 6 dB.

Table 7 summarises the estimated impact ranges out to which auditory injury may occur, based on the single pulse Sound Exposure Level (SEL) criteria which have taken consideration of the hearing capabilities of marine mammal function hearing groups (Southall *et al*., 2007). The largest estimated ranges are for the seals, the injury range was greater when modelling was carried out for the two deeper water turbines, with a mean range of auditory injury of between 120 and 130 m (130 m taken as the worst case). For the three cetacean groups the largest impact ranges are predicted for the low frequency cetaceans (20 m) followed by the mid frequency cetaceans (10 m) with the smallest ranges predicted for the high frequency cetaceans (7 m). This is due to piling noise containing mainly low frequency components. There was no observable variability between the wind turbine locations using the Southall criteria.

Table 7 Summary of the auditory injury range for marine mammals using the Southall *et al*., 2007 Sound Exposure Level M-weighting criteria for function hearing groups of marine mammals

	Auditory Injury Range* 198 dB re.1 µPa^2/s (M_{lf}/ M_{mf}/ M_{hf}/ M_{pf})
Low Frequency Cetaceans	20 m
Mid Frequency Cetaceans	10 m
High Frequency Cetaceans	7 m
Pinnipeds (in water)	130 m (worst case)

(M_{lf} = M weighted low frequency M_{mf}= M weighted medium frequency / M_{hf}= M weighted high frequency M_{pf})

Southall *et al*., (2007) recommend using the most conservative impact ranges in impact assessments. Therefore the impact ranges for that were based on the M-weighted sound exposure level will be the most precautionary to use for marine mammals for estimating injury from single pulses (Table 7), as opposed to using the peak sound pressure levels (Table 6). The impact ranges for single pulses are not the most appropriate metrics to apply for pile driving applications which consist of multiple pile strikes. For such installations it is important to make assessment of the cumulative nose dosage that could occur over an entire piling sequence, which is discussed further below.

It may be noted that the impact ranges (for single pulses; shown in Table 6 and Table 7) disagree with those predicted using the dB_{ht} model (Table 5). The modelling results indicate substantially lower ranges of effect for the species of cetacean when using the single pulse Southall *et al.,* (2007) criteria. The disparity in values can be attributed to fundamental differences between the sound levels that are considered to be capable of causing physical impact using the dB_{ht} method and Southall *et al*., (2007) approach. It should be noted however that the SEL of a noise source will vary with range in a different way to that which has been assumed for its SPL (as it depends upon the averaging period used to define the pulse); and this may account in part for the differing results, which is to be expected when applying different impact criteria. Irrespective of this, it can be considered that the dB_{ht} approach is more conservative than the Southall *et al*., (2007) exposure criteria in that it produces impact ranges that are far greater than those produced by the Southall criteria. However, it should be pointed out Southall *et al*., (2007), which has been widely supported by the scientific community consider their pressure and exposure values to be precautionary for the assessment of impacts to marine mammals.

3.1.1.3.1 Estimated Ranges at Which Auditory Hearing Damage May Occur for Multiple Pulses

The installation of each pile is anticipated to take a maximum of 24 hours, this value should be considered as the maximum possible duration, and although it is expected piling will be completed within a shorter timeframe (~ 8 hours). The steel pile will be driven into the seabed starting off with a gradual ramping up of power, increasing to a max rate of 32 strikes per minute.

In order to assess the range at which a marine mammal could experience physical injury the model applied different scenarios based on cumulative noise exposure of multiple pile strikes, and the receptor (marine mammal) being either a stationary, or fleeing animal; moving away from the sound source.

3.1.1.3.2 Assessment of Cumulative Exposure Applying the dBht Method

In the assessment of cumulative exposure, a 90 dBht level has been applied as the level at which impacts could occur for an exposure durations of 8 hours. The maximum expected duration of piling has been estimated to be 24 hours, although it is likely to be considerably shorted duration and would be dependent upon the diameter of piles and seabed conditions.

The 90 dBht level was selected on the results of the Masden *et al*., (2006) who demonstrated a near linear relationship between sound exposure level and duration of exposure. A doubling of the noise energy (eg 3 dB increase) results in a halving of the duration of exposure period required. The relationship between sound exposure level and duration of exposure is shown in Table 8.

Table 8 Comparison of noise exposure level and duration of exposure for a sound level of 90 dB_{ht}

Exposure Level dB(A) (dB_{ht})	Exposure Duration
90	8 hours
93	4 hours
99	1 hour
110	Approx. 5 minutes
120	Approx. 30 seconds
130	Approx. 3 seconds

An estimate of the minimum safe standoff distances from the piling operation has been based on the INSPIRE fleeing animal noise dose algorithm. Each standoff range indicates that if a particular species is closer than that range at the onset of piling, then they are unlikely to be able to flee the area before suffering hearing damage. This is based on a conservative swim speed of 1 metre per second (m/s) and takes into account the accumulated noise dose over a typical piling operation.

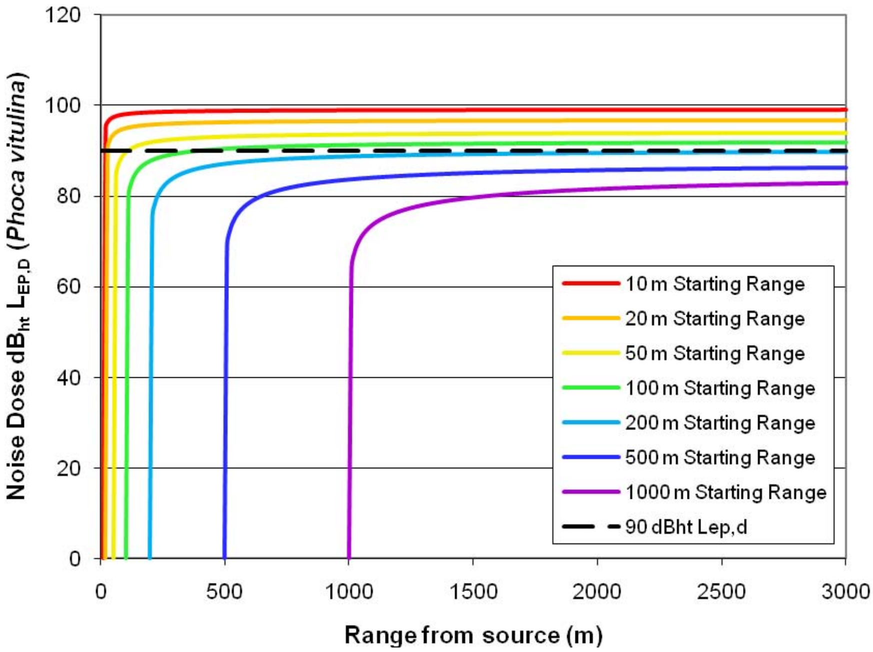
Figure 7 shows a detailed plot of the results of this modelling that has been carried out for each of the key species, in this case the figure is shown for species of seal. It can be seen that the 90 dB_{ht} $L_{EP,\ D}$ (Level of exposure and duration criteria; illustrated by the dashed line) is met between the 100 and 200 m starting range datasets (Table 9). The results of this indicate the ranges at which animals have to be before an injury is to occur, for example if a seal were to be closer to the piling operations than 190 m at the onset of piling it is unlikely to escape the area without receiving a damaging noise dose.

Table 9 presents the results of this modelling for the other species of marine mammal. It can be seen from these data that the harbour porpoise will need to be at the greatest distance (1,350 m) from the piling operation at its onset to avoid suffering hearing damage. If the fleeing animal is beyond the ranges presented in Table 9 they are likely to be able to reach a safe distance before receiving an unacceptable noise dose (when applying the 90 dB_{ht} criteria).

Table 9 Summary of the maximum starting ranges for various marine species using the fleeing animal noise dose model (when applying the 90 dB_{ht} criteria).

Marine Species	Maximum Starting Range for Fleeing Animal
Bottlenose Dolphin / Risso's Dolphin	120 m
Harbour Porpoise	1,350 m
White-Beaked Dolphin	460 m
Harbour Seal / Grey Seal	190 m

Figure 7 Estimated noise dose for a fleeing harbour / grey seal for impact piling of an 8.5 m diameter pile

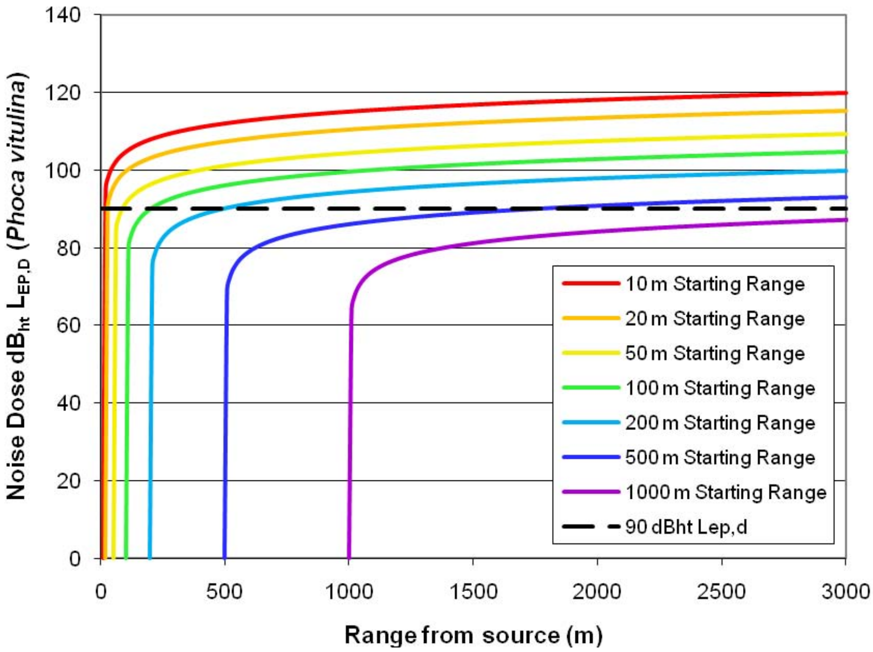


Noise dose modelling has also been carried out for a stationary animal during piling operations. It should be noted that this is considered an unlikely scenario as it implies that the animal makes no attempt to flee the high sound field area. This assessment has only been carried out for the harbour seal / grey seal and the results can be seen in Figure 8.

It can be seen that the results for the stationary animal modelling give much higher starting ranges than for the fleeing animal modelling, with the starting range for the harbour seal rising from 190 m (for a fleeing animal) up to almost 1 km for a stationary animal.

Further modelling to estimate similar impact ranges for other species has not been carried out for the stationary animal scenario as it is not felt to represent a realistic case. The data presented for the seal is provided to indicate the potential differences in the two scenarios.

Figure 8 Estimated noise dose for a stationary harbour / grey seal (used for illustrative purposes)



3.1.1.3.3 Assessment of Cumulative Exposure using Southall *et al*., (2007) Impact Criteria for Multiple Pulses

The accumulated exposure to sound for marine mammals has been assessed using the auditory injury criteria proposed by Southall *et al*., (2007). This has been done by calculating a standoff range for each marine mammal group, whereby it would safely be able to escape the affected area without receiving a damaging exposure to the sound. Table 10 shows a summary of these standoff ranges for fleeing animals, assuming a swim speed of 1 m/s. The largest standoff ranges are calculated for the seals, which, based on the M-weighting criteria are likely to need to be at a range of at least 3.6 km at the onset of piling to avoid a damaging exposure to the sound. Lower standoff ranges are predicted for the three cetacean groups with low frequency cetaceans being the most sensitive to the sound and high frequency cetaceans being the least.

Figure 9 shows the calculated multiple pulse M-weighted sound exposure levels for a fleeing high frequency cetacean at various starting ranges, from this it can be seen that if the animal was situated at a range of less than approximately 500 m from the piling operations at the onset of piling it is unlikely to escape the area without receiving a damaging exposure to noise according to the Southall *et al*., (2007) criteria. Figure 10 shows similar data for the high frequency cetacean group; however, this is for a stationary animal during the piling operations. It can be seen that the animal would have to be between 1 and 1.5 km at the onset of piling to avoid a damaging sound exposure level, assuming that it stayed in the same position throughout the entire piling operation. It should be noted that this scenario is considered highly unlikely as marine species are likely to attempt to escape areas where injury is likely to be caused.

Table 10 Summary of the maximum starting ranges for marine mammal groups before receiving an exposure that could cause auditory injury, using the multiple pulse criteria from Southall *et al*., (2007)

Marine Mammal Group	Maximum Starting Range
Low Frequency Cetaceans	1,350 m
Mid Frequency Cetaceans	820 m
High Frequency Cetaceans	650 m
Seals (in water)	3,600 m

Figure 9 Estimated M-weighting Sound Exposure Levels from various starting ranges for high frequency cetaceans using the multiple pulse criteria from Southall *et al*., (2007) for a fleeing animal

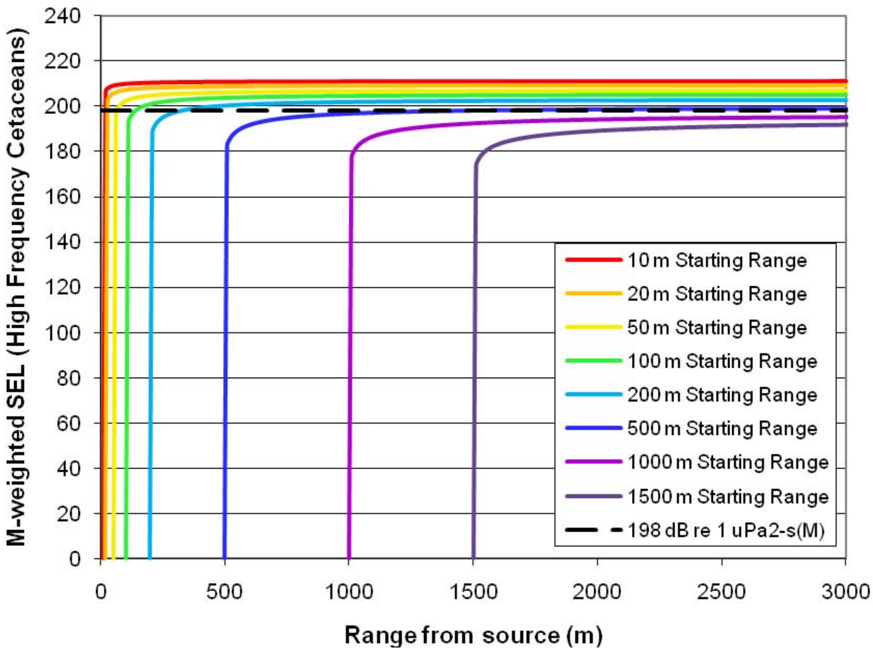
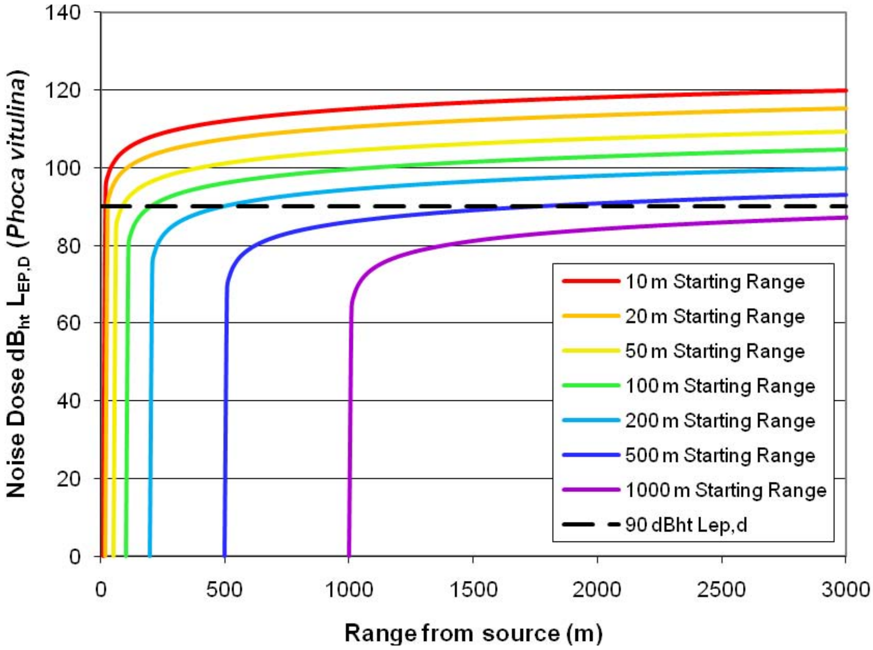


Figure 10 Estimated noise dose for a stationary harbour seal or grey seal for impact piling of an 8.5 m diameter pile



3.1.1.3.4 Summary of Cumulative Exposure Impacts Using the dB_{ht} and Southall *et al.*, 2007 Exposure Criteria

Table 11 shows a comparison between multiple pulse auditory injury impact ranges for three marine mammals species calculated using the dB_{ht} criteria and the three equivalent M-weighted SEL marine mammal groups. The data indicate that, unlike the single pulse exposure modelling, in some cases the dB_{ht} metric provides the largest estimated range of impact and in some cases the M-weighted SEL metric provides the largest impact range. This discrepancy is a result of the different values used in the impact thresholds for the two metrics. Highlighted in bold are the precautionary values which have been chosen to apply in the cumulative impact assessment as the minimum distances that auditory impacts could occur in a fleeing animal scenario.

The ranges at which auditory injury could occur to marine mammals will be factored into the MMPP and the mitigation measures adopted during the construction activities. It should be noted that these results (fleeing animal scenario etc) do not take into account the mitigating effects of a soft start procedure; these results assume a high blow force at the onset of piling. As long as a soft start procedure is used the effect is likely to be considerably reduced.

Table 11 Summary of impact ranges comparing the multiple auditory injury ranges, using the fleeing animal model, predicted using the dBht criteria (Nedwell *et al*., 2007) and the M-weighted SEL (Southall *et al*., 2007) criteria

dB_{ht} (Nedwell *et al*, 2007)		M-weighted SELs (Southall *et al*, 2007)	
Species	**Multiple pulse auditory injury range (fleeing animal)**	**Equivalent M-weighting group**	**Multiple pulse auditory injury range (fleeing animal)**
Bottlenose Dolphin	120 m	Mid Frequency Cetacean	**820 m**
Harbour Porpoise	**1,350 m**	High Frequency Cetacean	650 m
Harbour Seal	190 m	Pinnipeds	**3,600 m**

Figures in bold represent the maximum auditory impact ranges

The modelling results indicate that unless a cetacean is within the immediate vicinity of piling operations (<1.35 km) or a seal is situated (3.6 km) in the local area, the only possibility for an auditory injury to occur is during the initial piling period. It is expected that the perceived loudness of the piling activity will cause the marine mammal to exhibit an aversive behavioural reaction, with the animal moving from the area before the onset of any auditory injury can occur.

There is clearly a risk to individual marine mammals that are exposed to high sound levels in the immediate vicinity of the piling operation, given that marine mammals may be subject to sound levels that are capable of causing physical impacts, including both auditory and non-auditory impacts. Animals would have to be present within the immediate area of the pile driver to be at risk of physical effects and it is considered the risk of marine mammals receiving sound levels capable of causing their death appears to be remote.

The marine mammals which are most likely to be exposed are the more commonly sighted species within Aberdeen Bay, with the harbour porpoise, bottlenose dolphins and grey and common seals being the species most at risk from physical impacts.

To individual marine mammals the potential impact is considered to be of high magnitude and potentially of major significance. In terms of risks to the population most of the marine mammal species; with the exception of the bottlenose dolphin, have wide ranging populations. Subsequently, the risk to the population level is anticipated to be of low magnitude and moderate significance. Given that the relatively small Moray Firth bottlenose dolphin population has been increasing its range expansion in a southerly direction, and that Aberdeen Bay frequently has bottlenose dolphins, especially during the winter and spring months, the potential impact both to the individual and population is considered to be of high magnitude and potentially of major significance. It should be considered the majority of bottlenose dolphins sightings have been observed frequenting the harbour mouth area and that the mitigation measures mentioned below they should be sufficient to ensure that no bottlenose dolphins are situated within 820 m prior to piling activities, if such measures are put in place the anticipated magnitude of the effects is expected to be negligible and thus be of minor significance to the bottlenose dolphin populations.

Other forms of construction associated sounds are expected to be dominated by vessel noise. In terms of direct physical injuries to hearing structures in marine mammals, it appears from the available research that loud and/or sustained exposures are required to cause even temporary changes in marine mammal hearing sensitivity (Southall *et al*., 2007). Consequently, the likelihood that an isolated exposure to vessel noise would be sufficient to permanently damage the hearing of a marine mammal appears to be remote, and the significance of other forms of construction activities causing physical injury to marine mammals is considered to be of minor impact.

3.1.1.4 Mitigation

The mitigation measures that are planned to be used to minimise the risk of causing physical impacts to marine mammals are as follows:

- use of trained and experienced Marine Mammal Observers (having undertaken a JNCC recognised course);
- pre-piling search for marine mammals prior to piling monitoring a suitable sized exclusion zone;
- use of Passive Acoustic Monitoring (PAM) system monitored by experienced PAM operatives; and
- soft-start (gradual ramp up) of pile driver.

The modelling of cumulative exposure to piling noise indicates that in a fleeing animal situation the marine mammal that is most sensitive to pile driving sound are the seals, and that to avoid auditory injury they will have to be 3.6 km away from the piling location. A typical mitigation zone for marine mammal observers to monitor has been recommended as a default 1 km (JNCC, 2010), the results of the modelling indicate that this zone should be increased for seals (but will also be applied to all marine mammal species).

Given that there is a risk to marine mammals in the immediate vicinity of the piling operations, and the risk is apparently greater for seal species, it may be worth considering the use of Acoustic Mitigation Devices (AMD's) which, providing they are used appropriately, could temporarily displace marine mammals from the area prior to piling operations. The use of devices whose purpose is to deter marine mammals could be seen as advantageous given the potential risk to marine mammals from noise impacts from pile driving, by removing animals or certain species from the area of operations this action may minimise the risk of causing injury.

AOWFL recognise that the use of AMD's as part of the mitigation measures for piling is currently an area of active scientific research (Kastelein, *et al*., 2010). From a review of commercially available Acoustic Mitigation Devices there are a number which have been designed as seal deterrents, including the Lofitech, Ace Aquatech (Nedwell, *et al*., 2010), and their use could prove advantageous as part of the overall mitigation strategy during construction. Any use of AMD's will be subject to strict timing constraints so that the underwater noise generated will be minimised. If these are used it is envisaged that they will be subject to timing and deployment constraints, for example being deployed 1 hour prior to the commencement of the soft-start and switched off immediately after the piling has ceased (Kastelein, *et al*., 2010). It is also recognised that the use of any such devices may require European Protected Species licences to deploy as they will constitute deliberate disturbance of marine mammals.

AOWFL are open to incorporating the latest advice on the mitigation procedures used as part of the development of the EOWDC. The final MMPP will be agreed following advice and consultation with SNH and Marine Scotland.

3.1.1.5 Residual Impacts

In order to determine the residual impacts, it has been assumed that the mitigation measures described in Section 3.1.1.4 will be successfully implemented then it is expected that physical impacts to marine mammals are unlikely to occur. Impacts on marine mammals would be of negligible magnitude and, therefore, of minor significance.

3.1.1.6 Cumulative Impacts

There are not anticipated to be any cumulative impacts from other renewable energy projects, as all construction activities of other nearby proposed wind farm developments are expected to commence after the EOWDC has been completed. Should the proposed project timescale for the construction of the EOWDC change and coincide with the commencement of construction activities of other renewable energy projects, then further assessment of cumulative impacts from concurrent piling shall be carried out at a later date.

The development and installation of the proposed Ocean Laboratory could occur within the same construction period as the piling of the foundation structures. The installation of the Ocean Laboratory would be comparable to the installation of another monopole. As a worst case the piling of the Ocean Laboratory will take 24 hours and is unlikely to result in any significant cumulative impacts, providing that the mitigation measures that were used for the wind turbines are applied.

The other industrial activity that could cause physical impacts to marine mammals are seismic surveys. There are currently no planned surveys times to occur during the construction period of the EOWDC. There is unlikely to be any seismic surveys occurring simultaneously with the pile driving, as the sound underwater sound interferes with recording of the sound signals received from the seabed. As such any seismic surveys that are planned to occur in the waters of the North Sea, will be timed to avoid known periods of pile driving activity. The waters immediately offshore the north east of Scotland has a low prospectively for hydrocarbons and as such are of little interest to the oil and gas industry. The closest hydrocarbon field to the EOWDC is the Buzzard field which is situated 100 km away.

3.1.1.7 In-Combination Impacts

No in-combination impacts are anticipated.

3.1.1.7.1 Monitoring

The piling operation will follow the MMPP. The presence of marine mammals will be monitored during the construction period through the continuation of the boat based surveys and through the use of static C-pods deployed throughout Aberdeen Bay. The presence of observers and acoustic recording instrument (C-pods) deployed throughout the development stage will enable an assessment of marine mammals presence during construction. Post construction analysis of the acoustic monitoring data collected by the C-pods with other visual observation effort will allow an assessment and validation of construction impacts.

3.1.2 Noise Generated during the Construction of the EOWDC May Cause Behavioural Disturbance and Displacement to Marine Mammals

Worst Case Scenario: Piling of 8.5 m diameter pile at all eleven locations during one phase of installation (sequentially).

3.1.2.1 Potential Impacts

Behavioural disturbance to marine mammals can be caused by elevated sound levels. Upon receiving a sound level capable of causing disturbance the animal may exhibit a number of behaviours, one of the most apparent would be opting to swim away from the source (considered to be an aversive response to the sound signal). This section will assess the potential for piling sound to displace marine mammals from the area by assessing the potential for sound levels to induce a behavioural response. There are a number of sound sources that will be associated with construction activities, the principal sources being associated with construction vessels including: piling barge, support vessels, and other vessels involved with installing seabed cables and infrastructure.

Underwater sound generated by vessels has been recognised as capable of causing a number of different types of behavioural responses in marine mammals, including changing their distribution and abundances. Also it has been suggested that prolonged exposure to increased ambient noise may lead to physiological and behavioural stress (McDonald, *et al*., 2006; Parks and Clark 2005). Thus chronic exposure to noise can permanently impair important biological functions and may lead to consequences that are as severe as those induced by acute exposure from impulsive type sounds.

The construction vessels will only be present within the Aberdeen Bay for the duration of construction activities, which is a relatively short period of time. Moreover, Aberdeen Bay has a number of well established shipping lanes and the vessel noise associated with construction activities is not expected to cause a significant change to ambient sound levels.

Other types of construction activities that are expected to generate underwater noise other than the foundation installation are the cable trenching activities. Measurements of cable trenching activities at North Hoyle Offshore Wind Farm estimated that the sound levels were dominated by the noise from the vessel, and the predicted source levels (178 dB re.1µPa@1m) were considered to be below the level which would cause any behavioural reaction in marine mammals (npower renewables 2002). The cable laying activities as part of the construction of the EOWDC are likely to utilise a similar type of vessel, therefore the sound levels generated are thought to be comparable and are not of any particular concern for causing behavioural impacts to marine mammals.

In terms of the sound levels generated by construction by far the greatest contributor to underwater sound in terms of its peak sound pressure level will be the piling sound, therefore the assessment of behavioural impacts will focus principally on this noise source. The assessment of behavioural impacts will use and compare the results of two impact approaches, the dB_{ht} criteria; proposed by Nedwell *et al*., (2007) and the behavioural response criteria, Southall *et al*., (2007).

3.1.2.2 Assessment of Behavioural Impacts Using the dB_{ht} mectric

Measurements of underwater noise are frequently presented in terms of the overall linear level of that sound, such as its spectral level or peak pressure. This, however, does not provide an indication of the impact that the sound will have upon a particular fish or marine mammal species. This is of fundamental importance when considering the behavioural response of species to activities generating underwater noise, as avoidance is associated with the perceived level of loudness and vibration of the sound by the species. Therefore, the same underwater noise may have a different impact on different species with different hearing sensitivities.

The dB_{ht}(*Species*) metric (Nedwell *et al*, 2007) has been developed as a means for quantifying the potential for a behavioural impact on a species in the underwater environment. As any given sound will be perceived differently by different species (since they have differing hearing abilities) the species name must be appended when specifying a level. For instance, the same construction event for salmon (*Salmo salar*) might have a level of 70 dB_{ht} (*Salmo salar*) and for bottlenose dolphin a level of 110 dB_{ht}(*Tursiops truncatus*). Table

12 below summarises the assessment criteria for the dB_{ht} metric, the higher dB_{ht} levels are correspond to a greater behavioural effect, or at very high levels hearing damage (Nedwell, *et al*. 2007).

Table 12 Assessment criteria proposed by Nedwell *et al*., (2007) used in the impact assessment for behavioural impacts of underwater noise on marine mammals

Level in dB_{ht}(Species)	Effect
75	Significant avoidance
90 and above	Strong avoidance reaction by virtually all individuals.
Above 110	Tolerance limit of sound; unbearably loud.
Above 130	Possibility of traumatic hearing damage from single event.

In addition, a lower level of 75 dB_{ht} has been used for analysis as a level of "significant avoidance." At this level, about 85% of individuals will react to the noise, although the effect will probably be limited by habituation (Subacoustech 2011).

Figure 11 and Figure 12 shows the results for modelling 8.5 m diameter piles in terms of peak to peak dB_{ht} (*Species*) perceived sound levels for the marine species of interest for a deep water transect and a shallower water transect respectively. The depth profiles for these transects are shown in Figure 3.

Figure 11 Estimated peak to peak dB_{ht} level with range plot of various marine mammals and fish species along a deep water transect (wind wind turbine 11, bearing 60°) during the installation of a 8.5 m pile

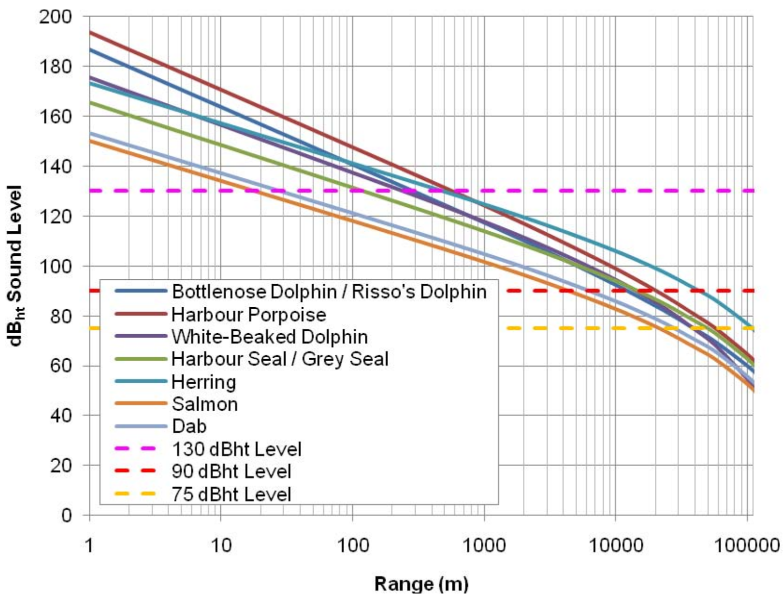


Figure 12 Estimated peak to peak dB_{ht} level with range plot of various marine mammals and fish species along a shallow water transect (wind wind turbine 11, bearing 195^{o}) during the installation of a 8.5 m pile

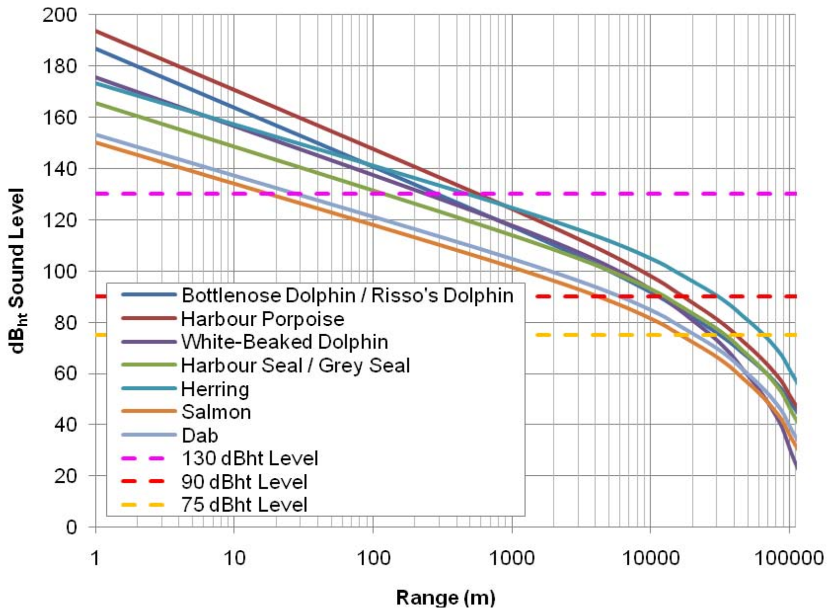


Table 13 - Table 16 present a comparison of estimated 90 dB_{ht} impact ranges for behavioural response for the species of interest. Mean ranges along with the overall range of values are presented for all four wind turbine positions.

The largest range for a behavioural response is predicted for the harbour porpoise, which is likely to receive an underwater noise level of 90 dB_{ht} out to maximum of 22 km from piling operations. The smallest 90 dB_{ht} impact ranges predicted for species of marine mammal is for bottlenose dolphin and Risso's dolphin, with behavioural response ranges of between 12 and 13 km.

The INSPIRE model calculates impact ranges along transect paths from a selected point, in this case the wind turbine positions, along 180 equally spaced transects (one every 2^{o}). The maximum, minimum and mean ranges from all of these transects are collected in the tables below. It should be noted that the minimum ranges are for transects heading into shallow water, and in most cases, are reaching the coastline before the sound has attenuated to below 90 dB_{ht}. Hence why, for example, all the minimum ranges from Wind turbine 1 are calculated to be 3 km, as this is the minimum distance between the wind turbine position and the coastline. All the predicted received noise for all the key species is still above 90 dB_{ht} at this particular piece of coastline.

The mean values quoted in the tables take into account all of the transects, these apparently shorter impact ranges are also used in the averaging.

Table 13 Summary of the estimated behavioural impact ranges for piling an 8.5 m diameter pile at wind turbine position 1 using the dB_{ht} impact criteria

Species	90 dB_{ht} Range	
	Mean	Range of values
Bottlenose Dolphin / Risso's Dolphin	8.5 km	3.0 – 13 km
Harbour Porpoise	12 km	3.0 – 21 km
White-Beaked Dolphin	9.3 km	3.0 – 15 km
Harbour Seal /Grey Seal	9.6 km	3.0 – 16 km

Table 14 Summary of the estimated behavioural impact ranges for piling an 8.5m diameter pile at wind wind turbine position 3 using the dB_{ht} impact criteria

Species	90 dB_{ht} Range	
	Mean	Range of values
Bottlenose Dolphin / Risso's Dolphin	7.9 km	2.3 – 12 km
Harbour Porpoise	11 km	2.3 – 20km
White-Beaked Dolphin	8.4 km	2.3 – 14km
Harbour Seal /Grey Seal	8.7 km	2.3 – 15 km

Table 15 Summary of the estimated behavioural impact ranges for piling an 8.5m diameter pile at wind wind turbine position 7 using the dB_{ht} impact criteria

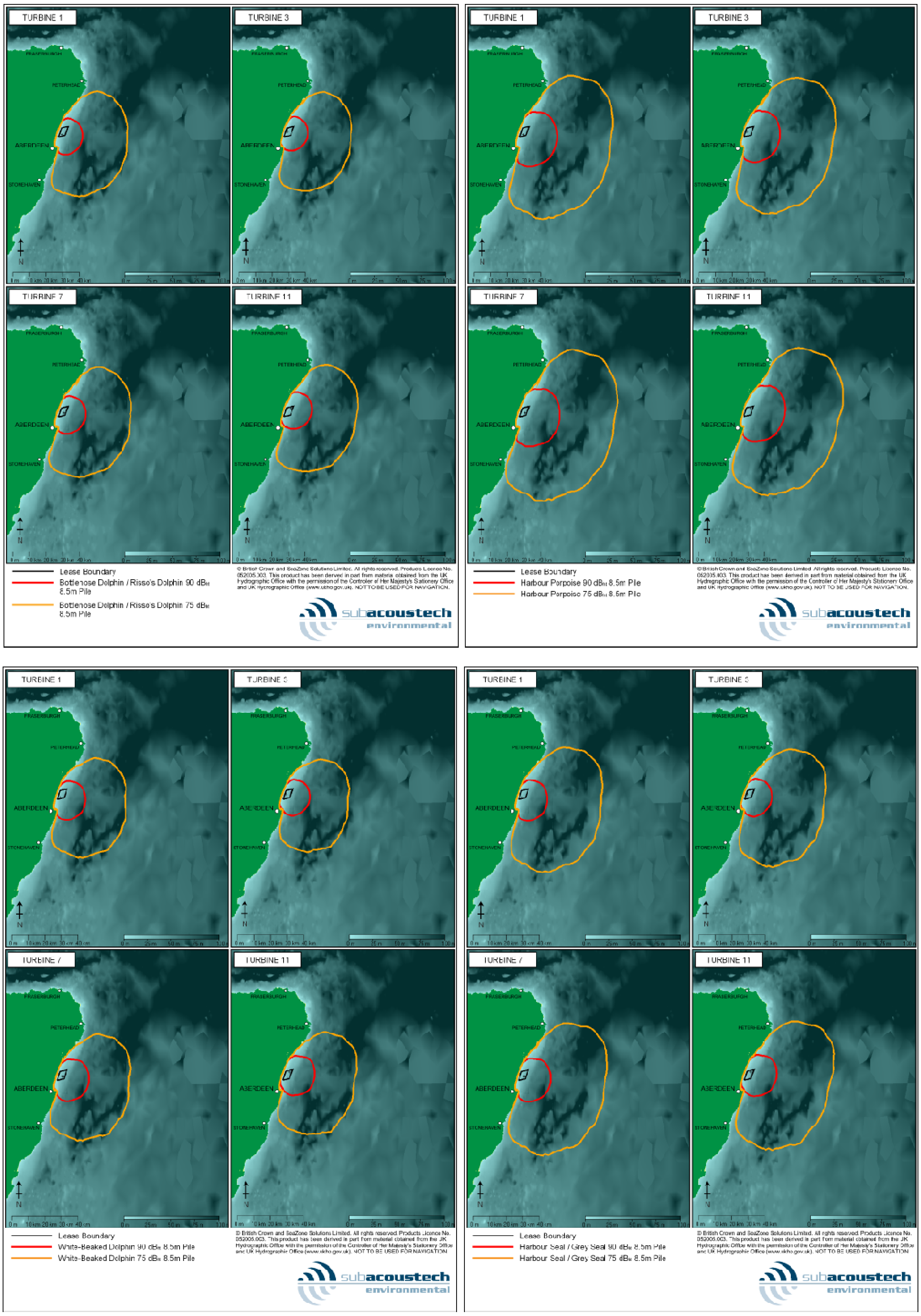
Species	90 dB_{ht} Range	
	Mean	Range of values
Bottlenose Dolphin / Risso's Dolphin	9.5 km	4.1 – 13 km
Harbour Porpoise	13 km	4.1 – 22 km
White-Beaked Dolphin	10 km	4.1 – 16 km
Harbour Seal /Grey Seal	11 km	4.1 – 16 km

Table 16 Summary of the estimated behavioural impact ranges for piling an 8.5m diameter pile at wind wind turbine position 11 using the dB_{ht} impact criteria

Species	90 dB_{ht} Range	
	Mean	Range of values
Bottlenose Dolphin / Risso's Dolphin	9.2 km	3.8 – 13 km
Harbour Porpoise	13 km	3.8 – 21 km
White-Beaked Dolphin	10 km	3.8 – 16 km
Harbour Seal /Grey Seal	10 km	3.8 – 16 km

These results are also presented graphically as contour plots in Figure 13, with each group of images showing the 90 and 75 dB_{ht} impact ranges for each marine species of interest. The 75 dB_{ht} level is a lower behavioural avoidance level, although the effect will probably be limited in duration by habituation. In general, the 90 dB_{ht} criteria level is thought to represent the most useful measure of behavioural disturbance in this case. It can be seen from these figures that the maximum impact ranges stretch out to the east and north east of the proposed EOWDC into the deeper water of the North Sea, where, in some places, water depths are in excess of 100 m LAT. The data indicate that, in nearly all cases, the minimum 90 dB_{ht} contours are the same for each pile; this is due to sound levels being above 90 dB_{ht} for these species at the Scottish coastline. The difference between the impact ranges at the four wind turbine sites is similar. The largest impact ranges are estimated for wind turbines 7 and 11; this is due to being situated on the east boundary of the proposed EOWDC, which is closer to the deep water of the North Sea.

Figure 13 Contour plots showing the estimate 90 and 75 dB_{ht} peak impact ranges for bottlenose / risso's dolphins, harbour porpoise, white beaked dolphin and harbour / grey seals during the installation of an 8.5 m diameter pile (Subacoustech, 2011)



3.1.2.3 Assessment of Behavioural Impacts Using Southall et al., 2007

The assessment of behavioural disturbance also applied the Southall *et al*., (2007) criteria, where the onset of a behavioural response has been proposed as the sound exposure level capable of causing a Temporary Threshold Shift (TTS) in the hearing ability of marine mammals. The criteria associated to be capable of causing a TTS are shown in Table 17 (Southall *et al*., 2007).

Table 17 Proposed behavioural response criteria in terms of single pulses for various marine mammal hearing groups (including low, mid and high frequency cetaceans and seals in water)

Marine mammal group	Sound type
	Single pulses & Multiple pulses
Low Frequency Cetaceans	
Sound Exposure Level	183 dB re 1 µPa^2/s (M_{lf*})
Mid Frequency Cetaceans	
Sound Exposure Level	183 dB re 1 µPa^2/s (M_{mf*})
High Frequency Cetaceans	
Sound Exposure Level	183 dB re 1 µPa^2/s (M_{hf*})
Seals (in water)	
Sound Exposure Level	171 dB re 1 µPa^2/s (M_{pw*})

(M_{lf} = M weighted low frequency M_{mf}= M weighted medium frequency / M_{hf}= M weighted high frequency M_{pf})

The Southall *et al*., (2007) criteria specify that behavioural avoidance is anticipated to occur at a frequency weighted (M- weighted) sound exposure level of 183 dB re.1 µ Pa^2/s (referenced to 1 micro Pascal squared seconds). The sound pressure levels modelled during the piling operation were weighted accordingly and the anticipated maximum impact ranges were determined. Table 18 – Table 21 show summaries of the single pulse behavioural impact ranges predicted. It can be seen that the largest impact ranges are predicted for the seals with behavioural avoidance predicted out to a range of 1.6 km. The three cetacean groups predict lower single pulse behavioural impact ranges, ranging from 280 m, for low frequency cetaceans, to 100 m, for high frequency cetaceans.

Due to these SEL levels predicting relatively low impact ranges, no maximum and minimum ranges have been included as, at these close ranges, changes in bathymetry do not affect the attenuation of sound significantly, resulting in relatively uniform results.

Table 18 Summary of ranges out to which a behavioural avoidance reaction in cetaceans in the low frequency hearing group may occur using the Southall *et al*., (2007) criteria

Low Frequency Cetaceans	Behavioural Avoidance Range 183 dB re. 1 µPa^2/s (M_{lf})
Wind turbine 1	270 m
Wind turbine 3	260 m
Wind turbine 7	280 m
Wind turbine 11	280 m

Table 19 Summary of ranges out to which a behavioural avoidance reaction in cetaceans in the mid frequency hearing group may occur using the Southall *et al.*, (2007) criteria

Mid Frequency Cetaceans	Behavioural Avoidance Range 183 dB re. 1 µPa^2/s (M_{mf})
Wind turbine 1	120 m
Wind turbine 3	110 m
Wind turbine 7	120 m
Wind turbine 11	120 m

Table 20 Summary of ranges out to which a behavioural avoidance reaction in cetaceans in the high frequency hearing group may occur using the Southall *et al.*, (2007) criteria

High Frequency Cetaceans	Behavioural Avoidance Range 183 dB re. 1 µPa^2/s (M_{hf})
Wind turbine 1	100 m
Wind turbine 3	100 m
Wind turbine 7	100 m
Wind turbine 11	100 m

Table 21 Summary of ranges out to which a behavioural avoidance reaction in seals (in water) may occur using the Southall *et al.*, (2007) criteria

Seals in water	Behavioural Avoidance Range 183 dB re. 1 µPa^2/s (M_{pw})
Wind turbine 1	1.6 km
Wind turbine 3	1.5 km
Wind turbine 7	1.6 km
Wind turbine 11	1.6 km

3.1.2.4 Summary of Behavioural Impacts and Comparison between dBht and Southall et al., (2007) approach

Table 22 presents a comparison between the mean predicted dB_{ht} behavioural avoidance impact ranges and the mean M-weighted SEL behavioural avoidance impact ranges for the equivalent marine mammal groups for modelling undertaken for wind turbine position 1.

Again it can be seen that the impact ranges for dB_{ht} differ substantially from those predicted using the M-weighted SEL criteria. The ranges using the M-weighted SEL criteria are thought to be highly optimistic, and are in conflict with the limited amount of published information currently available. For instance, harbour porpoise have been found to avoid an area around similar pile driving operations out to a distance of 15 km (Tougaard, *et al.*, 2006). The most conservative (precautionary) estimates of the extent of potential disturbance have been highlighted in bold (Table 22).

Table 22 Summary of impact ranges comparing the single pulse behavioural avoidance ranges predicted using the dB_{ht} criteria (Nedwell *et al.*, 2007) and the M-weighted SEL approach (Southall *et al.*, 2007) (using wind turbine position 1 for illustration)

dB_{ht} (Nedwell *et al*, 2007)		M-weighted SELs (Southall *et al*, 2007)	
Species	Mean behavioural avoidance range (90 dB_{ht})	Equivalent M-weighting group	Mean behavioural avoidance range
Bottlenose Dolphin	**8.5 km**	Mid Frequency Cetacean	120 m
Harbour Porpoise	**12 km**	High Frequency Cetacean	100 m
Harbour Seal	**9.6 km**	Pinnipeds (in water)	1.6 km

The behavioural effects are only expected to occur during the piling activities and as such as limited to a maximum time period of 24 hours per pile, although it is expected to take considerably less time than this. The piling of jacket structures is expected to require piles with smaller diameters and will take less time to install, although there will be a greater number of piles per platform. Any behavioural effects that occur to the marine mammals are expected to be reversible, in that their behaviour will no longer be changed when the piling activity has ceased.

The range at which potential adverse behavioural responses is considerable being upto 22 km for harbour porpoise and 16 km for common and grey seals. For harbour porpoises the results of post-monitoring studies suggest that after piling stops the animals have been found to return to the area within a few hours. Therefore, behavioural disturbance, which could lead to displacement of marine mammals from the piling activities, is only expected to occur for the duration of piling activities.

The closest seal haul out location identified from SMRU aerial surveys was 7.9 km away (SMRU, 2007), however, harbour seals are also known to occasionally haul out on the sand banks at the Bridge of Don. Both locations are within the radius of potential behavioural displacement. If piling occurs when seals are hauled out no impacts would be expected. Sound impacts would only occur once the animal returns to the water if piling is ongoing. In shallow waters however, the levels of sound an animal receives decreases rapidly due to the greater transmission loss associated with shallower waters. The haul out locations of seals could be affected by the piling operations, which could cause the temporarily displacement of seals from such areas, the significance of this is considered to be moderate.

Aberdeen Bay is recognised as being important for bottlenose dolphins, although there remains some uncertainty as to how the area is used throughout the year by the Moray Firth population of dolphins. The potential exclusion of bottlenose dolphins through behavioural displacement for the duration of the piling activity and out to an extent of 16 km has been assessed as being of high magnitude, and therefore of potentially of major significance to the bottlenose dolphin. As bottlenose dolphins are present along the east coast of Scotland, it has been predicted that the temporary displacement of animals from the Aberdeen Bay area will be mitigated by animals moving into other areas within their natural range, this is a hypothetical assessment and is based on the available habitat range for bottlenose dolphins being extensive covering the coastal waters along the Scottish east coast.

For the other species of cetacean present in Aberdeen Bay they are not restricted to coastal areas and are present throughout a far wider area. Aberdeen Bay has not been recognised as being of particular importance for breeding or calving purposes for other cetacean species, the possible exception in that shallower coastal water of the east coast of Scotland have been speculated to have a role in breeding or calving for the white beaked dolphin during the summer period.

If piling occurs during summer months (July/August) the significance of the behavioural disturbance is likely to be major for the white beaked dolphins, but will still be of moderate impact for all other cetacean species with the exception of the bottlenose dolphin (major). Any temporary exclusion of the cetacean species from Aberdeen Bay is considered to be of minor significance, given that there is likely to be adequate areas for foraging relatively nearby.

The vessels used in the construction of Aberdeen Bay may locally increase the ambient sound levels and as such may temporarily contribute to the displacement marine mammal from the vicinity of construction activities, the significance of this local displacement of marine mammals is negligible.

3.1.2.5 Mitigation

No further mitigation measures above and beyond the MMPP are going to be put in place.

3.1.2.6 Residual Impacts

Upon cessation of piling marine mammals that have been exposed to sound levels capable of inducing behavioural effects (such as swimming away from the area of elevated underwater sound) are expected to return to the abundance and densities levels that are consistent with their redistribution not being significantly changed from levels prior to construction activities. Aberdeen Bay has had a number of notable construction activities in the past including beach protection works and harbour modifications all of which have not appeared to have any lasting impact upon the use of the area by marine mammals. Assuming that marine mammals return to the area after the construction activities have finished there are not anticipated to be any residual impacts.

3.1.2.7 Cumulative Impacts

The cumulative impacts for behavioural disturbance and displacement of marine mammals are not anticipated to be significant during the construction of the EOWDC as this is expected to be the only renewable energy project in Scottish territorial waters where construction is planned to commence during 2013.

3.1.2.8 In-Combination Impacts

There are no other activities that are planned to occur in the wider area that are expected to cause additional behavioural disturbance and displacement of marine mammals.

3.1.2.9 Monitoring

No further monitoring over and above the MMPP is proposed.

3.1.3 Noise Generated during the Construction of the EOWDC May Cause Interference with use of Sound by Marine Mammals

Worst Case Scenario: Piling of 8.5 m diameter pile at all eleven locations during one phase of installation (sequentially).

3.1.3.1 Potential Impacts

Marine mammals use sound for a variety of purposes including in communication, orientation, predator avoidance and foraging. The range of sounds used by marine mammals is broad, and ranges from the low frequency calls of baleen whales to the ultrasonic clicks of 145 kHz in harbour porpoise (Villadsgaard, *et al*., 2007). Harbour seals communicate using low frequency calls and have a well developed under water hearing system (Kastak and Schusterman 1998). Harbour seal males produce underwater vocalisations during the mating season to attract females or to compete with other males and are known to establish territories in the waters offshore of haul-out sites (Hayes, 2004). The results of the acoustic surveys have demonstrate the use of Aberdeen Bay for foraging activities by the harbour porpoise (echolocation clicks) and vocalisations of other dolphin species.

During the pile driving construction activities there is the potential for the sound to mask any seal vocalisations, potentially out to a distance of 80 km (Thomsen, *et al*., 2006). The spatial scale of the potential masking will be dependent upon prevailing ambient sound levels and 80 km is a theoretical maximum. The actual significance of this potential impact is expected to be low given that there are no notable haul out locations in close proximity to Aberdeen Bay and that any potential masking will be temporary.

Masking of biologically relevant sounds produced by high frequency cetaceans, such as the harbour porpoise, and possibly mid-frequency cetaceans, such as the bottlenose dolphin, is unlikely as the piling pulses have little high frequency energy (Thomsen *et al*., 2006). Pile driving pulses are of short duration, and are therefore may be below the time where full detection of signals is possible in cetaceans (Thomsen *et al*., 2006).

Other forms of construction sounds, such as those associated with vessel activity, are continuous type sounds, as opposed to the short duration impulsive piling sounds, and are therefore likely to be above the timeframe where full detection of the signals is possible by cetaceans, and are therefore expected to be audible. Although the vessel sounds are likely to be audible to marine mammals, they are not considered to be capable of masking the cetacean species that are most commonly present in Aberdeen Bay.

3.1.3.2 Mitigation

No mitigation is required.

3.1.3.3 Residual Impacts

The magnitude of the impact on marine mammal vocalisations is considered to be low for seal and negligible for other cetacean species. The overall significance is considered to be moderate for seals and minor for cetaceans. After completion of the construction works there are not anticipated to be any residual impacts.

3.1.3.4 Cumulative Impacts

The Ocean Laboratory will add cumulatively to the construction sound generated, although this is only expected to represent a minor additional cumulative impact that is expected to occur over a short installation timeframe (that would be equivalent of the installation an additional wind turbine), therefore there are no significant impacts expected upon the use of sound by marine mammals.

3.1.3.5 In-Combination Impacts

Cumulatively, vessel noises are a concern for increasing the ambient underwater sound levels, and have been found to influence the vocalisation behaviours of the cetaceans that generate low frequency calls, such as certain species of baleen whales. The development will increase shipping levels and as such will cumulatively contribute to increased underwater sound levels for the duration of the construction activities. Considering Aberdeen Bay is within a relatively busy shipping area, and as large baleen whales are relatively rare in this area of the North Sea, the local elevation of underwater sound is considered to be of minor to negligible significance.

3.1.3.6 Monitoring

No specific monitoring is required.

3.1.4 Installation of Wind Turbines and Cable will Cause Elevated Suspended Sediment Levels within Aberdeen Bay, Which May Impact upon Marine Mammals

Worst Case Scenario: Piling of 8.5 m diameter pile at all eleven locations during one phase of installation (sequentially) and installation the cable within the proposed corridor.

3.1.4.1 Potential Impacts

The impacts of the construction activities of the EOWDC and cable corridor have been considered within the assessment of coastal processes (see the Coastal Process Assessment, Chapter 8 of the ES). This assessment considered the suspended sediment concentrations that would result from the installation of 11 monopiles and the trenching of the cable within the predicted corridor.

The installation of the monopole wind turbines has been shown to result in the release of silts and fine sands which become suspended following mobilisation by the construction works (ABPmer, 2011). The displaced sediment will not act in the same manner of the surficial sediments which are not as easily suspended. The sediment plume has a wider concentration of 8 mg/l, with maximum concentrations reaching 100 mg/l in local areas. The main area of SSC changes lies between the area of Aberdeen Harbour, and 5 km south of the Ythan estuary.

The modelling indicates that the installation of the cable will result in the release of silts and fine sands which become suspended, this material does undergo deposition on the bed when the tidal flow is insufficient to maintain suspension, it does not remain on the seabed long-term such that it becomes resuspended. The cable lay activities are expected to as a worst case generated locally elevated concentrations of 90 mg/l occurring.

Naturally high suspended sediment concentrations are can be found in Aberdeen Bay (43 mg/l), although the installation of the wind turbines is expected to produce levels in excess of these levels, the source of suspended sediment is temporal and will cease once the construction activities are completed. Also it is highly unlikely that all the foundations will be gravity bases, therefore the magnitude of impacts from suspended sediments is expected to be considerably reduced.

Cetaceans generally have poor vision, the exception being the dolphin species which have well developed eyes for seeing above and below the water. In foraging pinnipeds vision has been suggested to be the predominant source of sensory information (Levenson and Schusterman 1999), but the presence of blind but well nourished seals in the wild have challenged this view, although more recently water turbidity has been proposed to be an important factor in the sensory ecology of pinnipeds ((Newby, *et al*., 1970; Weiffen, *et al*., 1996).

Marine mammals present in Aberdeen Bay are likely to be tolerant of the range of suspended sediment levels that can be present within background levels and would be also expected to be resilient to temporary elevation of suspended sediments that would occur during storms and when the Rivers Dee and Don are in flood. The construction activities will not generate excessively high levels of suspended sediment, and any locally high levels will only be present for a temporary duration, the direct impact on marine mammals is anticipated to be negligible.

3.1.4.2 Mitigation

No mitigation is proposed.

3.1.4.3 Residual Impacts

This impact has been assessed as being of negligible significance and no residual impacts are anticipated.

3.1.4.4 Cumulative Impacts

None anticipated.

3.1.4.5 In-Combination Impacts

None anticipated.

3.1.4.6 Monitoring

No specific monitoring is required

3.1.5 Construction of the EOWDC May Cause Displacement of Prey Species of Marine Mammals

Worst Case Scenario: Piling of 8.5 m diameter pile at all eleven locations during one phase of installation (sequentially).

3.1.5.1 Potential Impacts

Changes to prey species as a result of construction activities could potentially have an indirect impact upon marine mammals present in Aberdeen Bay. The impact assessments of the Marine Ecology (Chapter 8 of the ES), Commercial Fisheries (Chapter 21 of the ES) and Salmon and Sea Trout (Chapter 22 of the ES) have been used to assess potential indirect impacts to marine mammals from changes to prey species.

The principal impact identified was from construction associated noise during the installation of the monopiles, this has been assessed as capable of causing displacement of fish species. The magnitude of the displacement is dependent upon the hearing sensitivity of the fish species, with the most sensitive fish species, such as the herring, potentially being displaced as far as 47 km from the piling location

(Subacoustech, 2011). The range of noise induced behavioural displacement for other species of fish which have reduced hearing sensitivity is considerably reduced.

Marine mammals are highly mobile and are expected to follow their prey should they be displaced from the area during construction activities. Piling will be infrequent and temporary so that any disturbance to prey species will be intermittent and not consecutive so any foraging impacts are unlikely to be of sufficient magnitude or duration to adversely affect any life history traits of marine mammals. The marine mammals present in Aberdeen have been known to feed on varied prey species and should be adaptable should one of the more sensitive species to sound be temporarily displaced from the local area.

3.1.5.2 Mitigation

Although the mitigation measures were principally designed for marine mammals, measures such as the soft-start may minimise the risk of causing any physical injury to prey species, as they may move away from the area before any physical impacts are caused.

3.1.5.3 Residual Impacts

This magnitude of the impact upon marine mammals is considered to be negligible, the significance of the impact is considered to be minor.

3.1.5.4 Cumulative Impacts

The construction of the Ocean Laboratory is another aspect that could cumulatively add to the disturbance of marine life and prey species of marine mammals. The associated disturbances that would result from the installation of one additional structure are not considered to result in any significant adverse impacts upon marine mammals.

3.1.5.5 In-Combination Impacts

None anticipated.

3.1.5.6 Monitoring

No specific monitoring is required

3.1.6 Increased Vessel Activity at the Proposed EOWDC May Disturb Marine Mammals

Worst Case Scenario: Installation of 10 MW wind turbines with gravity based foundations.

3.1.6.1 Potential Impacts

The exact vessels requirements have yet to be finalised for each of the development scenarios. It is expected that the required vessels for the wind turbines are a jack-up installation vessel and a feeder barge to transport the wind turbine components to the jack-up vessel. The gravity based structure is considered the worst case foundation structure, as this may require a marginally greater number of vessels (tugs) to float the structure to the location and 2-4 transfer vessels to be used daily in the construction period. Other vessels that will be used in the construction period will include a cable lay vessel and potentially a dive support vessel for rock placement.

During the construction period it is expected that some construction vessels will be undergoing daily movements to and from Aberdeen Harbour, however, at this stage in the project the locations where construction materials will be stored has not yet been finalised as such it is not possible to specify precise details regarding movements of all construction vessels.

Seals have inquisitive behaviour which makes them susceptible to approaching vessels, especially those that are associated with a potential food such as fishing vessels. Certain cetaceans, such as bottlenose dolphins, can be temporarily attracted to moving vessels and bow-ride, whereas other species such as the harbour porpoise appear to exhibit avoidance behaviour and swim away from vessels.

Bottlenose dolphins are often sighted in the middle of the harbour mouth, in the centre of the shipping channel leaving Aberdeen harbour. This species appears to tolerate high levels of daily shipping activity including the movement of large shipping vessels to and from the harbour.

Increased shipping levels could be considered to increase the risk of collisions with marine mammals. Construction vessels will be transiting at slow speeds within Aberdeen Bay and are typically slow moving and generate low frequencies. It is considered that any marine mammals will be able to avoid approaching vessels. There have never been any reports of ship strikes from stranding records along the Grampian coast, which suggests the magnitude of the effect to marine mammals is negligible.

3.1.6.2 Mitigation

All vessels that access the EOWDC site will be instructed to keep within the existing shipping lanes as far as is reasonably practicable and within the zone designated as the wider working area.

3.1.6.3 Residual Impacts

The magnitude of the impact on marine mammals is assessed as being negligible, the significance of this impact is assessed as being minor.

3.1.6.4 Cumulative Impacts

The are not anticipated be any novel types of vessels required to install the Ocean Laboratory that are not already considered to be required as part of the installation of the foundations and turbines (eg heavy lift vessels, barges etc). It is only the duration that vessels are present within Aberdeen Bay that will change during the construction period. The expected installation duration of the Ocean Laboratory has not been finalised, although foundations could be installed in 24 hours, with any topsides potentially taking a similar timeframe. As the Ocean Laboratory will only result in a minor increase in vessel activity, over a short time frame, there are not anticipated to be any adverse cumulative impacts that could disturb marine mammals.

The increase in shipping as part of the construction activities will temporarily, albeit to a small degree, increase the shipping traffic and number of vessels within Aberdeen Bay. The principal effect will be the increase in sound levels and vessel associated disturbance to marine mammals, the overall significance of this is expected to be minor given the volume of shipping traffic that frequents Aberdeen harbour, or transits through the Bay.

3.1.6.5 In-Combination Impacts

None anticipated.

3.1.6.6 Monitoring

No specific monitoring is necessary.

3.2 Operational Phase

3.2.1 The Underwater Sound Generated from the Operational Noise at the EOWDC May Disturb Marine Mammals

Worst Case Scenario: Installation of 10 MW wind turbines with monopile foundations.

3.2.1.1 Potential Impacts

Measurements from operational offshore wind farms suggest that noise generated is generally at low levels and dominated by low frequencies (Nedwell, *et al*., 2007). There have been no measurements from operational wind farms to suggest that source levels ever exceed 145 dB (root mean squared) re.1µPa@1m and such levels are the absolute highest back-calculated source levels recorded (Wahlberg and Westerberg 2005). All measurements of operational wind farm noise have suggested that the received levels (what the animal receives) drop to <120 dB (rms) re.1µPa@1m at 100 m, and that levels propagating in the water column beyond this distance will be low.

Comparing the audiogram data of the harbour porpoise and the bottlenose dolphin with the frequency level of the sound produced from the operational wind farm it becomes highly unlikely that this sound will be audible beyond a distance of 100 m (Madsen, *et al*., 2006). For the low frequency hearing specialists that could be present in Aberdeen such as the harbour seals and baleen whale species, such as the minke whale, Masden *et al*., (2006) estimates that the zone of audibility has a theoretical maximum of >10 km, but the ambient sound levels and propagation losses will reduce this zone considerably. Post monitoring studies at the Barrow Offshore Wind Farm found that the operational noise within the wind farm was detectable out to a distance of 600 m at which it became indistinguishable from ambient noise (BOwind 2008). The known sound levels produced by operating wind farms are low by comparison to modern cargo ships, which have source levels around 175 dB (rms) re.1µPa@1m (NRC 2005).

Marine mammals have been recorded in close proximity to other fixed and noisy features such as drilling rigs and oil production platforms, often using such features for foraging. Therefore, it is not expected that these species will suffer adverse effects from the limited noise and vibration produced by wind turbines. There has been considerable variation in the reported values from operational wind farms, yet all the sound levels reported thus far are relatively low. It is appreciated that no studies have yet attempted to measure marine mammal reactions to operational wind farms and this is a potential area of future research.

Maintenance vessels are only expected to consist of one or two smaller transfer vessels working on at most a daily basis and occasionally larger vessels used for any major repairs. These additional vessel movements would not represent a significant increase on current vessel activity in this area. Aberdeen Bay is already very busy with a wide range of human activities and the small increase in vessel activity associated with the proposed wind farm is unlikely to cause any notable disturbance to marine mammals.

3.2.1.2 Mitigation

No specific mitigation is required.

3.2.1.3 Residual Impacts

The current information suggests that the magnitude of effects upon marine mammals are likely to be negligible, and therefore of minor significance. No residual impacts are expected.

3.2.1.4 Cumulative Impacts

Marine mammals do not appear to be affected by turbine noise generated by wind farms. Therefore the cumulative effects of the EOWDC with the Beatrice demonstrator project is expected to be negligible. Given the potential scale of proposed offshore wind farm developments in Scottish waters with large areas that could be exposed to low levels of operational generated sound the potential for significant cumulative impacts upon marine mammal populations cannot be ruled out, with the significance of such impacts being unknown.

At a local level within Aberdeen Bay the operation of the wind turbines will contribute to increasing the ambient sound levels, the degree of influence will be dependent upon the operational state of the wind turbines (eg wind speed), local weather conditions (eg sea state) and other sources of underwater sound. The operational sound levels are only likely to be detectable from other sound sources within close proximity to the wind turbines and as such are not considered likely to result in any significant in-combination impacts.

3.2.1.5 In-Combination Impacts

None anticipated.

3.2.1.6 Monitoring

No specific monitoring is planned for operational noise.

3.2.2 Loss of Habitat for Marine Mammals within Aberdeen Bay

Worst Case Scenario: Installation of 10 MW wind turbines with gravity based foundations, resulting in a net habitat loss of 0.03 km^2

3.2.2.1 Potential Impacts

Once operational the presence of the wind turbines in the water column removes previously available habitat to marine and could create a barrier to the passage of marine mammals through Aberdeen Bay. The worst case scenario in terms of seabed habitat lost would be through the use of gravity based structures for all eleven wind turbines, this would result in the loss of 0.03 km^2 of seabed habitat (the loss of habitat is a worst case as it takes into potential impacts of scouring). The wind turbines are separated by a considerable distance from each other, this separation distance should not restrict the movement of marine mammals through the EOWDC.

Once operational the wind turbines could act as attractants to colonising benthic fauna, which in turn could attract fish and marine mammal predators. Studies have identified the presence of previously unrecorded species of fish and invertebrates after the development of a wind farm, and it is possible that these in turn could be prey items of marine mammals. The benefit of wind farms to marine mammals is currently uncertain, any positive effects such as providing a limited increase in prey are likely to be only restricted to the immediate vicinity of the EOWDC are as such are expected to have a negligible overall benefit. Further research is needed to justify any claims of positive benefit of renewable energy developments upon marine mammals.

This loss of seabed habitat, in terms of similar available habitat within Aberdeen Bay is of negligible magnitude, with the significance of the impact being minor.

3.2.2.2 Mitigation

No specific mitigation is required.

3.2.2.3 Residual Impacts

The current information suggests that any effects upon marine mammals are likely to be minor, there may be some beneficial effects upon certain marine mammals species, although the overall benefit of this is likely to be negligible.

3.2.2.4 Cumulative Impacts

The Ocean Laboratory will result in the incremental loss of habitat in Aberdeen Bay, the exact dimensions of the structure have yet to be determined so quantification of the loss is not possible, although it is expected to be comparable as a 'worst case' to an offshore oil and gas platform.

The only other offshore wind farm that will have been constructed at the proposed development time for the EOWDC will have been the Beatrice demonstrator, which consisted of two steel jackets in the Moray Firth, the cumulative impacts of the loss of habitat associated with the EOWDC, Beatrice demonstrator and Ocean Laboratory are negligible.

The cumulative impacts associated with the loss of habitat from proposed offshore wind farm developments (including territorial waters and Round 3) is not yet known, although it could result in significant impacts to certain populations of marine mammals, the significance of the impact will depend upon the types of foundations used and the overall footprint of the renewable energy developments in relation to available habitat.

The oil and gas industry has historically been the main offshore industry in the North Sea which places infrastructure, in the forms of platforms, wells and pipeline on the seabed thus removing available habitat for marine mammals. Other industries that contribute to the modification of seabed habitat by laying subsea cables are the telecommunications. The density of oil and gas structures and other subsea cables in relation to total seabed is minimal and therefore no in-combination impacts are expected when the cumulative loss and modification of seabed habitat are considered together.

3.2.2.5 In-Combination Impacts

None anticipated.

3.2.2.6 Monitoring

No specific monitoring is planned for the loss of seabed habitat.

3.2.3 The Cables will Generate Electromagnetic Fields (EMF) Which may Disturb Marine Mammals

Worst Case Scenario: 4 shore cables (total distance 26 km) and inter-array cables (total distance 13 km)

3.2.3.1 Potential Impacts

Electromagnetic fields (EMF) are associated with the operational phase once the cables are conducting electricity. Potential impacts to animals include attraction or repulsion from the fields, behavioural interference (navigation) and physiological effects (Chapter 13 Electromagnetic Fields).

Animals that are attracted to EMFs as a result of confusion with the signal with those of prey species may waste energy, whilst repulsion of animals will result in the reduction of available habitat or disrupt the movement or migration of animals throughout Aberdeen Bay. Disruption to the navigation or orientation may arise for those species using the Earth's geomagnetic field to orientate or time behavioural movements in response to daily events such as tidal cycles. Depending on the magnitude and persistence of the magnetic field, the impact could be a relatively minor temporary change in swimming direction or a more serious impact on migration. The potential physiological effects on marine organisms may include impacts on cell development. There is a lack of targeted research into the potential effects of EMFs generated from offshore wind farms so impacts remain hypothetical.

The current design is planned to use a maximum of 4 shore cables (26 km) and inter-array cables (13 km) that will use an Alternating Current (AC). At this stage in the design process it is not yet known what the power requirements of the cables will be.

There are three components associated with power cables that are elements of EMF. Firstly, there is an electric field, secondly there is a magnetic field outside of the cable and thirdly there is an induced electric field (iE-field). The electric field is of little relevance as the design of the AC cables is shielded by a metallic screen within an industry standard cable this ensures the electric field does is not present beyond the cable.

Magnetic fields from AC power cables rapidly decrease with increasing distance from the cable and within a few metres they are largely undetectable. The magnetic field is proportional to the current, meaning that an increase of the current by five times would lead to an increase of the magnetic field strength by the same.

Cartilaginous fish, which include the elasmobranchs, are the major group of organisms that are known to be electroreceptive. There are no cetacean species which are known to be electroreceptive. Only one semi-aquatic Monotreme (egg laying mammal that is only found in Australia and New Guinea) has been found to use electroreception, which it uses to localise benthic invertebrates (Bullock 1999).

Cetaceans are believed to use weak anomalies in the geomagnetic field as cues for orientation and navigation, this hypothesis was tested by analysing the magnetic fields data of the United States Continental Shelf with cetacean stranding data. The results demonstrate a relationship between cetaceans stranding positions and the geomagnetic field along the U.S Atlantic continental margin (Kirschvink *et al*., 1986).

Marine mammals in Aberdeen Bay in the vicinity of the proposed EOWDC are thought to be able to detect magnetic fields and are also likely to use the Earth's magnetic field for the purposes of orientation and navigation. The magnetic field produced by the EOWDC could possibly result in the disruption of orientation and navigational behaviours. It is not known if the EMF would result in attraction or navigation to marine mammals, or cause other forms of behavioural responses.

The available information on potential impacts from submarine AC cables on magnetoreceptive or electroreceptive species is relatively sparse, with the focus of the studies having been conducted on effects of EMF on migrating eels and elasmobranchs which exhibited behavioural responses to the stimuli. From the monitoring studies of constructed wind farms there is no evidence of any increases or decreases in marine mammal activity that would suggest attraction or avoidance related to magnetic fields. The information on the potential effects of EMF on marine mammals is largely unknown and further research is required to determine the potential risks this may pose to these species. The ecological significance of EMFs is an area of research which requires further study.

3.2.3.2 Mitigation

The electric field will be shielded by an industry standard cable which will stop any electric field being generated beyond the cable. Cable burial increases the distance between any receivers of EMF and the source, but burying the cable only has a minor impact upon the magnetic field as burial of cables to a depth of 5m has essentially the same effect as a cable buried to 1 m.

3.2.3.3 Residual Impacts

Even assuming that marine mammals exhibit some small scale effects, the small areas affected together with the lack of evidence for any significant effects on marine mammals implies that this potential effect is considered to be of minor significance for marine mammals. Further research is needed to fully understand how EMFs are interpreted and used by marine mammals in order to more accurately determine impacts.

3.2.3.4 Cumulative Impacts

The Ocean Laboratory will need to be powered although the electricity generation system has not been selected yet as it will depend upon the requirements of the Ocean Laboratory. A power cable running from the shoreline may be used, and it is initial thought that this will be an AC 11 kV single power line. The magnitude of the EMF effects are likely to be lower than the wind turbine cables, as the strength of EMF fields decreases in lower powered cables, there are not anticipated to be any significant EMF impacts as the result of EMF fields from a power cable to the Ocean Laboratory.

Given the current knowledge of the effects of EMF upon marine mammals it is not expected that there will be any significant cumulative impacts from other constructed renewable energy developments, although it is accepted that further research is required.

The issue of cumulative impacts from power cables may become more of a concern, and the impact of greater significance, with the construction of the proposed wind farms and other forms of renewable energy in UK waters.

There are no known active subsea cables within the Aberdeen Bay area, therefore no cumulative EMF impacts are expected.

3.2.3.5 In-Combination Impacts

None anticipated.

3.2.3.6 Monitoring

No specific monitoring is planned for EMF.

3.3 Decommissioning Phase

3.3.1 Noise Associated with the Decommissioning of the EOWDC May Cause Disturbance to Marine Mammals

Worst Case Scenario: Removal of eleven 10 MW wind turbines, foundations and associated cables and inter-array cables

3.3.1.1 Potential Impacts

The decommissioning plan for the EOWDC has yet to be finalised and as such a detailed impact assessment on this section is not possible, the Description of the Proposed Project provides an outline of the activities that are expected to be associated with the removal of the EOWDC.

The main potential impact to marine mammals is expected to be from the underwater sound and associated disturbance that could arise from decommissioning activities. The activities associated with decommissioning are expected to require similar types of vessel to construction activities including a heavy lift and support vessels. The decommissioning vessels will produce relatively low levels of predominantly low frequency sound throughout during active periods. The impacts from vessels is expected to be temporary and of minor significance.

At the end of the design life the wind turbine foundations will have to be removed from the seabed and if monopiles or steel jackets have been used they will have to be cut. Current non-explosive pile cutting techniques include mechanical and abrasive cutting. Mechanical cutters use either, hydraulically actuated carbide tipped tungsten blades or diamond wire to mill through the inside of piles. Abrasive cutters have mechanisms to direct a water jet containing cutting materials to abrasively wear away steel. In both these techniques sound will be generated by the action of the cutter on the pile and by the machinery which drives the cutter. This sound may radiate into the water directly through the pile via a waterborne path or via the substrate by a ground borne path.

It would be highly unlikely that explosives will be considered for use on the basis of a risk of their perceived environmental impact, with mechanical cutting being the preferred choice to cut structures below the seabed.

AOWFL are not aware of any measurements of the underwater sound levels produced mechanical or abrasive cutters. The lack of published results makes it difficult to assess the environmental impact of cutting steel foundation structures, it is expected that the peak sound levels will be considerably below those generated from impact pile driving. The duration of cutting steel structures will be over a period of hours, per structure, so any impacts will be temporary.

The magnitude of any impacts upon marine mammals will be dependent upon the type of activities that are planned as part of the decommissioning programme; the selection of the removal technique for the foundation is likely to generate the highest sound levels from all decommissioning activities.

Given the current uncertainties in the type of activities that the decommissioning programme will entail, and the lack of any published studies on measurements of cutting of steel structures the magnitude of effect has been assessed as low/medium, with the overall significance being a moderate to major impact on marine mammals. The final decommissioning plan once submitted will allow for a revaluation of the potential impacts upon marine mammals.

3.3.1.2 Mitigation

The Impact Assessment associated with the decommissioning plan will identify any potential impacts and mitigation according to potential environmental risks. It is expected that any risks to marine mammals from decommissioning activities will be mitigated through the use of appropriate measures, such as the use of marine mammal observers and mitigation zones.

3.3.1.3 Residual Impacts

Providing that the mitigation measures are implemented successfully no residual impacts are envisaged from decommissioning activities.

3.3.1.4 Cumulative Impacts

The sound levels generated by decommissioning activities involving mechanical cutting are unlikely to radiate to other areas proposed for renewable energy development. Cumulative decommissioning impacts are only expected to occur if other renewable projects are decommissioning simultaneously to the EOWDC. Consideration will be given to any other renewable energy developments which may be embarking on decommissioning activities within a similar timeframe to the EOWDC, although at this stage there are no significant cumulative decommissioning impacts envisaged.

3.3.1.5 In-Combination Impacts

No in-combination impacts are anticipated from decommissioning activities.

3.3.1.6 Monitoring

Mitigation measures are planned to help ensure that the decommissioning programme will not have a significant impact on the environment. The exact detail of the mitigation and monitoring will be decided during the impact assessment associated with the formulation of the decommissioning plan. During the decommissioning works monitoring of activities will be in place to minimise any impacts that have been identified.

3.4 Summary of Mitigation and Monitoring

The MMPP will specify the procedures to be put in place to minimise the risk of causing adverse impacts to marine mammals. One of the key aspects of the MMPP will be outlining the mitigation measures that are planned to be used in the event of piling, these are:

- Use of trained and experienced Marine Mammal Observers (having undertaken a JNCC recognised course);
- Pre-piling search for marine mammals prior to piling monitoring a suitable sized exclusion zone;
- Use of Passive Acoustic Monitoring (PAM) system monitored by experienced PAM operatives; and
- Soft-start (gradual ramp up) of pile driver.
- Consideration of the use of Acoustic Mitigation Devices; if used they will be subject to stringent operating procedures.
- AOWFL are open to incorporating the latest advice on the mitigation procedures used as part of the development of the EOWDC. The final Marine Mammal Protection Plan (MMPP) will be agreed following advice and consultation with SNH and Marine Scotland.

The disturbance of marine mammals by construction vessels will be controlled and monitored by stipulating working areas.

Throughout the construction of the EOWDC there will be a programme of boat surveys that will be simultaneously collecting data on the distribution and abundance of marine mammals using a combination of visual and towed acoustic techniques. In addition, there will be a series of eleven C-Pods (acoustic hydrophones) that will be permanently moored within Aberdeen Bay. The analysis of these data sources will enable an assessment of the actual impacts of construction activities in relation to the project impacts identified during the impact assessment.

During the decommissioning works monitoring of activities will be in place to minimise any impacts that have been identified, with the exact detail of monitoring programmes having yet to be determined.

Table 23 Summary of Impact Assessment

Impact	Environ-mental effect	Probability of effect occurring	Magnitude	Duration	Spatial extent	Significance level*	Mitigation	Residual impacts	Monitoring
Construction									
Sound	Physiological damage (death) marine mammals	Negligible	High	Temporary	Site specific 3 m from piling	Major	Marine Mammal Protection Plan (MMPP) Including piling mitigation measures; soft –start Marine Mammal Observers, Passive Acoustic Monitoring (PAM).	None	MMPP
	Physiological damage (non-auditory) injury	Very Low			Local (injury possible to 60 m and cumulative dosage impacts upto 3.6 km)				
	Physiological damage (auditory damage) to marine mammals	Very Low	High	Temporary	Local (species specific ranges)	Major	MMPP	None	MMPP
	Behavioural disturbance and displacement	High*(seasonally variable for white beaked dolphins)	High (bottlenose dolphins, White beaked dolphins	Temporary	Regional	Major (piling sound)	MMPP	None	MMPP

			Low (other species marine mammals)			Minor (piling and construction sound)			
Sound (piling)	Interference of sound produced by seals	Low	Low / Negligible	Temporary	Local	Moderate / Minor	MMPP	None	None
	Interference of sound produced by cetaceans	Very low	Negligible	Temporary	Local	Minor	MMPP	None	None
Sound (all other construction sounds)	Interference sound marine produced by mammals	Very low	Negligible	Temporary	Local	Minor	MMPP	None	None
Suspended sediment levels	Impact to marine mammals (foraging etc)	Negligible	Negligible	Temporary	Local	Minor	None	None	None
Disturbance to prey species	In-direct impact upon marine mammals	Low	Low	Temporary	Regional	Moderate	None	None	None
Construction vessels and infrastructure	Disturbance to marine mammals	Negligible	Negligible	Temporary	Local	Minor	MMPP	None	MMPP

Operation									
Operational noise wind turbines	Disturbance to cetaceans	Low	Negligible	Long term	Site specific	Minor	None	None	None
	Disturbance to seals and baleen whales	Medium	Low	Long term	Local	Moderate	None	None	None
Maintenance vessels	Disturbance marine mammals	Negligible	Negligible	Long term	Local	Minor	None	None	None
Wind turbine foundations	Habitat loss	High	Low	Long term	Local	Moderate	None	None	None
Electromagnetic Fields	Disturbance to marine mammals	Negligible	Negligible	Long term	Local	Minor	None	None	None
Decommissioning									
Cutting of foundations	Disturbance to marine mammals	Low / Medium	Moderate	Temporary	Local	Moderate / Major	Decommissioning Plan recommended mitigation	None	None

*All marine mammal species are protected species as such their sensitivity within the impact assessment, is considered to be 'Very high', therefore even when the magnitude of effect has been assessed as being of negligible significance this still results in a 'minor' significant impact.

3.5 SUMMARY

The impact assessment has considered the risks and impacts to marine mammals from the construction, operation and decommissioning of the EOWDC.

The significance of potentially killing a marine mammal during the piling of the EOWDC was assessed as being of major significance, however, with the successful adoption of the mitigation measures for piling, there are not anticipated to be any residual risks given that a marine mammal would have to be present in such close proximity to the pile driver (3 m) to be at any risk. It is considered the risk of marine mammals receiving sound levels capable of causing their death appears to be remote.

Other forms of physical injury (non-auditory) are estimated to occur out to a greater range (60 m), and the risk of piling causing other forms of physical impacts cannot be ruled out, and has been assessed as being of major significance for all marine mammal species. The natural curiosity of seals may increase the risk of exposing both grey and common seals to sound levels capable of causing adverse physical effects.

The cumulative noise dose modelling indicate that unless a cetacean is within the immediate vicinity of piling operations (<1.35 km) or a seal is situated within 3.6 km, the only possibility for an auditory injury to occur is during the initial piling period. It is expected that the perceived loudness of the piling activity will cause the marine mammal to exhibit an aversive behavioural reaction, with the animal moving from the area before the onset of any auditory injury can occur.

The marine mammals which are most likely to be exposed are the more commonly sighted species within Aberdeen Bay, with the harbour porpoise, bottlenose dolphins and grey and common seals being the species most at risk from physical impacts. Given that the relatively small Moray Firth bottlenose dolphin population has been increasing its range expansion in a southerly direction, and that Aberdeen Bay frequently has bottlenose dolphins, especially during the winter and spring months, the potential impact both to the individual and population is considered to be of high magnitude and potentially of major significance. It should be considered the majority of bottlenose dolphins sightings have been observed frequenting the harbour mouth area and that the mitigation measures mentioned below they should be sufficient to ensure that no bottlenose dolphins are situated within 820 m prior to piling activities, if such measures are put in place the anticipated magnitude of the effects is expected to be negligible and thus be of minor significance to the bottlenose dolphin populations.

The range at which potential adverse behavioural responses is considerable being upto 22 km for harbour porpoise and 16 km for common and grey seals. For harbour porpoises the results of post-monitoring studies suggest that after piling stops the animals have been found to return to the area within a few hours. The haul out locations of seals could be affected by the piling operations, which could cause the temporarily displacement of seals from such areas. Therefore, behavioural disturbance, which would lead to displacement of marine mammals from the piling activities, is only expected to occur for the duration of piling activities.

The potential exclusion of bottlenose dolphins through behavioural displacement for the duration of the piling activity and out to an extent of 16 km has been assessed as being of high magnitude, and therefore of potentially of major significance to the bottlenose dolphin. As bottlenose dolphins are present along the east coast of Scotland, it has been predicted that the temporary displacement of animals from the Aberdeen Bay area will be mitigated by animals moving into other areas within their natural range, this is a hypothetical assessment and is based on the available habitat range for bottlenose dolphins being extensive covering the coastal waters along the Scottish east coast.

For the other species of cetacean present in Aberdeen Bay they are not restricted to coastal areas and are present throughout a far wider area. Aberdeen Bay has not been recognised as being of particular importance for breeding or calving purposes for other cetacean species, the possible exception in that shallower coastal water of the east coast of Scotland have been speculated to have a role in breeding or calving for the white beaked dolphin during the summer period.

If piling occurs during summer months (July/August) the significance of the behavioural disturbance could be major for the white beaked dolphins, but of minor significance impact for all other cetacean species with the exception of the bottlenose dolphin (major). Any temporary exclusion of the cetacean species (except bottlenose from Aberdeen Bay is considered to be of moderate significance, given that there is likely to be adequate areas for foraging relatively nearby.

The vessels used in the construction of Aberdeen Bay may locally increase the ambient sound levels and cause disturbance and may temporarily contribute to the displacement marine mammal from the vicinity of construction activities, the significance of this local displacement of marine mammals is minor.

During the pile driving construction activities there is the potential for the sound to mask any seal vocalisations, potentially out to a distance of 80 km (Thomsen, *et al*., 2006). The spatial scale of the potential masking will be dependent upon prevailing ambient sound levels and 80 km is a theoretical maximum. The actual significance of this potential impact is expected to be low given that there are no notable haul out locations in close proximity to Aberdeen Bay and that any potential masking will be temporary.

Masking of biologically relevant sounds produced by high frequency cetaceans, such as the harbour porpoise, and possibly mid-frequency cetaceans, such as the bottlenose dolphin, is unlikely as the piling pulses have little high frequency energy (Thomsen *et al*., 2006). Pile driving pulses are of short duration, and are therefore may be below the time where full detection of signals is possible in cetaceans (Thomsen *et al*., 2006). The magnitude of the impact on marine mammal vocalisations is considered to be low for seal and negligible for other cetacean species. The overall significance is considered to be moderate for seals and minor for cetaceans. After completion of the construction works there are not anticipated to be any residual impacts.

Vessel sounds are likely to be audible to marine mammals, they are not considered to be capable of permanently masking the sounds produced by cetacean species that are most commonly present in Aberdeen Bay.

No impacts to marine mammals are anticipated from an increase in suspended sediments levels as the increases are still within the ranges they are expected to be tolerant of.

Marine mammals are highly mobile and are expected to follow their prey should they be displaced from the area during construction activities. Piling will be infrequent and temporary so that any disturbance to prey species will be intermittent and not consecutive so any foraging impacts are unlikely to be of sufficient magnitude or duration to adversely affect any life history traits of marine mammals. The marine mammals present in Aberdeen have been known to feed on varied prey species and should be adaptable if one of the more sensitive species to sound is temporarily displaced from the local area.

Increased shipping levels could be considered to increase the risk of collisions with marine mammals. Construction vessels will be transiting at slow speeds within Aberdeen Bay and are typically slow moving and generate low frequencies. It is considered that any marine mammals will be able to avoid approaching vessels. There have never been any reports of ship strikes from stranding records along the Grampian coast, which suggests the magnitude of the effect to marine mammals is negligible.

The noise from the operational wind farm is not considered to be capable of causing disturbance or displacement to marine mammals. There has been considerable variation in the reported underwater noise measurement from operational wind farms, yet all the sound levels reported thus far are relatively low.

Aberdeen Bay is already very busy with a wide range of human activities and the small increase in vessel activity associated with the maintenance of the proposed EOWDC is unlikely to cause any notable increase disturbance to marine mammals.

The worst case scenario in terms of seabed habitat lost would be through the use of gravity based structures for all eleven wind turbines; this would result in the loss of 0.03 km^2 of seabed habitat. The wind turbines are separated by a considerable distance from each other, this separation distance should not restrict the movement of marine mammals through the EOWDC. This loss of seabed habitat, in terms of similar available habitat within Aberdeen Bay is of negligible magnitude, with the significance of the impact being minor.

Given the current uncertainties in the type of activities that the decommissioning programme will entail, and the lack of any published studies on measurements of cutting of steel structures the magnitude of effect has been assessed as low/medium, with the overall significance being a moderate to major impact on marine mammals. The final decommissioning plan once submitted will allow for a revaluation of the potential impacts upon marine mammals.

From the monitoring studies of constructed wind farms there is no evidence of any increases or decreases in marine mammal activity that would suggest attraction or avoidance related to magnetic fields. The information on the potential effects of EMF on marine mammals is largely unknown and further research is required to determine the potential risks this may pose to these species. The ecological significance of EMFs is an area of research which requires further study.

The MMPP will be developed to address and mitigate any of the impacts identified as being of concern to marine mammals. The MMPP will outline the chosen mitigation procedures during any piling operations and construction activities to minimise the risk of impacts to marine mammals, the final MMPP will be developed in consultation with advice from statutory consultees. The programme of boat based and acoustic monitoring using C-Pods will continue throughout the development and construction of the EOWDC to enable any potential impacts upon marine mammals to be identified and recorded.

AOWFL will follow any advice provided by Marine Scotland on the European Protected Species licences to apply for, if these are required.

3.6 Glossary

AOWFL	Aberdeen Offshore Wind Farm Limited
AMD	Acoustic Mitigation Device
DECC	Department Energy and Climate Change
DTI	Department of Trade and Industry
EOWDC	European Offshore Wind Deployment Centre
EIA	Environmental Impact Assessment
EMEC	European Marine Energy Centre
EMF	Electromagnetic Fields
GOGC	Genesis Oil and Gas Consultants
IECS	Institute of Estuarine and Coastal Studies
JNCC	Joint Nature Conservation Committee
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
PTS	Permanent Threshold Shift
SMRU	Sea Mammal Research Unit
SNH	Scottish Natural Heritage
TTS	Temporary Threshold Shift

3.7 Units

dB	decibel
dB_{ht}	decibel above hearing threshold
Hz	hertz
kilo	thousand
m	metre
µ	micro
Pa	Pascal
s	second

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European Offshore Wind Deployment Centre

Environmental Statement

Appendix 15.1: Navigational Risk Assessment

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

Navigation Risk Assessment

European Offshore Wind Deployment Centre

(Technical Note)

Prepared by:	Anatec Limited
Presented to:	Aberdeen Offshore Wind Farm Limited
Date:	09 June 2011
Revision No.:	03
Ref.:	A2555-AREG-NRA-1

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This study has been carried out by Anatec Ltd on behalf of Aberdeen Offshore Wind Farm Limited. The assessment represents Anatec's best judgment based on the information available at the time of preparation. Any use which a third party makes of this report is the responsibility of such third party. Anatec accepts no responsibility for damages suffered as a result of decisions made or actions taken in reliance on information contained in this report.

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1. INTRODUCTION

1.1 Background

Anatec was commissioned by Aberdeen Offshore Wind Farm Limited (AOWFL) to perform a shipping and navigation assessment of the European Offshore Wind Deployment Centre (EOWDC), situated in Aberdeen Bay.

The report presents information on the proposed development relative to the baseline navigational activity and features for the area. Following this, an assessment of the impact of the proposed development on navigation is presented.

1.2 Scope of the Assessment and Methodology

The assessment methodology principally followed the Department of Energy and Climate Change (DECC) Risk Assessment Methodology (Ref. i) and the Maritime and Coastguard Agency's (MCA) Marine Guidance Notice 371 (MGN 371) (Ref. ii).

An overview of the general methodology applied in the assessment is presented in Figure 1.1. (More information on the regulations and guidance being addressed is presented in Section 2.)

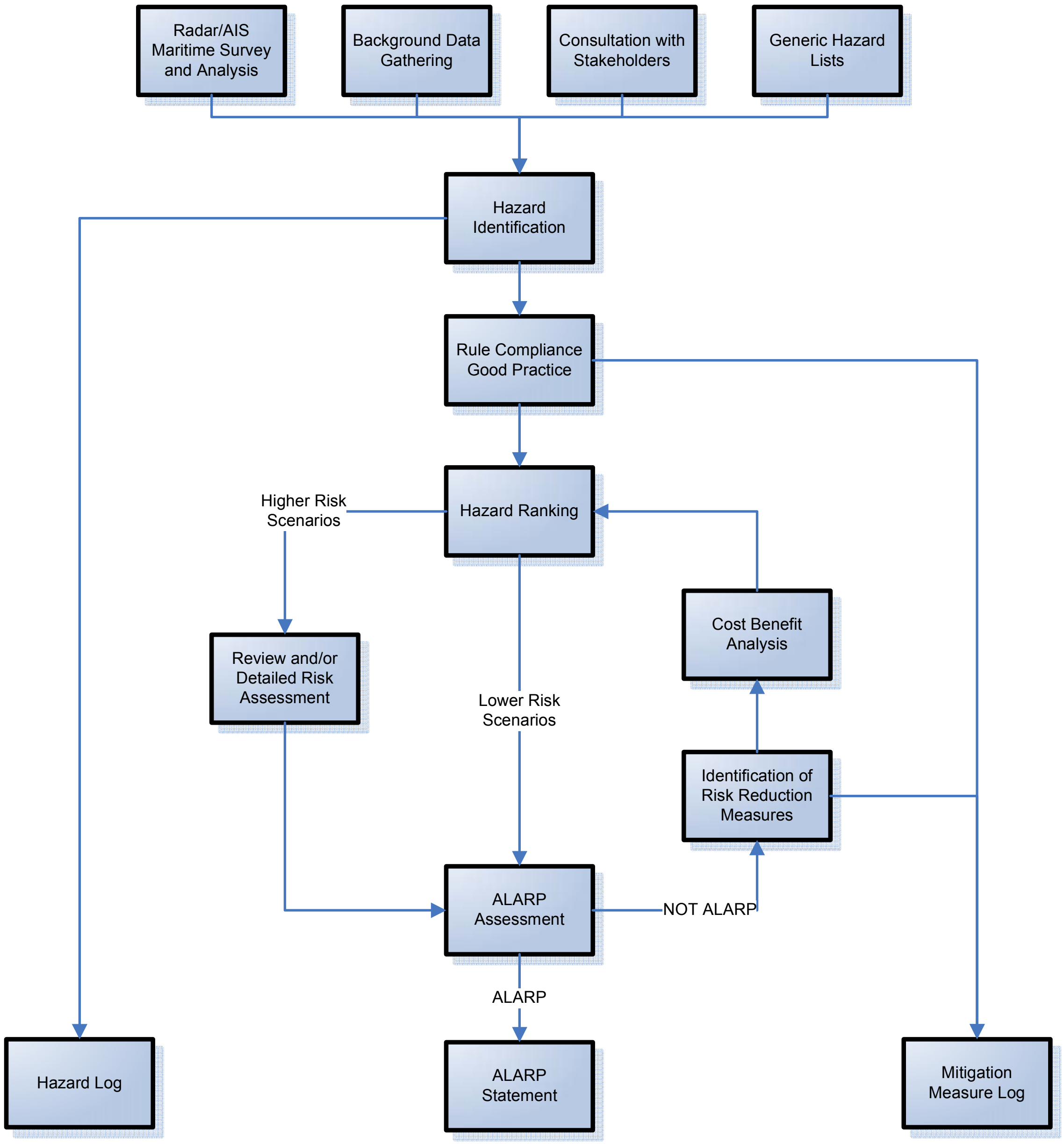


Figure 1.1 Overview of Methodology for Navigation Assessment

The main part of the assessment considers the impact of the surface structures associated with the operational phase of the proposed development on the following maritime activities:

- Commercial Shipping
- Fishing
- Recreational Sailing

In addition to these activities, consideration is given to the following:

- Impacts of Structures on Marine Radar

- Impact of Subsea cables
- Impacts associated with Construction / Decommissioning phases
- Cumulative Impacts with other nearby developments

The assessment is based on the turbine layout 039 which has evolved from various site iterations and extensive consultation. The number of turbines has subsequently been reduced from the initial plans to take on board comments received from navigational stakeholders, in particular Aberdeen Harbour Board and the Marine Safety Forum.

1.3 Abbreviations

The following abbreviations are used in this report:

AHB	-	Aberdeen Harbour Board
AIS	-	Automatic Identification System
ALARP	-	As Low as Reasonably Practicable
ALB	-	All-Weather Lifeboat
AOWFL	-	Aberdeen Offshore Wind Farm Limited
AREG	-	Aberdeen Renewable Energy Group
ARPA	-	Automatic Radar Plotting Aid
ARRC	-	Autonomous Rescue and Recovery Craft
AtoN	-	Aid to Navigation
BATNEC	-	Best Available Technology Not at Excessive Cost
BERR	-	Department for Business Enterprise & Regulatory Reform
BMAPA	-	British Marine Aggregate Producers Association
BWEA	-	British Wind Energy Association
CA	-	Cruising Association
CAA	-	Civil Aviation Authority
CBA	-	Cost Benefit Analysis
COLREGS	-	International Regulations for Preventing Collisions at Sea
CPA	-	Closest Point of Approach
DECC	-	Department of Energy and Climate Change
DEFRA	-	Department for Environment, Food and Rural Affairs
DfT	-	Department for Transport
DSC	-	Digital Selective Calling
DTI	-	Department of Trade and Industry
DW	-	Deep Water
DWT	-	Dead Weight Tonnes
DZ	-	Danger Zone
EIA	-	Environmental Impact Assessment
EOWDC	-	European Offshore Wind Deployment Centre
ERCoP	-	Emergency Response Cooperation Plan
ERRV	-	Emergency Response and Rescue Vessel
ES	-	Environmental Statement
ETV	-	Emergency Towing Vessel
FN	-	Frequency-Number

FSA	-	Formal Safety Assessment
GPS	-	Global Positioning System
GRP	-	Glass Reinforced Plastic
HAT	-	Highest Astronomical Tide
HF	-	High Frequency
HSC	-	High Speed Craft
HSE	-	Health and Safety Executive
HW	-	High Water
IALA	-	International Association of Marine Aids to Navigation and Lighthouses
ILB	-	Inshore Lifeboat
ICES	-	International Council for the Exploration of the Seas
ICST	-	The International Classification of Ships by Type
IMO	-	International Maritime Organisation
IPS	-	Intermediate Peripheral Structures
ITOPF	-	International Tanker Owners Pollution Federation Limited
km	-	Kilometre
LORAN	-	Long Range Navigation
MAIB	-	Marine Accident Investigation Branch
MBS	-	Maritime Buoyage System
MCA	-	Maritime and Coastguard Agency
MFA	-	Marine and Fisheries Agency
MGN	-	Marine Guidance Notice
MHWN	-	Mean High Water Neaps
MHWS	-	Mean High Water Springs
MLWN	-	Mean Low Water Neaps
MLWS	-	Mean Low Water Springs
MRCC	-	Maritime Rescue Co-ordination Centre
MRSC	-	Maritime Rescue Sub-Centre
MSL	-	Mean Sea Level
MW	-	Mega-Watt
nm	-	Nautical Miles
NUC	-	Not Under Command
OREI	-	Offshore Renewable Energy Installations
OWF	-	Offshore Wind Farm
PLA	-	Port of London Authority
PLL	-	Potential Loss of Life
PLN	-	Port Letter Number
PPE	-	Personal Protective Equipment
RAF	-	Royal Air Force
RCM	-	Risk Control Measure
RIB	-	Rigid Inflatable Boat
RNLI	-	Royal National Lifeboat Institution
Ro-Ro	-	Roll-on, Roll-off
RYA	-	Royal Yachting Association

SAR	-	Search and Rescue
SEA	-	Strategic Environmental Assessment
SFF	-	Scottish Fishermen's Federation
SPS	-	Significant Peripheral Structure
SRR	-	Search and Rescue Region
TSS	-	Traffic Separation Scheme
UHF	-	Ultra High Frequency
UKCS	-	United Kingdom Continental Shelf
UKHO	-	United Kingdom Hydrographic Office
VHF	-	Very High Frequency
VMS	-	Vessel Monitoring Service
VTS	-	Vessel Traffic Services

2. REGULATIONS AND GUIDANCE

2.1 Introduction

This section briefly summarises the key regulations and guidance relevant when considering the navigation safety issues associated with offshore wind farm developments in the UK.

2.2 MCA Marine Guidance Notice 371

This guidance notice (Ref. ii) highlights issues that need to be taken into consideration when assessing the impact on navigational safety from offshore renewable energy developments, proposed for United Kingdom internal waters, territorial sea or Renewable Energy Zones.

There are 5 annexes containing recommendations (1-4) and regulatory extracts (5-6) as follows:

- Annex 1: Considerations on site position, structures and safety zones.
- Annex 2: Navigation, collision avoidance and communications.
- Annex 3: MCA shipping template, assessing wind farm boundary distances from shipping routes.
- Annex 4: Safety and mitigation measures recommended for OREI during construction, operation and decommissioning.
- Annex 5: Standards and procedures for generator shutdown and other operational requirements in the event of a search and rescue, counter pollution or salvage incident in or around an OREI.

A checklist referencing the sections in this report which address MCA requirements is presented in Appendix A.

2.3 MCA Wind Farm: "Shipping Route" Template

A trial performed by the Maritime & Coastguard Agency at the North Hoyle Offshore Wind Farm (Ref.iii) indicated that turbines provide erroneous returns to radar transceivers. Multiple side echoes may be generated that have the potential to mask real targets. This has been validated by more recent trials carried out by the industry on the Kentish Flats Offshore Wind Farm in the Thames estuary (Ref. iv). The onset range from the turbines of these returns is about 1.5nm, with a progressive deterioration in the radar picture as the turbines are closed to about 500 m. Adjustment of the radar controls can filter out some of these unwanted radar returns but comes at the cost of potentially losing small radar cross sectional targets such as buoys or small craft.

The MCA's Wind farm Shipping Route Template (Annex 3 of Ref. ii), reproduced in Figure 2.1, indicates that turbines within 0.5nm of a route will be Very High Risk. Close scrutiny and potentially mitigation will be needed between 0.5nm and 5nm to ensure risks are ALARP, particularly between 0.5nm and 2nm which is considered Medium to High Risk. Beyond 2nm is Low Risk although an adjacent wind farm or TSS introduces cumulative effects which have to be scrutinised.

Annex 3 of Ref. ii states that the template is not a prescriptive tool but needs intelligent application to explore where the distance should be measured from, e.g., route centre, 90% traffic level, nearest ship, etc. The potential boundaries are illustrated in Figure 2.2.

Marine traffic survey information collected for the proposed EOWDC site has been analysed in this study to inform such boundaries and investigate influencing factors such as route bias, vessel type, size, cargo, etc.

WIND FARM: "SHIPPING ROUTE" Template

Distance in miles (nm) of Turbine Boundary from Shipping Route	Factors	Risk	Tolerability
< 0.25nm (500m)	500m inter-turbine spacing = small craft only recommended	**VERY HIGH**	**INTOLERABLE**
0.25nm (500m)	X band radar interference	**VERY HIGH**	
0.45nm (800m)	Vessels may generate multiple echoes on shore based radars	**VERY HIGH**	
			TOLERABLE IF ALARP (As Low As Reasonably Practicable)* * Descriptions of ALARP can be found in a) Great Britain Health and Safety Executive (2001) Reducing risks protecting people b) IMO (2002) MSC Circ 1023 dated 5th April 2002 Formal Safety Assessment c) IMO (2007) MSC 83-21-INF2 Consolidated guidelines for Formal Safety Assessment
0.5nm (926m)	Mariners' high traffic density domain	**HIGH**	
0.8nm (1481m)	Mariners' ship domain	**HIGH**	
1 nm (1852m)	Minimum distance to parallel boundary of TSS	**MEDIUM**	
1.5nm (2778m)	S band radar interference ARPA affected	**MEDIUM**	
2 nm (3704m)	Compliance with COLREGS becomes less challenging	**MEDIUM**	
>2nm > (3704m)	But not near TSS	**LOW**	
3.5nm (6482m)	Minimum separation distance between turbines opposite sides of a route	**LOW**	
5nm (9260m)	Adjacent wind farm introduces cumulative effect Distance from TSS entry/exit	**VERY LOW**	**BROADLY ACCEPTABLE**
10nm (18520m)	No other wind farms	**VERY LOW**	

Figure 2.1 Wind Farm "Shipping Route" Template (Ref. ii)

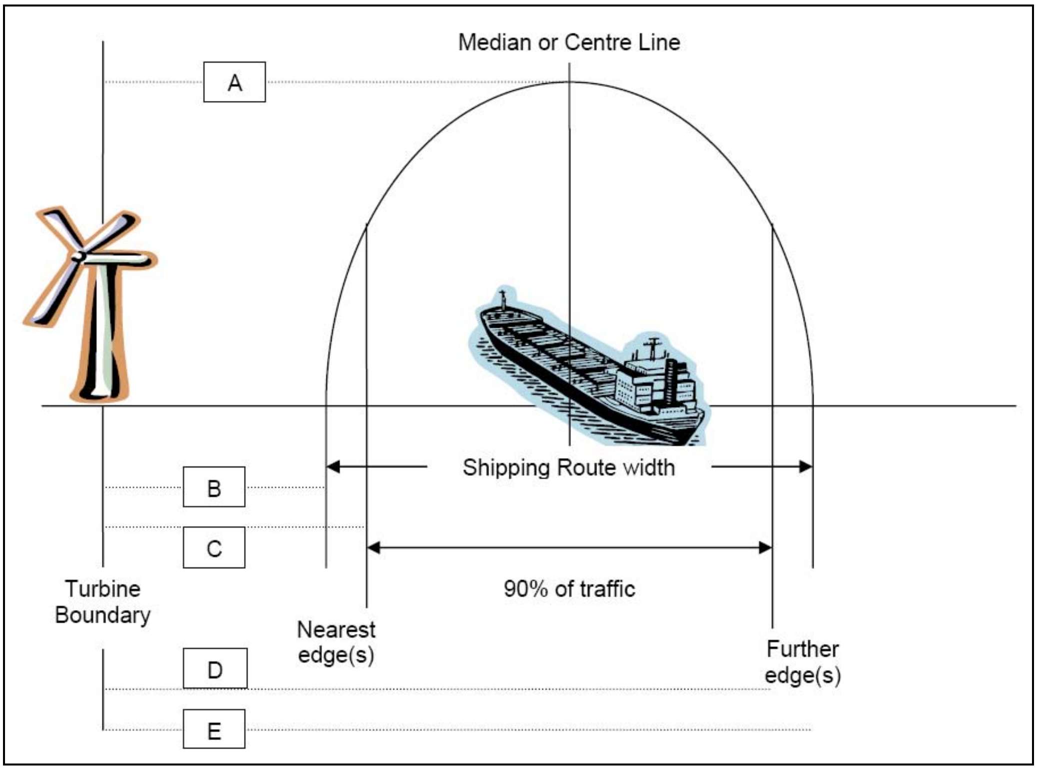


Figure 2.2 Interactive Boundaries (require Interpretative Flexibility), where:

A = Turbine boundary to the shipping route median or centre line
B = Turbine boundary to nearest shipping route edge
C = Turbine boundary to nearest shipping 90% traffic level*
D = Turbine boundary to further shipping 90% traffic level*
E = Turbine boundary to further shipping route edge
(* = or another % to be determined)

2.4 DECC Methodology

DECC (formerly BERR) produced a Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms in association with the MCA and the DfT (Ref. i).

Its purpose is to be used as a template by Developers in preparing their NRAs, and for Government Departments to help in the assessment of these.

The Methodology is centred around risk controls and the feedback from risk controls into risk assessment. It requires a submission that shows that sufficient risk controls are, or will be, in place for the assessed risk to be judged as broadly acceptable or tolerable with further controls or actions.

The key features of the Marine Safety NRA Methodology are risk assessment (supported by appropriate techniques and tools), creating a hazard log, defining the risk controls (in a Risk Control Log) required to achieve a level of risk that is broadly acceptable (or tolerable with controls or actions), and preparing a submission that includes a claim, based on a reasoned argument, for a positive consent decision.

Table 2.1 Key Features of the DECC Methodology (Ref. i)

1	Define a scope and depth of the submission proportionate to the scale of the development and the magnitude of the risk
2	Estimate the "base case" level of risk
3	Estimate the "future case" level of risk
4	Create a hazard log
5	Define risk control and create a risk control log
6	Predict "base case with wind farm" level of risk
7	Predict "future case with wind farm" level of risk
8	Submission

2.5 Aids to Navigation

The proposed EOWDC would be marked in accordance with the requirements of The Northern Lighthouse Board (NLB) which is the statutory body advising on the marking of Renewable Energy Installations in Scottish waters. The requirements will be agreed for all phases of the development.

3. PROJECT DETAILS

3.1 Introduction

This section presents details on the proposed development in Aberdeen Bay. Improvements have been made to the site layout in order to minimise the risk of the proposed project.

3.2 Lease Boundary

The lease boundary for the proposed EOWDC site is located approximately 1nm east of Black Dog. The total area of the lease boundary is approximately 5.8nm^2 (20 km^2). The corner coordinates of this area are presented in Table 3.1.

Table 3.1 Co-ordinates of EOWDC Lease Boundary (WGS 84)

Corner	Latitude (dd)	Longitude (dd)
c1	57.2060° N	1.9780° W
c2	57.1974° N	2.0454° W
c3	57.2454° N	2.0152° W
c4	57.2540° N	1.9477° W

The proposed turbine layout has a perimeter (area formed by joining outer turbine locations) considerably smaller than the licensed area. The coordinates of the proposed eleven turbine locations are presented in Table 3.2.

Table 3.2 Co-ordinates of Proposed EOWDC Turbines (WGS 84)

Turbine Number	Latitude (dsm)	Longitude (dsm)
1	57° 12' 28.570" N	002° 00' 35.007" W
2	57° 12' 56.899" N	002° 00' 40.259" W
3	57° 13' 25.226" N	002° 00' 45.453" W
4	57° 12' 42.251" N	001° 59' 55.259" W
5	57° 13' 12.197" N	002° 00' 0.801" W
6	57° 13' 42.142" N	002° 00' 6.286" W
7	57° 12' 57.642" N	001° 59' 10.554" W
8	57° 13' 29.399" N	001° 59' 16.385" W
9	57° 14' 01.188" N	001° 59' 22.218" W
10	57° 13' 48.536" N	001° 58' 27.007" W
11	57° 14' 22.331" N	001° 58' 33.185" W

Charts of the lease boundary and proposed turbine locations are presented in Figure 3.1 and Figure 3.2, respectively. Adjacent turbines are located approximately 800-1,110m apart.

Water depths (below chart datum) at the turbine locations range from approximately 20m to 30m.

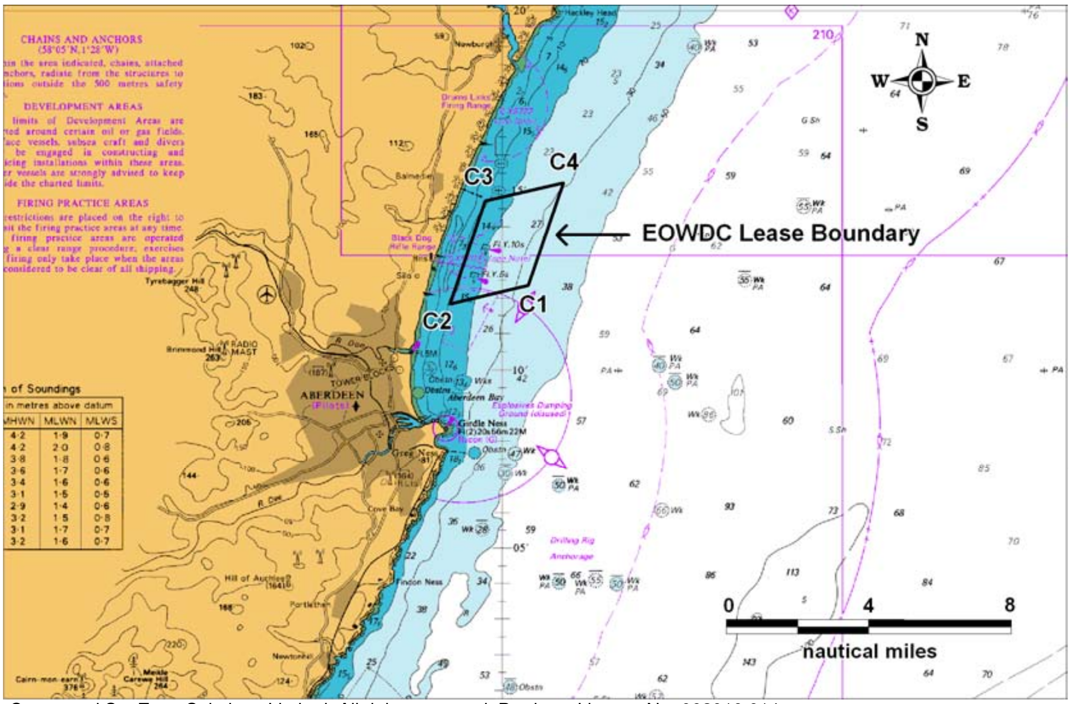


Figure 3.1 Chart Overview of EOWDC Lease Boundary

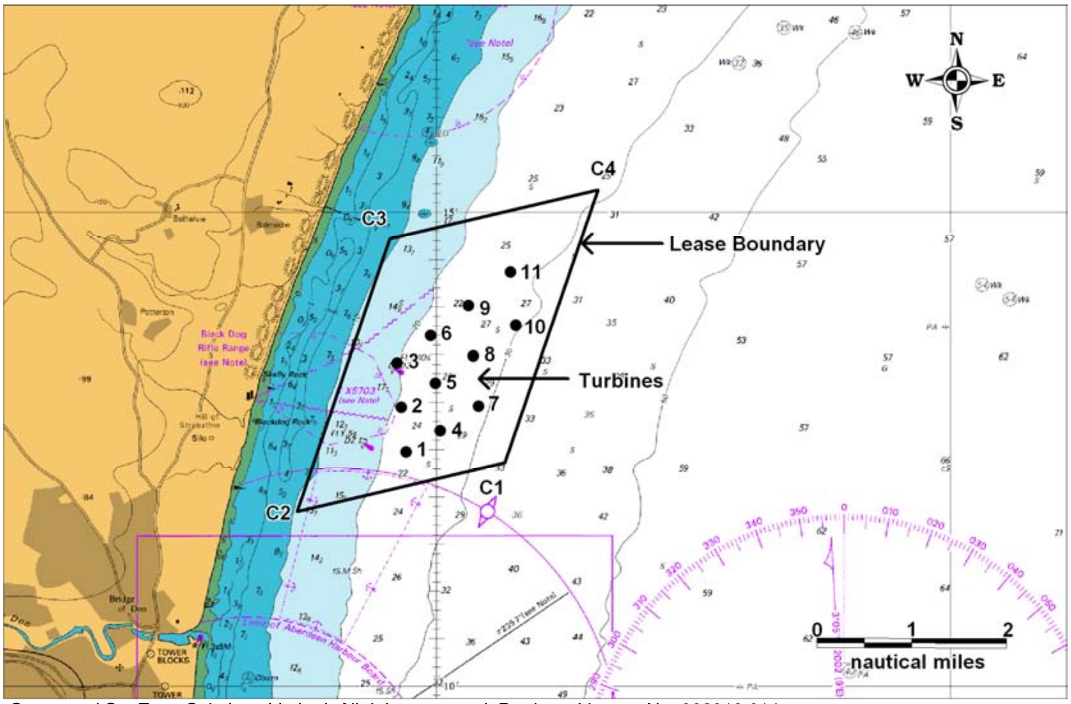


Figure 3.2 Detailed Chart Overview of proposed EOWDC site and Lease boundary

3.3 Site Revision

Figure 3.3 shows the current turbine layout versus a previous layout from 2006. It can be seen that there are now fewer turbines and that the overall 'turbine footprint' area is much smaller. The site has also been moved further north away from Aberdeen port to reduce the impact on ships navigating and anchoring in the vicinity. These changes were agreed with maritime stakeholders, such as the Aberdeen Harbour Board, during consultation on the proposed development.

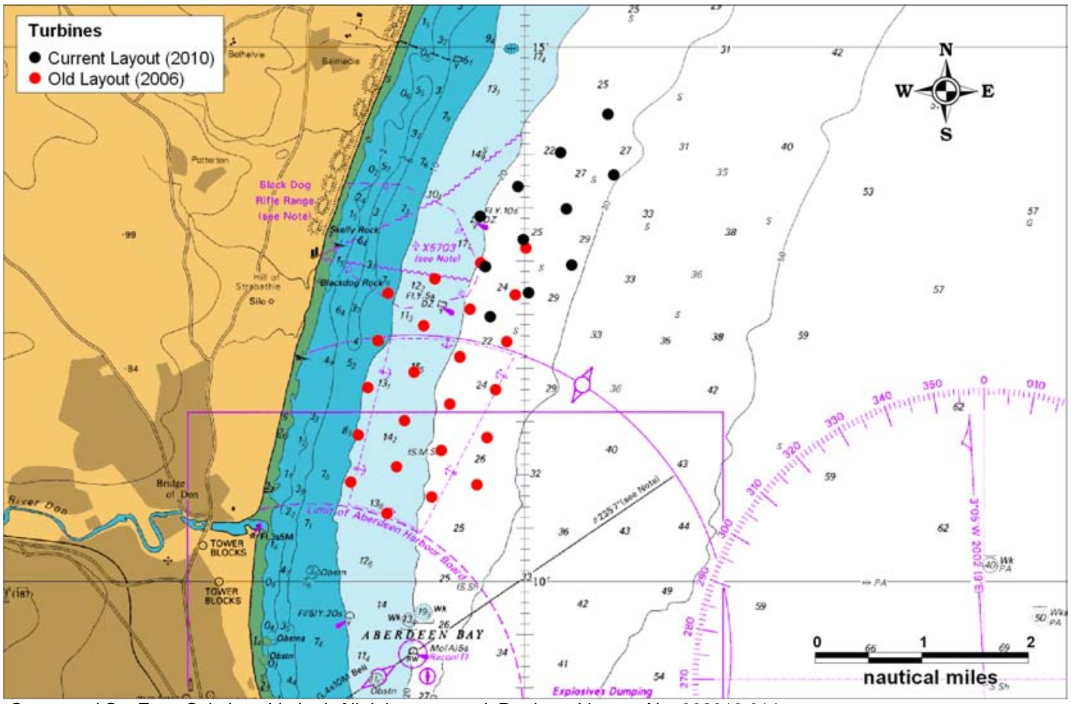


Figure 3.3 Current Layout (2010) versus Old Layout (2006)

3.4 Structure Details

Several layout options have been considered for the proposed EOWDC. The finalised turbine arrangement (layout 39) consists of 11 wind turbines on jacket substructures. It is expected that the turbines installed will vary in size and power. The table below summarises the dimensions of the possible machines ranging from 4 MW to 10 MW.

Table 3.3 Dimensions for Minimum and Maximum Size Machines

Wind Turbine Size	Max Hub Height above LAT (m)	Max Rotor Diameter (m)	Maximum Tip Height above LAT (m)
4MW	100	120	160
10MW	120	150	195

Conservatively, the worst case jacket substructure dimensions of 21m by 21m have been assumed within this collision risk assessment, as a worst case out of all potential foundations being considered for the site as defined by the project.

A typical design of the wind turbine and the jacket sub-structure is represented in Figure 3.4 and Figure 3.5. There will be a minimum 22m rotor blade tip clearance (air draught) over MHWS in accordance with MCA and RYA recommendations.

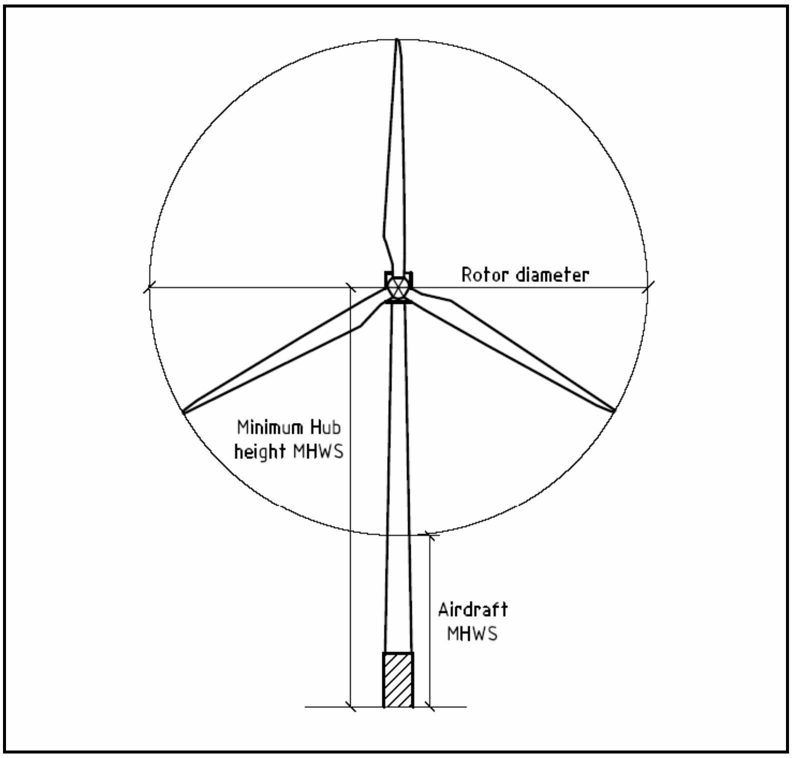


Figure 3.4 Outline of Typical Turbine Structure

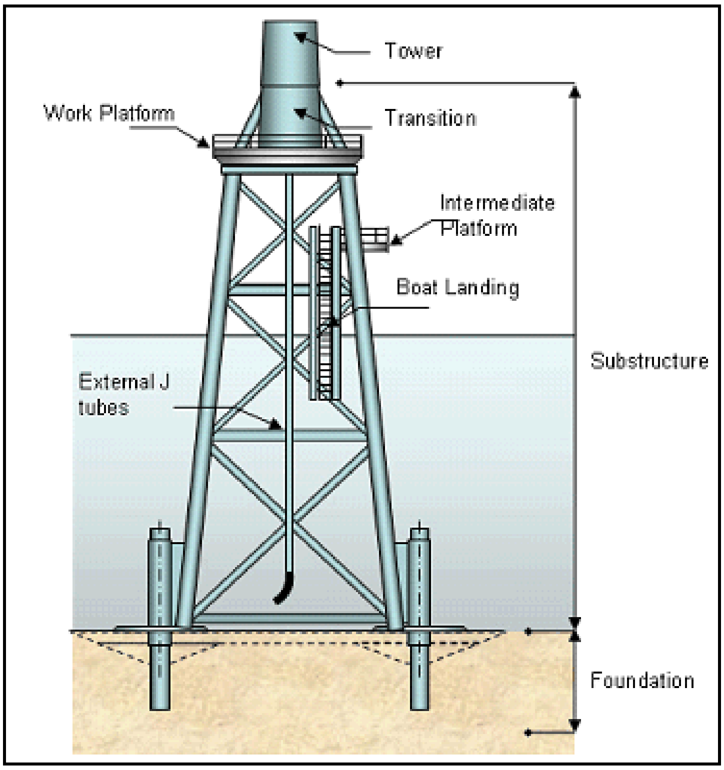


Figure 3.5 Outline of Typical Jacket Substructure

3.5 Offshore Cable Routes

An overview of the cable corridor is presented in the following figure:

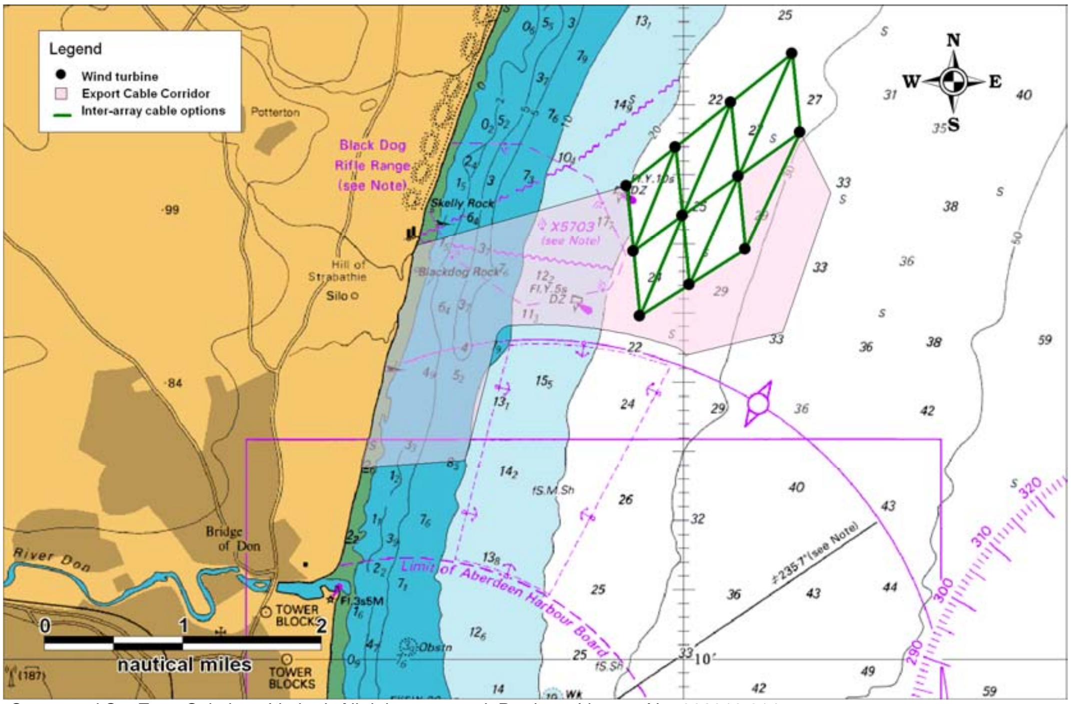


Figure 3.6 Cables associated with Wind Farm

The Rochdale envelope for the project states that the export and inter-array cables will be buried to a minimum depth of 0.6 and to a maximum depth of 3m.

4. MARINE NAVIGATIONAL MARKINGS

4.1 Introduction

Throughout the project marine navigational marking will be provided in accordance with the Northern Lighthouse Board requirements, which will comply with IALA Recommendation 0-139 on the Marking of Offshore Wind Farms and the additional requirements of MCA MGN 371(Ref. ii). It is also noted that there is a requirement to mark selected structures with lights for aviation as per Civil Aviation Authority (CAA) requirements.

NLB have advised that final marking and lighting recommendations will be made in a formal response through the Coast Protection Act 1949: Section 34 consultation process. This will now be implemented through the Marine Licence. All navigational marking and lighting of the site or its associated marine infrastructure will require the Statutory Sanction of the Northern Lighthouse Board prior to deployment.

4.2 Construction/Decommissioning

During the construction / decommissioning of the project, working areas will be established and marked in accordance with the IALA Maritime Buoyage System (MBS). In addition to this, where advised by NLB, additional temporary marking will be applied.

Notices to Mariners, Radio Navigational Warnings-NAVTEX and/or broadcast warnings as well as Notices to Airmen will be promulgated in advance of and during construction / decommissioning of any individual structure/project.

4.3 Marking of Individual Structures

The tower of every wind turbine will be painted yellow all around from the level of Highest Astronomical Tide (HAT) to 12m above HAT or the height of the Aid to Navigation, if fitted, whichever is greater.

As per the MCA requirements, each of the structures will be marked with clearly visible unique identification characteristics at a location that is easily and readily serviceable. The identification characteristics will each be illuminated by a low-intensity light, so that the sign is visible from a vessel thus enabling the structure to be detected at a suitable distance to avoid a collision with it. This will be such that under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer (with naked eye), stationed 3m above sea level, and at a distance of at least 150 m from the turbine. The light will be either hooded or baffled so as to avoid unnecessary light pollution or confusion with navigation marks.

4.4 Proposed Markings

The markings for the proposed EOWDC will be agreed in consultation with NLB. As per IALA guidelines it is likely that once fully developed:

- All corner towers will be marked as Significant Peripheral Structures (SPSs) and where necessary, depending on spacing, intermediate towers on each of the north, east and south facing boundaries will be marked as Intermediate Peripheral Structures (IPSs).

- In all the layouts, towers designated as SPSs are to exhibit Flashing Yellow 5 second (Fl Y 5s) lights of 5nm nominal range and omnidirectional fog signals with a character of 1 blast of 2 seconds duration every 30 seconds and an IALA usual range of 2nm. Towers designated as IPSs are to exhibit Fl Y 2.5s lights of 2nm nominal range.

- All the lights are to be visible to shipping through 360 degrees and if more than 1 lantern is required on a tower to meet the all round visibility requirement, then all the lanterns on that tower should be synchronised.

- All the lights are to be exhibited at the same height at least 12m above Highest Astronomical Tide (HAT) and below the arc of the lowest turbine blades.

- All the lights are to be exhibited at least at night and when the visibility is reduced to 2nm or less. Fog signals are to be sounded at least when the visibility is 2nm or less.

- All the structures in the boundary of the turbine towers are to be coloured yellow from at least HAT to the height of the lights (the equivalent height on the unlighted structures).

- Any lighting required for aeronautical purposes is to be shielded / arranged such that it is not visible to shipping. If this cannot be achieved, then the requirement will be considered as having been met if the aviation light is reduced to 10% of its peak intensity when the visibility is more than 5km.

Over the period of the site being developed the above may vary but all markings will be agreed with NLB in advance.

4.5 Superintendence and Management

Aberdeen Offshore Wind Farm Limited (AOWFL) will ensure that they have a reliable maintenance and casualty response regime in place such that the required availability targets are met.

5. CONSULTATION

5.1 Introduction

Extensive consultation on navigational issues has been carried out with stakeholders during the evolution of the proposed development. This section briefly summarises the key consultations.

5.2 Aberdeen Harbour

Several meetings have been held with Aberdeen Harbour, including the Harbour Master, over the past five years.

This has led to the changes in the site layout as identified in Section 3.3. Aberdeen Harbour officials also participated in the Hazard Review Workshop discussed below.

5.3 Marine Stakeholders Meetings

A number of consultation meetings have been held with maritime stakeholders during the course of the project, including presentations to the Marine Safety Forum.

More recently, a marine stakeholders meeting was held in Aberdeen on 18th March 2010. The meeting was attended by representatives of various marine stakeholders including Aberdeen Harbour, Craig Group, Gulf Offshore, Trico and Shell Marine.

Within this meeting, the main navigational concerns (associated with the previous layout) were highlighted as loss of anchorage, increased congestion and potential impact on navigational aids.

Further meetings were held on the 26th March and 12th April 2010 involving members of the project team, and aviation and marine stakeholders. From these meetings two optimal layouts were derived (Layouts 038 and 039).

Following this, a consultation document was circulated by the Marine Safety Forum on 10th May with both proposed layouts presented to gather their input (Ref. v). The response to this is quoted below as received on 17th May 2010.

> *"Following feedback we are able to give you our (MSF Steering Group) acceptance of either layout 38 or 39 as the footprint layout for the test facility. Please note we will be attending the risk assessment with a positive attitude to the windfarm on this basis. Should the layout revert to the previous more southerly positions we would then be forced to withdraw our agreement."*

Details on the workshop are provided in Section 12.

NorthLink Ferries operate passenger ferry services between Aberdeen and the Northern Isles (Kirkwall in Orkney and Lerwick in Shetland).

An initial meeting between AREG and NorthLink Ferries was held in Aberdeen on 15 January 2009. The purpose of the meeting was to discuss maritime safety issues associated with the proposed EOWDC.

NorthLink advised that they had two main safety concerns (based on the earlier 23 turbine layout (date)):

- Radar interference
- A navigational hazard, due to the pinching effect of loss of approach width. This would be particularly serious when traveling south with a northerly wind behind.

It was pointed out that radar interference was now a well understood issue which had been dealt with at many sites. On navigation it was agreed that routing issues would be discussed at a follow-up meeting during the risk assessment work.

Two further meetings were held onboard the NorthLink ferries *Hjaltland* and *Hrossey* in Aberdeen on 1 and 2 June 2010 following revision of the turbine layout. The Ferry Masters indicated the new layout was a vast improvement by moving to the north, away from the harbour entrance and anchorage area. The ferries normal passage plan keeps to the east of the current turbine layout, although it can vary in different wind conditions. If necessary the passage plan could be adjusted a few miles to the east without a major problem.

Radar interference was not considered to be a major issue based on past experience at other sites.

5.4 Scottish Fishermen's Federation (SFF)

Meetings have been held in Aberdeen with SFF to discuss the potential impact of the proposed EOWDC site on fishing vessels. No significant navigational issues were identified.

Further consultation on fisheries has been carried out as part of the Commercial Fisheries study (Chapter 7.7).

5.5 Hazard Review Workshop – Aberdeen

A hazard review workshop was held in Aberdeen on the 25 August 2010, hosted by Aberdeen Harbour. The purpose of the workshop was to identify and review the potential navigational hazards associated with the proposed development of the EOWDC.

More details on the workshop are provided in Section 12.

5.6 Other Consultation

Various consultation exercises have been carried out by the project over a number of years including several public events which allowed all stakeholders to contribute opinions on the proposals. This and other feedback was used in developing the current layout.

6. BASELINE ENVIRONMENT

6.1 Introduction

This section presents the following baseline information relating to navigation in the Aberdeen area:

- Ports
- Navigational Aids
- Sailing Directions
- Oil & Gas Infrastructure
- Military Exercise Areas
- Metocean data

6.2 Aberdeen Harbour

Aberdeen Harbour is the principal commercial port serving the northeast of Scotland with approximately 16,000 ship movements in 2009 handling approximately 4.5 million tonnes of imports and exports. The Port is the main marine support centre for the North Sea oil and gas industry. In addition to the oil and gas support services there are regular shipping services to Orkney, Shetland and Scandinavia via Ro-Ro services for passengers and cargo, with 142,468 passengers passing through the port in 2009 (Ref vi).

The Port also has a large modern fish market and although there are no commercial fisheries within the area of jurisdiction of Aberdeen Harbour or proximity, deep-sea fishing vessels and a number of locally registered potters land their catches at the Aberdeen fish market located at Palmerston Quay.

The nearest proposed turbine within the EOWDC site would be located over 2 nautical miles (nm) from the northern limits of Aberdeen Harbour.

A chart of the Aberdeen Harbour limit and main features is presented in Figure 6.1. There is a designated anchorage area just to the north of the Aberdeen Port boundary, which was established in the first half of 2010.

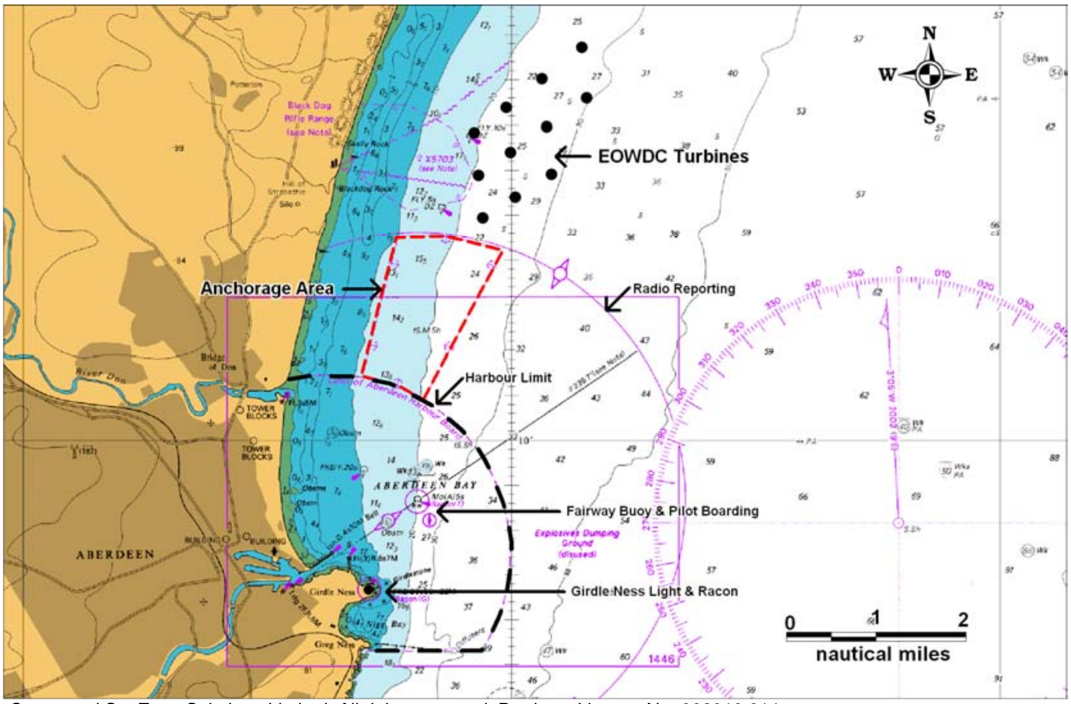


Figure 6.1 Overview of Aberdeen Harbour Limit

6.3 Port Facilities/Services

Aberdeen Harbour is a modern port with a state-of-the-art Marine Operations Centre.

Figure 6.2 Marine Operations Centre at Aberdeen Harbour Entrance

Facilities and services that assist in the safe navigation of shipping within the harbour include:

- Controlling depths & maximum vessel size
- Radar based vessel traffic services
- Pilotage
- Anchorage
- Navigational aids

More details are provided below.

6.3.1 Controlling Depths & Maximum Vessel Size

The maximum dimensions and size for vessels entering Aberdeen are quoted as:

- Length: 165m
- Beam: 26m
- Draught: 8.5m
- Largest Vessel (Tonnage): 18,500 GT

However, it is noted that there are a number of deep-water berths available within the harbour which are restricted by water depth based on mean low water springs (MLWS) and mean high water springs (MHWS) levels. The deep-water berths are given below:

- Atlantic Wharf is 137 m long with depth of 9.3m at MLWS and 13.0m at MHWS.
- Pacific Wharf is 205m long with 9.9m of water at MLWS and 13.6m at MHWS.
- Waterloo Quay West is 172m long with 9.9m of water at MLWS and 13.6m at MHWS.
- Regent Quay East is 255m long with 9.9m of water MLWS and 13.6m at MHWS.
- Telford Dock has 520m of berthing with 9.6m of water at MLWS and 13.3m at MHWS.
- Matthews Quay is 236 m long with 9.6m of water at MLWS and 13.3m at MHWS.

Berthing is also available in six areas within the harbour; the details of each are given in Table 6.1.

Table 6.1 Details of Berthing Locations in Aberdeen Harbour

Location	Area (ha)	Length of Quays (m)	Max depth of berths MLWS / MHWS (m)
Tidal Harbour	14.5	1,574	9.6/13.3
Albert Basin	8.5	1,525	8.4/13.6
River Dee (navigable area)	4.1	928	8.4/10.8

Location	Area (ha)	Length of Quays (m)	Max depth of berths MLWS / MHWS (m)
Dock	1.5	410	9.6/13.3
Upper Dock	2.0	429	6.6/10.3
Victoria Dock	8.5	1,500	9.9/13.6

6.3.2 Vessel Traffic Service (VTS)

All shipping movements in Aberdeen Harbour are controlled and monitored from the state-of-the-art Navigation Control Centre situated at the inner end of the North Pier.

The Centre operates continuously for 24 Hrs and is fitted with radar and VHF Radio (Channels 12 and 16). Masters and boat crews have to obtain permission from the Harbour Master before launching a vessel into the harbour waters, by contacting VTS on VHF Channel 12.

There are reporting procedures as well as reporting points for vessels as listed below:

Vessels Inward Bound:

(1) All vessels (except fishing and recreational craft) should send Aberdeen VTS 24hr prior to arrival (or give as much advance notice as possible) stating:

- Vessels name
- IMO number
- Length overall (LOA)
- Maximum draught
- Last port/location
- ETA
- Pilotage requirements
- Gross tonnage (GT)
- List of defects
- Cargo
- Agent

(2) All vessels (including fishing and recreational craft) must call Aberdeen VTS when 1hr from the Fairway light buoy, and confirm ETA and draught.

(3) All vessels (including fishing and recreational craft) must call Aberdeen VTS when 3nm from the Fairway light buoy to obtain permission to enter the Aberdeen VTS area. Fishing vessels and recreational craft should provide the information listed at (1) if required to do so.

(4) All vessels must maintain a continuous listening watch on VHF channel 12 when navigating within the Aberdeen VTS area.

(5) All vessels must report to Aberdeen VTS when in close vicinity to the Fairway light buoy in order to obtain authorization to enter the navigation channel.

(6) *Vessels within the area:*
(a) All vessels must maintain a continuous listening watch on channel 12.
(b) All vessels must report on anchoring or berthing
(c) All vessels must obtain authorisation from Aberdeen VTS before getting underway from anchor or leaving a berth.
(d) All vessels must report on leaving anchorage or berth

(7) Vessels Outward-Bound and Shifting Berth:
(a) All vessels must send ETD to Aberdeen VTS when known, message should also include:
(i) Draught
(ii) Where bound (next Port/Location/Berth)
(iii) All vessels must obtain authorisation from Aberdeen VTS prior to leaving berth.

All vessels must report to Aberdeen VTS when passing the reporting points I and B. All vessels, when required by VTS to do so, must report when passing Reporting Points A, C and D.

Table 6.2 VTS Reporting Points for Aberdeen Harbour (Note [1])

Reporting Point	Position	Remarks
I	3 nm from Fairway light buoy	Inward and Outward-Bound
B	Close vicinity to Fairway Lt buoy	Inward and Outward-Bound
A	57° 08.52' N, 002° 04.77' W	Entrance to Albert Basin
C	57° 08.63'N, 002° 04.85' W	Entrance to Victoria Dock (the Cut)
D	57° 08.42' N 02° 04.52' W	Entrance to Dee River

Note [1]: Vessels (in particular Offshore Support and Fishing Vessels) may be required to hold at these points.

For entry into the port, there are light signals that have the following meanings:

- A **GREEN** light - No entry into the Navigation Channel for vessels proceeding towards the Harbour.
- A **RED** light - No entry into the Navigation Channel for vessels proceeding to sea.
- A **GREEN** and **RED** light - No entry into the Navigation Channel for any vessel.

The traffic regulations as laid out in Ref. vii state:

The master of a vessel waiting within the limits of the port and harbour to enter the harbour shall so manoeuvre such vessel as to be at all times clear of the ordinary course of ships entering or leaving the harbour.

The master or owner of a vessel which is to enter the harbour shall, on the arrival of such vessel in Aberdeen Bay and before it approaches the harbour entrance, notify the harbour master of the intended entry of the vessel, giving the name of the vessel, the name of the master, the port or place from which the vessel has arrived and the draught of water of the vessel.

The master of a vessel shall not cause or permit such vessel to enter the navigation channel abreast of any other vessel or to overtake any other vessel in said channel, and every master shall keep his vessel at a distance of not less than 70m behind any other vessel proceeding in the same direction ahead of his vessel in the said channel except when towing or being towed.

The master of a vessel shall not cause or permit such vessel to proceed in any part of the harbour at a speed in excess of 5 knots over the ground.

6.3.3 Pilotage & Tugs

All vessel movements within Aberdeen Harbour are well managed by Port Control with set pilotage procedures. Aberdeen has compulsory pilotage for vessels of 60 m and over in length. However, for vessels with an operational bow thruster this limit is increased to 75 m.

The majority of vessels entering Aberdeen Harbour have bow and stern thrusters and are highly manoeuvrable. When pilotage is required the Pilot will normally board vessels in the vicinity of the Fairway Buoy. There are two pilot vessels in operation at Aberdeen, the *Sea Haven* and *Sea Shepherd*, which are show in Figure 6.3 and Figure 6.4.

Figure 6.3 Pilot Vessel *Sea Haven*

Figure 6.4 Pilot Vessel *Sea Shepherd*

It is noted that two tugs are available within Aberdeen Harbour for towing vessels into and out of the port.

6.3.4 Anchorage

Aberdeen Bay is free of danger and has a regular sandy bottom, therefore can be used as a long term temporary anchorage.

A designated anchorage area to the north of Aberdeen Bay was established in 2010.

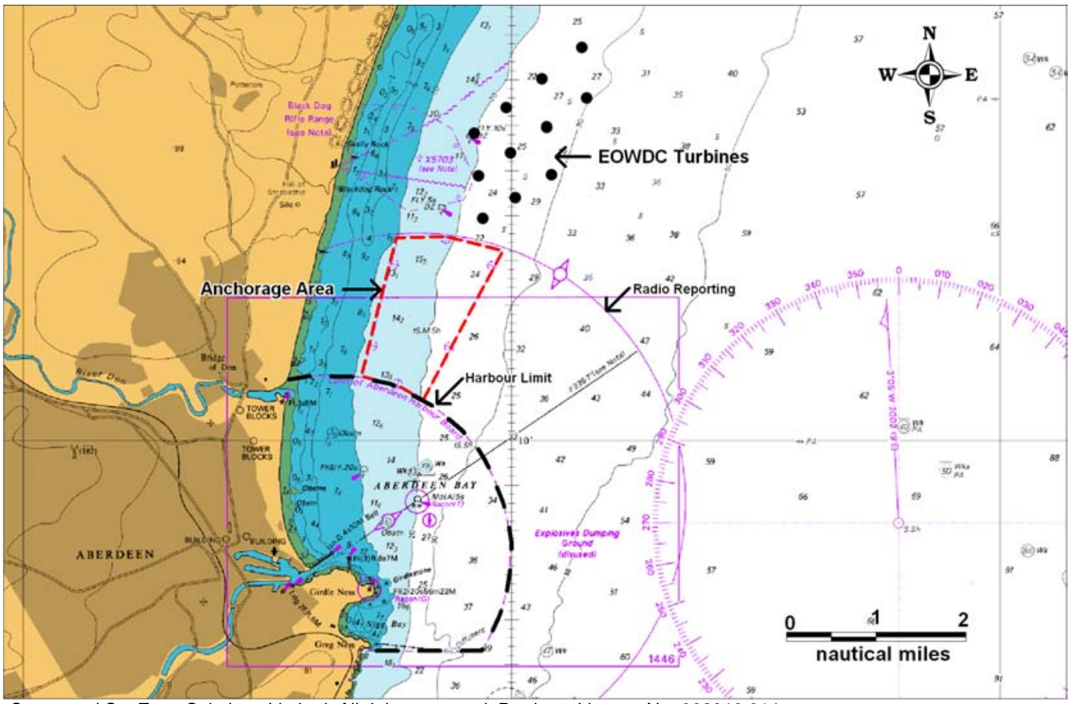


Figure 6.5 Official Anchorage Area to the North of Aberdeen Bay

A detailed analysis of anchoring within Aberdeen Bay is presented in Section 8.6.

6.4 Navigational Aids

A plot of the principal navigational aids within 15nm of Aberdeen Bay is presented in Figure 6.6, with a detailed plot of Aberdeen Bay presented in Figure 6.7.

The principal landmarks are those listed in Admiralty Sailing Directions for the area (Ref. vii). The buoy positions are taken from Admiralty Charts of the area.

The Fairway Buoy (Racon) is the main navigational aid approximately 1 mile from Aberdeen Harbour's South Breakwater.

Other buoys in the vicinity of the Aberdeen Bay are generally located along the coastline. The closest buoys are approximately 4nm and 5nm, respectively, to the north of Aberdeen Bay, marking the limits of a military practice firing range at Blackdog. Other main aids to navigation are located at Stonehaven Harbour approximately 14nm south and at The Skares off Cruden Bay approximately 15nm north.

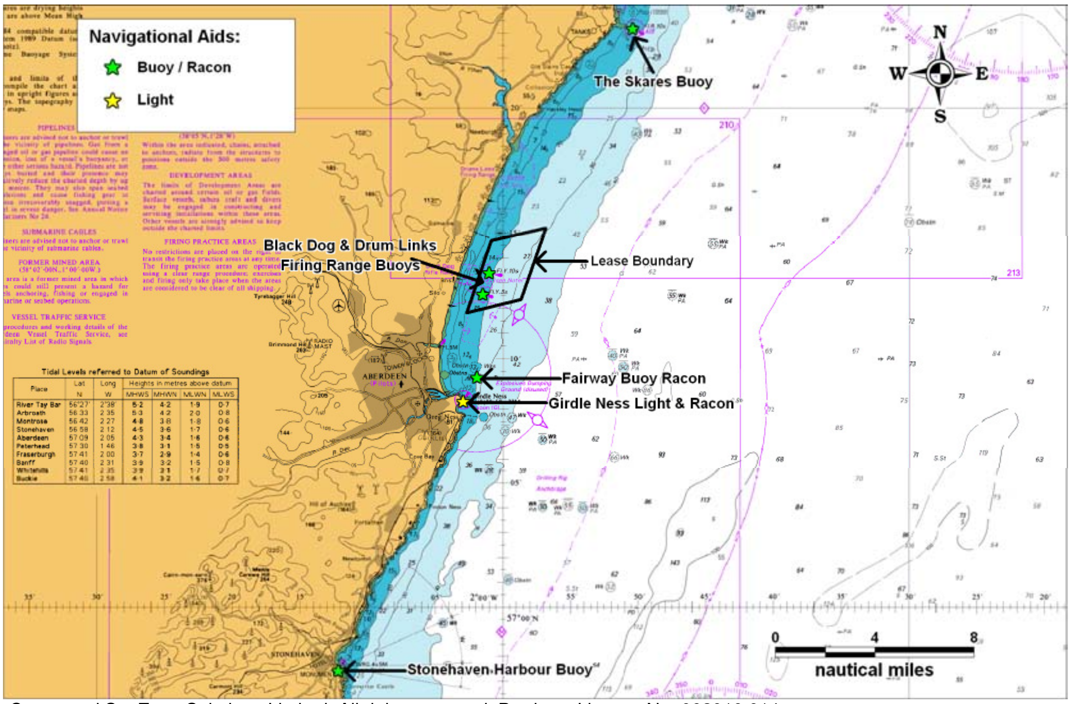


Figure 6.6 Navigational Aids along the North East Coast relative to Aberdeen

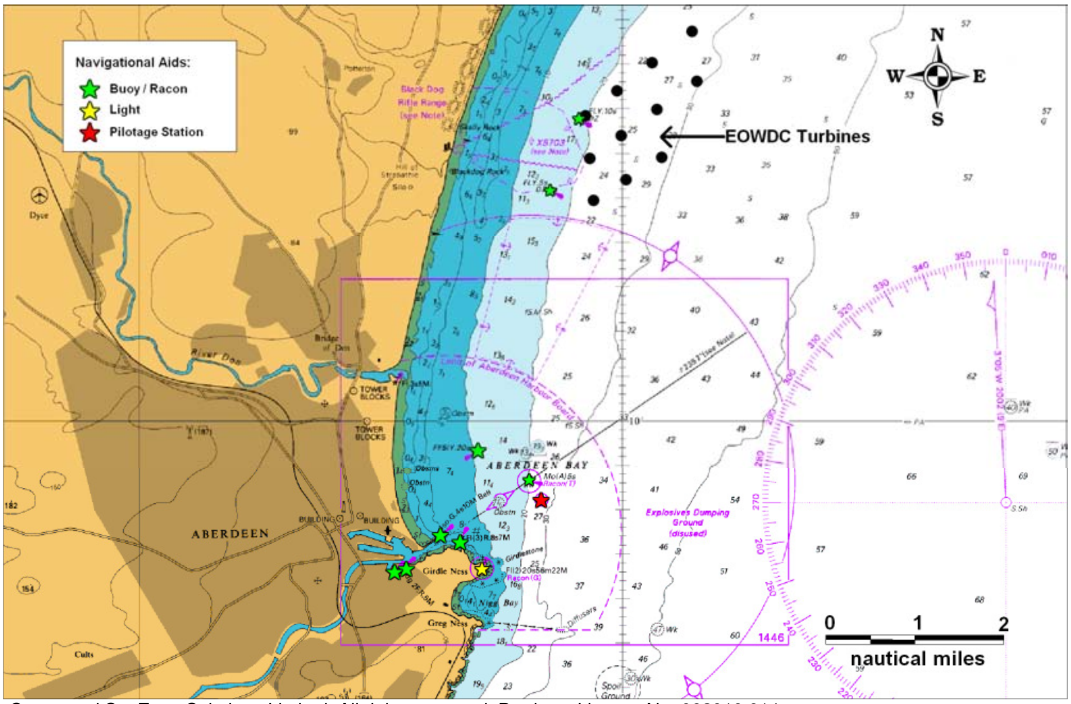


Figure 6.7 Navigational Aids in the vicinity of Aberdeen Bay

6.5 Sailing Directions

Sailing directions for the area are presented in the North Sea (West) Pilot (Ref. vii). A plot of the routes for vessels bound from Rattray Head to Isle of May is presented in Figure 6.8.

The arrows are not accurate if superimposed on a chart but they illustrate the general passages used by ships. A description of the two routes passing the site is given below.

- (3.43) From a position E of Buchan Ness (57° 28' N, 1° 46' W) the route leads SSW for a distance of 22 miles to the Fairway Light-buoy 1 mile NE of the entrance to Aberdeen Harbour.
- (3.86) From a position E of Girdle Ness (57° 08' N, 2° 03' W) the coastal route leads SSW to a position E of Stonehaven.

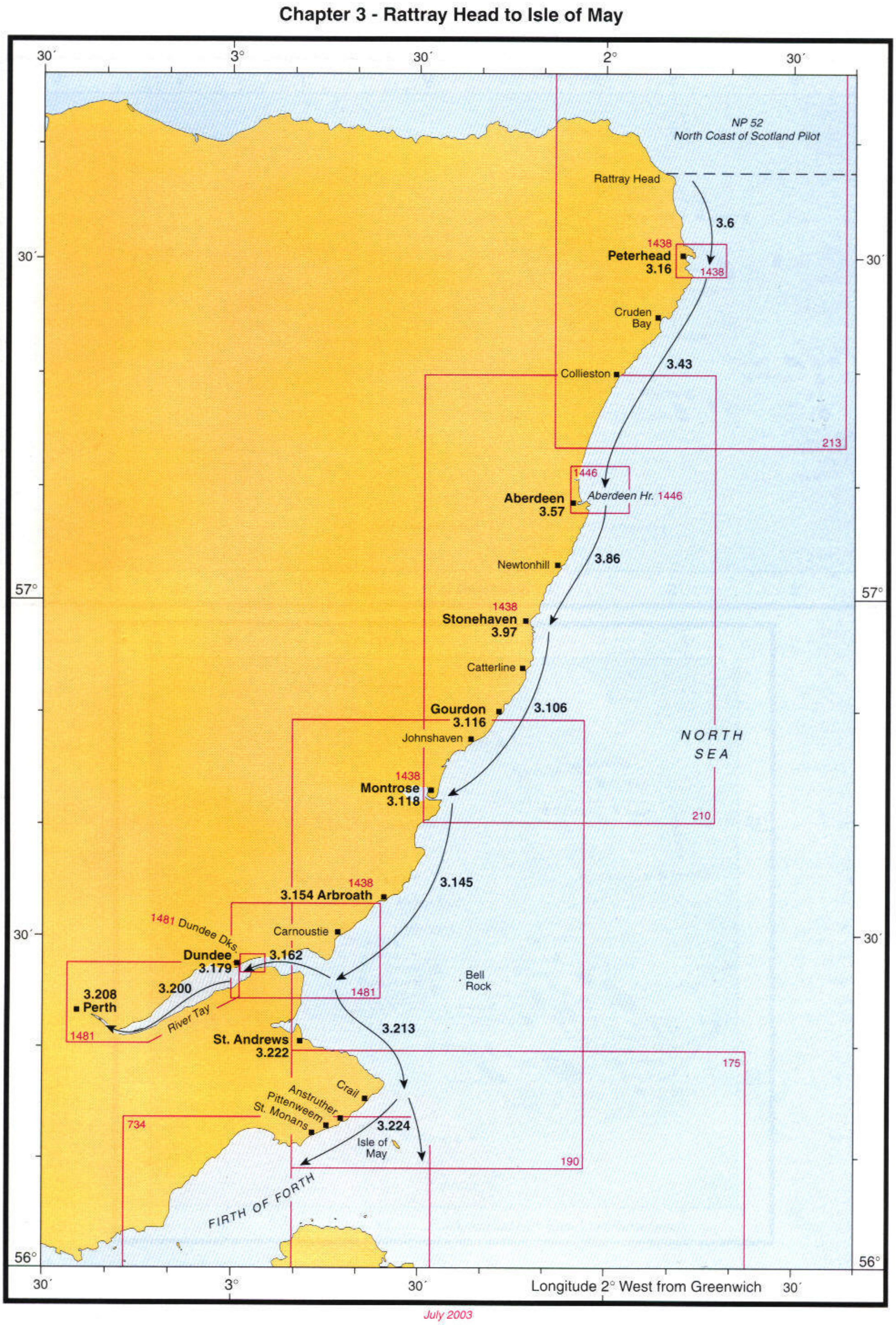


Figure 6.8 Routes from Rattray Head to Isle of May (Ref. vii)

6.6 Wrecks

An assessment of the offshore archaeology has been carried out as part of this ES to identify wrecks and archaeological sites of interest in the area. This identified a single wreck with a height of 0.7m within the area. Further details can be found in the Offshore Assessment Archaeology Section of the ES.

6.7 Oil & Gas Infrastructure

The licence blocks in the area of the proposed EOWDC are presented in Figure 6.9.

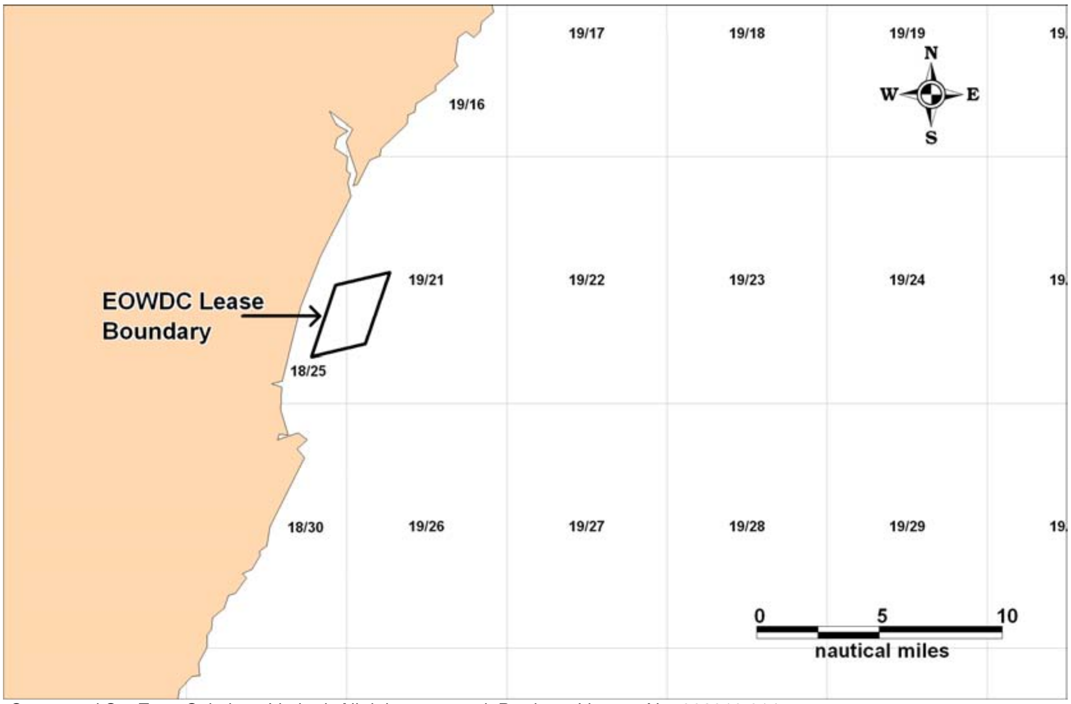


Figure 6.9 Oil & Gas UKCS Blocks, Installations and Licence Areas near Aberdeen

The proposed site is mostly within UKCS Block 19/21 which was on offer as part of the 26th round of UKCS licensing. This block has never previously been licensed and at the moment there is no operator for this block. Block 18/25 which contains part of the EOWDC site was not available due to the MOD military practice area at Blackdog and Drums Links.

The nearest existing offshore surface installation is at the Buzzard Field which is approximately 47nm to the northeast of the site which is remote from the site, beyond the extents of the Figure 6.9.

6.8 Exercise Areas

There is a rifle firing range at Blackdog which borders the western edge of the proposed EOWDC site, and is marked with Danger Zone (DZ) Buoys, as shown in Figure 6.10.

No restrictions are placed on the right to transit the Blackdog firing practice area at any time and they operate a clear range procedure with exercises only taking place when the areas are clear of shipping. Red flags or red lights are displayed to indicate that the area is in use.

The Drums Links military firing range is located approximately 1.7nm to the north of the proposed EOWDC site; this area uses the same procedures as Blackdog, whereby firing will only take place when the area is clear of shipping, as firing takes place seaward. There is also the central Managed Danger Area (MDA), which is a military practice zone for high altitude RAF training exercises and is located approximately 6.7nm to the east of the proposed EOWDC site.

Figure 6.10 Military Practice Areas relative to Site

6.9 Metocean Data

6.9.1 Introduction

This section presents Metocean statistics for the area of the proposed EOWDC site which have been used as input to the risk assessment.

According to the Admiralty Sailing Directions (Ref. vii), the west North Sea region enjoys a generally mild climate.

Rainfall is not considerable, and there is little variation throughout the year. It is frequently cloudy throughout the year; however, the winter months are more susceptible to overcast skies.

Fog (or haar) occasionally affects the east cost of the UK, particularly in the north.

6.9.2 Wind

The wind data presented here has been taken from recordings made at Dyce, Aberdeen (Ref.vii).

The wind direction distribution is presented in Figure 6.11 based on 20 to 30 years observations between 1960 and 2002. It can be seen that the predominant wind direction is from the south.

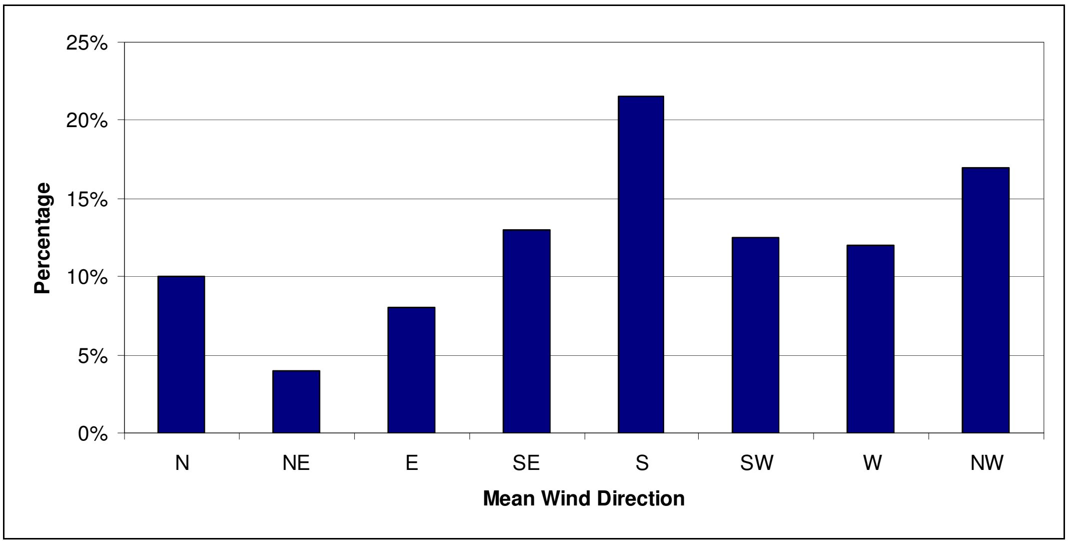


Figure 6.11 Average Annual Wind Direction Distribution

Gales are more common in the winter months, although they still may occur during the summer with the average wind speed recorded over a twenty year period between 10 and 11 knots (height above mean sea level of 65m).

6.9.3 Visibility

Historically, visibility has been shown to have a major influence on the risk of ship collision.

Visibility data was obtained from Dyce, Aberdeen. The number of days with fog per month over 20 years of data is presented in Figure 6.12.

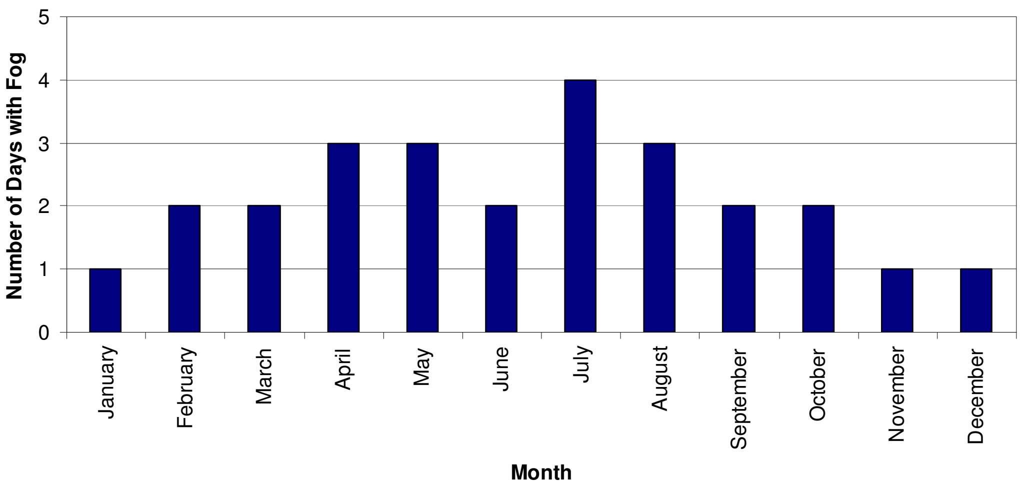


Figure 6.12 Monthly Distribution of Days with Fog (1983-2002)

It can be seen from the above figure that fog is more common between April and August and occurs less frequently from November to January.

6.9.4 Tide

A description of the tidal streams in the general area is provided below (Ref. vii):

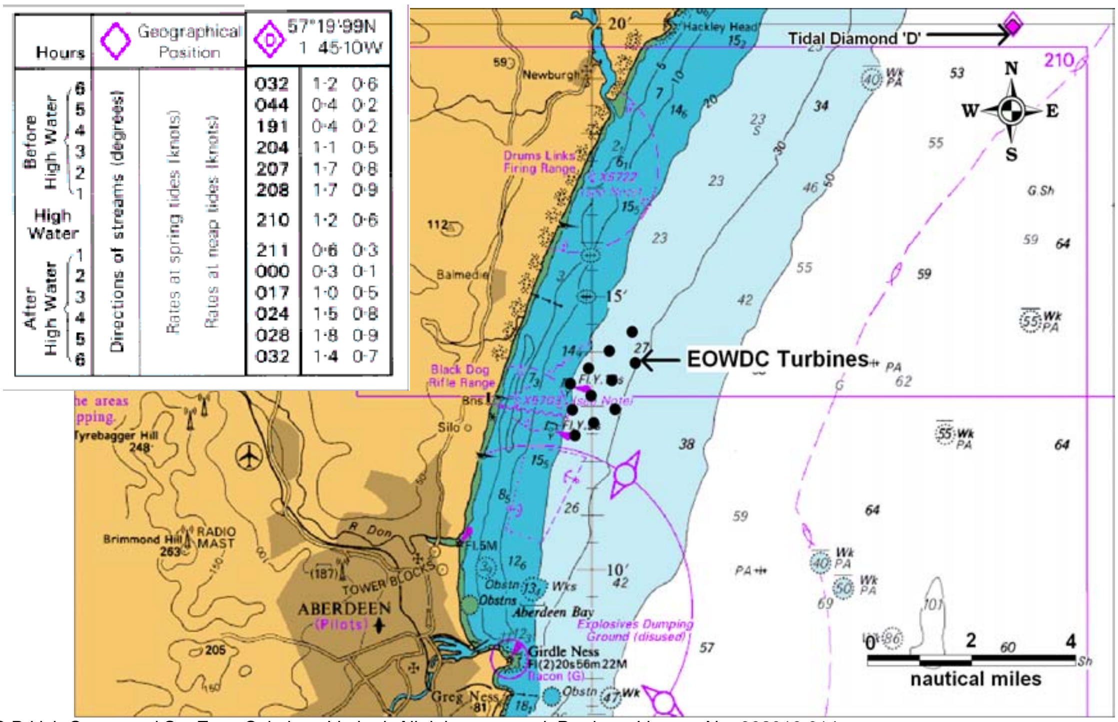
> *The offshore stream runs generally north and south from Rattray Head to Bells Rock and tidal streams in the North Sea generally run N/S parallel to the east coast of the UK.*
>
> *However, as the entrance to Aberdeen is approached the streams heading south become more easterly and the streams running north become more westerly and the tidal stream runs SE/NW across the approach to Aberdeen.*

Tidal levels for Aberdeen above Chart Datum (CD) are presented below.

Table 6.3 Tidal Levels above Chart Datum at Aberdeen

Tidal Level	Height above Chart Datum
Highest Astronomical Tide (HAT)	4.9m
Mean High Water Springs (MHWS)	4.3m
Mean High Water Neaps (MHWN)	3.4m
Mean Sea Level (MSL) (approx.)	2.6m
Mean Low Water Neaps (MLWN)	1.7m
Mean Low Water Springs (MLWS)	0.6m
Lowest Astronomical Tide (LAT)	0.1m

Admiralty Chart 213 (Tidal Diamond "D" approximately 10nm NE of the EOWDC site - Ref. viii) indicates that currents in the area set in a generally SSW direction on the flood and NNE direction on the ebb, with a peak spring tidal rate of 1.8 knots and peak neap rate of 0.9 knots. This has been considered within the drifting scenario modelling for this development (Section 13).



Hours		Directions of streams (degrees)	Rates at spring tides (knots)	Rates at neap tides (knots)
Geographical Position		◇D 57°19'·99N 1 45·10W		
Before High Water	6	032	1·2	0·6
	5	044	0·4	0·2
	4	191	0·4	0·2
	3	204	1·1	0·5
	2	207	1·7	0·8
	1	208	1·7	0·9
High Water		210	1·2	0·6
After High Water	1	211	0·6	0·3
	2	000	0·3	0·1
	3	017	1·0	0·5
	4	024	1·5	0·8
	5	028	1·8	0·9
	6	032	1·4	0·7

Figure 6.13 Tidal Stream Data for Aberdeen Bay (Tide Point "D")

7. MARITIME INCIDENTS

7.1 Introduction

This section reviews maritime incidents that have occurred in the vicinity of the proposed EOWDC site in recent years.

The analysis is intended to provide a general indication as to whether the area of the proposed development is currently low or high risk in terms of maritime incidents. If it was found to be a particularly high risk area for incidents, this may indicate that the development could exacerbate the existing maritime safety risks in the area.

Data from the following sources has been analysed:

- Marine Accident Investigation Branch (MAIB)
- Royal National Lifeboat Institution (RNLI)

(It is noted that the same incident may be recorded by both sources.)

7.2 Marine Accident Investigation Branch (MAIB)

All UK-flagged commercial vessels are required to report accidents to MAIB. Non-UK flagged vessels do not have to report unless they are within a UK port/harbour or within UK 12 nm territorial waters and carrying passengers to or from a UK port (including those in inland waterways). However, the MAIB will record details of significant accidents of which they are notified by bodies such as the Coastguard, or by monitoring news and other information sources for relevant accidents. The MCA, harbour authorities and inland waterway authorities also have a duty to report accidents to MAIB.

The locations[1] of accidents, injuries and hazardous incidents reported to MAIB within 10nm of the proposed EOWDC turbines between January 1994 and March 2010 are presented in Figure 7.1, colour-coded by type. (It is noted that several incidents may have taken place in coastal areas around Aberdeen Bay and therefore a symbol may represent more than one incident.)

[1] MAIB aim for 97% accuracy in reporting the locations of incidents.

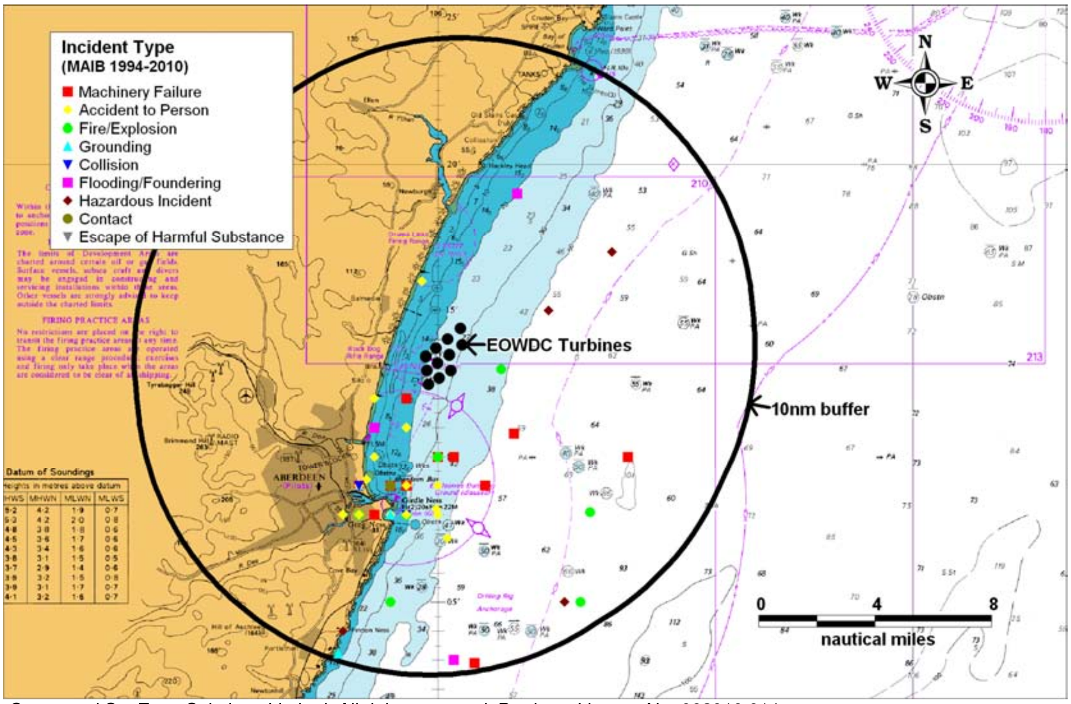


Figure 7.1 MAIB Incident Locations by Type within 10nm of EOWDC Turbines

A total of 162 incidents were reported in the area, corresponding to an average of 9-10 per year. The majority of the incidents occurred in and around Aberdeen Harbour. The distribution by incident type and year is presented in Figure 7.2 and Figure 7.3, respectively.

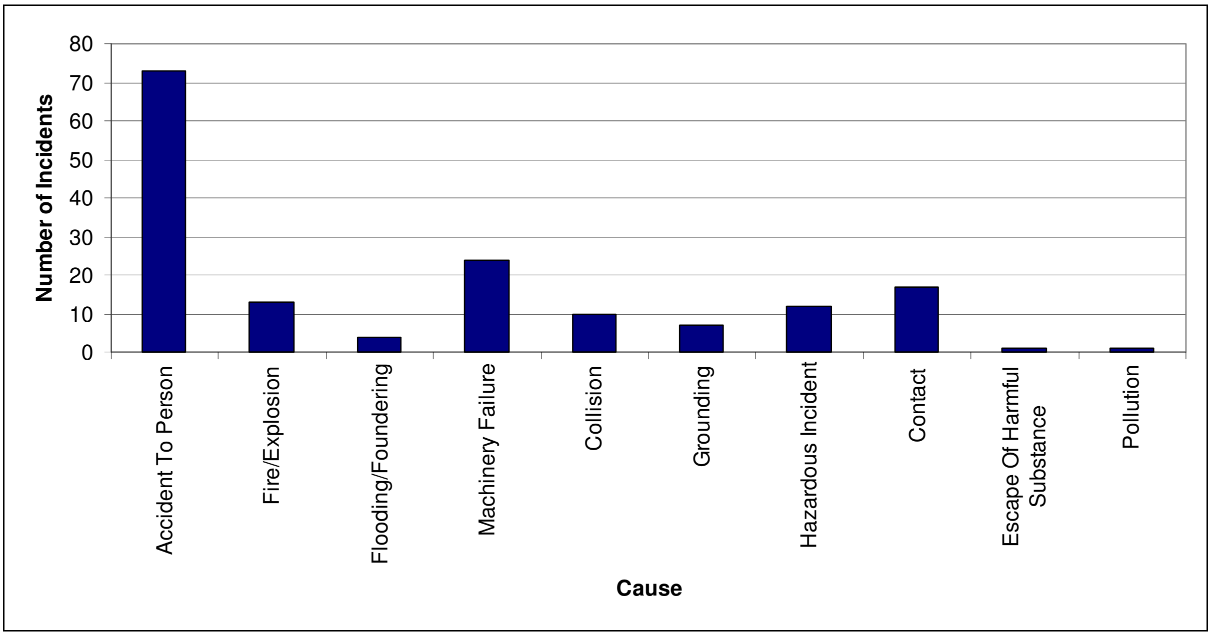


Figure 7.2 MAIB Incidents by Type within 10nm of EOWDC turbines (1994-2010)

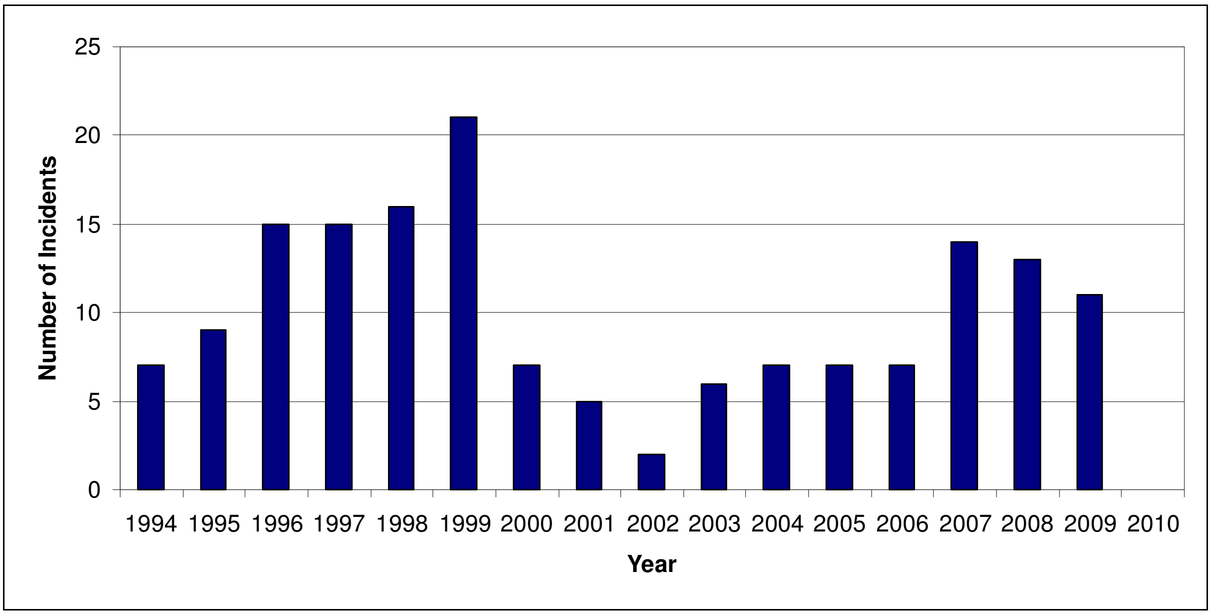


Figure 7.3 MAIB Incidents by Year within 10nm of EOWDC Turbines (1994-March 2010)

The most common incident type recorded within 10nm of the site boundary was accident to person. 1999 was the year with the most recorded incidents with 21 incidents reported during this year. It is noted that 2010 data was obtained up to March and there were no incidents recorded during this period.

There were no incidents reported within the EOWDC turbine locations. The closest incident to the proposed turbines was a machinery failure approximately 0.9nm to the southwest of the most southern turbine on 17 February 2007. The incident involved a non-commercial pleasure craft which broke down and had no working radio. After a considerable search the vessel was located and towed to port with no major damage reported.

Five collisions were recorded within 10 nm of the proposed EOWDC turbines, all within the harbour. Details are as follows:

1. On 31 May 1996 two offshore supply boats collided. Both vessels suffered material damage but no injuries or casualties were reported. One of the vessels was manoeuvring in Aberdeen Harbour and contacted the other vessel which was secured at berth.
2. On 2 November 1998 two anchor handling tug supply boats collided when a manoeuvring vessel collided with a berthed vessel due to a fault in pitch overload. The earth fault was subsequently found and eliminated meaning only material damage was caused to both vessels.
3. On 28 February 1999 an offshore support vessel suffered minor damage after colliding with scaffolding hung off a berthed vessel. This happened while manoeuvring alongside due to a navigational misjudgement.

4. On 30 June 1999 a commercial vessel collided with another berthed vessel after failing to respond to the controls quickly enough when approaching the berth. The system was operating correctly but with a new master and pilot the orders were not given in time. This caused material damage to the colliding vessel.
5. On 10 November 2000 a pilot boat collided with a commercial vessel due to a delay in engine control. The mechanical fault was investigated and rectified and no damage was reported.

None of the reported collisions reported any injuries or fatalities. There were no reported MAIB collision incidents from November 2000 onwards.

7.3 Royal National Lifeboat Institution (RNLI)

Data on RNLI lifeboat responses within 10nm of the EOWDC turbines in the ten-year period between 2000 and 2009 have been analysed. A total of 173 launches were recorded by the RNLI (excluding hoaxes and false alarms).

Figure 7.4 presents the geographical location of incidents colour-coded by casualty type. It can be seen that the vast majority occurred near the coast, with relatively few further out to sea. The area of interest includes various stretches of beach.

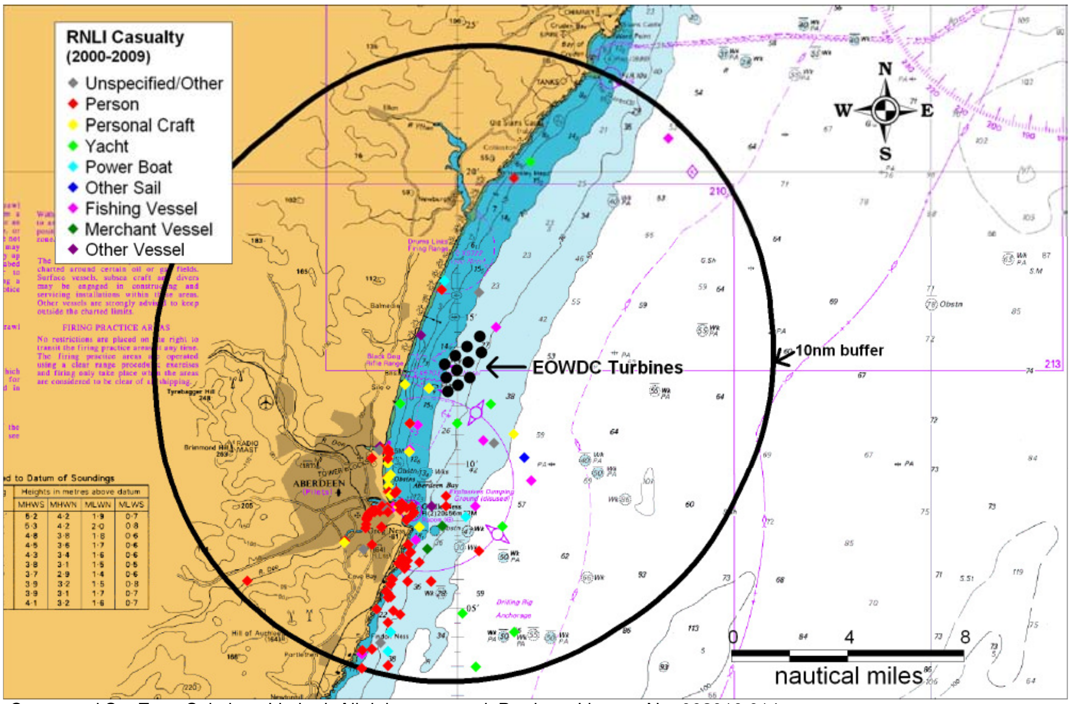


Figure 7.4 RNLI Incidents by Casualty Type within 10nm of EOWDC Turbines

The overall distribution by casualty type is summarised in Figure 7.5. People were the most common casualty type involved, responsible for 60% of RNLI launches.

Personal craft accounted for 12% of all incidents and fishing vessels accounted for 10% with various other vessel types making up the remainder of incidents.

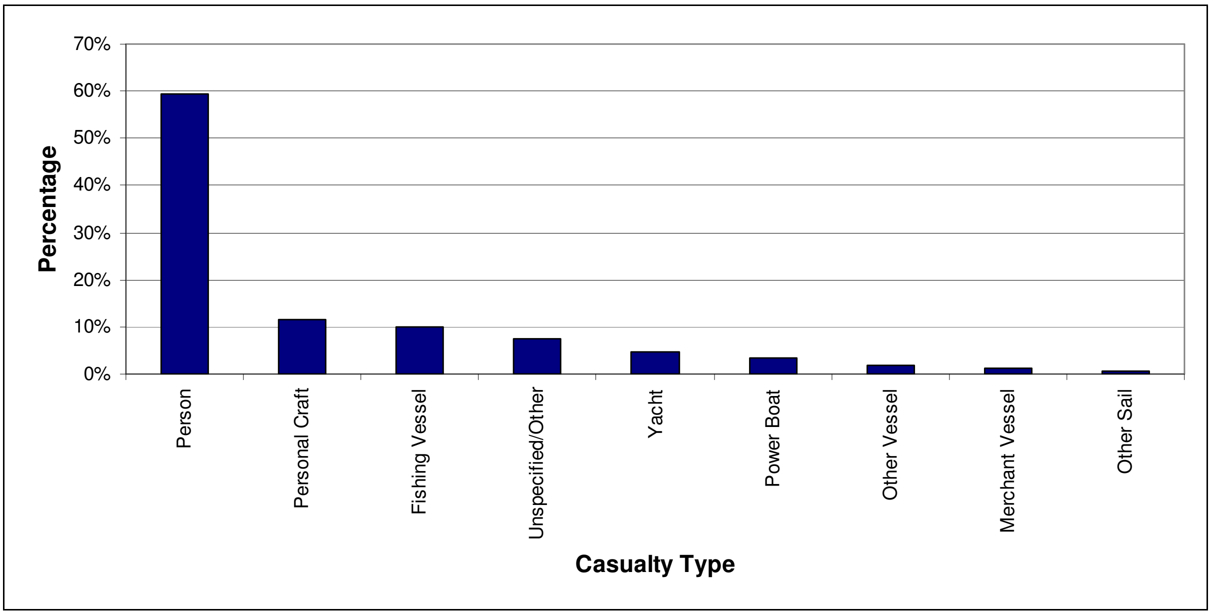


Figure 7.5 RNLI Incidents by Casualty Type within 10nm of EOWDC Turbines (1998-2007)

A chart of the incidents by cause is presented in Figure 7.6.

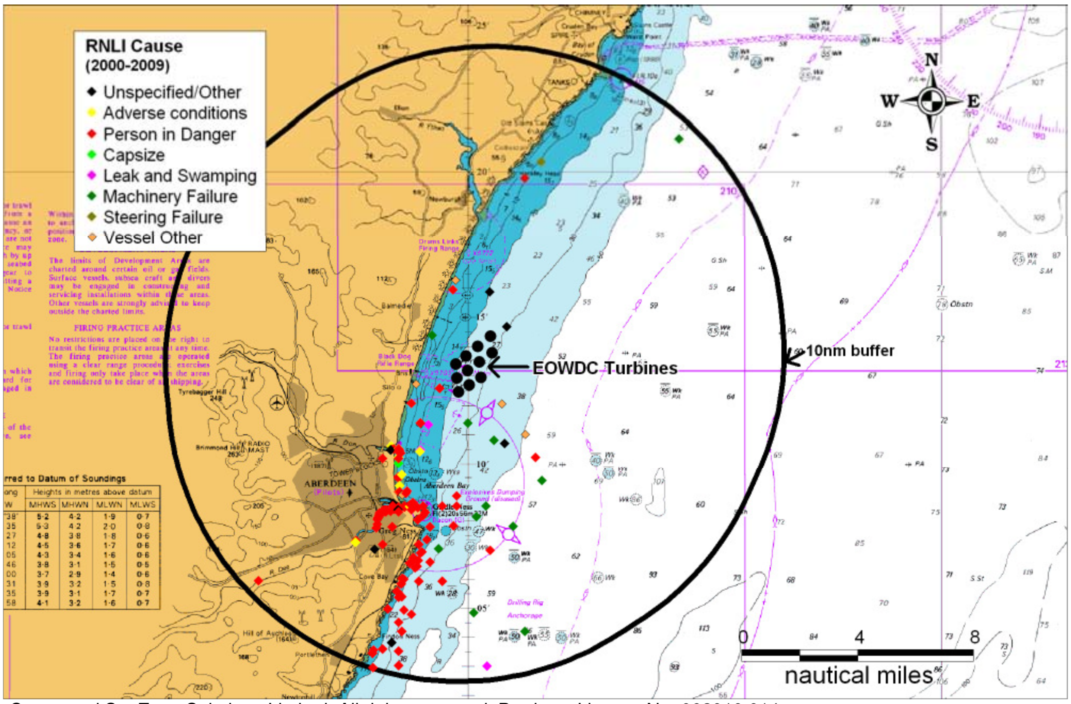


Figure 7.6 RNLI Incidents by Cause within 10nm of EOWDC Turbines

The reported causes are summarised in Figure 7.7. The main cause was "Person in Danger" contributing three-quarters of all incidents.

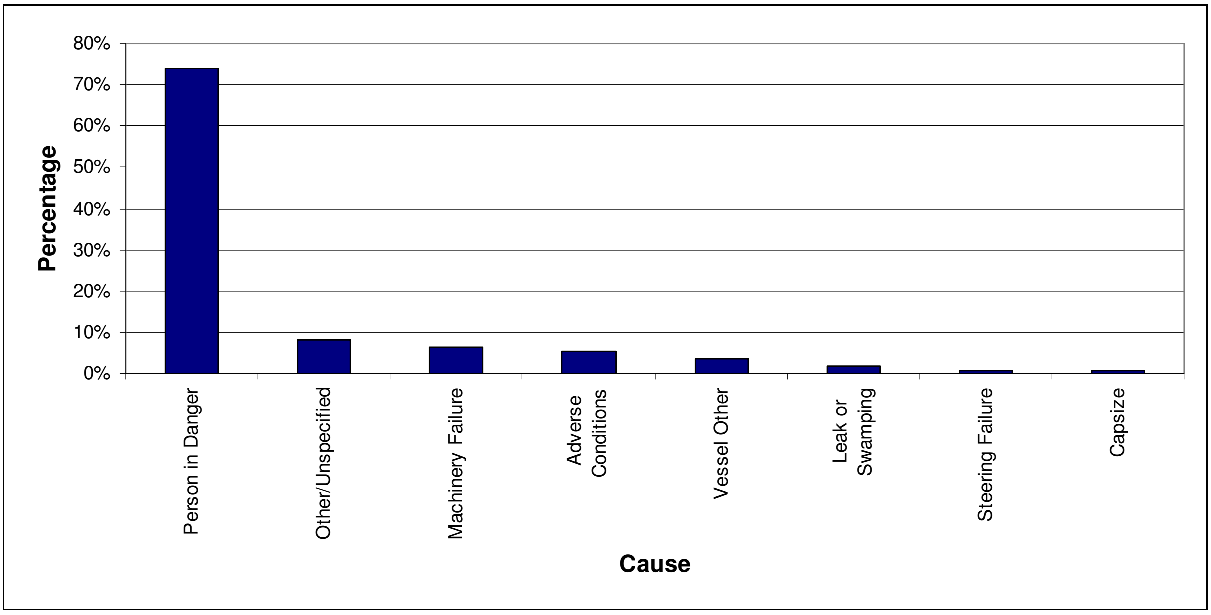


Figure 7.7 RNLI Incidents by Cause within 10nm of EOWDC Turbines (1998-2007)

The annual rate of incidents in the past ten years is summarised in Figure 7.8. The year with the most incidents was 2000.

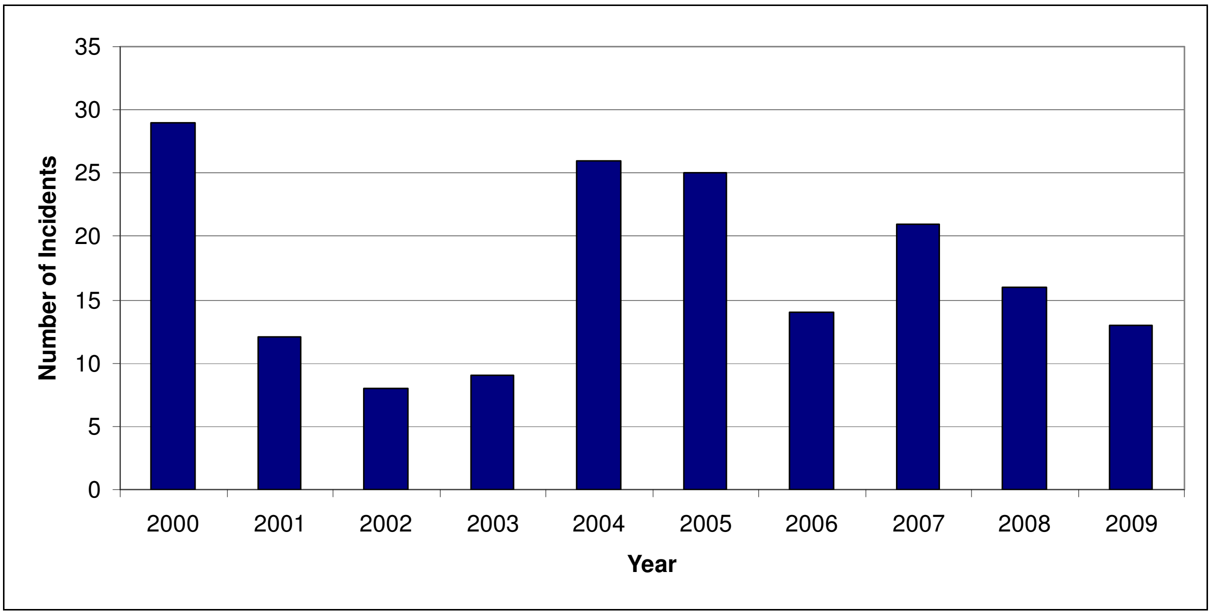


Figure 7.8 RNLI Incidents by Year within 10nm of EOWDC Turbines (1998-2007)

The stations and types of lifeboat responding to incidents (ALB = all-weather lifeboat and ILB = inshore lifeboat) are illustrated in Figure 7.9.

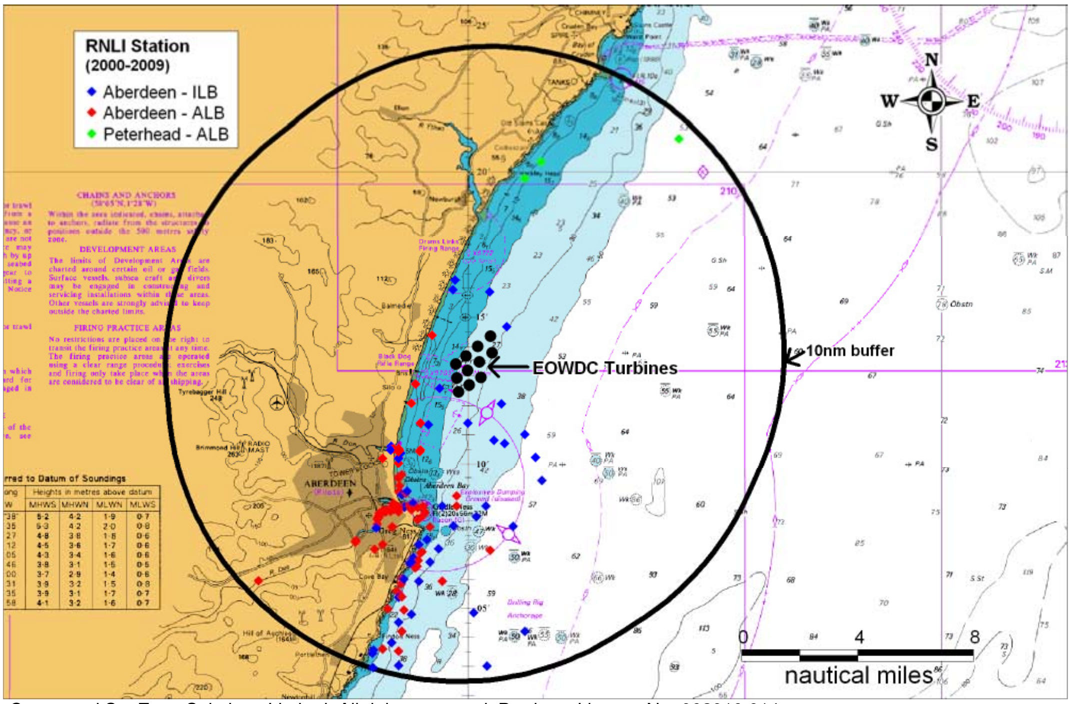


Figure 7.9 RNLI Incidents by Station within 10nm of EOWDC turbines

It can be seen that incidents away from the coast tended to be answered by the all weather lifeboat based in Aberdeen. The inshore lifeboat from Aberdeen tended to respond to calls closer to the coast and the Peterhead all weather lifeboat attended calls further to the north.

There were no incidents responded to by the RNLI within the proposed EOWDC turbine locations between 2000 and 2009.

7.4 Conclusions

Based on the review of incidents, it can be seen that the proposed EOWDC site and its immediate vicinity has experienced a relatively low rate of accidents in recent years. Most incidents in the area have occurred on the coast in and around Aberdeen.

8. MARITIME TRAFFIC SURVEYS

8.1 Introduction

This section summarises the results of the maritime traffic surveys carried out from Girdle Ness Lighthouse in Aberdeen, using a combination of shore-based radar, AIS and visual observations.

Further analysis of survey vessel types according to the DECC Methodology classification (Ref. i) is presented in Appendix B.

8.2 Survey Details

Four 14-day traffic surveys (total of 56 days) were carried out during the following periods:

1. 24 March – 7 April 2009.
2. 21 September – 5 October 2009.
3. 9 April – 23 April 2010.
4. 1 November – 15 November 2010.

(Note: A fifth survey has been carried out between18th February and 4th March 2011 (Ref. ix). Due to it being conducted recently, this has not been fully reported within the NRA but the findings of the survey were well-aligned with the previous four surveys.)

Full details of the survey analyses are presented in separate reports prepared by Anatec (Ref.x, xi, xii, and xiii).

The radar was set up at Girdle Ness Lighthouse (57° 08'.364 N, 2° 02'.916 W) giving good coverage to the north and Aberdeen Bay, including the harbour entrance. The survey location relative to the proposed EOWDC site is shown in Figure 8.1.

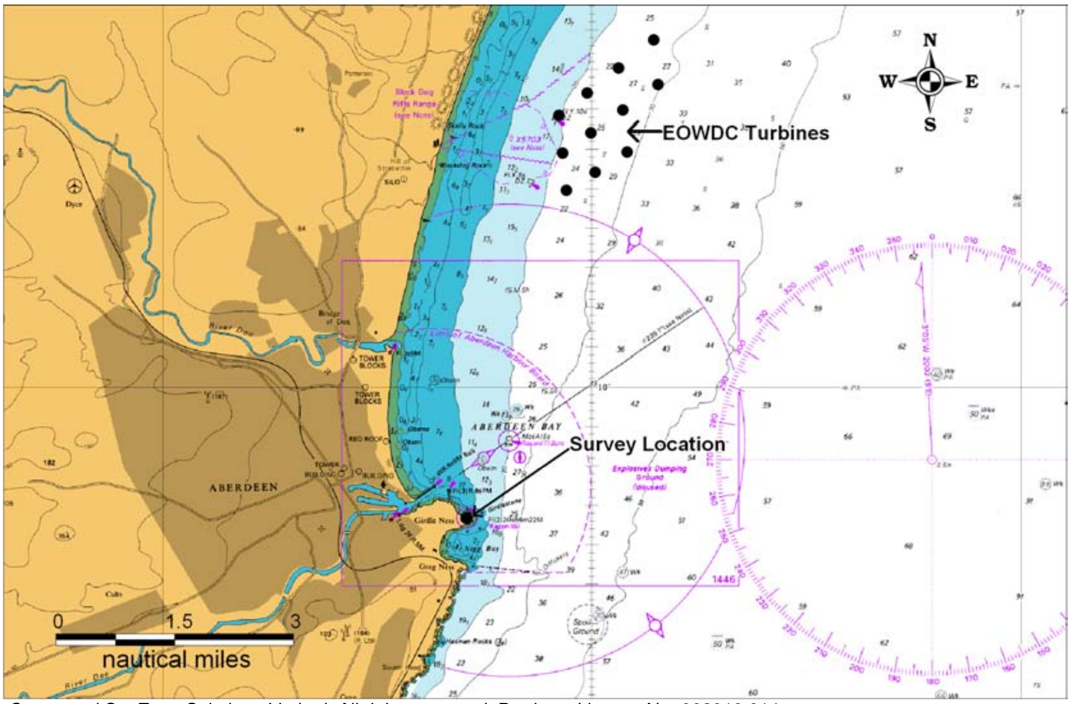


Figure 8.1 Chart Overview of the Survey Location

Figure 8.2 presents the equipment setup at the site.

Figure 8.2 Radar Scanner located next to Girdle Ness Lighthouse

The surveys covered a full range of tidal and weather conditions.

8.3 Survey Analysis

The following filters were applied to the survey data collected in each survey period:

- Removal of tracks more than 20 nm from the survey location.
- Removal of tracks wholly within harbour, i.e., berthed for the entire survey.
- Removal of Aberdeen Harbour pilot vessels.

Plots of the tracks by type recorded on radar and AIS during each fortnight are presented below.

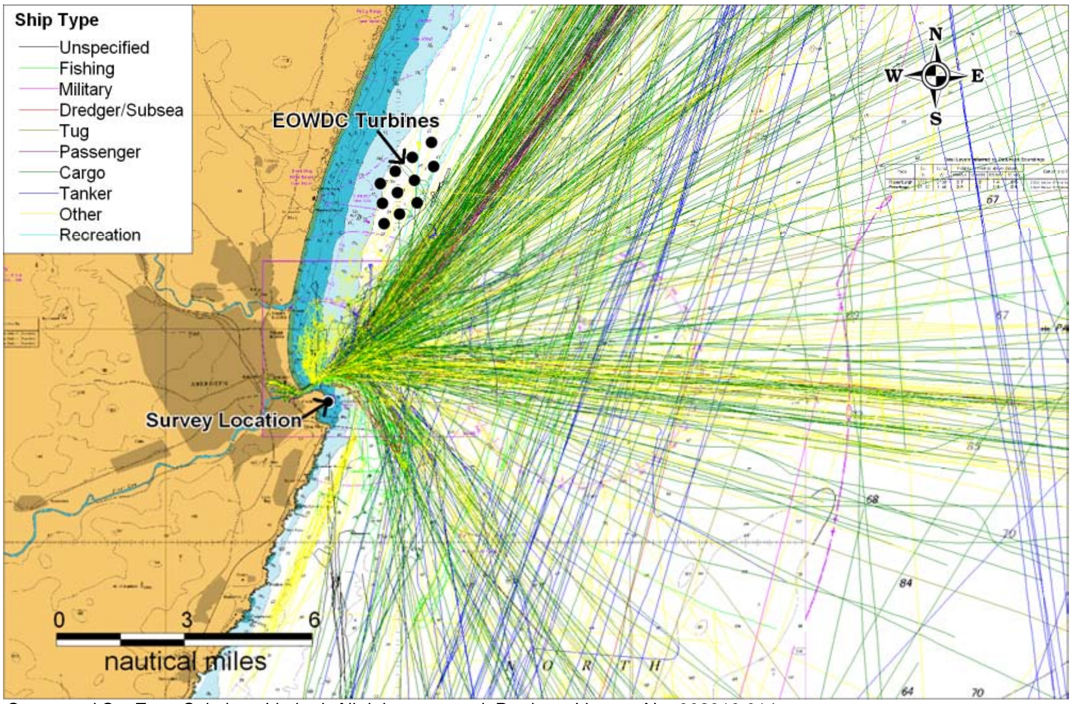


Figure 8.3 Survey 1: 24 March – 7 April 2009 (AIS & Radar tracks)

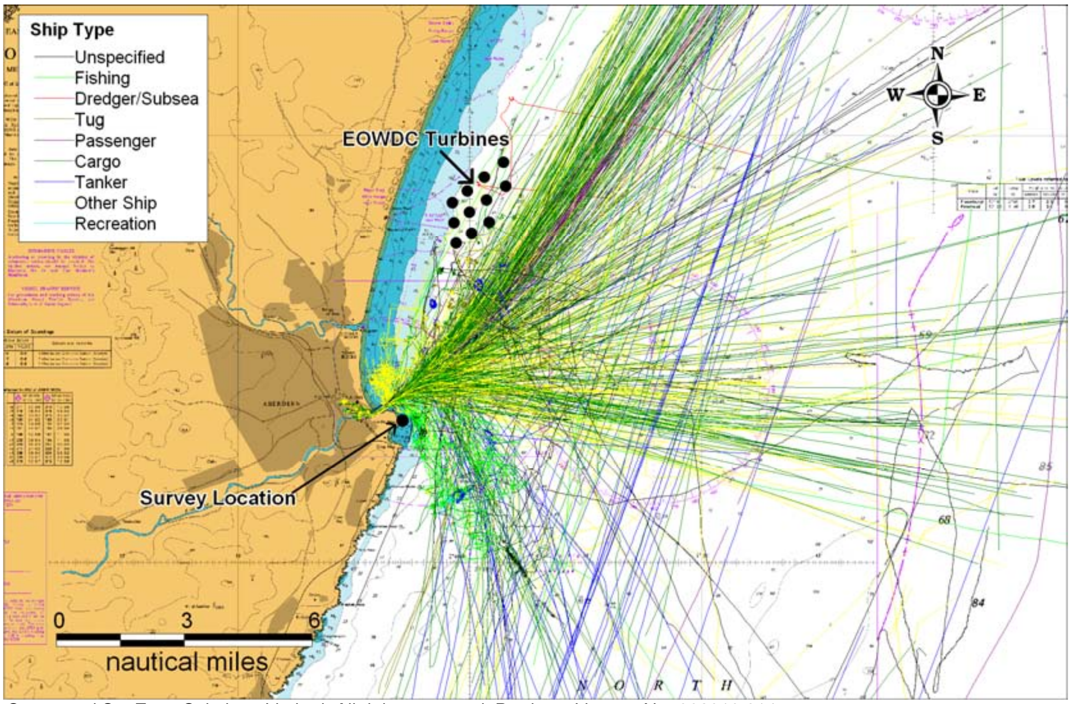


Figure 8.4 Survey 2: 21 September - 5 October 2009 (AIS & Radar tracks)

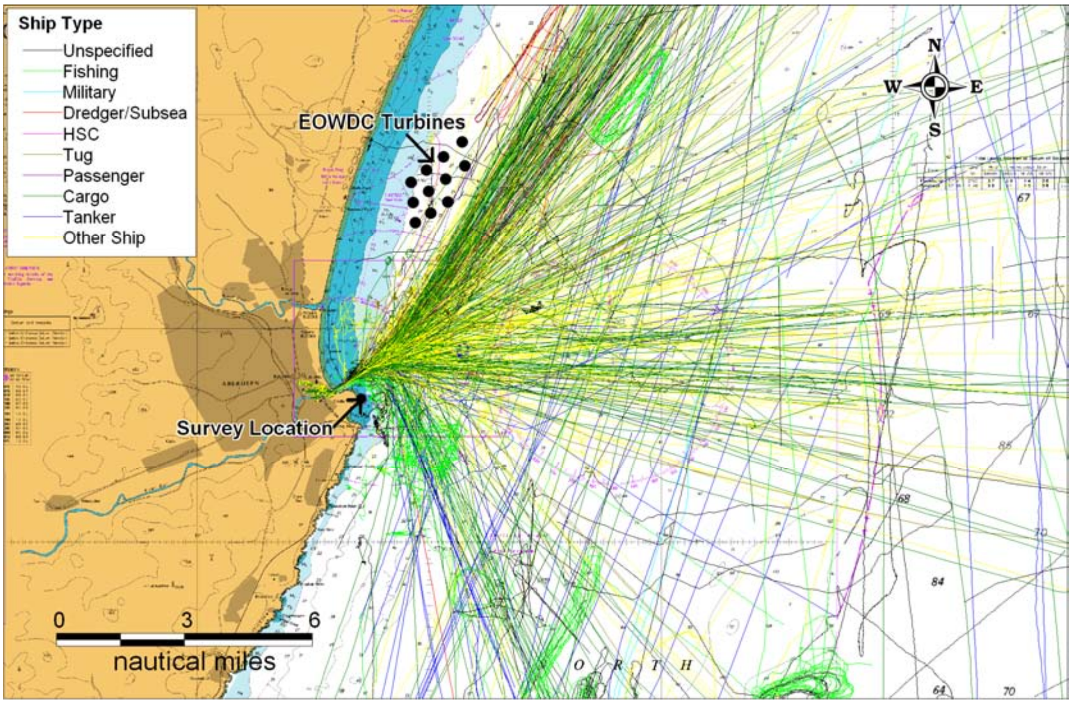


Figure 8.5 Survey 3: 9 April - 23 April 2010 (AIS & Radar tracks)

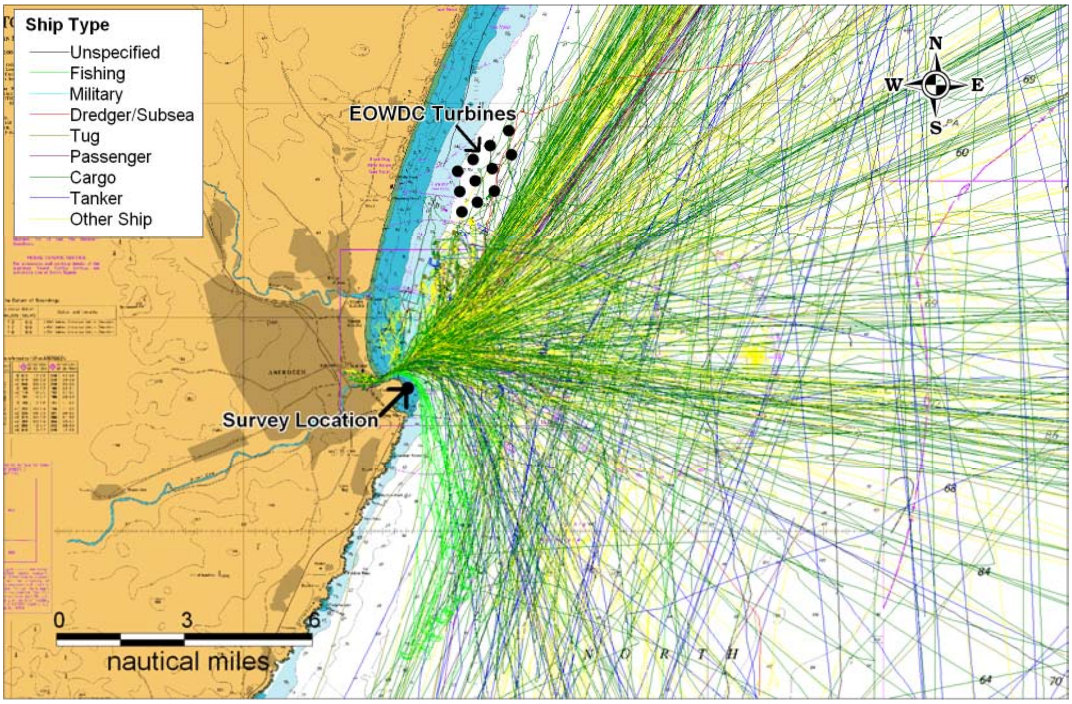


Figure 8.6 Survey 4: 1 November - 15 November 2010 (AIS & Radar tracks)

The number of unique vessels within 20nm of the survey location at Girdle Ness averaged approximately 50-55 vessels per day over the combined 56 days of surveying. The majority of tracks were associated with Aberdeen Harbour with approximately equal numbers inwards and outwards per day.

To put the traffic into a daily context, the tracks recorded on the busiest day during the two most recent surveys are presented below.

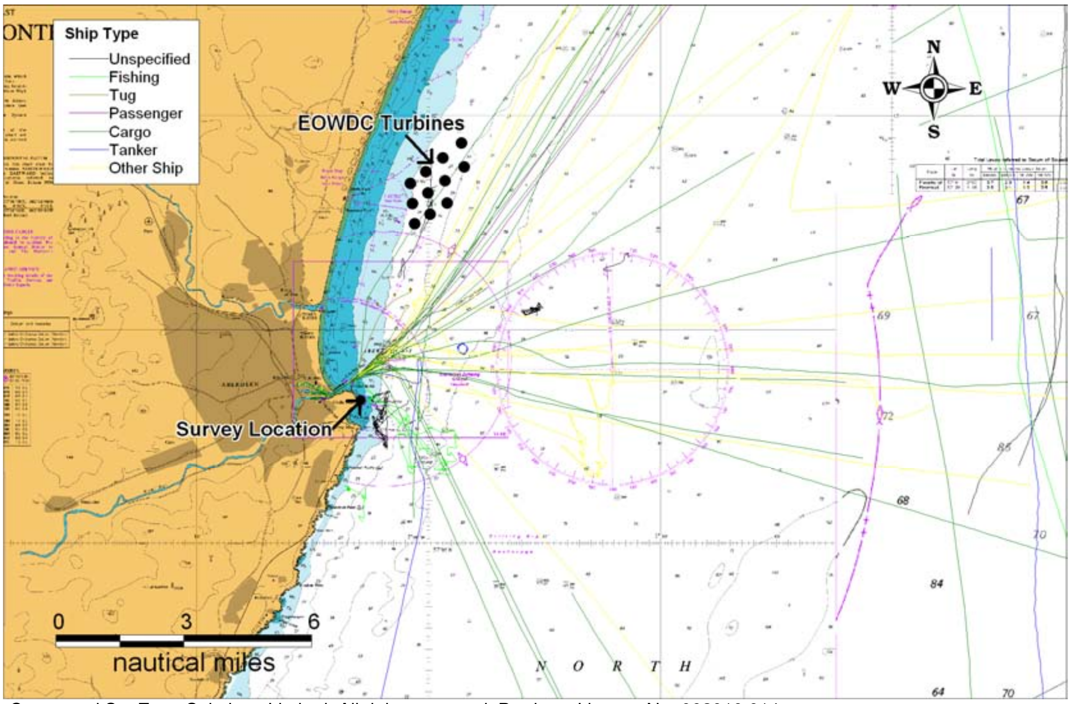


Figure 8.7 Survey 3 Busiest Day – 11 April 2010 (68 Unique Tracks)

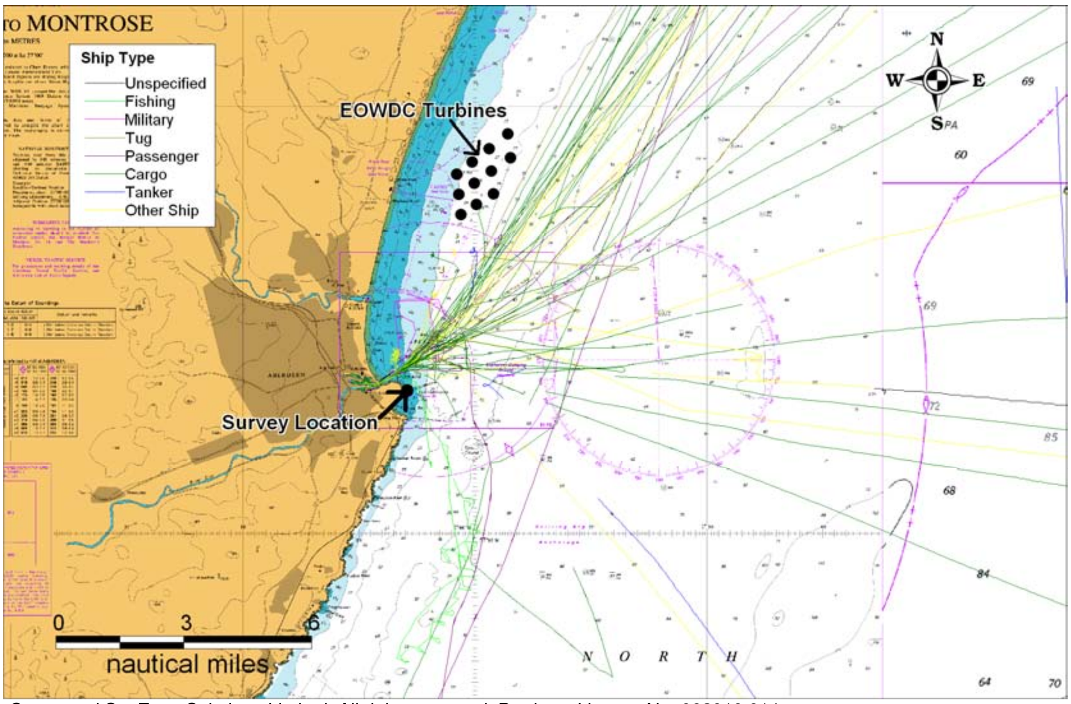


Figure 8.8 Survey 4 Busiest Day –10th November 2010 (74 Unique Tracks)

The breakdown of ships by type for vessels within 20nm of the survey location is presented in Figure 8.9. This considers all vessels recorded during the 56 days of the combined 4 surveys.

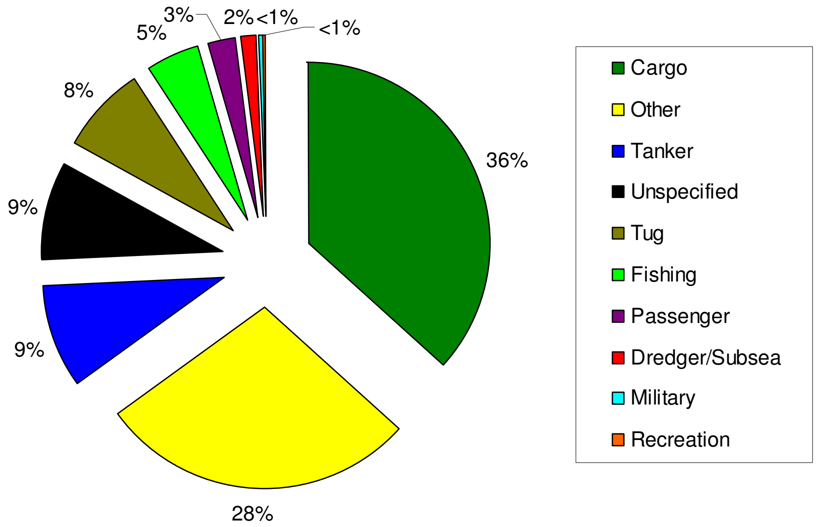


Figure 8.9 Vessel Types identified during the Combined Surveys

The most commonly recorded vessel type during the four surveys was cargo ships (36%) with 'other' vessels the second most commonly tracked (28%). It is noted that a large percentage of both these categories were offshore oil and gas industry related.

The distribution of vessels by draught (excluding unspecified) for the combined 4 surveys is presented in Figure 8.10. It can be seen that the majority of vessels had draughts between 4 and 6 m. Plots of all tracks colour-coded by draught for the two most recent surveys are shown in Figure 8.11 and Figure 8.12.

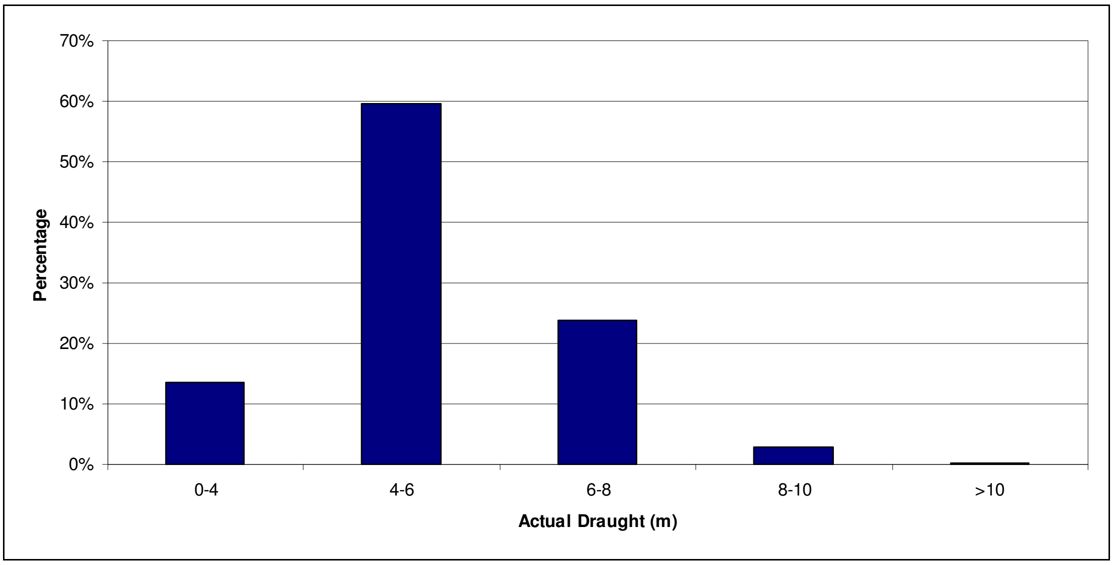


Figure 8.10 Distribution of Vessels by Actual Draught for the Combined 4 Surveys

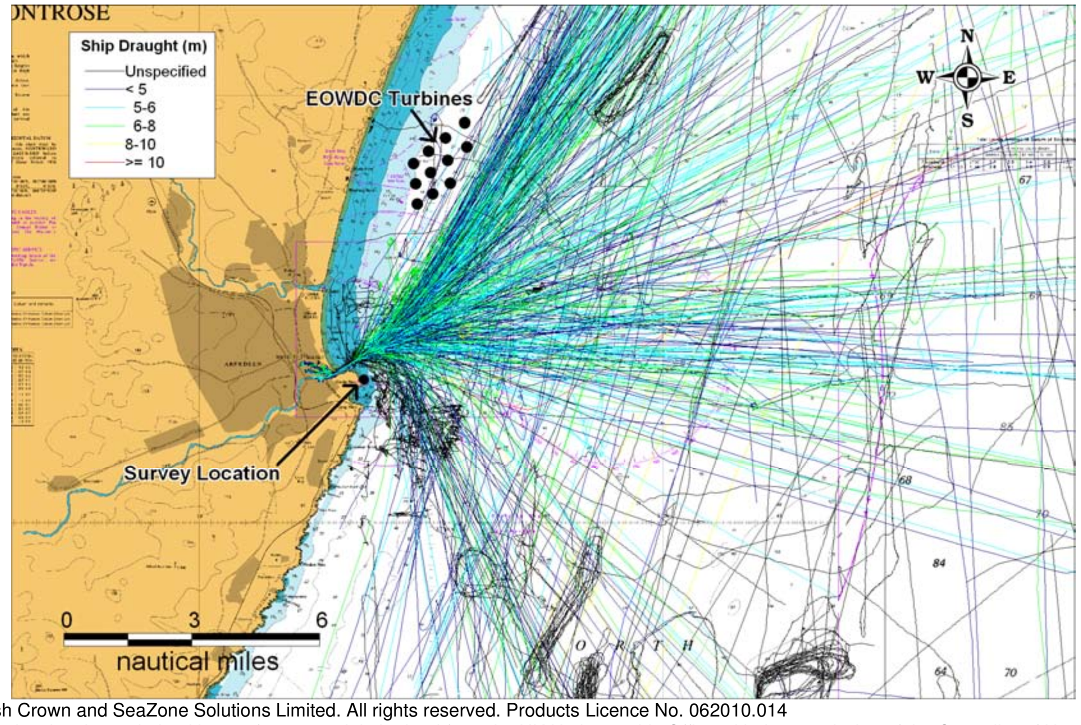


Figure 8.11 Survey 3 Tracks by Ship Draught

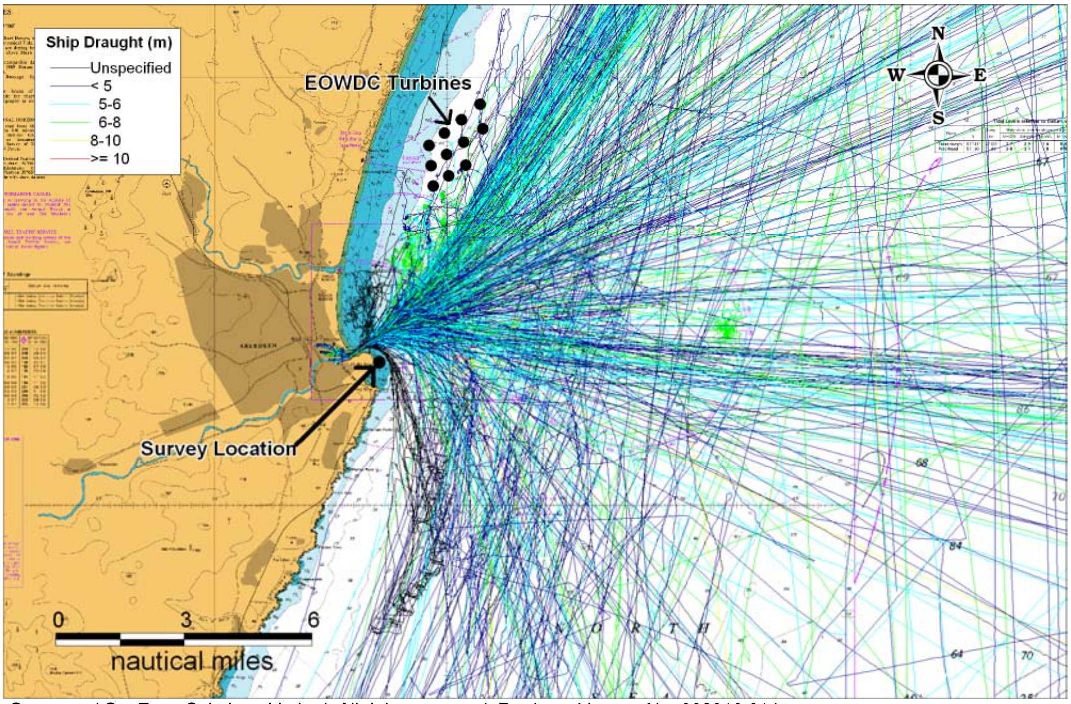


Figure 8.12 Survey 4 Tracks by Ship Draught

The vessel with the deepest draught overall was the shuttle tanker *Navion Fennia* (Figure 8.13) which broadcasted a draught of 11.5m on 10th November 2010 (Survey 4). This vessel approached Aberdeen Bay from the NE, stopping briefly approximately 1.8nm to the east of the survey location before leaving to the SE. It has a deadweight tonnage (DWT) of 95,195 tonnes.

Figure 8.13 Shuttle Tanker *Navion Fennia* (Library Picture)

The distribution of vessels by length (excluding unspecified) for the combined 4 surveys is presented in Figure 8.14. Plots of all tracks colour-coded by length for the two most recent surveys are presented in Figure 8.15 and Figure 8.16. It can be seen that the majority of vessels had lengths between 70 and 90 m.

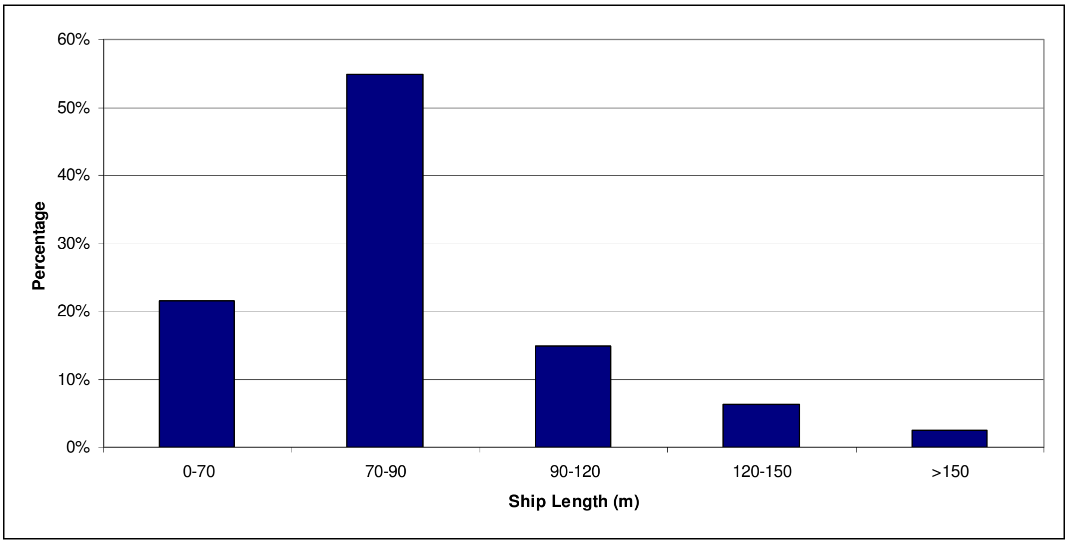


Figure 8.14 Distribution of Vessels by Length for the Combined 4 Surveys

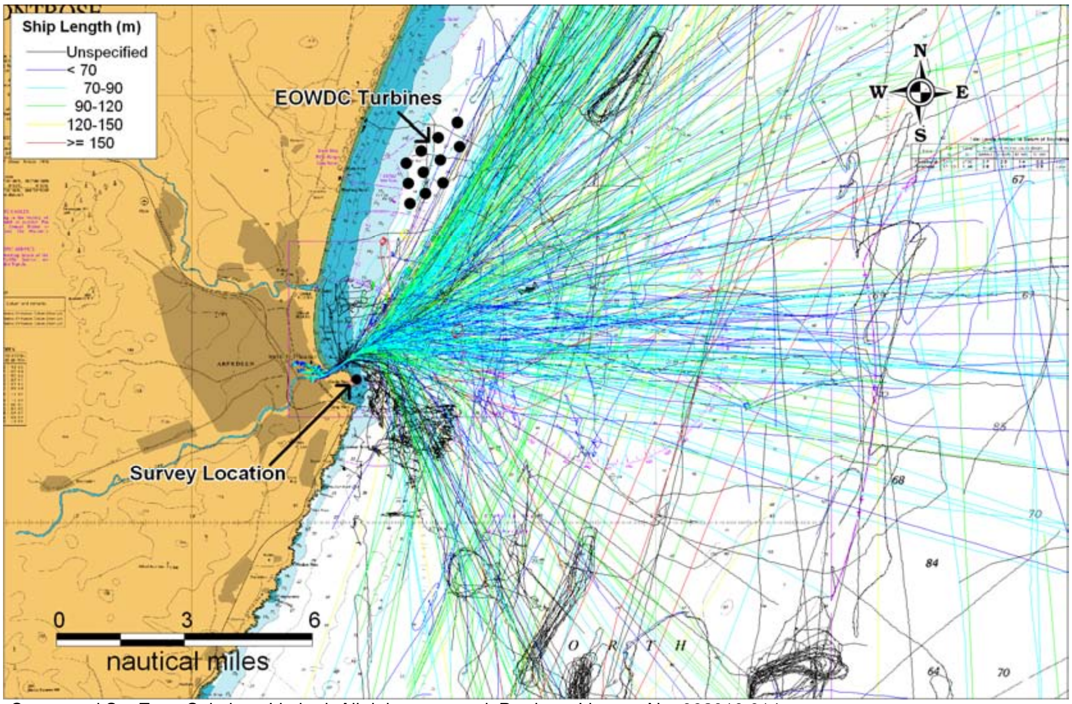


Figure 8.15 Survey 3 Tracks by Ship Length

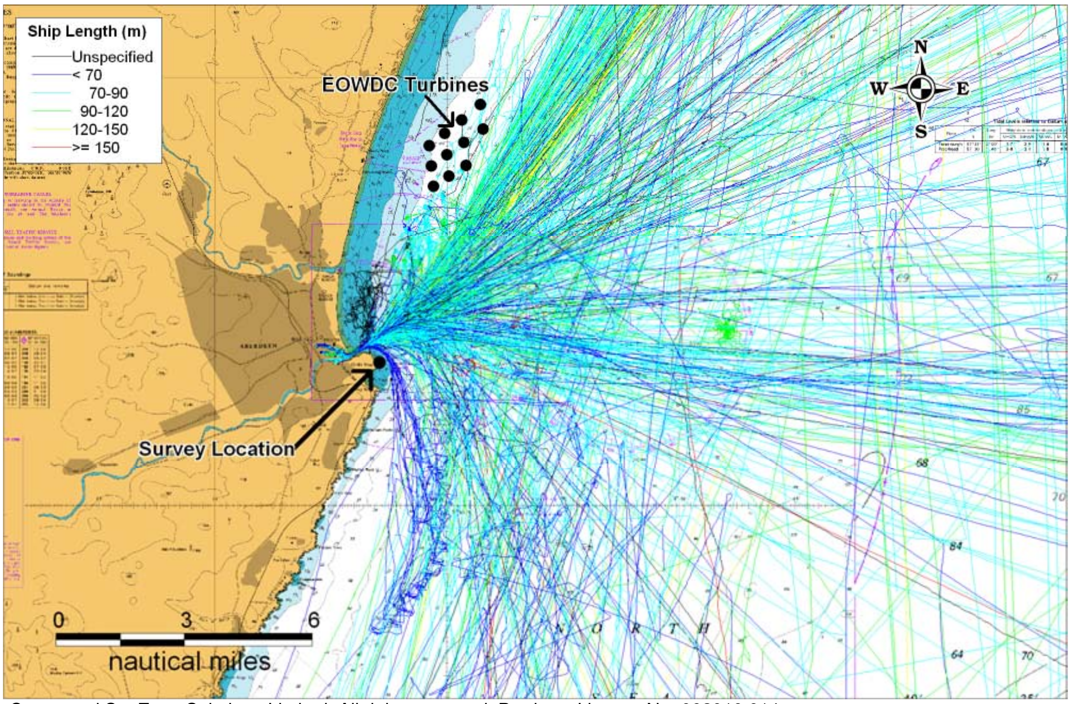


Figure 8.16 Survey 4 Tracks by Ship Length

The longest vessel tracked was the shuttle tanker *Grena* (272m) (Figure 8.17). This vessel anchored for 3 days approximately 1.9nm to the ESE of the survey location before heading to the Captain Oil Field on 23rd September 2009 (Survey 3).

Figure 8.17 Shuttle Tanker *Grena* (Library Picture)

Figure 8.18 presents the distributions of average speed for each of the four surveys.

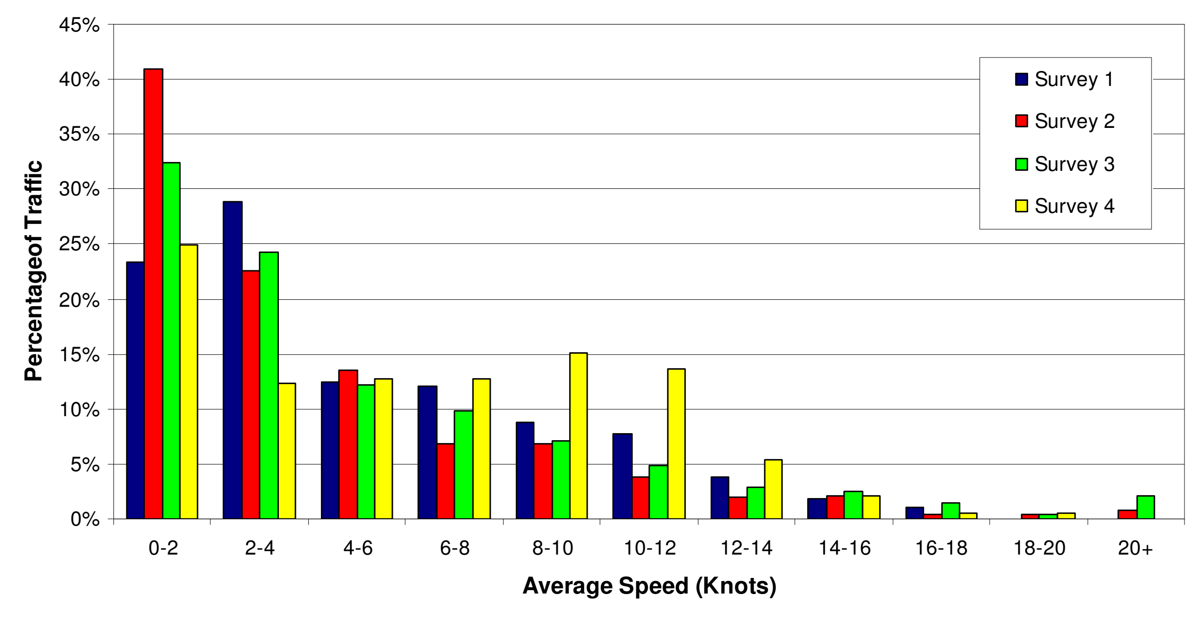


Figure 8.18 Average Speed Distributions for each Survey

The average speeds per survey ranged from 4-6 knots. These relatively low averages can be explained by the large proportion of tracks made by vessels visiting Aberdeen which either were berthed, at anchor or waiting to enter the harbour for part of the tracking period.

Additional analysis indicated the average speed of steaming vessels crossing the Radio Reporting point was 11.7 knots, which reduced to 10 knots crossing the Harbour Limit. At both points the fastest vessels recorded regularly were the NorthLink ferries *Hrossey* and *Hjaltland* travelling at 20-30 knots.

8.4 EOWDC Site-Specific Review

A detailed plot of the 56 days survey tracks passing the proposed EOWDC turbines is presented in Figure 8.19.

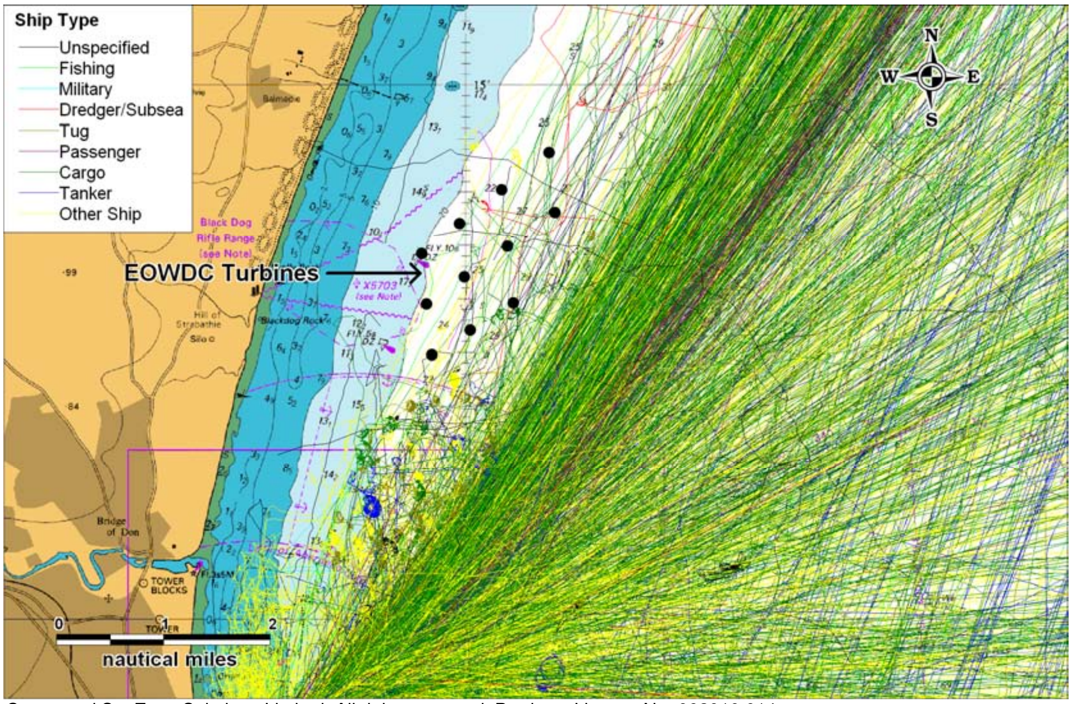


Figure 8.19 Detailed Plot of the Combined 4 Surveys Tracks Passing the Site

In the following figures the plots of vessel tracks passing close to the turbines are broken down into individual types with the following vessel types considered:

- Tankers (Figure 8.20)
- Passenger Ships (Figure 8.21)
- Offshore Oil and Gas Vessels (consisting mainly of cargo and 'other' ships on AIS) (Figure 8.23)

The closest passing tanker to the proposed turbines was the chemical/products tanker *Brovig Bora* recorded approximately 0.2nm from turbine 10 on 2 November 2010 travelling southbound.

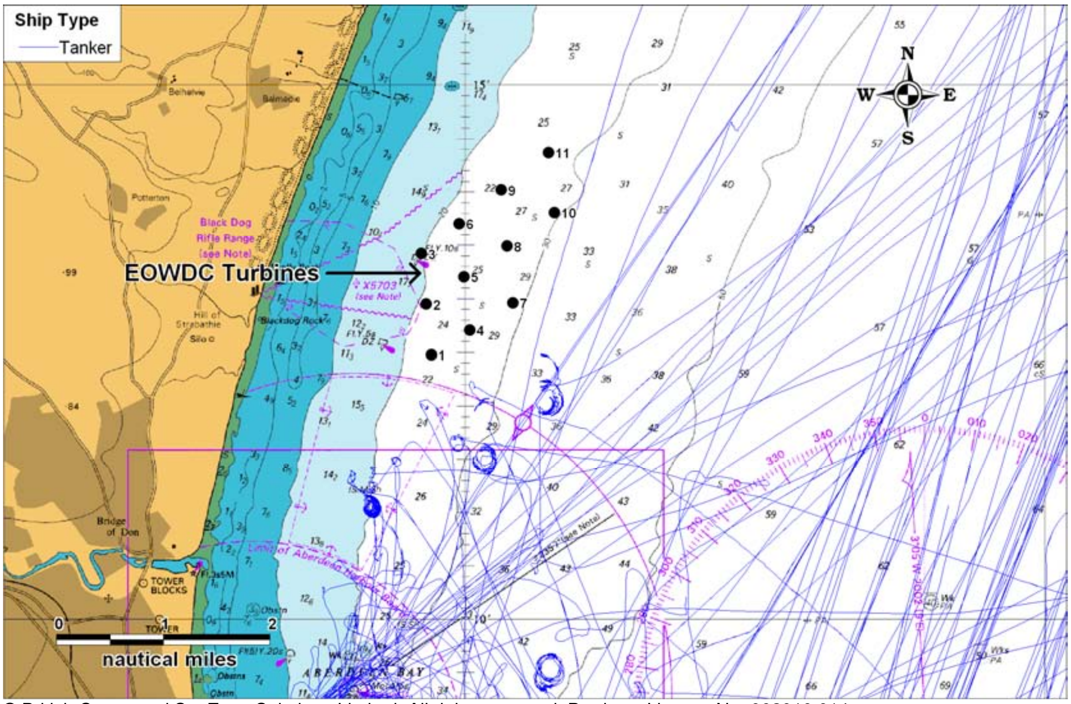


Figure 8.20 Plot of Tanker Tracks Passing Close to the Proposed Turbines

The vast majority of the passenger ships were the NorthLink ferries *Hrossey* and *Hjaltland* between Aberdeen and Orkney/Shetland. A photograph of *Hjaltland* during Survey 4 is presented in Figure 8.22. There was one instance of *Hrossey* passing within 100m of the proposed turbine 7 on 15 April 2010 but generally the vessels pass at least 0.6nm to the east of the proposed turbines with an average Closest Point of Approach (CPA) of 1.3nm.

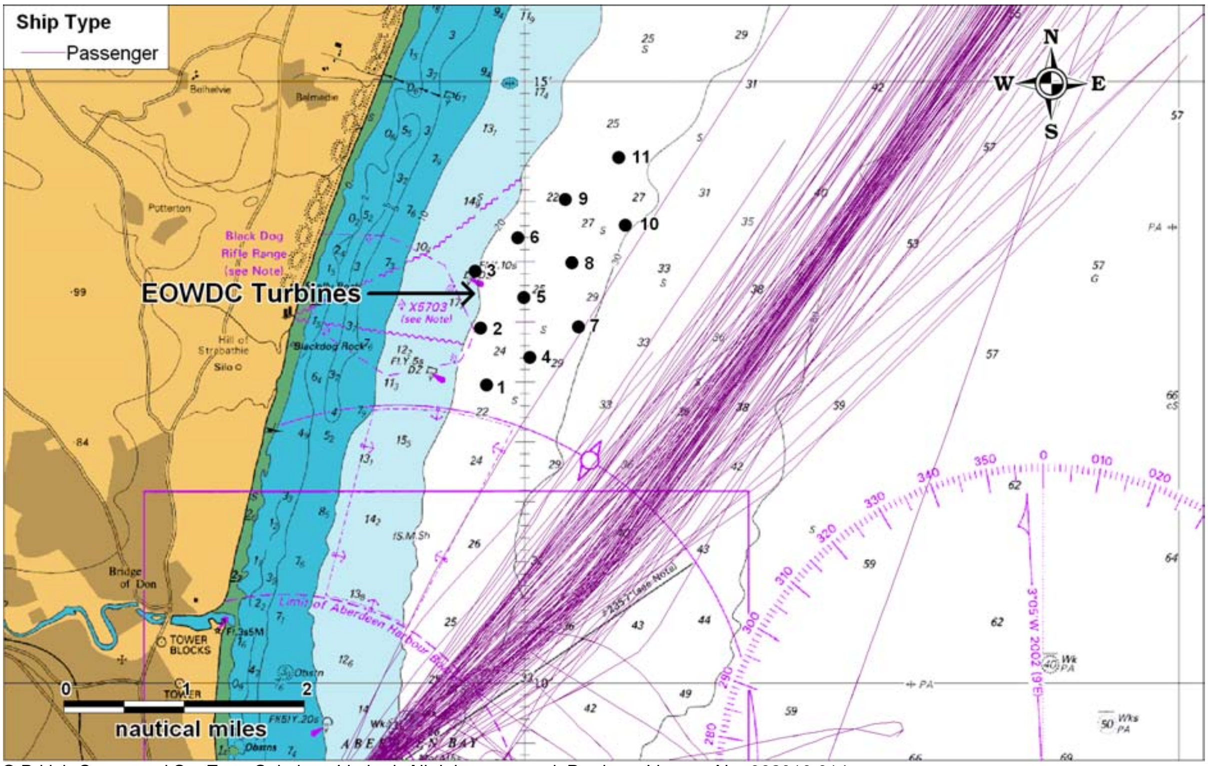


Figure 8.21 Plot of Passenger Ships Passing close to the Proposed Turbines

Figure 8.22 Picture of the passenger ferry *Hjaltland* during Survey 4

A small proportion of offshore oil and gas industry vessels passed through the proposed turbine locations, with the vast majority passing to the east.

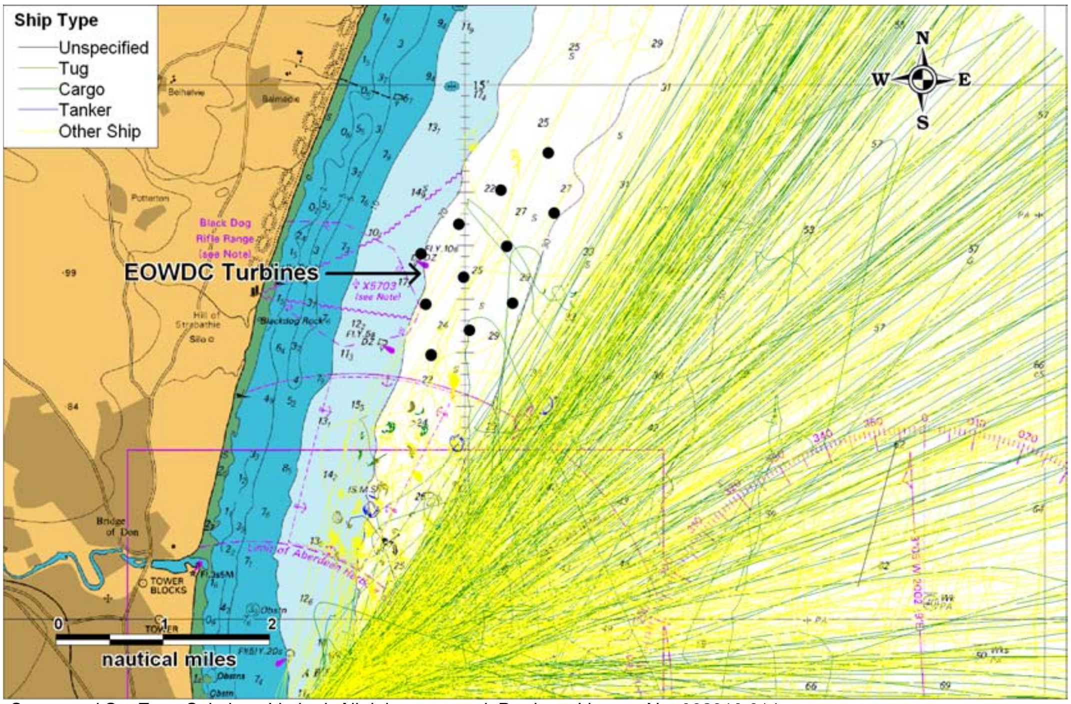


Figure 8.23 Plot of Offshore Industry Vessels passing close to the Proposed Turbines

Figure 8.24 presents the tracks of all vessels which were identified to pass within the proposed turbine locations during the combined 56-day survey period.

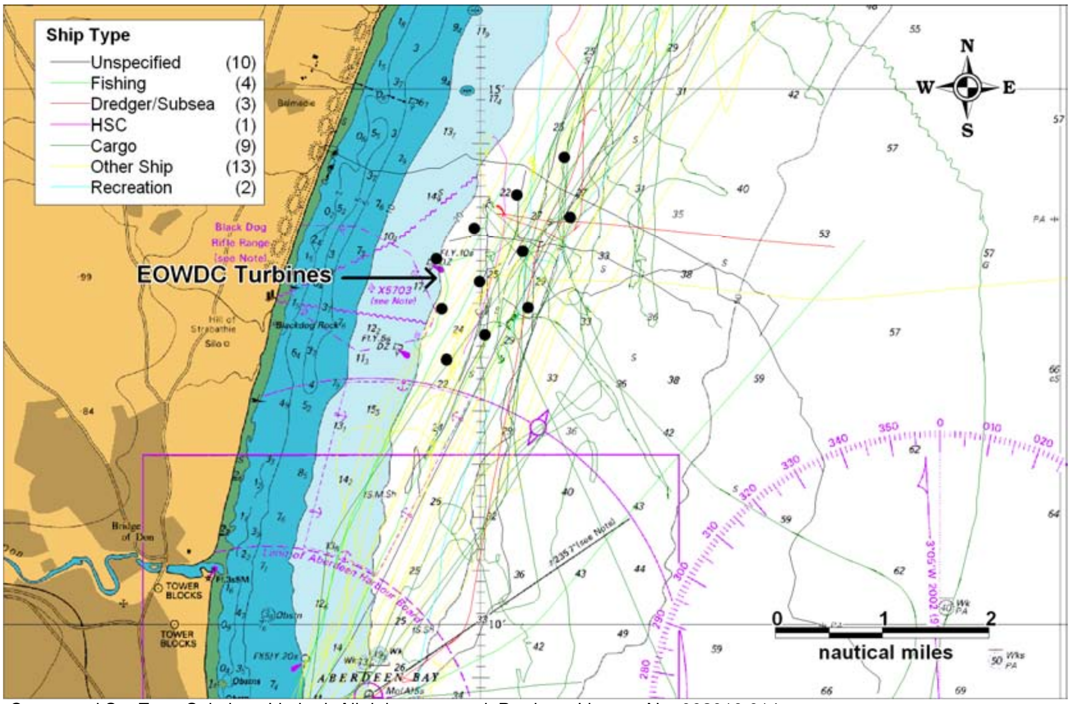


Figure 8.24 Tracks passing within EOWDC Site (All Surveys)

A total of 42 tracks were identified to pass within the proposed turbine locations during the four surveys, corresponding to an average of less than one per day. Excluding unspecified vessels (mainly radar targets which were not identified visually), the most common types of ship passing through the area were 'other' and cargo ships, a large portion of which were offshore industry related.

The traffic on passage through the site was mainly heading in a NNE-SSW direction. Details of the 26 vessels tracked on AIS through the site are given in Table 8.1.

Table 8.1 Details of Merchant Vessels Intersecting EOWDC Site on AIS

Ship Name	Type	Length (m)	Destination	Survey	Tracks
Aberdonian	Other	45	Aberdeen	1	1
Amanda	Cargo	81	Aberdeen	3	1
ARRC03	Other	19	Miller	3	1
Balityskiy-202	Cargo	90	Klaipeda (Lithuania) / Peterhead	3	1
Dea Pilot	Other	11	Aberdeen Bay	1	1
Dea Searcher	Cargo	11	Aberdeen	1	1
Geobay	Dredging	88	Aberdeen	4	1
Grampian Defender	Other	47	J.W. McLean	2	1

Ship Name	Type	Length (m)	Destination	Survey	Tracks
Grampian Frontier	Other	61	Aberdeen	3	1
Havila Fortress	Cargo	83	Aberdeen	4	1
Hellespont Dione	Cargo	73	Aberdeen	4	2
Island Express	Cargo	77	Elgin	1	1
M.V. Skandi Falcon	Other	82	Aberdeen	4	1
North Fortune	Cargo	80	Aberdeen	3	1
Ocean Clever	Other	73	Aberdeen	1 & 3	2
Ocean Seeker	Dredging	Unspecified	Phylis	2	2
Onward BF440	Fishing	25	Unspecified	2 & 4	2
Skagerak	Unspecified	17	Whitehaven	2	1
Toisa Coral	Cargo	73	Aberdeen	4	1
VOS Lismore	Other	54	Buzzard	2	1
VOS Mariner	Other	53	Aberdeen	1 & 3	2

The table above shows that in terms of AIS-equipped ships, no vessels passed through the site on more than two occasions with only 5 vessels passing more than once. The majority of vessels passing through the site were offshore oil and gas industry related vessels travelling to and from Aberdeen. The number of vessels on AIS intersecting the site for each survey was similar with 6 vessels intersecting in Surveys 1 and 2 and 7 vessels intersecting in Surveys 3 and 4.

Sixteen tracks were recorded on radar passing within EOWDC turbine locations during the 4 surveys. Details of these are provided, where available, in the fishing and recreation sections.

8.5 Detailed Analysis of Main Shipping Lane

The main shipping lane in closest proximity to the proposed EOWDC site is the NE-SW lane to/from Aberdeen Harbour. The AIS tracks using this lane during the surveys have been isolated for analysis.

Figure 8.25 presents the aforementioned shipping lane tracks colour-coded by ship type and Figure 8.26 shows the percentage distribution of these tracks.

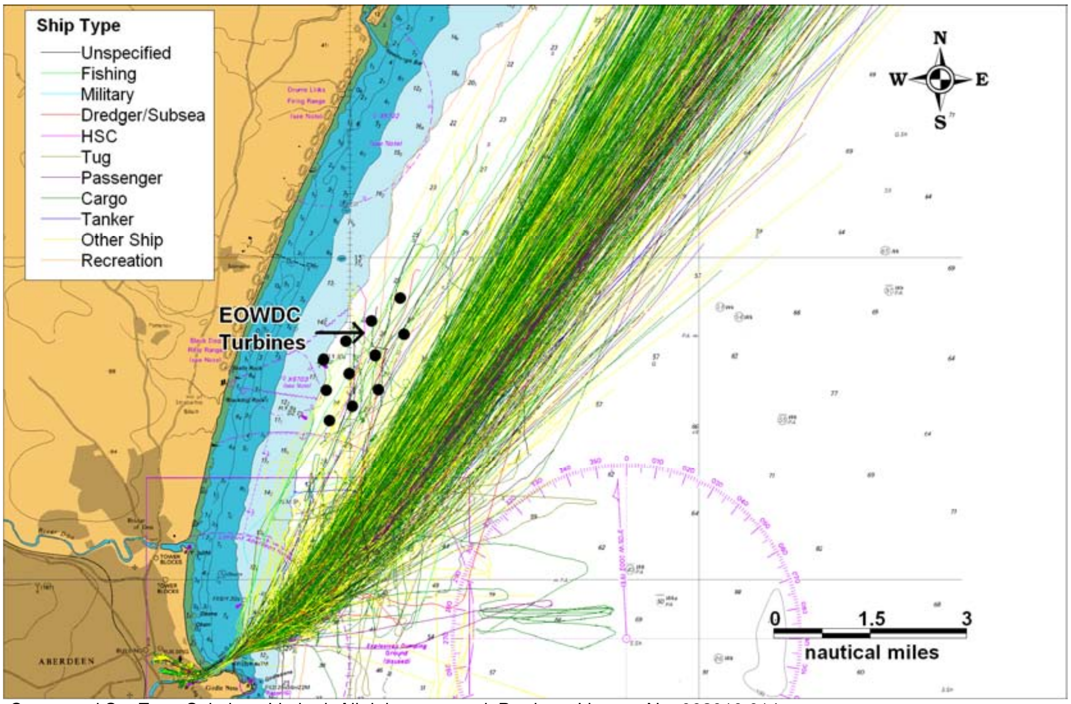


Figure 8.25 Tracks by Type on NE-SW Shipping Lane

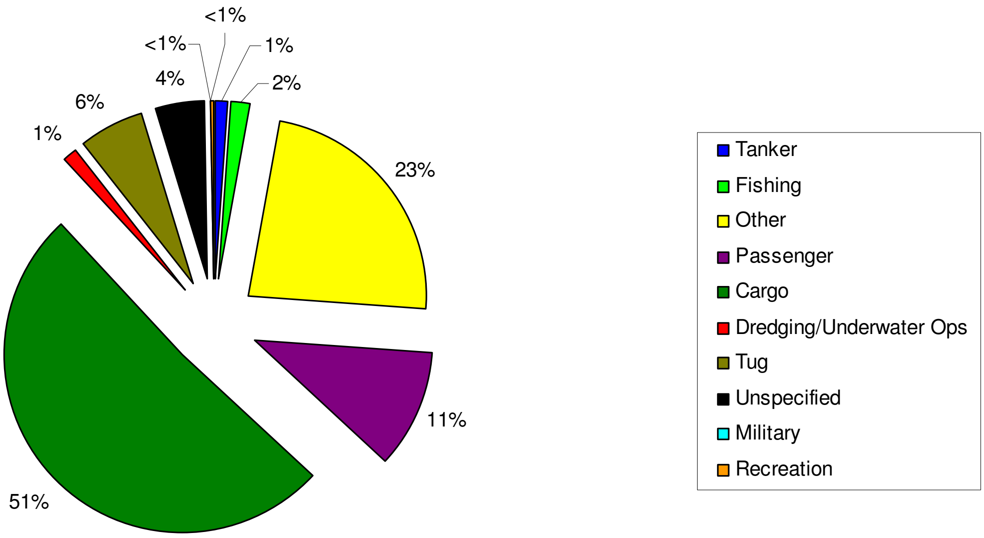


Figure 8.26 Distribution of Vessel Types Recorded on the NE-SW Shipping Lane

During the surveys there was an average of 12 to 13 ships per day using the lane, with offshore industry vessels (cargo and other) the most frequent users.

The tracks are analysed in more detail in Figure 8.27 to Figure 8.29.

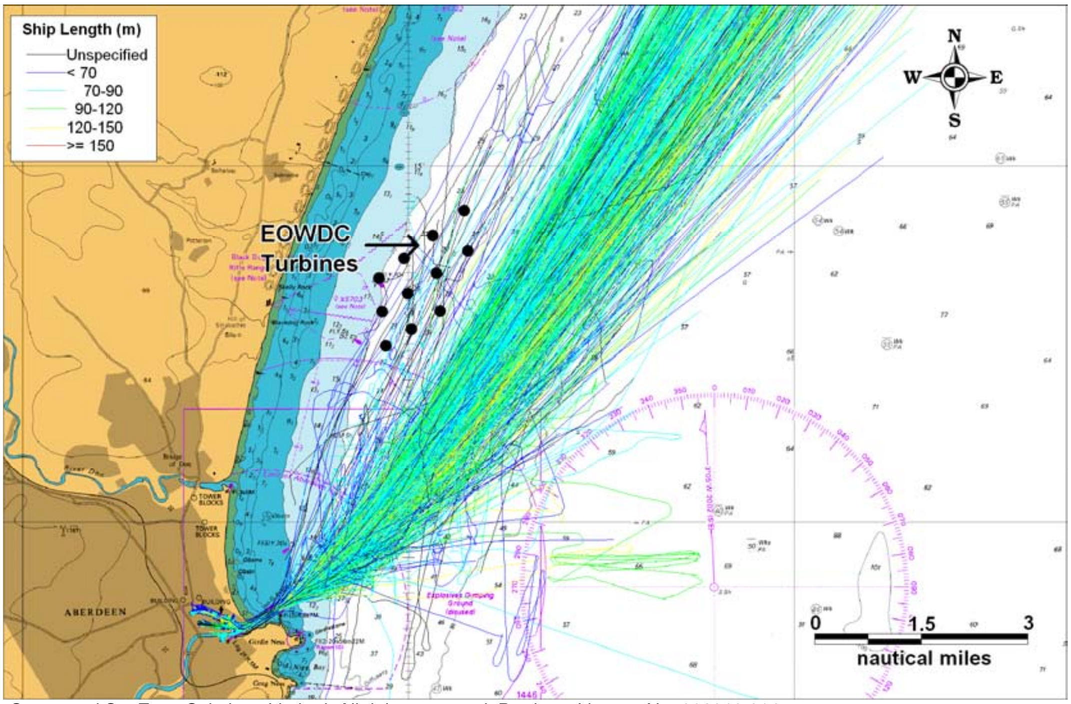


Figure 8.27 Tracks by Ship Length on NE-SW Route

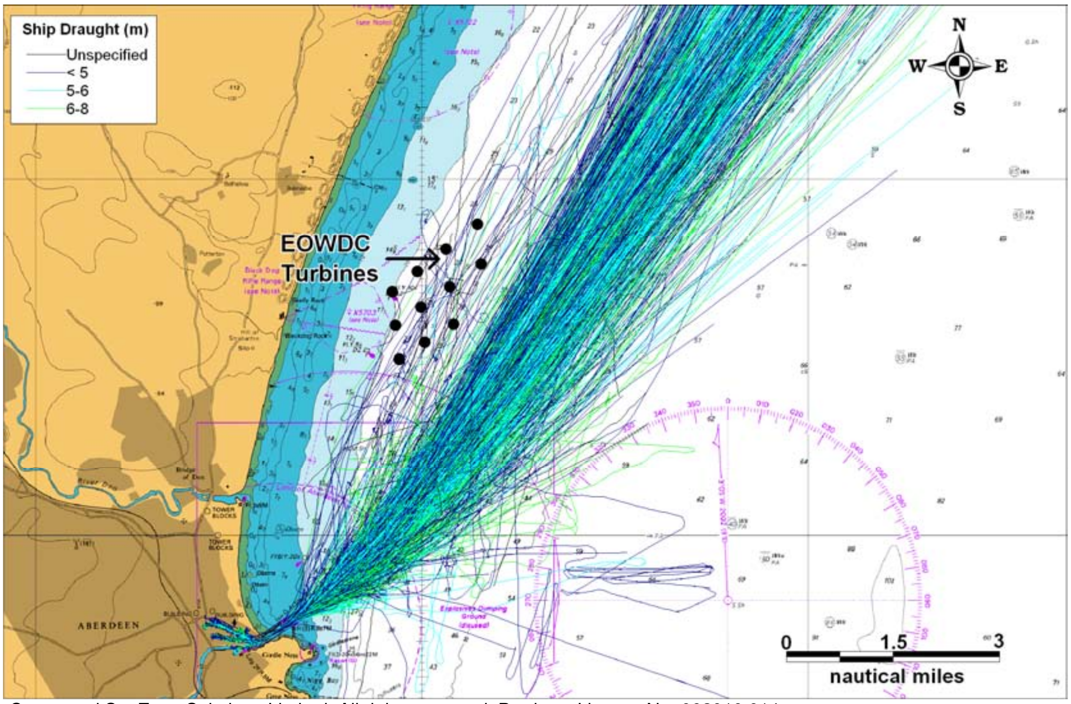


Figure 8.28 Tracks by Ship Draught on NE-SW Route

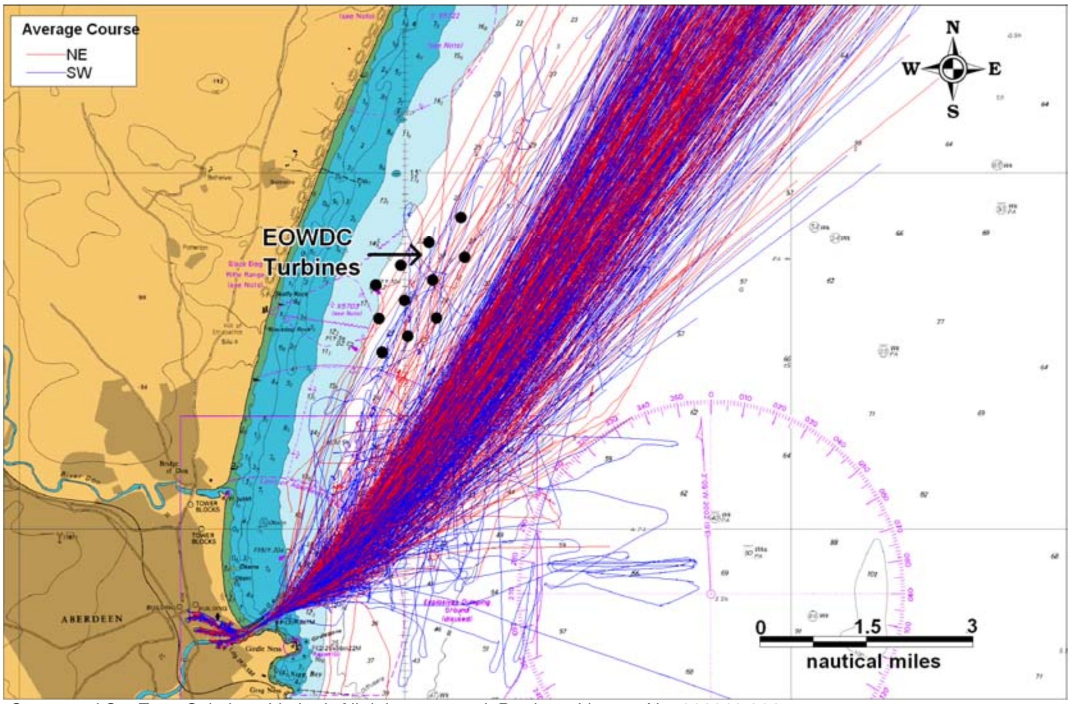


Figure 8.29 Tracks by Average Course on NE-SW Route

Approximately 52% of vessels on the NE-SW shipping lane were travelling NE, while 48% of vessels were heading SW.

8.6 Anchored Vessels

The positions of vessels at anchor recorded during the four surveys are presented in Figure 8.30 to Figure 8.33.

Between Survey 3 and Survey 4, a charted anchorage area was designated off Aberdeen.

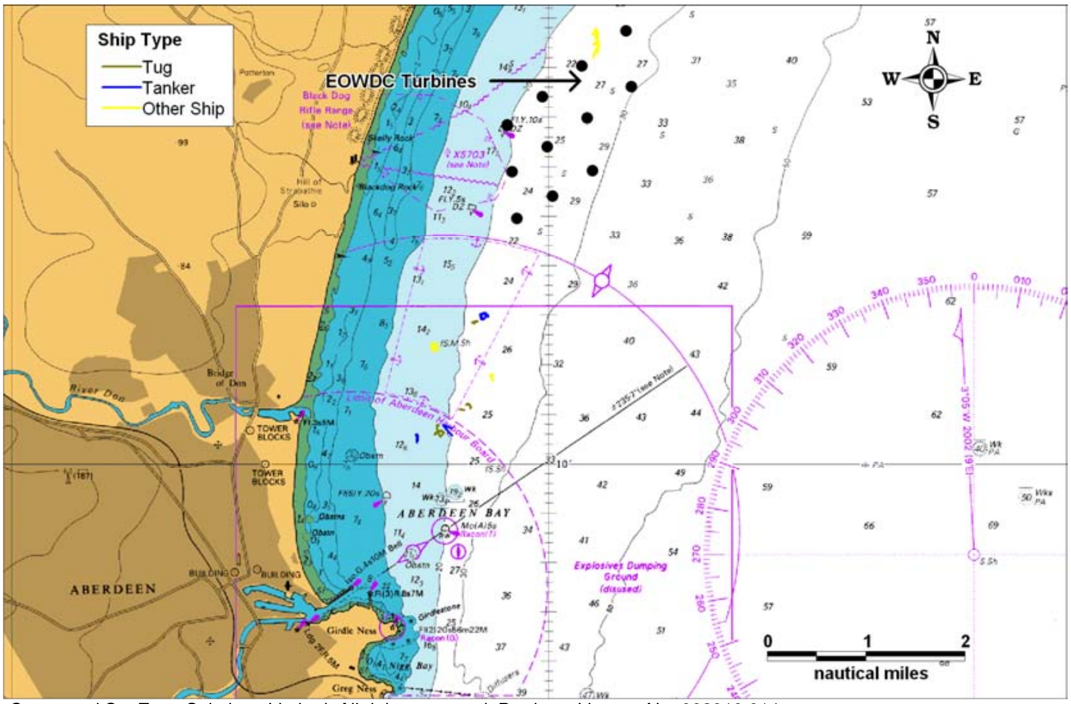


Figure 8.30 Anchored Vessels during Survey 1 (prior to anchorage area being designated)

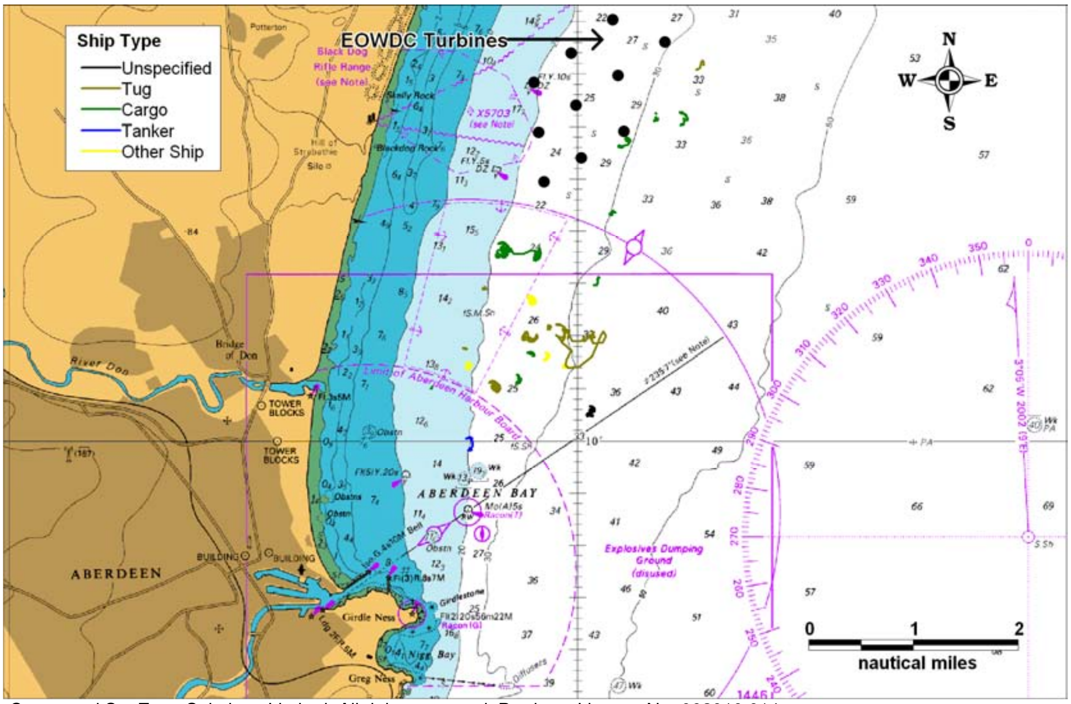


Figure 8.31 Anchored Vessels during Survey 2 (<u>prior to anchorage area being designated)</u>

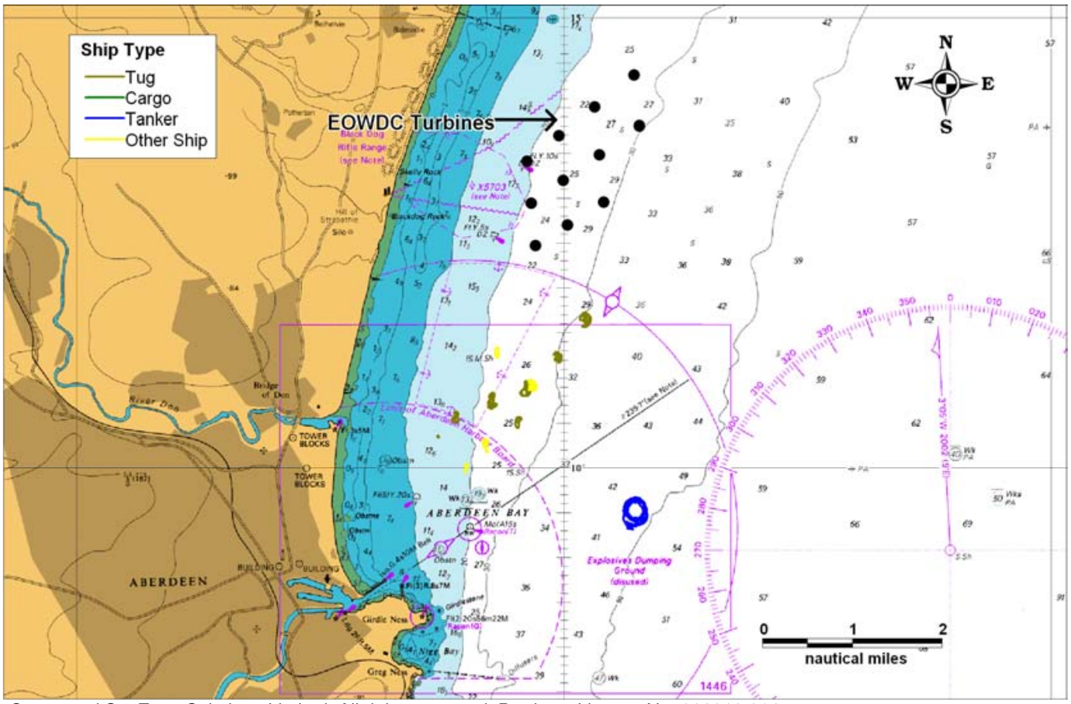


Figure 8.32 Anchored Vessels during Survey 3 (prior to anchorage area being designated)

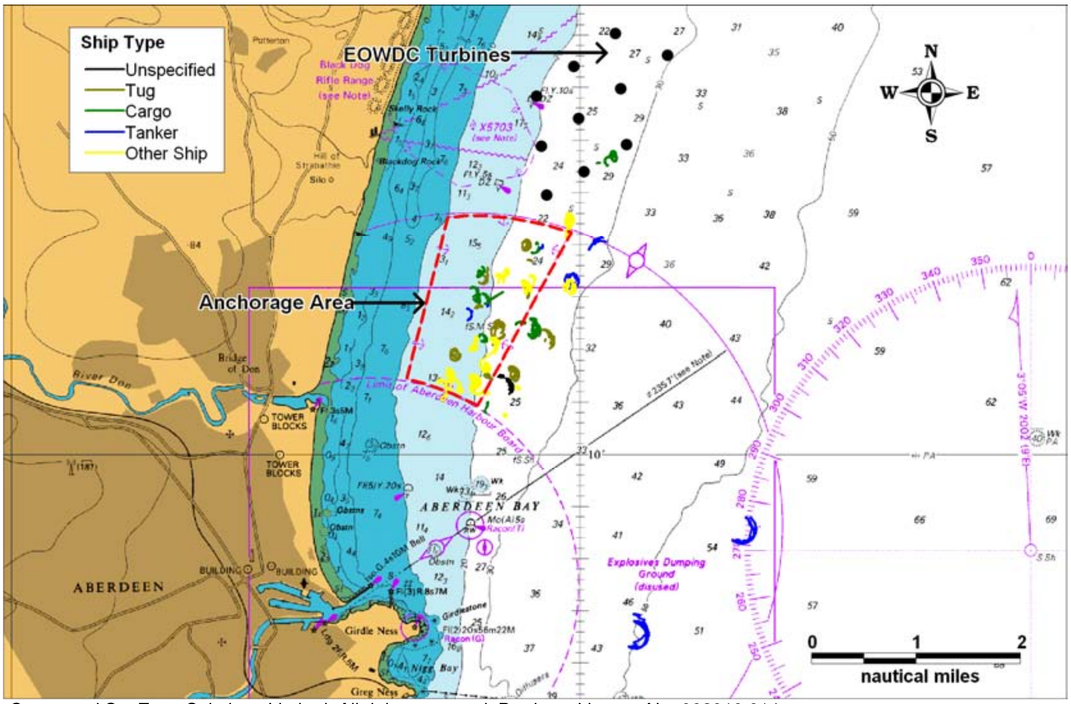


Figure 8.33 Anchored Vessels during Survey 4 (with Charted Anchorage Area shown in red)

There were 10, 29, 20 and 37 vessels observed at anchor during Surveys 1-4, respectively. During part of Survey 4, Aberdeen Harbour was experiencing high winds and pilotage ceased for a period, leading to the higher number of vessels at anchor.

It can be seen from the above figures that most masters have responded to the introduction of the charted anchorage area by anchoring within or close to the designated area. Two cargo vessels anchored for a short time within the EOWDC turbine locations during Survey 4 before entering Aberdeen Harbour. (The fifth survey carried out in 2011 showed most vessels were using the charted anchorage area – see Figure 13.10.)

More detailed analysis of anchoring practices in Aberdeen using long-term data is presented in Appendix C.

9. IMPACT ON COMMERCIAL SHIPPING NAVIGATION

9.1 Passing Ships

Based on the analysis of the shipping survey data presented in Section 8, it is considered that the proposed EOWDC site will not significantly affect passing ships not bound to or from Aberdeen Harbour as they mostly pass well to the east of the proposed EOWDC site (generally at least 3nm away).

In terms of Aberdeen traffic, the majority of traffic also passes well clear of the proposed EOWDC site (i.e., shipping lanes to the east and south of Aberdeen). The only route that will be partly affected is the NE-SW shipping lane to/from Aberdeen. Approximately 12 to 13 vessels per day use this route on average, the majority of which are associated with the oil & gas industry. The current position of this traffic lane is analysed in Section 8.5. A small proportion of tracks currently pass through the site but the vast majority pass to the east, with a Closest Point of Approach (CPA) of approximately 1.1nm from the nearest proposed turbine location. The CPA distribution for these vessels (excluding vessels passing through the turbine perimeter) is presented in Figure 9.1.

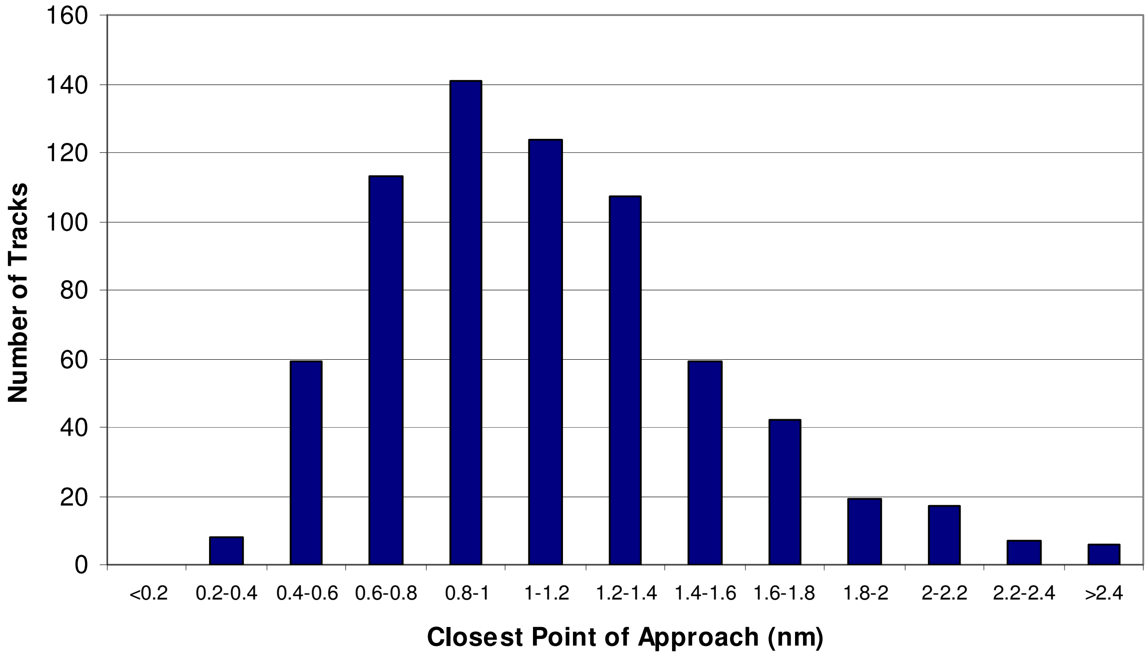


Figure 9.1 CPA Distribution for Vessels travelling on the NE-SW Shipping Lane

The MCA has published draft "Guidance to Mariners Operating in the Vicinity of UK Offshore Renewable Energy Installations (OREIs)". It does not provide guidance on a safe distance at which to pass, as this depends upon individual vessels and conditions, but states that:

> *"In planning a voyage mariners must assess all hazards and associated risks. The proximity of wind farms and turbines should be included in this assessment. "*

Based on experience at other sites, the introduction of the proposed EOWDC is not expected to affect the majority of the NE shipping lane although vessels currently passing near the site are likely to shift to the east, which will result in an increased mean passing distance of approximately 1.5nm. There is sufficient sea room for vessels to make this change. The route is also expected to narrow slightly.

An average track estimated to be taken by a NE/SW vessel prior to the construction of the proposed EOWDC is presented in Figure 9.2. This was calculated by finding the average position of tracks currently using the NE-SW shipping lane. The anticipated deviation is also shown in the chart.

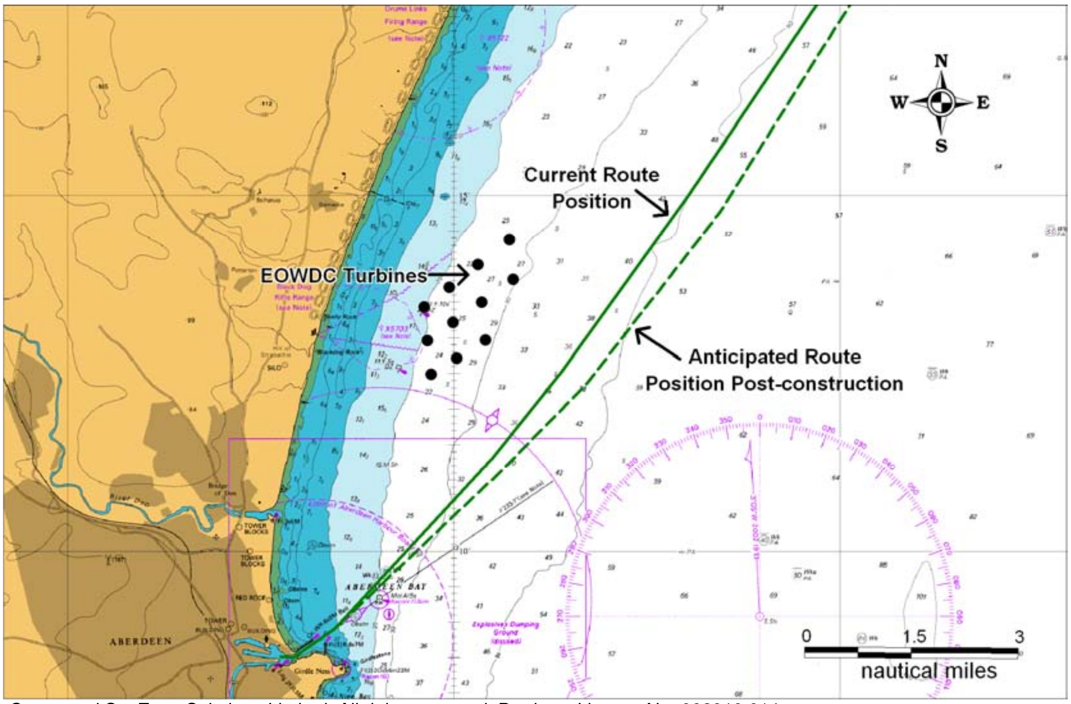


Figure 9.2 Current and Anticipated NE-SW Mean Route Position

The risks associated with the shipping changes anticipated due to the proposed project have been quantified as part of the Formal Safety Assessment (see Sections 12 and 13). The proposed EOWDC may also have an affect on marine radar. This potential impact is discussed in Section 15.

9.2 Anchored Ships

From the maritime surveys it was observed that vessels frequently anchor in Aberdeen Bay. This may be for a number of reasons, such as their intended berth being occupied, awaiting the tide or lack of space in the harbour.

A detailed analysis of anchoring data for Aberdeen Bay, including a review of one-year of AIS data (see Appendix C), was conducted. Following this, discussions with the port and other maritime stakeholders, such as via the MSF, were conducted.

It was identified that the previous turbine locations would have significantly reduced the sea room available for anchored vessels in Aberdeen Bay. Therefore, in consultation with stakeholders, the site has been relocated to the north and reduced in size. Separate to this, an anchorage area has been designated and charted in Aberdeen Bay. This has an area of 1.6nm^2 and its closest limit is 0.25 nautical miles from the nearest turbine (see Section 6.3.4).

Based on these actions, it is considered that following the EOWDC installation there will be sufficient sea room available for the levels of anchoring experienced in the Aberdeen Bay area, as identified in the long-term survey data analysis.

10. RECREATIONAL VESSEL ACTIVITY

10.1 Introduction

This section reviews recreational vessel activity at the EOWDC site based on information published by the Royal Yachting Association (RYA) and radar tracking of recreational vessels during the maritime traffic surveys.

10.2 RYA Data

10.2.1 Introduction

The RYA, supported by the Cruising Association (CA), have identified recreational cruising routes, general sailing and racing areas around the UK in the Coastal Atlas (Ref. xiv). This work was based on extensive consultation and qualitative data collection from RYA and CA members, through the organisations' specialist and regional committees and through the RYA affiliated clubs. The consultation was also sent to berth holder associations and marinas.

10.2.2 Aberdeen Area Recreational Data

A summary plot of the recreational sailing activity and facilities in the Aberdeen area is presented in Figure 10.1.

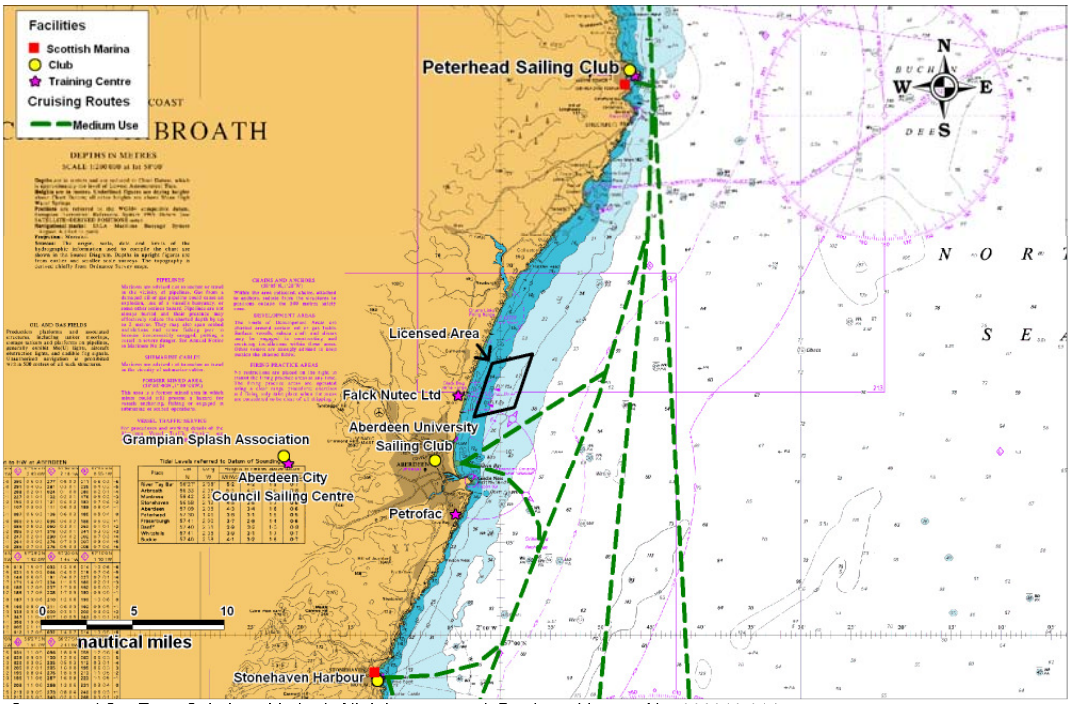


Figure 10.1 Recreational Information for the Aberdeen Area

Based on the RYA published data, the site is close to a few medium-use[1] RYA sailing routes, with the closest indicated route passing approximately 1.7nm to the south of the EOWDC site.

In terms of facilities, there are a few clubs and training centres for recreational vessels located on the coast around Aberdeen. The nearest marina is in Peterhead to the north.

10.3 Survey Data

A total of three recreational vessels (two yachts and one jet ski) were tracked on radar in Survey 1 and three yachts were recorded on radar during Survey 2, as presented in Figure 10.2. There were no recreational vessels tracked on radar during Surveys 3 or 4, although four vessels were manually sighted during Survey 3 - a white sailing boat, a jet ski and two kayaks.

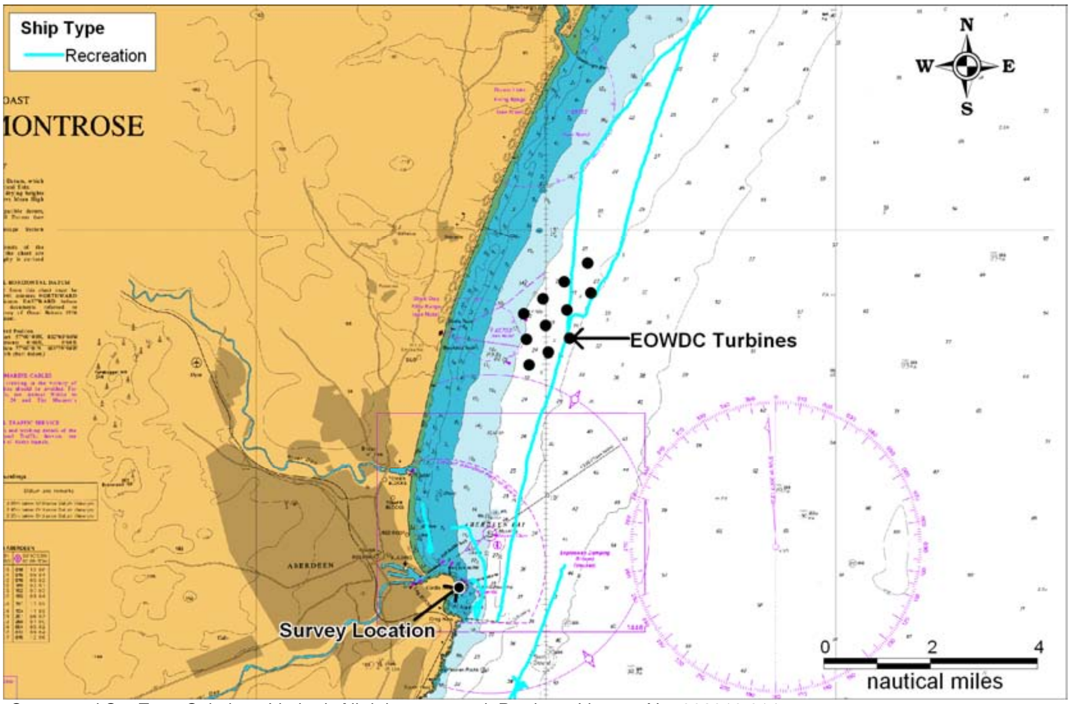


Figure 10.2 Recreational Vessels Tracked during Surveys (56 Days)

Two yachts passed within the proposed turbines and a picture of one of these yachts is shown below.

[1] Popular route on which some recreational craft will be seen at most times during summer daylight hours.

Figure 10.3 Photograph of a Yacht observed on 2nd April 2009 (Survey 1)

10.4 Impact Assessment

The air clearance between turbine rotors and sea level conditions at Mean High Water Springs (MHWS) will not be less than 22m, as recommended by the MCA and RYA. This minimises the risk of interaction between rotor blades and yacht masts.

In terms of vessel routeing, recreational vessels should be able to pass between turbines in suitable conditions, as well as being able to pass inshore and offshore. Based on the activity review, this is not expected to be a frequent event and hence the impact on recreational vessels is considered to be minor.

The Macmillan REEDS Nautical Almanac (Ref. xv) indicates that yachts are generally not encouraged within the busy commercial port of Aberdeen.

11. FISHING VESSEL ACTIVITY

11.1 Introduction

This section reviews the fishing vessel activity at the EOWDC site based on the maritime traffic survey and Commercial Fisheries assessment (Ref. xvi).

11.2 Survey Tracks

The fishing vessels tracked during the combined 56 days maritime traffic survey are plotted in Figure 11.1. Overall, 146 fishing vessels were tracked during the combined survey period, an average of 2 to 3 per day.

The majority of fishing vessels were small trawlers and potters working out of Aberdeen, mainly working south of Girdle Ness, where a number of buoys marking pots were visible from the coastline.

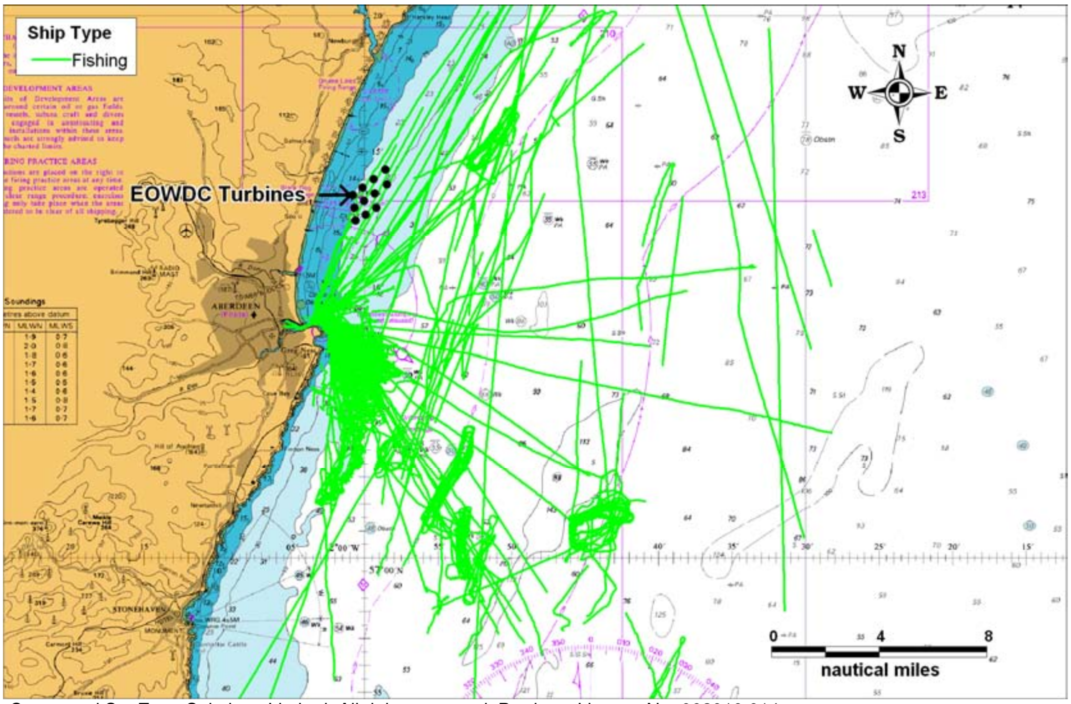


Figure 11.1 All Fishing Vessel Survey Tracks (56 Days)

A total of 4 fishing vessel tracks were logged passing through the proposed EOWDC site during the combined survey period, averaging 1 per fortnight. Details of the vessels are provided in Table 11.1.

Table 11.1 Details of Fishing Vessels Intersecting EOWDC Site during Surveys

Vessel Name	Type	Length (m)	Registered Tonnage	AIS / Radar	Survey
Crystal Tide AH135	Trawler	18.5	75	Radar	1
Boy John INS110	Trawler	20.8	174	Radar	2
Onward BF440	Trawler	21.3	202	AIS	2
Onward BF440	Trawler	21.3	202	AIS	2

Note that all instances of fishing vessels intersecting the proposed site were observed during the first two survey periods in 2009.

Examples of fishing vessels observed during the survey are presented the figures below. It is noted that the photographs are of vessels observed leaving Aberdeen port during the survey. Not all the vessels intersecting the area were photographed due to range and conditions.

Figure 11.2 Photograph of *Fame* A17 during Survey 1

Figure 11.3 Photograph of *Boy Gordon* A441 during Survey 2

Figure 11.4 Photograph of *Crystal Tide* AH135 during Survey 4

11.3 Commercial Fisheries Study

The commercial fishing aspects report (Ref.xvi) carried out for the proposed EOWDC uses the following principal sources of data and information:

- International Council for the Exploration of the Sea (ICES)
- Marine Management Organisation (MMO)
- Marine Scotland, Marine Scotland Science (MS)
- Scottish Fisheries Protection Agency (SFPA)
- European Fisheries Commission (Europa)

Based on the current fishing activity in the area, and the assumption that this will continue after the EOWDC is built, there will be a limited risk of collision between fishing vessels and turbines. In general this is due to the low levels of fishing activity in this area.

There is also potential to impact on the navigation of vessels to and from fishing grounds, for example, increased steaming distances and times. This is mainly an issue during the construction and decommissioning phases when there will be a safety zone and hence there may be some increased steaming distances. During operation there should be sufficient spacing between turbines for vessels to steam through the site if the conditions are considered suitable.

The above was confirmed through consultation with the SFF (Ref. xvii) who indicated there were no major fishing vessel navigational issues associated with the EOWDC proposal.

The risk of interaction between fishing gear and subsea cabling associated with the development is discussed in Section 13.4.

12. FORMAL SAFETY ASSESSMENT

12.1 Introduction

The IMO Formal Safety Assessment process (Ref. xviii) as approved by the IMO in 2002 under SC/Circ.1023/MEPC/Circ392 has been applied within this study. This is a structured and systematic methodology based on risk analysis and cost benefit assessment (if applicable). There are five basic steps within this process:

1. Identification of hazards (a list of all relevant accident scenarios with potential causes and outcomes);
2. Assessment of risks (evaluation of risk factors);
3. Risk control options (devising regulatory measures to control and reduce the identified risks);
4. Cost benefit assessment (determining cost effectiveness of risk control measures); and
5. Recommendations for decision-making (information about the hazards, their associated risks and the cost effectiveness of alternative risk control measures).

Figure 12.1 is a flow diagram of the FSA methodology applied.

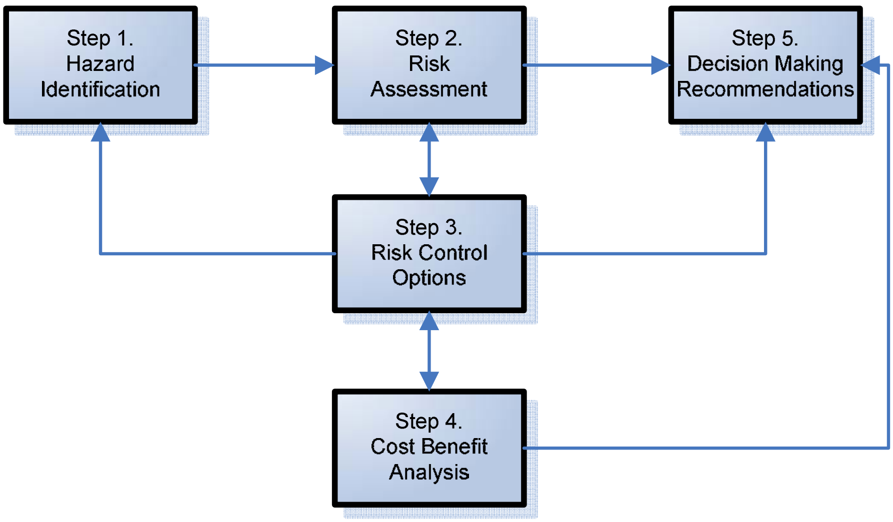


Figure 12.1 Overview of Formal Safety Assessment Methodology

As indicated within the IMO FSA guidelines and the DECC guidance on risk assessment methodology (Ref. i) for offshore renewable projects, the depth of the assessment should be commensurate with the nature and significance of the problem. Within the assessment of proportionality consideration was given to both the scale of the development and the magnitude of the risks/navigational impact.

From review it was concluded that the EOWDC project is a large scale development with the potential to impact navigational safety. As a result, the content and methods of the risk assessment were responsive to this and included the following:

- Comprehensive Hazard Log
- Risk Ranking
- Detailed and quantified Navigational Risk Assessment for selected hazards
- Preliminary search and rescue overview
- Preliminary emergency response overview
- Comprehensive risk control/mitigation measures log

12.2 Hazard Identification

A Hazard Review workshop was held in Aberdeen on 25 August 2010 attended by local stakeholders representing the port and shipping industry, as outlined in Table 12.1. Representatives from MCA, British Chamber of Shipping and NorthLink Ferries were also invited to attend but unfortunately could not make it on the day.

Table 12.1 Hazard Review Workshop Attendees

Name	Organisation
Colin Thomson	James Fisher
Daniel Stroud	Aberdeen Assistant Harbour Master
Brian Turnbull	Marine Safety Forum
David Kenwright	Emergency Response and Rescue Vessel Association
Steve Ferguson*	Marine Safety Forum
Jimmy Chestnutt	Anatec Ltd
Archie Johnstone	Northern Lighthouse Board
Frank Hall	Fisher Offshore
Ray Shaw	Aberdeen Harbour Master
Ian Todd*	AREG
John Sutcliffe	Technip
Nicola Fry	Technip
Liam Dallas-Ross	Anatec Ltd (secretary)
Michael Cain	Anatec Ltd (chairman)

*Attended for part of the meeting

12.3 Key Findings

The focus of the meeting was on shipping navigational hazards and the key findings from the meeting are summarised below:

- It was agreed that all phases of the development need to be appropriately managed to ensure safe navigation:
    - Construction
    - Operation
    - Decommissioning

- Due to the project being a test facility, construction and maintenance activities may be intermittent and would require careful management.

- It was agreed that the construction phase was likely to be prolonged and result in the greatest impact to navigation. This phase was considered as the base case for the Hazard Workshop.

- It was agreed that a project website would provide a useful mechanism for circulating information on the project to the marine industry and keep stakeholders informed about activities associated with the proposed development.

- The main identified impact on shipping was that vessels currently passing close to the East of the site would migrate further east. It was estimated that this displacement of shipping would provide clearance of around 1nm to the turbines. There are no significant sea room restrictions to the East to prevent this happening.

- Concern was expressed that a figure recently circulated showed that the cables could be laid through the anchorage area. This was not acceptable to the marine stakeholders.

- Anatec are to provide more information on the potential effects of wind farms on Marine Radar and other navigational equipment.

- The standard navigational control measures that have been applied to other sites were generally considered the most effective in reducing risks at the site, e.g., marking and lighting.

- Overall the workshop concluded that with the correct mitigation measures in place the navigational risks were likely to be Low.

- It was assessed that although the use of a dedicated support vessel and/or permanent VTS would be beneficial they were not justifiable. It was also agreed that the introduction of a TSS would be unnecessary.

12.4 Risk and Mitigation Measures

The risks involved with the proposed project and the associated mitigation measures are summarised in the following table. In all cases, the competency of mariners has been assumed when assigning the risk of each hazard.

Hazard	Key Points	Mitigation
Commercial ship (powered) collision with turbine.	The vast majority of commercial vessels passing the site tend to naturally avoid it, although it was agreed that shipping will move further to the East passing about 1nm off the turbines. An East Cardinal Mark will result in pushing shipping even further East, and is likely to be swept away. Overall this was not considered necessary. The project are to hold discussions with the Northern Lighthouse Board and UKHO to ensure the project is appropriately marked, lit and depicted on charts, etc. Notices to Mariners to be used to circulate information on the project to stakeholders Competent mariners and the "rules of the road" will contribute to risk reduction. Overall the risks were identified as **LOW**.	Marking and Lighting Sound signal Chart Markings Safety Zones Development Area Notices to Mariners Consultation with Local Users Website
NUC vessel collision	It was highlighted that it was difficult to estimate how often vessels become NUC as this often goes unreported.	Marking and Lighting

Hazard	Key Points	Mitigation
	It was suggested that vessels become NUC most often within 5nm of the port/harbour, when they change engine settings or move from passage to manoeuvring mode. Generally a result of human error. Overall the risks were identified as **LOW** as it was considered unlikely that a vessel would become NUC and drift toward the turbines without sufficient time to drop anchor.	Sound signal Chart Markings (cables) Notices to Mariners Consultation with Local Users Website Cable route away from shipping Appropriate cable protection/burial
Vessel anchoring / dragging anchor	Incident rates of vessels dragging anchor were difficult to quantify for the area. Overall risks were identified as **LOW** as it was considered unlikely that a vessel would drag anchor undetected and drift towards the turbines without starting engines. The main modes of detection were noted as alarm on the bridge, watch keeper/crew detection, and also other vessels at anchor in the anchorage. In addition to this the VTS sets a guard zone with alarm around each vessel when at anchor in the anchorage.	Marking and Lighting Sound signal Chart Markings (cables) Notices to Mariners Consultation with Local Users Website Cable route away from shipping Appropriate cable protection/burial

Hazard	Key Points	Mitigation
Vessel-to vessel-collision due to avoidance of site (includes fishing, recreational and attendant/construction/ maintenance vessels)	An increase in ship-to-ship encounters was identified to be the most likely outcome of the proposed development. However with competent crew/seamanship it was agreed that the risks of ship to ship collision were still likely to be **LOW**. In poor weather it was indicated that vessels are likely to give more sea room to the turbines thereby reducing congestion in periods when visual observation of other vessels was compromised. The vast majority of ships (excluding fishing and recreational) using Aberdeen Harbour have AIS and as a result detection levels will be high so there should be good situational awareness at all times. Radar returns for larger vessels passing 0.7 to 1nm off the turbines are unlikely to be impacted significantly. However smaller vessels exiting the EOWDC site itself have potential to go undetected which could pose difficulty to passing vessels. It was noted that it was extremely unlikely for this event to happen as there was limited small vessel navigation in this area (fishing and recreational) and	Marking and Lighting Sound signal Chart Markings Safety Zones Development Area Notices to Mariners Consultation with Local Users Website Effective Management of Vessels working in site Consultation with fishing and recreational stakeholders.

Hazard	Key Points	Mitigation
	when there was it was very local to Aberdeen so unlikely to exit/enter the site from/to the East. However it was agreed that further discussions should be held with these stakeholders. It is noted that fishing and recreational activity is very limited in the area, however, it is expected that these will both increase within the EOWDC site once it is operational (only small fishing vessels). Further discussions are to be held with both stakeholder groups. A particularly undesirable scenario was recorded as a vessel leaving anchor to go offshore in bad visibility, encountering an inbound vessel. It was agreed that in this instance the vessel leaving anchor would take particular care and that the inbound vessel was likely to pass further off the turbines creating more sea room. In these circumstances most competent mariners would broadcast their intentions to leave the anchorage. With the use of AIS and radar it was concluded that the risks were likely to be well managed by a competent mariner.	

12.5 Risk Analysis

Following identification of the key navigational hazards, risk analyses were carried out to investigate selected hazards in more detail. This allowed more attention to be focused upon the high risk areas to identify and evaluate the factors which influence the level of risk with a view to their effective management. Four risk assessments were carried out as per the DECC guidelines:

1. Base case without wind farm level of risk
2. Base case with wind farm level of risk
3. Future case without wind farm level of risk
4. Future case with wind farm level of risk

The following scenarios were investigated in detail, quantitatively or qualitatively.

Without Wind Farm:

- Vessel-to-vessel collisions

With Wind Farm

- Vessel-to-vessel collisions
- Vessel-to-wind farm collisions (powered and drifting)
- Cable interaction

All the quantified risk assessments were carried out using Anatec's COLLRISK software which conforms to the DECC methodology as outlined in Annex D3 in the Guidance (Ref. i). In line with this, Anatec makes the declaration that the models used within this work have been validated and are appropriate for the intended use. As required the following have been considered and justified:

- Tuning of parameters
- Consistency checks
- Behavioural reasonableness
- Sensitivity analysis
- Comparison with the real world

The results of the detailed risk analyses are presented in Section 13. Where considered appropriate in high risk scenarios, the change in individual and societal risk (based on Potential Loss of Life), as well as the risk of pollution, were calculated and compared to background risk levels in the UK.

12.6 Risk Control Measures

A summary of measures is presented in Section 20.

13. RISK ASSESSMENT

13.1 Introduction

This section assesses the risks identified from the hazard review to require more detailed assessment. This is divided into without EOWDC (pre-installation) and with EOWDC (post-installation) risks.

The base case assessment uses the present day vessel activity level identified from the maritime traffic survey, consultation and other data sources. The future case assessment makes conservative assumptions on shipping traffic growth over the life of the project.

The modelling is based on the current proposed EOWDC set-up, i.e., 11 turbines and assumes the maximum jacket structure (21 m x 21 m (see Section 3.4) (worst case).

13.2 Without Wind Farm Risk

13.2.1 Encounters

An assessment of current ship-to-ship encounters has been carried out by replaying at high-speed two weeks of survey data from Survey 3 in April 2010.

Encounter distances between vessels of 1nm, 0.5nm and 0.25nm were considered. The tracks of vessels during encounters, and heat maps based on the geographical distribution of encounters within a grid of cells, are presented in Figure 13.1 to Figure 13.3. This helps to illustrate where existing shipping congestion is highest and therefore where offshore developments, such as the proposed EOWDC, could potentially exacerbate congestion and hence increase the risk of encounters / collisions.

It can be seen that in all cases, the density of encounters in the vicinity of the proposed EOWDC is minimal.

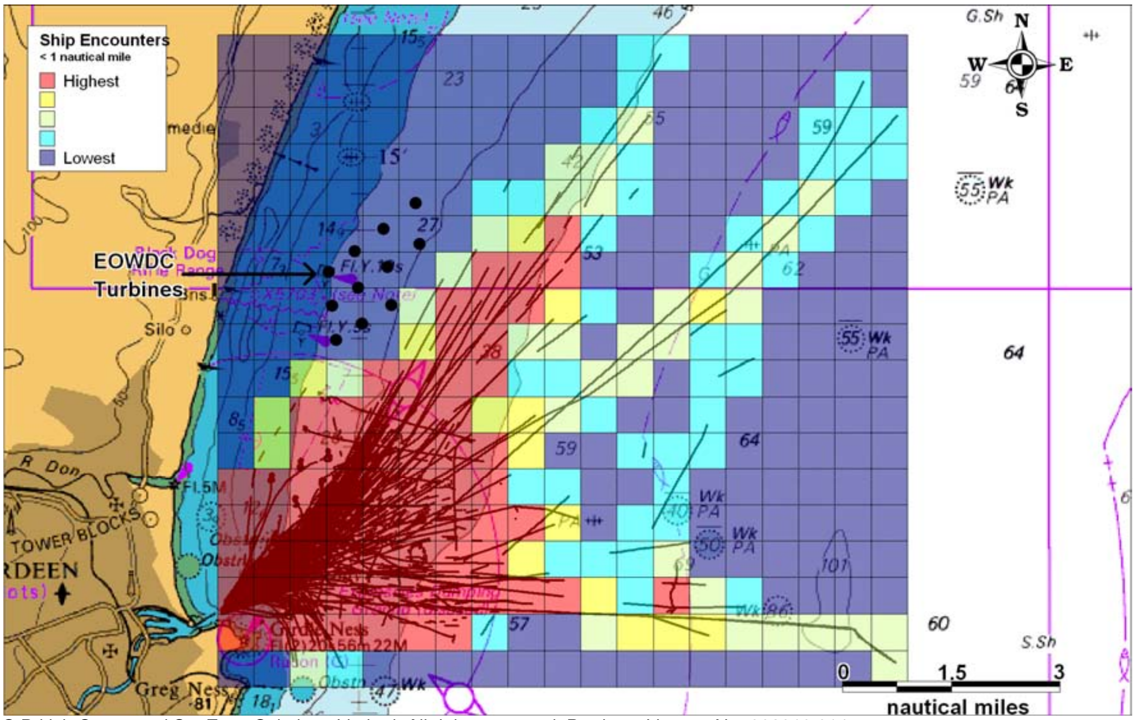


Figure 13.1 Ship Encounters within 1nm

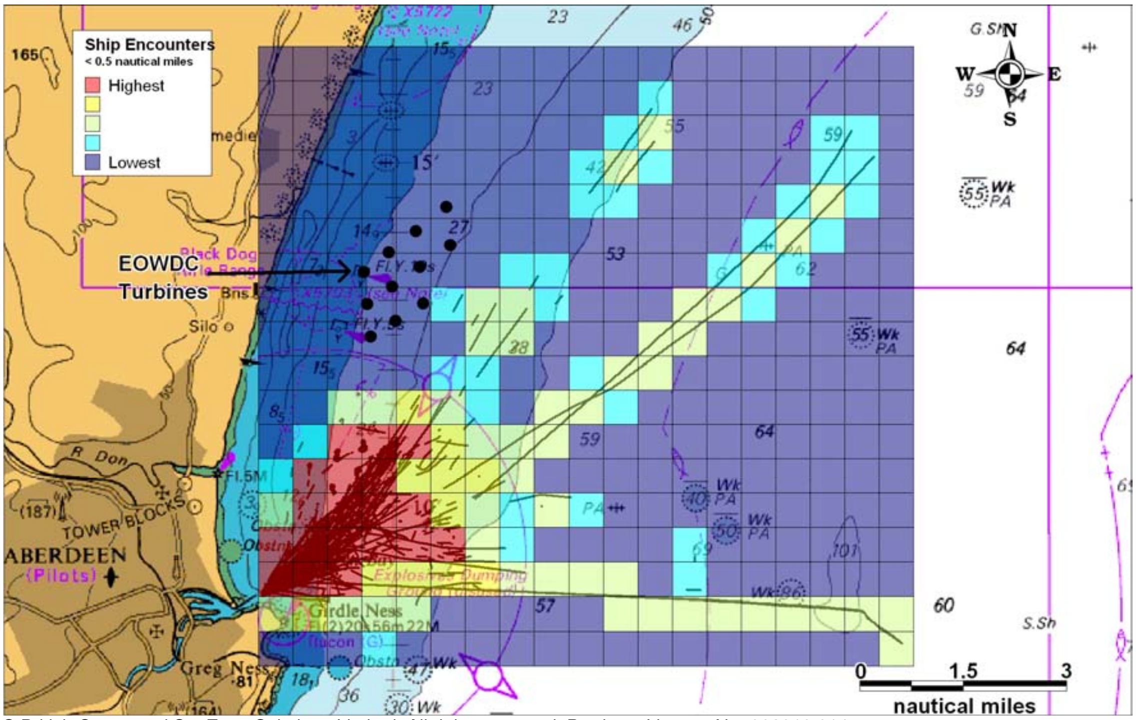


Figure 13.2 Ship Encounters within 0.5nm

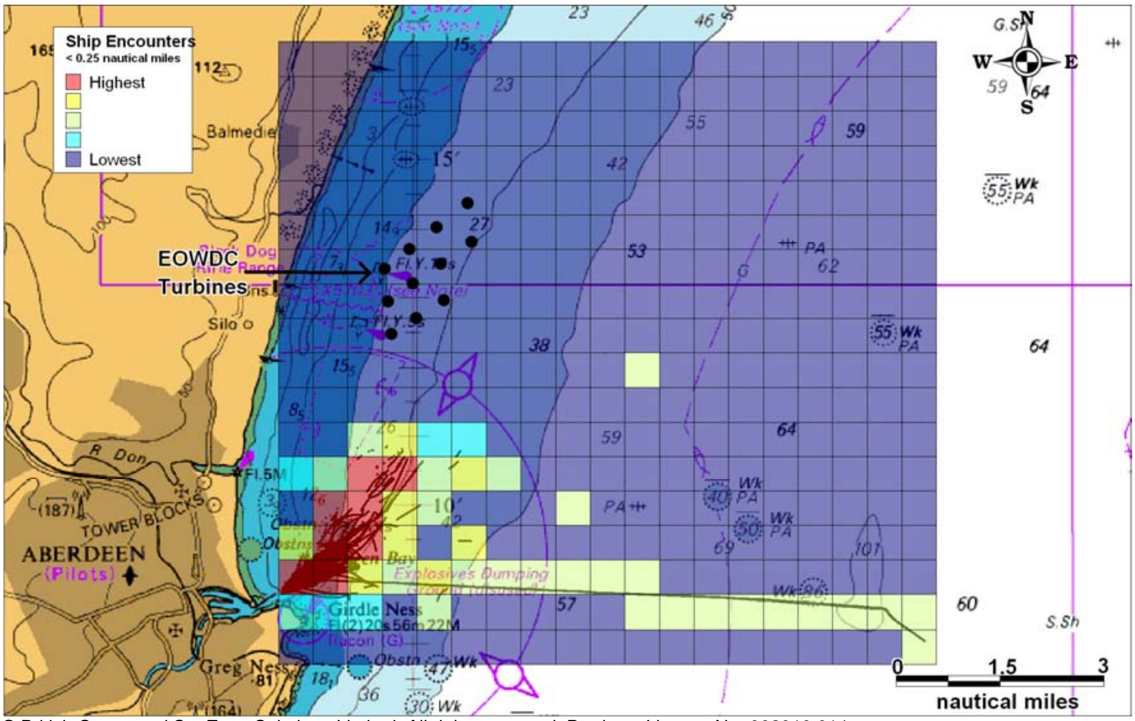


Figure 13.3 Ship Encounters within 0.25nm

Due to the location of the proposed EOWDC site (i.e., near a port), an encounter distance of 0.5nm has been used for further analysing encounters.

There were 789 encounters during the 14-day period. Figure 13.4 presents the number of encounters per day.

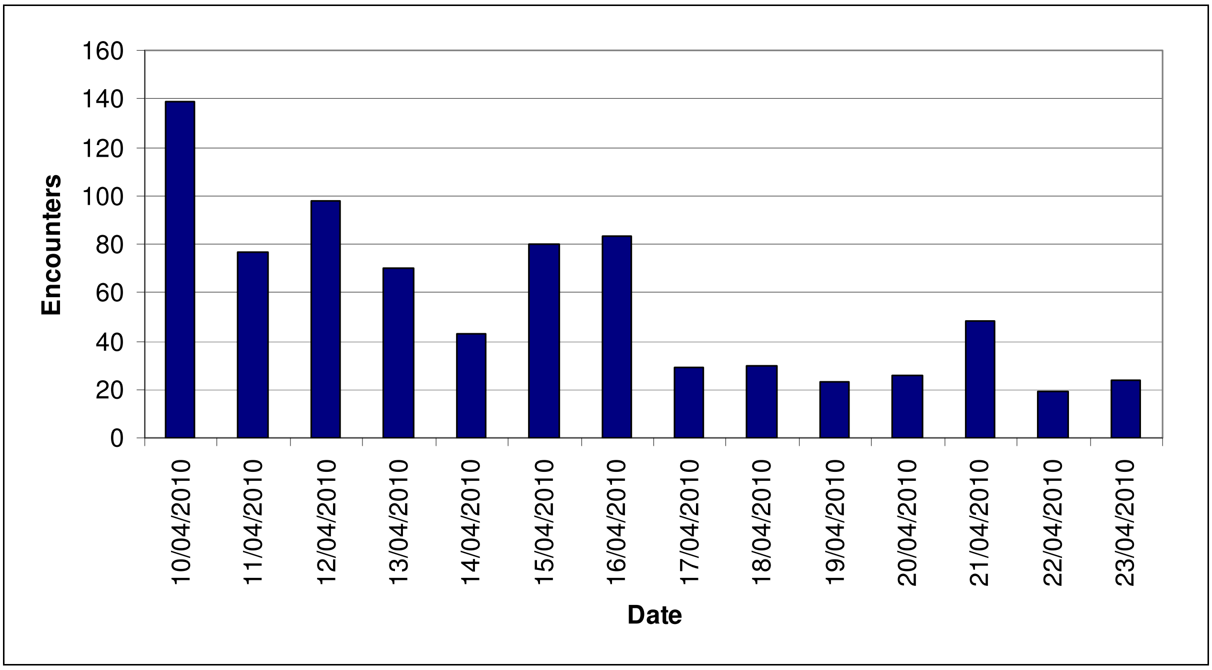


Figure 13.4 Number of Encounters per Day

The average number of encounters was 56 per day, with the highest number (139 encounters) observed on 10 April 2010.

Figure 13.5 presents the distribution of vessel types involved in encounters (excluding unspecified).

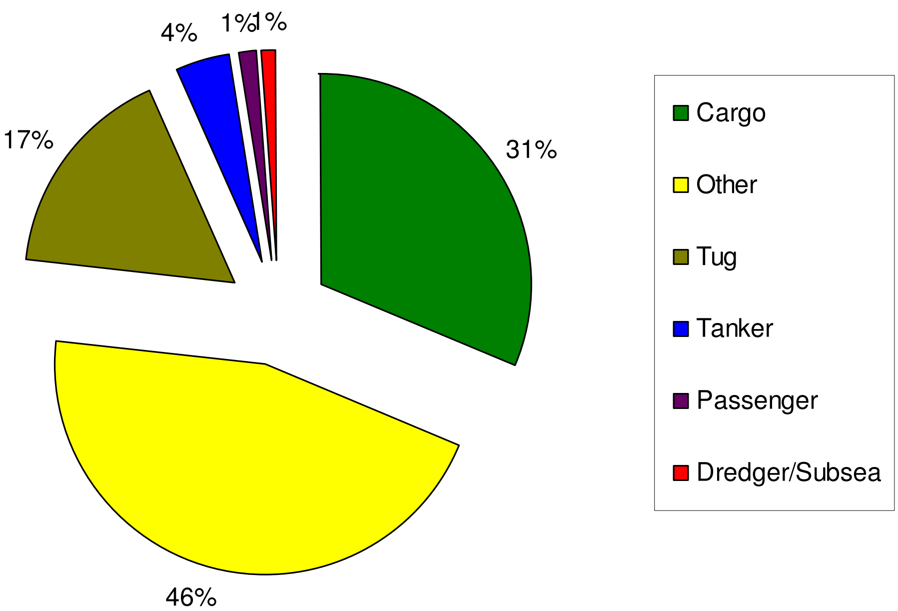


Figure 13.5 Vessel Types Involved in Encounters

It can be seen that the majority of encounters involved 'other ships' (46%) and cargo vessels (31%). The majority of both are offshore industry support vessels.

The locations of encounters during the 14 day period are presented in Figure 13.6. A density map of the encounters is presented in Figure 13.7.

The vast majority of encounters occurred where ships converge on approach to or departure from Aberdeen Harbour to the south of the proposed EOWDC site. There were no encounters recorded within the proposed turbine locations although there were a few close to the eastern boundary of the proposed site.

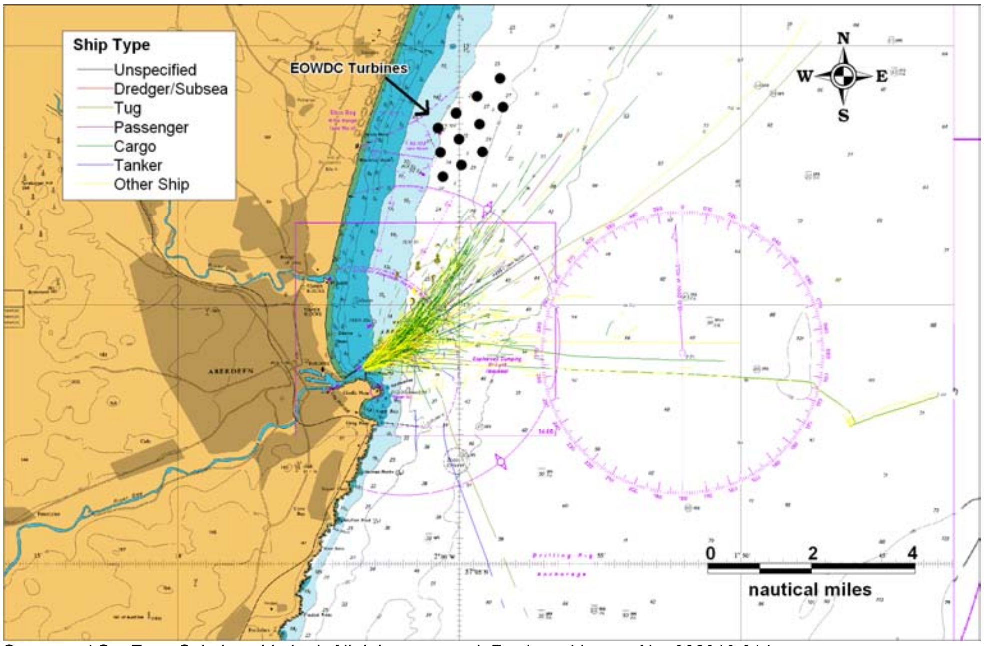


Figure 13.6 Overview of Encounters <0.5nm during 14 Days (AIS)

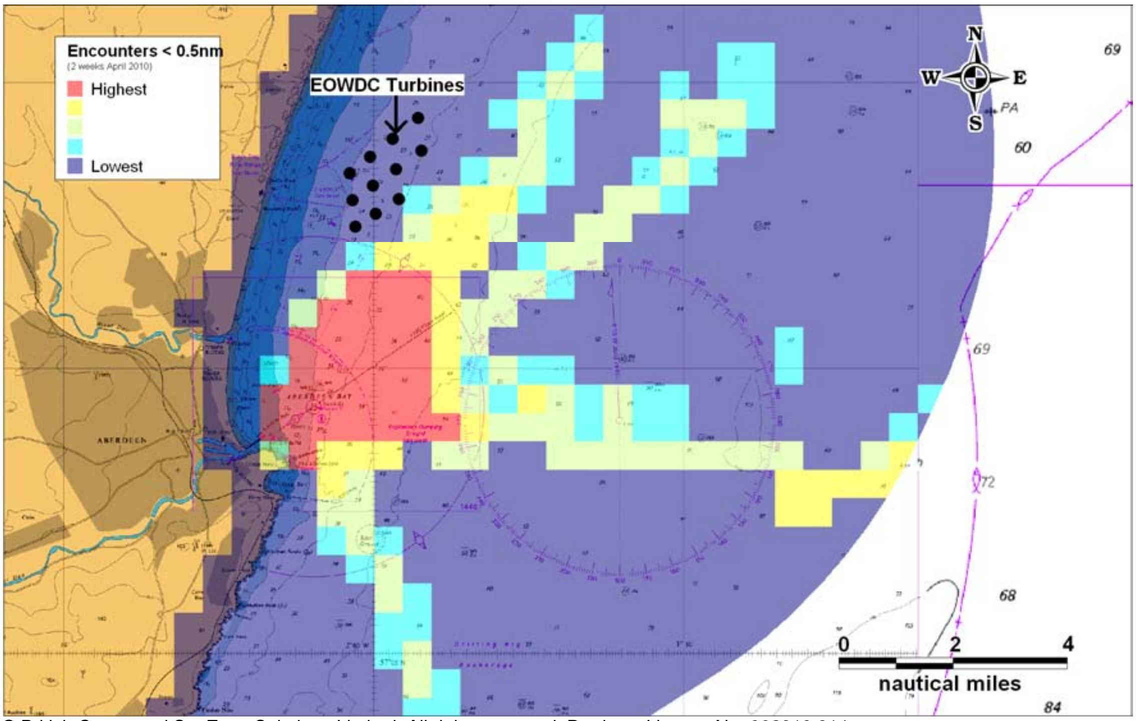


Figure 13.7 Density Distribution of Encounters < 0.5nm

13.2.2 Vessel-to-Vessel Collisions

Based on the existing routeing and encounter levels in the area, Anatec's COLLRISK model has been run to estimate the existing vessel-to-vessel collision risks in the local area around the proposed EOWDC site. The route positions and widths are based on the survey analysis with the annual densities based on port logs and Anatec's ShipRoutes database, which takes seasonal variations into consideration.

Based on the model run for the area, the baseline vessel-to-vessel collision risk level pre-wind farm is in the order of 1 serious collision in just over 153 years[1].

It is emphasised the model is calibrated based on major incident data at sea which allows for benchmarking but does not cover all incidents, such as minor impacts, or incidents occurring within port. Other incident data from RNLI and MAIB is presented in Section 7. This includes other minor incidents including collisions in port (all five collisions reported by MAIB within 10nm of the site were in Aberdeen Harbour).

13.3 With Wind Farm Risk (Base Case)

13.3.1 Vessel-to-Vessel Collisions – Change in Risk

The revised routeing pattern following construction of the proposed EOWDC project has been estimated based on the review of impact on navigation (see Section 8.6). The main change is displacement of ships passing close to the site area on approach/departure from Aberdeen. It is assumed that ships will be able to pre-plan their revised passage in advance of encountering the proposed site due to effective mitigation in the form of information distribution about the development to shipping through Notices to Mariners, updated charts, liaison with ports, etc. Fishing vessels may also be displaced from the site to other areas, which could increase the frequency of encounters.

Based on vessel-to-vessel collision risk modelling of the revised traffic pattern, the collision risk was estimated to increase to 1 major collision in 150 years. The change in collision frequency due to the proposed EOWDC was estimated to be 1.3×10^{-4} per year.

As noted earlier, the model is calibrated based on major incidents at sea which allows for benchmarking but does not cover all incidents, such as minor impacts, or incidents occurring within port.

[1] Note that the models have been calibrated against 'serious' casualty data at sea. This excludes incidents in port, e.g., minor bumps during berthing, requires the incident to be of a defined degree of seriousness in terms of loss of life, environmental damage and/or financial impact. Non-serious casualties are estimated to be in the order of 4 times more frequent than serious casualties. Anatec's models are calibrated against serious casualties as this minimises the probability of under-reporting and provides a benchmark level when comparing the frequency of accidents in different parts of the World.

The following potential effects have not been quantified but may indirectly influence the vessel-to-vessel collision risk:

- Radar interference
- Visual obscuration when ships approach each other

Radar interference is discussed in Section 15. It is noted that any potential impact is only likely to be a problem during bad visibility and this is mitigated to an extent by the widespread adoption of AIS which will assist vessels in discriminating genuine targets (although AIS is not currently mandatory for smaller vessels, e.g., fishing and recreational vessels). Ships may also call Aberdeen VTS if unsure whether a radar target is genuine.

The visual aspect is reviewed in Section 19.2 and is not considered a significant factor for the proposed EOWDC site due to its position and orientation relative to the shipping lanes and the other navigational features in the area.

13.3.2 Ship Collision with Structure

There are two main scenarios for passing ships colliding with offshore structures such as wind turbines:

- Powered Collision:
  - Where the vessel is under power but errant
- Drifting Collision:
  - Where a ship on a passing route experiences propulsion failure and drifts under the influence of the prevailing conditions.

Each scenario is assessed below.

<u>Powered Ship Collision</u>
Based on the ship routeing identified for the area and the anticipated change in routeing due to the site, and assuming effective mitigation in terms of making mariners aware of the site through Notices to Mariners, charts, lights and markings, etc., the frequency of an errant ship under power deviating from its route to the extent that it comes into proximity with the proposed EOWDC site is not considered to be a likely event.

From consultation with the shipping industry it is assumed that merchant ships will not attempt to navigate between turbines due to the restricted sea room and will be directed by the navigational aids in the area.

The main risk of powered collision with a wind farm structure is from human error on the bridge of the ship, however, the proximity to the coastline and Aberdeen port should mean that mariners are already very attentive to their vessel's position and proximity to other vessels and obstructions in this area.

Based on modelling the revised ship routeing pattern estimated with the proposed EOWDC structures in place and using local metocean data, the risk of a passing powered ship collision was estimated to be 1.1 x 10^{-3} per year (approximately 1 in 871 years) for all 11 turbines.

The individual turbine collision frequencies ranged from 4 x 10^{-4} for Turbine 7 to 8.6 x $10^{-6}$for Turbine 3 This compares to the historical average of 5.3 x 10^{-4} per installation-year for offshore installations on the UKCS. A bar chart showing the passing powered collision frequency for each structure relative to the historical benchmark is presented in Figure 13.8. The risk per turbine is below the historical average, which reflects the smaller size of turbines compared to typical North Sea installations, as well as the shipping characteristics of the area.

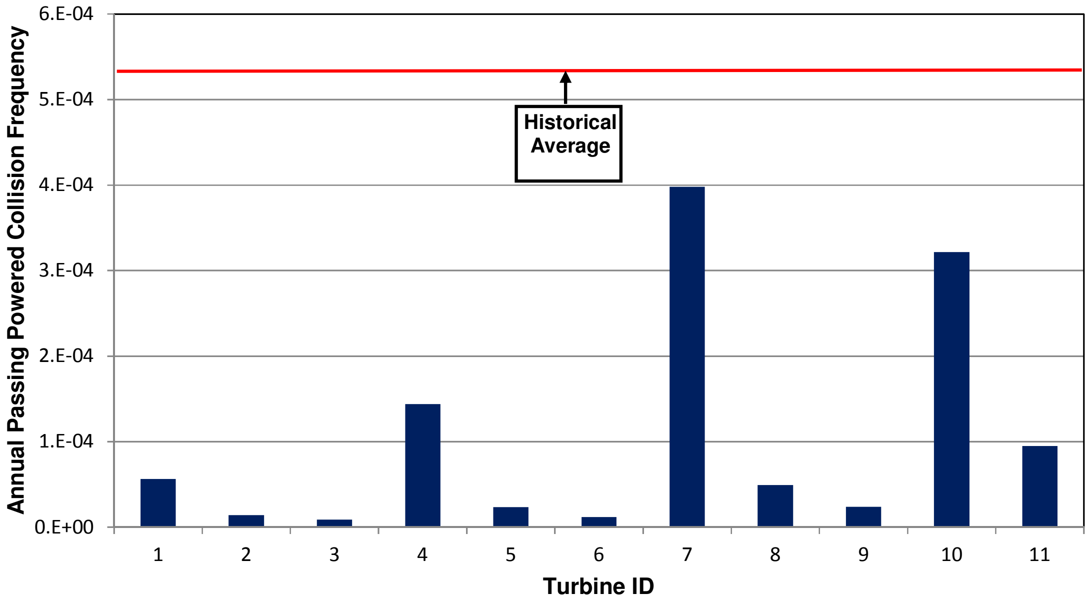


Figure 13.8 Annual Passing Powered Collision Frequency for the 11 Turbines

<u>Drifting Ship Collision</u>
The risk of a ship losing power and drifting into an EOWDC structure was assessed using Anatec's COLLRISK model. This model is based on the premise that propulsion on a vessel must fail before a vessel will drift. The model takes account of the type and size of the vessel, number of engines and average time to repair in different conditions.

The exposure times for a drifting scenario are based on the ship-hours spent in proximity to the proposed EOWDC site (up to 10nm from turbines). These have been estimated based on the traffic levels, speeds and revised routeing pattern. The exposure is divided by vessel type and size to ensure these factors, which based on analysis of historical accident data have been shown to influence accident rates, are taken into account within the modelling.

Using this information the overall rate of breakdown within the area surrounding the project was estimated. The probability of a ship drifting towards a structure and the drift speed are dependent on the prevailing wind, wave and tide conditions at the time of the accident.

The following drift scenarios were modelled:

- Wind
- Peak Spring Flood Tide
- Peak Spring Ebb Tide

The probability of vessel recovery from drift is estimated based on the speed of drift and hence the time available before reaching the wind farm structure. Vessels that do not recover within this time are assumed to collide.

After modelling the three scenarios it was established that wind-dominated drift produced the worst case results for the proposed EOWDC, therefore, this result is presented. This was mainly due to the majority of tidal based drifts being parallel to the site rather than towards it.

The annual drifting ship collision frequency with the Aberdeen structures (all 11 turbines) was estimated to be 5.4 x 10^{-5} per year corresponding to an average of one drifting ship collision in 18,600 years. The low risk levels reflect the fact that a drifting collision is a low probability event. (There have been no reported 'passing' drifting ship collisions with offshore installations on the UKCS in over 6,000 operational-years. Whilst a large number of drifting ships have occurred each year in UK waters, most vessels have been recovered in time, e.g., anchored, restarted engines or taken in tow. There have also been a small number of 'near-misses'.)

The majority of the drifting vessel collision frequency is associated with the more easterly turbines, e.g., Turbines 4, 7 and 10. The westerly turbines tend to be partially shielded from drifting events.

13.3.3 Fishing Vessel Collision

Anatec's COLLRISK fishing vessel risk model has been calibrated using fishing vessel activity data along with offshore installation operating experience in the UK (oil and gas) and the experience of collisions between fishing vessels and UKCS offshore installations (published by HSE).

The two main inputs to the model are the fishing vessel density for the area and the structure details. The fishing vessel density in the area of the proposed EOWDC was based on the number of sightings per patrol in the five-year period 2005-09. The maximum dimensions of the 11 proposed turbines have also been input.

Using the above site-specific data as input to the model, the annual fishing vessel collision frequency with the proposed EOWDC turbines was estimated to be 1.1 x 10^{-3}, which corresponds to an average of 1 collision in 873 years. This collision frequency reflects the relatively low density of fishing vessels operating in the area.

13.3.4 Recreational Vessel Collision

There are two main collision hazards from recreational vessels interacting with wind farms:

1. Turbine Rotor Blade to Yacht Mast Collision
2. Vessel Collision with Main Structures

<u>Blade/Mast Collision:</u>
A collision between a turbine blade and the mast of a yacht could result in structural failure of the yacht.

For a blade/mast collision to occur, the air draught of the yacht (from water-line to top of masthead) must be greater than the available clearance under the area swept by the rotating blade.

The planned minimum rotor blade clearance for the turbines is at least 22m above Mean High Water Springs (MHWS), which matches the MCA minimum requirement and recommendation of RYA. This is the clearance when the blade is in its lowest ('6 o'clock') position. The actual clearance at a given time will depend upon the prevailing tide and wave conditions, i.e., lower clearance at high water and rough seas, greater clearance at low water and calm seas.

To determine the extent to which yacht masts could interact with the rotor blades, details on the air draughts of the IRC fleet are provided in Figure 13.9 based on a fleet size of over 3,000 vessels. IRC is a rating (or 'handicapping' system) used Worldwide which allows boats of different sizes and designs to race on equal terms. The UK IRC fleet, although numerically only a small proportion of the total number of sailing yachts in the UK, is considered representative of the range of modern sailing boats in general use in UK waters.

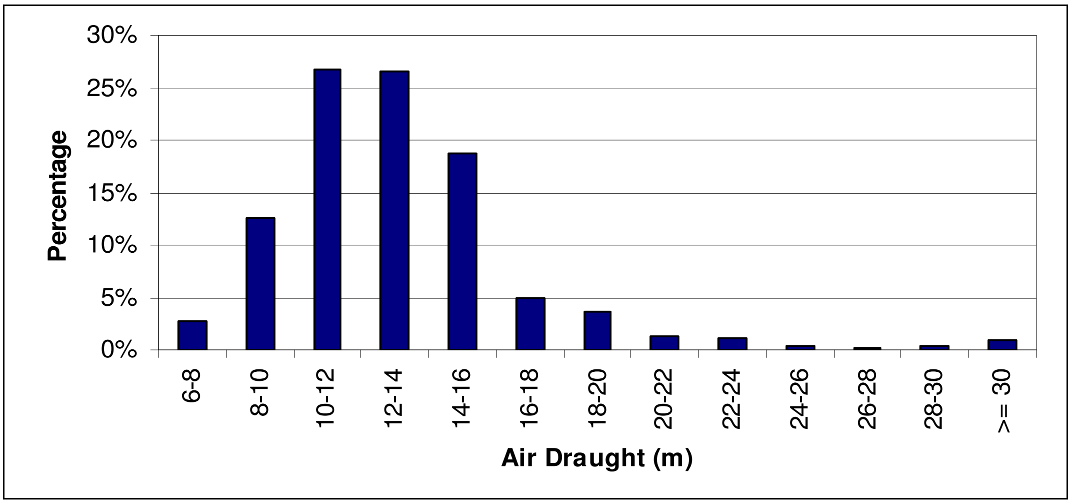


Figure 13.9 Air Draught Data – IRC Fleet (2002)

From this data, just under 3% of boats have air draughts exceeding 22m. Therefore, only a fraction of vessels could potentially be at risk of dismasting if they were directly under a rotating blade in the worst-case conditions. It is also noted that with these larger vessels, crews are likely to be greater in numbers and passage planning will give particular attention to air draught and safe avoidance of potential hazards.

It is further noted that the proposed EOWDC will be designed and constructed to satisfy the requirement of the Maritime & Coastguard Agency in respect of control functions and safety features, as specified in the MCA standards (Ref. ii).

The most likely reason for the Emergency Management System being ineffective is considered to be the mariner failing to alert the Coastguard either directly or indirectly using VHF, mobile phone, flares, etc. It is noted that very large yachts, which are the only boats that could potentially interact with the rotor blades, are also most likely to be equipped with VHF radio and other safety equipment.

Based on the information presented in this section, the risk of the dismasting of a yacht by a rotating blade of an EOWDC turbine is assessed to be minimal, and has not been further quantified.

Vessel/Structure Collision

In good conditions the proposed EOWDC should be visible, especially as most activity occurs during daylight hours. In this case, vessels, if competently skippered, will be able to navigate safely to avoid the structures. Even if a vessel were to get into difficulty, most should be able to keep clear of the structures or anchor or moor if necessary to avoid drifting closer to the proposed EOWDC whilst they fix the problem or call for assistance.

The main risk of collision is considered to be in bad weather, especially poor visibility, where a small craft could fail to see the proposed EOWDC and inadvertently end up closer than intended.

If there were poor visibility combined with adverse weather and/or strong tides, the vessel may not be able to anchor.

The risk of small craft being in the area during bad weather is reduced by the fact that most craft are fitted with radio receivers and VHF so will be able to listen to regular broadcasts of the weather forecast by the BBC and Coastguard. It is also standard practice for local clubs to post weather forecasts on notice boards.

Given the ready availability of weather forecasts and growing use of GPS, the risk of a vessel being in proximity to the proposed EOWDC in bad weather is considered to be low but not negligible. In this scenario, a vessel unable to make way from the proposed EOWDC and at risk of collision may alert Aberdeen VTS and the Coastguard using mobile phone, VHF or flares.

To minimise the risk of collision in this worst case scenario, mitigation in line with regulator guidance will be put in place. It will be ensured, consistent with the requirements of NLB, that the structures are marked in such a way as to enhance the prospect of visual observation by passing recreational craft even in adverse conditions.

The Operator will also ensure notification of the development to the recreational craft community is widespread and effective throughout all phases.

These measures mean that whilst the collision risk cannot be completely eliminated it will be reduced to a level as low as reasonably practicable. In terms of consequences, any collisions with the turbines would be relatively low speed and hence low energy. If the seaworthiness of the recreational craft was threatened by the impact, the turbines will be equipped with access ladders for use in emergency, placed in the optimum position taking into account the prevailing wind, wave and tidal conditions, as required by the MCA. This should provide a place of safety/refuge until such time as the rescue services arrive.

13.4 Cable Interaction – Anchor and Trawl

The following figure provides an overview of the export cable corridor versus the most recent survey data on vessel anchoring (survey 5 from 18th February 2011 to the 4th March 2011).

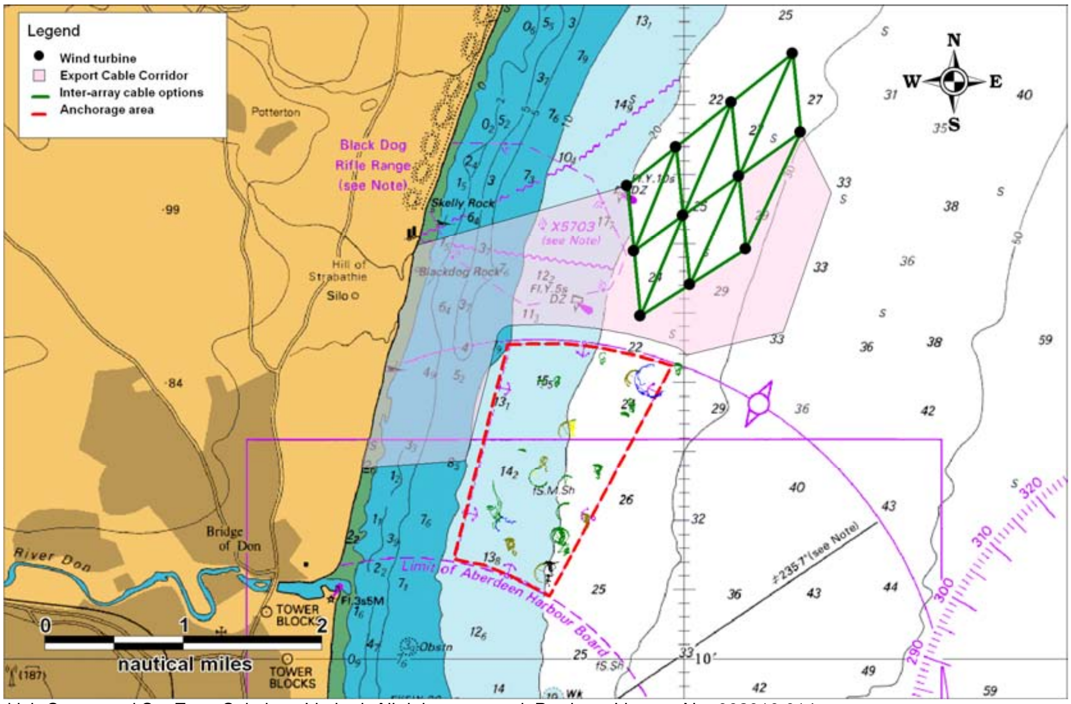


Figure 13.10 Indicative Export Cable Corridor

The main points to note from the figure are:

- There is a 200m buffer between the corridor and the designated anchorage to reduce the risks of interaction between anchoring vessels and the cable.
- Anchored vessels are observed to anchor within the newly designated area thereby staying clear of the cable corridor

There is limited fishing vessel activity in this area (see Section 11) and that the cables are to be buried to a depth between 0.6 and 3m, to reduce the likelihood of interaction.

13.5 Future Case Level of Risk

13.5.1 Shipping

The main factor that is likely to influence the future levels and composition of shipping in the vicinity of the proposed EOWDC is the traffic using Aberdeen Harbour.

Aberdeen Harbour is one of the busiest Trust Ports in the UK. An economic impact assessment of Aberdeen Harbour (Ref. xix), identified its principal activities as follows:

- Marine support for the offshore oil and gas industry in North-west Europe: Aberdeen is well placed to take advantage of the North Sea sector due to its strategic location and comprehensive infrastructure.

- The principal commercial port for North-east Scotland: The Harbour handles a range and scale of general cargo to and from other ports in Europe and has positioned it as the principal commercial port for North-east Scotland, the major mainland port serving the Northern Isles of Orkney and Shetland and as a centre of international trade. Aberdeen Harbour is the nearest port on the UK mainland to Norway, Sweden, Finland, Russia and the Faroe Islands and is the closest Scottish port to the German and Baltic ports. The Harbour is also an international port, with direct, regular connections to around 30 countries including countries in West Africa and the Far East.

- Ferry and cruise services: Aberdeen Harbour has become a principal mainland terminal for ferry services to Norway and to the Northern Islands of Orkney and Shetland. It is also a port of call for cruise ships.

- A gateway for the agriculture industry: Aberdeen Harbour's proximity to rural hinterland makes it ideal for the import and export of agricultural products. In recent years a transit shed has been dedicated for grain export. The Harbour also handles seasonal imports of livestock including sheep and cattle from the Northern Isles.

- A major centre for the import of forest products and the export of finished paper products

Data published by Aberdeen Harbour Board indicates the following changes in ship numbers and goods handled in recent years.

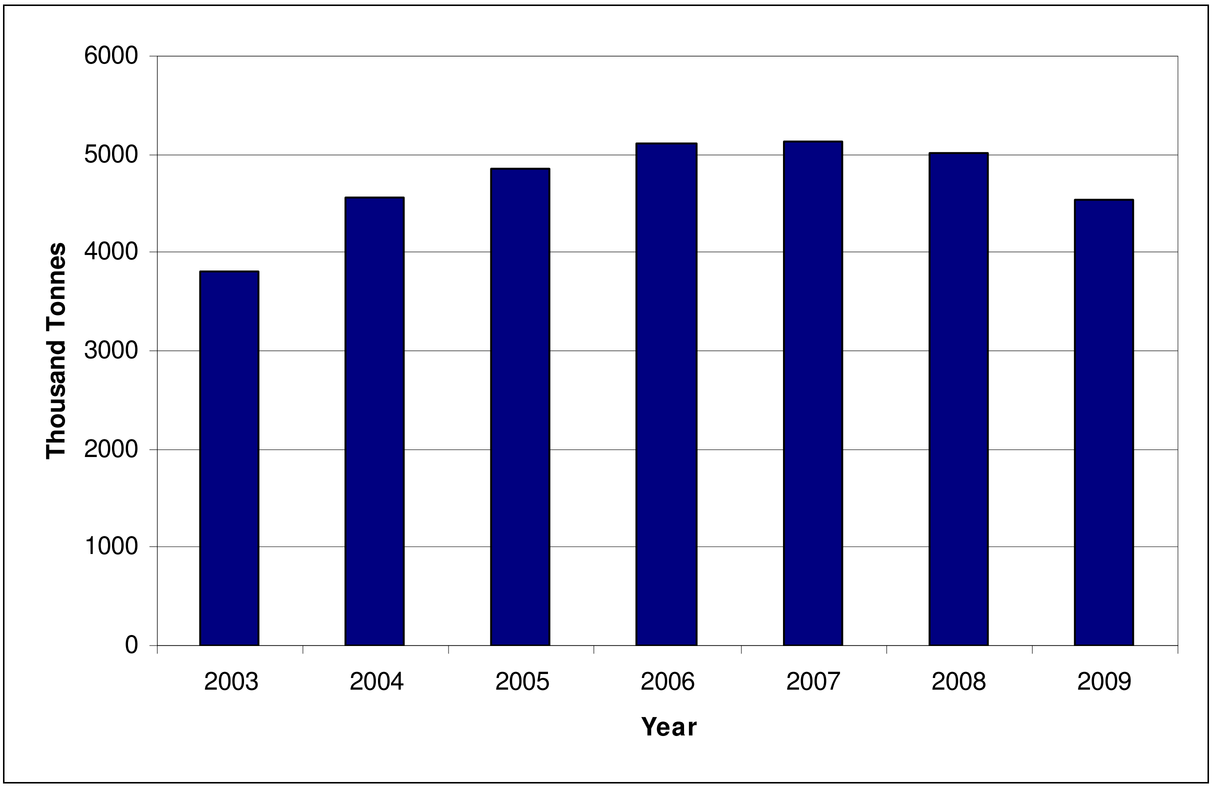


Figure 13.11 Tonnage through Aberdeen Harbour (AHB)

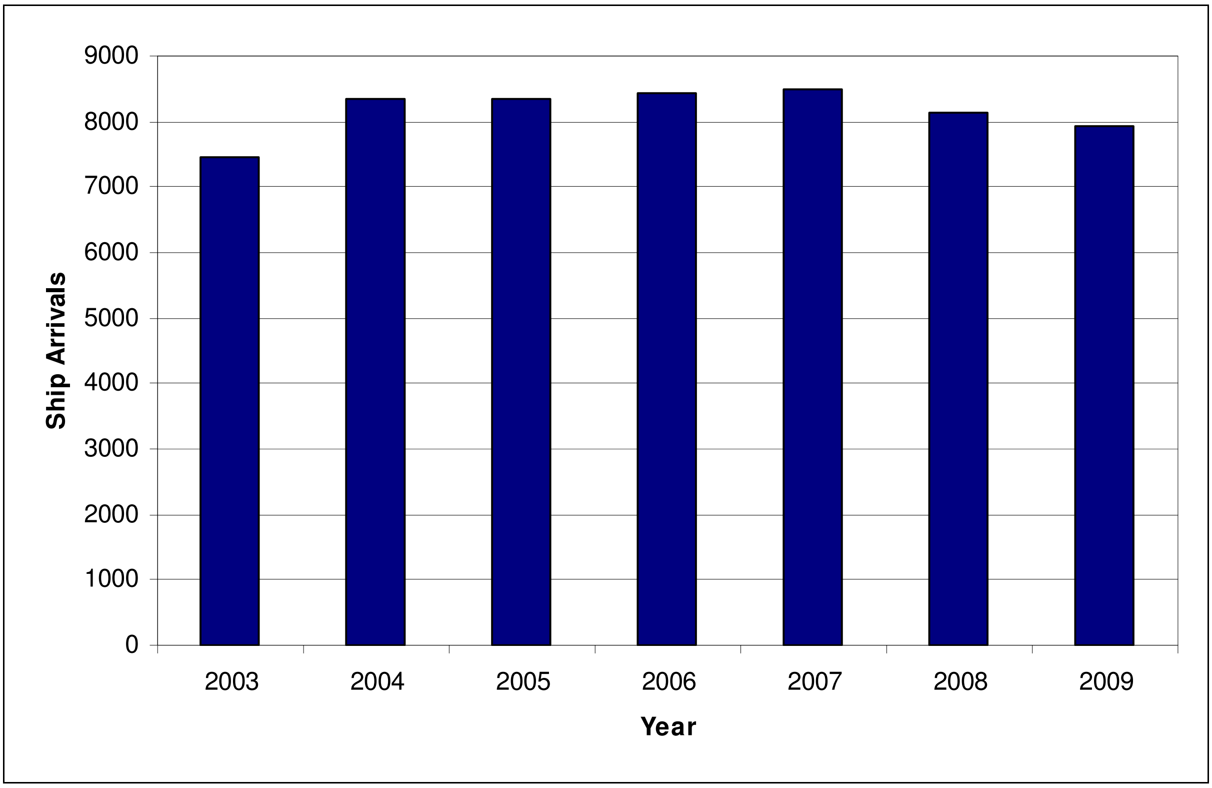


Figure 13.12 Ships through Aberdeen Harbour (AHB)

The number of ships has increased by 6% compared to a tonnage increase of 19% over the period 2003-09. This reflects a general trend in the shipping industry where increased trading tonnages are mainly being achieved through the use of larger vessels as opposed to increased ship movements.

Longer term tonnage data for Aberdeen based on Department for Transport statistics (Ref.xx) are presented in Figure 13.13. (The DfT tonnages for 2003-09 differ slightly from the AHB data but they are reasonably well aligned.)

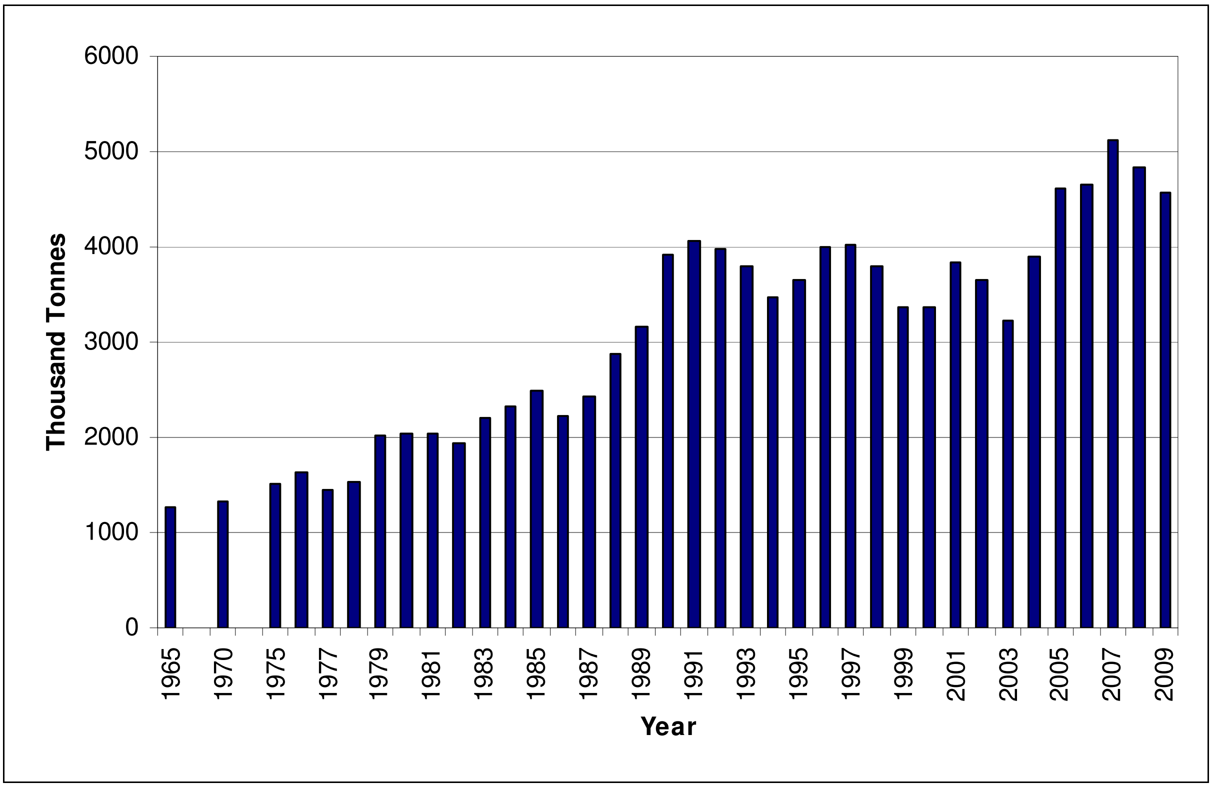


Figure 13.13 Total Tonnage through Aberdeen Harbour (DfT 1965-2009)

Between 1965 and 2009, tonnage has more than trebled. However, in the last 20 years between 1990 and 2009, the overall increase has only been 17%.

Based on the consultation meetings carried out during the project, including several meetings with AHB, no proposals were identified which are likely to have a significant impact on the volume of shipping using the Harbour in the next few years.

The key NW-SW route passing to the east of the proposed EOWDC site is predominantly used by oil & gas industry vessels, and to a lesser extent cargo and passenger ferry services to the Northern Isles. The key factor influencing ship numbers is likely to be the strength of the oil & gas sector in future years. In the long-term, this is expected to decline but the timescale for this is uncertain.

It has been conservatively assumed that over the life of the proposed EOWDC (22 years), there will be a 10% increase in shipping movements.

13.5.2 Fishing

The Commercial Fisheries assessment (Ref.xvi) carried out for the proposed EOWDC Environmental Statement considered the potential changes to the fishing baseline over the life of the development. It is recognised this is a speculative exercise due to numerous unpredictable, direct and indirect factors which can materially affect fisheries.

It stated the following:

> *"At present no new fisheries are foreseen in the area surrounding Aberdeen Bay, and in all probability there is unlikely to be an increase in either fishing effort or vessel numbers. It is also possible that increasing conservation concerns will lead to the implementation of designated protected marine conservation areas which will conceivably have the effect of enforcing further restrictions upon certain commercial fishing activities.*
>
> *There exists the possibility that fishing practices within the proposed EOWDC site could change during its operational life. An example is the appearance of large shoals of squid inshore during the summer in the Moray Firth, providing a valuable fishery which previously did not exist. Furthermore, squid has been recorded at low levels in inshore areas in the proximity of the proposed EOWDC site. It is however considered that this species favours rockier grounds and that the substrate in Aberdeen Bay is not suitable.*
>
> *Finally, future environmental and/or economic constraints may force fishermen to alter or amend current fishing practices. It is possible that vessels may be reconfigured with alternative gear, either to target the same species, or a different fishery."*

The Hazard Review Workshop also indicated that fishing by smaller vessels within the EOWDC site may increase slightly due to the development of the proposed EOWDC.

Based on the discussion presented, the future level of activity has been assumed to increase by 10% over the life of the proposed EOWDC compared to current levels.

13.5.3 Recreational

In terms of recreational vessel activity, there are no major developments known of that will increase the activity of these vessels in the area. There have been suggestions from time to time that a marina for recreational vessels could be established in Aberdeen but there are no known plans for this.

It was suggested at the Hazard Review workshop that the turbines could attract sightseers, given their proximity to the shore.

Based on the discussion presented, the future level of activity has been assumed to increase by 10% over the life of the proposed EOWDC compared to the current, low levels.

13.5.4 Collision Probabilities

The potential increase in vessel activity levels would increase the probability of ship-to-structure collisions (both powered and drifting). Whilst in reality the risk would vary by vessel type, size and route, it is roughly estimated this would lead to a linear 10% increase in the base case collision risks.

The increased activity would also increase the probability of vessel-to-vessel encounters and hence collisions. Whilst this is not a direct result of the proposed project, the increased congestion caused by the site and potential displacement of traffic in the area may have an influence. Again a 10% overall increase is assumed over the life of the proposed EOWDC.

13.6 Risk Results Summary

The base case and future case annual levels of risk without and with the proposed EOWDC site are summarised in Table 13.1 and Figure 13.14. The change in risk is also shown, i.e., the estimated collision risk with the EOWDC minus the baseline collision risk without the EOWDC (which is zero except for vessel-to-vessel collisions).

Table 13.1 Summary of Results

Collision Scenario	Base Case			Future Case		
	Without	With	Change	Without	With	Change
Passing Powered	--	1.1E-03	1.1E-03	--	1.3E-03	1.3E-03
Passing Drifting	--	5.4E-05	5.4E-05	--	5.9E-05	5.9E-05
Vessel-to-Vessel	6.6E-03	6.7E-03	1.3E-04	7.2E-03	7.3E-03	1.4E-04
Fishing	--	1.1E-03	1.1E-03	--	1.3E-03	1.3E-03
Total	6.6E-03	9.0E-03	2.5E-03	7.2E-03	9.9E-03	2.7E-03

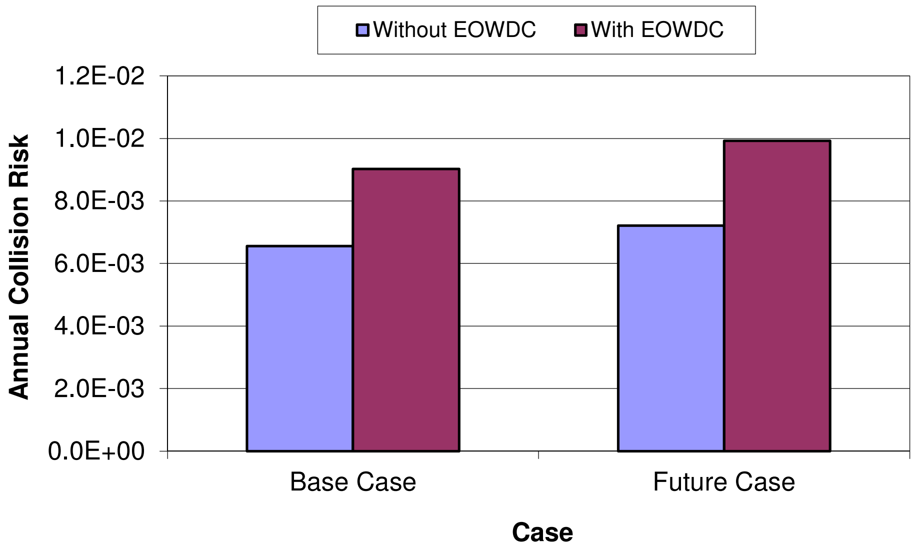


Figure 13.14 Summary of Results

The overall annual level of collision risk is estimated to increase due to the proposed project by approximately 1 in 404 years (base case) and 1 in 367 years (future case). The majority of this risk is from passing powered ship collisions with the turbines on the closest passing route heading in and out of Aberdeen (SSW/NNE), followed by fishing vessel collisions.

The increases are relatively low compared to the existing maritime risks in the area.

13.7 Consequences

The probable outcomes for the majority of hazards are expected to be minor. However, the worst case outcomes could be severe, including events with potentially multiple fatalities.

A collision involving a larger ship is likely to result in collapse of a turbine with limited damage to the ship. Breach of a ship's fuel tank is considered unlikely and in the case of vessels carrying hazardous cargoes, e.g., tanker or gas carrier, the additional safety features associated with these vessels would further mitigate the risk of pollution. Similarly, in a drifting collision the proposed EOWDC structure is likely to absorb the majority of the impact energy, with some energy also being retained by the vessel in terms of rotational movement (glancing blow).

In terms of smaller vessels such as fishing and recreational craft, the worst case scenario would be risk of vessel damage leading to foundering of the vessel and potential loss of life.

A quantitative assessment of the potential consequences of collision due to the proposed EOWDC project is presented in Appendix D. This applies the site-specific collision frequency results presented above with estimated outcomes in terms of fatalities onboard and oil pollution from the vessel based on research into historical collision incidents (MAIB, ITOPF, etc.). The results are summarised in Table 13.2. It is noted that these are based on a conservative approach to give account to the uncertainty surrounding the jacket sub-structure foundation type.

Table 13.2 Annual Predicted Change in Collision Risk due to the proposed EOWDC

Criteria	Base Case	Future Case
Potential Loss of Life (PLL)	1 fatality in 43,000 years	1 fatality in 39,000 years
Oil Spill	0.039 tonnes	0.043 tonnes

Comparing the above estimates with the background marine accident risk levels in the UK (29 fatalities and 16,111 Tonnes of Oil Spilt per annum), the incremental increase in risk to both people and the environment caused by the proposed EOWDC was estimated to be low.

However, it should be noted that this is the localised impact of a single project and there will be additional maritime risks associated with other offshore wind farm projects in Scotland as well as in the UK as a whole.

14. CONSTRUCTION AND DECOMMISIONING IMPACTS

14.1 Introduction

This study has primarily focused on the operational and maintenance phase of the proposed EOWDC, however, it is recognised that there will be additional potential impacts during the construction and decommissioning phases of the project.

In general, whilst the same hazards apply as during the operational and maintenance phase, there are additional hazards which are distinctly associated with these phases of the project and require different risk control measures.

14.2 Hazards during Construction/Decommissioning

During the construction/decommissioning phase there will be an increased level of vessel activity within the proposed EOWDC site and along the cable route.

The presence of construction vessels within the area is likely to pose an additional navigational risk, although such vessels can also provide on-site response and mitigation. The main hazards associated with construction/decommissioning which have been identified over and above those associated with all phases (i.e., where the same risk control measures and emergency response will apply during all phases) are listed below.

- Construction vessel collision with another vessel on-site
- Construction vessel collision with structure
- Construction vessel collision with passing vessel en route to or from site
- Construction vessel encounters (jack-ups or anchors on) underwater obstruction (e.g., cable, pipeline etc).
- Construction vessel jacks-up or anchors onto unexploded ordnance
- Man overboard during personnel transfer operations
- Dropped object during major lifting operations

It is noted that to a large extent the hazards will depend on the vessels and procedures which are to be used for these operations. This will not be known in detail until the structures, construction methods and vessels/contractors have been selected. It is therefore planned that hazard/risk assessment workshops be carried out as part of the project-planning process. The objective of the workshops will be to identify all of the different activities which will be taking place and identify any potential hazards as well as appropriate mitigation measures and operating procedures relevant to the selected vessels and construction methods.

An example measure might be that, wherever possible, construction vessels would follow prescribed transit corridors. These corridors would be defined in consultation with local maritime stakeholders, such as Aberdeen Harbour Board.

The suggested attendees for the workshops are as follows:

- Project Team
- Contractor Representatives (e.g., barges, cable-laying)
- Harbour Representatives
- HM Coastguard (MCA)
- Fishing Representative
- Recreational Vessel Representative
- RNLI Representative

This process will build mutual understanding of the activities and operating constraints of the different parties involved and allow effective procedures to be developed. Separate workshops should be held for each phase of the project as well as for distinct activities.

It is noted that the construction company appointed will have their own internal health and safety procedures that they will adhere to during the work, providing additional security. Experience and lessons learned from the construction of other offshore wind farm projects will be considered prior to the proposed EOWDC being constructed. The same process will apply during the decommissioning phase of the project

14.3 Risk Control/Mitigation during Construction/Decommissioning

Details of risk control/mitigation measures which will apply during these phases of the work are summarised in Section 20.

15. IMPACT ON MARINE RADAR SYSTEMS

15.1 Introduction

In 2004 the MCA conducted trials at the North Hoyle Offshore Wind Farm off North Wales to determine any impact of wind turbines on marine communications and navigations systems (Ref. iii).

The trials indicated that there is minimal impact on VHF radio, Global Positioning Systems (GPS) receivers, cellular telephones and AIS. UHF and other microwave systems suffered from the normal masking effect when turbines were in the line of the transmissions.

This trial identified areas of concern with regard to the potential impact on ship borne and shore based radar systems. This is due to the large vertical extent of the wind turbine generators returning radar responses strong enough to produce interfering side lobe, multiple and reflected echoes (ghosts). This has also been raised as a major concern by the maritime industry with further evidence of the problems being identified by the Port of London Authority around the Kentish Flats Offshore Wind Farm in the Thames Estuary. Based on the results of the North Hoyle trial, the MCA produced a wind farm/shipping route template (see Section 2.2) to give guidance on the distances which should be established between shipping routes and offshore wind farms.

A second trial was conducted at Kentish Flats Offshore Wind Farm on behalf of BWEA (Ref. iv). The project steering group had members from BERR, the MCA and the Port of London Authority (PLA). The trial took place between 30 April and 27 June 2006. This trial was conducted in Pilotage waters and in an area covered by the PLA VTS. It therefore had the benefit of Pilot advice and experience but was also able to assess the impact of the generated effects on VTS radars.

The trial concluded that:

- The phenomena referred to above detected on marine radar displays in the vicinity of wind farms can be produced by other strong echoes close to the observing ship although not necessarily to the same extent.
- Reflections and distortions by ships structures and fittings created many of the effects and that the effects vary from ship to ship and radar to radar.
- VTS scanners static radars can be subject to similar phenomena as above if passing vessels provide a suitable reflecting surface but the effect did not seem to present a significant problem for the PLA VTS.
- Small vessels operating in or near the proposed EOWDC site were detectable by radar on ships operating near the array but were less detectable when the ship was operating within the array.

15.2 Impact on Collision Risk

The potential radar interference is mainly a problem during periods of bad visibility when mariners may not be able to visually confirm the presence of other vessels in the vicinity.

The onset range from the turbines of false returns is about 1.5 nautical miles, with progressive deterioration in the radar display as the range closes. Figure 15.1 presents the combined 56 days of survey tracks relative to the Aberdeen turbine locations, based on the 11 turbine layout. 500m, 1.5nm and 2nm buffers have been applied around each turbine location to illustrate current passing distances.

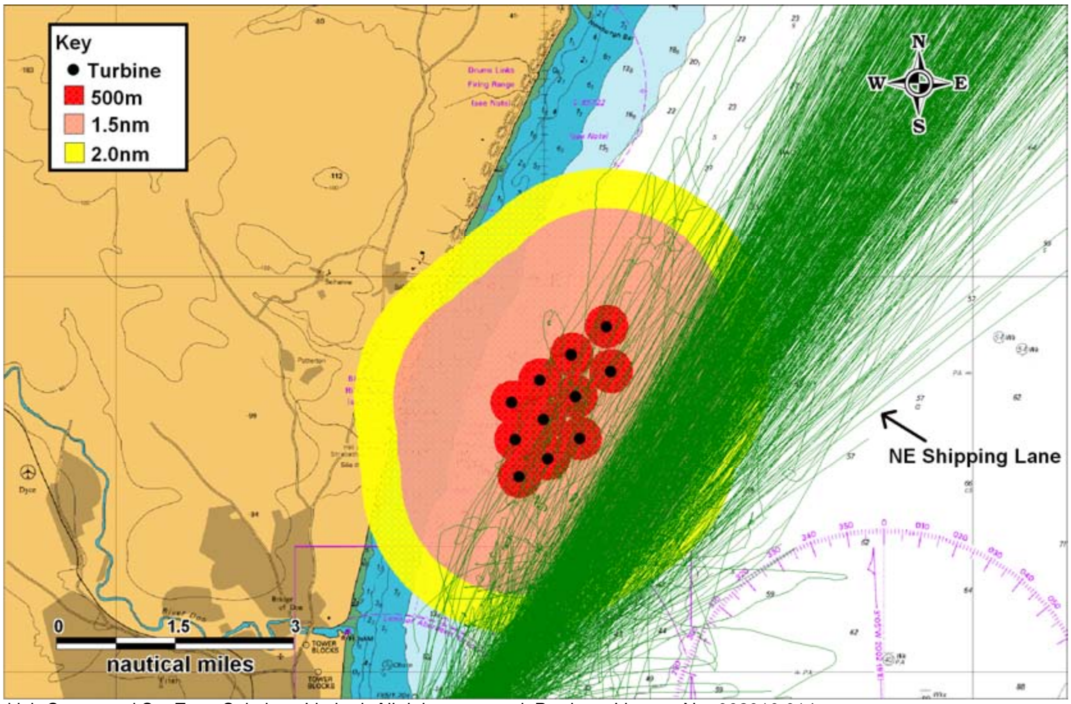


Figure 15.1 Buffer Zones versus Current Shipping Tracks (56 Days Survey Tracks)

It can be seen that, at present, ships pass inside the 1.5nm range from turbines at which radar interference could be experienced.

Assuming an average speed of 11 knots for NE-SW ships based on the survey data, the exposure of a typical ship to the turbines during a 10 mile transit from Aberdeen port travelling northeast is illustrated in Figure 15.2 for the current mean route position and anticipated mean route position (see Figure 9.2).

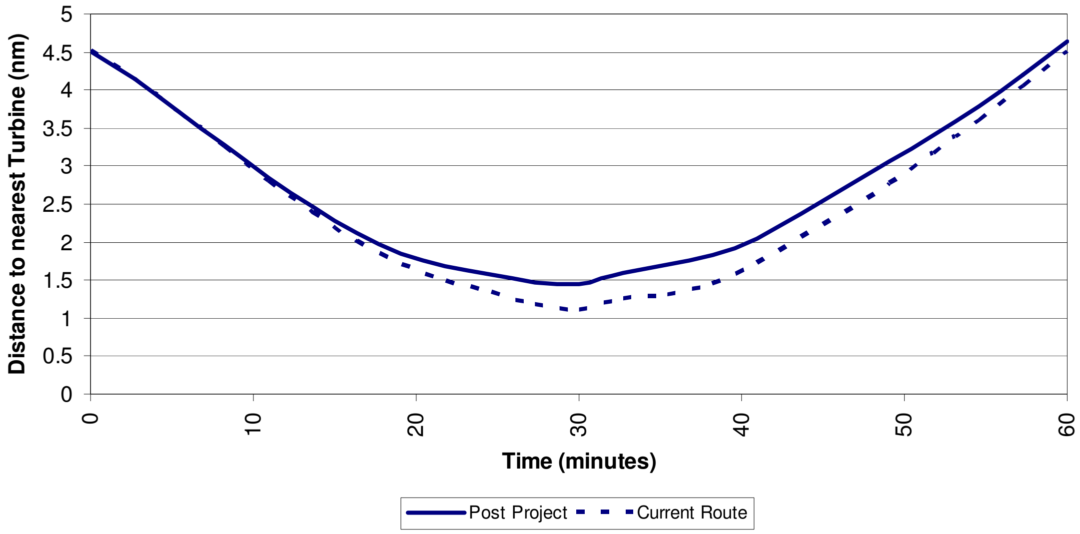


Figure 15.2 Typical Exposure Time versus Distance of Northbound Ship to Turbines

Based on the current transit vessels will be within 1.5nm of the turbines for a total duration of approximately 20 minutes and have a minimum CPA of 1.1nm. Based on the anticipated transit post-project, the typical ship will have a minimum CPA of 1.5nm from the turbines.

Experienced mariners should be able to suppress the observed problems to an extent and for short periods (a few sweeps) by careful adjustment of the receiver amplification (gain), sea clutter and range settings of the radar. However, there is a consequent risk of losing targets with a small radar cross section, which may include buoys or small craft, particularly yachts or GRP constructed craft, therefore due care is needed in making such adjustments. The Kentish Flats Offshore Wind Farm study observed that the use of an easily identifiable reference target (a small buoy) can help the operator select the optimum radar settings.

The performance of a vessel's automatic radar plotting aid (ARPA) could also be affected when tracking targets in or near the wind farm. However, although greater vigilance is required, it appears that during the Kentish Flats Offshore Wind Farm trials, false targets were quickly identified as such by the mariners and then the equipment itself.

Although the evidence from mariners operating in the vicinity of existing wind farms is that they quickly learn to work with and around the effects, it is possible that the radar impacts may result in an increase in the risk of collision. The MCA have produced guidance to mariners operating in the vicinity of UK OREIs which highlights this issue amongst others to be taken into account when planning and undertaking voyages in the vicinity of offshore renewable energy installations (OREIs) off the UK coast (Ref. xxi).

AIS information can be used to verify the targets of larger vessels, generally ships above 300 tonnes. Finally, Aberdeen VTS may be able to assist a vessel if in doubt as to whether a target is genuine during periods of reduced visibility.

The VTS radar may also be affected by the turbines. Discussions are being held with Aberdeen Harbour Board as to how this can be managed / mitigated. At other wind farm sites in the UK, a scanner will be fitted to one of the turbines, linked to the VTS.

16. CUMULATIVE AND IN-COMBINATION EFFECTS

Cumulative impacts with maritime activities (shipping, fishing, recreation and associated facilities) are assessed in the main part of this report.

In terms of other potential cumulative impacts, the only known development in the area was the associated Ocean Laboratory. This is likely to be a Met Mast type structure located in proximity to the proposed EOWDC.

The details available on this development were obtained from the Rochdale Envelope document, as summarised below.

Maximum Height above LAT (m)	120 m
Platform size	20 m x 20 m
Height of platform above LAT	18-20 m
Depth of Platform	Max 4 m including containers and ancillary equipment.
Foundation Type/Size	As per wind turbines
Navigation lighting requirements and colour scheme	The final scheme is to be determined in accordance with British law (IALA requirements) Aviation lighting in accordance with CAA requirements.

There is a potential location identified for this site (see Chapter 3 Description of the Proposed Project) however the final location will be such that it gives full consideration to navigational stakeholders in the area, also allowing for the proposed EOWDC and as a result, cumulative impacts will be negligible.

It is noted that the cumulative assessment also included a review of all Round 1 and 2 offshore wind farms, Round 3 Zones and Scottish Territorial Water sites as presented in Figure 16.1. It can be seen from the figure that the proposed EOWDC is not in close proximity to any other developments. The nearest is the Firth of Forth Round 3 Zone, over 30nm to the south.

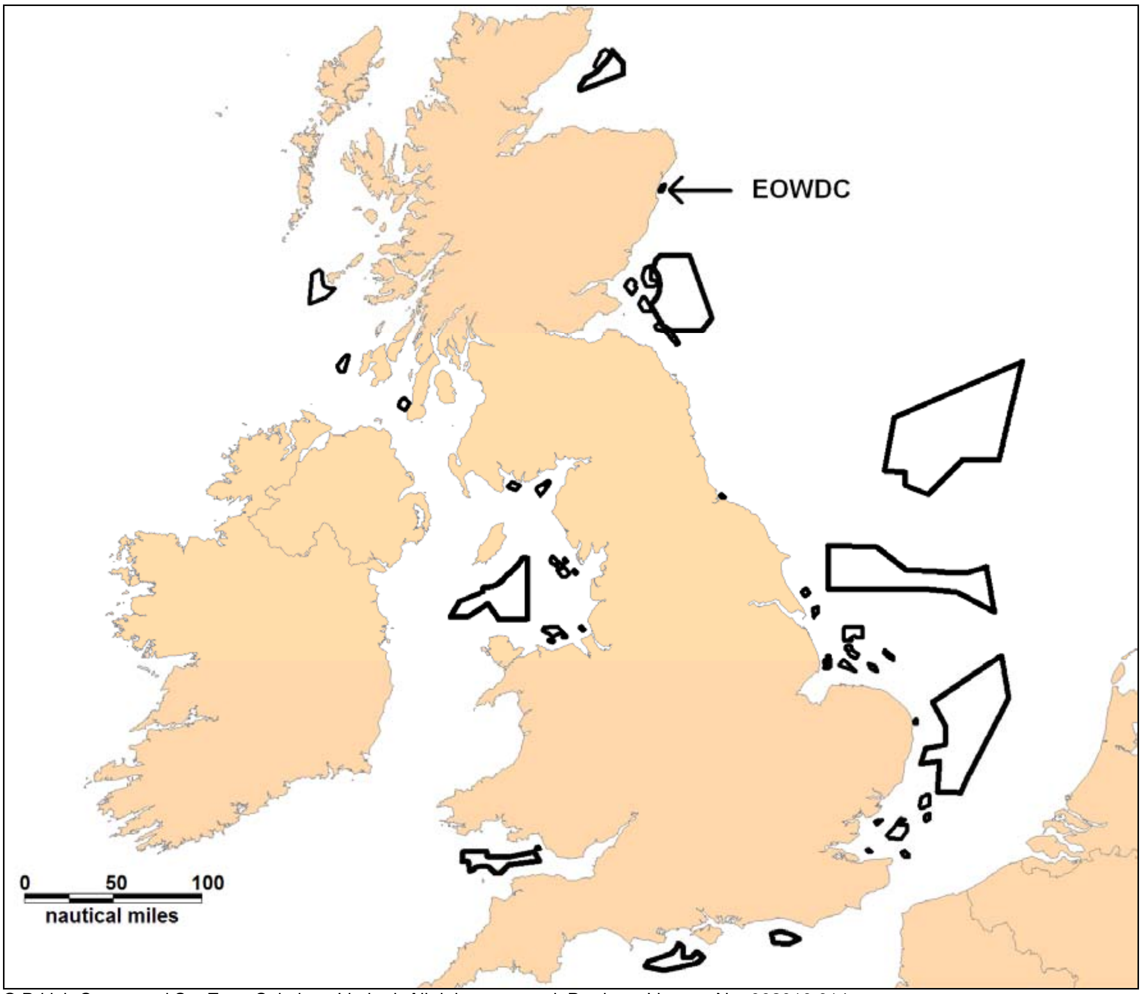


Figure 16.1 Overview of Wind Farm Sites in UK

As mentioned in Section 6.8 there are military practice areas in the vicinity, such as the rifle firing range at Black Dog, but these should not lead to any cumulative navigational impacts.

There are no identified in-combination impacts.

17. SAFETY ZONES

17.1 Construction and Decommissioning Phases

During this phase of the development there will be large construction vessels, working personnel and support craft in operation within and around the proposed EOWDC site area. Further, heavy lifting, piling and cable laying operations will be carried out which have inherent dangers.

In addition the cost of operating construction vessels, and the cost of delay can be significant. A means of controlling 3rd party navigation during these periods of high activity is required. Without this it will not be possible to exclude vessels and carry out their offshore operations in a controlled manner.

Therefore, to ensure the personnel carrying out these activities and those navigating in this sea area are not exposed to unnecessary risk, 500m safety zones may be applied for around each construction activity whilst work is being performed, as indicated by the presence of construction vessels. This will provide a means of regulating the rights of navigation so as to preserve the safety of those working in the proposed EOWDC site and those onboard other vessels that may be navigating in this area. These safety zones will apply to all vessel types not involved in the project operations.

During the construction and decommissioning phases, operational procedures will be implemented for radar and AIS monitoring of vessel activities within the working area, to detect safety zone infringements. Procedures will also be established to ensure that any infringements are formally reported in line with the regulatory requirements.

17.2 Operational Phase

During normal operations the working activities will be limited to general and emergency maintenance work and as such the benefits and requirements for safety zones were reassessed giving account to the working vessels likely to be present within and around the proposed EOWDC site. These vessels will generally be smaller than those involved in the construction phases of the project and therefore smaller safety zones may be applied for during normal operations.

In terms of third-party vessels, it is considered highly unlikely that merchant ships would elect to pass between turbines due to the limited sea room and the fact that the closest routes tend to naturally avoid the location. Therefore, it is only a limited number of fishing and recreational vessels which may choose to pass between turbines.

These vessels were observed in the survey to be mostly heading NE-SW when on passage. It will be up to individual Masters, taking into account the prevailing weather and sea conditions, to decide whether it is safe to navigate, or fish, within the turbine array.

At present 50m safety zones around turbines are planned, which is in-line with other UK offshore wind farm sites. A 200m anchor exclusion is also planned around cables.

17.3 Summary

The safety zones being considered for the project are as follows:

- Construction/Decommissioning:
  - 500m safety zones may be applied for around each construction activity whilst work is being performed.
- Operation:
  - A permanent exclusion zone of 50m around each structure, with a 200m anchor exclusion zone around cables.

The existence of safety zones will be published electronically and via Notices to Mariners.

18. Search and Rescue (SAR)

18.1 Introduction

This section summarises the existing Search & Rescue resources in the region and the issues being considered in relation to the design of the project.

(A detailed review of the historical incidents in the area, including RNLI launches, has been presented in Section 7.)

18.2 SAR Resources

18.2.1 SAR Helicopters

A review of the assets in the area of the proposed EOWDC site indicated that the closest SAR helicopter base is located at Lossiemouth, operated by the RAF, approximately 52nm to the northwest of the proposed EOWDC site. This base has Sea King helicopters with a maximum endurance of 6 hours giving a radius of action of approximately 250nm which is well within the range of the proposed EOWDC site. One helicopter is available at 15 minutes readiness between 0800 and 2200 hours, with another available at 60 minutes readiness between 0800 hours and evening civil twilight (ECT). Between 2200 and 0800 hours, one helicopter is held at 45 minutes readiness.

All RAF SAR helicopters are equipped for full day/night all weather operations over land and sea (some limitations exist with regard to freezing conditions, but in general terms the helicopters are all weather capable) and have a full night vision goggle (NVG) capability. Crews are well practised in NVG operations which is a major enhancement to search capability. In addition, all RAF SAR helicopter rear crew are medically trained, with the winchman trained up to paramedic standard.

Up to 18 persons can be carried, however this is dependent on weather conditions and the distance of the incident from the helicopter’s operating base. All RAF SAR helicopters are equipped with VHF (Marine and Air Band), UHF and HF radios. They are also capable of homing to all international distress frequencies.

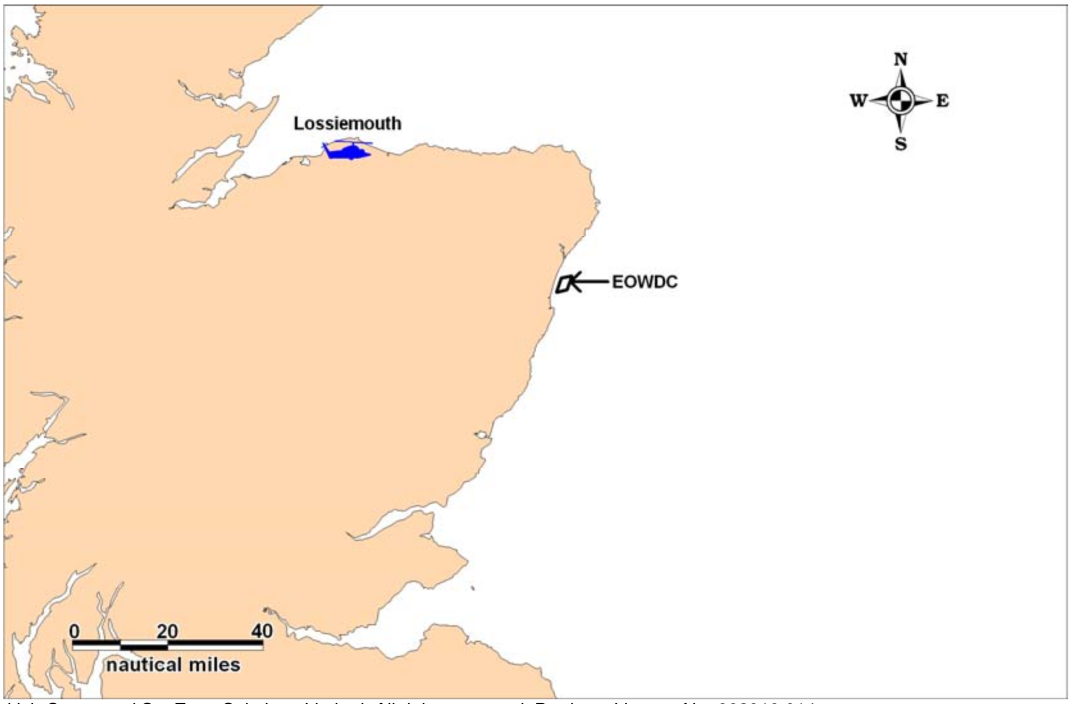


Figure 18.1 SAR Helicopter Bases relative to proposed EOWDC site

Based on the above information, the day-time response to the proposed EOWDC site will be in the order of 1 hour. At night time this will increase by 30 minutes to approximately 1 and a half hours due to the additional response time at the base. It is noted that these calculations are based on still air and will vary depending on the prevailing conditions.

18.2.2 RNLI Lifeboats

The Royal National Lifeboat Institution maintains a fleet of over 400 lifeboats of various types at 235 stations round the coast of the UK and Ireland. The RNLI stations in the vicinity of the proposed EOWDC site are presented in Figure 18.2.

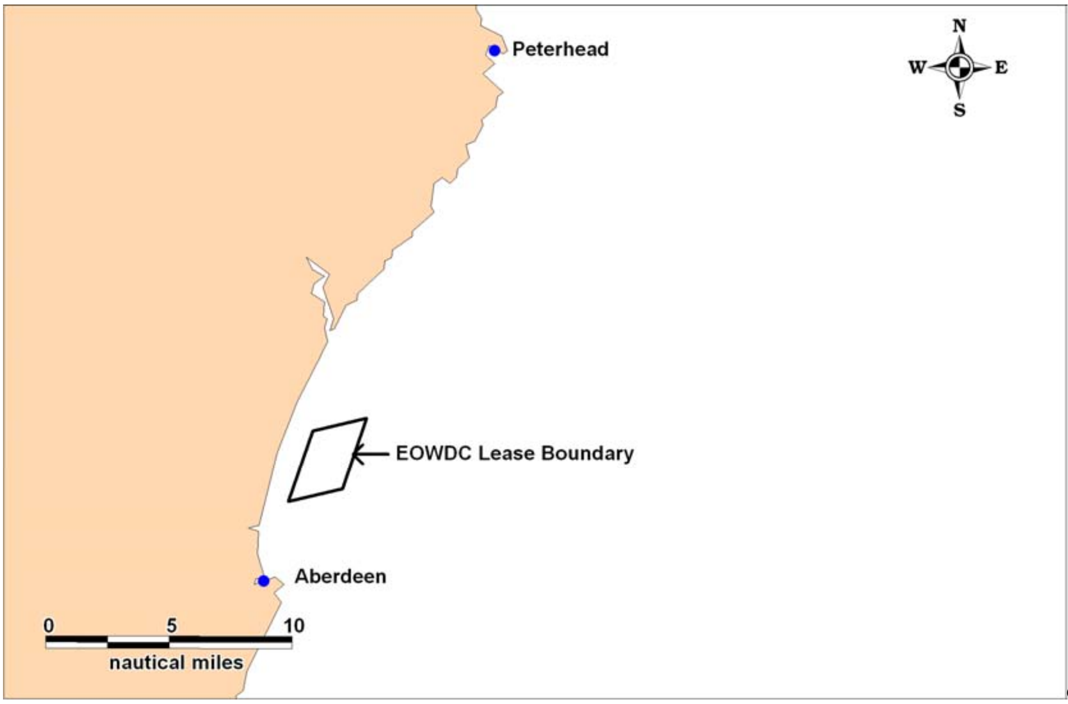


Figure 18.2 RNLI Bases near the proposed EOWDC site

At each of these stations crew and lifeboats are available on a 24-hour basis throughout the year. Table 18.1 provides a summary of the facilities at the stations closest to the proposed EOWDC site.

Table 18.1 Lifeboats held at nearby RNLI Stations

Station	Lifeboats	ALB Spec	ILB Spec	Distance to Site Boundary
Aberdeen	ALB/ILB	Severn	D Class	4.5nm
Peterhead	ALB	Tamar	--	17nm

The Severn class lifeboat has a speed of 25 knots, range of 250nm and can operate in all-weather. The Tamar is also an all weather boat and has a speed of 25 Knots and a 250nm range All-weather lifeboats are fitted with the latest in navigation, location and communication equipment, including electronic chart plotter, VHF radio with direction finder, radar and global positioning systems (GPS).

The D class lifeboat is small and highly manoeuvrable, making it ideal for rescues close to shore in fair to moderate conditions. It has a speed of 25 knots, range of 3 hours at maximum speed and is equipped with VHF radio and GPS.

Response times vary but an average declared by RNLI is 14 minutes for all-weather lifeboats and 7 minutes for inshore lifeboats. This is the time from callout, i.e., first intimation from Coastguard to the lifeboat station to launch. This means the ALB at Aberdeen could be on the scene within 30 minutes.

18.2.3 Coastguard Stations

HM Coastguard is responsible for requesting and tasking SAR resources made available by other authorities and for co-ordinating the subsequent SAR operations (unless they fall within military jurisdiction).

HM Coastguard co-ordinates SAR through its network of 18 Maritime Rescue Co-ordination Centres (MRCC), although this is currently under review. A corps of over 3100 volunteer Auxiliary Coastguards around the UK coast form over 400 local Coastguard Rescue Teams (CRT) involved in coastal rescue, searches and surveillance.

All of the MCA's operations, including SAR, are divided into three geographical regions. The East of England Region covers the East and South Coasts of England from the Scottish border down to the Dorset/Devon border. The Wales and West of England Region extends from Devon and Cornwall to cover the coast of Wales, North West England and the Moray Firth. The Scotland and Northern Ireland Region covers the remainder of the UK coastline including the Western Isles, Orkney and Shetland.

Each region is divided into six districts with its own Maritime Rescue Co-ordination Centre (MRCC), which co-ordinates the Search and Rescue response for maritime and coastal emergencies within its district boundaries (East of England Region includes an additional station, London Coastguard, for co-ordinating Search and Rescue on the River Thames).

The proposed EOWDC site lies within the Scotland and Northern Ireland Region with the nearest rescue coordination centre being Aberdeen. MRCC Aberdeen's area of responsibility provides search and rescue coverage from Cape Wrath to Doonies Point.

MRCC Aberdeen is subdivided into fourteen sectors with the proposed EOWDC site within the Aberdeen sector between Balmedie in the North to Doonies Point in the South.

18.2.4 Salvage

MCA charters four Emergency Towing Vessels (ETVs) to provide emergency towing cover in winter months in the four areas adjudged to pose the highest risk of a marine accident: the Dover Strait, the Minches, the Western Approaches and the Fair Isle Channel.

These are a considerable distance from the proposed EOWDC site; however, each MRCC also holds comprehensive databases of harbour tugs available locally.

Procedures are also in place with Brokers and Lloyd's Casualty Reporting Service to quickly obtain information on towing vessels that may be able to respond to an incident.

MCA has an agreement with the British Tug owners Association (BTA) for emergency chartering arrangements for harbour tugs. The agreement covers activation, contractual arrangements, liabilities and operational procedures, should MCA request assistance from any local harbour tug as part of the response to an incident.

Tugs are available within Aberdeen Harbour through a licensed Tug Operator. An agreement exists which retains one tug permanently in Aberdeen, however in practice there are two tugs most of the time. The tugs *Cultra* and *Carrickfergus* have a bollard pull of 30 tonnes each. A third tug is available with notice. There are also a number of offshore industry vessels with towing capability based in Aberdeen.

18.3 Wind Farm SAR Matters

The proposed EOWDC site will meet the MCA's requirements in terms of standards and procedures for generator shutdown and other operational requirements in the event of a search and rescue, counter pollution or salvage incident in or around the site. These are laid out in Annex 5 of MGN 371 (Ref. ii).

This includes the development of an Emergency Response Co-operation Plan (ERCoP) for the proposed project, which will be in place pre-construction.

Examples of features to be incorporated are as follows:

Design:

- All wind turbine generators (WTGs) and other OREI individual structures will each be marked with clearly visible unique identification characters which can be seen by both vessels at sea level and aircraft (helicopters and fixed wing) from above.

- The identification characters shall each be illuminated by a low-intensity light visible from a vessel thus enabling the structure to be detected at a suitable distance to avoid a collision with it. The size of the identification characters in combination with the lighting will be such that, under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer, stationed 3 m above sea level, and at a distance of at least 150 m from the turbine.

Operation:

- The Central Control Room, or mutually agreed single contact point, will be manned 24 hours a day.

- All MRCCs will be advised of the contact telephone number of the Central Control Room, or single contact point (and vice versa)

- The control room operator, or single contact point, will immediately initiate the shut-down procedure for WTGs as requested by the MRCC, and maintain the WTG in the appropriate shut-down position, as requested by the MRCC, until receiving notification from the MRCC that it is safe to restart the WTG.

19. ADDITIONAL NAVIGATION ISSUES

19.1 Introduction

There are a number of additional navigational issues identified within MGN 371 (Ref. ii) which require to be addressed by the developer. The following subsections cover additional navigation related issues which have not been covered elsewhere within this report.

19.2 Visual Navigation and Collision Avoidance

19.2.1 Introduction

MGN 371 identifies the potential for visual navigation to be impaired by the location of offshore wind farm structures, based on vessels not being visible to each other (hidden behind structures) and navigational aids and/or landmarks not being visible to shipping.

19.2.2 Visual Impact (Other Vessels)

Based on the position, orientation, number of turbines and spacing between turbines it is not considered there will be any significant issue of visual impact between vessels on the main commercial shipping routes in the area, which should all pass to the east. There is an anchorage area just over 2nm to the south of the proposed EOWDC site, but the vessels using it should also remain visible and will generally be travelling at low speeds when entering or leaving the area.

There is limited small craft activity in the area which limits the likelihood of a small craft emerging from the proposed EOWDC site towards shipping traffic. Even if that were the case, the vessel should be visible for the vast majority of the time due to the small size of the turbines relative to the large spacing between them.

19.2.3 Visual Impact (Navigational Aids and/or Landmarks)

Depending on the approach direction of vessels, the proposed project could hamper the view of existing navigational aids and landmarks, such as the firing range buoys to the west, Girdle Ness Lighthouse, the Fairway Buoy and the lights located on the breakwaters.

However, the proposed EOWDC site itself will form a significant aid to navigation, which will be very visible to shipping with lights on significant peripheral structures as well as selected intermediate structures in accordance with NLB requirements (see Section 4). It is therefore not considered that the EOWDC site will degrade the ability of ships to navigate in the area through visual impairment of navigation aids or landmarks.

19.3 Potential Effects on Waves and Tidal Currents

Based on a specialist study, it was concluded that there will be no significant impact from the proposed project on local tidal currents or waves.

19.4 Impacts of Structures on Wind Masking/Turbulence or Shear

The offshore turbines have the potential to affect vessels under sail when passing through the site from effects such as wind shear, masking and turbulence. From previous studies of offshore wind farms it was concluded that turbines do reduce wind velocity by in the order of 10% downwind of a turbine. The temporary effect is not considered as being significant and similar to that experienced passing a large ship or close to other large structures (e.g., bridges) or the coastline. In addition, practical experience to date from RYA members taking vessels into other sites indicates that this is not likely to be an issue. Finally, it is noted that there is limited sailing activity in the Aberdeen Bay area.

19.5 Sedimentation/Scouring Impacting Navigable Water Depths in Area

There exists the potential for structures in the tidal stream to produce siltation, deposition of sediment or scouring which could affect the navigable water depths in the proposed EOWDC site area or adjacent to the area. The specialist work carried out as part of the ES has shown that no significant impact on navigation will result from the potential effects of the EOWDC development on the physical environment.

19.6 Structures and Generators affecting Sonar Systems in Area

No evidence has been found to date with regard to existing wind farms to suggest that they produce any kind of sonar interference which is detrimental to the fishing industry, or to military systems. No impact is anticipated for the EOWDC project.

19.7 Electromagnetic Interference on Navigation Equipment

Based on the findings of the trials at the North Hoyle Offshore Wind Farm (Ref. iii), the wind turbines and their cabling, inter-turbine and onshore, did not cause any compass deviation during the trials. However, it is stated that as with any ferrous metal structure, caution should be exercised when using magnetic compasses close to turbine towers.

It is noted that all equipment and cables will be rated and in compliance with design codes. In addition the cables associated with the wind farm will be buried to a minimum of 0.6 m and any generated fields will be very weak and will have no impact on navigation or electronic equipment. No impact is anticipated for the EOWDC project.

19.8 Impacts on Communications and Position Fixing

The following summarises the potential impacts of the different communications and position fixing devices used in and around offshore wind farms. The basis for the assessment is the trials carried out by the MCA at North Hoyle Offshore Wind Farm and experience of personnel/vessels operating in and around other offshore wind farm sites.

19.8.1 VHF Communications (including Digital Selective Calling)

Vessels operating in and around offshore wind farms have not noted any noticeable effects on VHF (including voice and DSC communications). No significant impact is anticipated at the proposed EOWDC site.

19.8.2 Navtex

The Navtex system is used for the automatic broadcast of localised Maritime Safety Information (MSI). The system mainly operates in the Medium Frequency radio band just above and below the old 500 kHz Morse Distress frequency. No significant impact has been noted at other sites and none are expected at the proposed EOWDC site.

19.8.3 VHF Direction Finding

During the North Hoyle Offshore Wind Farm trials, the VHF direction equipment carried in the lifeboats did not function correctly when very close to turbines (within about 50 m). This is deemed to be a relatively small scale impact and provided the effect is recognised, it should not be a problem in practical search and rescue.

19.8.4 Automatic Identification System (AIS)

In theory there could be interference when there is a structure located between the transmitting and receiving antennas (i.e., blocking line of sight). This was not evident in the trials carried out at the North Hoyle Offshore Wind Farm site and no significant impact is anticipated for AIS signals being transmitted and received at the proposed EOWDC site.

19.8.5 Global Positioning System (GPS)

No problems with basic GPS reception or positional accuracy were reported during the trials at North Hoyle Offshore Wind Farm and this has been confirmed from other vessels which have been inside offshore wind farms. Consideration will require to be given to any potential degradation of DGPS signals being used to position construction equipment when close to a turbine tower.

19.8.6 LORAN-C

LORAN-C is a low frequency electronic position-fixing system using pulsed transmissions at 100 kHz. The absolute accuracy of Loran-C varies from 0.1 to 0.25 nm. Its use is in steep decline, with GPS being the primary replacement. It is mostly used in ships on and near the US coast, although some GPS receivers have built-in Loran C software.

Attempts were made to test a system during the North Hoyle Offshore Wind Farm trial, but there were difficulties which were probably attributable to operational errors or lack of a nearby transmitter.

Although a position could not be obtained using LORAN-C in the wind farm area, the available signals were received without apparent degradation. The proposed EOWDC is not expected to have a significant impact on LORAN-C. It is noted that the Department for Transport are funding an enhanced LORAN (eLORAN) service in the UK.

19.9 Noise Impact

19.9.1 Acoustic Noise Masking Sound Signals

The concern which must be addressed under MGN 371 is whether acoustic noise from the wind farm could mask prescribed sound signals.

The sound level from a wind farm at a distance of 350m has been predicted to be 51 dB (A) to 54 dB (A) and it should therefore be well below a background sound level which is typically 63-68 dB. A ship's whistle for a vessel of 75m should generate in the order of 138 dB and be audible at a range of 1.5nm, so this should be heard above the background noise of the site. Foghorns will also be audible over the background noise of the project.

Therefore, there is no indication that the sound level of the proposed EOWDC will have any significant influence on marine safety.

19.9.2 Noise Impacting Sonar

Once in operation it is not believed that there will be any subsea acoustic noise generated by the proposed EOWDC that will have any significant impact on sonar systems.

20. RISK MITIGATION MEASURES & MONITORING

20.1 Mitigation

This section summarises the main risk mitigation measures adopted by AOWFL for the proposed EOWDC to reduce the navigational impact of the project.

Table 20.1 Mitigation Measures

Mitigation	Description
Site selection	Site selected to avoid significant navigational impacts, e.g., located away from main anchorage area and navigation lanes to/from Aberdeen following consultation with Aberdeen Harbour, etc.
Marked on Admiralty Charts	EOWDC will be charted by the UK Hydrographic Office using the magenta turbine tower chart symbol found in publication "NP 5011 - Symbols and Abbreviations used in Admiralty Charts". Submarine cables associated with the project will also be charted on the appropriate scale charts.
Information Circulation	Appropriate liaison to ensure information on the wind farm and special activities is circulated in Notices to Mariners, Navigation Information Broadcasts and other appropriate media.
Marking and Lighting	Structures to be marked and lit in-line with NLB and IALA guidance. (See Section 4.)
Turbine Air Draught	Lowest point of rotor sweep at least 22m above Mean High Water Springs as per RYA and MCA recommendations.
Cable Protection	Cables to be buried to suitable depth based on cable protection study taking into account fishing and anchoring practices in Aberdeen Bay. Periodic inspection of the cable to ensure it remains buried. Positions of cable routes notified to Kingfisher Information Services (KIS) for inclusion in cable awareness charts and plotters for the fishing industry.
Compliance with MCA's Marine Guidance Notice (MGN) 371 including Annex 5	Annex 5 specifies "Standards and procedures for generator shutdown and other operational requirements in the event of a search and rescue, counter pollution or salvage incident in or around an OREI."
Formulation of an Emergency Response Cooperation Plan (ERCoP) as per MCA template	AOWFL will use the draft template created by the MCA to formulate an emergency response plan and site Safety Management Systems, in consultation with the MCA.

Discussions on other measures will continue both pre- and post-construction and during the life of the project with the MCA, Aberdeen Harbour Board and other relevant stakeholders.

20.2 Future Monitoring

From a navigation risk perspective, monitoring will take place through the project's Safety Management System (SMS). The Safety Management System will include an incident/accident reporting system which will allow incidents and near misses to be recorded and reviewed to monitor the effectiveness of the risk control measures in place at the site. In addition to this any information gleaned from near misses/accidents at other offshore wind farm sites will be considered with respect to the control measures applied at the proposed EOWDC.

Whilst no radar monitoring of vessel movements has been proposed for the site, AIS monitoring is being considered which can be used to monitor and record the movements of vessels around the proposed EOWDC site and associated export cables to shore, as well as company vessels working at the site.

During maintenance, there will regularly be vessels operating in the site which can monitor any third party vessel activity both visually and on radar, although this will not be their primary function.

The subsea cable routes will be subject to periodic inspection to ensure they remain buried.

Finally, it is noted that the site and cable route are within coverage of Aberdeen VTS, and the VTS will be vigilant to hazardous navigational practices within the general area.

21. CONCLUSIONS

The main conclusions of this work are as follows:

- The proposed EOWDC site has been relocated and reduced in size such that it will not affect the main navigation routes in the area, including the bulk of shipping heading to/from Aberdeen Harbour.

- Moving the site to the north has provided a 0.25 nm separation between the nearest turbine and the designated anchorage area in Aberdeen Bay.

- Consultation with Aberdeen Harbour Board and other users of the area, such as NorthLink Ferries, indicated the site is acceptable.

- There is limited fishing and recreational vessel activity in the area.

- In the hazard review workshop involving local navigational stakeholders, all hazards were identified to be low.

- Following identification of the key navigational hazards, risk analyses were carried out to investigate selected hazards in more detail. The overall annual level of risk was estimated to increase due to the proposed EOWDC by approximately 1 in 404 years (base case) and 1 in 367 years (future case based on traffic growth estimates over the life of the development). The majority of this risk is from passing powered ship collisions with the turbines from the closest passing route headed to/from Aberdeen, followed by fishing vessel collisions.

- The risks associated with recreational craft interaction with the proposed EOWDC structures (blade/mast and vessel/structure collisions) were qualitatively assessed and concluded to be as low as reasonably practicable given the mitigation measures planned.

- A quantitative assessment estimated that, compared to the background marine accident risk levels in the UK, the increase in risk to both people and the environment caused by the proposed EOWDC is low.

22. REFERENCES

i DECC, U.K. Government, Methodology for Assessing the Marine Navigational Safety Risks of Offshore Windfarms, Version Date: 7th September 2005.

ii MCA Marine Guidance Notice 371, Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues.

iii Results of the EM Investigations and assessments of marine radar, communications and positioning systems undertaken at the North Hoyle Wind Farm by QinetiQ and the Maritime & Coastguard Agency; 29 September 2004.

iv Investigation of Technical and Operational Effects on Marine Radar Close to Kentish Flats Offshore Wind Farm, BWEA, DTI, MCA & PLA; April 2007.

v The Proposed Aberdeen Bay Wind Turbine Location Maritime Safety Concerns Opinion document. http://www.marinesafetyforum.co.uk/upload-files/notices/wind_deployment_centre_-_wind_farm_maritime_safety_concerns_info_sheet_rev_043%7D.pdf

vi Aberdeen Harbour Annual Report and Financial Statements 2009, Aberdeen Harbour Board, 2010.

vii Admiralty Sailing Directions - North Sea (West) Pilot, NP 54, 6th Edition, 2003.

viii Chart 213, Fraserburgh to Newburgh, Tidal Diamond D, 57 19'.99 N, 001 45'.10 E.

ix Anatec Ltd, Maritime Traffic Survey 5, Report No: A2622-AREG -TS-5, 4 April 2011.

x Anatec Ltd, Maritime Traffic Survey 1, Report No: A2185-AREG-TS-1, 9 June 2009.

xi Anatec Ltd, Maritime Traffic Survey 2, Report No: A2185- AREG -TS-2, 13 November 2009.

xii Anatec Ltd, Maritime Traffic Survey 3, Report No: A2185- AREG -TS-3, 12 July 2010.

xiii Anatec Ltd, Maritime Traffic Survey 4, Report No: A2555- AREG -TS-4, 12 January 2011.

xiv RYA, UK Coastal Atlas.

xv The Macmillan REEDS Nautical Almanac 2001

xvi EOWDC Commercial Fisheries Aspects, Brown and May Ltd.

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xviii IMO, Guidelines for Formal Safety Assessment (FSA) for use in the IMO rule Making Process, 5th April 2002.

xix Aberdeen Harbour Board, Economic Impact Assessment of Aberdeen Harbour, Final Report, May 2007.

xx Department for Transport, Maritime Statistics, 2009.

xxi MCA Marine Guidance Notice 372 (M+F), Guidance to Mariners Operating in the Vicinity of UK OREIs, August 2008.

MCA MGN 371 Checklist

European Offshore Wind Deployment Centre

(Appendix A)

Prepared by:	Anatec Limited
Presented to:	Aberdeen Offshore Wind Farm Limited
Date:	9 June 2011
Revision No.:	01
Ref.:	A2555-AOWF-NRA-1 App A

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A1. Introduction

This Appendix presents the MCA checklist based on the requirements set out in MGN 371 which was the guidance set by the MCA during the NRA preparation.

Reference notes/remarks are made within the table based on which sections of the NRA, or other documents, address the issue noted in the MGN 371 checklist.

A2. MGN 371 Compliance Checklist

Table 1 MGN 371 Compliance Checklist for the European Offshore Wind Deployment Centre

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
Considerations on Site Position, Structures and Safety Zones			
1. Traffic Survey			
All vessel types	✔		Section 8 of NRA.
Four weeks duration, within 12 months prior to submission of the Environmental Statement	✔		Survey period comprised two weeks of data from April 2009, September 2009, April 2010 and November 2010 totalling 56 days.
Seasonal variations	✔		Surveys have been carried out in April, September and November. Other long-term data sets and consultation were used to identify variations in recreational and fishing vessel activity. (Also refer to the Commercial Fisheries study carried out for the ES.)
Recreational and fishing vessel organisations	✔		Sections 10 and 11 of NRA.
Port and navigation authorities	✔		Sections 5, 6 and 8 of NRA.
Assessment			
Proposed OREI site relative to areas used by any type of marine craft.	✔		Sections 8-11 of NRA.
Numbers, types and sizes of vessels presently using such areas	✔		Sections 8-11 of NRA.
Non-transit uses of the areas, e.g. fishing, day cruising of leisure craft, racing, aggregate dredging, etc.	✔		Sections 8-11 of NRA.
Whether these areas contain transit routes used by coastal or deep-draught vessels on passage.	✔		Section 8 of NRA.
Alignment and proximity of the site relative to adjacent shipping lanes	✔		Sections 8 and 9 of NRA.
Whether the nearby area contains prescribed routeing schemes or precautionary areas	✔		Sections 6, 8 and 9 of NRA.
Whether the site lies on or near a prescribed or conventionally accepted separation zone between two opposing routes	✔		Sections 6, 8 and 9 of NRA.
Proximity of the site to areas used for anchorage, safe haven, port approaches	✔		Sections 6, 8 and 9 of NRA.

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
and pilot boarding or landing areas.			
Whether the site lies within the limits of jurisdiction of a port and/or navigation authority.	✔		Section 6.2 of NRA.
Proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds.	✔		Section 11 of NRA and Commercial Fisheries study.
Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.	✔		Section 6.8 and Section 16 of NRA.
Proximity of the site to existing or proposed offshore oil / gas platform, marine aggregate dredging, or other exploration/exploitation sites	✔		Section 6.7 and Section 16 of NRA.
Proximity of the site relative to any designated areas for the disposal of dredging spoil	✔		Not applicable.
Proximity of the site to aids to navigation and/or Vessel Traffic Services (VTS) in or adjacent to the area and any impact thereon.	✔		Sections 6 of NRA.
Researched opinion using computer simulation techniques with respect to the displacement of traffic and, in particular, the creation of 'choke points' in areas of high traffic density.	✔		Sections 8, 9 and 13 of NRA.
Type(s) of simulation used in analysis Limitation of system (s)	✔		Sections 8, 9 and 13 of NRA
2. OREI Structures			
Whether any features of the OREI, including auxiliary platforms outside the main generator site and cabling to the shore, could pose any type of difficulty or danger to vessels underway, performing normal operations, or anchoring	✔		Sections 9-15 of NRA. (Note: The final design has not yet been selected therefore the current expected layout has been assumed).
Clearances of wind turbine blades above the sea surface *not less than 22 metres*	✔		Section 3.4 of NRA.
Least depth of current turbine blades	✔		Not applicable.
The burial depth of cabling	✔		0.6m to 3m (Ref Rochdale Envelope Requirements for the European Offshore Wind Development Centre – RE18554-W-02-11)
Whether any feature of the installation could create problems for emergency rescue services, including the use of lifeboats, helicopters and emergency towing vessels (ETVs)	✔		Section 18 of NRA.
How rotor blade rotation and power	✔		Section 18 of NRA.

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
transmission, etc., will be controlled by the designated services when this is required in an emergency.			
3. Assessment of Access to and Navigation Within, or Close to , an OREI To determine the extent to which navigation would be feasible within the OREI site itself by assessing whether:			
a. Navigation within the site would be safe:	✔		
i. by all vessels, or ii. by specified vessel types, operations and/or sizes. iii. in all directions or areas, or iv. in specified directions or areas. v. in specified tidal, weather or other conditions			Entire NRA.
b. Navigation in and/or near the site should be:	✔		
i. prohibited by specified vessels types, operations and/or sizes. ii. prohibited in respect of specific activities, iii. prohibited in all areas or directions, or iv. prohibited in specified areas or directions, or v. prohibited in specified tidal or weather conditions, or simply vi. recommended to be avoided.			Entire NRA.
c. Exclusion from the site could cause navigational, safety or routeing problems for vessels operating in the area.	✔		See Sections 8-11 for discussion of likely impacts of site on vessel activity.
Relevant information concerning a decision	✔		Section 17 of NRA.

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
to seek a "safety zone" for a particular site during any point in its construction, operation or decommissioning.			
Navigation, collision avoidance and communications			
1. The Effect of Tides and Tidal Streams : It should be determined whether or not:			
Current maritime traffic flows and operations in the general area are affected by the depth of water in which the proposed installation is situated at various states of the tide i.e. whether the installation could pose problems at high water which do not exist at low water conditions, and vice versa.	✔		Sections 3, 6, 8 of NRA
Set and rate of the tidal stream, at any state of the tide, has a significant affect on vessels in the area of the OREI site.	✔		Sections 6,.7, 8 and 13 of NRA
Maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect.	✔		Section 6.9 of NRA.
The set is across the major axis of the layout at any time, and, if so, at what rate.	✔		Section 6.9 of NRA.
In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream.	✔		Section 6.9, 9 and 13.3 of NRA. (Tides in the area used to model risk of drifting ship collision.)
Structures themselves could cause changes in the set and rate of the tidal stream.	✔		Section 19.3 of NRA.
Structures in the tidal stream could be such as to produce siltation, deposition of sediment or scouring, affecting navigable water depths in the windfarm area or adjacent to the area	✔		Section 19.5 of NRA.
			.
2. Weather: To determine if:			
The site, in normal, bad weather, or restricted visibility conditions, could present difficulties or dangers to craft, including sailing vessels, which might pass in close proximity to it.	✔		Sections 3, 6.9, 7, 8-13, 15, 19 and 20 of NRA.
The structures could create problems in the area for vessels under sail, such as wind masking, turbulence or sheer.	✔		Section 19.4 of NRA.
In general taking into account the prevailing winds for the area, whether engine failure or other circumstances could cause vessels to drift into danger, particularly if in conjunction with a tidal set.	✔		Section 13.3 of NRA (Drifting collision risk model).

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
3. Visual Navigation and Collision Avoidance: To assess the extent to which			
Structures could block or hinder the view of other vessels under way on any route.	✔		Section 19.2 of NRA.
Structures could block or hinder the view of the coastline or of any other navigational feature such as aids to navigation, landmarks, promontories, etc	✔		Section 19.2 of NRA.
4. Communications, Radar and Positioning Systems : To provide researched opinion of a generic and, where appropriate, site specific nature concerning whether or not:			
Structures could produce radio interference such as shadowing, reflections or phase changes, with respect to any frequencies used for marine positioning, navigation or communications, including Automatic Identification Systems (AIS), whether ship borne, ashore or fitted to any of the proposed structures.	✔		Section 15 of NRA.
Structures could produce radar reflections, blind spots, shadow areas or other adverse effects: a. Vessel to vessel; b. Vessel to shore; c. VTS radar to vessel; d. Racon to/from vessel.	✔		Section 15 of NRA.
OREI, in general, would comply with current recommendations concerning electromagnetic interference.	✔		Section 15 of NRA.
Structures and generators might produce sonar interference affecting fishing, industrial or military systems used in the area.	✔		Section 19.6 of NRA.
Site might produce acoustic noise which could mask prescribed sound signals.	✔		Section 19.9 of NRA.
Generators and the seabed cabling within the site and onshore might produce electro-magnetic fields affecting compasses and other navigation systems.	✔		Section 19.7 of NRA.
5. Marine Navigational Marking : To determine:			
How the overall site would be marked by day and by night taking into account that there may be an ongoing requirement for	✔		Section 4 of NRA.

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
marking on completion of decommissioning, depending on individual circumstances.			
How individual structures on the perimeter of and within the site, both above and below the sea surface, would be marked by day and by night.	✔		Section 4 of NRA.
If the specific OREI structure would be inherently radar conspicuous from all seawards directions (and for SAR and maritime surveillance aviation purposes) or would require passive enhancers	✔		Section 4 of NRA.
If the site would be marked by one or more racons and/ or,	✔		Section 6.4 of NRA.
If the site would be marked by an Automatic Identification System (AIS) transceiver, and if so, the data it would transmit.	✔		Sections 20 of NRA. (under consideration)
If the site would be fitted with a sound signal, and where the signal or signals would be sited	✔		Section 12.4 of NRA (potential mitigation measure).
If the structure (s) would be fitted with aviation marks, and if so, how these would be screened from mariners or potential confusion with other navigational marks & lights resolved.	✔		Not applicable
Whether the proposed site and/or its individual generators would comply in general with markings for such structures, as required by the relevant General Lighthouse Authority (GLA) or recommended by the Maritime and Coastguard Agency, respectively.	✔		Section 4 of NRA.
The aids to navigation specified by the GLAs are being maintained such that the ‘availability criteria’, as laid down and applied by the GLAs, is met at all times.	✔		Section 4 of NRA.
The procedures that need to be put in place to respond to casualties to the aids to navigation specified by the GLAs, within the timescales laid down and specified by the GLAs.	✔		Section 4 of NRA.
5. Hydrography : In order to establish a baseline, detailed and accurate hydrographic surveys are required to IHO Order 1 standard multibeam bathymetry with final data being supplied as a digital full density data set, and erroneous surrounding flagged as deleted but included in the data set. A full report detailing survey methodology and equipment should accompany the			

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
surveys.			
	✔		This was a requirement of the Hydrographic Surveys contract.
Safety and mitigation measures recommended for OREI during construction, operation and decommissioning.			
Mitigation and safety measures will be applied to the OREI development appropriate to the level and type of risk determined during the Environmental Impact Assessment (EIA).The specific measures to be employed will be selected in consultation with the Maritime and Coastguard Agency and will be listed in the developer's Environmental Statement (ES). These will be consistent with international standards contained in, for example, the Safety of Life at Sea (SOLAS) Convention - Chapter V, IMO Resolution A.572 (14)[3] and Resolution A.671(16)[4] and could include any or all of the following:	✔		Sections 18 and 20 of NRA.
Promulgation of information and warnings through notices to mariners and other appropriate media.	✔		Sections 18 and 20 of NRA.
Continuous watch by multi-channel VHF, including Digital Selective Calling (DSC).	✔		Sections 18 and 20 of NRA.
Safety zones of appropriate configuration, extent and application to specified vessels	✔		Section 17 of NRA.
Designation of the site as an area to be avoided (ATBA).	✔		Not applicable.
Implementation of routeing measures within or near to the development.	✔		Not applicable. (See Section 9 of for Impact on Commercial Shipping Navigation).
Monitoring by radar, AIS and/or closed circuit television (CCTV).	✔		Sections 18 and 20 of NRA.
Appropriate means to notify and provide evidence of the infringement of safety zones or ATBA's.	✔		Sections 17, 18 and 20 of NRA.
Any other measures and procedures considered appropriate in consultation with other stakeholders.	✔		Sections 18 and 20 of NRA.
Standards and procedures for wind turbine generator shutdown in the event of a search and rescue, counter pollution or salvage incident in or around a wind farm. The wind farm should be designed and constructed to satisfy the following design requirements for emergency rotor shut-down in the event of a search and rescue (SAR), counter pollution or salvage operation in or around a wind farm:			

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
All wind turbine generators (WTGs) will be marked with clearly visible unique identification characters which can be seen by both vessels at sea level and aircraft (helicopters and fixed wing) from above.	✔		Sections 4 and 18 of NRA.
The identification characters shall each be illuminated by a low intensity light visible from a vessel this enabling the structure to be detected at a suitable distance to avoid a collision with it. The size of the identification characters in combination with the lighting should be such that, under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer, stationed 3 metres above sea levels, and at a distance of at least 150 metres from the turbine. It is recommended that lighting for this purpose be hooded or baffled so as to avoid unnecessary light pollution or confusion with navigation marks. (Precise dimensions to be determined by the height of lights and necessary range of visibility of the identification numbers).	✔		Sections 4 and 18 of NRA
For aviation purposes, OREI structures should be marked with hazard warning lighting in accordance with CAA guidance and also with unique identification numbers (with illumination controlled from the site control centre and activated as required) on the upper works of the OREI structure so that aircraft can identify each installation from a height of 500ft (150 metres) above the highest part of the OREI structure.	✔		Sections 4 and 18 of NRA.
Wind Turbine Generators (WTG) shall have high contrast markings (dots or stripes) placed at 10 metre intervals on both sides of the blades to provide SAR helicopter pilots with a hover reference point.	✔		Section 18 of NRA.
All WTGs should be equipped with control mechanisms that can be operated from the Central Control Room of the wind farm or through a single contact point.	✔		Section 18 of NRA.
Throughout the design process for a wind farm, appropriate assessments and methods for safe shutdown should be established and agreed, through consultation with MCA and other emergency support services.	✔		Sections 18 and 20 of NRA.
The WTG control mechanisms should allow	✔		Sections 18 and 20 of NRA.

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
the Control Room Operator to fix and maintain the position of the WTG blades as determined by the Maritime Rescue Co-ordination Centre or Maritime Rescue Sub Centre (MRCC/SC).			
Nacelle hatches should be capable of being opened from the outside. This will allow rescuers (e.g. helicopter winch-man) to gain access to the tower if tower occupants are unable to assist and when sea-borne approach is not possible.	✔		Sections 18 and 20 of NRA.
Access ladders, although designed for entry by trained personnel using specialised equipment and procedures for turbine maintenance in calm weather, could conceivably be used, in an emergency situation, to provide refuge on the turbine structure for distressed mariners. This scenario should therefore be considered when identifying the optimum position of such ladders and take into account the prevailing wind, wave and tidal conditions.	✔		Section 13 of NRA.
Although it may not be feasible for mariners in emergency situations to be able to use wave or tidal generators as places of refuge, consideration should nevertheless be given to the provision of appropriate facilities.	✔		Section 18 of NRA
2. Operational Requirements			
The Central Control Room, or mutually agreed single point of contact, should be manned 24 hours a day.	✔		Sections 18 and 20 of NRA.
The Central Control Room operator, or mutually agreed single point of contact, should have a chart indicating the Global Positioning System (GPS) position and unique identification numbers of each of the WTGs in the wind farm.	✔		Sections 18 and 20 of NRA.
All MRCCs will be advised of the contact telephone number of the Central Control Room, or mutually agreed central point of conatct.	✔		Sections 18 and 20 of NRA.
All MRCCs will have a chart indicating the GPS position and unique identification number of each of the WTGs in all wind farms.	✔		Sections 18 and 20 of NRA.

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
3. Operational Procedures			
Upon receiving a distress call or other emergency alert from a vessel which is concerned about a possible collision with a WTG or is already close to or within the wind farm, or when the MRCC receives a report that persons are in actual or possible danger in or near a wind farm and search and rescue aircraft and/or rescue boats or craft are required to operate over or within the wind farm, the MRCC will establish the position of the vessel and the identification numbers of any WTGs which are visible to the vessel. This information will be passed immediately to the Central Control Room, or single contact point, by the MRCC. A similar procedure will be followed when vessels are close to or within other types of OREI site	✔		Sections 18 and 20 of NRA.
The control room operator should immediately initiate the shut-down procedure for those WTGs as requested by the MRCC, and maintain the WTG in the appropriate shut-down position, again as requested by the MRCC, or as agreed with MCA Navigation Safety Branch or Search and Rescue Branch for that particular installation, until receiving notification from the MRCC that it is safe to restart the WTG.	✔		Sections 18 and 20 of NRA.
The appropriate procedure to be followed in respect of other OREI types, designs and configurations will be determined by these MCA branches on a case by case basis, in consultation with appropriate stakeholders, during the Scoping and Environmental Impact Assessment processes.	✔		Section 19 of NRA
Communication and shutdown procedures should be tested satisfactorily at least twice a year. Shutdown and other procedures should be tested as and when mutually agreed with the MCA.	✔		Sections 18 and 20 of NRA.

DECC Ship Type Checklist

European Offshore Wind Deployment Centre

(Appendix B)

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B1. Introduction

The AIS type classification has been converted to the DECC (formerly BERR) Methodology "Vessel Types involved in Navigational Activities - Example Checklist", reproduced below (Ref. i).

H6	Types of Vessel
1	*All*
2a	Large Vessels
	1. Bulk Carriers
	2. Bulk/Oil Carriers
	3. Chemical Tankers
	4. Container Vessels
	5. Cruise Vessels
	6. Liquefied Gas Carriers
	7. Oil Tankers
2b	Medium Vessels
	1. General Cargo
	2. Specialised Carriers
	3. Passenger
	4. Passenger Ferries
2c	High Speed Craft (HSC's)
	1. High speed ferries
	2. Other high speed recreational and commercial craft
3	Fishing Vessels
	1. Fish Processing
	2. Fishing Vessels (Various types and operations)
4	Recreational Vessels
	1. Sailing dinghies and Yachts
	2. Motor Boats
	3. Small Personal Watercraft
	4. Rowing boats
	5. Sports Fishing
	6. Windsurfer
	7. Kite Boards
	8. Tall Ships
	9. Recreational Submarines and dive support craft
5	Anchored Vessels
	All
6	Other Operational Vessels
	1. Barges
	2. Dredgers
	3. Dry Cargo Barge
	4. Offshore Production and Support
	5. Salvage
	6. Tank Barges
	7. Tugs and Tows
7	Military Vessels
	1. Warships
	2. Submarines
	3. Royal Fleet Auxiliaries
8	Other Vessels
	1. Seaplanes
	2. Wing-In-Ground Craft (WIG)
	3. Hovercraft

Figure 1.1 Vessel Types involved in Navigation Activities – Example Checklist

It is noted that the DECC list is not comprehensive, for example, it does not include explicit categories for vessels such as Ro-Ro and Wind Farm Support. Where this is the case, marine knowledge has been used to classify vessels, e.g., Ro-Ro vessels classified as "Medium Vessels – Ro-Ro" and Wind Farm as "Other Operational Vessels – Wind Farm".

The general commercial ship types identified in the traffic survey were:

2a. Large Vessels
2b. Medium Vessels
3. Fishing Vessels
6. Other Operational Vessels
7. Military Vessels
8. Other Vessels

[Note: Anchored Vessels (DECC Type 5) were also recorded in the survey. This reflects navigational status rather than vessel type, as all vessels may anchor at certain times. Therefore, anchored vessels have not been presented as a separate type in the plots but are discernible from the track behaviour.]

B2. Ship Types

The overall percentage distribution of ships passing within 20nm of the proposed European Offshore Wind Deployment Centre (EOWDC) site based on the general (top-level) DECC categorisation (excluding undefined vessels) and is presented below.

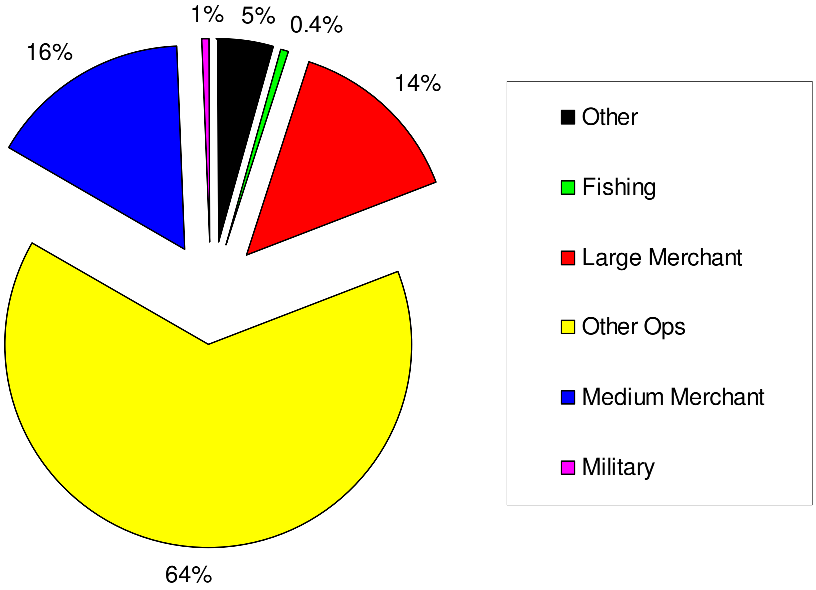

Figure 2.1 DECC General Ship Type Categorisation within 20nm of the Wind Farm

The majority of ships were other operational vessels according to the DECC classification and these are likely to be vessels related to the offshore oil and gas industry. The majority of the remaining vessels were medium and large merchant vessels with a small proportion of fishing vessels, military vessels and 'other' vessels.

A plot of the tracks colour-coded by the DECC general ship type categories is presented in Figure 2.2.

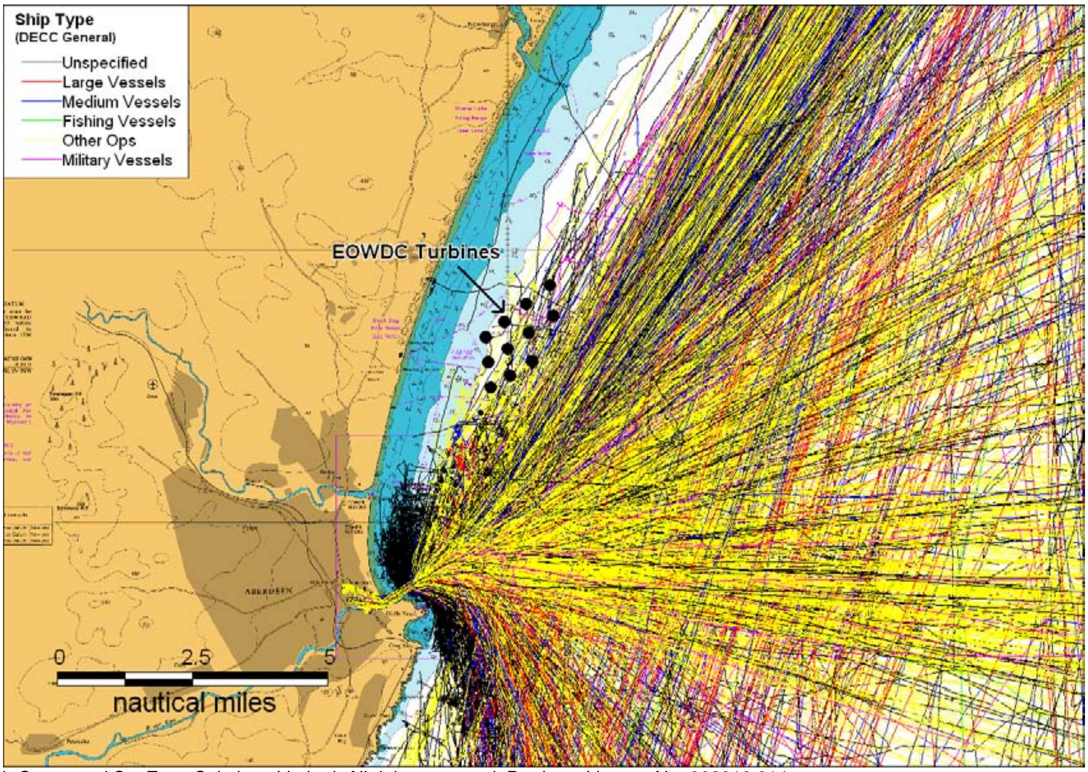

Figure 2.2 Tracks colour-coded by DECC General Ship Types

Dividing the types further using the more detailed (second-level) DECC categories, the distribution within 20nm was as follows:

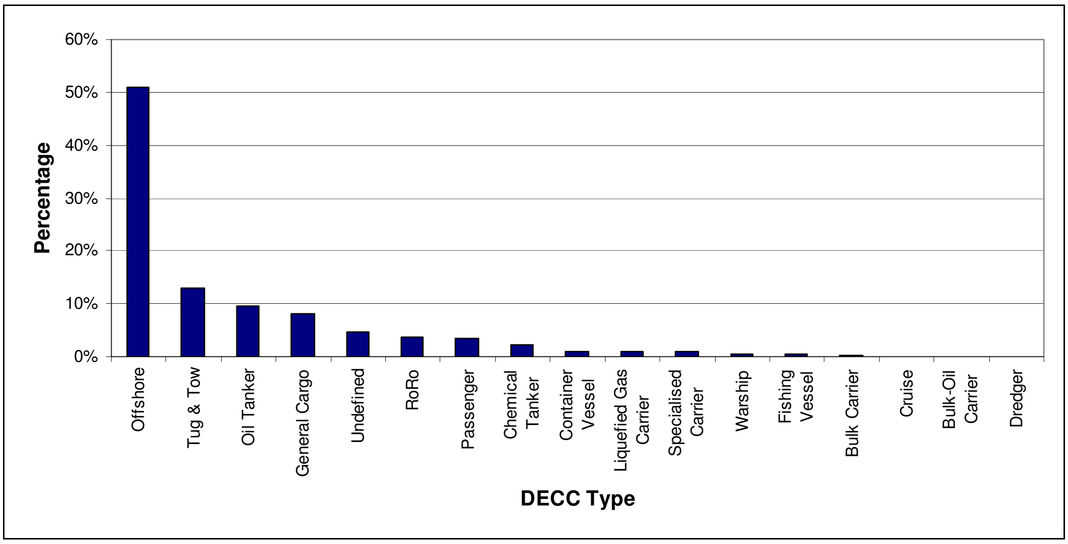

Figure 2.3 Detailed DECC Vessel Types identified within 20nm of the EOWDC Site

The most common category overall was offshore containing just over half of all vessels. There were also a large percentage of tug and tow vessels, oil tankers and general cargo ships.

A plot of the survey data colour-coded by the detailed DECC type classification is presented below.

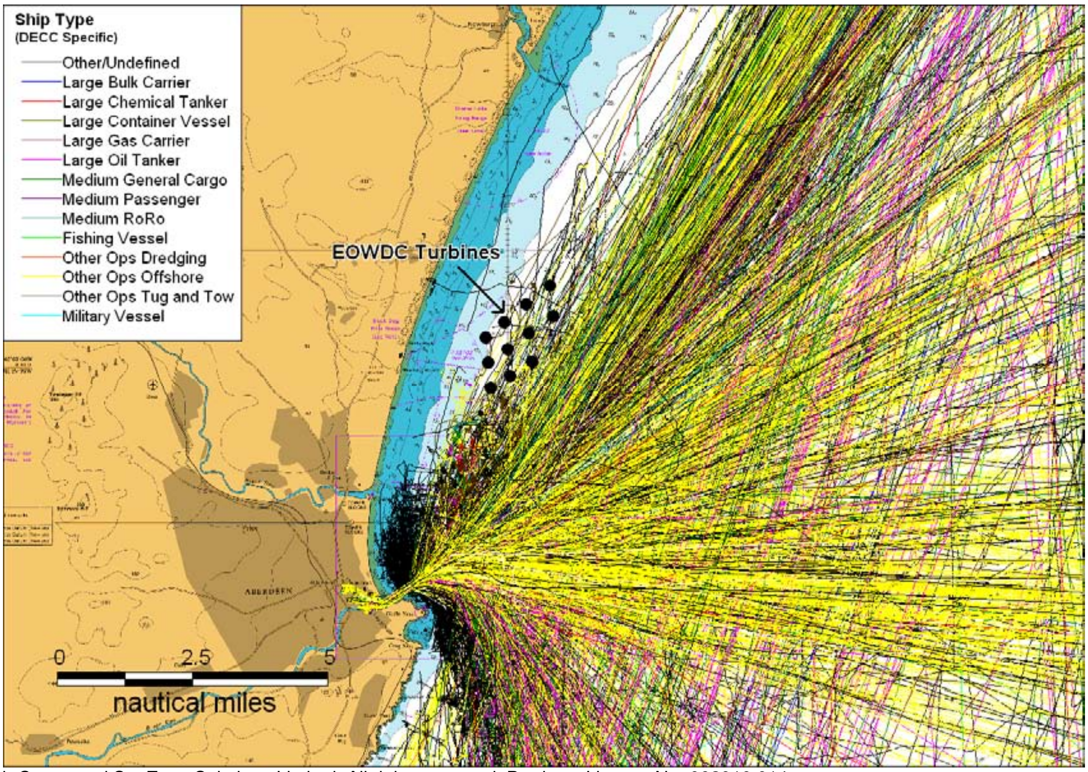

Figure 2.4 Tracks by DECC Detailed Type Categories

The majority of vessels passing between the proposed turbine locations during the surveys were "other operational vessels". This Appendix presents an assessment of the consequences of collision incidents, in terms of people and the environment, due to the impact of the proposed EOWDC.

B3. References

i DECC (formerly BERR), U.K. Government, Methodology for Assessing the Marine Navigational Safety Risks of Offshore Windfarms, Version Date: 7th September 2005

Anchoring Analysis

European Offshore Wind Deployment Centre

(Appendix C)

Prepared by:	Anatec Limited
Presented to:	Aberdeen Offshore Wind Farm Limited
Date:	9 June 2011
Revision No.:	01
Ref.:	A2555- AOWF-NRA-1 App C

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C1. Introduction

This Appendix presents an assessment of anchoring by vessels off Aberdeen.

52 weeks of AIS data from October 2008 to October 2009 was examined to gain a broad overview of ships anchoring off Aberdeen. For a more in-depth analysis, 4 weeks of survey data was used which covered two weeks in winter and two weeks in summer. The winter survey took place from 25 March to 7 April 2009 (Survey 1) and the summer survey took place from 21 September to 5 October 2009 (Survey 2).

It should be noted this analysis was carried out before the introduction of an official anchorage area in 2010 to the North of Aberdeen port. With respect to this it is noted that the types and numbers of vessels using the new anchorage are likely to be in line with the information presented within this analysis, and that it is only the anchoring locations that are likely to vary.

To ensure the analysis of the 4 week survey was relevant to Aberdeen Harbour, only those vessels which used the Port were considered. Throughout the report when discussing the number of anchored vessels during the 4 week survey, this refers to those which anchored and visited the Port during this period.

It should be noted that the accuracy regarding the number of anchorings relies on the officers of the ships to manually update their navigation status on their AIS.

C2. Vessel Type

The distribution of vessel type for vessels which anchored off Aberdeen during the 52 week period is presented in Figure 2.1 (excluding 3 % unspecified vessels).

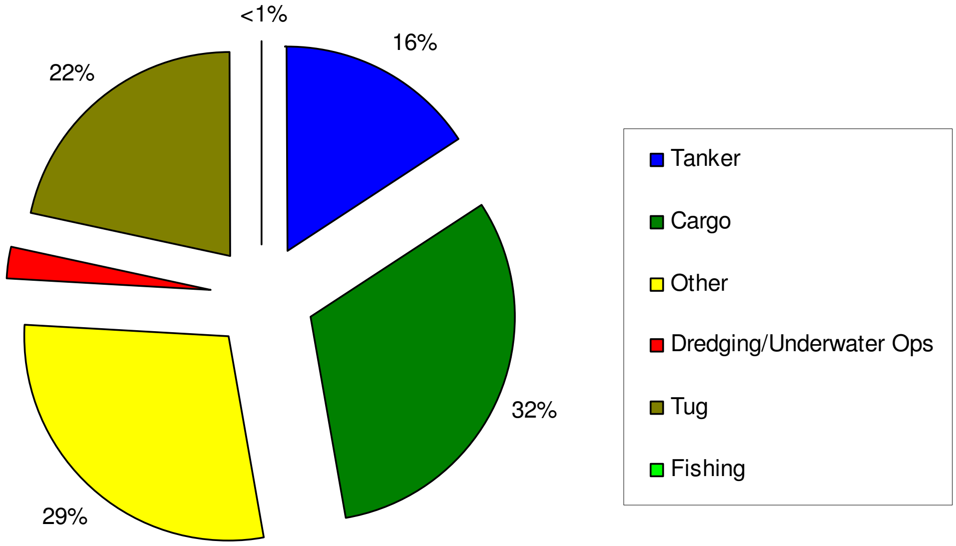

Figure 2.1 Distribution of Anchored Vessels by Type (52 Week Survey)

During this period the type of vessel which anchored most was cargo ships (32%). 'Other' vessels which comprise mainly of offshore support vessels also frequently anchored off Aberdeen (29%). There were no passenger, High Speed Craft (HSC) or military vessels recorded anchoring during the survey.

The distribution of vessel types during the 4 week survey is shown in Figure 2.2 below. There was a total of 36 recorded anchorings during this period.

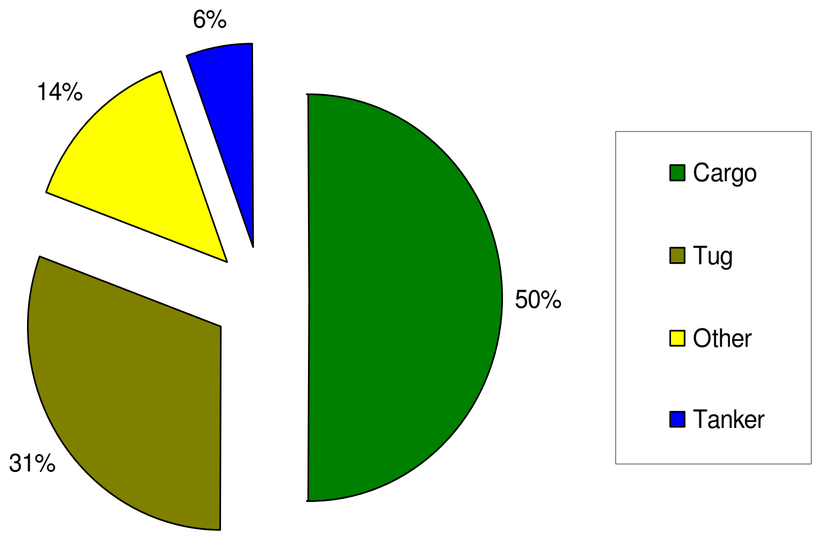

Figure 2.2 Distribution of Anchored Vessels by Type (4 Week Survey)

863 vessels were recorded using the port during the survey. The distribution of these vessels is shown in Figure 2.3 below (excluding 1% unspecified). Pilot vessels and vessels which stayed in the Harbour for the duration of the survey have also been omitted.

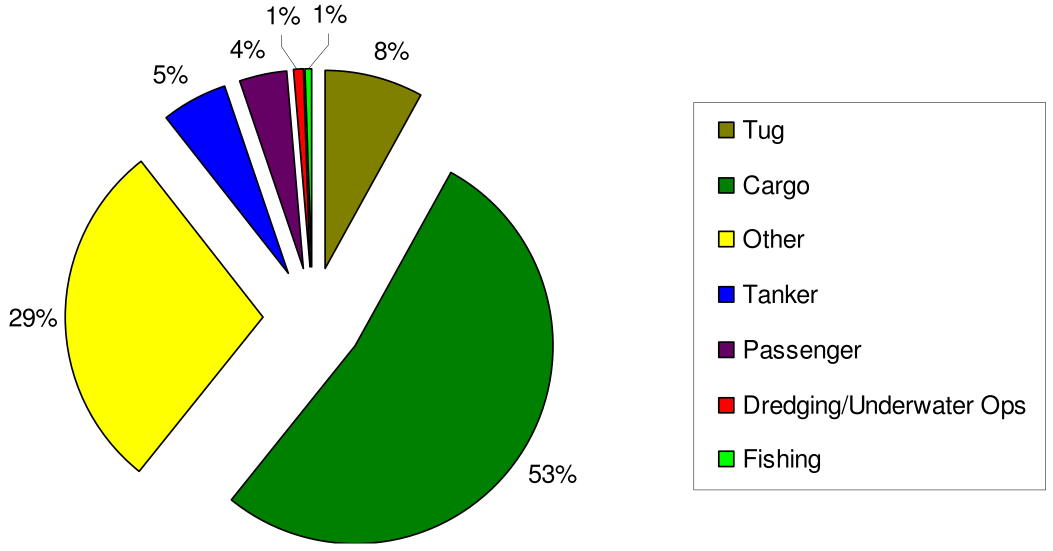

Figure 2.3 Distribution of Vessels using the Port by Type (4 Week Survey)

It can be seen from Figure 2.2 and Figure 2.3 that during the survey approximately half of the vessels using both the anchorage area and the port were cargo ships (50% and 53%, respectively). A bar chart comparing anchoring with port usage is presented in Figure 2.4.

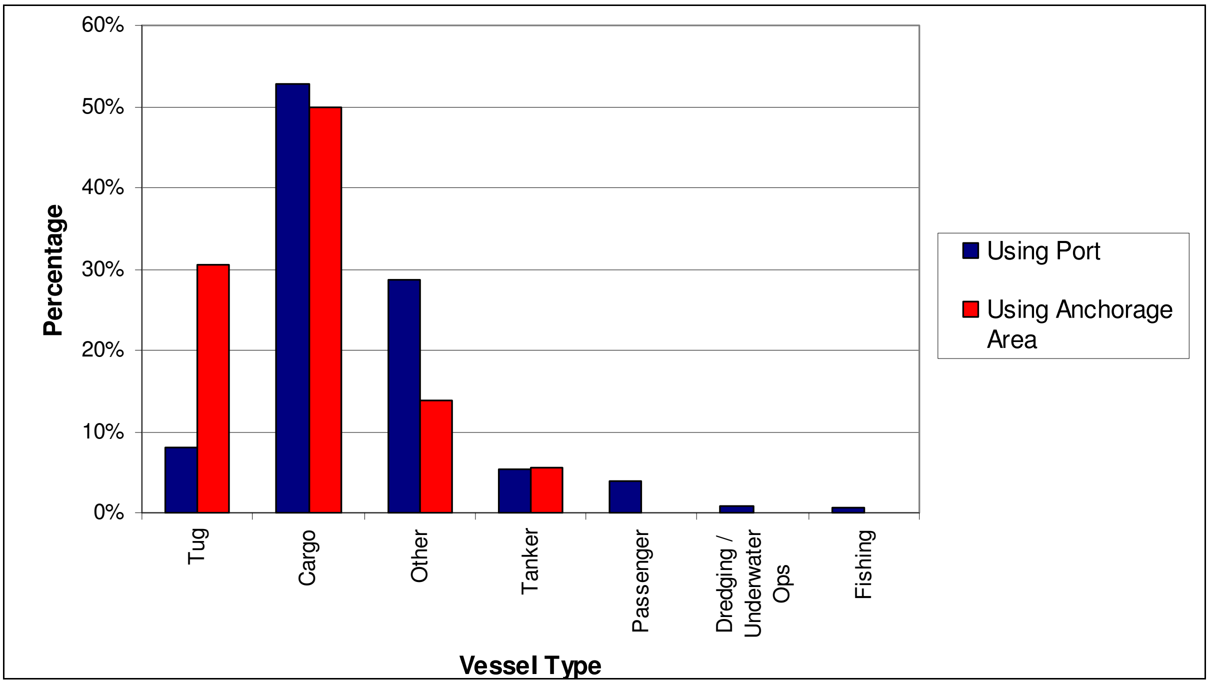

Figure 2.4 Comparison of Port Usage and Anchorage Usage (4-Week Survey)

It can be seen that during the 4 week survey tankers and cargo vessels anchored off Aberdeen in similar proportion to those which used the port. The type of vessel which anchored most frequently relative to how often it used the Port was tugs. With the exception of passenger, dredging/underwater ops and fishing vessels which were all recorded visiting the Port but not anchoring, the type of vessel which anchored least relative to how often it used the Port was 'other' vessels.

The draught distributions of anchored vessels and of those using the Port during the 4 week survey are presented in Figure 2.5.

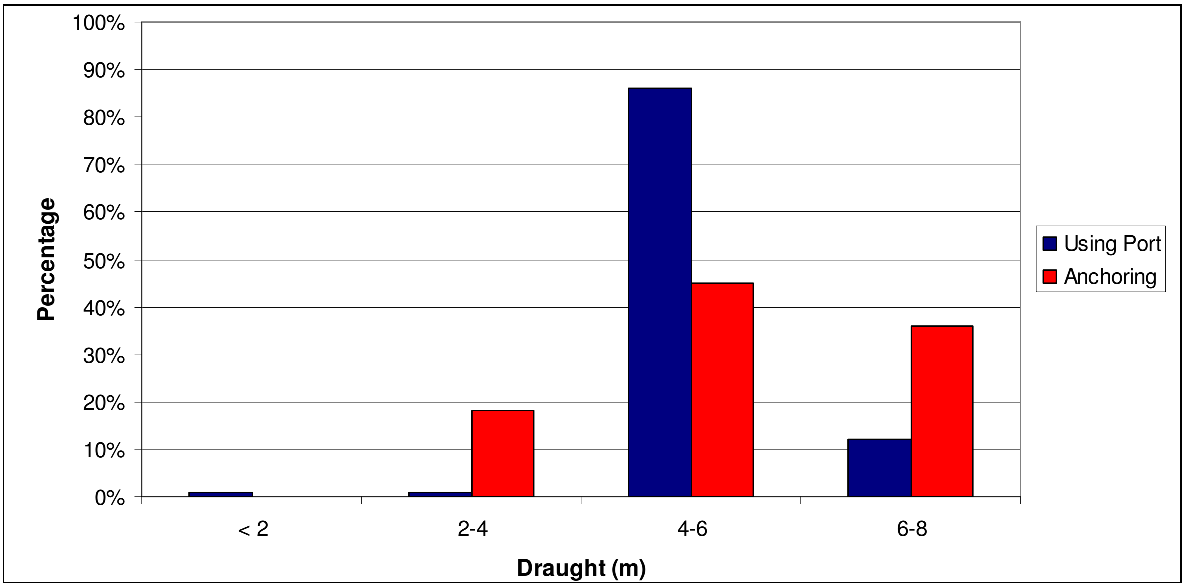

Figure 2.5 Comparison of Draught Distributions (Using Port vs. Anchoring)

In both cases the most common draught size was in the range of 4m to 6m. Vessels with draughts in this size range dominated within those which used the Port (86%) whereas the draughts of those which anchored were more evenly spread. 36% of the anchored vessels had draughts of 6m to 8m whereas only 12% of the vessels using the Port had draughts in this range. This suggests that vessels with a deeper draught are more likely to anchor than vessels with a smaller draught – most likely due to the deeper vessels having to 'wait for tide' before entering the port. It should also be noted that several vessels during the survey with draughts greater than 8m anchored off Aberdeen, but none of these vessels also used the Port.

C3. Anchorage Positions

Taken from the 52-week data set, the tracks of the 5 most common types of vessel to anchor off Aberdeen are shown in the following figures.

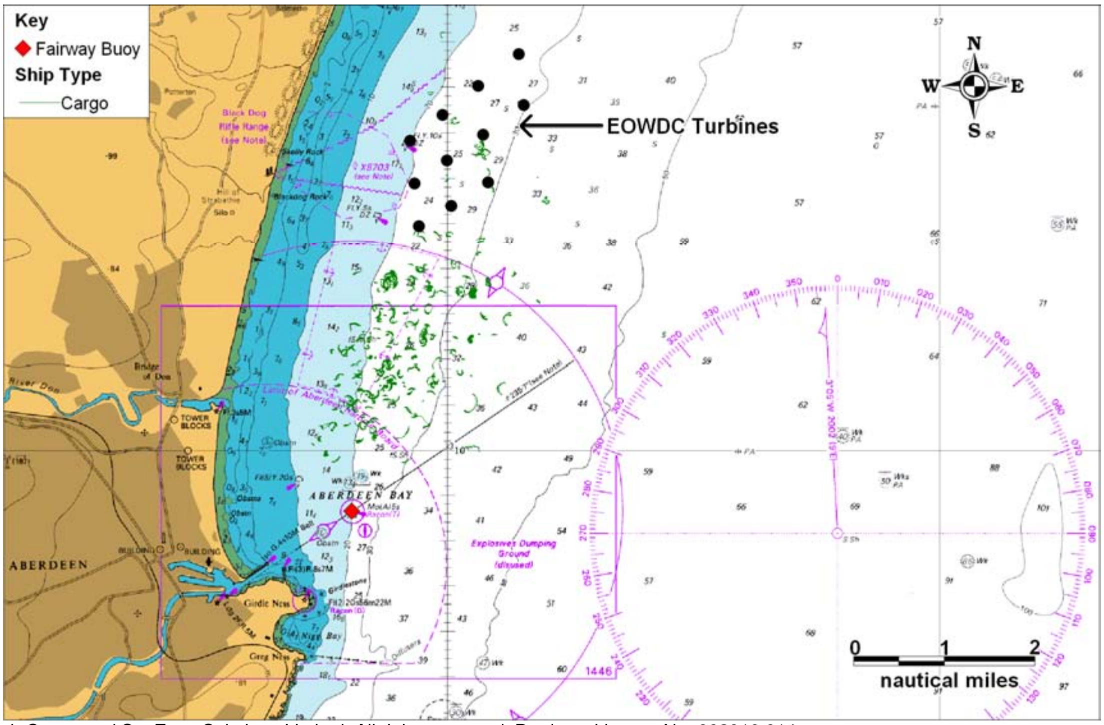

Figure 3.1 Anchored Cargo Vessels during 52 Week Survey (prior to anchorage being designated)

It can be seen that cargo ships were consistent in anchoring to the north, NNE and NE of the Fairway Buoy. Six cargo vessels anchored within the turbine area during the 52 week period.

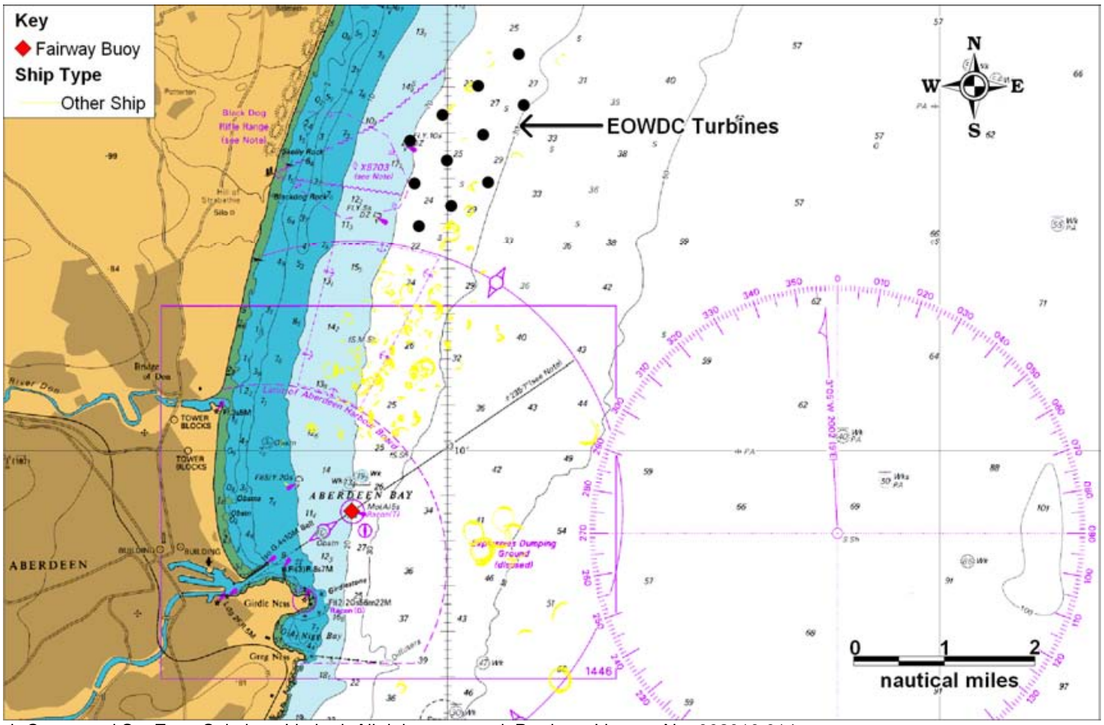

Figure 3.2 Anchored Other Vessels during 52 Week Survey (prior to anchorage being designated)

'Other' vessels generally anchored to the north and NNE of the Fairway Buoy. Almost all of the tracks to the south, SE and east of the Fairway Buoy were made by the shuttle tanker *Navion Fennia* – see discussion below on tankers anchoring in this area. Four 'other' ships anchored within the site during the 52 week period.

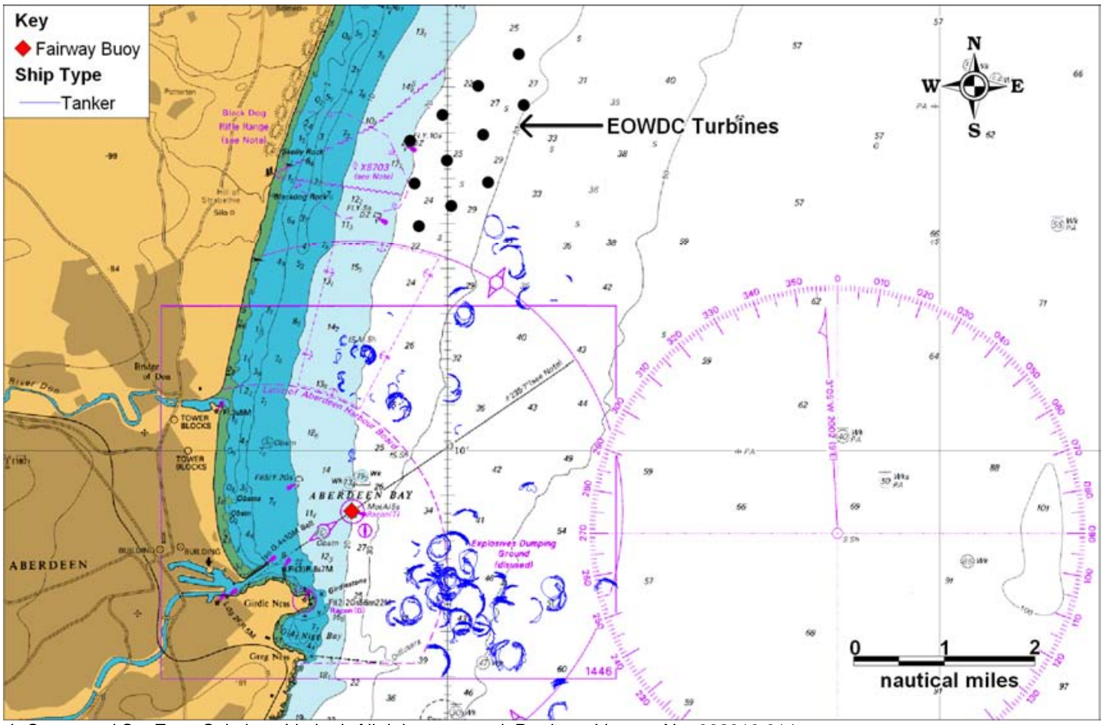

Figure 3.3 Anchored Tankers during 52 Week Survey (prior to anchorage being designated)

The majority of tankers anchored to the SE of the Fairway Buoy but several also anchored to the north and NE. Those to the north and NE and within 2nm of the Fairway Buoy generally had draughts less than 8m and were awaiting entry to Aberdeen Harbour, and the rest generally had draughts greater than 8m and were not visiting the Harbour.

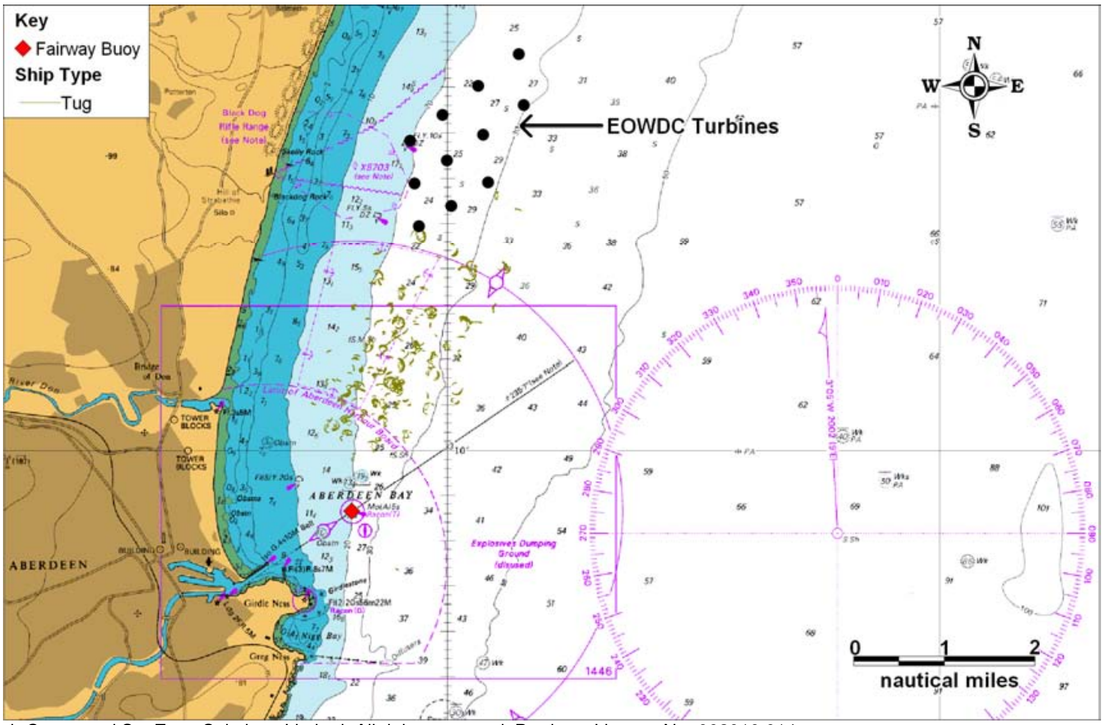

Figure 3.4 Anchored Tugs during 52 Week Survey (prior to anchorage being designated)

Tug vessels were consistent in anchoring to the north and NNE of the Fairway Buoy.

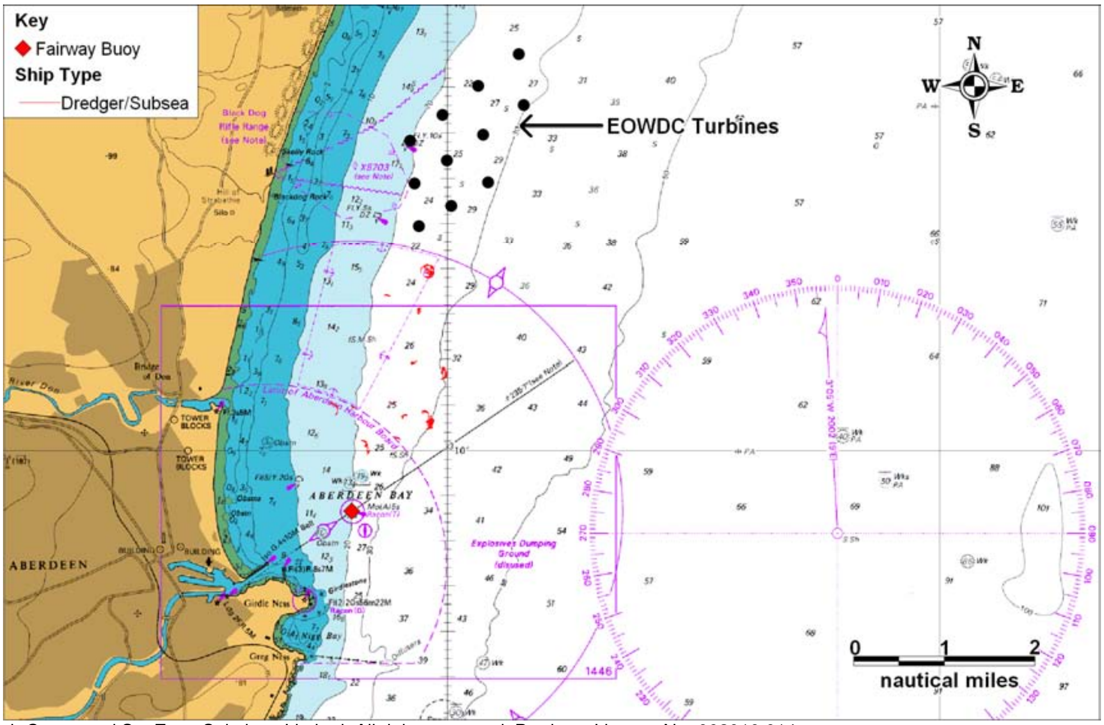

Figure 3.5 Anchored Dredging/Subsea Vessels during 52 Week Survey (prior to anchorage being designated)

Based on the limited data, it is assumed that dredging/subsea vessels tend to anchor to the north and NNE of the Fairway Buoy.

It can be concluded that all vessels visiting Aberdeen Harbour anchor off the Fairway Buoy to the north, NNE and NE, and vessels not visiting (i.e., large tankers) anchor elsewhere.

C4. Weather Analysis

The weather was recorded 4 times a day throughout the 4 week survey. During the winter survey the wind was predominantly from the SW, although for significant periods the wind came from the NE, and then the SE. During the summer survey the wind was predominantly from the west and SW, although for two days the wind came from the NW.

3 vessels were recorded anchoring during the winter survey and 33 during the summer survey. In Figure 4.1 below, each vessel which anchored during the survey periods is represented by a coloured dot, where the colour denotes the wind direction on the day the ship anchored, if wind direction is unknown then the plot has been omitted.

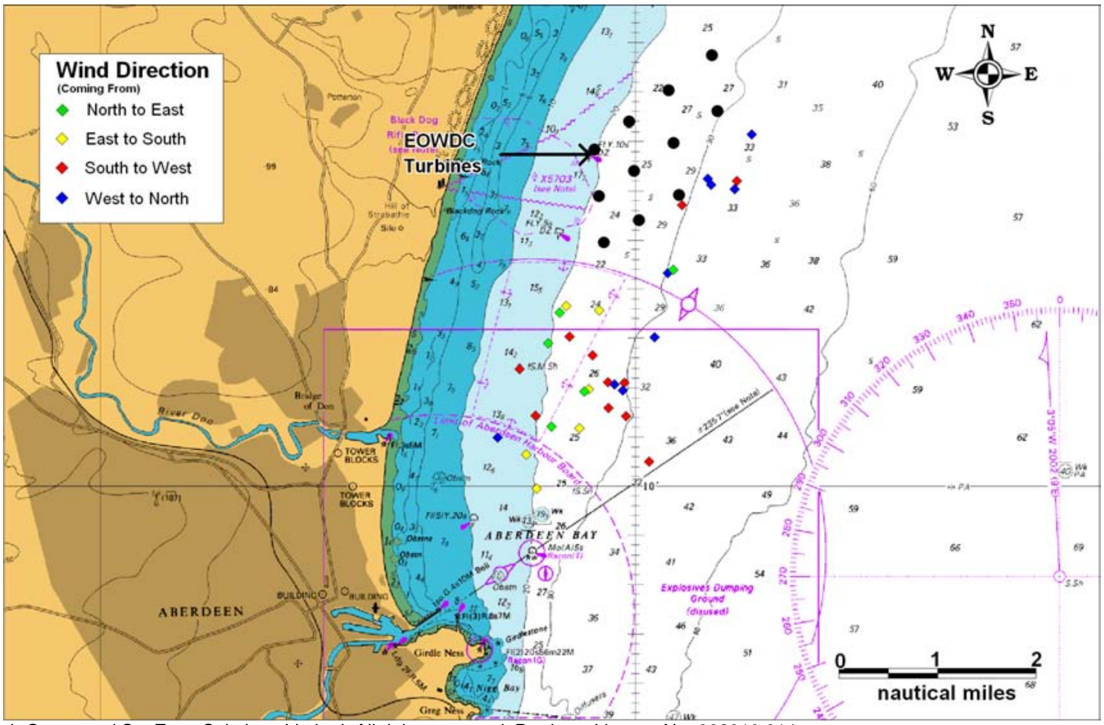

Figure 4.1 Preferred Anchorage Locations with Wind Direction (prior to anchorage being designated)

It should be noted first that in the legend key in the above figure, the second term is not inclusive, i.e., 'North to East' consists of wind coming from the north right through to, but not including, the east. There is no clear relation between the position of the anchored vessels and the wind direction. A more conclusive analysis might be more achievable with the use of further wind data.

C5. Tide Analysis

The tidal variations at Aberdeen during the winter and summer surveys are presented below.

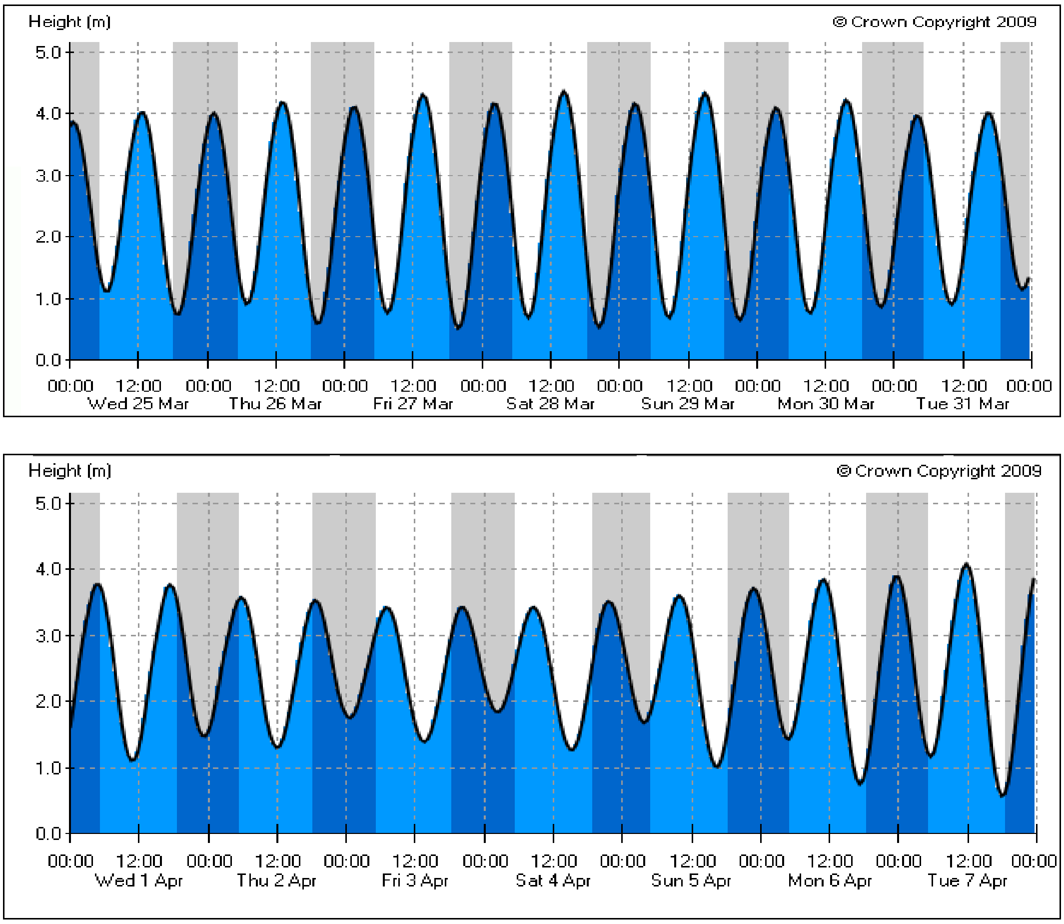

Figure 5.1 Tidal Predictions for Aberdeen during Winter Survey Period (Source: Admiralty Tides, UTC Times)

The 26-30 March has been treated as a spring period and the 1-5 April as a neap period. The remainder of days are considered to be 'neutral'.

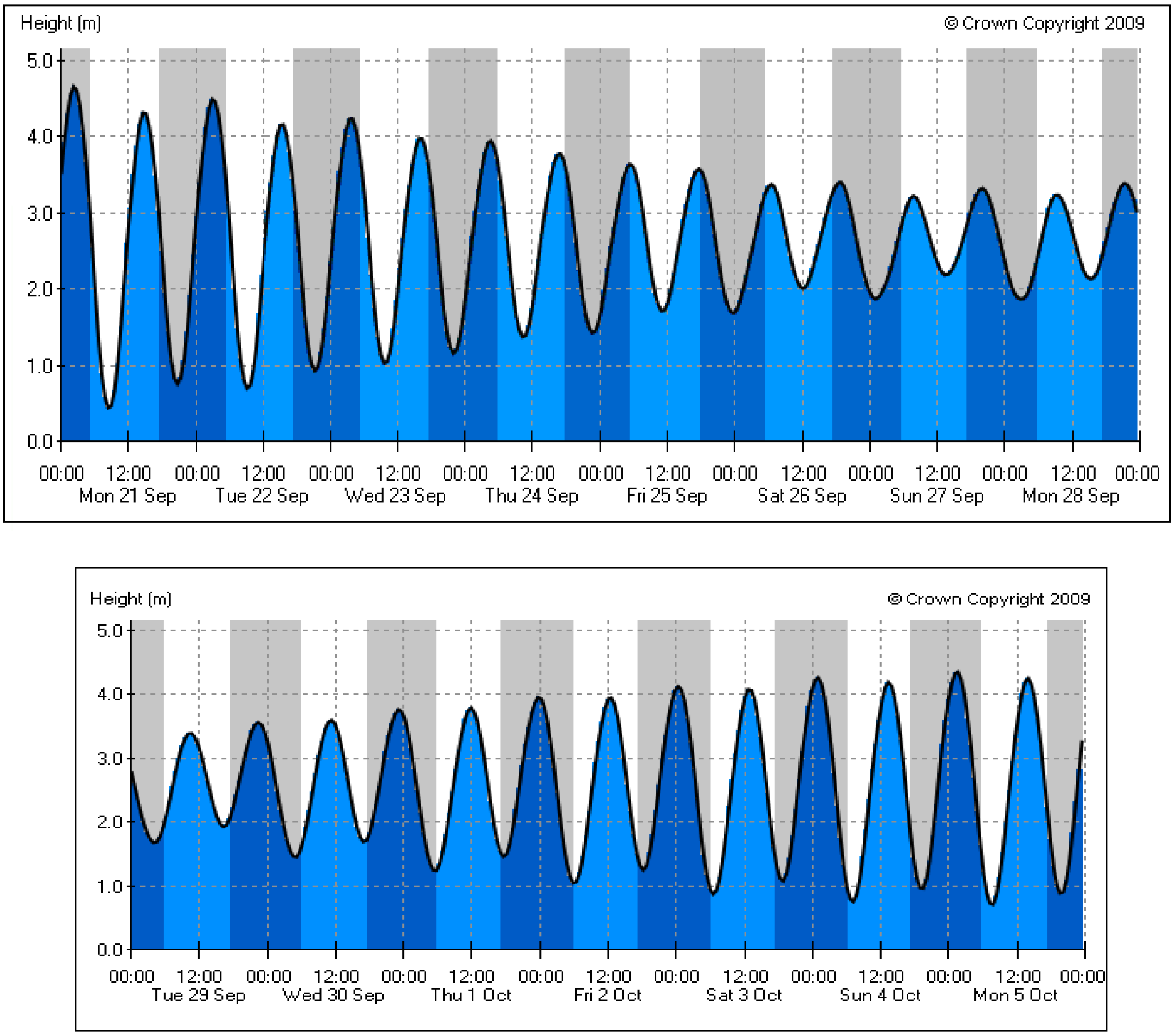

Figure 5.2 Tidal Predictions for Aberdeen during Summer Survey Period (Source: Admiralty Tides, UTC Times)

The periods between 21-22 September and 3-5 October have been classed as spring periods and 25-29 September has been classed as a neap period. Again, the remainder of days have been classed as ‘neutral’.

Of the 28 days that make up the survey, 10 days represent spring tides (36%), 10 represent neap tides (36%) and 8 are ‘neutral’ (29%).

Figure 5.3 below presents the locations of anchored vessels during different tidal conditions.

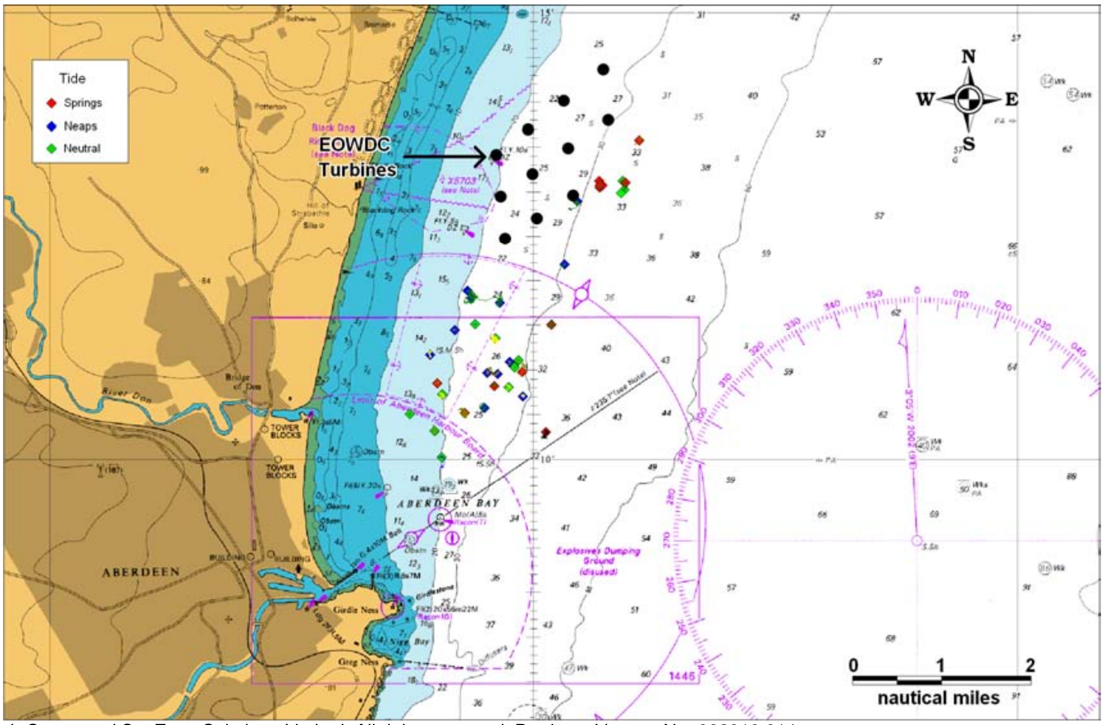

Figure 5.3 Preferred Anchorage Locations during different Tides (prior to anchorage being designated)

There is no clear pattern of anchorage locations by tidal conditions. A more conclusive analysis may be more achievable with the use of more tidal data. The frequency of anchoring during the different tidal conditions was quite equally spread, with 12 ships anchoring during each of the periods. The average numbers of anchorings per day has been calculated for each tidal condition and are presented in Figure 5.4 below.

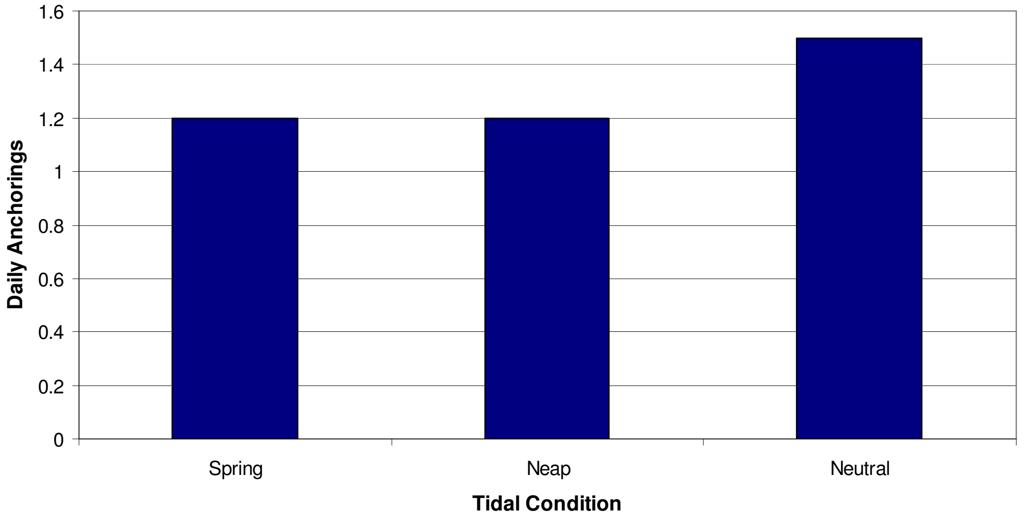

Figure 5.4 Average Number of Daily Anchorings during different Tidal Conditions

The average number of vessels to anchor each day was 1.2 during the spring and neap periods and 1.5 during the 'neutral' periods.

C6. Vessel Movements

The anchored vessels at Aberdeen were analysed visually for one week in September 2009 by replaying the AIS data at high-speed. During this week 22 vessels were observed anchoring off Aberdeen. Figure 6.1 below presents the percentages of these vessels which were in the Port prior to anchoring, and which vessels went on to enter the Port after anchoring.

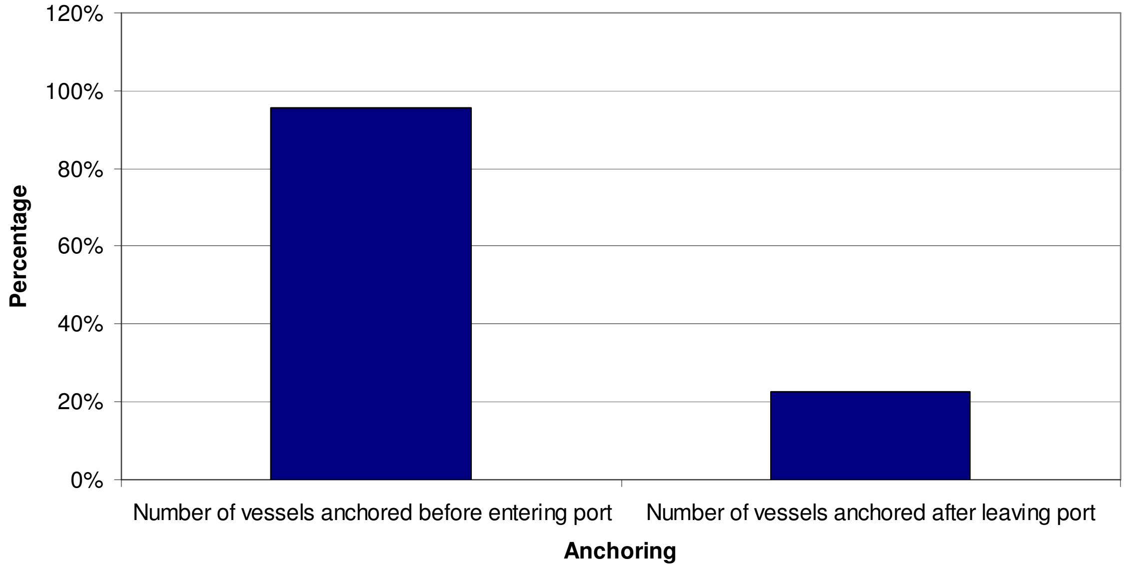

Figure 6.1 Pre- and Post-Anchor Locations

During this 1-week survey 23% of the anchored vessels had come directly from the Harbour with 77% coming from sea. For vessels leaving anchor, 95% went to the Harbour with the remainder going to sea. Of those that entered the Harbour after anchoring, 83% had been out at sea prior to anchoring..

C7. Anchorage Location Preference

Aberdeen bay always contained at least one anchored vessel throughout the summer survey but there were numerous periods during the winter survey when the area was empty. Figure 7.1 shows where vessels opted to anchor when they had the entire bay to choose from.

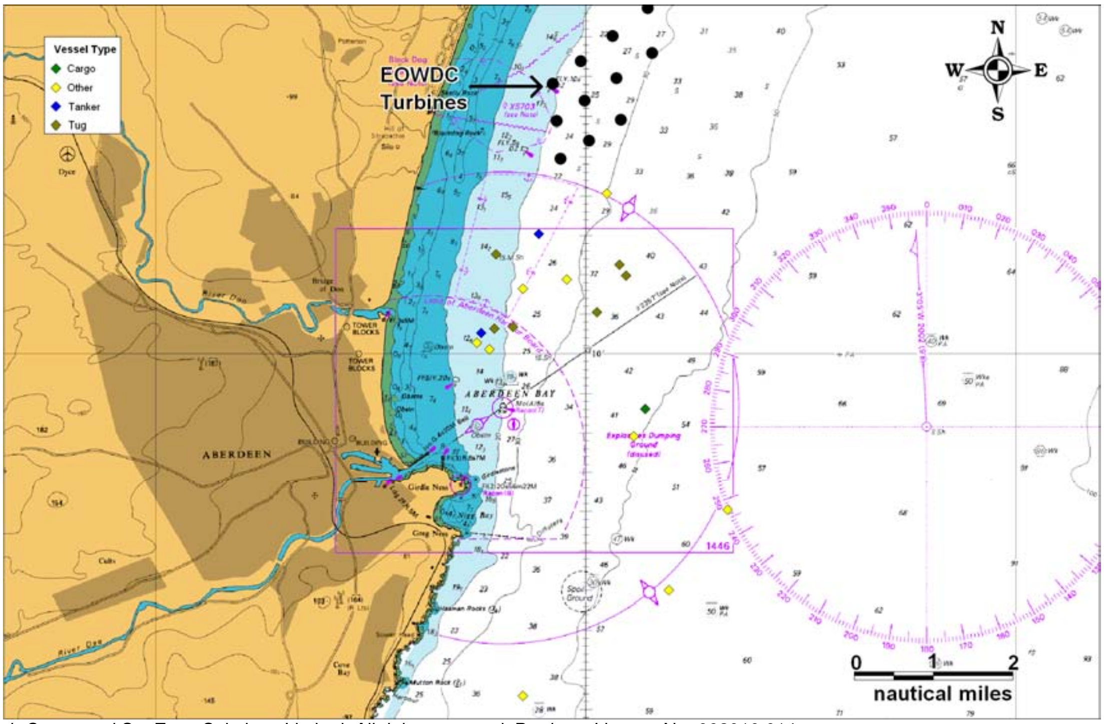

Figure 7.1 First Choice Anchorage Locations (prior to anchorage being designated)

It can be seen that the most common anchorage of choice was in the area to the north, NNE and NE of the Fairway Buoy. It should be noted that not all vessels were definitely visiting the Port and it is assumed that those which anchored to the east, ESE and SE of the Fairway Buoy were not, as comparing with previous figures shows that no ships visiting the Harbour anchored in this area.

C8. Anchorage Duration

The 36 recorded anchorings during the 4 week survey gave a combined anchoring duration of approximately 44 days, which corresponds to an average anchoring duration of 29 hours. The length of time which ships stayed at anchor ranged from under an hour to over 6 days.

Vessels which were not visiting the Port were recorded anchoring for up to 14 days. Figure 8.1 below presents the distribution of the time vessels spent at anchor.

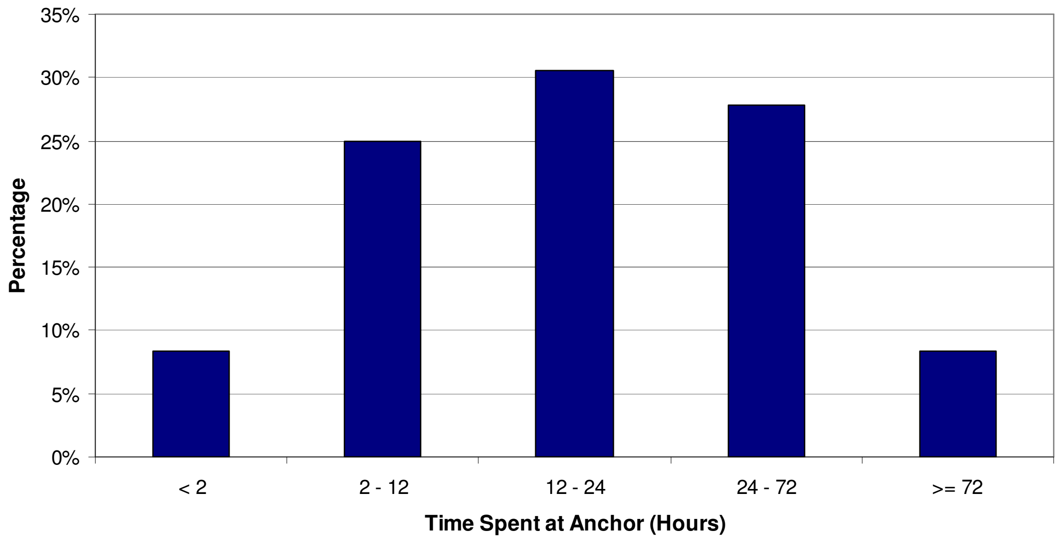

Figure 8.1 Distribution of Time Spent at Anchor

It can be seen that approximately a third of all vessels fall within the category of anchoring for 12 to 24 hours (31%). Another significant point to take from this figure is that 8% of vessels were anchored for less than 2 hours.

The dots in the plot below indicate the locations of the anchored vessels, colour-coded by the length of their stay.

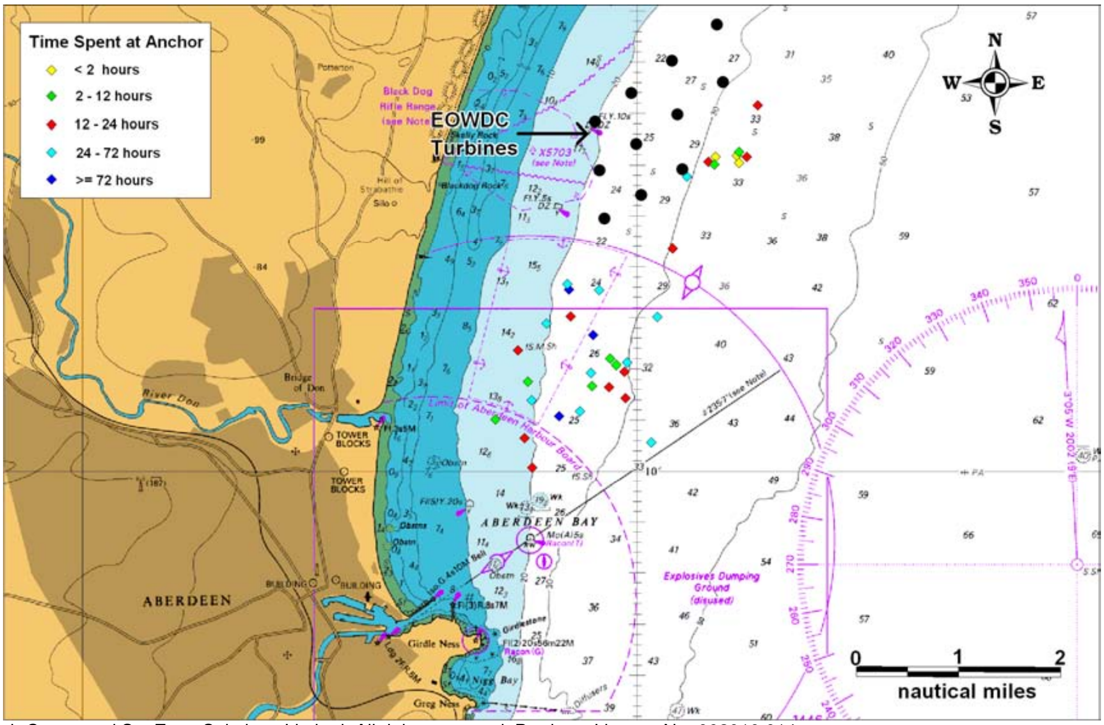

Figure 8.2 Locations of Anchored Vessels with Duration (prior to anchorage being designated)

From the data there is no clear relation between vessels' anchorage location and duration at anchor.

C9. Designation Anchorage

During the course of preparing this navigational impact assessment an anchorage was designated in Aberdeen Bay. The following figure provides an overview of the anchored vessels following this designation (14 day period).

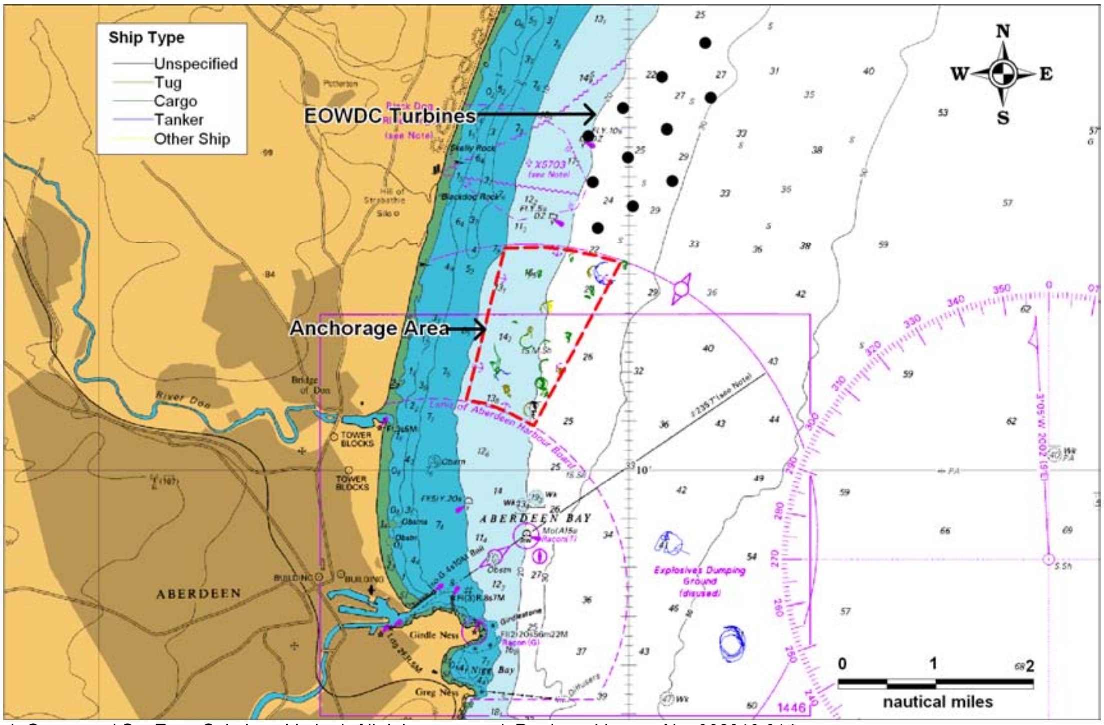

Figure 9-1 Anchored Vessels during Survey 5 (with Charted Anchorage Area shown in red)

Consequences Assessment

European Offshore Wind Deployment Centre

(Appendix D)

Prepared by:	Anatec Limited
Presented to:	Aberdeen Offshore Wind Farm Limited
Date:	9 June 2011
Revision No.:	01
Ref.:	A2555-AOWF-NRA-1 App D

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D1. Introduction

This Appendix presents an assessment of the consequences of collision incidents, in terms of people and the environment, due to the impact of the proposed European Offshore Wind Deployment Centre (EOWDC).

The significance of the impact of the proposed EOWDC is also assessed based on risk evaluation criteria and comparison with historical accident data in the UK waters[1].

D2. Risk Evaluation Criteria

2.1 Risk to People

With regard to the assessment of risk to people two measures are considered, namely;

- Individual Risk
- Societal Risk

2.1.1 Individual Risk (per Year)

This measure considers whether the risk from an accident to a particular individual changes significantly due to the wind farm. Individual risk considers not only the frequency of the accident and the consequence (likelihood of death), but also the individual's fractional exposure to that risk, i.e., the probability of the individual of being in the given location at the time of the accident.

The purpose of estimating the Individual Risk is to ensure that individuals, who may be affected by the presence of the wind farm, are not exposed to excessive risks. This is achieved by considering the significance of the change in individual risk resulting from the presence of the wind farm, relative to the background individual risk levels.

Annual individual risk levels to crew (i.e., the annual fatality risk of an average crew member) for different ship types are presented in Figure 2.1 (Ref.i). The figure also highlights the risk acceptance criteria as suggested in IMO MSC 72/16.

[1] In this technical note, UK waters means the UK Exclusive Economic Zone and UK territorial waters means within the 12 nautical miles limit.

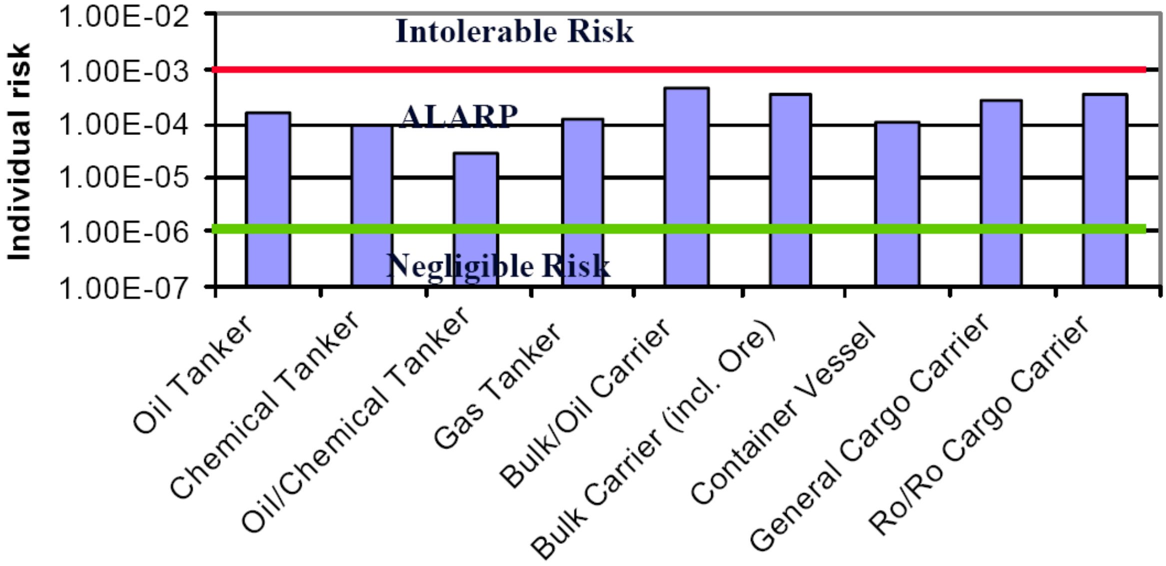


Figure 2.1 Individual Risk Levels and Acceptance Criteria per Ship Type

Typical bounds defining the ALARP regions for decision making within shipping are as follows.

Table 2.1 Individual Risk ALARP Criteria

Individual	Lower Bound for ALARP	Upper Bound for ALARP
To crew member	10^{-6}	10^{-3}
To passenger	10^{-6}	10^{-4}
3rd party	10^{-6}	10^{-4}
New ship target	10^{-6}	Above values reduced by one order of magnitude

On a UK basis, the MCA website presents individual risks for various UK industries based on HSE data for 1987-91 (Ref. ii). The risks for different industries are compared in Figure 2.2.

The individual risk for sea transport of 2.9 x 10^{-4} per year is consistent with the worldwide data presented in Figure 2.1, whilst the individual risk for sea fishing of 1.2 x 10^{-3} per year is the highest across all of the industries listed.

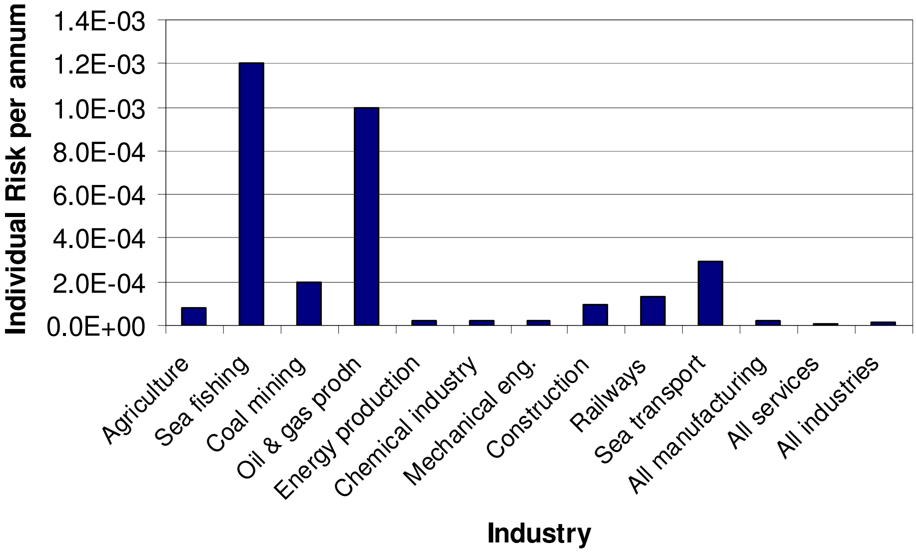


Figure 2.2 Individual Risk per Year for various UK Industries

2.1.2 Societal Risk

Societal Risk is used to estimate risks of accidents affecting many persons, e.g., catastrophes, and acknowledging risk averse or neutral attitudes. Societal Risk includes the risk to every person, even if a person is only exposed on one brief occasion to that risk. For assessing the risk to a large number of affected people, societal risk is desirable because individual risk is insufficient in evaluating risks imposed on large numbers of people.

Within this assessment societal risk (navigational based) can be assessed for the proposed EOWDC giving account to the change in risk associated with each accident scenario caused by the introduction of the structures. Societal risk may be expressed as:

- Annual fatality rate: frequency and fatality are combined into a convenient one-dimensional measure of Societal Risk. This is also known as Potential Loss of Life (PLL).

- FN-diagrams showing explicitly the relationship between the cumulative frequency of an accident and the number of fatalities in a multi-dimensional diagram.

When assessing societal risk this study focuses on PLL, which takes into account the number of people likely to be involved in an incident (which is higher for passenger ferries, for example), and assesses the significance of the change in risk compared to background risk levels for the UK.

2.2 Risk to Environment

For risk to the environment the key criteria considered in terms of the effect of the proposed EOWDC is the potential amount of oil spilled from the vessel involved in an incident.

It is recognised there will be other potential pollution, e.g., hazardous containerised cargoes, however, oil is considered the most likely pollutant and the extent of predicted oil spills will provide an indication of the significance of pollution risk due to the proposed EOWDC compared to background pollution risk levels for the UK.

D3. MAIB Incident Analysis

3.1 All Incidents

All UK commercial vessels are required to report accidents to MAIB. Non-UK vessels do not have to report unless they are in a UK port or are in 12 nautical mile territorial waters and carrying passengers to a UK port. There are no requirements for non-commercial recreational craft to report accidents to MAIB, however, a significant proportion of these incidents are reported and investigated by the MAIB.

A total of 19,130 accidents, injuries and hazardous incidents were reported to MAIB between 1 January 1994 and 27 September 2005 involving 21,140 vessels (some incidents such as collisions involved more than one vessel). 72% of incidents were in UK waters with 28% reported in foreign waters.

The locations[1] of incidents reported in the vicinity of the UK are presented in Figure 3.1, colour-coded by type.

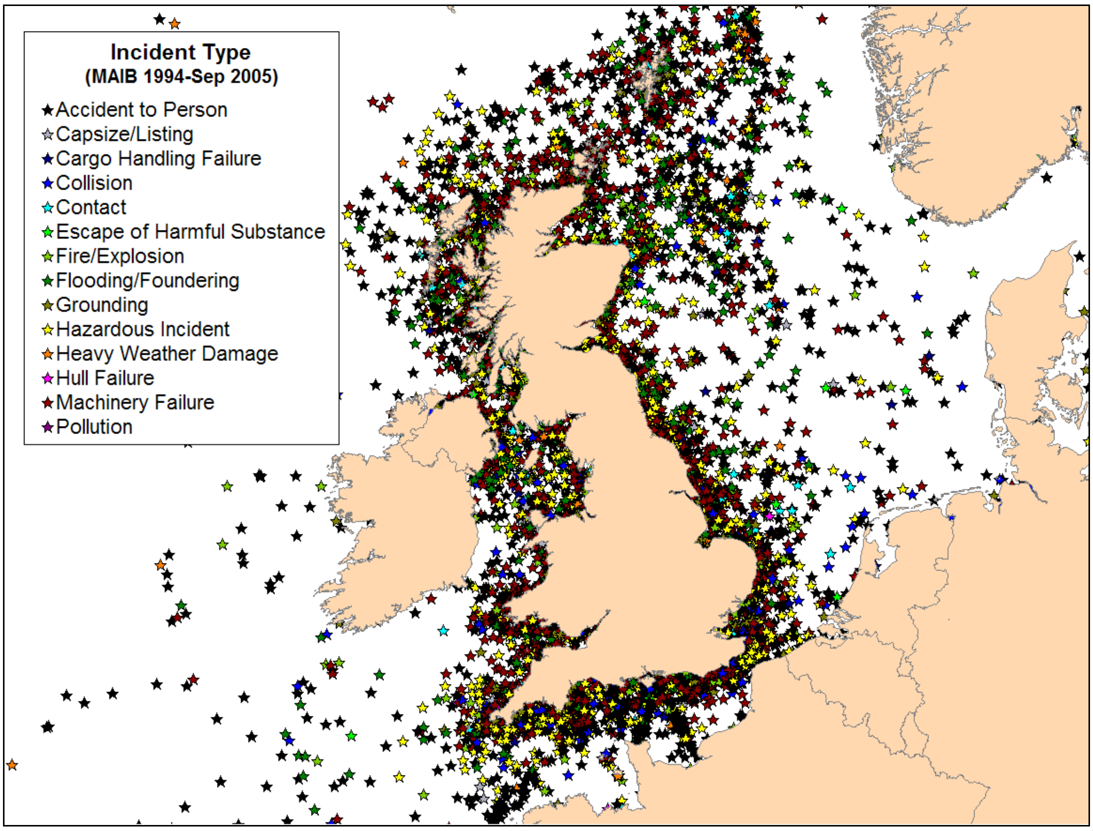


Figure 3.1 Incident Locations by Type (MAIB 1994-Sep 2005)

[1] MAIB aim for 97% accuracy in reporting the locations of incidents.

The distribution of incidents by year is presented in Figure 3.2.

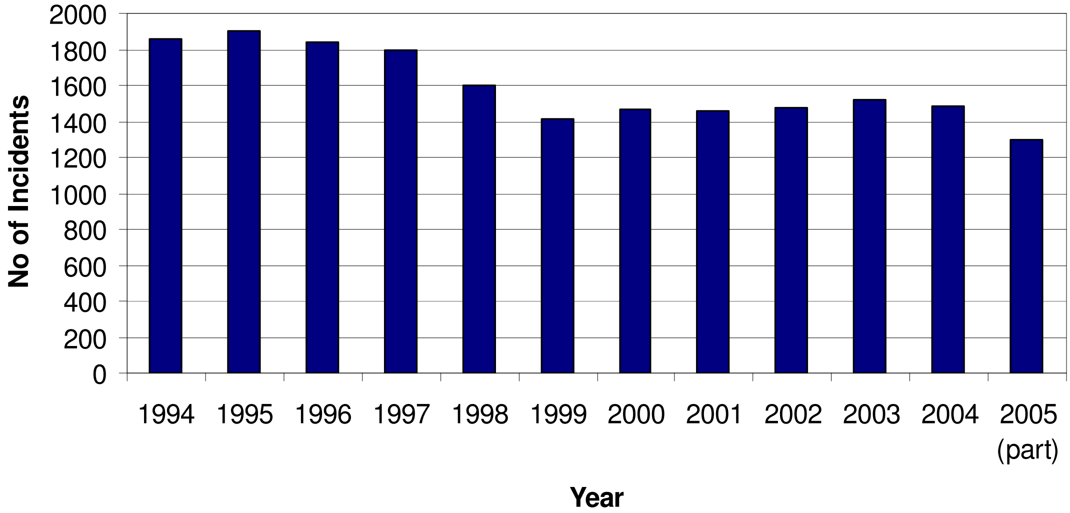


Figure 3.2 Incidents per Year (MAIB 1994-Sep 2005)

The average number of incidents per year, excluding 2005 which is a part-year, was 1,621. There is a declining trend in incidents.

The distribution by incident type is presented in Figure 3.3.

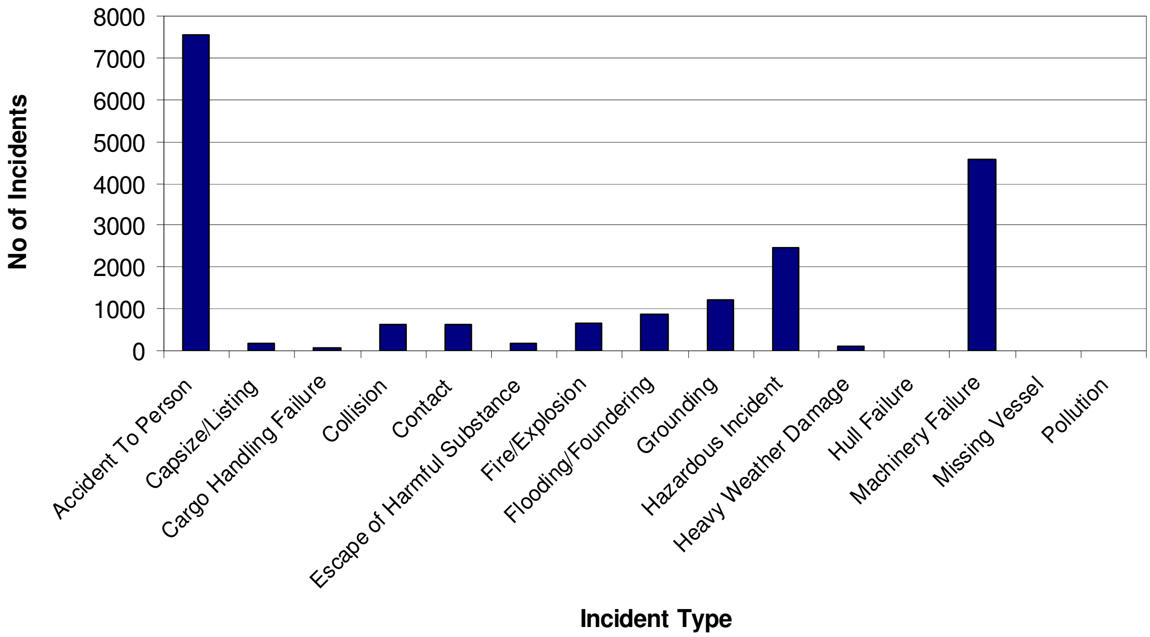


Figure 3.3 Incidents by Incident Type (MAIB 1994-Sep 2005)

Therefore, the most common incident types were Accident to Person[1] (40%), Machinery Failure (24%) and Hazardous Incident (13%). Collisions and Contacts each represented 3% of total incidents.

The distribution of vessel type categories involved in incidents is presented in Figure 3.4.

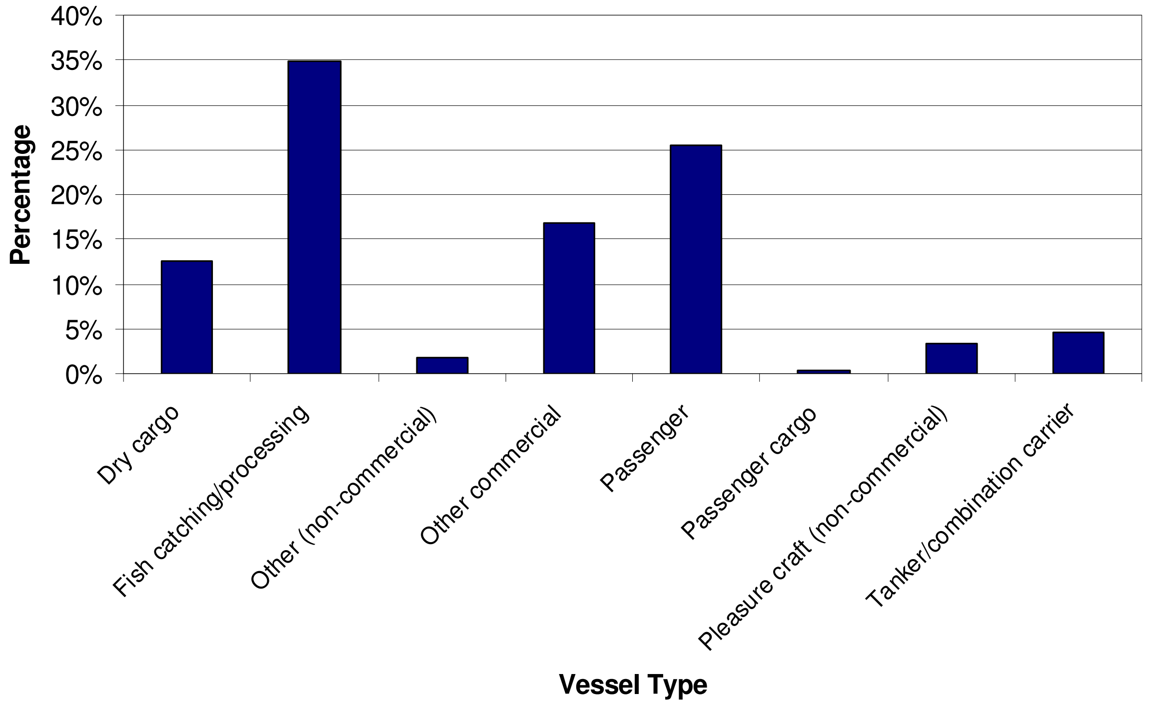


Figure 3.4 Incidents by Vessel Type (MAIB 1994-Sep 2005)

The most common vessel types involved in incidents were fishing vessels (35%), passenger vessels (25%) and other commercial vessels (17%), which includes offshore industry vessels, tugs, workboats and pilot vessels.

The total number of fatalities per year (divided into crew, passenger and other) reported in the MAIB incidents is presented in Figure 3.5.

[1] Where the incident is an accident to a vessel, e.g., collision or machinery failure, it would be reported under this vessel accident category.

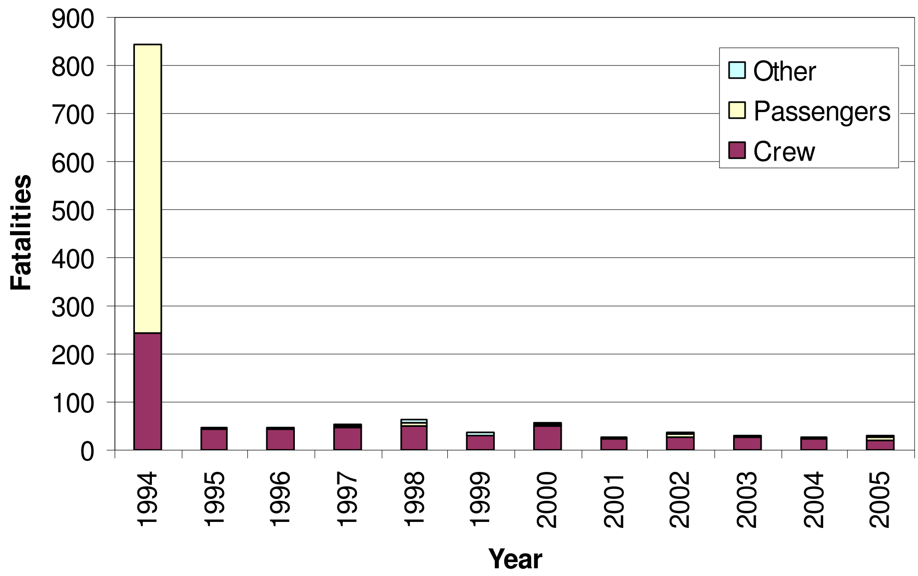


Figure 3.5 Number of Fatalities (MAIB 1994-Sep 2005)

The average number of fatalities per year, excluding 2005 which is a part-year, was 115. The sinking of the 'Estonia' passenger ferry in the Baltic Sea in 1994, which resulted in a reported 852 fatalities, dominates the figures. If 1994 were excluded, the average number of fatalities per year would drop to 42.

Considering only the incidents reported to have occurred in UK territorial waters, the number of fatalities per year is presented in Figure 3.6.

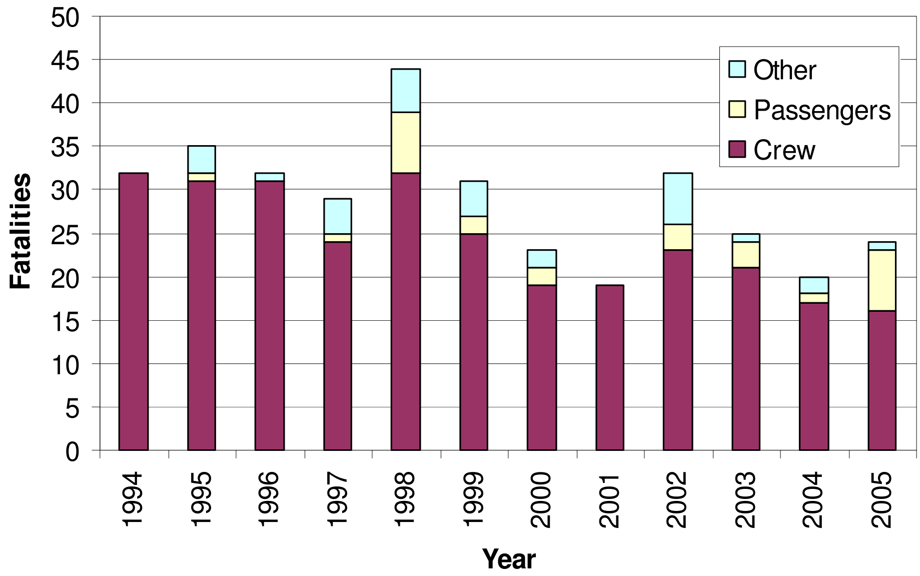


Figure 3.6 Number of Fatalities for Incidents in UK Waters (MAIB 1994-Sep 2005)

Therefore, the average number of fatalities per year in UK territorial waters between 1994 and 2004 was 29.

The distribution of fatalities in UK waters by vessel type and person category is presented in Figure 3.7.

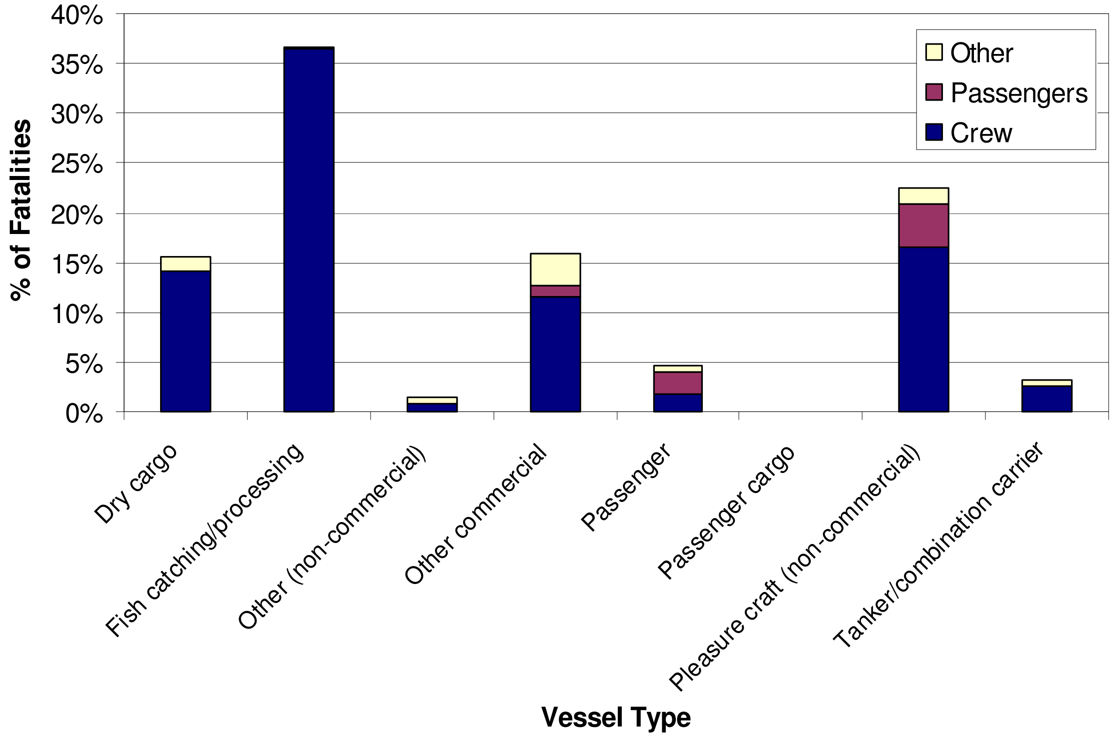


Figure 3.7 Fatalities by Vessel Type for Incidents in UK (MAIB 1994-Sep 2005)

It can be seen that the majority of fatalities in the UK occurred to fishing vessels and pleasure craft, with crew members the main people involved.

3.2 Collision Incidents

MAIB define a collision incident as "vessel hits another vessel that is floating freely or is anchored (as opposed to being tied up alongside)."

A total of 623 collisions were reported to MAIB between 1 January 1994 and 27 September 2005 involving 1,241 vessels (in a handful of cases the other vessel involved was not logged).

The locations of collisions reported in the vicinity of the UK are presented in Figure 3.8, colour-coded by type.

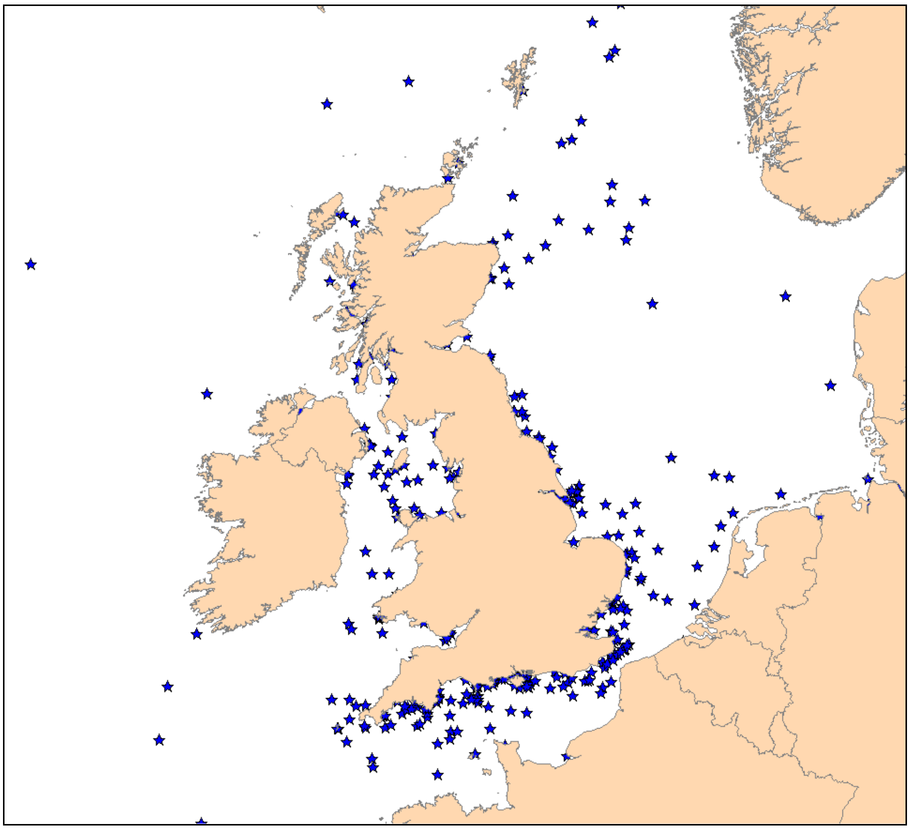


Figure 3.8 Collision Incident Locations (MAIB 1994-Sep 2005)

The distribution of all collision incidents by year is presented in Figure 3.9.

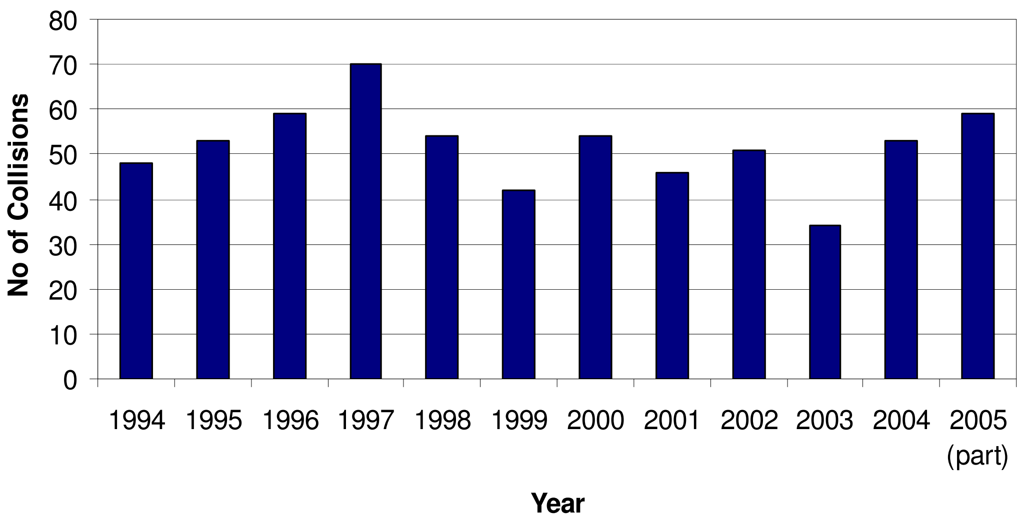


Figure 3.9 Collisions per Year (MAIB 1994-Sep 2005)

The average number of collisions per year, excluding 2005 which is a part-year, was 51.

The distribution of vessel types involved in collisions is presented in Figure 3.10.

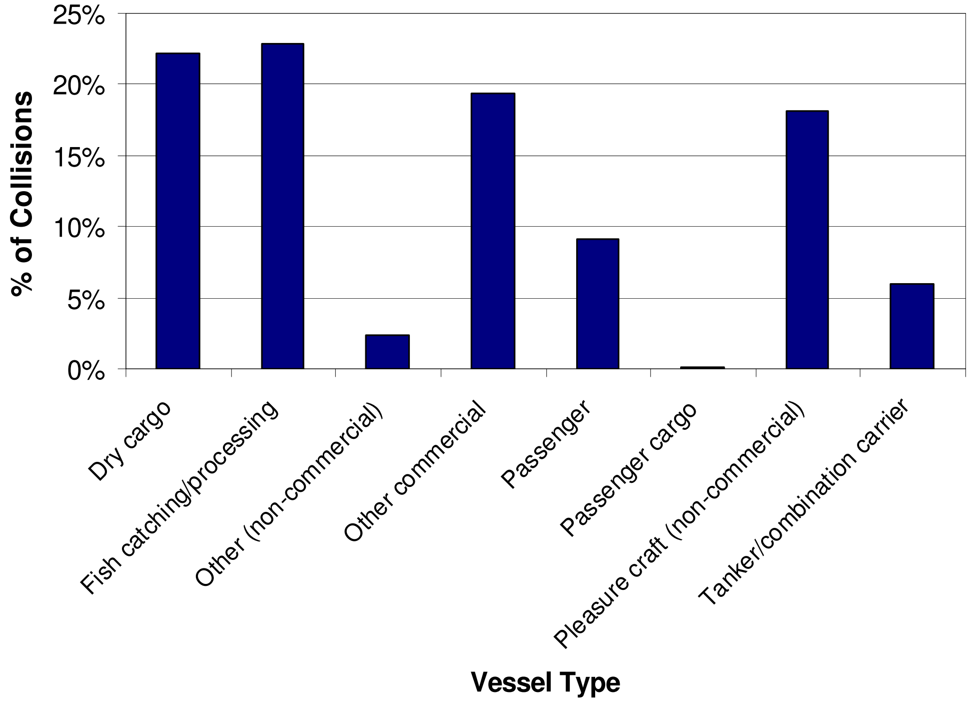


Figure 3.10 Collisions by Vessel Type (MAIB 1994-Sep 2005)

Therefore, the most common vessel type involved in collisions were fishing vessels (25%), dry cargo vessels (22%), other commercial vessels (19%) and non-commercial pleasure craft (18%).

Finally, the total number of fatalities per year (divided into crew and passenger) reported in all MAIB collisions is presented in Figure 3.11.

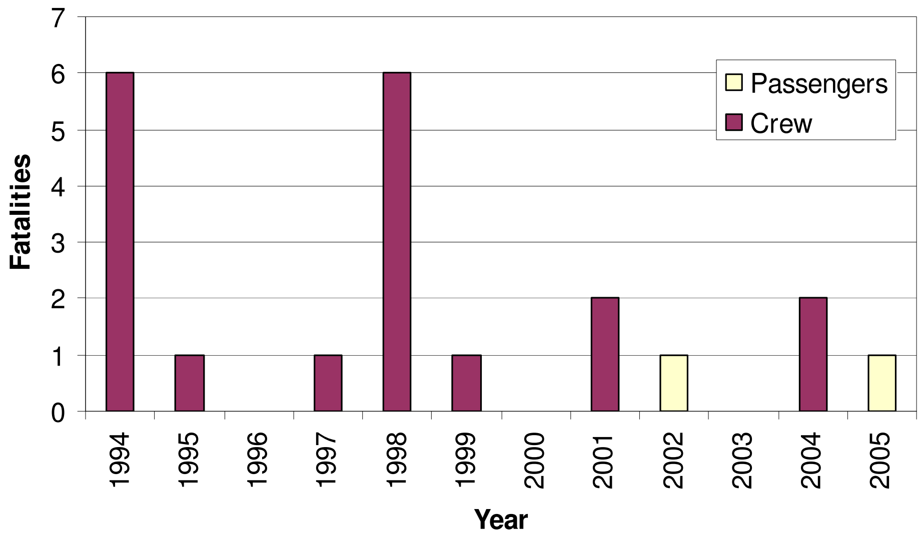


Figure 3.11 Fatalities from Collisions (MAIB 1994-Sep 2005)

The average number of fatalities per year, excluding 2005 which is a part-year, was 1.8.

Details on the 12 incidents reported by MAIB that involved fatalities are presented in Table 3.1. In each case the first vessel listed suffered the losses. It can be seen that most incidents involved fishing vessels and recreational craft.

Table 3.1 Fatal Collision Incidents (MAIB 1994-Sep 2005)

Date	Description	Fatalities
Nov 1994	Beam trawler collision with bulk carrier Foreign waters, high seas, moderate visibility and sea state	6
Jun 1998	Seine netter collision with container ship Foreign waters, high seas, good visibility, moderate seas	5
Feb 1995	Stern trawler collision with supply ship Foreign waters, river/canal, good visibility, moderate seas	1
Mar 1997	Stern trawler collision with other fishing vessel Foreign waters, good visibility, calm seas	1
Jun 1998	RIB collision with other RIB UK territorial waters, river/canal	1
Mar 1999	Fishing vessel collision with container ship Foreign waters, coastal waters, good visibility	1
Aug 2001	Pleasure craft collision with small commercial motor vessel UK territorial waters	1
Oct 2001	General cargo vessel collision with chemical tanker	1

Date	Description	Fatalities
	UK territorial waters, coastal waters, good visibility	
Aug 2002	Speed craft collision with another speed boat UK waters, unspecified location, good visibility, calm seas	1
May 2004	Port service tug collision with passenger ferry (during towing) Foreign waters, coastal waters	1
Jun 2004	Pleasure craft collision with other pleasure craft Foreign waters, river/canal	1
Jul 2005	Pleasure craft collision with (1 passenger fatality) UK territorial waters, coastal waters, good visibility, calm seas	1

A more detailed description of the two incidents which resulted in multiple fatalities is provided below:

- Collision between bulk carrier and beam trawler in eastward lane of Terschelling - German Bight TSS. Both vessels were on passage. Visibility was about 5 miles. Collision caused extensive damage to beam trawler and vessel rapidly flooded and sank with loss of her 6 crew, all of whom were Dutch nationals. Collision was primarily caused by Master of bulk carrier failing to take early and substantial action when complying with his obligation to keep out of the way.

- The fishing vessel was on an easterly course while on passage from Firth of Forth to Esbjerg, and the container ship was on a north-westerly course from Hamburg to Gothenburg. The fishing vessel was the give-way vessel but did not alter course and speed, the cause of which could not be established. The chief officer of the container ship did not alter course until it was too late and the two vessels collided. The fishing vessel foundered so quickly that all hands were trapped inside the accommodation and the container ship was so badly damaged that she had to use Esbjerg as a port of refuge.

3.3 Contact Incidents

MAIB define a contact incident as "vessel hits an object that is immobile and is not subject to the collision regulations e.g. buoy, post, dock (too hard), etc. Also, another ship if it is tied up alongside. Also floating logs, containers etc."

A total of 609 contacts were reported to MAIB between 1 January 1994 and 27 September 2005 involving 663 vessels.

The locations of contacts reported in the vicinity of the UK are presented in Figure 3.12, colour-coded by type.

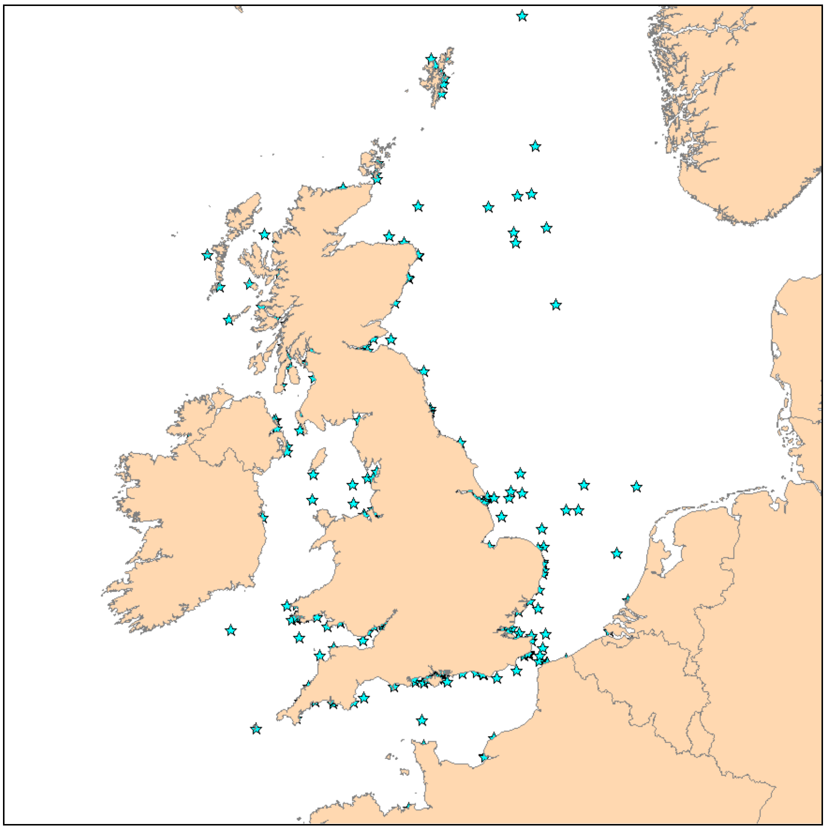


Figure 3.12 Contact Incident Locations (MAIB 1994-Sep 2005)

The distribution of contact incidents by year is presented in Figure 3.13.

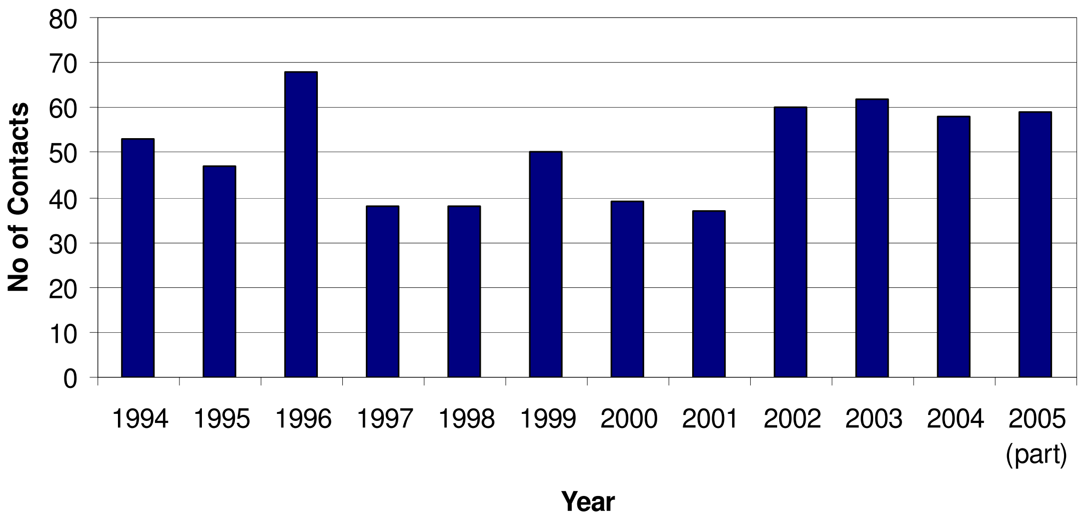


Figure 3.13 Contact Incidents per Year (MAIB 1994-Sep 2005)

The average number of contacts per year, excluding 2005 which is a part-year, was 50.

The distribution of vessel types involved in contacts is presented in Figure 3.14.

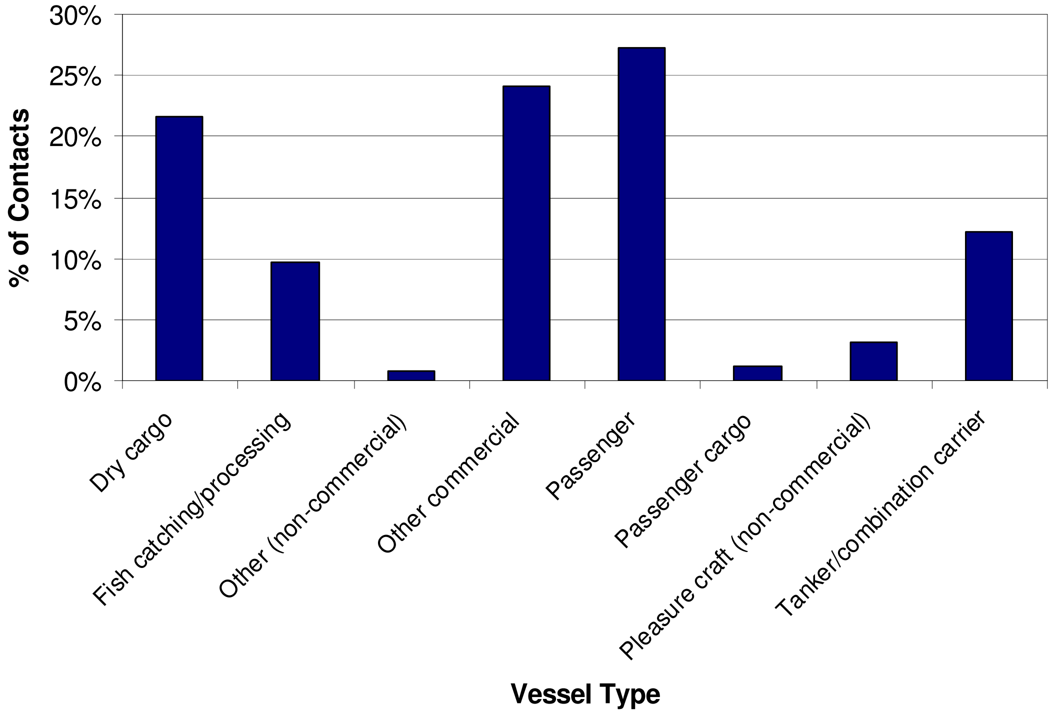


Figure 3.14 Contacts by Vessel Type (MAIB 1994-Sep 2005)

Therefore, the most common vessel type involved in contacts were passenger ferries (27%), other commercial vessels (24%) and dry cargo vessels (22%).

There were no fatalities in any of the contact incidents recorded by MAIB.

D4. Fatality Risk

4.1 Introduction

This section uses the MAIB incident data along with information on average manning levels per vessel type to estimate the probability of fatality in a marine incident associated with the proposed EOWDC development.

The proposed EOWDC is assessed to have the potential to affect the following incidents:

- Passing Powered Collision with Wind Farm Structure
- Passing Drifting Collision with Wind Farm Structure
- Vessel-to-Vessel Collision
- Fishing Vessel Collision with Wind Farm Structure

Of these incidents, only vessel-to-vessel collisions match the MAIB definition of collisions and hence the fatality analysis presented in Section 3.2 is considered to be directly applicable to these types of incidents.

The other scenarios of passing powered, passing drifting and fishing vessel collisions with the wind farm structures are technically contacts, i.e., vessel hits an immobile object in the form of a turbine or substation. From Section 3.3 it can be seen that none of the 609 contact incidents reported by MAIB between 1994 and 2005 resulted in fatalities.

However, as the mechanics involved in a vessel contacting a wind turbine may differ in severity from hitting, for example, a buoy, quayside or moored vessel, the MAIB collision fatality risk rate has also been conservatively applied for these incidents.

4.2 Fatality Probability

Twelve of the 623 collision incidents reported by MAIB resulted in one or more fatalities. This represents a 2% probability that a collision will lead to a fatal accident. A total of 21 fatalities resulted from the collision incidents.

To assess the fatality risk for personnel onboard a vessel, either crew, passenger or other, the number of persons involved in the incidents needs to be estimated. From an ILO survey of seafarers during 1998-99 (Ref. iii), the average commercial vessel had a crew of 17. For other (non-commercial vessels) such as naval craft and RNLI lifeboats the average crew has been estimated to be 20. Onboard fishing vessels and pleasure craft the average crew has been estimated to be 5. Finally, for passenger vessels it is estimated that the average number of passengers carried, in addition to crew, is 300 (based on UK sea passenger movements on principal ferry routes, Ref. iv).

It is recognised these numbers can be substantially higher or lower on an individual vessel basis depending on size, subtype, etc., but applying reasonable averages is considered sufficient for this analysis.

Using the average number of persons carried along with the vessel type information involved in collisions reported by MAIB (see Figure 3.10), gives an estimated 50,000 personnel onboard the ships involved in the collisions.

Based on 21 fatalities, the overall fatality probability in a collision for any individual onboard is approximately 4.3 x 10^{-4} per collision (0.04%).

It is considered inappropriate to apply this rate uniformly as the statistics clearly shown that the majority of fatalities tend be associated with smaller craft, such as fishing vessels and recreational vessels. Therefore, the fatality probability has been subdivided into two categories of vessel as presented in Table 4.1.

Table 4.1 Fatality Probability per Incident per Vessel Category

Vessel Category	Sub Categories	Fatalities	People Involved	Fatality Probability
Commercial	Dry cargo, passenger, tanker, etc.	3	46,200	6.5E-05
Non-Commercial	Fishing, pleasure, etc.	18	3,120	5.8E-03

From the above table it can be seen the risk is approximately two orders of magnitude higher for people onboard non-commercial vessels.

4.3 Fatality Risk due to the Proposed EOWDC

The base case and future case annual collision frequency levels without and with the proposed EOWDC site are summarised below.

Table 4.2 Summary of Annual Collision Frequency Results

Risk Scenario	Base Case			Future Case		
	Without	With	Change	Without	With	Change
Passing Powered	--	1.0E-03	1.0E-03	--	1.1E-03	1.1E-03
Passing Drifting	--	5.5E-05	5.5E-05	--	6.0E-05	6.0E-05
Vessel-to-Vessel	6.6E-03	6.7E-03	1.3E-04	7.2E-03	7.3E-03	1.4E-04
Fishing	--	2.5E-04	2.5E-04	--	2.8E-04	2.8E-04
Total	6.6E-03	8.0E-03	1.4E-03	7.2E-03	8.8E-03	1.6E-03

For the local vessels operating in the area of the site, the average manning has been estimated as follows.

Table 4.3 Vessel Types, Incidents and Average Persons exposed

Vessel Type	Collision Incidents	Average Manning
Cargo/Offshore	Passing powered, passing drifting, vessel-to-vessel.	17
Tanker	Passing powered, passing drifting, vessel-to-vessel.	20
Ferry	Passing powered, passing drifting, vessel-to-vessel.	250
Fishing Vessel	Vessel-to-vessel and fishing.	3
Recreational Vessel	Vessel-to-vessel.	4

From the detailed results of the collision frequency modelling, the distribution of the predicted change in collision frequency by vessel type due to the proposed EOWDC is as follows.

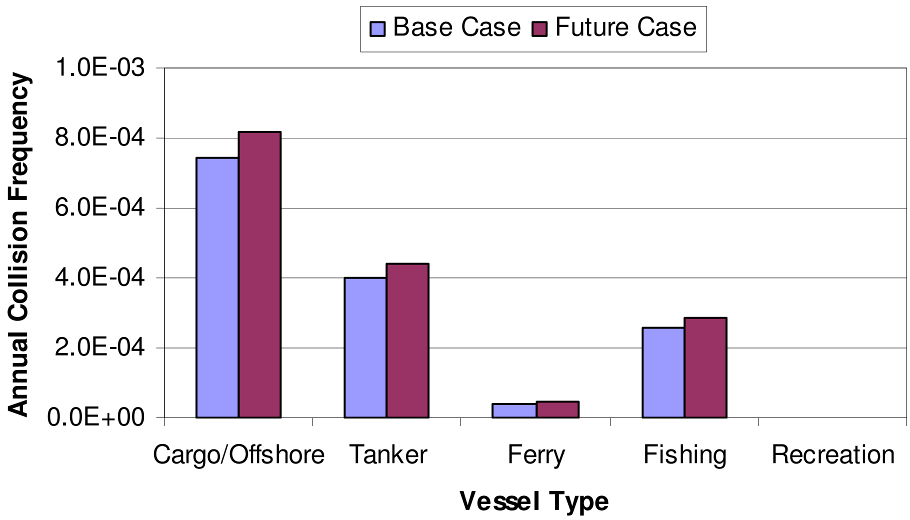


Figure 4.1 Collision Frequency by Vessel Type estimated for the proposed EOWDC

It can be seen the change in collision frequency is highest for cargo/offshore ships and tankers. The change in frequency is lowest for ferries and recreational vessels.

Combining the collision frequency (Table 4.2), the estimated number of persons onboard each vessel type (Table 4.3) and the estimated fatality probability for that vessel category (Table 4.1), the annual increase in Potential Loss of Life (PLL) due to the impact of the proposed EOWDC is estimated to be as follows:

- Base Case PLL: 6.8×10^{-6} fatalities per year
- Future Case PLL: 7.4×10^{-6} fatalities per year

The estimated base case PLL increase equates to an average of one additional fatality in 148,000 years, whilst the future case PLL increase corresponds to an average of one additional fatality in 135,000 years.

The predicted incremental increases in PLL due to the wind farm, distributed by vessel type for the base and future cases, are presented in Figure 4.2.

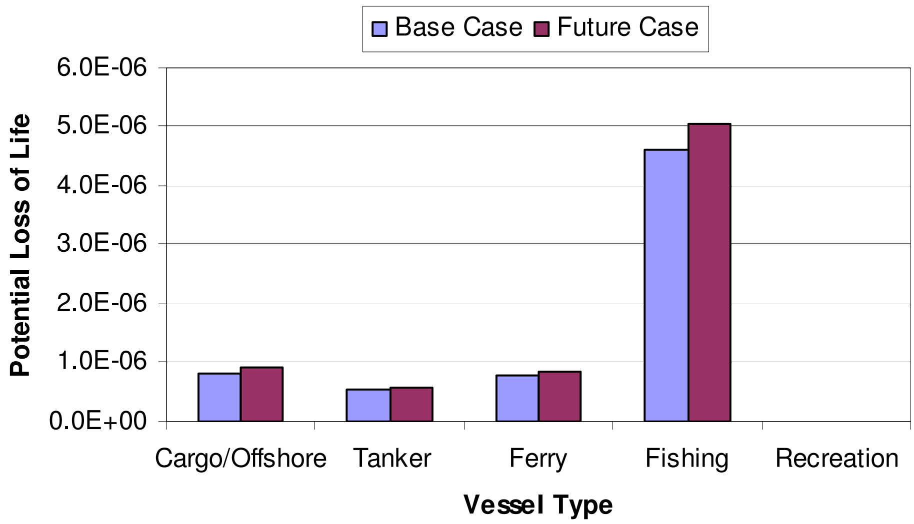


Figure 4.2 Estimated change in Annual PLL by Vessel Type due to the proposed EOWDC

Therefore, it can be seen that the fatality risk is dominated by fishing vessels, which historically have a higher fatality probability per incident than merchant vessels.

Converting the PLL to individual risk based on the average number of people exposed by vessel type, the results are presented in Figure 4.3. (This calculation assumes that the risk is shared between 10 vessels of each type, which is considered to be conservative based on the number of different vessels operating in the vicinity of the site.)

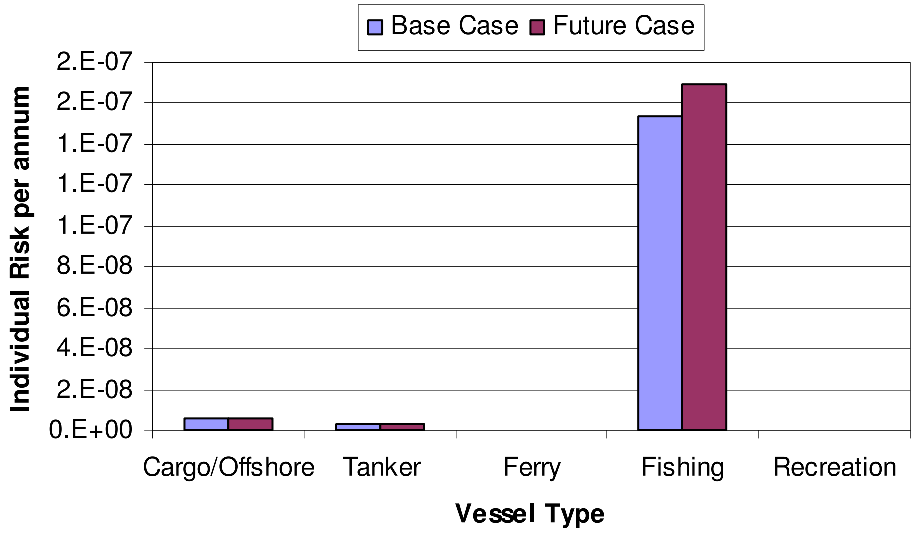


Figure 4.3 Estimated change in Individual Risk by Vessel Type due to the proposed EOWDC

Therefore, individual risk is highest for people on fishing vessels, which is related to the higher probability of fatalities occurring in the event of an incident.

4.4 Significance of Increase in Fatality Risk – Proposed EOWDC

The overall increase in PLL estimated due to the development is 6.8 x 10^{-6} fatalities per year (base case), which equates to one additional fatality in 148,000 years. This is a small change compared to the MAIB statistics which indicate an average of 29 fatalities per year in UK territorial waters.

In terms of individual risk to people, the incremental increase for commercial ships (in the region of 10^{-8}) is very low compared to the background risk level for the UK sea transport industry of 2.9 x 10^{-4} per year.

Similarly, for fishing vessels, whilst the change in individual risk attributed to the development is higher than for commercial vessels (in the region of 10^{-7}), it is very low compared to the background risk level for the UK sea fishing industry of 1.2 x 10^{-3} per year.

D5. Pollution Risk

5.1 Historical Analysis

The pollution consequences of a collision in terms of oil spill depend on the following:

- Spill probability (i.e., likelihood of outflow following an accident)
- Spill size (amount of oil)

Two types of oil spill are considered:

- Fuel oil spills from bunkers (all vessel types)
- Cargo oil spills (laden tankers)

The research undertaken as part of the DfT's MEHRAs project (Ref. v) has been used as it was comprehensive and based on worldwide marine spill data analysis.

From this research, the overall probability of a spill per accident was calculated based on historical accident data for each accident type as presented in Figure 5.1.

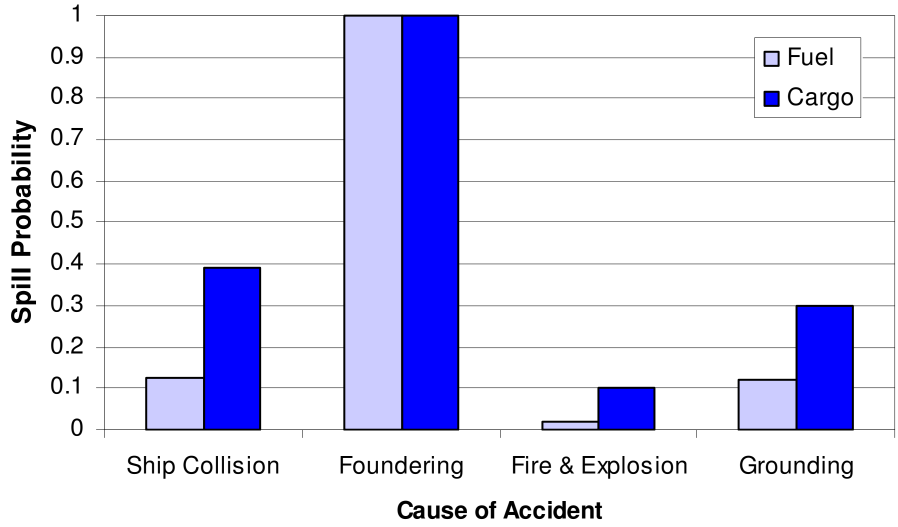


Figure 5.1 Probability of an Oil Spill resulting from an Accident

Therefore, it was estimated that 13% of ship collisions result in a fuel oil spill and 39% of collisions involving a laden tanker result in a cargo oil spill.

In the event of a bunker spill, the potential outflow of oil depends on the bunker capacity of the vessel. Historical bunker spills from ships have generally been limited to a size below 50% of the bunker capacity, and in most incidents much lower. For the types and sizes of ships exposed to the site, an average spill size of 100 tonnes of fuel oil is considered to be a conservative assumption.

For cargo spills from laden tankers, the spill size can vary significantly. ITOPF report the following spill size distribution for tanker collisions between 1974 and 2004.

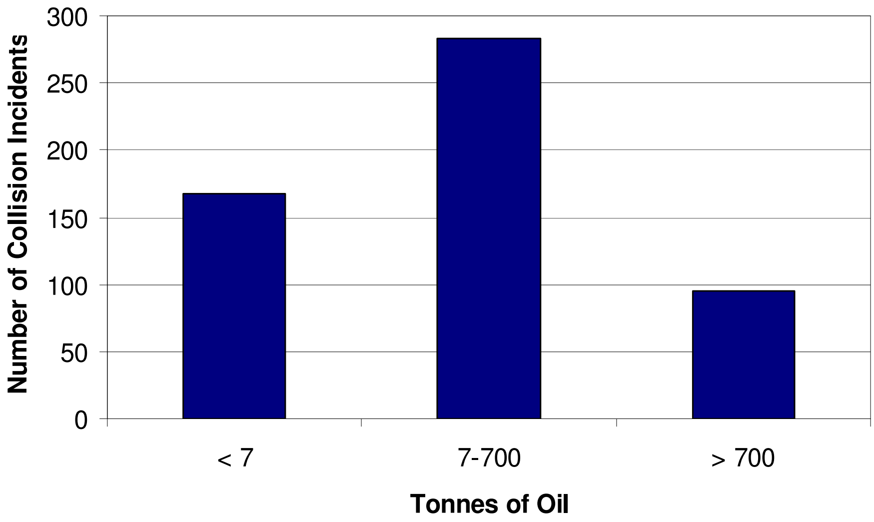


Figure 5.2 Spill Size Distribution in Tanker Collision Incident (ITOPF 1974-2004)

31% of spills are below 7 tonnes, 52% are between 7 and 700 tonnes and 17% are greater than 700 tonnes. Based on this data and the tankers transiting the area in proximity to the proposed EOWDC site, an average spill size of 400 tonnes is considered conservative.

For fishing and recreational vessel collisions, comprehensive statistical data is not available so it is conservatively assumed that 50% of all collisions involving these vessels will lead to oil spill with the quantity spilled being an average of 5 tonnes for fishing vessels and 1 tonne for recreational vessels.

5.2 Pollution Risk – Proposed EOWDC

Applying the above probabilities to the collision frequency by vessel type presented in Figure 4.1 and the average spill size per vessel, the amount of oil spilled per year due to the impact of the development is estimated to be as follows:

- Base Case: 0.07 tonnes of oil per year
- Future Case: 0.08 tonnes of oil per year

The predicted increases in tonnes of oil spilled distributed by vessel type for the base and future cases are presented in Figure 5.3.

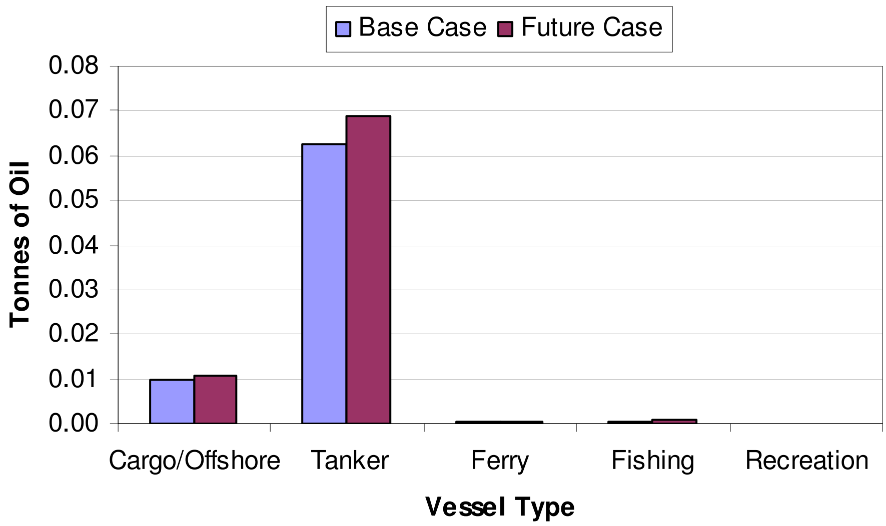


Figure 5.3 Estimated change in Pollution by Vessel Type due to Site

It can be seen that tankers, which can spill both fuel and cargo oils, pose the largest oil spill threat.

5.3 Significance of Increase in Pollution Risk – Proposed EOWDC

To assess the significance of the increased pollution risk from marine vessels caused by the proposed EOWDC, historical oil spill data for the UK has been used as a benchmark.

From the MEHRAs research (Ref. v), the average annual tonnes of oil spilled in the waters around the British Isles due to marine accidents in the 10-year period from 1989-98 1998 was 16,111. This is based on a total of 146 reported oil pollution incidents of greater than 1 tonne (smaller spills are excluded as are incidents which occurred within port and harbour areas or as a result of operational errors or equipment failure). Merchant vessel spills accounted for approximately 99% of the total while fishing vessel incidents accounted for less than 1%.

The overall increase in pollution estimated due to the development is very low compared to the historical average pollution quantities from marine accidents in UK waters (approximately 0.0005%).

D6. Conclusions

The quantitative risk assessment indicates that the impact of the proposed EOWDC on people and the environment is relatively low compared to background risk levels in UK waters.

However, it is recognised that there is a degree of uncertainty associated with numerical modelling. For example, the model does not consider the potential radar interference from turbines which may have an influence on the risk of vessel-to-vessel collisions, especially in reduced visibility where one or both of the vessels involved is not carrying AIS. Therefore, conservative assumptions have been applied in this analysis and the overall project is being carried out based on the principle of ALARP to ensure the risks to people and the environment are managed to a level that is as low as reasonably practicable.

It should also be noted that this is the localised impact of a single project and there will be additional maritime risks associated with other offshore wind farm projects in Scotland and the UK as a whole.

D7. References

i IMO Maritime Safety Committee, 74th Edition, Agenda Item 5 (MSC 74/5/X), Bulk Carrier Safety – Formal Safety Assessment, 2001.

ii MCA "Safety Information – FSA, Statistical Data" web page.

iii International Labour Organisation, The Impact on Seafarers' Living and Working Conditions of Changes in the Structure of the Shipping Industry, Geneva 2001, JMC/29/2001/3.

iv Department for Transport Maritime Statistics 2004.

v Department for Transport, Identification of Marine Environmental High Risk Areas (MEHRA's) in the UK, 2001.

European Offshore Wind Deployment Centre
Environmental Statement

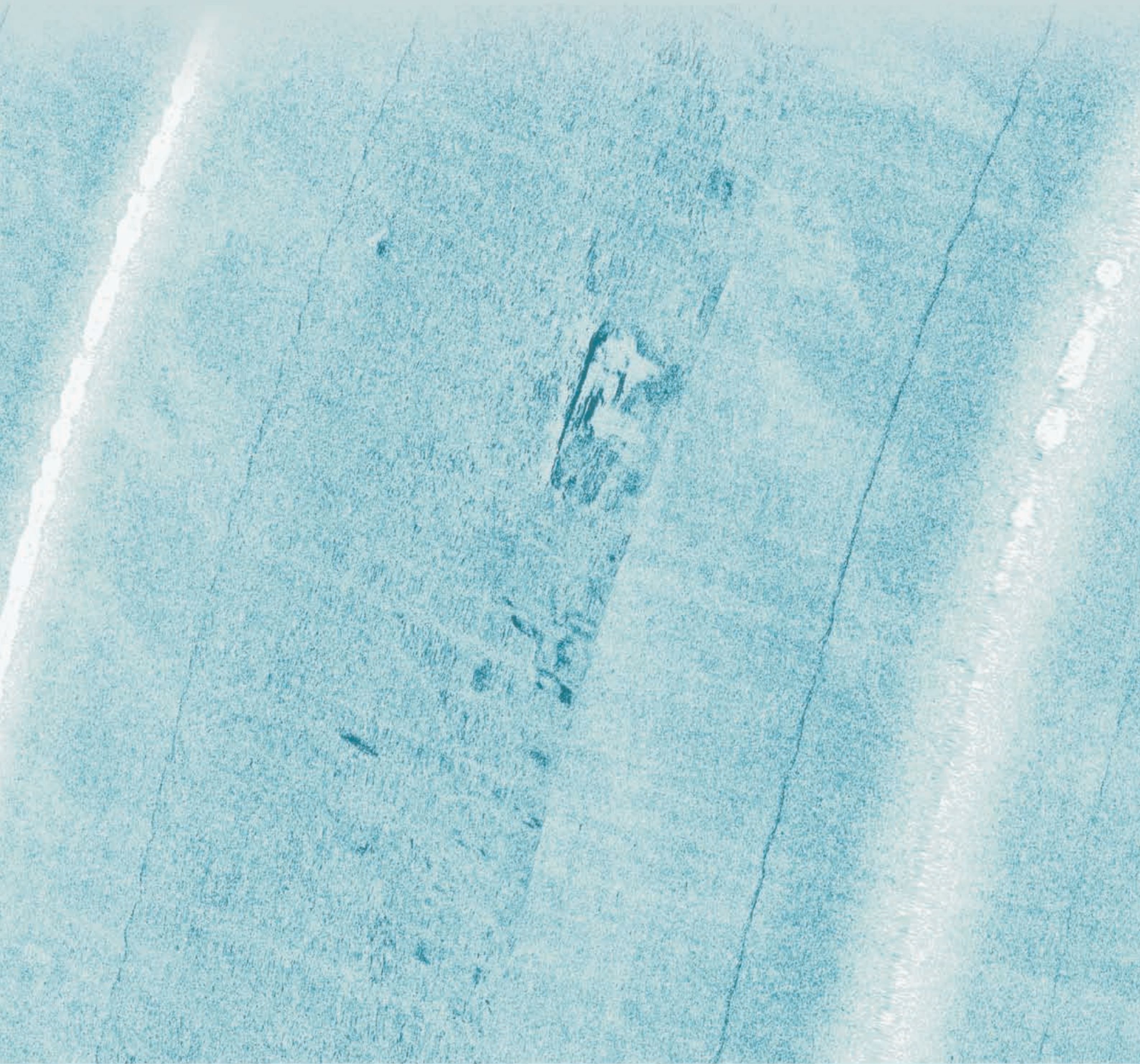
Appendix 18.1: Marine and Maritime Archaeology Baseline Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

Wessex Archaeology

European Offshore Wind Deployment Centre: Baseline

Technical Report



Ref: 65391.04

June 2011

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE: BASELINE

TECHNICAL REPORT

65391.04

Prepared for:

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June 2011

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE: BASELINE

TECHNICAL REPORT

65391.04

Title:	EOWDC baseline: technical report
Principal Author(s):	Dr Andrew Bicket
Managed by:	Dr Jonathan Benjamin
Origination date:	28 January 2011
Date of last revision:	6 June 2011
Version:	65391.04
Wessex Archaeology QA:	John McCarthy
Status:	Final
Summary of changes:	Client comments addressed
Associated reports:	65390.01, 65391.14, 65391.24
Client Approval:	

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE: BASELINE

TECHNICAL REPORT

65391.04

Acknowledgements

Wessex Archaeology was commissioned by Aberdeen Offshore Wind Power Ltd to undertake a technical archaeological assessment to underpin the environmental impact assessment (EIA) of the known and potential marine and maritime cultural heritage assets associated with the proposed European Offshore Wind Deployment Centre (EOWDC). Gavin Scarff and Edwina Sleightholme at Vattenfall Wind Power Ltd are thanked for their support.

Data was provided by the United Kingdom Hydrographic Office (UKHO), Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) and Aberdeenshire Sites and Monuments Record (SMR). The geophysical data was provided by EMU Ltd (2007) and Osiris Projects (2010).

Wessex Archaeology is grateful to the staff of all the above organisations for their co-operation during the project.

Dr Andrew Bicket produced this report. David Howell and Patrick Dresch processed and reviewed the geophysical data and further contributed to the report. Kitty Brandon prepared the illustrations. Dr Jonathan Benjamin managed the project for Wessex Archaeology, and quality assurance was conducted by John McCarthy and Dr Paul Baggaley.

Data Licences

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Front: Unidentified wreck WA_7071.
Back: Wessex Archaeology diver returning to dive vessel (© Wessex Archaeology 2008).

1 MARINE & MARITIME ARCHAEOLOGY

1.1 Information for the Non-Technical Summary

1 The proposed European Offshore Wind Deployment Centre (EOWDC) comprises 11 wind turbines and inter-turbine and export electrical cables.

2 A total of two cultural heritage assets characterised as A1 – being '*anthropogenic origin of archaeological interest*' (**WA 7071** and **7072**) have been identified within the survey area, approximately 40m apart. Of these, one is a previously uncharted wreck site (**7071**) and the other is a large piece of debris, possibly relating to a wreck (**7072**) (**Table 1**).

3 Wreck **7071** exhibits a magnetometer contact and therefore may be of partly metal construction, with dimensions similar to that of a small trawler or sailing vessel. Identification is not possible with the available evidence.

WA ID	Name / Classification	Easting	Northing	Archaeological Discrimination
7071	Wreck	561077	6342919	**A1**
7072	Debris	561038	6342931	**A1**

Table 1: Summary table of principal features of archaeological interest within assessed geophysical survey area. **N.B. FULL DETAILS CAN BE FOUND IN SECTION A.4.**

4 The shallow geological sequence of much of the survey area represents a prograding shoreline sequence relating to the Forth Formation (**WA 7505**) (**Figure 3**). This type of deposit records changes in sea-level in the area since the Last Glacial Maximum. These deposits are therefore potentially an important palaeogeographical and palaeoenvironmental sequence in relation to local and regional patterns of Mesolithic coastal activity and now-submerged archaeological landscapes. Any cultural heritage assets of early prehistoric origin encountered in an offshore, primary (*in situ*) context would be of national importance.

5 Five small possible cut and fills (**7500**, **7501**, **7502**, **7503** and **7504**) have also been identified in the south-west of the Marine Study Area (MSA). These are shallow, relatively small features and, since it has not been possible to trace them between adjacent geophysical survey lines, they are expected to be isolated depressions and not part of a coherent palaeochannel system. Reworked archaeological material in secondary contexts may be present in the fills of these features.

1.2 Introduction

6 Wessex Archaeology (WA) was commissioned to undertake a technical archaeological assessment for the Environmental Impact Assessment (EIA) of the known and potential marine and maritime cultural heritage assets within the vicinity of the proposed European Offshore Wind Deployment Centre (EOWDC).

1.2.1 Aim & Objectives

1.2.1.1 *Project Aim*

7 The aim of this report is to provide a baseline of the known and potential cultural heritage assets within a defined Marine Study Area (MSA) (see **paragraph 9**). The MSA contains the maximum proposed development area associated with the installation of 11 turbines and inter-turbine cabling in addition to an indicative export cable corridor. The MSA is outlined on **Figure 1**.

1.2.1.2 *Project Objectives*

- To outline and discuss the known cultural heritage assets within the MSA based on existing archaeological records, an assessment of marine geophysical data and secondary sources
- To summarise the potential for the presence of unknown archaeological sites that may be impacted by the proposed development with specific reference to human activity associated with palaeo-shoreline change and submerged prehistoric landscapes, maritime installations and wreck sites (civilian and military) of domestic and foreign origin
- To make an assessment of the importance of known and potential cultural heritage assets
- To present the statutory, planning and policy context relating to the historic environment within the MSA (see **Appendix A.1**)

1.2.2 Methodology Consultation

8 During the preparation of this baseline report stakeholders and organisations have been consulted. These are listed below:

- UK Hydrographic Office (101201) – consulted on source data
- RCAHMS (101201) – consulted on source data
- Ministry of Defence, Third Sector Heritage (110128) – consulted on source data

9 In order to provide adequate spatial context for assessing marine and maritime archaeology the MSA was created by placing a 1km buffer around the combined area of the proposed AOWFL Crown Estate lease boundary and the 2010 geophysical survey area as studied by Osiris Projects Ltd (**Figure 1**). This allowed an assessment of maritime cultural heritage assets preserved on the coast (i.e. wrecks run aground on the beach) as well as wrecks and other features on the seabed.

Point	Easting	Northing
1	558678	6346426
2	560802	6345476
3	563484	6346151
4	561740	6340780
5	560394	6340441
6	560813	6342626
7	557769	6341578
8	557275	6339047
9	556445	6339515
Datum: WGS84 **Projection:** UTM z30N		
To obtain MSA, apply 1km buffer to polygon derived from these points		

Table 2: Vertex coordinates of marine study area.

10 The terrestrial components of the proposed scheme are not considered in this report, except where documented wrecks are present on the beach and to provide qualitative context for submerged landscape features.

11 Sub-bottom profiling surveys have also allowed an investigation of Quaternary sedimentary units permitting an assessment of potential for encountering palaeolandscape features of archaeological significance within the context of published sources.

12 The methodology reflects the requirements of Environmental Impact Assessment arising as set out in European Council Directive 85/337/EEC as amended by Directive 97/11/EC. This follows best practice for archaeological reporting as outlined by the Institute for Archaeologists (IfA) in Standards and Guidance for Archaeological Desk-based Assessment (2008).

13 The approach actively assesses models of past sea-level, palaeo-shorelines and submerged prehistoric landscapes alongside the archaeological record to effectively communicate the relationship of the MSA to the extent of inhabitable land throughout the late Pleistocene and Holocene (i.e. last 18,000 years). The broader geological and geomorphological context of the MSA is also summarised to provide sufficient context to allow an assessment of potential for encountering submerged prehistoric landscapes.

14 A variety of documentary sources have been consulted to provide a gazetteer of recorded maritime assets as well as a contextual baseline. This information underpins an assessment of the archaeological and historic importance of maritime resources identified during the geophysical assessment of survey data.

15 This has partly been undertaken within the context of maritime resources compiled and discussed in a previous desk based assessment (DBA) from an area abutting the south of the MSA (Wessex Archaeology 2007) – where appropriate, this report has incorporated and updated elements of the 2007 report, notably maritime history in the Aberdeen Bay area and gazetteers of known losses (**Appendix A.5**).

1.2.3 Data Information and Sources

- Archaeological records for the MSA available in the maritime section of the CANMORE database held by the Royal Commission for Ancient and

Historic Monuments Scotland (RCAHMS) which constitute the National Monuments Record for Scotland (NMRS), also interrogated via a map interface, CANMAP

- Archaeological records for the MSA held locally in the Aberdeenshire, Moray and Angus Sites and Monuments Record (SMR)
- Records of wrecks and obstructions collated by the UK Hydrographic Office (UKHO)
- Records of Protected Places and Controlled Sites provided by the Ministry of Defence
- SeaZone datasets provided by AOWFL including basemapping and wreck information (derived from UKHO records)
- British Geological Survey (BGS) mapping and UKHO charts
- Various secondary sources relating to the palaeo-environment of the area and to the Palaeolithic and Mesolithic archaeology of Northern Europe (see **section 4**)
- Secondary sources relating to wrecks and the maritime environment and the history and archaeology of Aberdeen and its surrounding area (see **section 4**)

16 Geophysical data that has been archaeologically assessed as part of this report is associated with the following reports:

- Emu Ltd (2008) *Geophysical and Seabed Habitat Assessment of the Proposed Aberdeen Offshore Wind Farm for Aberdeen Offshore Wind Farm Ltd.* Report No. 07/J/1/02/1136/0716
- Osiris Projects (2010) *Aberdeen Offshore Windfarm Geophysical Survey. Volume 1: Operations Report. No. C10023*

1.2.3.1 *Data Management*

17 A Geographical Information System (GIS) using ArcGIS 9.3 has been built to store spatial data for the MSA. Qualitative data without accurate geospatial positions have been compiled in a project archive and used to provide baseline context (e.g. recorded losses).

Feature Numbering System

18 Records of wrecks, casualties and seabed features with sufficient positional data have been mapped in the GIS to determine spatial relationships within the MSA. Duplicate records (i.e. sites and features that appeared in more than one dataset) have been merged where practicable and examined against identified geophysical features and anomalies – reference to original sources are retained in the gazetteer located in section A.2, and highlighted by a Wessex Archaeology identification number (WA_ID) beginning (**WA_2000**).

19 Features identified during the geophysical assessment are numbered with a Wessex Archaeology identification number beginning (WA_6000).

20 Once the documentary records (WA_2000s) and observed geophysical anomalies (WA_6000s) are incorporated into the geophysical assessment the known assets and anomalies on the resulting list have each been given a final unique WA_ID number in a sequence starting at **WA_7000**; reference is retained in the gazetteer to the earlier documented features number system (i.e. WA 2000s – documentary records – and 6000s – geophysical anomalies).

21 A full gazetteer of wrecks, casualties and obstructions within the MSA is presented in Appendices A.2 - A.5.

Data Source Quality

22 The UKHO is considered to be the primary record for wrecks and obstructions on the seabed. Wreck information from the UKHO is incorporated into the SeaZone datasets that were also consulted during this project. The following definitions describe the state of the wreck and obstruction records held by the UKHO (incorporated into the SeaZone datasets), and which have been used to classify some of the sites in the gazetteer:

- ABEY: Previously reported but not detected by survey, leading to doubts about its reported position or existence
- DEAD: Not detected by repeated surveys, therefore considered not to exist
- LIFT: A salvaged wreck
- LIVE: All wrecks and anomalies found by UKHO survey

23 DEAD features may just be buried or obscured during subsequent surveys, and therefore represent potential cultural heritage assets which must be considered. This may apply to ABEY records as well; however, poor positioning of such records may make it difficult to reconcile documentary sources with seabed features.

24 CANMORE/CANMAP provides a mapping interface in which to examine the National Monument Record of Scotland (NMRS). The database assigns the positions of these losses with varying degrees of positional accuracy. Where wreck positions are provided by both the UKHO and CANMORE databases, and positional quality can be accurately assessed, the most accurate positional information has been used. For wrecks discussed in this report, positional information is derived from UKHO records (duplicated in the SeaZone datasets). Wreck records from CANMORE have been integrated into the gazetteer of recorded losses as the positional information was found to be inaccurate (**Appendix A.5**).

25 The Aberdeenshire SMR also provides a map interface allowing the creation of polygons to define the desired search area. The marine and maritime content is relatively scarce, within the MSA some records of beached wrecks are present but with relatively poor positional information. The SMR is also a valuable source for early prehistory, particularly for Mesolithic period sites that provide context for submerged Holocene landscapes, inundated by sea-level rise. These themes are developed in the baseline (see **section 2.3.2.4**, **Table 10**).

26 Many of the records in the CANMORE (RCAHMS) and Aberdeenshire SMR databases and other sources (e.g. literary sources) can be termed ‘recorded losses’. These records refer to maritime casualties for which there are no currently known or confirmed seabed remains. Casualty positions are often based on descriptive definitions or dead reckoning and therefore tend to be much less precise and reliable for older shipwrecks. The records are based on the recording practice of ‘Named Locations’, such as 'off Aberdeen' whereby records are assigned to an arbitrary position not directly related to their point of loss, but within the general area.

27 Casualties that will not have resulted in an archaeological site, such as strandings that were subsequently refloated, have been excluded.

28 A qualitative assessment for the potential for encountering military aircraft crash sites at sea is made in **section 2.5**.

29 Recorded losses 'attached' to the Named Locations that may fall within the MSA have been included in the gazetteer (**Appendix A.5**). However, it should be understood that considerable uncertainty attaches to the actual location of many of the losses records. Therefore the gazetteer is likely to contain records of many losses that have not occurred within the MSA.

1.2.3.2 Mapping and Datums

30 All positions and figures are presented in **UTM zone 30N**, relative to the **WGS 84** datum.

31 Unless otherwise stated, all depths are given in metres and relate either to the Chart Datum (CD) Aberdeen or to the Ordnance Datum (OD), Newlyn. The difference between CD Aberdeen and OD is -2.25m, i.e. CD Aberdeen is 2.25m below OD (Newlyn).

1.2.3.3 Chronology

32 In order to clarify the discussion of submerged landscape potential the chronology of British prehistory currently extending to the last 1 Million years (Ma) is presented in **Figure 2**. Major archaeological industries (characteristic artefacts and technologies of particular periods) and their sea-level context are provided; the fluctuating 'island' palaeogeography of Britain is a critical factor for understanding and assessing the archaeological record.

33 The archaeological dating presented in this report relies on two distinct chronological systems. These are as follows:

- Calendar dates, which are suffixed with BC (Before Christ). Such dates can be considered as part of our present day calendar. Derived from chronological methods that equate directly to calendar years or calibrated radiocarbon dates are either related to our modern calendar as BC (cal.BC) dates, or presented as cal.BP (before present) dates calculated in years before 1950
- BP dates (before 1950) are generally used for geological time and refer to dates derived by means other than radiocarbon dating (which is limited to dating the last 45,000 years

34 Archaeological periods during the Holocene (last 10,000 years BP) are outlined in **Table 3**, based upon the scheme adopted for Scotland by the RCAHMS.

Period	Dates
Mesolithic	8600-4000 BC
Neolithic	4000-2000 BC
Bronze Age	2000-800 BC
Iron Age	800 BC – AD 79
Prehistoric	Pre-AD 79
Roman	AD 79-410
Early Historic	AD 411-700
Early Medieval	AD 700-1100
Medieval	AD 1100-1540
Post-Medieval	AD 1541-1700
Industrial	1700-1899
20th Century	1900-1999

Table 3: Key archaeological periods pertaining to Scotland (RCAHMS).

1.2.3.4 Geophysical Assessment Methodology

35 As part of this technical report WA carried out an archaeological assessment of marine geophysical data previously collected by Emu Ltd. (2007) and Osiris Projects Ltd. (2010) in conjunction with records of historic wreck sites and the archaeological record. This has resulted in an archaeological review of the effects of the proposed development upon sites of archaeological interest within the MSA (Wessex Archaeology 2011b). The objectives were as follows:

- To assess geophysical data in order to identify any material of archaeological interest lying within the limits of the survey area
- To locate, identify and characterise any previously unrecorded archaeological sites, and confirm the presence and condition of any known sites within the survey area
- To identify the presence of any sedimentary deposits of archaeological potential
- To propose future mitigation for material of archaeological interest within the survey area

36 The geophysical data used for this report were assessed for quality and were rated as variable using the following criteria:

Data Quality	Description
Good	Data which are clear and unaffected by weather conditions or sea state. The dataset is suitable for the interpretation of standing and partially buried metal wrecks and their character and associated debris field. These data also provide the highest chance of identifying wooden wrecks and debris.
Average	Data which are affected by weather conditions and sea state to a slight or moderate degree. The dataset is suitable for the identification and partial interpretation of standing and partially buried metal wrecks, and the larger elements of their debris fields. Wooden wrecks may be visible in the data, but their identification as such is likely to be difficult.
Variable	This category contains datasets with the quality of individual lines ranging from good to average to below average. The dataset is suitable for the identification of standing and some partially buried metal wrecks. Detailed interpretation of the wrecks and debris field is likely to be problematic. Wooden wrecks are unlikely to be identified.

Table 4: Geophysical survey data quality categorisation.

37 A particular issue which adversely affected the quality of the data appears to have been variable weather conditions encountered during both of the surveys. This has resulted in a minor to high degree of noise being present on both the sub-bottom profiler and sidescan sonar datasets, though the sidescan sonar appeared more detrimentally affected. As a result of this, it is not possible to guarantee that all the potential archaeological features in the data have been correctly identified during archaeological assessment by WA.

Geophysical Data –Technical Specifications

38 The data were obtained during two separate surveys. The first was conducted by Emu Ltd. (Emu 2008) between the 13th and 18th September 2007 on the *FPV Morven*, and the second by Osiris Projects Ltd. (Osiris 2010) between the 3rd September and 26th October 2010 on the *MV Lia*. Both datasets consisted of sidescan sonar, sub-bottom profiler, multibeam bathymetry and marine magnetometer data.

39 Emu used a Klein 3000 dual frequency (100kHz and 500kHz) sidescan sonar system operated at 100m range, with positioning provided by manual layback applied during processing. Data were recorded digitally using SonarPro software and provided to WA as *.xtf* files. Osiris used a GeoAcoustics 159D dual frequency (110kHz and 410kHz) sidescan sonar towfish operated at 75m range, again with laybacks applied during processing. Data were digitally recorded using a Coda DA2000 acquisition system and provided to WA as *.cod* files.

40 For the sub-bottom profiler data, both Emu and Osiris used a surface-towed Applied Acoustics AA200 Boomer, with either a C-Products (Emu 2008) or Applied Acoustics (Osiris 2010) 8 element trailing hydrophone. The systems were operated at a power of 100J and 250ms firing rate. Data were digitally recorded using a Coda DA2000 acquisition system in both cases, with the data being provided to WA as *.cod* files.

41 The magnetic data for both surveys was acquired using a Geometrics G882 Caesium Vapour magnetometer, with the data being logged directly by the

navigational computer. The data were provided to WA as *.txt* files by Emu and as *.csv* files by Osiris.

42 To acquire the multibeam bathymetry data, Emu used a Reson Seabat 8101 240kHz swathe head and QINSy 8 acquisition software. The data were provided to WA as *.txt* files. Osiris used a GeoAcoustics GeoSwath 250kHz sytem with a Valeport Mini SVS providing real time SVP data. Data were recorded using GeoSwath Plus software, and provided to WA as *.txt* files.

43 For the 2007 survey, positioning was provided by a CS1 Minimax DGPS system, receiving corrections from the EGNOS differential network. For the 2010 survey, primary positioning was provided by C-Nav 3050M system receiving corrections from the EGNOS differential network, whilst secondary positioning was provided by a Leica GX 1230 Smartnet RTK GPS system.

Geophysical Data - Processing

44 The sidescan sonar data were processed by WA using Coda Geosurvey software. This allowed the data to be replayed with various gain settings in order to optimise the quality of the images. The data were initially scanned to give an understanding of the geological nature of the area and were then interpreted for any objects of possible anthropogenic origin. This involves creating a database of anomalies within Coda by tagging individual features of possible archaeological potential, recording their positions and dimensions, and acquiring an image of each anomaly for future reference.

45 A mosaic of the sidescan sonar data is produced during this process to assess the quality of the sonar towfish positioning. The survey lines are smoothed, and the navigation corrected either with CNV files provided by the survey company who acquired the data or individual fixed laybacks as recorded in the survey logs. This allows the position of anomalies to be checked between different survey lines and for the layback values to be further refined if necessary.

46 The form, size, and/or extent of an anomaly is a guide to its potential to be an anthropogenic feature, and therefore of its potential archaeological interest. A single, small, but prominent anomaly may be part of a much more extensive feature that is largely buried. Similarly, a scatter of minor anomalies may define the edges of a buried but intact feature, or it may be all that remains of a feature as a result of past impacts from, for example, dredging or fishing. The application of a ratings system is therefore a means of prioritising sites in order to inform further staged of the interpretation process, and on its own is not definitive.

47 The shallow seismic data were studied in order to detect any in-filled palaeochannels, ravinement surfaces and peat/fine-grained sediment horizons that may have archaeological potential.

48 The shallow seismic data were processed by WA using Coda Seismic+ software. This software allows the data to be visualised with user selected filters and gain settings in order to optimise the appearance of the data for interpretation. The software then allows an interpretation to be applied to the data by identifying and selecting a sedimentary boundary that might be of archaeological interest.

49 The shallow seismic data were interpreted with a two-way travel time (TWTT) along the z-axis. In order to convert from TWTT to depth, the velocity of the seismic waves was estimated to be 1,600ms^{-1}. This is a standard estimate for shallow, unconsolidated sediments.

50 Any small reflectors which appear to be buried material such as a wreck site covered by sediment were also recorded, the position and dimensions of any such objects noted in a gazetteer, and an image of each anomaly acquired. It should be noted that anomalies of this type are rare, as the sensors must pass directly over such an object in order to produce an anomaly.

51 The magnetometer data were processed by WA using Geometrics MagPick software in order to identify any discrete magnetic contacts which could represent buried metallic debris or structures such as wrecks.

52 The software enables both visualisation of individual lines of data and gridding of data to produce a magnetic anomaly map. Smoothed averages of the data were first calculated, and the subtracted from the raw data values in order to reduce the effect of natural variations in the magnetic field such as changes in geology or water depth.

53 The multibeam bathymetry data were used to provide a vertical reference for the sub-bottom profiler data, and were fully analysed to identify any unusual seabed structure that could be shipwrecks or other anthropogenic debris. The data were gridded and analysed using Fledermaus software, which enables 3-D visualisation of the acquired data and geo-picking of seabed anomalies

Geophysical Data – Anomaly Grouping & Discrimination

54 The previous section describes the initial interpretation of all available geophysical datasets, which were conducted independently of each other. This inevitably leads to the possibility of any one object being the cause of numerous anomalies in different datasets and apparently overstating the number of archaeological features in the study area.

55 To address this fact, the anomalies were grouped together along with the results of the desk-based study of known archaeological sites. This allows one ID number to be assigned to a single object for which there may be, for example, a UKHO record, a magnetic anomaly, and multiple sidescan sonar anomalies.

56 Once all the geophysical anomalies and desk-based information have been grouped, a discrimination flag is added to the record in order to discriminate against those which are not thought to be of an archaeological concern. These flags are ascribed as follows:

Non-Archaeological	U1	Not of anthropogenic origin
	U2	Known non-archaeological feature
	U3	Non-archaeological hazard
Archaeological	A1	Anthropogenic origin of archaeological interest
	A2	Uncertain origin of possible archaeological interest
	A3	Historic record of possible archaeological interest with no corresponding geophysical anomaly

Table 5: Criteria discriminating relevance of feature to proposed scheme.

57 All the sites that have been identified within the study areas are presented in **Appendix A.4** and discussed in this report.

58 The grouping and discrimination of information at this stage is based on all available information and is not definitive. It allows for all features of potential archaeological interest to be highlighted, while retaining all the information produced during the course of the geophysical interpretation and desk-based assessment for further evaluation should more information become available.

1.2.4 Key Guidance Documents

59 There is various archaeological guidance applicable to offshore developments, details of which may be found here (see references for full details, **section 4**):

- The Code of Practice for Seabed Developers, Joint Nautical Archaeology Policy Committee 2006 (JNAPC 2006)
- Historic Environment Guidance for the Offshore Renewable Energy Sector, COWRIE 2007 (Wessex Archaeology 2007)
- Guidance for Assessment of Cumulative Impacts on the Historic Environment; from Offshore Renewable Energy, COWRIE 2008 (Oxford Archaeology & George Lambrick Archaeology and Heritage 2008)
- Protocol for Archaeological Discoveries: Offshore Renewables Projects, The Crown Estate, 2010 (Wessex Archaeology 2010)
- Towards a Strategy for Scotland's Marine Historic Environment (Historic Scotland 2009) http://www.historic-scotland.gov.uk/marine-strategy.pdf

2 BASELINE DESCRIPTION

60 In order to assess the existing marine and maritime archaeological record within the MSA and the potential for encountering other cultural heritage assets during the course of future development activity, a baseline is discussed below.

61 The **known cultural heritage assets** are identified primarily through the archaeological assessment of geophysical survey data and integrated where possible with documentary sources.

- Palaeolandscape features visible on sub-bottom profiler (SBP) survey lines are identified and discussed within the regional geological and palaeogeographical literature
- Seabed features identified from sonar and magnetometry survey datasets are then discussed, focusing upon wrecks and obstructions that are preserved on the seabed, where possible, in conjunction with documented losses

62 The potential for encountering further cultural heritage assets within the MSA is then discussed with specific reference to regional records of prehistoric archaeology and submerged Holocene palaeolandscapes preserved at or beneath the modern seabed. This potential is directly focused on the data-led assessment of the geophysical survey reported below where possible. In some cases it is necessary to provide a broader overview in order to highlight the range of issues that may encountered by offshore developments of all kinds.

63 Later prehistory and maritime history are then discussed for the north-east region of Scotland and Aberdeen Bay within an increasing focus upon vessels as rising sea-levels reached modern levels by the Neolithic (*c.* 4000 BC).

2.1 Archaeological Assessment of Geophysical Survey Data

2.1.1 Sub-bottom Profiler (SBP) Assessment

64 Both Emu and Osiris used a surface-towed boomer and trailing hydrophone to acquire the shallow seismic data from the survey area. Of the dataset collected by EMU and Osiris, 20% was archaeologically assessed by WA for the purpose of this report, in line with current practice.

65 The broad geological sequence across the survey area can be summarised as follows (interpreted from the current geophysical data, BGS 1986, Gatliff *et al.* 1994, and Stoker *et al.* 2008):

Unit	Description
1	Recent (Holocene) seabed sediments, silty sand.
2	Late Devensian / Early Holocene fluvio-deltaic and marine sands (**Forth Formation (FH)**, **St. Andrew's Bay Member**)
3	Late Devensian Till (**Wee Bankie Formation**)
4	Devonian Bedrock (**Old Red Sandstone**)

Table 6: General geological sequence from the survey area.

66 Not all of the sequence described above is present across the entire geophysical survey area, with some of the units being absent in places. The geological units are individually described below.

67 **Unit 4** is the oldest unit and forms the basement geology across the MSA. The unit is often very shallow and outcrops at the seabed in places along the western edge of the survey area, though is seen to dip towards the east. BGS reports indicate the sequence is Old Red Sandstone of Devonian age, and is therefore considered too old to be of possible archaeological potential. It is possible that the upper surface of the unit could have once been a land surface upon which archaeological material could have been deposited, though it is expected that any land surfaces which were once present have been subsequently removed by ice erosion during the Devensian glaciation.

68 **Unit 3** directly overlies **Unit 4** across most of the survey area, although it is possibly absent in places. The upper reflector of the unit is irregular and often shows high relief creating a unit of variable thickness. As with Unit 4, it outcrops at seabed towards the west of the survey are and, in general, dips towards the east. The internal structure is generally chaotic. This unit is interpreted as being the Wee Bankie Formation, a glacial till of Late Devensian Age. Due to its glacial nature, this unit is again not considered of possible archaeological potential.

69 **Unit 2** is present across most of the survey area. In the west it fills hollows formed by the irregular relief of **Unit 3** and gradually thickens to the east where it appears as a more uniform blanket deposit. This is interpreted as being the St. Andrew's Bay Member of the Forth Formation (FH, **Figure 3**), a deposit of Late Devensian / Early Holocene fluvio-deltaic and marine sand (Gatcliff *et al.* 1994).

70 Previous work in the wider region (Stoker *et al.* 2008) has suggested that this deposit is part of a prograding shoreline created during periods of relative sea-level change (caused by glacial melting and isostatic rebound) after the last glacial maximum, and that it is divided into four distinct lithozones. A poorly defined reflector (**7505**), observed dipping gently eastwards from a line approximately shore-parallel across the centre of the survey area, could indicate a boundary between two of these lithozones (**Figure 3**).

71 Five small possible cut and fills (**7500**, **7501**, **7502**, **7503** and **7504**) have also been identified in the surface of **Unit 3**. These are shallow, relatively small features and, since it has not been possible to trace them between adjacent lines, they are expected to be isolated depressions and not part of a coherent palaeochannel system.

72 **Unit 2** is potentially of some palaeoenvironmental interest as it contains a record of sea-level change and coastal position since the last glacial maximum. However, the generally sandy nature of the sediments indicate it is unlikely that any organic matter would be preserved within the unit, and it has been previously found that even more inorganic microfossils (e.g. foraminifera) are sparse within this sequence (Stoker *et al.* 2008), reducing its significance from this point of view. Additionally, while there is the potential for some archaeological material to be present within **Unit 2**, this potential is low, and any material that does survive is likely to be re-deposited and not in a primary context.

73 **Unit 1** comprises the Holocene seabed sediment across the study area, and for the most part consists of a thin veneer of silty sand with numerous patches of finer grained sediment. **Unit 1** is not present across the entire site, and is absent in patches towards the west of the study area where **Unit 4** and **Unit 3** outcrop at the

seabed. A curvilinear, roughly shore-parallel sand bank up to approximately 5m high has been identified running along the western edge of the survey area, and represents the thickest localised accumulation of superficial seabed sediment. This is expected to be a Holocene feature, probably comprising older, re-worked sediment.

74 Holocene seabed sediments are not considered archaeologically important in themselves, though where they form large mobile sand waves and banks they can potentially cover archaeological sites including shipwrecks. However, due to the generally thin nature of **Unit 1** in the study area, the potential for this to occur is low.

2.1.2 Seabed Features Assessment

75 A total of 87 sidescan sonar anomalies plus 154 magnetometer anomalies were individually identified within the MSA using data collected by EMU Ltd and Osiris Projects Ltd. These were grouped, together with any recorded wrecks and obstructions as identified by the UKHO within the area covered by the geophysical data, to produce a list of 103 sites of potential archaeological interest. Additionally, 2 of these 103 features are recorded wrecks or obstructions provided by the UKHO and NMR searches. Being located outside of the geophysical survey area in the MSA buffer they are listed as A3 features as they have not been observed. These were all characterised as follows:

Archaeological Discrimination	Number of Anomalies	Interpretation
A1	2	Anthropogenic origin of archaeological interest
A2	97	Uncertain origin of possible archaeological interest
A3	4	Historic record of possible archaeological interest with no corresponding geophysical anomaly
Total:	**103**	

Table 7: Archaeological assessment of identified geophysical anomalies.

76 Furthermore, these anomalies can be classified by probable type, which can further aid in assigning archaeological potential and importance:

Anomaly Classification	Number of Anomalies
Recorded Wreck / Obstruction (*based solely on documentary sources*)	4
Wreck (*features identified solely by geophysical assessment*)	1
Debris	23
Seafloor Disturbance	1
Dark Reflector	13
Rope / chain	3
Magnetic	58
Total	**103**

Table 8: Classification of geophysical anomalies.

77 The individual sites identified in the geophysical survey are discussed below. Further detail can be found in **Appendix A.4** and **Figure 4**.

78 Documented wrecks with accurate positions within the MSA are presented in **Figure 4** (see **Appendix A.2**). Following geophysical assessment it was not possible to identify or confirm the presence of these features as they were either outside of the geophysical survey area (although still within the overall MSA) or their recorded positions were not accurate. See **Figure 4** for details of the dataset used to underpin the conclusions of this report.

79 Only one definite wreck site (**WA 7071**) was identified across the entire survey area, located approximately 60m north-west from the proposed location of Turbine 8 (**Figure 5**). The wreck measures (approximately 25m x 6.5m x 0.7m), and exhibits structure and height suggesting it is upright and relatively intact, though it is possibly partially buried. Multibeam bathymetry data indicate it is located in a very shallow (<0.5m deep) scour, and an associated magnetic anomaly of 58nT (magnetic amplitude (nT)) indicate the structure is at least partially ferrous in composition. The name and history of the structure is unknown, as it was not present in the provided UKHO data, suggesting it is a previously unknown structure. The wreck is illustrated in **Figure 5**.

80 Lavery (2001:78-79) describes steam trawlers of similar dimensions dating to throughout the later 19^{th} and 20^{th} centuries and Aberdeen was a centre for shipbuilding with local vessel types a distinctive aspect of the maritime history of the area as discussed in the maritime baseline (**Section 2.4**). Further information will be required to enable an assessment of the archaeological importance of this wreck.

81 Additionally, four previously documented wrecks or obstructions (**WA 7046**, **7093**, **7102** and **7103**) were not identified by the geophysical survey. **WA 7102** and **7103**, the given locations of the wrecks of the *Sheriffmuir* and the *Coastal Emperor* respectively, were located outside of the geophysical survey area and so their presence/location/current condition cannot be commented upon at this time.

82 **WA 7093** is the given location of the wreck of the SS *Archangel*, which was not identified by any of the survey equipment despite the UKHO records indicating it is a large vessel and probably contains a number of ferrous elements. The last amended survey date is given as 1977, which may indicate that this position is inaccurate and the wreck is actually located elsewhere beyond the boundaries of the survey area.

83 **WA 7046** is recorded as the location of a seabed obstruction, specifically an anchor and shackles abandoned on the seabed. This was not identified by any of the geophysical equipment, and could either be located a short distance away outside of the geophysical survey area, or be buried by seabed sediments at the time of survey.

84 Three sites (**WA 7000**, **7047** and **7051**) comprise curvilinear dark reflectors, with a small acoustic shadow and small magnetic anomaly in the case of **WA 7000**. These are interpreted as possible lengths of rope or chain. Lengths of rope or chain such as this could be pieces of modern debris abandoned on the seabed, or could be all that is visible of mostly buried structures or those that have been damaged by wave action or fishing.

85 23 sites (**WA 7001**, **7006**, **7019**, **7020**, **7023**, **7024**, **7027**, **7029**, **7038**, **7045**, **7049**, **7052**, **7069**, **7072**, **7073**, **7074**, **7076**, **7085**, **7086**, **7087**, **7090**, **7097** and **7100**)

have been classified as possible pieces of anthropogenic debris (A2 - **Table 5**). Of these, **WA 7001**, **7038**, **7045** and **7087** have been found associated with magnetic anomalies and are interpreted as being at least partially ferrous in nature. **WA 7038** in particular, a rounded dark reflector with an acoustic shadow and associated scour, is associated with a magnetic anomaly of 53nT and is possibly highly ferrous in nature.

86 The remainder of the debris sites are interpreted as being non-ferrous. **WA 7006**, **7049**, **7052**, **7074**, **7076**, **7085**, **7086** and **7100** are short, linear reflectors (or linear alignments of individual reflectors) and are possibly the visible portions of partially buried structures **WA 7069** is a longer linear reflector and possibly a length of rope or chain, but the data is unclear. **WA 7090** is a very long, straight dark reflector extending seawards from an outfall pipe observed on the magnetometer data. This is possibly a piece of debris caught on the edge of the outfall pipe, though the pipe itself is not easily visible. **WA 7029** is a curvilinear dark reflector linking a number of small point contacts, and could possibly be fishing gear.

87 **WA 7019** and **7020** are limited areas of small, irregular dark reflectors and are potential small scatters of badly degraded non-ferrous debris. The remainder (**WA 7023**, **7024**, **7027**, **7072**, **7073** and **7097**) are individual, generally isolated features, generally with acoustic shadows, and could be individual large pieces of non-ferrous debris. Site **WA 7072** is of particular note, as it is located close to wreck **WA 7071** and is possibly debris relating to the structure.

88 13 of the sites (**WA 7002**, **7013**, **7022**, **7025**, **7028**, **7030**, **7031**, **7032**, **7033**, **7034**, **7075**, **7098** and **7099**) have been interpreted as dark reflectors. These are all generally isolated, poorly defined contacts without magnetic anomalies which could either be natural features, likely in an area where the bedrock outcrops at seabed periodically, or pieces of non-ferrous anthropogenic debris.

89 One site (**WA 7021**) has been classified as an area of seafloor disturbance, and is characterised by a small area of low seabed reflectivity containing small dark reflectors. Due to the data quality on the survey line where this site was identified, the feature is poorly resolved and so its precise nature is uncertain. It could either be of anthropogenic or natural origin.

90 The remaining 58 sites (see **Appendix A.4** for full list) are magnetic anomalies without any apparent sidescan sonar or multibeam bathymetry contact. Of these, 38 are relatively small in size (<20nT) and could represent either small pieces of buried debris or natural changes in the seabed geology. A further 16 are slightly larger, and are more likely to represent small pieces of buried ferrous debris than natural features.

91 Four sites (**WA 7065**, **7081**, **7091** and **7092**) are significantly larger. **WA 7065** (68nT) is an isolated magnetic anomaly and could possibly represent the presence of a large piece of buried ferrous debris. **WA 7081** (183nT) is the largest magnetic anomaly and is situated on the western edge of the survey area, close to the shoreline. This position indicates it could be an anthropogenic coastal structure (e.g. pipe), though it could be the remains of a now buried beached shipwreck. **WA 7091** (47nT) is located close to the end of an outfall pipe (itself identified by a linear alignment of strong magnetic anomalies) and could be either ferrous debris from a marine context, or terrestrial material introduced into the area via the pipe. **WA 7092** (45nT) is located at the far northern edge of the survey area. It could represent a piece of buried ferrous debris, though its position at the end of a survey

line indicates it could also have been caused by continuing logging of data as the survey equipment was pulled in.

92 Additionally, a large area of very strong magnetic anomalies is present towards the south-west of the survey area (**Figure 4**). This is too large to have been caused by an anthropogenic feature, and is instead interpreted as representing an igneous intrusion at depth, beyond the penetration of the sub-bottom profiler equipment. Such intrusions are known to be present on land in the area (GSGB 1957), and it is conceivable that they continue offshore in the region of the survey area.

2.2 Environmental Baseline – Pertaining to Cultural Heritage Asset Potential

2.2.1 Introduction

93 The potential for the presence of submerged prehistoric archaeology within the region is dependent upon the age and nature of the sedimentary units present at and offshore of the coast, and is closely related to relative sea-level change through time (**Figure 2**). Therefore an outline of the relevant known shallow geological, sea-level, topographical and climate change data relating to the region and the impact that they are likely to have on archaeological potential is given below.

94 An assessment of sea-level is important because at various times during prehistory the sea-level will have been low enough for the offshore areas of eastern Scotland in the North Sea Basin to have been dry land, and therefore available for exploitation by humans. This occurred when water that would otherwise be held in oceans and seas was locked into ice sheets during periods of glaciation.

2.2.1.1 Site formation - Taphonomy

95 The taphonomy (contributory formation processes) of archaeological deposits is of central importance to assessing the nature, development and significance of the archaeological record. Archaeological material can be preserved in primary contexts, where the spatial relationship between finds has not substantially altered since deposition, and in secondary contexts, where artefacts have been 'derived' or moved from their original positions. Secondary context sites can be associated with fluvial re-deposition, glacial processes, marine transgression and other processes of disturbance.

96 The formation, preservation, survival and discovery of submerged prehistoric sites and deposits (in primary and secondary contexts) are dependent on a number of factors. With respect to environmental conditions, they are likely to have been affected by:

- Beach and offshore gradient
- Speed of transgression
- Fetch magnitude, influencing wave amplitude and wavelength
- The degree of cohesiveness of the deposit being submerged
- Local topography, in terms of coastal forms, presence/absence of estuaries, sediment bars and islands
- The presence of frozen ground or permafrost at inundation

2.2.1.2 Geomorphology and Hydrology

97 Dune-backed sandy beaches characterise much of the coast of eastern Scotland at river mouths and sheltered embayments (e.g. Aberdeen Bay), interspersed with rocky coastline. Estuaries and tidal reaches of major rivers are also areas of archaeological interest such as at Montrose, the Tay and Forth. Broadly speaking, nearshore areas off the east Scottish coast slope gently from Mean Low Water (MLW) to an extensive and generally flat offshore platform at a depth of 50-70m.

98 Wave direction along the eastern coast is predominantly from the east or south-east. Significant wave heights of 2m can be expected for 10% of the year (Flemming 2004). Along the Scottish east coast there is a general southern flood and northern ebb tidal flow.

2.2.1.3 Climate

99 The climate during the last 780,000 years (Cromerian Complex stages OIS 13 to 17) alternated between cold and warm phases. At least six distinct temperate phases have been identified, between approximately 450,000 and 780,000 BP (Preece 1995). Since then there has been a similar sequence of alternating cold and relatively warm periods. The cold periods correspond with the glacial advances noted below.

2.2.1.4 Sea-level Change and Glaciation

100 There were at least two glacial phases (MIS 14 and 16) during the Cromerian (**Figure 2**). Since then the Northern European landscape was shaped by a further three major glaciations which are known as the Anglian (480,000-425,000 BP), Wolstonian (380,000-130,000 BP) and Devensian (70,000-12,000 BP). During these glaciations north-eastern Scotland would probably have been covered by ice sheets, though the exact extents of ice sheets during different glaciations and the time of maximum extents at different points on the margins of the ice sheets is still the subject of considerable debate (Merritt *et al.* 1995; Shennan and Horton 2002; Ballantyne 2004).

101 Most of the Scottish continental shelf was covered by these successive ice sheets, although at least six phases of growth and retreat have been identified (Ballantyne 2004). The ice sheets were centred upon the Scottish Highlands and extended as far as the continental shelf to the north and north-west.

102 In northern Scotland the Devensian glacial maximum occurred some time after 26,000 BP, with deglaciation well advanced by 15,000 BP (Ballantyne 2004). By 13,000 BP the ice sheets had completely melted in lowland areas, although there was a brief period of renewed ice cover during the Loch Lomond stadial at about 11-10,000 BP (Ballantyne 2004). Allowing for the uncertainties of isobase mapping, north-east Scotland (Aberdeenshire) probably ceased to be covered by the ice sheet at some point between 18,000 and 14,000 BP (Lambeck 1995) with more southerly areas becoming ice free by the Holocene (10,000 BP) (**Figure 6**).

2.2.1.5 Suitability for Human Occupation

103 Ethnographic evidence shows that human hunting cultures can operate successfully along the margins of ice and sea (Blankholm 2004). That this was the

same in the past is demonstrated by the discovery of a number of sites in the Russian high Arctic (Pitulko *et al.* 2004, Pavlov *et al.* 2001) and observations made of native Inuit populations in the Canadian Arctic by early European explorers strongly suggests that cold was not the principal limiting factor for the spread of early human populations.

104 Suitability for human occupation instead depended upon the availability of food. The nature of available food sources would have varied with climate. There is no evidence for agriculture in Britain prior to the Neolithic and earlier human populations would have been dependent upon a hunter-gatherer mode of subsistence.

105 The region is likely to have been suitable for early human populations whenever it was not covered by ice or submerged (**Figure 6**). During the cooler periods plant resources would have been relatively sparse, and populations would have been largely reliant on animal resources, either marine or terrestrial. Such animals are likely to have been present within the region, during cooler periods perhaps on a migratory basis and during warmer periods on a permanent basis.

2.3 Cultural Heritage Baseline - NE Scotland & Blackdog, Aberdeen Bay

2.3.1 Lower, Middle and Early Upper Palaeolithic (>780,000 – 12,000 BP)

2.3.1.1 Introduction

106 During the Lower and Middle Palaeolithic Britain would have been occupied by a range of hominins, including *Homo heidelbergensis* and *Homo neanderthalensis*. During the Upper Palaeolithic, these populations would have been replaced by modern humans - *Homo sapiens* (**Figure 2**).

107 The dominant palaeogeographic setting of Britain for the majority of the late Pleistocene is that of a peninsula connected directly to mainland Europe across a broad front; from southern Scandinavia to north-west France. The flux of eustatic sea-level during inter-glacial periods has periodically flooded the English Channel and areas of the North Sea to create an island Britain. For the majority of the last 1 million years, especially during glacial periods, lower sea-level meant that Britain and Scotland were, to a greater or lesser extent directly connected to continental Europe (**Figure 2**, **Figure 6**).

2.3.1.2 Evidence of Human Occupation in Scotland

108 No well-provenanced and reliable archaeological evidence of human occupation during the Lower, Middle and Early Upper Palaeolithic is known from Scotland. (Wickham-Jones 1994). The cave site excavated in 1926 at Creag nan Uamh in Sutherland contained an accumulation of reindeer bones dating from between 44,000 and 22,000 BP. It has been interpreted as evidence of early hunting by humans but plausible alternative interpretations are possible (Lawson 1981). Nevertheless, whilst it may not prove the presence of humans, it does prove the presence of suitable prey species (Fleming 2004: 8).

2.3.1.3 *Potential for Submerged Palaeolithic Prehistory at Blackdog*

109 Any assessment of the archaeological potential of the east Scotland coast must take into account the more general records of Lower, Middle and Early Upper Palaeolithic human occupation of Britain, as well as local climatic and geological conditions.

110 Recent work at the terrestrial site of Happisburgh 3, Suffolk, (Parfitt *et al.* 2010) has produced lithic evidence of human activity in an interglacial environment that dates to between 780,000 to 1,000,000 BP (OIS 17 or earlier) (**Figure 2**). It is therefore theoretically possible for a human presence in eastern Scotland from at least this time onwards when climate conditions were cold but potentially favourable and the area was not submerged or covered by ice.

111 As noted above, the region has been subject to considerable glacial action, culminating in the Late Devensian glacial maximum. Although the survival of archaeological material in primary contexts under ice is possible (Cook and Ashton 1991), it is unusual. Therefore any earlier archaeological deposits are likely to have been destroyed or buried under glacial deposits and any surviving artefacts may be some distance from their original site of deposition. The potential for the presence of Palaeolithic material within the region pre-dating the Devensian glaciation is therefore probably extremely low.

112 The principal Quaternary and Holocene geology is defined by the Wee Bankie Formation which is overlain by the Forth Formation. The latter formations are contemporaneous during their early deposition. The modern seabed is generally of sand-sized sediments (**Table 6**) (Gatcliff *et al.* 1994).

113 The Wee Bankie Formation is a diamicton (glacial deposit of poorly sorted sediments i.e. complex mixture ranging from boulders to clay-sized particles) of up to 40m thick probably of basal till from glacial down-wasting during the end of the last glacial period (i.e. Devensian). Diagnostic faunal and floral material is present but reworked (and therefore out of context).

114 The archaeological potential for encountering *in situ* Palaeolithic material from the Wee Bankie Formation (i.e. from offshore of the entire east coast of Scotland) is likely to be reduced as a result of the turbated nature of the formation however it may be possible to encounter artefacts in secondary contexts, although the chances are likely to be low.

115 The Late Glacial age of the deposits suggests there is potential for archaeological sites and material to have been located on the “uneven, ridged upper surface” lying conformably below the Forth Formation; and also within the Forth Formation sediments that subsequently accumulated during the late Glacial and Holocene.

2.3.2 Late Upper Palaeolithic and Mesolithic (12,000 BP – 4,000 BC)

2.3.2.1 *Climate*

116 The Late Devensian ice sheet had completely melted by *c.* 13,000-12,000 BP (Ballantyne 2004). Although there was a temporary return to cooler conditions during the Loch Lomond Stadial between 10,800 and 10,000 BP, the climate would not have precluded human occupation outwith the core glacial and periglacial area. Coasts may have been principal areas of activity as maritime climates are less

extreme. After 10,000 BP temperatures rose quickly and by 8,500 BP appear to have been slightly higher than today (Ballantyne 2004). A general scheme for Holocene climate based on the Blytt and Sernander peat scheme is presented below (**Table 9**). It must be remembered that short-term, high-magnitude events during the early Holocene made the environment, climate and sea-level change very dynamic (e.g. meltwater pulses, the 8200 BP event, **section 124**). The influence upon Mesolithic people's behaviour and subsistence strategies for example is likely to be complex and highly variable between groups and over space and time (Warren 2005, Bailey and Spikins 2008).

Period	Inferred Climate	Evidence	Approximate Age (BP)
Pre-Boreal	Subarctic (cool-dry)	Macrofossils of subarctic plants in peat	10,000 – 9500
Boreal	Warm-dry	Pine stumps in humified peat	9500 – 7000
Atlantic	Warm-wet	Poorly humified Sphagnum peat	7000 – 5000
Sub-Boreal	Warm-dry	Pine stumps in humified peat	5000 – 2500
Sub-Atlantic	Cool-wet	Poorly humified Sphagnum peat	2500 – present

Table 9: General scheme of Holocene climate (Blytt-Sernander) adapted from Lowe & Walker, 1997; Warren 2005).

2.3.2.2 Suitability for Human Occupation

117 Following deglaciation (*c.*18,000-14,000 BP) the climate became increasingly suitable for human occupation (Ballantyne 2004). As conditions became warmer, tundra would have given way to open grassland and then woodland. Ultimately open woodland predominated with birch, hazel, oak and pine (Wickham-Jones 2004). Even at the start of this period, suitable food resources are likely to have been available for hunter-gatherer populations. The recently discovered site at Howburn Farm, South Lanarkshire, is dated on typological grounds to *c*. 12,000 BP and demonstrates the potential for later Upper Palaeolithic sites in Scotland (Ballin *et al.* 2010). Given the probable rate of decay of the Scottish ice sheet it may be speculated that occupation evidence might survive in the north-east from this period, or perhaps even as early as 13,000 BP.

118 The only marine find from the Late Upper Palaeolithic occupation is a single worked flint obtained during vibrocoring close to Viking Bank, 150km north-east of Shetland. Sedimentary deposits below the tool date it to post-11,000 BP (Wickham-Jones and Dawson 2006).

119 The climatic amelioration from 13,000 BP, even allowing for the slight hiatus in the form of the Loch Lomond Stadial (*c.*11,000-10,000 BP), would have driven environmental change, so that while the broad suitability of the region for human occupation would have probably improved over the course of the early to mid Holocene, the nature of the environment that humans would have had to deal with would have changed significantly over this period.

120 Another key form of environmental change would have been changes in hydrological regime associated with marine transgression (rising sea-level

inundating the land). As sea-level rose the effective gradient of local river systems would have lessened, causing channel aggradation and flood plain formation, potentially leading to the formation of wetlands. It has been proposed, for example, that the area where Aberdeen stands would have been an area of wetland during the early Holocene (Warren 2005). Such environments are known to be ecologically diverse and to offer a wide range of resources for human exploitation.

2.3.2.3 Sea-level & Rapid Coastal Change in the early Holocene

121 Modelling of the sea-level history of Scotland during the Holocene (the last 10,000 years) is greatly complicated by the presence and varying thickness of the ice sheet that covered the land during the Late Devensian glaciation and variable rates of glacio-isostatic rebound as a result (**Figure 7**).

122 Glacio-isostatic uplift following deglaciation was greater and more rapid in areas that lay close to the centre of the last ice sheet. This centre was in the area of Rannoch Moor in the Western Grampian Highlands. In areas farther from the centre, such as the east of Scotland, uplift was slower and less pronounced. The figures for relative sea-level change from reconstruction models should therefore be applied with caution – e.g. Funnel (1995:4), Westley, Dix and Quinn (2004:67-80), Holocene sea-levels from Lambeck (1995), Shennan & Horton (2002) and Smith *et al.* (2007).

123 The principal work on late Devensian and Holocene relative sea-level change in the region is based on work on the river valleys of the Ythan and the Philorth (Smith *et al.* 2004), and the Montrose Basin (e.g. Smith, Cullingford & Seymour 1982; Smith, Cullingford & Brooks 2006; Smith and Cullingford 1985). This work suggests that between 18,000 and about 14,000 BP relative sea-level could have been approximately -5m, falling to about -10m by 10,000 BP. From 9,000-8,000 BP relative sea-level rose 8 m and then continued to rise until it was approximately 4 m above present sea-level by c. 5,000 BP, before dropping gradually to current levels (Shennan and Horton 2002). This pattern of relative sea-level rise and then fall reflects the interplay of varying rates eustatic sea-level rise and glacio-isostatic recovery, with eustatic rise initially outpacing but then being overtaken by glacio-isostatic recovery (Ballantyne 2004).

The Storegga Landslide and Tsunami – c. 8100 BP

124 Around 8100 BP, a massive undersea landslide off the coast of north-west Norway caused a tsunami wave. Evidence for the Storegga tsunami has been found along palaeo-shorelines in Scandinavia, north-west Europe and northern and eastern Scotland as a clear sandy horizon. Mesolithic sites at Inverness and Morton, Fife are preserved beneath the Storegga tsunami deposit suggesting human groups on the coast were directly affected (Dawson *et al.* 1990; Weninger *et al.* 2008). The tsunami also had a widespread effect inland, penetrating along major rivers like the Forth (Smith *et al.* 2010). The destruction of camp sites, and disruption to coastal food resources, in addition to a loss of life, would have had a significant effect upon Mesolithic groups' ability to successfully exploit affected coastal, estuarine and riverine environments across eastern and northern Scotland. The tsunami may also have contributed to the final flooding of 'Doggerland' in the southern North Sea (Weninger *et al.* 2008; Gehrels 2010). In conjunction with (and not to be confused with) the so-called 8200 BP event (a rapid and large-magnitude oscillation to cold, regionally arid conditions) (Alley *et al.* 1997; Barber *et al.* 1999), and rapid sea-level rise after *c.*8000 BP, the regional climate was dynamic in the

early Holocene. This may have had significant effects upon human groups in Scotland during this time.

2.3.2.4 Distribution of Evidence

125 There is a degree of geographical bias in the distribution of known, and in particular intensively investigated, sites within Scotland, with much effort expended on the west coast, Inner Hebrides and recently the south-west (Warren 2005). This, unusually in modern British archaeology, probably tends to reflect research effort rather than development impacts: by contrast a number of the Mesolithic sites in the north-east of Scotland have been excavated as a result of development mitigation (e.g. Murray 1982, Suddaby 2007, Murray *et al.* 2009).

126 Findspots and recorded sites along the east coast compiled in the Aberdeenshire SMR suggest that along the modern coast directly adjacent to the proposed EOWDC there are several flint working and lithic scatter sites of prehistoric age, several are Mesolithic age within coastal dune complexes (**Table 10**). Sub-bottom profiling assessed as part of this project has identified geomorphological deposits indicative of a prograding coastline preserved offshore suggesting there is potential for similar Mesolithic sites to be present in submerged contexts.

Name	Aberdeenshire SMR ID	CANMORE ID	Site type	Description	Source
Easter Hatton	NJ91NE0071	NJ91NE58	Findspot	Flint scatter – prehistoric.	http://www.aberdeenshire.gov.uk/smrpub/shire/detail.aspx?refno=NJ91NE0071
Menie	NJ92SE0028	NJ92SE6	Findspot	Site of findspot of microliths and flints; shows evidence of Mesolithic occupation.	http://www.aberdeenshire.gov.uk/smrpub/shire/detail.aspx?refno=NJ92SE0028
Drumside Links	NJ91NE0094		Findspot	Former beach deposit, worked flints.	http://www.aberdeenshire.gov.uk/smrpub/shire/detail.aspx?refno=NJ91NE0094
Menie Links	NJ92SE0005	NJ92SE13	Findspot	Multiple sites of findspot of flints and flint working.	http://www.aberdeenshire.gov.uk/smrpub/shire/detail.aspx?refno=NJ92SE0005
Menie Links	NJ92SE0021	NJ92SE6	Findspot	Site of findspot of a number of flints; found in the sand dunes on Menie Links.	http://www.aberdeenshire.gov.uk/smrpub/shire/detail.aspx?refno=NJ92SE0021
Balmedie Country Park	NJ91NE0095		Findspot	Site of findspot of a flint knife – unknown age.	http://www.aberdeenshire.gov.uk/smrpub/shire/detail.aspx?refno=NJ91NE0095
Belhelvie	NJ91NE0004	NJ91NE5	Findspot	Site of findspot of flint flakes and two anvil stones found - prehistoric	http://www.aberdeenshire.gov.uk/smrpub/shire/detail.aspx?refno=NJ91NE0004

Leyton Farm	NJ92SE0004	NJ92SE7	Findspot	Site of findspot of flint artifacts & a stone bead with hour-glass perforation – poss. Neolithic	http://www.aberdeenshire.gov.uk/smrpub/shire/detail.aspx?tab=main&refno=NJ92SE0004

Table 10: Selected sites indicative of Mesolithic & prehistoric findspots contextualising early Holocene coastal palaeogeography in the vicinity of the MSA.

127 Flint scatters, as a class, is very wide ranging from a few lithics to large sites incorporating a variety of lithic materials and forms (Warren 2007). As a class it reflects the durability of stone tools, and any associated working debris, rather than a functional distinction in terms of site use. Lithic material may be associated with any other type of site, such as shelter structures, middens and caves. The ephemeral nature of stone tools scatters will make identification in intertidal and offshore contexts difficult.

2.3.3 Potential for Holocene Submerged Palaeolandscapes

128 At the coast, the Forth Formation outcrops (Gatcliff, *et al.* 1994) (**Figure 3**). The St Andrews Bay member presents a significant target for investigating the perceived potential for encountering submerged Upper Palaeolithic and Mesolithic archaeological and palaeoenvironmental material in primary contexts along much of the east coast of Scotland. The geological sequence, associated with the Forth Formation, is very extensive, extending as far south as St. Andrew's and possibly as far north as Peterhead (Gatcliff, *et al.* 1994).

129 The sandy nature of the Holocene sediments suggests that in conjunction with lower sea-levels, human occupation could have occurred throughout the early Holocene and very late Pleistocene in a transgressive coastal environment (i.e. the shoreline at a given period progressively moves inland as sea-level rises relative to earlier incarnations). Indeed the forms of the deposits have been described as "coastal sand bars created from sediment delivered by rivers flowing from Scotland" (Gatcliff *et al.* 1994: 93). Where encountered, the **St Andrews Bay member** of the **Forth Formation** would be of primary archaeological interest for assessing Upper Palaeolithic and latterly Mesolithic offshore archaeological potential in the east coast of Scotland (**Figure 8**, **Table** 6).

130 Sea-level models suggest that the rate of land uplift and sea – level rise on the east Aberdeenshire coast are generally emerging at a rate of around 0.5 mm/yr relative to Eustatic sea- level rise (Gehrels 2010). This would suggest that nearshore sediments containing submerged prehistoric material could have been uplifted around 2.5m in the last 5000 years; for example, Mesolithic remains may then exist at a shallower depth than could be assumed from general estimates of Holocene sea-level rise alone.

131 Archaeological deposits in the region post-dating 13,000 BP will not have been affected directly by glaciation, although periglacial effects may have occurred. The available archaeological and sea-level data suggests that the potential for the presence of archaeological sites and materials in terrestrial settings in the region exists from about 13-12,000 BP. In lower lying coastal and estuarine settings there may be a hiatus after 7000 to 6500 BP until 5000-3500 BP due to the Main Holocene Transgression (**Figures 6** & **7**).

132 The **St Andrews Bay Member** of the **Forth Formation** which may frequently outcrop at the coast is of primary archaeological interest for late Pleistocene and early Holocene archaeological and palaeoenvironmental investigation. The sands (and clays) in the form of coastal geomorphic structures such as sand bars indicate that coastal bedforms are preserved; and by inference potentially archaeological remains (if any) where local conditions permit.

2.3.4 Regional Archaeological Potential and Wider Relationships

133 The presence of relatively large areas of (now submerged) land to the south should be noted: 'Doggerland' (Coles 1998) would have formed both a relatively near route to Scotland from other regions of Europe, and a population reservoir for colonists moving northwards as climatic conditions ameliorated.

134 There is potential for the presence of submerged late Upper Palaeolithic and Mesolithic archaeology along the coast of the north-east of Scotland. The various reconstructions of landscape around the late Devensian and early Holocene (from 13,000 to 8000 BP) suggest a relatively narrow strip, perhaps in the order of several kilometres of submerged landscape along the coast from eastern Yorkshire to the north-eastern tip of Aberdeenshire, in contrast with the very extensive areas of now-submerged landscape in the southern North Sea and the Moray Firth.

135 The relatively narrow dimensions of the modern offshore area that has the potential for the presence of submerged Late Upper Palaeolithic and Mesolithic remains, together with a presumed preference by early populations for coastal settings for settlement and exploitation, implies that the density of remains may be relatively high if present and preserved but the spatial extent of development activity will be a primary factor in the potential for encountering such remains.

136 The cultural remains of the Later Upper Palaeolithic and Mesolithic tend to be relatively small-scale, ephemeral, and largely lithic in nature. This renders these remains particularly vulnerable to disturbance processes, both cultural and natural. In an offshore environment the factors listed above will largely determine the degree of disturbance such remains undergo. When these factors work against preservation, the effects on primary contexts can be severe. Where these factors favour preservation, primary contexts may be much better preserved than the majority of onshore sites. In particular, long term cultural disturbance will generally have been excluded.

137 The sandy nature of the offshore sediments is similar to the coastal dunes known to contain early prehistoric lithic remains not necessarily in the presence of palaeoenvironmental material. It is currently not possible to assess potential of likely impacts upon these types of cultural heritage assets.

2.4 Potential for Maritime Archaeology

138 The potential exists for archaeological evidence of maritime sites of all periods from the Mesolithic to the present day to be recoverable from within the MSA. Given the offshore location of the MSA, Maritime sites considered shall consist of either vessels (wrecks) or debris accidentally or deliberately lost overboard from a vessel.

139 The potential for evidence of maritime activity within the MSA from the Post–medieval and Modern periods can be expected to be greatest because of the

increasing volume of trade and other marine activities in the area during these periods, and because of the relatively short period of time since its deposition on the seabed. Potential for the survival of evidence of medieval or earlier date is likely to be low, although certain classes of material, such as stone ballast, can be expected to survive for very long periods and the survival of more vulnerable organic material can occur in the right circumstances.

140 Estimates for the density of shipping losses around the coast of the UK estimate eight to 40 wrecks for every mile of coastline. This does not include losses in open water, which are particularly difficult to quantify. Records such as Lloyd's Lists contain many references to ships that are 'overdue' and for which no knowledge of their fate has ever been recovered.

141 As a result, the currently known maritime casualties in UK waters probably only represent a small percentage of actual losses. The positions of losses are often vague or inaccurate, and hence require interpretation. It is perhaps reasonable to assume that post–medieval wreck recording close to important ports such as Aberdeen will be more reliable, but nevertheless it is likely to be incomplete.

142 The nature of the loss record also means that it is heavily weighted towards Industrial and 20^{th} century period wrecks (**Appendix A.5**). Whilst it is undoubtedly the case that there was an increase in vessel numbers traversing the MSA during this period, the record is almost certainly misleading in this respect. The record is also likely to be weighted towards larger vessels, with this bias continuing into the 20th century.

143 There are no protected places or controlled sites, as recorded by the Ministry of Defence that would be subject to statutory protection, within or in the vicinity of the MSA.

2.4.1 Shipping Losses – Causal Factors

144 The North East Scottish coast focused upon Aberdeenshire is characterized by a combination of rugged cliffs interspersed by long sandy shores. Shipping losses along this coast have been caused by a wide range of factors. However the principal causes can be summarised as follows:

- South easterly gales. The shape of the coastline makes shipping that is reliant upon sail power particularly vulnerable and severe storms have historically caused catastrophic losses, such as in 1800 and 1876
- Haar or coastal fog, particularly during the summer months when dense fog could last for days. Prior to the widespread introduction of radar, fog was a significant factor in many shipping losses
- Lack of reliable navigational tools. Although Lindsay's A Rutter of the Scottish Seas was published in 1540 it was not until Grenville Collins' work in the early 17th century that more reliable charting became available
- Enemy action, principally during the two World Wars of the 20th century

145 There are three major concentrations of shipping losses in Scotland: around the major ports of Aberdeen and Wick; and at the extreme north–east coast of Aberdeenshire (Ferguson 1991: 4). Historically shipping losses in the vicinity of the ports of Aberdeen and Wick have mainly been caused by ships being driven ashore whilst trying to lie off or enter the ports in heavy weather (Ferguson 1991:

4). It therefore follows that sailing vessels should have been the principal victims and that the greatest risk was from east and south–easterly gales.

146 Aberdeen harbour entrance, with its long piers has proved to be a hazard in itself. Construction of these piers in the 18th century greatly improved access to the harbour by reducing the impact of the bar at the mouth of the Dee. However, it is clear from the available loss records (**Appendix A.5**) that numerous casualties resulted from vessels either colliding with the piers or missing them altogether.

147 The approach to the harbour is quite confined and difficulties could be experienced in wind against tide conditions, particularly if the wind was blowing strongly from the south–east. Once a vessel missed the harbour entrance it was likely to go aground near the piers or be driven ashore on the beach, unless it was able to escape the threat by bearing away to the north. Several recorded losses and recorded wrecks in the MSA are reported run aground on the beach at Blackdog following difficulties in bad weather trying to navigate the approaches to Aberdeen harbour.

2.4.2 Prehistoric Seafaring (before AD 79)

148 Human settlement patterns in north-west Europe suggest that sea voyages were conducted as early as 7,000 BC, during the Mesolithic. No archaeological remains of vessels that pre – date the Mesolithic have been found in Western Europe. This may reflect the very low probability of organic remains of this type surviving. However, the simple technology required to construct a small boat will almost certainly have existed. The Mesolithic record currently consists exclusively of log boats.

149 Extensive coastal and continental trade and sea fishing increased during the Neolithic, Bronze Age and Iron Age. Small ports or anchorages developed in Britain as the scale of this activity grew. Log boats, hide boats and plank boats were all used and there is evidence of significant advances in technology and vessel size from the Bronze Age onwards.

150 The earliest boat found in Scotland is the log boat found at Catherine Field in Dumfriesshire which dates to the early Bronze Age. A log boat with a separate transom and dating to about 1,500 BC has also been found in Loch Tay. A further late Bronze Age log boat has been found in the Tay Estuary, dating between about 1130 – 970 BC. Other boat finds from Scotland are Iron Age or later. Of the approximately 150 log boats found in Scotland, most are medieval. No Prehistoric boat finds of more complex construction or demonstrably capable of being used in open, maritime water have been found in Scotland.

151 Mesolithic artefacts have been recovered from terrestrial contexts in the Aberdeen area. Although the extent of Mesolithic occupation is not known, this does suggest that there is potential for archaeological evidence of prehistoric seafaring within the MSA from the Mesolithic onwards.

2.4.3 Roman Seafaring (AD 79 – 410)

152 For most of this period, Aberdeen and the surrounding area lay outside the Roman Empire, although not necessarily beyond Roman influence. A Roman military camp has been found at Normandykes on the outskirts of modern Aberdeen and finds of Roman coins and other artefacts have been made in the area. Additionally, the

Alexandrian geographer Ptolemy's map of Scotland of AD 145 shows Devana, 'the town of the two waters' (the Rivers Dee and Don), a town or settlement on the Deva Fluvius. Devana appears to have been within the greater Aberdeen area. Its appearance on Ptolemy's map indicates that it must have been a settlement of some size or importance.

153 Although it is not a safe anchorage, Aberdeen Bay is likely to have been traversed by coastal trading vessels and fishing boats throughout this period. The existence of the riverside Devana settlement somewhere in the area may mean that this activity was at a relatively high level for the north–east coast of Scotland. In addition, the camp at Normandykes may have been supplied by sea, with ships approaching through the Dee Estuary. There is therefore potential for the presence of archaeological evidence of Roman period seafaring within the MSA.

2.4.4 Early Historic (AD 411 – 700) & Early Medieval (AD 700 – 1100) Seafaring

154 The region around modern Aberdeen appears to have been dominated by Pictish tribes during the Early Historic period, a group of indigenous people first referred to in the 3rd century by Roman writers as Picti meaning either 'painted ones' or 'people of the designs' (Foster 2004: 1). The Picts are known to have been seafarers and depictions of their vessels are known, such as from St Orland's Stone from Cossans in Angus (Graham-Campbell and Batey 1998: 8).

155 The estuary of the Dee provides a sheltered anchorage and it is likely that some use was made of it. Vessels, in the form of fishing boats and coastal trading vessels (perhaps capable of long distance voyages) will have traversed the MSA. It is also possible that some use was made of the River Don and the River Ythan to the north.

156 Terrestrial archaeological evidence from the Early Medieval period has been recovered from the Aberdeen area. Given that there is historical evidence that Aberdeen had a significant harbour by 1136, the probability of there being a harbour and therefore maritime activity in the vicinity of the MSA during this period is high. In addition to coastal trade and fishing, trade and other maritime interaction with Scandinavia is also probable.

2.4.5 Medieval Seafaring (AD 1100 – 1540)

157 There is no direct archaeological evidence for medieval maritime activity in the MSA in the form of shipwrecks or seabed debris. However, the historical and terrestrial archaeological evidence is relatively plentiful and documentary evidence becomes available for the first time. The first reference to a shipwreck in the vicinity of the MSA occurs during this period, in 1444.

158 Aberdeen was a significant port during this period and is clearly crucial to the maritime significance of the MSA. By 1136 it was busy enough for David I to grant Bishop Nectan the right to levy a charge on shipping using the harbour (Turner 1986: 3). It was also significant enough to attract hostile attention and in the late 12th century the Norse King Eystein raided 'Apardion'.

159 Aberdeen was also important enough to attract traders from the Continent. King David I is known to have encouraged Scottish merchants to engage in foreign trade in the 12th century. Aberdeen's earliest recorded trade with mainland Europe was with Flanders. This trade, based upon the export of wool, appears to have

been well established by the late 13th century when Philip IV of France ordered Count Guy de Dampierre to allow Scottish merchants freedom to trade in Flanders (Turner 1986: 4). Merchants trading through Aberdeen subsequently appear to have established trading posts on the Continent.

160 Piracy was a problem off the Scottish east coast in the 14th century. This appears to have impacted on the number of vessels trading with Aberdeen. By 1368 the number of vessels entering the port was reduced to ten and by 1398 just six (Turner 1986: 4). Trade recovered in the 15th century, despite disputes with the Hanseatic League and with Flanders in the first half of the century. By the mid – 15th century Aberdeen and Leith held a joint monopoly on the Scottish wool trade with Flanders. Wool, cloth, hides, fur, wood and salmon were exported and wheat, provisions, wine and luxury goods were imported. Mention of other ports is made at this time, including some in Scandinavia, although goods exported from Aberdeen seem to have been largely transhipped from Flanders.

161 There is documentary evidence of a quay on the north side of the Dee by 1453, when the quay is recorded as having been enlarged. Navigation beacons were also established at the mouth of the estuary in 1484. Furthermore in the early 16th century the Town Council commissioned a local pilot to produce a sea chart for the use of Aberdeen ships. Nevertheless Aberdeen does not appear to have been regarded as having good harbour facilities (Turner 1986: 6).

162 During the reign of Alexander II (1241 – 1286), Aberdeen gained a reputation as a fish exporter. Fish curing was a specialism of the town and in 1281 Edward I of England apparently sent agents to obtain salt fish provisions for his campaign in Wales (Turner 1986: 133). In 1290 Aberdeen fish were shipped to Yarmouth, the premier fishing port of England and thence to Norway. However, it seems that during this period fishing was confined to the River Dee and in the immediate environs of the estuary. Salmon would have been the main catch and Robert I (the Bruce) granted rights in this respect to the town in 1319. As a result of the probable increase in maritime activity in the vicinity of the MSA, the probability of wreck – related evidence of maritime activity surviving is greater than for earlier periods.

2.4.6 Post – medieval Seafaring (AD 1540 – 1700)

163 Trade between Aberdeen and the Baltic expanded greatly during the 16th century. Ports to which reference is made at this time include Dantzig, Campveere, Bruges, Middleburg, Antwerp and Stralsund. Substantial numbers of the poor, and refugees from both political and religious strife emigrated through Aberdeen to both the Netherlands and Poland.

164 Competition arose during the 16th century as Peterhead, Newburgh (14 miles north of Aberdeen) and smaller harbours in the area all sought to compete for business. Aberdeen responding with an aggressive enforcement of its rights and by undertaking works to improve the harbour.

165 Navigating the entrance to the harbour had become a serious problem by the mid – 17th century, despite efforts to improve matters, including the building of a bulwark in a failed attempt to defeat the threat of the bar in 1607. In 1656 it was reported that the harbour was “less useful of late than formerly” and it appears that at low tide there was only about two feet (0.61m) of water at the bar (Turner 1986).

2.4.7 *Industrial Seafaring (1700 – 1900)*

166 The Act of Union in 1707 opened up the English market, particularly London and the English colonies to Aberdeen merchants. Trade with the American colonies became particularly important, with woollen and linen goods, salmon, salted herrings and French wine being exported, together with emigrants. A wide variety of raw materials were imported from the Americas, but principally sugar and tobacco. Goods were also exported to Norway, Holland, Portugal, Sweden, Spain, Germany and Italy.

167 By the end of the 18th century Aberdeen was handling 73 inward and 248 outward cargoes annually. Most of the trade was coastwise around the UK, although cargo was exported to 14 different overseas countries and part of the coastwise trade appears to have been of goods destined for export through other ports. Trade with the Low Countries declined as Aberdeen merchants exploited new markets.

168 In 1769 one of the most significant events in the maritime history of the Aberdeen area occurred. The great 18th century engineer John Smeaton was invited to investigate the harbour entrance and suggest remedial measures to deal with the problem of the bar. Smeaton was one of a number of great engineers, including Telford and Rennie, to be involved in the development of the port of Aberdeen. He reported in 1770 and recommended the construction of a pier on the north side of the entrance. The pier was duly built and was successful because it had the effect of enhancing the natural scour of the river. As a result, the number of vessels using the port rose quickly.

169 Smeaton's scheme was subsequently improved, with the north pier being lengthened. A south pier was constructed to prevent swell entering the harbour from the east. In addition, the course of the Dee was altered, allowing for an extensive complex of docks to be built in the 19th century.

170 In the late 18th century the number of ships engaged in foreign trade using the port declined, probably as a result of the wars in Europe, although coastal trade increased. However, during the 19th century Aberdeen's trade increased beyond recognition. Numbers of commercial vessels and total tonnage using the port had increased to 3368 vessels totalling 956,496 tons by 1899, with almost 1.25 million tons of cargo being handled annually (Turner 1986: 43).

171 The first steamship service to Aberdeen commenced in 1821 and by 1855, 16 steamers were operating from the port. By the turn of the century this number had grown to 83 (Turner 1986: 118). The rise of steam reduced the dangers of entry into the harbour and gave vessels which missed the entrance in poor weather a greater chance of avoiding going ashore.

172 This period also saw a dramatic rise in the importance and scale of the fishing and whaling businesses off Aberdeen. The first reference to whaling activity was in 1752 and by 1817 there were 14 Aberdeen whaling vessels (Turner 1986: 136).

2.4.8 *20th Century Maritime Activity*

173 With regard to the fishing industry, whereas it had previously been largely salmon-based and inshore in character, the Aberdeen fleet gradually moved offshore and into trawling. Chief amongst the offshore catch was the herring, and the herring boom from the 1870s and the First World War brought seasonally hectic activity to the port. A large fleet of Aberdeen vessels, mainly small sailing boats or yawls

called ‘Zulus’ and ‘Fifties’, followed the annual migration of these fish south (Edwards 2004: 107).

174 In addition, other fish were pursued in great quantities, with numerous line fishing boats plying the inshore waters of the MSA. Smaller harbours and beaches around Aberdeen were also used by fishing vessels of all types.

175 The first half of the 20th century was the great era of the steam trawlers, which had been gradually introduced in the 19th century. By 1910, 217 of the Scottish fleet of 320 steam trawlers operated out of Aberdeen. In 1888 there were 10,810 arrivals of fishing craft, largely small sailing craft.

176 By the outbreak of the First World War in 1914, Aberdeen was the most important fishing port in the British Isles. 1925 marked the peak of the trade in terms of catch landed. By then 83% of arrivals were steam trawlers and only a small proportion were sailing vessels. Thereafter the fishing fleet declined and by the end of the 20th century the number of fishing vessel arrivals at Aberdeen represented only a very small proportion of that at the turn of the century.

177 The 20th century was an era of other short term changes for the port. The import business of the port became increasingly important. In 1901 coal dominated this trade, but by mid – century this had changed to fuel and other oils. Granite shipments, destined for use as carriageway stones, became a significant export. The early 20th century also saw the last large commercial sailing vessels to use the port. Between the two world wars the pattern of trade did not change significantly. The ferry and, to a lesser extent, liner business built up in the 19th century continued to be important. Following the Second World War import cargoes increased and coastwise traffic declined as a result of the increasing reliance on rail and particularly road transport, and the increasing importance of ferry ports in the southern UK.

2.4.9 Late 20th Century Offshore Activity

178 Undoubtedly the most significant recent development in vessel movements in and around Aberdeen has been the development of the North Sea oil and gas industry. Aberdeen became the major European base for this industry in the 1970s and this caused a dramatic rise in the number of large vessels using the port on a regular basis. Although this is now starting to decline as the industry matures, it is still responsible for a major proportion of vessel movements into or out of the harbour. Several wrecks beached within Aberdeen Bay are rig support vessels highlighting the potential for modern (as well as historic wrecks) to be present.

2.5 Potential for Aviation Archaeology

179 A qualitative assessment of the potential for encountering aircraft crash sites, especially of military origin which may be protected under the Protection of Military Remains Act (PMRA) 1986 was conducted. Air-Sea rescue maps relating to the general locations of rescue missions around the British Isles during World War II and other documentary sources have been compiled by Wessex Archaeology for the Aggregates Levy Sustainability Fund (ALSF) project *Aircraft crash sites at sea* (2008). Positions of specific crash sites and rescue missions are not accurate but relate to the general area of crash reports made at the time. They are useful to provide a means of assessing areas of increased potential.

180 Although no specific aircraft wrecks are noted in the documentary sources consulted for the MSA, there is a moderate concentration of offshore aircraft losses along the north-east coast of Scotland, in the vicinity of Aberdeen. There is potential for encountering unrecorded, unidentified aircraft losses that are buried but this is regarded as low following the geophysical assessment.

3 SUMMARY

3.1 Maritime Cultural Heritage Assets

181 The proposed EOWDC comprises 11 wind turbines, and associated inter-turbine and export electrical cables within the MSA.

182 A total of two sites designated as '*Anthropogenic origin of archaeological interest*' (**WA 7071** and **7072**) have been identified within the marine survey area, the sites are located approximately 40m apart, around 50m north-west of turbine 8. Of these, one is a previously uncharted wreck site (**WA 7071**) and the other is possibly a large piece of debris relating to a wreck (**WA 7072**).

183 It is not currently possible to clearly define the name and type of the unidentified wreck (**WA 7071**) located by the geophysical survey within the MSA, north-west of the proposed position of Turbine 8. The sonar dimensions of the vessel are 25 m long by 6.5 m wide and it is partially buried from the east. The wreck is associated with a small magnetic anomaly suggesting it could be of partly metal construction.

184 Lavery (2001:78-79) describes steam trawlers of similar dimensions dating to throughout the later 19th and 20th centuries and Aberdeen was a centre for shipbuilding with local vessel types a distinctive aspect of the maritime history of the area. Further evidence from the wreck site would be required for a more accurate assessment of archaeological importance to be made.

185 Wreck **WA 7071** exhibits a magnetometer contact and therefore may be of partly metal construction, with dimensions similar to that of a small trawler or sailing vessel. Identification is not possible with the available evidence.

3.2 Submerged Prehistory & Palaeo-landscape Potential

186 The shallow geological sequence of much of the survey area represents a prograding shoreline sequence relating to the Forth Formation (**WA 7505**) (**Figure 3**). This type of deposit records changes in sea-level in the area since the Last Glacial Maximum. These deposits are therefore potentially an important palaeogeographical and palaeoenvironmental sequence in relation to local and regional patterns of Mesolithic coastal activity and now-submerged archaeological landscapes. Any cultural heritage assets of early prehistoric origin encountered in an offshore, primary (*in situ*) context would be of national importance.

187 The nature of the local Mesolithic records of lithic scatters associated with coastal sand dunes directly adjacent to the MSA suggests there may be potential for encountering lithic finds in offshore sediments of appropriate age.

188 Five small possible cut and fills (**7500**, **7501**, **7502**, **7503** and **7504**) have also been identified in the south-west of the MSA. These are shallow, relatively small features and, since it has not been possible to trace them between adjacent lines, they are expected to be isolated depressions and not part of a coherent palaeochannel system. Reworked archaeological material in secondary contexts may be present in the fills of these features.

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4.2 Web Resources

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CANMAP, RCAHMS http://jura.rcahms.gov.uk/CANMAP/Map

Aberdeenshire SMR, map query
http://www.aberdeenshire.gov.uk/smrpub/shire/mapquery.aspx)

A APPENDICES

A.1 Legislation Guidance

A.1.1 Summary

189 Description of the domestic, European and international legal framework, including:

- Existing statutory mechanisms relevant to the archaeological heritage
- The application of marine consent and licensing procedures
- The implications of proposed changes associated with the Marine (Scotland) Act 2010 and Marine and Coastal Access Act 2009
- National and regional plans, policies and guidance relating to marine archaeology

A.1.2 Legal and Policy Framework

A.1.2.1 Outline

190 This section presents the legal and policy framework applicable to marine archaeology within the UK Continental Shelf (UKCS), encompassing UK territorial waters and the UKCS itself.

191 The legal framework applicable to marine archaeology is subject to a variety of jurisdictional divisions. It is generally accepted in international law that states have jurisdiction in respect of heritage within their territorial waters (to 12 nautical miles (nm)). Accordingly, the UK exercises authority in respect of marine archaeology to 12nm on the basis of UK-wide legislation. However, as cultural issues are generally devolved, marine archaeology is administered separately by different authorities in each of the home countries, in the case of Scotland, Historic Scotland are the relevant authority.

192 Some aspects of the law relating to marine archaeology, such as the Marine and Coastal Access Act 2009, Protection of Military Remains Act 1986 and the Merchant Shipping Act 1995, are administered by authorities with UK-wide powers.

193 Administration beyond 12nm is not devolved, so that – in principal – marine archaeology on the UKCS is addressed UK-wide. However, in practice the UK-wide authorities with powers relating to archaeology beyond 12nm generally call upon the expertise of the heritage agency responsible for the adjacent territorial waters.

A.1.3 UK-wide

A.1.3.1 Introduction

194 There are two different pieces of legislation under which wrecks of archaeological interest may be designated, namely the Protection of Wrecks

Act 1973 (PWA 1973, which has two relevant sections) and the Protection of Military Remains Act 1986 (PMRA 1986). Designation of wrecks is also possible under a third act, the Ancient Monuments and Archaeological Areas Act 1979 (AMAA 1979), which applies to England, Scotland and Wales, but not Northern Ireland which has its own equivalent legislation.

195 N.B. Scotland's Marine Act (2010; see below), will allow for new Scottish-specific legislation and protection to be implemented.

196 In addition, there are UK-wide provisions applying generally to people who find or take possession of wreck – including wreck of archaeological interest – under the Merchant Shipping Act 1995 (MSA 1985).

197 The Protection of Military Remains Act 1986 and the Merchant Shipping Act 1995 are administered UK-wide by the Ministry of Defence (MOD) and the Maritime and Coastguard Agency (MCA) respectively. Section Two of the Protection of Wrecks Act 1973, which deals with dangerous wrecks, is also administered UK-wide by the MCA. However, Section One of the Protection of Wrecks Act 1973, which deals with wrecks of historic or archaeological importance, is administered by the heritage agencies of each of the home countries. The Ancient Monuments and Archaeological Areas Act 1979 is also administered by the heritage agencies of England, Scotland and Wales.

A.1.3.2 Protection of Wrecks Act 1973: Section One

198 The following paragraphs set out the general provisions and background of Section One of the PWA 1973. Further details relating to its administration in each home country are dealt with subsequently, under the heading for each country.

199 Section One of the Protection of Wrecks Act 1973 enables the Secretary of State to protect wreck sites from unauthorised interference if they are of historic, archaeological or artistic importance.

200 Under the Act it is an offence to carry out certain activities in a defined area surrounding the site, unless a licence for those activities has been obtained from the Government.

201 Section One of the PWA 1973 is administered by each of the home country heritage agencies, largely independently.

202 The relevant Secretary of State (or Scottish Government) must consult appropriate advisors prior to designation, though it is possible to designate a wreck in an emergency without first seeking advice. Advice on designations is provided by the heritage agencies.

203 There are currently a total of 61 sites protected under Section One of the Act http://www.english-heritage.org.uk/daysout/maritime-heritage/map/. The sites range in date and character from dispersed cargoes of Bronze Age metalwork to the largely intact remains of the submarine A1, lost in 1911.

204 Generally, sites are designated following an extended consultation process. However, there have been instances (such as the Swash Channel wreck) where an emergency designation order has been obtained after detection by geophysical investigations in the course of Environmental Impact Assessment

(EIA). The Act does provide for the rapid protection of wrecks at risk, if necessary.

A.1.3.3 *Protection of Wrecks Act 1973: Section Two.*

205 Section Two of the Protection of Wrecks Act 1973 provides protection for wrecks that are designated as dangerous due to their contents and is administered by the Maritime and Coastguard Agency (MCA) through the Receiver of Wreck (ROW).

206 There are currently two wrecks designated as dangerous wrecks under Section Two of the Act: the wreck of the Richard Montgomery off Sheerness; and the wreck of the SS Castilian, East Platters, Anglesey http://www.mcga.gov.uk/c4mca/mcga07-home/emergencyresponse/mcga-receiverofwreck/mcga-protectedwrecks/mcga-protectedwrecks-wrecksact1973_3.htm.

207 Section Two of the PWA 1973 is not used to designate sites because of their archaeological interest, but it is possible that a dangerous wreck designated under this section might also be of archaeological or historic interest.

A.1.3.4 *The Protection of Military Remains Act 1986*

208 Under the Protection of Military Remains Act 1986 the Ministry of Defence has powers to protect vessels that were in military service when they were wrecked. The definition of ‘military service’ has been examined in detail in the course of judicial review and subsequent appeal, such that in some circumstances merchant vessels are eligible for protection (for example http://en.wikipedia.org/wiki/SS_Storaa).

209 The MOD can designate named vessels as Protected Places even if the position of the wreck is not known. In addition, the MOD can designate Controlled Sites around wrecks whose position is known. In the case of Protected Places, the vessel must have been lost after the 4th August 1914, whereas in the case of a wreck protected as Controlled Sites, no more than 200 years must have elapsed since loss (MOD 2001). In neither case is it necessary to demonstrate the presence of human remains.

210 Diving is not prohibited at a Protected Place but it is an offence to tamper with, damage, move or remove sensitive remains. Diving, salvage and excavation are all prohibited on Controlled Sites. Licences to undertake otherwise restricted activities can be sought from the MOD.

211 The provisions of the PMRA 1986 in respect of Protected Places and Controlled Sites are applicable in international waters, which would include the UK Continental Shelf, although they are only enforceable in respect of British-controlled ships, British citizens, and British companies.

212 The MOD is undergoing a rolling programme of identification and assessment that has resulted in several groups of wrecks being designated under the PMRA 1986 http://www.mod.uk/DefenceInternet/AboutDefence/WhatWeDo/Personnel/SPVA/AviationArchaeology.htm%20.

213 The most recent tranche came into effect on 1st May 2008. There are now a total of 12 controlled sites and 55 protected places around the world.

214 Records of vessels lost while in military service do not always give an exact location for the loss. Given the extent of military activity on the UKCS, the potential for wrecks eligible for further designation under the PMRA 1986 is high.

215 Under the Protection of Military Remains Act 1986, all aircraft that have crashed in military service automatically constitute a Protected Place. As such, it is an offence to tamper with, damage, move or remove any remains of military aircraft unless authorised by a licence. The provisions of the PMRA 1986 relating to aircraft are administered by the MOD Joint Casualty and Compassionate Centre.

216 It should also be noted that it is an offence under the PMRA 1986 to carry out unauthorised excavations for the purpose of discovering whether any place in UK waters contains remains of a vessel which has crashed, sunk or been stranded while in military service.

A.1.3.5 Ancient Monuments and Archaeological Areas Act 1979

217 The main legislation used to protect archaeological remains in the UK is the Ancient Monuments and Archaeological Areas Act 1979. This Act primarily deals with terrestrial sites but there is provision to designate sites in territorial waters as Scheduled Monuments.

218 Monuments are defined by the AMAA 1979 as including buildings, structures, works, caves, excavations, vehicles, vessels, aircraft or other movable structures. Monuments can only be scheduled if they are of national importance. Section 53 extends the AMAA 1979 to monuments situated in, on or under the seabed within UK territorial waters.

219 Once a monument has been Scheduled, visiting or diving on the site is not necessarily restricted. It is, however, an offence to demolish, destroy, alter or repair the monument without prior authorisation, in the form of Scheduled Monument Consent.

220 Examples of wreck sites that have been designated as Scheduled Monuments in UK waters (http://www.mcga.gov.uk/c4mca/mcga07-home/emergencyresponse/mcga-receiverofwreck/mcga-protectedwrecks/mcga-protectedwrecks-ancient.htm) include the following:

- The Light Cruisers Brummer, Dresden, Karlsruhe and Koln, along with the Battleships Konig, Kronprinz Wilhelm and Markgraf of the German High Seas Flee. All scuttled at Scapa Flow, Orkney, on 21st June, 1919
- The Kilspindie Hulks Nos.1-8. Examples of 19th to 20th century 'Fifie' sailing fishing vessels, Kilspindie, Aberlady Bay, Lothian
- The Louisa, a 19th century seagoing merchant vessel, Grangetown, Cardiff. This vessel was first protected in 2001 and now forms part of the Cardiff land reclamation scheme

A.1.3.6 Merchant Shipping Act 1995

221 The Merchant Shipping Act 1995 (MSA 1995) http://www.legislation.gov.uk/ukpga/1995/21/contents?view=plain is used to regulate the reporting and disposal of wreck – including wreck of archaeological interest – found or recovered from UK waters, or found or recovered outside UK waters but brought within those waters. Within the context of the MSA 1995, wreck refers to flotsam, jetsam, derelict and lagan found in or on the shores of the sea or any tidal water. It includes ships, aircraft and hovercraft, parts of these, their cargo and equipment.

222 All wreck that is found or taken into possession must be notified to the Receiver of Wreck by the finder. The wreck is then delivered to the Receiver, or, more commonly, held by the finder to the order of the Receiver.

223 The ownership and disposal of wreck is decided according to procedures contained within the MSA 1995. Provision is made for original owners to come forward to claim their property. Ownership of unclaimed wreck from within territorial waters lies with the Crown Estate or in a person to whom rights of wreck have previously been granted by the Crown.

224 The Receiver has a duty to ensure that finders who report their finds according to the legislation, receive an appropriate salvage payment. In the case of material considered to be of historic or archaeological importance, a suitable museum is asked to buy the material at the current valuation and the finder receives the net proceeds of the sale as a salvage payment. If the right to, or the amount of salvage cannot be agreed, either between owner and finder or between competing salvors, the Receiver will hold the wreck until the matter is settled, either through amicable agreement or by court judgement.

A.1.3.7 Archaeological Material other than Wreck

225 The Merchant Shipping Act 1995 applies only to archaeological material that is 'wreck', i.e. material that is derived in some way from a ship or aircraft.

A.1.3.8 Marine & Coastal Access Act 2009

226 The Marine & Coastal Access Act (MCAA) 2009 (http://www.defra.org.uk/environment/marine/legislation/mcaa/index.htm) has fundamentally changed the management of the UKCS, introducing the Marine Management Organisation (MMO), a system of Marine plans for managing coastal activities and development, a revised system licensing marine development, a new system of marine conservation zones (MCZs), and new fisheries management mechanisms.

227 Licensing and enforcement is devolved to Scottish, Welsh and Northern Irish authorities at various levels, to organisations including the Marine Management Organisation in England and Marine Scotland.

228 The Marine Policy Statement (MPS) (http://www.defra.gov.uk/corporate/consult/marine-policy/100721-marine-policy-statement.pdf%20), currently in draft form (Dec 2010), will be the framework for marine planning and decisions affecting the marine area. Marine Plans will set out how the MPS will be implemented in specific areas,

extending to mean high water and overlapping with terrestrial planning schemes. Marine policy guidance and Marine Plans will seek to complement rather than replace terrestrial schemes, recognising that both systems may adapt and evolve over time.

229 The MCAA 2009 itself does not contain specific provisions relating to the historic environment; however the MPS provides the policy context and framework within which all aspects of the historic environment should be managed.

230 The MPS defines the historic environment as including 'all aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged. Those elements of the historic environment – buildings, monuments, sites or landscapes – that hold particular significance due to their historic, archaeological, architectural or artistic interest are called heritage assets'. The MPS uses the term historic environment to include all heritage assets of whether they are afforded statutory protection or not.

231 In relation to the requirements for EIA's under Environmental Impact Assessment (EIA) Directive (Directive 85/337/EEC), the MPS outlines a number of principles to be used, specifically that decisions should:

- Be taken using a risk-based approach that allows for uncertainty, recognising the need to use sound science responsibly
- Be sensitive to potential impacts on sites of particular significance – including designated marine heritage assets
- Look to mitigate negative impacts where possible at various stages of development (in line with legal obligations) in a manner that is proportionate to the potential impacts of the proposal under consideration. Where alternative site selection or design could mitigate effects this should be considered, where appropriate

232 The MPS states that the protection and management of marine cultural heritage should be in a manner appropriate and proportionate to their significance. Significance is defined as 'the value of a heritage asset to this and future generations because of its heritage interests'. It is also highlighted within the MPS that many heritage assets with archaeological interest in coastal and offshore areas are not designated but are of equivalent significance. The MPS states that the 'absence of designation for such assets does not necessarily indicate lower significance' and that the same policy principles should be applied to them as to designated heritage assets.

233 In relation to the management of heritage assets, the MPS identifies the desirability of 'sustaining and enhancing the significance of heritage assets' and a general presumption in favour of the conservation of heritage assets should be adopted. The more significant the asset, the greater the presumption in favour of its conservation. Substantial loss or damage to heritage assets through development activities should be exceptional. Where loss or harm is unavoidable, appropriate mitigation should be considered.

234 In relation to mitigation measures, the MPS requires opportunities for acquiring new information from heritage assets should be taken, and made publicly available, particularly if a heritage asset is to be lost.' It goes further

to state that 'In England and Wales, where development resulting in the loss of a heritage asset's significance is justified, the marine plan authority should require developers to record the asset's significance before it is lost, and to deposit copies of the resulting reports with the relevant local authority planning authority, historic environment record and national heritage agency.'

235 Also of relevance to the historic environment, are the MPS's statements in relation to seascapes, which it defines as 'landscapes with views of the coast or seas, and coasts and the adjacent marine environment with cultural, historical and archaeological links with each other'. The MPS states that the visual, cultural, historical and archaeological impacts on seascapes should be considered for all coastal areas.

A.1.3.9 Other UK Plans, Policies and Guidance

236 Of direct relevance to offshore renewables development is COWRIE's Historic Environment Guidance for the Offshore Renewables Sector (2007) (http://www.offshorewindfarms.co.uk/Assets/archaeo_guidance.pdf). This guidance is UK-wide and provides information on all aspects of dealing with the historic environment in planning and implementing offshore renewable schemes. The guidance is also generally relevant to other forms of marine development, including oil and gas. COWRIE has also published Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy (http://www.offshorewindfarms.co.uk/Assets/cowrie_ciarch%20web.pdf%20) (2008).

237 The Joint Nautical Archaeology Policy Committee (JNAPC) Code of Practice for Seabed Development is a UK-wide code developed in conjunction with key industries. The JNAPC Code is voluntary but provides a framework that can be used in the course of development to ensure that activities are conducted in an archaeologically sensitivity manner (http://www.thecrownestate.co.uk/jnapc_code_of_practice.pdf).

238 The Crown Estate has recently commissioned Wessex Archaeology to prepare a guidance note on assessing, evaluating, mitigating and monitoring the archaeological effects of offshore renewables projects, Protocol for Archaeological Discoveries: Offshore Renewables Projects, (http://www.scribd.com/doc/45787868/The-Crown-Estate-Protocol-for-Archaeological-Discoveries) (The Crown Estate, 2010).

239 As general context for best-practice, English Heritage's general guidance with respect to wind energy is set out in 'Wind Energy and the Historic Environment' (October 2005), which includes a short section on offshore renewables (http://www.english-heritage.org.uk/publications/wind-energy-and-the-historic-environment/).

240 English Heritage has also developed a methodology for Historic Seascape Characterisation, which 'maps a cultural understanding of coastal and marine landscapes' to 'provide area based cultural context our marine management decision-making'. The character areas have no formal legal or planning status, but provide a framework within which seascapes can be understood and managed (http://www.english-heritage.org.uk/professional/advice/advice-by-topic/landscape-and-areas/characterisation/seaschape-character/).

241 English Heritage has recently circulated a consultation document on views, entitled 'Seeing the History in the View: a methodology for assessing heritage significance within views' (April 2008). As implied by the title, the consultation draft sets out a methodology that can be used for 'any view that may have heritage significance', with particular reference to development proposals and environmental impact assessment. English Heritage intends to use the methodology in its own decisions relating to developments affecting views, and also to encourage planning authorities to adopt the same approach. The document includes a methodology for assessing impacts to views in the course of EIA. Although the case studies presented in the document are urban, its potential application to heritage significance within views to and from the coast is apparent (http://www.english-heritage.org.uk/professional/advice/advice-by-topic/setting-and-views/seeing-the-history-in-the-view/).

242 In effect, these principles mean that the historic environment must be a material consideration in development control, that preservation in situ is the preferred approach for heritage assets, that developers are responsible for the recording, publication and dissemination of investigations of heritage assets that cannot be preserved in situ, and that consents are issued subject to sufficient information on archaeological impacts and mitigation.

243 The implications for the historic environment of wind energy developments should be reflected in Regional Spatial Strategies, Local Development Frameworks and Supplementary Planning Documents.

244 The effects of wind energy programmes and projects on the historic environment should be evaluated in all levels of environmental impact assessment.

- Consideration of the historic environment should include World Heritage Sites; marine, coastal and terrestrial archaeology; historic buildings and areas; designed landscapes; and the historic character of the wider landscape

- The significance of internationally and nationally designated sites should be safeguarded, and physical damage to historic sites should be avoided

- The impact of wind energy developments on the setting and visual amenity of historic places should also be considered

- Where wind energy developments affect historic sites, national planning policies on the historic environment should be taken into account

- Consideration should always be given to the reversibility of wind energy projects

A.1.4 Scotland

245 Historic Scotland (HS) carries the responsibilities of Scottish Ministers with regard to nationally important archaeological and built heritage matters, which extend offshore to the 12 nautical mile (nm) territorial limit under the Marine (Scotland) Act 2010. These responsibilities are carried out in collaboration

with other bodies such as Marine Scotland, public authorities and marine planning authorities where appropriate on matters of marine planning or licensing (http://www.scotland.gov.uk/Topics/marine/seamanagement/marineact).

246 There are three relevant pieces of legislation from which direct responsibilities arise: the Marine (Scotland) Act 2010, the Ancient Monuments and Archaeological Areas Act 1979 (http://www.legislation.gov.uk/ukpga/1979/46/contents) and the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997. Amendments to the latter two acts, are currently going through the Scottish Parliament as part of the The Ancient Monuments and Listed Buildings (Amendment) (Scotland) Bill (see below).

247 Under the Marine & Coastal Access Act 2009, Scottish Ministers now have powers over marine planning, licensing and conservation over the Scottish Marine Area from 12 - 200 nm offshore. UK Marine Policy Statement and resultant regional marine plans (due by 2012) will outline specific priorities and policy within 12 – 200 nm offshore.

248 Historic Scotland has used the definitions in AMAA 1979 as a basis for designating sites of archaeological interest. Amendments currently being considered in the The Ancient Monuments and Listed Buildings (Amendment) (Scotland) Bill (http://www.historic-scotland.gov.uk/amlb-bill.pdf), (December 2010) clarify what is regarded as a ‘monument’. The proposed change to the definition cites “any site comprising and thing, or group of things, that evidences previous human activity” (p22). This would therefore include artefact scatters, palaeoenvironmentally important sediments containing artefacts, i.e. archaeological material that does not fit under the previous definition that focused upon ‘structure’ or ‘work’. These kinds of archaeological remains are principal components in the archaeological record of submerged prehistoric sites and landscapes and wrecks sites where no vessel has been located. Therefore these proposed amendments are important considerations for the protection of marine archaeology and future guidance.

A.1.4.1 Marine (Scotland) Act 2010

249 The definitions of significance and importance set out in AMAA 1979 have been incorporated into the newly assented Marine (Scotland) Act 2010 and underpin the provisional policies (http://www.scottish.parliament.uk/s3/committees/rae/bills/Marine%20bill/documents/20100110CabSecSGS2Committments-ProvisionalpoliciesforHistoricMPAs-circulationtoparliament.pdf) based upon the Act which replaces the PWA 1973 in Scotland. Under section 4 of the Act, Scottish Ministers have the power to designate an area as an Historic Marine Protected Area (MPA) in order to preserve “a marine historic asset of national importance located, or believed to be located, in the area”.

250 A marine historic asset is defined as:

- a vessel, vehicle or aircraft (or a part of a vessel, vehicle or aircraft)
- the remains of a vessel, vehicle or aircraft (or a part of such remains)
- an object contained in, or formerly contained in, a vessel, vehicle or aircraft

- a building or other structure (or a part of a building or structure)
- a cave or excavation
- a deposit or artefact (whether or not formerly part of a cargo of a ship) or any other thing which evidences, or groups of things which evidence, previous human activity

251 Ministers would also be obliged to consider other environmental characteristics of the marine area with respect to biodiversity and geodiversity policy aims and planning and licensing proposals.

252 Scottish Ministers are required to publish notice and hold a consultation for a proposed Historic MPA designation, however if there is a perceived need to rapidly protect a marine historic asset a designation may be enforced without this process enabling protection for up to 2 years. Specific preservation objectives pertaining to an individual Historic MPA would be defined by Scottish Ministers through Marine Conservation Orders (MCOs) which could prohibit, restrict or regulate a wide range of activities not controlled by other means. The status of designations would be assessed in an ongoing process in relation to the changing state of knowledge and future requirements.

253 Within an MPA it would be an offence to "intentionally or recklessly carry out a prohibited act that significantly hinders or may significantly hinder the achievement of the state preservation objectives for the protected area". Prohibited acts would be to:

- carry out works or activities (or which are likely to) damage or interfere with a marine historic asset or have a significant impact on the protected area
- remove, alter or disturb a marine historic asset
- to contravene an MCO

254 Exceptions may apply when in accordance with a permit or authorisation issued by the Scottish Ministers.

255 Further to powers of protection, marine planning and some licensing powers (under the Marine and Coastal Access Act 2009) would be devolved to Scottish Ministers through the Marine (Scotland) Act 2010 covering the Scottish Marine Area.

A.1.4.2 Planning and the Historic Environment (Scotland)

256 The Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 contains the bulk of built heritage conservation planning law for Scotland. It requires Scottish Ministers to compile lists of buildings of archaeological or historic importance and provides for the designation of conservation areas. This Act is currently being discussed in the Scottish Parliament (December 2010) in conjunction with The Ancient Monuments and Listed Buildings (Amendment) (Scotland) Bill which aims to update The Historic Buildings and Ancient Monuments Act 1953, The Ancient Monuments and Archaeological Areas Act 1979 and Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 in order to harmonise existing legislation for the management of the historic environment.

257 Under the proposed broader definition of the archaeological record (as per Historic Environment (Amendment) (Scotland) Bill artefact scatters and archaeological important sediments containing evidence of past human activity could be protected once 'cultural significance' and 'national importance' have been discerned under the defined criteria. For example, this type of situation would be well-described by the known submerged prehistoric landscapes and stone tool scatters that define the Mesolithic and Palaeolithic archaeological record in the North Sea.

258 The scope of statutory planning control associated with legislation such as the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 and Town & Country Planning (Scotland) Act 1997 ends at the mean low water mark and it is therefore not possible for buildings or sites that are permanently submerged to be listed. However, it is possible for structures which are sometimes or partly below the sea to be listed, such as ports and harbours. Under the M(S)A 2010 the scope of The Act defines the "Sea" as including the mean high water spring tide, therefore in the case of the intertidal zone, there are overlapping jurisdictions between marine and terrestrial planning legislation and various public bodies including Local Planning authorities and Historic Scotland for example. The resolution of planning decisions in the intertidal zone will be achieved through the national marine plan, and regional marine plans as prepared by Government and regional Marine Planning Partnerships, respectively. The process of producing marine plans (national and regional) is set to take 2 years from the Royal Assent of the M(S)A (10th March 2010).

259 The strategic policies of Scottish Ministers to the historic environment are being set out in a new set of documents entitled Scottish Historic Environment Policies (SHEPs). These documents provide immediate context for advice arising from Historic Scotland, but importantly the SHEPS are effectively cross-governmental and can be expected to guide decisions across the range of authorities responsible to Scottish Ministers. Scotland's Historic Environment (SHEP 1 sets out an overall vision and brings together a broad range of existing guidance and a consolidated volume of the existing SHEPs has recently been prepared (http://www.historic-scotland.gov.uk/shep-july-2009.pdf); however, a document pertaining to the Marine Historic Environment is forthcoming. The consultation period on a draft SHEP on The Marine Historic Environment (http://www.historic-scotland.gov.uk/shep_marine.pdf) has now closed and is likely to be published during 2011-12 (pers. comm. Historic Scotland, December 2010).

260 *Scottish Planning Policy* (SPP) has recently been consolidated to provide a more focused statement of national planning policy (http://www.scotland.gov.uk/Resource/Doc/300760/0093908.pdf), whilst revoking some previous SPP guidance notes, in particular superseding *SPP 23: Planning and the Historic Environment*, Planning Advice Notes (PANs) (pertaining to coastal planning only) and National Planning Policy Guidelines (NPPGs) including *NPPG 18: Planning and the Historic Environment* and *NPPG 5:Archaeology and Planning*.

261 *SPP* sets out policy on how archaeological remains and discoveries should be handled. The guidance is aimed at planning authorities in Scotland, and is also of direct relevance to developers, owners, statutory undertakers, government departments, conservation organisations and others whose actions have a direct physical impact upon the natural or built environment as

it underlines the requirements of development plans to consider the historic environment.

262 The Planning Advice Note: Archaeology 42 - the Planning Process and Scheduled Monument Procedures (PAN 42 - http://www.scotland.gov.uk/Publications/1994/01/17081/21711) gives more detailed advice on planning procedures and the separate controls over scheduled monuments. With the current assessment of the Monuments and Listed Buildings (Amendment) (Scotland) Bill discussed above, this may be updated or changed in the future.

263 Although it is primarily concerned with development on land, a recent document on scoping wind farm proposals in Scotland from Historic Scotland (http://www.historic-scotland.gov.uk/eia_and_gdpo_scoping_setting.pdf) may also be relevant to offshore wind farms.

A.1.5 Local Authority – Aberdeenshire Council Planning

264 The Strategic Development Planning Authority (SDPA, 2010) of Aberdeen City and Shire Council has declared several targets for Quality of the Environment within the 2009 Structure Plan of particular note to archaeology and the historic environment is QE/T1, which is actively monitored during the planning application process:

- To make sure that development improves and does not lead to the loss of, or damage to, built, natural or cultural heritage assets

265 The structure plan highlights "The structure plan area has many sites of significant of built, natural and cultural value. Appropriate monitoring will be developed through 2010 to ensure that development does not have a detrimental effect." (SDPA, 2010:27).

A.1.6 Relevant International Instruments

266 A broader context is provided by international law, represented by customary law and the conventions to which the UK is party. The United Nations Convention on the Law of the Sea 1982 (UNCLOS 1982 - http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm), the European Convention on the Protection of the Archaeological Heritage (Revised) 1992 (the Valletta Convention), the UNESCO Convention on the Protection of the Underwater Cultural Heritage 2001 (UNESCO 2001 - http://unesdoc.unesco.org/images/0012/001260/12065e.pdf) and the European Landscape Convention 2000 (ELC 2000 - http://conventions.coe.int/Treaty/Commun/QueVoulezVous.asp?NT=176&CM=8&DF=5/19/2009&CL=ENG) are all relevant in this regard, as is the (ICOMOS) Charter on the Protection and Management of Underwater Cultural Heritage 1996.

267 UNCLOS 1982 was ratified by the UK in 1997. Article 303 stipulates that 'states have the duty to protect objects of an archaeological and historical nature found at sea and shall co-operate for this purpose'. Article 303 also provides for coastal states to exert a degree of control over the archaeological heritage to 24 nautical miles, though the UK has not introduced any measures to implement this right.

268 The Valletta Convention was ratified by the UK Government in 2000 and came into force in 2001. The convention binds the UK to implement protective measures for the archaeological heritage within the jurisdiction of each party, including sea areas. Insofar as the UK exerts jurisdiction over the Continental Shelf, then it would appear that the provisions of the Valletta Convention apply to that jurisdiction.

269 The UNESCO Convention 2001 is a comprehensive attempt to codify the law internationally in respect of the underwater archaeological heritage. Although the UK abstained in the vote on the final draft of the Convention, it has stated that it has adopted the Annex of the Convention – which governs the conduct of archaeological investigations – as best practice for archaeology (http://www.unesco.org/new/en/unesco/themes/underwater-cultural-heritage/).

270 The ELC 2000 became binding on the UK from 1 March 2007. Its principal clauses require the Government:

- to recognise landscapes in law as an essential component of people's surroundings, an expression of the diversity of their shared cultural and natural heritage, and a foundation of their identity
- to establish and implement landscape policies aimed at landscape protection, management and planning through the adoption of … specific measures
- to establish procedures for the participation of the general public, local and regional authorities, and other parties with an interest in the definition and implementation of the landscape policies mentioned in paragraph b above
- to integrate landscape into its regional and town planning policies and in its cultural, environmental, agricultural, social and economic policies, as well as in any other policies with possible direct or indirect impact on landscape

271 The Convention applies to the entire territory of the UK and includes land, inland water and marine areas.

272 One further international measure is worth noting, namely the International Council on Monuments and Sites (ICOMOS) Charter on the Protection and Management of Underwater Cultural Heritage 1996 (the Sofia Charter). The Charter includes a series of statements regarding best practice, intending 'to ensure that all investigations are explicit in their aims, methodology and anticipated results so that the intention of each project is transparent to all'. The UK is a member of ICOMOS.

A.2 Gazetteer of Documented Wrecks and Features

(Subsequently compiled into the geophysical assessment of seabed features (section A.4) (co-numbered in Figure 4).

WA_ID (corresponding geophysical feature record)	**RCAHMS ID**	**UKHO ID**	**State**	**Easting**	**Northing**	**Name**	**Type**	**Length (m)**	**Beam (m)**	**Draught (m)**	**Date lost**
2000 (7093)	NJ91NE 8005	2145	Live	560106	6345633	*Archangel*	Steam Ship	101	13	6	16/05/1941
2001 (7103)		2170	Live	557170	6342158	*Coastal Emperor*	Motor Rig stand-by trawler	35	8	4	06/12/1978
2002 (7046)		71209	Live	561558	6340796		Anchor & cable				
2003 (7102)		2144	Live	556542	6340201	*Sherriffmuir*	Motor Fishing	31	7	3	01/10/1976

A.3 Gazetteer of Sub-bottom Features

WA ID	Name / Classification	Archaeological Discrimination	Description	Sources
7500	Simple Cut and Fill	A2	Small, shallow, possible simple cut and fill in the surface of FH, though could just be an internal reflector. Not definitively observed on adjacent lines, but in the vicinity of 7501 and possibly related. Depth Range: 1.0m - 2.9m BSB.	6500
7501	Simple Cut and Fill	A2	Possible simple cut and fill in the surface of FH, though could just be an internal reflector. Not definitively observed on adjacent lines, but in the vicinity of 7500 and possibly related. Depth Range: 0.4m - 3.7m BSB.	6501
7502	Simple Cut and Fill	A2	Small, shallow, possible simple cut and fill in the surface of FH, though could just be an internal reflector. Not definitively observed on adjacent lines, but in the vicinity of 7503 and 7504 and possibly related. Depth Range: 0.4m - 2.3m BSB.	6502
7503	Simple Cut and Fill	A2	Possible simple cut and fill in the surface of FH, though could just be an internal reflector. Not definitively observed on adjacent lines, but in the vicinity of 7502 and 7504 and possibly related. Depth Range: 1.6m - 6.1m BSB.	6503
7504	Simple Cut and Fill	A2	Possible simple cut and fill in the surface of FH, though could just be an internal reflector. Not definitively observed on adjacent lines, but in the vicinity of 7502 and 7503 and possibly related. Depth Range: 2.3m - 4.7m BSB.	6504
7505	Erosion Surface	A2	Generally fairly poorly defined but laterally continuous reflector within the FH. Appears at seabed just east of the centre of the survey area, in a line running approximately parallel to the shoreline, and dips gently eastwards. Possible erosion surface within FH, possibly representing the internal structure of a prograding palaeoshoreline. Depth Range: 1.4m - 8.3m BSB.	6506

A.4 Gazetteer of Seabed Features

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7000	Rope / Chain	556368	6338517	A2	106.9	0.2	0.1	17	Long, curvilinear dark reflector with a small shadow associated with a small magnetic anomaly. Possible length of rope or chain.	6035	-
7001	Debris	556655	6338337	A2	11.8	1.2	0.4	7	Large dark reflector with large shadow located adjacent to a similar, smaller dark reflector. Associated with a small magnetic anomaly, and possibly both part of the same partially buried piece of ferrous debris.	6036	-
7002	Dark Reflector	556729	6338404	A2	5.7	0.7	0.2	-	Elongate dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6037	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7003	Magnetic	556721	6338252	A2	-	-	-	12	Small magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contacts. In an area of variable seabed reflectivity and geology and could be due to natural reasons or a piece of buried ferrous debris.	6038	-
7004	Magnetic	557116	6338253	A2	-	-	-	23	Medium magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be a piece of buried ferrous debris, or caused by natural changes in the seabed geology.	6039	-
7005	Magnetic	557167	6338425	A2	-	-	-	23	Medium magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be a piece of buried ferrous debris, or caused by natural changes in the seabed geology.	6040	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7006	Debris	557386	6338562	A2	7.9	0.1	0.0	-	Short but well-defined linear dark reflector without a shadow or associated magnetic anomaly. Possible piece of linear non-ferrous debris.	6041	-
7007	Magnetic	557703	6338644	A2	-	-	-	5	Magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contacts. Anomaly is small but a definite spike compared with the background. Could be caused by natural changes in seabed geology or represent a piece of buried ferrous debris.	6042	-
7008	Magnetic	557447	6338914	A2	-	-	-	24	Medium magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Possibly a piece of buried ferrous debris.	6043	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7009	Magnetic	556700	6338738	A2	-	-	-	28	Medium magnetic anomaly with two positive peaks. No associated sidescan sonar or multibeam bathymetry contact, and possibly a piece of buried ferrous debris.	6044	-
7010	Magnetic	556655	6339020	A2	-	-	-	13	Small magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contacts. In an area of variable seabed reflectivity and could be due to natural geological variations or a piece of buried ferrous debris.	6045	-
7011	Magnetic	556638	6338913	A2	-	-	-	16	Small magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contacts. In an area of variable seabed reflectivity and could be due to natural geological variations or a piece of buried ferrous debris.	6046	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7012	Magnetic	556454	6338955	A2	-	-	-	23	Medium magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contacts. In an area of variable seabed reflectivity and could be due to natural geological variations or a piece of buried ferrous debris.	6047	-
7013	Dark Reflector	556695	6339095	A2	5.7	2.9	0.7	10	Very large dark reflector with very large shadow, possibly associated with a small magnetic anomaly, though the large number of scattered anomalies in the vicinity indicate this could not be the case. Located adjacent to an area of high seabed reflectivity containing numerous similar, but smaller, contacts so could be a natural feature. However is slightly apart from these, so could be a piece of ferrous debris.	6048	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7014	Magnetic	556551	6339186	A2	-	-	-	30	Two adjacent medium magnetic anomalies, probably part of the same broader feature. No associated sidescan sonar or multibeam bathymetry contacts, but is located in an area of variable seabed reflectivity so could be due to natural geological variations or a piece of buried ferrous debris.	6049	-
7015	Magnetic	556557	6339336	A2	-	-	-	27	Medium magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contacts. In an area of variable seabed reflectivity and could be due to natural geological variations or a piece of buried ferrous debris.	6050	-
7016	Magnetic	556896	6339182	A2	-	-	-	6	A linear alignment of three small magnetic anomalies, possibly part of the same broad anomaly though this is uncertain. Could be due to natural changes in seabed geology or represent a piece of elongate, buried ferrous debris (e.g. chain).	6051	-

WA ID	**Name / Class.**	**Easting**	**Northing**	**Arch. Discrim.**	**Length (m)**	**Width (m)**	**Height (m)**	**Magnetic Amplitude (nT)**	**Description**	**Sources**	**External References**
7017	Magnetic	557477	6339608	A2	-	-	-	14	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Possibly represents a small piece of buried ferrous debris.	6053	-
7018	Magnetic	558399	6339593	A2	-	-	-	9	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Possibly represents a small piece of buried ferrous debris.	6054	-
7019	Debris	558823	6339137	A2	20.1	4.1	0.0	-	Group of irregular dark reflectors without a shadow or associated magnetic anomaly. Could be natural or a small scatter of non-ferrous debris.	6055	
7020	Debris	558995	6339921	A2	8.4	4.9	0.3	-	Small area of dark reflectors, some with shadows but without an associated magnetic anomaly. Possible small scatter of non-ferrous debris.	6057	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7021	Seafloor Disturbance	559875	6339635	A2	10.1	4.6	0.0	-	Small area of low seabed reflectivity containing small dark reflectors, possible area of seafloor disturbance. Data is poor and feature is poorly resolved. Not associated with a magnetic anomaly, could be natural or anthropogenic in origin.	6064	-
7022	Dark Reflector	560039	6339560	A2	3.2	0.9	0.5	-	Dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6065	-
7023	Debris	560261	6339599	A2	2.9	0.6	0.6	-	Small, elongate dark reflector with small shadow but without an associated magnetic anomaly. Feature appears irregular and surround by a small area of disturbed seabed. Possible piece of partially buried non-ferrous debris.	6066	-
7024	Debris	557820	6340910	A2	15.9	1.9	0.0	-	Two adjacent, poorly defined, short linear dark reflectors without shadows or an associated magnetic anomaly. Possibly non-ferrous debris.	6067	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7025	DarkReflector	558423	6340262	A2	7.3	2.3	0.0	-	Poorly defined dark reflector or cluster of small dark reflectors without shadows or associated magnetic anomalies. Could be a natural feature or non-ferrous debris.	6069	-
7026	Magnetic	558680	6340514	A2	-	-	-	18	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Possibly represents a small piece of buried ferrous debris.	6070	-
7027	Debris	558237	6341081	A2	7.6	3.6	0.0	-	Small, irregular dark reflector without a shadow or associated magnetic anomaly. Possible piece of non-ferrous debris.	6071	-
7028	Dark Reflector	558662	6341183	A2	5.4	3.7	0.7	-	Two adjacent large dark reflectors with shadows but no associated magnetic anomaly. Could be natural or a piece of debris.	6076	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7029	Debris	559669	6341721	A2	57.6	0.2	0.0	-	A poorly defined curvilinear dark reflector linking two or three small dark reflectors with shadows. No associated magnetic anomaly, but could be an area of non-ferrous debris.	6088	-
7030	Dark Reflector	560154	6341600	A2	2.4	0.1	0.0	-	Short, indistinct dark reflector without a shadow or associated magnetic anomaly. Located in an area of poor data, and could be a piece of debris or noise.	6092	-
7031	Dark Reflector	560168	6342224	A2	5.3	1.8	0.0	-	Short, indistinct dark reflector without a shadow or associated magnetic anomaly. Located in an area of poor data, and could be a piece of debris or noise.	6093	-
7032	Dark Reflector	560525	6341860	A2	5.2	0.9	0.3	-	Elongate dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6094	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7033	Dark Reflector	560550	6341691	A2	2.2	0.8	0.1	-	Small dark reflector without a shadow or associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6095	-
7034	Dark Reflector	557063	6339094	A2	2.7	0.7	0.3	-	Poorly defined area of dark reflectors forming a rectangular shape. No shadows or associated magnetic anomalies. Possibly a natural feature or an area of non-ferrous debris.	6099	-
7035	Magnetic	556686	6339874	A2	-	-	-	22	Two adjacent medium magnetic anomalies, probably part of the same short linear anomaly. No associated sidescan sonar or multibeam bathymetry contact, but could represent a piece of buried linear ferrous debris.	6102	-
7036	Magnetic	556653	6340003	A2	-	-	-	14	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Possibly represents a small piece of buried ferrous debris.	6103	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7037	Magnetic	557195	6340055	A2	-	-	-	16	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Possibly represents a small piece of buried ferrous debris.	6104	-
7038	Debris	557009	6340182	A2	3.0	2.8	0.5	53	Isolated, rounded dark reflector with small shadow and associated scour. Possibly associated with a medium magnetic anomaly, though this was identified approx 50m away. Possible piece of ferrous debris.	6105	-
7039	Magnetic	556835	6340238	A2	-	-	-	32	Medium magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possible piece of buried ferrous debris.	6106	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7040	Magnetic	557250	6340545	A2	-	-	-	32	Medium magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possible piece of buried ferrous debris. Located in an area of similar contacts at the end of a possible outfall pipe, so could be debris from the pipe.	6107	-
7041	Magnetic	557175	6340485	A2	-	-	-	16	Small magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possible piece of buried ferrous debris. Located in an area of similar contacts at the end of a possible outfall pipe, so could be debris from the pipe.	6108	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7042	Magnetic	557113	6340448	A2	-	-	-	18	Small magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possible piece of buried ferrous debris. Located in an area of similar contacts at the end of a possible outfall pipe, so could be debris from the pipe.	6109	-
7043	Magnetic	557083	6340538	A2	-	-	-	34	Medium magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possible piece of buried ferrous debris. Located in an area of similar contacts at the end of a possible outfall pipe, so could be debris from the pipe.	6110	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7044	Magnetic	557020	6340495	A2	-	-	-	13	Small magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possible piece of buried ferrous debris. Located in an area of similar contacts at the end of a possible outfall pipe, so could be debris from the pipe.	6111	-
7045	Debris	557077	6340342	A2	4.2	1.7	1.3	23	Rectangular dark reflector with shadow, scour and associated medium magnetic anomaly. Possible piece of ferrous debris.	6112	-
7046	Recorded Obstruction	561558	6340796	A3	-	-	-	-	Given location of a seabed obstruction, recorded as an anchor and cable. Not identified by any of the geophysical equipment and could be located elsewhere or currently buried.	6115, 2002	71209 (UKHO)
7047	Rope / Chain	560862	6341169	A2	42.7	1.0	0.0	-	Poorly defined curvilinear dark reflector without a shadow or associated magnetic anomaly. Could be a partially buried length of rope or chain.	6117	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7048	Magnetic	560982	6342050	A2	-	-	-	15	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Possibly represents a small piece of buried ferrous debris.	6118	-
7049	Debris	561746	6341897	A2	14.4	0.5	0.2	-	Short linear dark reflector with small shadow but no associated magnetic anomaly. Possible piece of linear debris.	6119, 6120	-
7051	Rope / Chain	557387	6342034	A2	77.1	0.5	0.0	-	Long, poorly defined curvilinear dark reflector without a shadow or associated magnetic anomaly. Possible length of rope or chain.	6124	-
7052	Debris	557694	6342261	A2	9.7	0.9	0.0	-	Short linear dark reflector without a shadow or associated magnetic anomaly. Possibly a piece of linear non-ferrous debris.	6125	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7053	Magnetic	557806	6343320	A2	-	-	-	8	Two adjacent small but distinct magnetic anomalies, possibly part of the same feature. No associated sidescan sonar or multibeam bathymetry contacts. Could be natural in origin or indicative of a piece of buried ferrous debris.	6129	-
7054	Magnetic	557765	6343110	A2	-	-	-	7	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6131	-
7055	Magnetic	558178	6342835	A2	-	-	-	21	Medium magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possibly indicative of a small piece of buried ferrous debris.	6132	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7056	Magnetic	558523	6342853	A2	-	-	-	8	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6133	-
7057	Magnetic	558325	6342645	A2	-	-	-	9	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6135	-
7058	Magnetic	558185	6342965	A2	-	-	-	6	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6136	-
7059	Magnetic	558545	6343103	A2	-	-	-	6	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6137	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7060	Magnetic	558378	6344343	A2	-	-	-	12	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6141	-
7061	Magnetic	558368	6344145	A2	-	-	-	11	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6142	-
7062	Magnetic	558673	6344048	A2	-	-	-	8	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6143	-
7063	Magnetic	558648	6344283	A2	-	-	-	8	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6144	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7064	Magnetic	558998	6343508	A2	-	-	-	13	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6147	-
7065	Magnetic	559168	6343233	A2	-	-	-	68	Isolated medium magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possibly indicative of a piece of buried ferrous debris.	6148	-
7066	Magnetic	559755	6343090	A2	-	-	-	6	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6149	-
7067	Magnetic	558965	6342600	A2	-	-	-	15	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6151	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7068	Magnetic	559193	6342323	A2	-	-	-	5	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6152	-
7069	Debris	559509	6342605	A2	20.2	5.8	0.1	15	Irregular shaped dark reflector with a small shadow and associated with two small magnetic anomalies. Possible ferrous debris, could be a length of rope or chain but data is unclear.	6153	-
7070	Magnetic	559580	6342703	A2	-	-	-	22	Medium magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Located close to possible ferrous debris 7069, and could be a piece of associated buried ferrous debris.	6154	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7071	Wreck	561077	6342919	A1	25.0	6.5	0.7	58	Wreck not present in the given UKHO or NMR data. Appears upright and fairly intact, still showing structure and height, though is possibly partially buried. No debris field was observed, though one possible piece of discrete debris was located approx. 35m NW. Multibeam bathymetry data indicate the structure is located in a very small (<0.5m deep) scour.	6155	-
7072	Debris	561038	6342931	A1	2.1	1.1	0.2	-	Small dark reflector with a small shadow. Magnetic signature unknown due to the high response created by nearby wreck 7071. Possibly a piece of debris related to the wreck.	6156	-
7073	Debris	562359	6343072	A2	4.8	2.0	0.4	-	Irregular elongate dark reflector with shadow but no associated magnetic anomaly. Possible piece of non-ferrous debris.	6157	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7074	Debris	562363	6343516	A2	4.3	0.4	0.0	-	Short linear dark reflector without a shadow or associated magnetic anomaly. Possible piece of linear non-ferrous debris.	6158	-
7075	Dark Reflector	561821	6343582	A2	3.8	0.9	0.4	-	Isolated dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6159	-
7076	Debris	561217	6343496	A2	9.8	0.7	0.1	-	Short linear dark reflector or alignment of individual dark reflectors, with a very small shadow but no associated magnetic anomaly. Possible piece of partially buried non-ferrous debris.	6160	-
7077	Magnetic	560093	6344288	A2	-	-	-	7	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6166	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7078	Magnetic	559363	6344785	A2	-	-	-	22	Medium magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possibly indicative of a small piece of buried ferrous debris.	6167	-
7079	Magnetic	559495	6344720	A2	-	-	-	15	Small but definite magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possibly indicative of a small piece of buried ferrous debris.	6168	-
7080	Magnetic	558970	6344655	A2	-	-	-	6	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6169	-
7081	Magnetic	558363	6345125	A2	-	-	-	183	Large magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contacts. No know wrecks or structures in the area, and origin of the anomaly is unknown. Possibly a buried shoreline structure.	6170	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7082	Magnetic	558695	6345140	A2	-	-	-	6	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6171	-
7083	Magnetic	558745	6345160	A2	-	-	-	6	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6172	-
7084	Magnetic	558658	6345208	A2	-	-	-	17	Small but definite magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possibly indicative of a small piece of buried ferrous debris.	6173	-
7085	Debris	558552	6345391	A2	5.1	0.4	0.0	-	Small linear dark reflector without a shadow or associated magnetic anomaly. Possible piece of non-ferrous debris.	6175	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7086	Debris	558530	6345401	A2	5.7	0.4	0.0	-	Small linear dark reflector without a shadow or associated magnetic anomaly. Possible piece of non-ferrous debris.	6176	-
7087	Debris	558468	6345520	A2	11.2	0.4	0.0	18	Small linear dark reflector without a shadow but possibly associated with a small magnetic anomaly. Possible piece of ferrous debris.	6177	-
7088	Magnetic	558763	6346265	A2	-	-	-	22	Two adjacent medium anomalies, possibly part of the same feature. No associated sidescan sonar or multibeam bathymetry contact. Could be a natural feature or indicative of buried ferrous debris.	6179	-
7089	Magnetic	559238	6346023	A2	-	-	-	8	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6180	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7090	Debris	559201	6345459	A2	37.7	2.8	0.2	-	Long, linear dark reflector without a shadow. Extending from the outfall pipe exit away from the shore, and is possibly related debris.	6183	-
7091	Magnetic	559348	6345393	A2	-	-	-	47	Medium magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contacts. Possibly indicative of a buried piece of ferrous debris. Located a short distance from the mouth of an outfall pipe, so could be recent debris washed in from onshore.	6184	-
7092	Magnetic	560063	6345973	A2	-	-	-	45	Medium magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possibly indicative of a small piece of buried ferrous debris.	6185	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7093	Recorded Wreck	560106	6345633	A3	-	-	-	-	Given location of the wreck of the SS *Archangel*, not identified by any of the geophysical equipment. UKHO records show it was last surveyed in 1977, suggesting the positioning may not be accurate and it could lie elsewhere outside of the survey area.	6187, 2000	2145 (UKHO)
7094	Magnetic	560170	6344850	A2	-	-	-	22	Medium magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Possibly indicative of a small piece of buried ferrous debris.	6189	-
7095	Magnetic	560320	6345318	A2	-	-	-	12	Small but definite magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Could be natural or indicative of a small piece of buried ferrous debris.	6190	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7096	Magnetic	560390	6345093	A2	-	-	-	15	Two adjacent small magnetic anomalies, possibly part of the same feature. No associated sidescan sonar or multibeam bathymetry contact. Could be a natural feature or indicative of buried ferrous debris.	6191	-
7097	Debris	561127	6345539	A2	2.3	1.4	0.7	-	Well defined, irregular dark reflector with shadow but no associated magnetic anomaly. Possible piece of non-ferrous debris.	6192	-
7098	DarkRefl ector	561104	6344923	A2	2.0	1.2	0.4	-	Poorly defined rounded dark reflector with shadow and some scour, but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6194	-
7099	Dark Reflector	560950	6344554	A2	2.7	0.7	0.3	-	Small isolated dark reflector with small shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6193, 6195	-

WA ID	Name / Class.	Easting	Northing	Arch. Discrim.	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	Sources	External References
7100	Debris	561855	6345765	A2	15.7	11.0	0.0	-	Collection of short linear dark reflectors without shadows, possible partially buried object/debris. Length of rope or chain possibly extending from one end. No associated magnetic anomaly identified.	6196	-
7101	Magnetic	562015	6345405	A2	-	-	-	8	Medium, complex magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Could be a natural feature or indicative of buried ferrous debris.	6198	-
7102	Recorded Wreck	556542	6340201	A3	-	-	-	-	Given location of the wreck of the *Sheriffmuir*. Located outside of the geophysical survey area, so the current condition of the structure cannot be commented upon.	2003	2144 (UKHO)
7103	Recorded Wreck	557170	6342158	A3	-	-	-	-	Given location of the wreck of the *Coastal Emperor*. Located outside of the geophysical survey area, so the current condition of the structure cannot be commented upon.	2001	2170 (UKHO)

A.5 Gazetteer of Recorded Losses

(Vessels known to have been lost in the vicinity of the MSA, with absent or poor positional information).

Name	**RCAHMS ID**	**Date Lost or Reported**	**Period**	**Type**	**Location**	**Comment**
Unknown		1444	Medieval	Barge	Near Aberdeen	From Ferguson 1991, 5
Falcoun		1584	Post-Medieval		Aberdeen	From Ferguson 1991, 6
Elizabeth		1697	Post-Medieval		Mouth of the Dee	Stranded on the bar; from Ferguson 1991, 10
Levant/Smyrna Galley		1707	Industrial	Galley?	Belhevie	6 miles N of Aberdeen; from Ferguson 1991, 11
Fussroun Geertruy		1707	Industrial	Dogger	Belhevie	6 miles N of Aberdeen; from Ferguson 1991, 11
St Andrew	NJ90NE 8248	1723	Industrial		Mouth of the Dee	
Unknown	NJ90NE 8016	1774	Industrial		Aberdeen Bay	
Dolphin	NJ90NE 8018	1768	Industrial		Aberdeen Harbour	
Unknown	NJ90NE 8019	1768	Industrial	Brig	Aberdeen	
Friendship	NJ90NE 8020	1774	Industrial		Aberdeen	
Jenny	NJ90NE 8021	1774	Industrial		Aberdeen	
Unknown	NJ90NE 8023	1783	Industrial		Aberdeen	
Unknown	NJ90NE 8024	1783	Industrial		Aberdeen	
Unknown	NJ90NE 8025	1783	Industrial		Aberdeen	
Active	NJ90NE 8027	1793	Industrial		Near Aberdeen	
Mary	NJ90NE 8028	1793	Industrial		Near Aberdeen	
Mary	NJ90NE 8029	1797	Industrial		Ashore E of Aberdeen	
Martha		1800	Industrial		Belhevie	From Ferguson 1991, 23
Lord Saltoun		1800	Industrial	Brigantine	Belhevie	From Ferguson 1991, 23
Neptune		1800	Industrial		Belhevie	From Ferguson 1991, 23
Unknown		1800	Industrial	Brig	Aberdeen	From Ferguson 1991, 23
Unknown		1800	Industrial	Brig	Aberdeen	From Ferguson 1991, 23
Lord Saltoun		1800	Industrial	Brig	Aberdeen Beach	From Ferguson 1991, 24

Name	RCAHMS ID	Date Lost or Reported	Period	Type	Location	Comment
Peggy and Mary		1800	Industrial	Sloop	Aberdeen Beach	From Ferguson 1991, 24
Good Intent	NJ90NE 8030	1803	Industrial		Near Aberdeen	
Amaris	NJ90NE 8031	1803	Industrial		Aberdeen	
Persuit / Pursuit	NJ90NE 8221/8032	1803	Industrial		Near Aberdeen	
Mary		1803	Industrial		Blackdog, Belhevie Sands	From Ferguson 1991, 27
Thetis	NJ90NE 8035	1805	Industrial		Aberdeen	
Barbara	NJ90NE 8037	1807	Industrial		Near Aberdeen	
Luna	NJ90NE 8038	1807	Industrial		Near Aberdeen	Ashore, may have been refloated
Alert	NJ90NE 8039	1808	Industrial		Aberdeen	Broad Hill (?)
Fortune	NJ90NE 8040	1809	Industrial		Near Aberdeen	Ashore
Hawke	NJ90NE 8041	1809	Industrial		Near Aberdeen	Ashore
Jane	NJ90NE 8043	1809	Industrial		Near Aberdeen	Ashore
Nancy	NJ90NE 8044	1809	Industrial		Aberdeen coast	
Caesar	NJ90NE 8045	1810	Industrial	Ship	Near Aberdeen	
Hercules	NJ90NE 8047	1813	Industrial		Aberdeen harbour entrance, back of N Pier	
Joanna	NJ90NE 8049	1813	Industrial	Brig	Aberdeen harbour entrance, back of S Pier	
St Andrew	NJ90NE 8225	1813	Industrial		Aberdeen harbour entrance, back of N Pier	
Caledonian	NJ90NE 8010	1815	Industrial	Brig	Aberdeen Harbour Entrance	
Thames	NJ90NE 8050	1815	Industrial	Smack	Aberdeen Harbour Entrance	

Name	RCAHMS ID	Date Lost or Reported	Period	Type	Location	Comment
Charsten and Perter Larsen	NJ90NE 8228/8229	1815	Industrial	Galliot	Aberdeen Harbour, N Pier	
Peggy	NJ90NE 8052	1816	Industrial		Near Aberdeen	
Admiral Nelson	NJ91SE 8005	1816	Industrial		Aberdeen	Stranded at Black Dog, appears to have subsequently moved
Gibraltar	NJ90NE 8054	1817	Industrial	Brig	Black Dog	Lost 2 miles N of Aberdeen
James and Mary	NJ90NE 8055	1817	Industrial	Schooner	Aberdeen	Collision 1 mile NNW of Girdle Ness
Gleaner	NJ90NE 8058	1817	Industrial	Brig	Aberdeen Harbour Entrance	
Expedition	NJ90NE 8059	1818	Industrial	Ship	Black Dog	
Sheepfold	NJ90NE 8061	1819	Industrial	Schooner	Aberdeen Harbour Entrance	
Perfect	NJ90NE 8062	1820	Industrial	Brig	Aberdeen Harbour, Breakwater	Lost S of breakwater (S pier?) on rocks
Jean	NJ90NE 8063	1821	Industrial	Whaler/Brig	Aberdeen Harbour, N Pier Head	
Ann	NJ90NE 8230	1821	Industrial		Aberdeen Harbour Entrance	Breakwater
Alpha	NJ90NE 8066	1822	Industrial	Sloop	Mouth of the Don	
Deveron	NJ91SE 8019	1825	Industrial		Mouth of the Don	N of
Friends	NJ90NE 8215	1826	Industrial	Sloop	Aberdeen Harbour, S Pier Head	
Friendship	NJ91SE 8020	1826	Industrial		Mouth of the Don	To the N of
Friendship	NJ90NE 8235	1827	Industrial		Mouth of the Don	To the N of
Corsair	NJ90NE 8236	1828	Industrial	Schooner	Aberdeen Harbour, Pier Head	
Unknown	NJ90NE 8070	1830	Industrial		Aberdeen	
Grampion / Grampian	NJ90NE 8239	1830	Industrial	Brigantine	Aberdeen Harbour, N Pier	

Name	RCAHMS ID	Date Lost or Reported	Period	Type	Location	Comment
Fame		1830	Industrial	Fishing Smack	Blackdog	6 miles N of Aberdeen; from Ferguson 1991, 35
Lady Forbes	NJ90NE 8073	1832	Industrial		Near the mouth of the Dee	
Caledonia	NJ90NE 8074	1832	Industrial		Aberdeen	
Pirate	NJ91SE 8006	1832	Industrial	Smack	Aberdeen Beach	3 miles N of Aberdeen
William and Mary	NJ90NE 8075	1833	Industrial	Sloop	Near Aberdeen	
Margaret	NJ90NE 8242	1834	Industrial		Off Aberdeen	
Marquis of Huntly	NJ90NE 8245	1835	Industrial	Smack	Aberdeen Beach	1 mile N of N Pier
Unknown	NJ90NE 8077	1838	Industrial		Aberdeen	
Unknown	NJ90NE 8078	1838	Industrial		Aberdeen	
Brilliant	NJ90NE 8251	1839	Industrial	Steamship	Aberdeen Harbour, N Pier	
Tinker		1841	Industrial	Schooner	Aberdeen Beach	Opposite the bathing station
Migvie	NJ90NE 8080	1842	Industrial	Brig	Aberdeen Harbour Entrance	Within the bar
Migvie	NJ90NE 8081	1844	Industrial		Aberdeen Beach	Between N Pier and Don Mouth
Frau Anna Katharina	NJ90NE 8254	1844	Industrial		Aberdeen Harbour, N Pier	
Nimrod	NJ90NE 8255	1844	Industrial	Hermaphrodite Brig	Aberdeen Harbour, N Pier Head	
George and Mary	NJ90NE 8247	1845	Industrial	Sloop	Aberdeen harbour entrance, back of N Pier	
Aurora	NJ91SE 8021	1845	Industrial	Brig	Blackdog Links	3 miles N of Don Mouth / 4 miles N of Aberdeen
Lord Reidhaven	NJ90NE 8173	1847	Industrial	Sloop	Aberdeen Harbour Entrance	Stranded outside the breakwater

Name	RCAHMS ID	Date Lost or Reported	Period	Type	Location	Comment
Paquebot Du Havre Et Bourdeaux	NJ90NE 8261	1848	Industrial	Brig	Aberdeen Beach	
Elizabeth	NJ90NE 8262	1848	Industrial		Aberdeen Harbour, N Pier	
Velocity	NJ90NE 8263	1848	Industrial	Paddle Steamer	Aberdeen Harbour Entrance, Pier	
Margarets	NJ90NE 8264	1848	Industrial	Brig	Aberdeen Harbour, N Pier	
Union	NJ90NE 8265	1849	Industrial	Schooner	Aberdeen Harbour, N Pier	
Unknown	NJ91SE 8022	1849	Industrial	Brig	Mouth of Don	N of
Bamboro' Castle	NJ90NE 8174	1850	Industrial	Schooner	Aberdeen Bay	
Venus	NJ90NE 8177	1852	Industrial	Brig	Aberdeen Beach	1 mile N of Aberdeen?
Annistead	NJ90NE 8084	1852	Industrial	Brig	Aberdeen Beach	
Duke of Sutherland	NJ90NE 8085	1853	Industrial	Paddle steamer	Aberdeen Harbour Entrance	
Margaret and Jane	NJ90NE 8256	1854	Industrial		Aberdeen Harbour Entrance	Ashore between the Pier (?) and Girdle Ness
Dargs	NJ90NE 8272	1857	Industrial	Sloop	Aberdeen Harbour Entrance	S side
Mackintosh	NJ90NE 8273	1857	Industrial		Near Aberdeen	
Hero	NJ90NE 8249	1858	Industrial	Schooner	Aberdeen Harbour Entrance	
Lion	NJ90NE 8089	1858	Industrial	Brig	Aberdeen Bay	Stranded whilst attempting to enter the harbour
Scottish Maid	NJ90NE 8090	1858	Industrial	Barque	Aberdeen Harbour Entrance	Stranded on the Bar, not clear whether vessel lost
Earl of Caithness	NJ90NE 8091	1859	Industrial	Steamship	Aberdeen Harbour Entrance	Stranded near S Pier, not clear whether vessel lost
Saint Nicholas	NJ90NE 8092	1859	Industrial	Brigantine	Aberdeen Bay	Ashore near harbour entrance
Duke of Richmond	NJ91SE 8007	1859	Industrial	Paddle Steamer	Blackdog	4 miles N of Aberdeen

Name	RCAHMS ID	Date Lost or Reported	Period	Type	Location	Comment
Ocean Bride	NJ91SE 8023	1859	Industrial		Blackdog	4 miles N of Aberdeen
Ellen And Catherine	NJ90NE 8086	1860	Industrial	Schooner	Aberdeen	Possibly offshore
Chance	NJ90NE 8274	1860	Industrial	Dandy	Aberdeen harbour entrance, back of S Pier	
Britannia	NJ90NE 8275	1860	Industrial	Brig	Aberdeen Harbour Entrance	
Elida	NJ91SE 8024	1860	Industrial	Schooner	Aberdeen	May have been offshore
Eagle	NJ90NE 8087	1861	Industrial	Brig	Aberdeen Harbour Entrance	
Tyne Packet	NJ90NE 8283/4	1861	Industrial	Sloop	Aberdeen Beach	0.5 miles N of Aberdeen; may have been salvaged
Wave	NJ90NE 8093	1864	Industrial	Schooner	Off Aberdeen	Probably offshore
David	NJ90NE 8094	1865	Industrial	Schooner	Aberdeen Bay	Stranded 3/4 mile N of Aberdeen Pier
Agricola	NJ90NE 8095	1866	Industrial	Brig	Aberdeen Beach	Near N Pier
Mercury	NJ90NE 8096	1866	Industrial	Schooner	Aberdeen Harbour, N Pier Head	
Mary	NJ90NE 8276	1866	Industrial	Schooner	Aberdeen Harbour Entrance	
Oxford	NJ90NE 8281	1866	Industrial	Barque	Aberdeen Harbour Entrance	May have been salvaged
Liverpool Packet	NJ90NE 8277	1867	Industrial	Schooner	Aberdeen Beach	
Jeannie	NJ90NE 8097	1869	Industrial	Schooner	Aberdeen Harbour, N Pier Head	
Isabella Davidson	NJ90NE 8279	1870	Industrial	Schooner	Aberdeen Harbour, N Pier	
Helen Scott	NJ90NE 8282	1870	Industrial	Brig	Aberdeen Harbour, N Pier	
Charles	NJ90NE 8183	1871	Industrial	Brig	Aberdeen Beach	2 miles N of the mouth of the Don

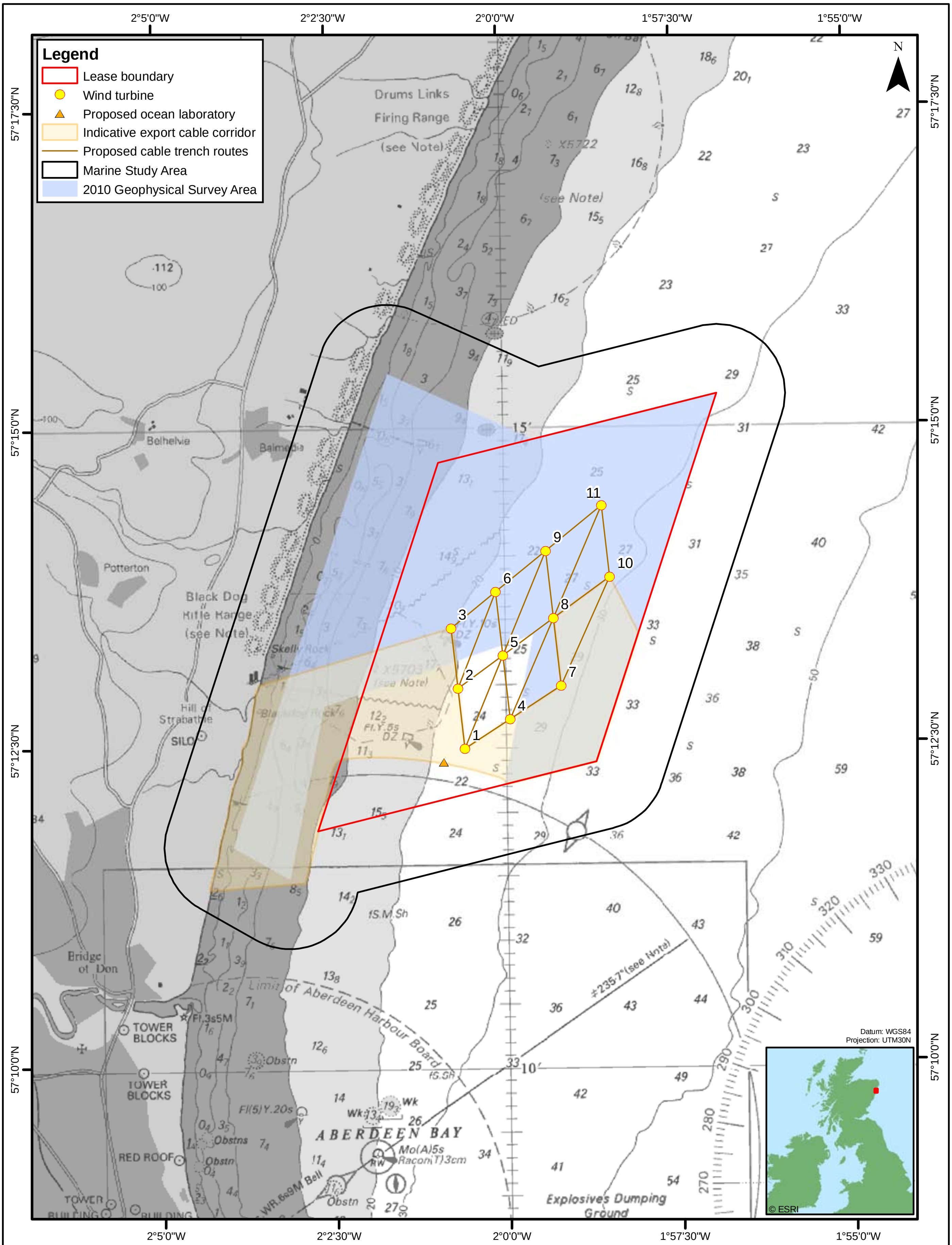
Name	RCAHMS ID	Date Lost or Reported	Period	Type	Location	Comment
Belina	NJ90NE 8199	1872	Industrial	Brigantine	Aberdeen Beach	S of the mouth of the Don, high on beach
Elizabeth	NJ90NE 8185	1874	Industrial	Fishing Lugger	Aberdeen Harbour Entrance	0.5 miles NE of Aberdeen Harbour Entrance
Agnes	NJ90NE 8186	1874	Industrial	Fishing Lugger	Aberdeen Harbour Entrance	S side
Dunchattan	NJ90NE 8099	1876	Industrial	Schooner	Aberdeen harbour entrance, back of N Pier	
Christina / Christine	NJ90NE 8100	1876	Industrial	Brig	Aberdeen Beach	2.5 miles N of the mouth of the Don
Johanna	NJ90NE 8205 / NJ91SE 8008	1876	Industrial	Brig	Near Aberdeen / Berryhill	Berryhill is 4 miles N of Aberdeen
Vider	NJ90NE 8205	1876	Industrial		Near Aberdeen	May have been offshore
Enighed	NJ90NE 8205	1876	Industrial	Brig	Balmedie Links	Loss may have been offshore
Unknown	NJ90NE 8205	1876	Industrial	Barque	Near Aberdeen	May have been offshore
De Goede Vrede	NJ91SE 8018	1876	Industrial	Barque	Balgownie Links (?)	Reported as both 4 and 9 miles N of Aberdeen, near Belhevie
William		1876	Industrial	Brig	Balmedie Links	From Ferguson 1991:129
Louise Elizabeth		1876	Industrial	Barque	Blackdog	From Ferguson 1991:129
Countess of Seafield	NJ90NE 8101	1877	Industrial	Brig	Aberdeen Beach	0.5 miles S of the mouth of the Don
Nina	NJ90NE 8102	1877	Industrial	Brig	Aberdeen Beach	2 miles S of the mouth of the Don
Charles Green	NJ90NE 8103	1878	Industrial	Schooner	Aberdeen Harbour, N Pier	
Gustav	NJ91SE 8009	1878	Industrial	Brig	Blackdog Rock	6 miles N of Aberdeen
Hurbottle Castle	NJ90NE 8098	1879	Industrial	Schooner	Aberdeen Bay	Lost 1/2 mile from Harbour entrance on approach
Nineveh	NJ91SE 8017	1879	Industrial	Sloop	Mouth of Don	1 mile N of

Name	RCAHMS ID	Date Lost or Reported	Period	Type	Location	Comment
Isabella	NJ90NE 8104	1880	Industrial	Schooner	Aberdeen Harbour, N Pier	
Diligentta	NJ90NE 8105	1880	Industrial	Brig	Aberdeen Harbour, N Pier	
Cassowary	NJ90NE 8106	1880	Industrial	Schooner	Near Aberdeen	
Mars	NJ90NE 8107	1881	Industrial	Brig	Aberdeen Harbour Entrance	
Ben Rhydding	NJ90NE 8108	1881	Industrial	Ship	Black Dog	About 6 miles N of Aberdeen
Morford and Trubey	NJ90NE 8109	1881	Industrial	Schooner	Mouth of the Don	
Elizabeth	NJ90NE 8110	1881	Industrial	Schooner	Aberdeen Bay	
Thomas Cochran	NJ90NE 8111	1881	Industrial	Barque	Aberdeen Beach	1 mile S of the mouth of the Don
Margaret Milne	NJ90NE 8189	1881	Industrial	Barque	Aberdeen Beach	300 yards N of N (?) Pier
Venus	NJ90NE 8190	1881	Industrial	Brigantine	Aberdeen Beach	
St Clair	NJ90NE 8220	1881	Industrial	Schooner	Aberdeen Bay	1 mile N of Aberdeen N (?) pier
Ann Williams	NJ91SE 8010	1881	Industrial	Schooner	Blackdog	
Helen		1881	Industrial	Schooner	Menie Links	Balmenie?; from Ferguson 1991:133
Josef		1881	Industrial	Brig	Aberdeen Bay	2 miles S of Ythanmouth; from Ferguson 1991:133
Wanderer		1881	Industrial	Schooner	Blackdog	2 miles N of; from Ferguson 1991:133
Duchess	NJ90NE 8112	1883	Industrial	Steamship	Aberdeen Harbour Entrance	Inside harbour entrance
Tom Duff	NJ90NE 8113	1883	Industrial	Schooner	Aberdeen Harbour, N Pier	Inside harbour entrance
Queen	NJ90NE 8114	1883	Industrial	Schooner	Aberdeen Harbour, N Pier	0.5m N of N Pier
Tasmania	NJ91SE 8011	1883	Industrial	Ship	Mouth of the Don	3/4 mile N of

Name	RCAHMS ID	Date Lost or Reported	Period	Type	Location	Comment
Walter Raleigh	NJ90NE 8181	1885	Industrial	Fishing Lugger	Off Aberdeen	2 miles off Aberdeen
Mizpah	NJ90NE 8116	1885	Industrial	Fishing Lugger	Aberdeen Bay	
Comply	NJ90NE 8117	1887	Industrial	Fishing Lugger	Off Aberdeen	
Bon Accord	NJ91SE 8012	1889	Industrial	Steam paddle tug	Balgownie Links	1 mile S of Blackdog Rock
Mountaineer	NJ90NE 8180	1890	Industrial	Fishing Lugger	Aberdeen Harbour Entrance	
William Meff	NJ90NE 8118	1890	Industrial	Fishing Lugger	Near Aberdeen	
Delight	NJ90NE 8120	1896	Industrial	Fishing Lugger	Aberdeen Harbour Entrance	
Indian Prince	NJ90NE 8121	1897	Industrial	Steam trawler	Aberdeen Harbour, N Pier	
Vine	NJ90NE 8123	1897	Industrial	Schooner	Aberdeen Harbour, N Pier Head	
Levang	NJ90NE 8124	1898	Industrial	Schooner	Aberdeen	
Watchful	NJ90NE 8125	1898	Industrial	Fishing Lugger	Aberdeen Harbour Entrance	
Ranger	NJ90NE 8126	1899	Industrial	Fishing Lugger	Aberdeen Harbour, N Pier	
Annie	NJ91NE 8013	1899	Industrial	Barquentine	Balgownie Links	3 miles S of Belhevie
Welcome Home	NJ90NE 8128	1900	20th Century	Schooner	Aberdeen Harbour, N Pier	
Anna	NJ90NE 8286	1900	20th Century	Sloop	Mouth of the Don	
Mary of Banff	NJ91NE 8002	1900	20th Century	Schooner	Balmedie Beach	SMR: NJ91NE0024
Metis	NJ90NE 8129	1901	20th Century	Steam Trawler	Mouth of the Don	
Black Prince	NJ91SE 8014	1902	20th Century	Steam Trawler	Balgownie Links	
Campania	NJ90NE 8130	1904	20th Century	Steam Trawler	Aberdeen Harbour Entrance	

Name	RCAHMS ID	Date Lost or Reported	Period	Type	Location	Comment
Fisher Lassie	NJ90NE 8132	1906	20th Century	Fishing Lugger	Aberdeen Harbour Entrance	
Brothers	NJ90NE 8135	1908	20th Century	Fishing Lugger	Aberdeen Harbour Entrance	
William Osten	NJ90NE 8136	1909	20th Century	Steam Trawler	Aberdeen Harbour, S Pier	
Duchess of Montrose	NJ90NE 8137	1909	20th Century	Steam Trawler	Aberdeen Harbour	
Lillie	NJ90NE 8138	1912	20th Century	Steam Drifter	Aberdeen Beach	
Fairweather	NJ90NE 8139	1912	20th Century	Steam Tug	Aberdeen Harbour Entrance	
Strathyre	NJ90NE 8140	1912	20th Century	Steam Trawler	Aberdeen Harbour, N Pier	
Braconhill	NJ90NE 8141	1913	20th Century	Steam Trawler	Aberdeen Harbour, N Pier	
Onward (H 980)	NJ90NE 8146	1916	20th Century	Requisitioned Steam Trawler	Off Aberdeen	
Nellie Nutten (Gn 69)	NJ90NE 8147	1916	20th Century	Requisitioned Steam Trawler	Off Aberdeen	
Era	NJ90NE 8148	1916	20th Century	Steam Trawler	Off Aberdeen	
Sercia	NJ90NE 8150	1918	20th Century	Steamship	Aberdeen	
North-West	NJ90NE 8151	1918	20th Century	Steam Trawler	Aberdeen Harbour Entrance	
Cepherus	NJ90NE 8153	1920	20th Century	Steam trawler	Aberdeen Harbour Entrance	
Craig Island	NJ90NE 8154	1922	20th Century	Steam Trawler	Aberdeen Harbour Entrance	
Imperial Prince	NJ91SE 8015	1923	20th Century	Steam Trawler	Hill of Strabathie	N of Balgownie Links

Name	RCAHMS ID	Date Lost or Reported	Period	Type	Location	Comment
Editor	NJ90NE 8157	1933	20th Century	Steam Trawler	Off Aberdeen	
Liva	NJ90NE 8158	1933	20th Century	Steam Trawler	Aberdeen	
George Stroud	NJ90NE 8159	1935	20th Century	Steam Trawler	Aberdeen Harbour Entrance	
Fairy	NJ91NE 8004	1937	20th Century	Steamship	Millden Links	N of Blackdog Rock; broken up on beach; Ferguson 1991: 111. SMR: NJ91NE0026
Robert Bowen	NJ90NE 8161	1940	20th Century	Steam Trawler	Off Aberdeen	
Fort Royal	NJ90NE 8162	1940	20th Century	Steam Trawler	Off Aberdeen	
Fruitful Bough (Bounty)	NJ91NE 8003	1961	20th Century	Motor Trawler	Balmedie Beach	SMR: NJ91NE0025
Christine	NJ91SE 8001	1981	20th Century	Fishing Vessel	Black Dog	
Unknown	NK11NW 8001				Balmedie	
Unknown	NK12SE 8001				Belhelvie-Balmedie	



VATTENFALL

areg Aberdeen Renewable Energy Group

Technip

0 0.5 1 km

0 0.25 0.5 nm

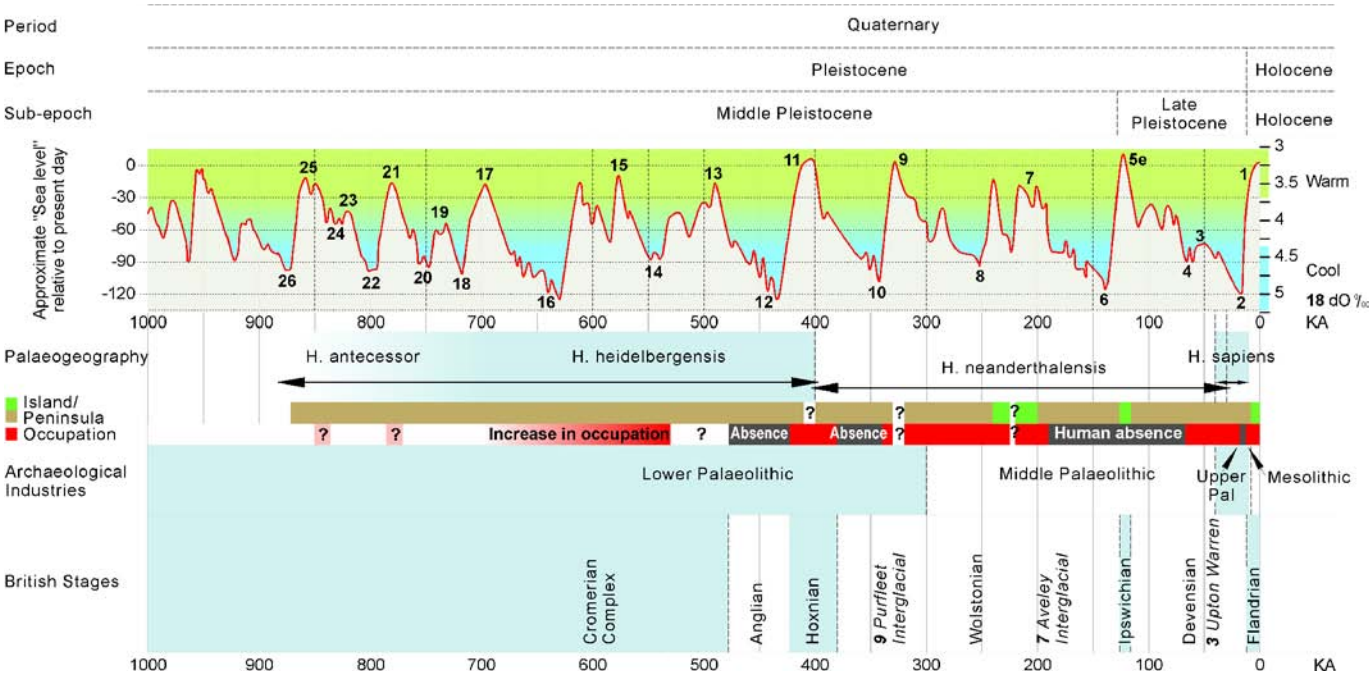
Original A4
Plot Scale
1:75,000

European Offshore Wind Deployment Centre

Site location

Layout	By	Date	Rev	Dwg No.
LABER039	KB	03/05/2011	B	6129-530-PW-001

Figure 1



(Incorporating Lisiecki & Raymo, 2005 doi:10.1029/2004PA001071)

Datum: WGS84
Projection: UTM30N

VATTENFALL

areg Aberdeen Renewable Energy Group

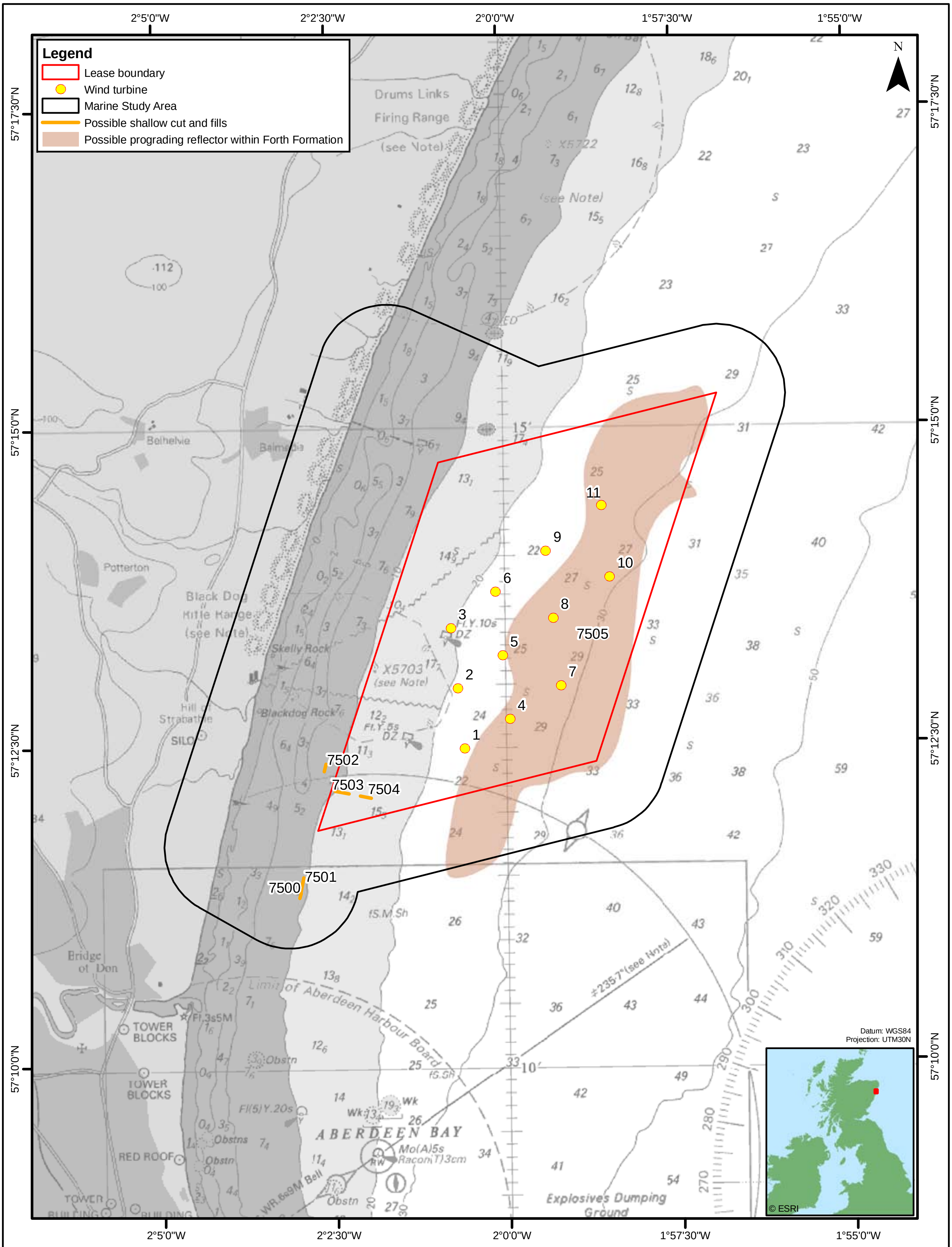
Technip

Original A4
Plot Scale
N/A

European Offshore Wind Deployment Centre

Chronostratigraphy of the British archaeological, geological records and sea level change during the last 1 million years

Layout	By	Date	Rev	Dwg No.	
LABER039	KB	03/05/2011	A	6129-530-PW-002	**Figure 2**



0 0.5 1 km

0 0.25 0.5 nm

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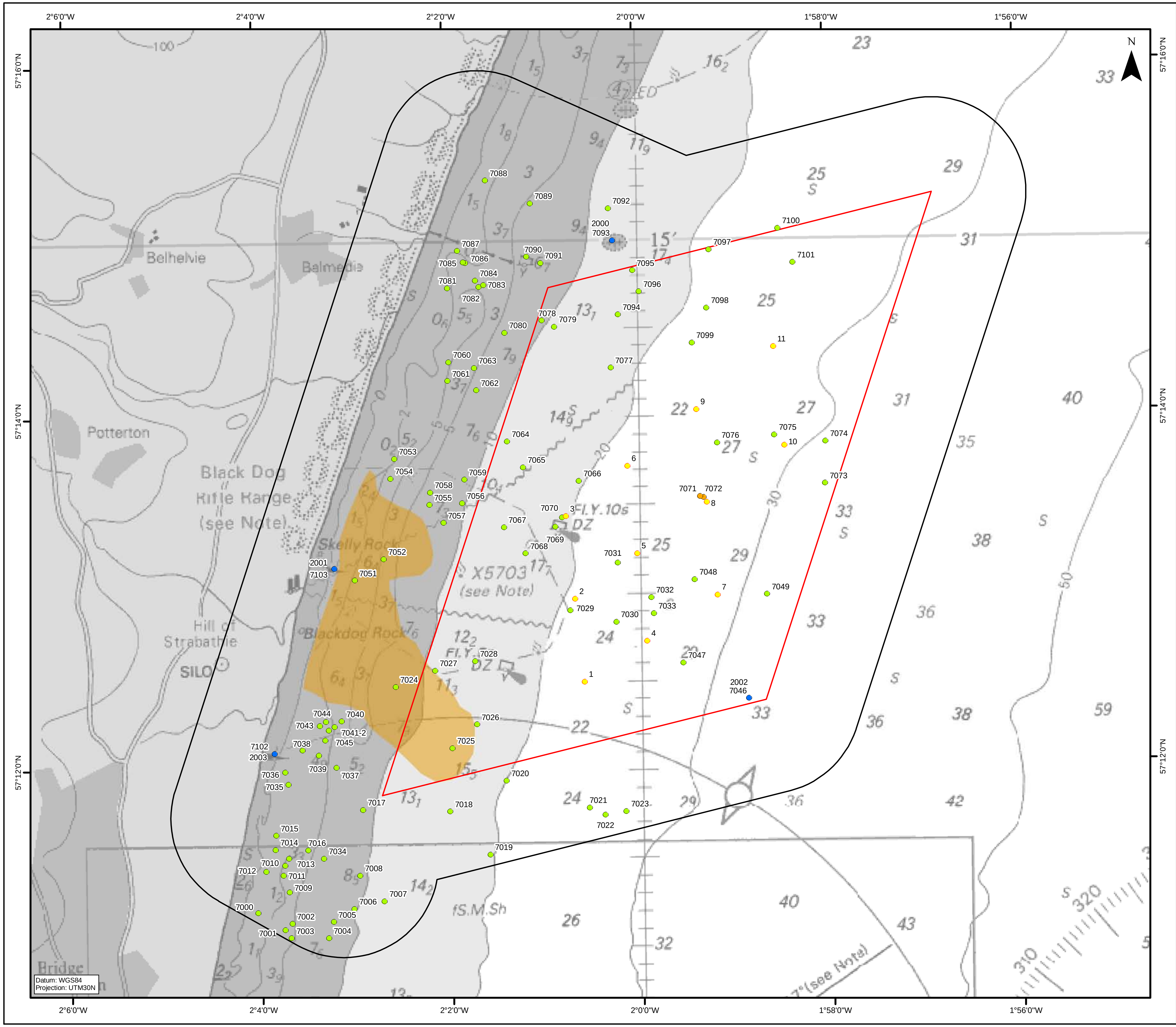
Plot Scale
1:75,000

European Offshore Wind Deployment Centre

Map illustrating the shallow geological features across the survey area

Layout	By	Date	Rev	Dwg No.
LABER039	KB	03/05/2011	B	6129-530-PW-003

Figure 3



EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 4

Wreck sites and featues as suggested by documentary sources (UKHO & SeaZone) and sites of potential archaeological interest based on geophysical assessment

Legend

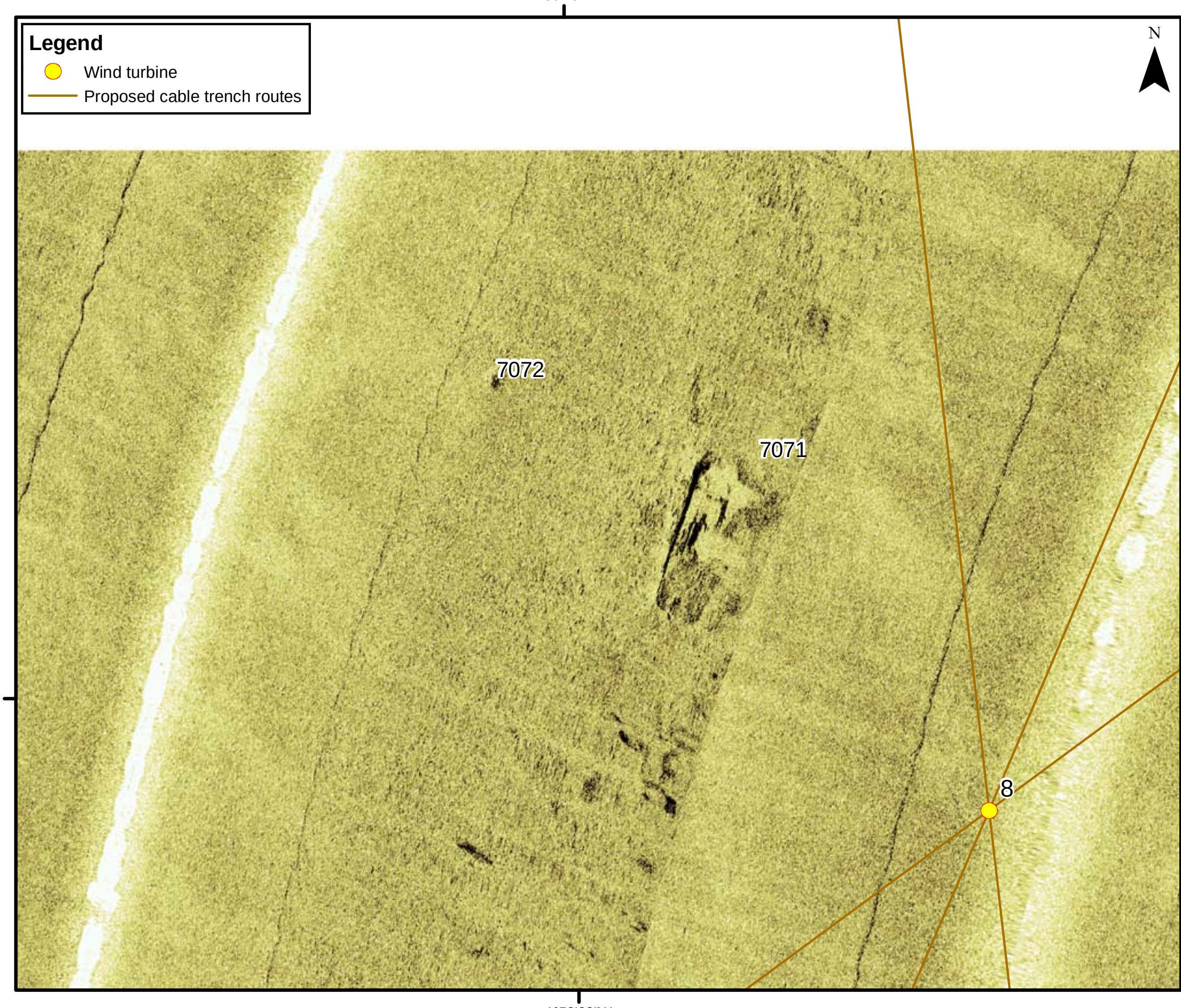
- Lease boundary
- Wind turbine
- Marine Study Area
- A1 - Anthropogenic origin of archaeological interest
- A2 - Uncertain origin of possible archaeological interest
- A3 - Historic record of possible archaeological interest
- Area of strong magnetic anomalies

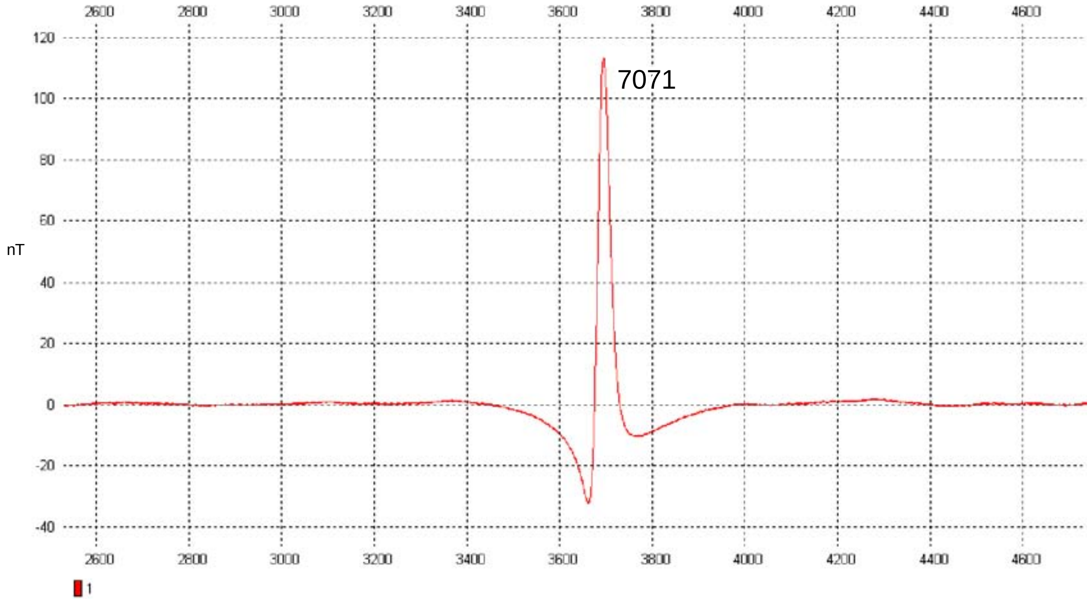
Notes
1 Do not scale

© ESRI

0 0.5 1 km 0 0.5 nm
Original A3 Plot Scale 1:40,000

Drg No	6129-530-PW-004			Figure 4
Rev	B	Date	03/05/2011	
By	KB	Layout	LABER039	





Datum: WGS84
Projection: UTM30N

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0 20 m

0 0.01 nm

Original A4 Plot Scale 1:1,000

European Offshore Wind Deployment Centre

Sidescan sonar data example and magnetometer profile illustrating wreck 7071

Layout	By	Date	Rev	Dwg No.
LABER039	KB	03/05/2011	B	6129-530-PW-005

Figure 5

18,000 BP (the last glacial maximum) | 10,000 BP (the beginning of the Holocene) | 5,000 BP (the late Mesolithic/early Neolithic)

VATTENFALL | areg Aberdeen Renewable Energy Group | Technip

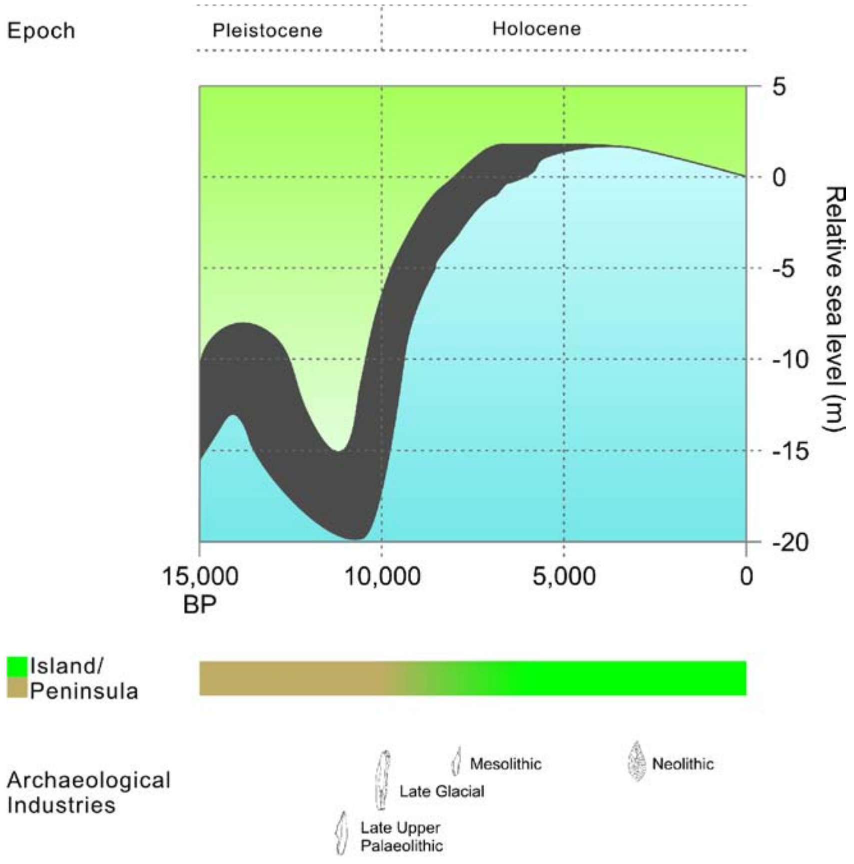
Original A4
Plot Scale
N/A

After Coles, 1998.
Jarvis A., H.I. Reuter, A. Nelson, E. Guevara, 2008, Hole-filled seamless SRTM data V4, International Centre for Tropical Agriculture (CIAT), available from http://srtm.csi.cgiar.org.

European Offshore Wind Deployment Centre

Palaeogeography of Britain

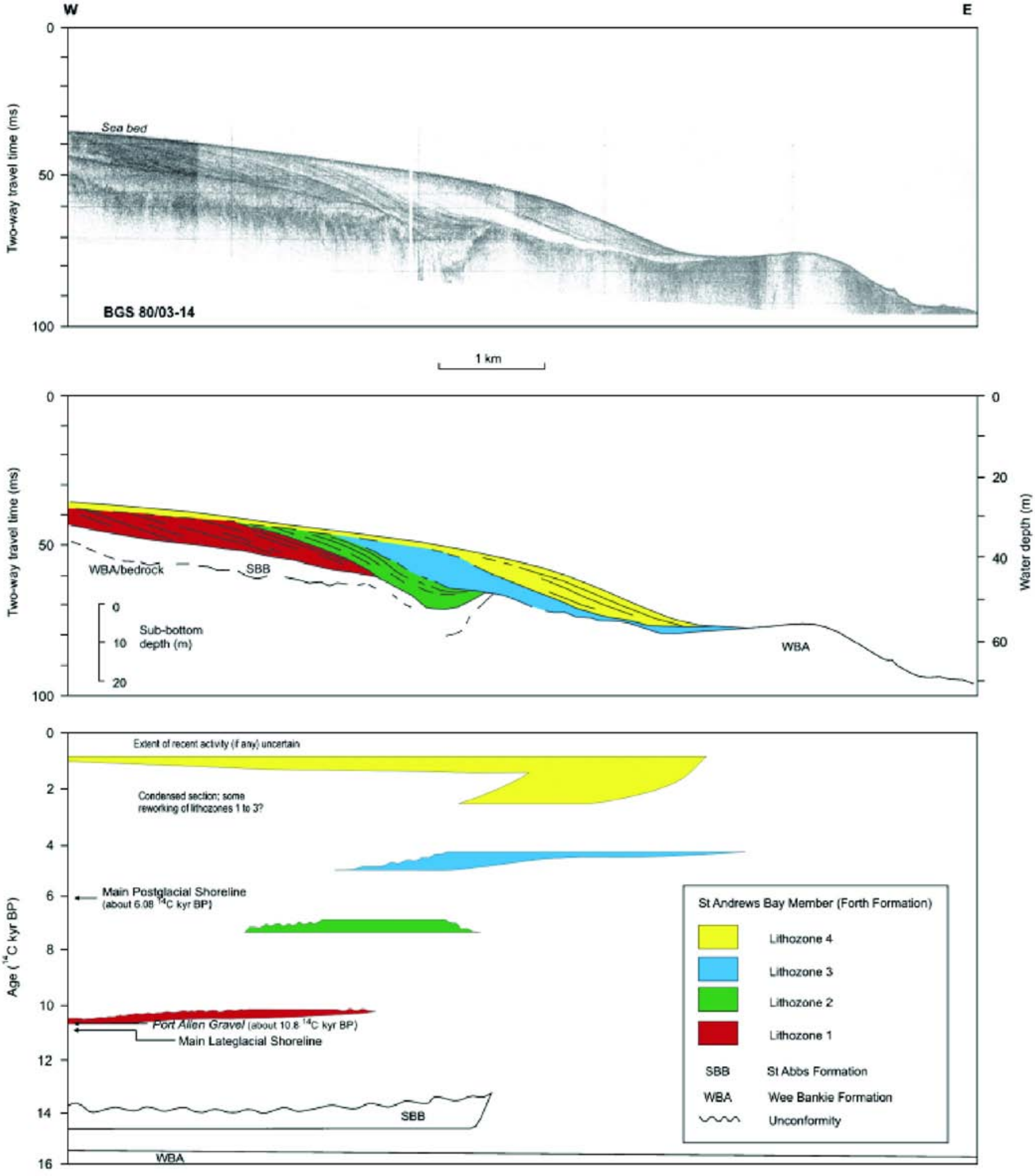
Layout	By	Date	Rev	Dwg No.	
NA	KB	03/05/2011	B	6129-530-PW-006	**Figure 6**



Adapted from Shennan and Horton, 2002, and Stoker *et al*., 2008

VATTENFALL areg Aberdeen Renewable Energy Group Technip	Original A4 Plot Scale N/A Adapted from Shennan and Horton, 2002, and Stoker *et al*., 2008 © Aberdeen Wind Deployment Centre Limited 2011	**European Offshore Wind Deployment Centre** General scheme of post-glacial relative sea-level in north-east Scotland

Layout	By	Date	Rev	Dwg No.	
NA	KB	03/05/2011	B	6129-530-PW-007	**Figure 7**



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Plot Scale
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Stoker *et al*., 2008

European Offshore Wind Deployment Centre

Post-glacial lithozones of the St Andrews Bay member of the Forth Formation (Stoker *et al*., 2008)

Layout	By	Date	Rev	Dwg No.
NA	KB	03/05/2011	A	6129-530-PW-008

Figure 8

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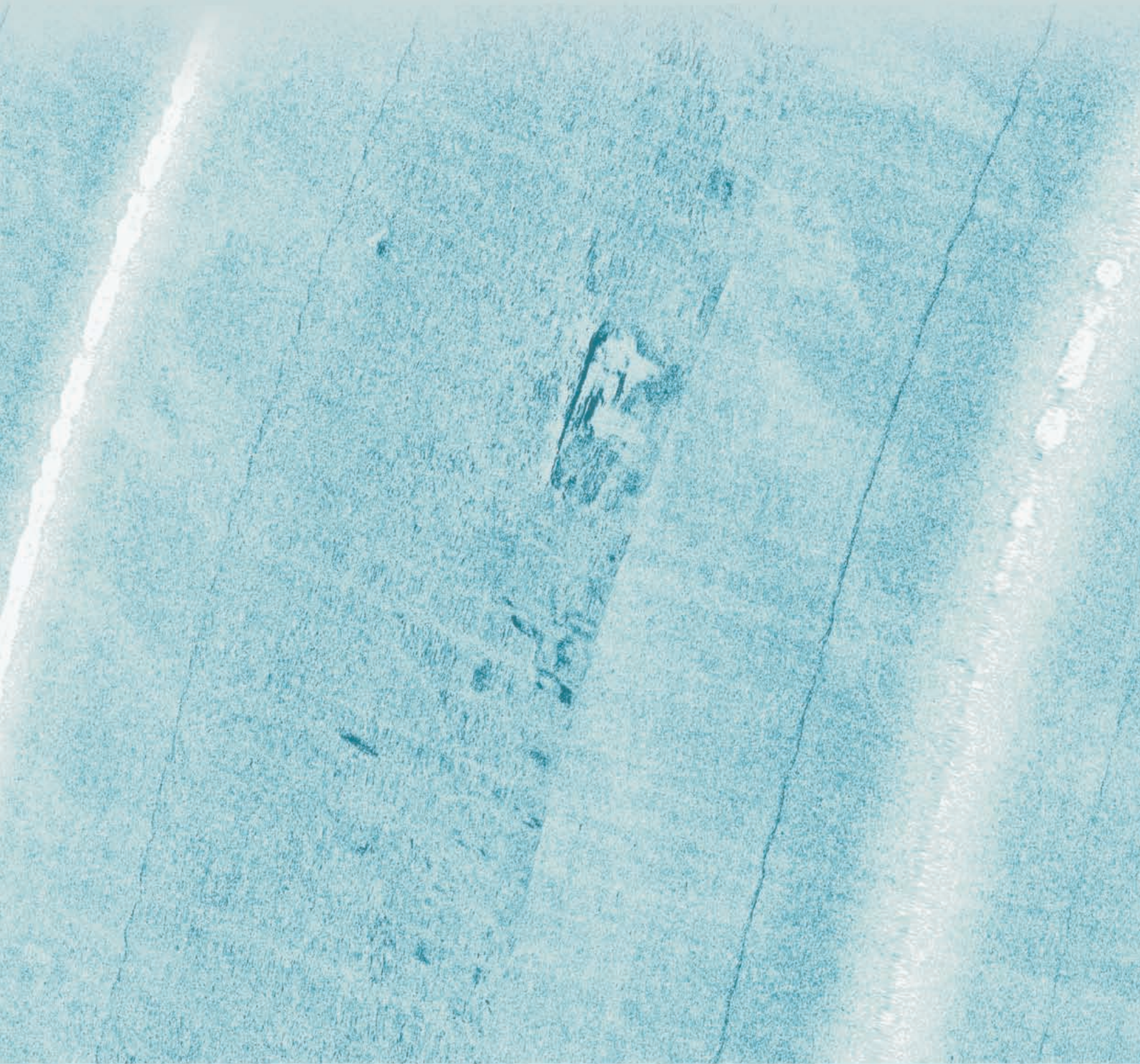
European Offshore Wind Deployment Centre
Environmental Statement

Appendix 18.2: Marine and Maritime Archaeology EIA Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

Wessex Archaeology

European Offshore Wind Deployment Centre: Impact Assessment



Ref: 65391.15

June 2011

Wessex Archaeology

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE: IMPACT ASSESSMENT

TECHNICAL REPORT

65391.15

Prepared for:

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June 2011

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE: IMPACT ASSESSMENT

TECHNICAL REPORT

65391.15

Title:	EOWDC impact assessment
Principal Author(s):	Dr Andrew Bicket
Managed by:	Dr Jonathan Benjamin
Origination date:	7 March 2011
Date of last revision:	7 June 2011
Version:	65391.15
Wessex Archaeology QA:	Euan McNeill, Candice Hatherley
Status:	Final
Summary of changes:	Client comments addressed
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Client Approval:	

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE: IMPACT ASSESSMENT

TECHNICAL REPORT

65391.15

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Data was provided by the United Kingdom Hydrographic Office (UKHO), Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) and Aberdeenshire Sites and Monuments Record (SMR). The geophysical data was provided by EMU Ltd (2007) and Osiris Projects (2010).

Wessex Archaeology is grateful to the staff of all the above organisations for their co-operation during the project.

Dr Andrew Bicket produced this report. David Howell and Patrick Dresch processed and reviewed the geophysical data and further contributed to the report. Kitty Brandon prepared the illustrations. Dr Jonathan Benjamin managed the project for Wessex Archaeology, and quality assurance was conducted by Euan McNeill and Candice Hatherley.

Data Licences

Contents:

Figures:

Tables:

1 MARINE & MARITIME ARCHAEOLOGY

1.1 Information for the Non-Technical Summary

1 Impacts to marine and maritime cultural heritage receptors have been assessed for the proposed European Offshore Wind Deployment Centre (EOWDC). Primary direct impacts relate to the construction, operation and decommissioning phases of wind turbine foundations and inter-array and export cable routes. Indirect impacts may derive from changes to the seabed produced by direct impacts. Secondary impacts are likely to be restricted to the seabed footprint of vessels involved in all phases of development.

2 Cultural heritage receptors in the Marine Study Area (MSA) have been grouped under three themes, based on the known and potential cultural heritage resource discussed in the baseline technical report (Wessex Archaeology 2011) – Prehistoric Archaeology; Maritime Archaeology and Aviation Archaeology. Under these themes, several receptors have been identified; these are outlined in Table 1.

3 Each archaeological feature is unique. Importance varies and may not be well understood; although they can still be assessed in terms of the general wreck resource or, in terms of prehistory, the regional potential for prehistoric material and the likely presence of sediments which may contain them.

4 Without mitigation, impacts upon these receptors, especially *known wreck sites*, are likely to be adverse and permanent. With mitigation adverse impacts may be avoided and/or their effects reduced. Adverse impacts relating to the damage and disturbance of heritage assets have been identified primarily with respect to the unidentified wreck (WA 7071) which lies in close proximity to Wind Turbine 8 and with respect to the associated potential inter-array cable routes between wind turbines (Figure 1).

5 Adverse impacts to prehistoric archaeology receptors are likely to be of *moderate* significance. Following mitigation this is likely to be significantly reduced and adverse impacts are likely to be of *minor* significance.

6 Avoidance, where practicable, is the preferred mitigation strategy for known cultural heritage assets (Wessex Archaeology 2007).

7 There is the potential to encounter currently unknown and unidentified cultural heritage assets in the Marine Study Area (MSA) (defined in the archaeological baseline technical report prepared by Wessex Archaeology for Aberdeen Offshore Wind Farm Ltd, 2011). The geophysical survey has identified several anomalies which may be man-made or natural features. Strategies have been proposed to mitigate adverse impacts to these receptors.

8 Research, particularly the geoarchaeological examination of vibrocores and grab samples from sub-seabed sediments taken for engineering purposes provides a cost-effective opportunity to directly investigate the age and archaeological potential of sub-seabed sediments of potential prehistoric archaeological importance. The integration of this kind of geoarchaeological analysis early in the sequence of development activities is advisable to provide the most effective mitigation strategy (Gribble and Leather 2011).

9 Monitoring may be achieved through remote means such as geophysical or ROV surveys. In addition, the Crown Estate has recently published a reporting protocol for finds from offshore renewable developments (The Crown Estate/Wessex Archaeology 2010). Best-practice and effective monitoring may be partly achieved by implementing this protocol. Added value will also be provided to the National Monuments Record.

1.2 Introduction

10 The baseline conditions for the Cultural Heritage Receptors assessed in this report have been reported in the Baseline Technical Report (Wessex Archaeology 2011, report ref: 65391.02).

11 This Impact Assessment should be read in conjunction with the Baseline Technical Report (Wessex Archaeology 2011).

12 The objectives of this impact assessment, in line with existing guidance (Wessex Archaeology 2011, and summarised in section 1.2.1), are to:

- Summarise the adverse and beneficial impacts of the development that are relevant to the submerged archaeology of the area, including
  - Direct
  - Indirect
  - Secondary
  - Cumulative Effects
- Summarise the sensitivity of the archaeological heritage that may be impacted by the development
- Assess the magnitude and scale of impacts on the archaeological heritage of the identified impacts
- Comment on the significance of effects upon the archaeological heritage
- Propose mitigation measures to remove or reduce significant adverse impacts

13 In-combination Effects, in this case, are not applicable to cultural heritage assets, and only apply to European sites associated with the EU Habitats Directive.

1.2.1 Key Guidance Documents

- The Code of Practice for Seabed Developers, Joint Nautical Archaeology Policy Committee 2006 (JNAPC 2006)
- Historic Environment Guidance for the Offshore Renewable Energy Sector, COWRIE 2007 (Wessex Archaeology 2007)
- Guidance for Assessment of Cumulative Impacts on the Historic Environment; from Offshore Renewable Energy, COWRIE 2008 (Oxford Archaeology & George Lambrick Archaeology and Heritage 2008)
- Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector. (Leather & Gribble/COWRIE 2011)
- Protocol for Archaeological Discoveries: Offshore Renewables Projects, The Crown Estate, 2010 (TCE, Wessex Archaeology 2010)

1.2.2 Data Information and Sources

- Archaeological records for the MSA available in the maritime section of the CANMORE database held by the Royal Commission for Ancient and Historic Monuments Scotland (RCAHMS) which constitute the National Monuments Record for Scotland (NMRS), also interrogated via a map interface, CANMAP
- Archaeological records for the MSA held locally in the Aberdeenshire, Moray and Angus Sites and Monuments Record (SMR)
- Records of wrecks and obstructions collated by the UK Hydrographic Office (UKHO)
- Records of Protected Places and Controlled Sites provided by the Ministry of Defence
- SeaZone datasets including basemapping and wreck information (derived from UKHO records)
- British Geological Survey (BGS) mapping and UKHO charts
- Various secondary sources relating to the palaeo-environment of the area and to the Palaeolithic and Mesolithic archaeology of Northern Europe
- Secondary sources relating to wrecks and the maritime environment and the history and archaeology of Aberdeen and its surrounding area
- Other readily available published sources

1.2.3 Impact Assessment Methodology

1.2.3.1 Cultural Heritage Receptors

14 In order to provide a targeted impact assessment, the cultural heritage receptors in the MSA have been grouped under three themes, based on the known and potential cultural heritage resource discussed in the baseline technical report (Wessex Archaeology 2011) – Prehistoric Archaeology; Maritime Archaeology and Aviation Archaeology. Known and potential receptors are outlined in Table 1.

Table 1: Cultural Heritage Receptors Defined for the MSA

Prehistoric Archaeology	Maritime Archaeology	Aviation Archaeology
Post-glacial submerged landscape features & fills	Known wreck sites	Unknown aircraft crash sites
Isolated prehistoric sites & finds	Unknown wreck sites	

15 Each archaeological feature is unique. Importance varies and it may not be possible to accurately assess importance given the available data; although the importance of each receptor can still be assessed in terms of the ‘potential’ for encountering them relative to baseline conditions (Wessex Archaeology 2011). This may be examined in relation to the general wreck resource or, in terms of prehistory, the regional potential for prehistoric material and the likely presence of sediments which may contain them (Wessex Archaeology 2011).

1.2.3.2 Criteria for Assessing Significance of Impact

16 The criteria that will be used in the impact assessment are summarised below:

Spatial Extent of Effect

17 The terms used in the impact assessment are:

- national/international effect
- a regional effect
- a local effect (within 5 km of the site)
- a site-specific effect

Duration of Effect

18 The terms used in the impact assessment are:

- long-term / permanent effect (more than 10 years)
- medium-term effect (existing for 5 to 10 years)
- short-term effect (existing for 1 to 5 years)
- temporary effect (existing for less than a year)

Recoverability of the Receptor

19 Generally impacts have adverse effects upon archaeological materials but some effects can be beneficial. The terms used in the impact assessment for receptor recoverability are:

- High
- Medium
- Low or
- None

20 Cultural heritage receptors are a finite non-renewable resource, they cannot recover following adverse impacts upon them, such as substrate removal and physical damage. The security of the context in which they are found is also a key factor in assessing their value and importance. Therefore against adverse effects, recoverability will be low to none.

Importance of the Receptor

21 Archaeological importance is gauged on the extent, rarity and perceived significance of the resource. For example, finds of Mesolithic and Palaeolithic age are rare compared to material from more recent archaeological periods. As a result they are likely to be of national to international importance (e.g. Parfitt *et al*. 2010; Ballin *et al*. 2010).

22 In contrast, vessels from the 20th century are relatively numerous and well-recorded therefore their archaeological importance may be lower. However, such wrecks may be significant for other reasons such as wartime importance (e.g. protected under the Protection of Military Remains Act (PMRA 1986) or technological advances.

23 There may also be significant local, regional and national importance associated with vessels that were lost with their crew (e.g. the Solway Harvester). http://news.bbc.co.uk/1/hi/scotland/south_of_scotland/8448887.stm

24 The terms used in the impact assessment are summarised within the definitions of Table 2.

1.2.3.3 Assessment of Significance

Sensitivity of the Receptor

25 Assessment of the sensitivity of the cultural heritage receptors is guided by the definitions in Table 2 developed from COWRIE guidance (Wessex Archaeology 2007, COWRIE 2008). Cultural heritage receptors may also be important for other reasons such as wartime history (e.g. protected under PMRA 1986).

26 Where the archaeological importance or sensitivity is unknown or cannot be clearly defined (e.g. for unknown distributions of prehistoric archaeological materials or unidentified wrecks), a precautionary approach is taken and the receptors' archaeological potential is assessed.

Table 2: Sensitivity of Receptors – Definition of terms (adapted from Wessex Archaeology 2007, COWRIE 2008).

Sensitivity	Definition
Very High	Feature of International Importance OR best known example and/or significant potential to contribute to knowledge and understanding and/or outreach
High	Feature of National Importance OR above average example and/or high potential to contribute to knowledge and understanding and/or outreach
Medium	Feature of Regional Importance OR average example and/or moderate potential to contribute to knowledge and understanding and/or outreach
Low	Feature of Local Importance OR below average example and/or low potential to contribute to knowledge and understanding and/or outreach

27 For some cases, a *negligible* significance of impact may be surmised in association with Table 4. In relation to cultural heritage assets this would be defined as a "poor example and/or little or no potential to contribute to knowledge and understanding and/or outreach".

Magnitude of Effect

28 The magnitude of effect is assessed relative to the worst realistic case where possible (see section 1.2.4) and the impact of development upon specific or regional cultural heritage assets relative to baseline conditions. The terms are defined in Table 3.

Table 3: Magnitude of Effect – Definition of terms (adapted from Wessex Archaeology 2007, COWRIE 2008).

Magnitude	Definition
Very High	Total loss or very major alteration to key elements/features of the baseline conditions such that post development character/composition/attributes will be fundamentally changed and may be lost from the site altogether.
High	Major alteration to key elements/features of the baseline (pre-development) conditions such that post development character/composition/attributes will be fundamentally changed.
Medium	Loss or alteration to one of more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns.
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the 'no change' situation.

29 Based upon these criteria a judgment on the receptors' sensitivity (Table 2) and the magnitude of effect (Table 3) is made. The significance of impact is guided by the matrix shown in Table 4.

Table 4: Matrix for Significance of Impact

		Sensitivity of Receptor			
		Very High	**High**	**Medium**	**Low**
Magnitude of Effect based on spatial, duration and scale of effect	**Very High**	Major	Major	Major	Moderate
	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

1.2.3.4 Cumulative and In-combination Impact Assessment Methodology

30 Aspects of development activities within the proposed EOWDC in conjunction with other activities and development projects in the region may create cumulative impacts upon cultural heritage receptors.

31 Several offshore activities within the region are considered under cumulative impacts, external or adjacent to the current proposed EOWDC development. A proposed application for an ocean laboratory to the south of Wind Turbine 1 is also discussed. Developments considered include:

- Other offshore wind developments
- Ocean Laboratory, EOWDC
- Maritime and Coastguard Agency designated anchorage area
- Commercial fisheries activity
- Subsea cables
- Port/harbour dredging operations

32 Where possible a brief statement of the nature of the cumulative impacts is made. Recent or future developments are likely to require undertaking EIA and the development of mitigation strategies. These processes in many cases will aid the reduction or avoidance of adverse impacts to cultural heritage assets.

33 In-combination effects, in this case, are not applicable to cultural heritage assets only to European sites associated with the EU Habitats Directive.

1.2.4 Worst Realistic Impact

34 The exact specification of the wind turbines has not been established at this time and a variety may be used. A maximum specification is used to examine the worst case scenario.

35 With respect to cultural heritage receptors within the MSA, the worst realistic impact would derive from activities producing the greatest spatial extent of seabed disturbance and greatest volume of seabed and sub-seabed sediment removal.

Impacts from Cable Trenching

36 As outlined in the Rochdale envelope for the proposed development, cable installation involving ploughing of up to 3 m depth and 10.38 m width would induce the greatest disturbance to the seabed (up to c. 202,500 m^3 depending upon configuration of cable network and method used) and it is considered that the proposed cable trenches have the greatest potential for impacts upon unknown cultural heritage assets.

37 Up to four export cables routes are proposed. Between the designated anchorage and Blackdog rifle range exclusion zones the area for routing these export cable trenches is constrained to a corridor roughly 250 m wide. If all four export cable trenches are excavated the relative area of seabed and sub-seabed sediments under disturbance will be intensified in this area.

38 Not all possible routes for inter-array cabling will be installed. This will enable mitigation through avoidance of cultural heritage assets or micro-siting of wind turbines and therefore the associated inter-array cable routes.

Impacts from Wind Turbine Foundations

39 Depending upon the type of wind turbine foundation used impacts upon the seabed and sub-seabed sediments will vary. The most horizontally-extensive (giving the largest seabed disturbance) wind turbine foundation proposed is a gravity base structure of up to 40 m in diameter. This base can also extend to depths of up to 2 m, so there is a high potential for unknown and buried cultural heritage receptors within this footprint to be adversely affected.

40 Seabed preparation may be required for construction of gravity base foundations which would involve groundworks to the seabed beneath the proposed location by dredging seabed sediments, partly to provide ballast for the gravity bases themselves. Any archaeological or palaeoenvironmental assets within sediment affected by this process would be lost or damaged.

41 In addition, an unknown width of scour protection (dumped aggregates) may also be deposited around the foundation footprint of wind turbine foundations increasing the area of effect further. The volume and extent of this scour protection will ultimately depend on local hydrographic conditions. Cultural heritage assets within

these footprints are likely to be adversely affected by compression under significant volumes of scour-protecting aggregates.

Vessel Footprint

42 Secondary adverse impacts from vessel footprint are also an important consideration, during all phases of the project. If during construction, operation and decommissioning vessels jack-up on legs or anchor to the seabed, either directly onto cultural heritage assets or their protective, sedimentary overburden, then the asset or its archaeological context may be significantly damaged or destroyed within this footprint.

Changes to Seabed Sediment Distribution

43 The prevailing wind and tide directions suggest that cultural heritage receptors in the lee of wind turbine foundations (i.e. sheltered) could be exposed to turbulence and scour produced by water flow around the foundations, removing protective sediment cover and deleteriously affecting the condition of cultural heritage receptors.

1.3 Impact Assessment

44 Cultural heritage receptors are a finite resource, they cannot recover following adverse physical impacts upon them and the security of the context in which they are found is critical to their value and importance. Generally impacts will be adverse in nature upon archaeological materials, but some impacts can be beneficial (Table 5). For example, indirect adverse impacts may manifest as scour around wreck sites created by turbulence induced by changes to water flow around wind turbine foundations leading to adverse effects from erosion (Table 5). In the case of sediment plumes created during trenching for cabling (or other disturbance to the seabed where sediments are entrained in the water column), when they resettle they can provide additional protection to archaeological materials. Clearly this action can not be easily quantified and does not imply direct or comparable mitigation of adverse impacts.

45 With respect to the MSA and cultural heritage receptors in marine contexts, only the impacts to resources on the seabed are considered here, i.e. the specifications of the wind turbine foundations, cable trenching methodologies and secondary impacts from vessels will be the critical factors for assessing impacts, not the above-water configuration of wind turbines.

46 The nature of impacts upon cultural heritage receptors can be seen to derive from two main activities during the lifetime of the proposed development. Impacts will derive from:

- inter-array and export cabling installation; and
- wind turbine foundation installation

47 Impacts from the installation of the inter-array and export cabling, primarily the seabed excavation aspect of the process, are likely occur at shallower depths but more spatially extensive with respect to the distribution of cultural heritage receptors on or beneath the seabed.

48 Impacts from the installation of the wind turbine foundations will be more restricted to the footprint of each wind turbine with respect to the distribution of cultural heritage receptors.

49 Depending upon the wind turbine foundation types ultimately used, pile foundations will have a smaller lateral footprint but will be considerably deeper than a shallower but wider gravity base structure (GBS). GBS foundations are regarded as the worst case scenario and form the focus of the impact assessment (see section 1.2.4). Adverse impacts are likely to be similar within the footprint of pile foundations but penetrate to a greater depth of seabed sediment. As the archaeological importance of the seabed sediment cannot be accurately assessed with the available data, the assessment of pile-driven wind turbine foundations is not developed further and general statements of impact are made within units of sediment of archaeological potential are made.

50 Secondary impacts from the seabed footprint of attending vessels are also likely to occur during construction, operation and decommissioning of the development. Secondary impacts are likely to interact with the seabed and shallow sub-seabed sediments in localised areas by jack-up legs and/or anchoring. Depending upon the methods used, any cultural heritage assets under this footprint are likely to be significantly and adversely impacted. It is not possible to accurately predict exactly where these impacts will affect the seabed at this time.

51 There is also scope for the construction of an Ocean Laboratory to the south-west of Wind Turbine 1. This will be applied for via a separate consent application but this will be considered under cumulative impacts (Figure 1 and 2).

52 The impacts upon cultural heritage receptors considered in this assessment are summarised in Table 5.

Table 5: Summary of the Nature and Type of Impacts

Impact	Nature of Impact	Type of Impact
Direct damage to both *in situ* cultural heritage assets and assets in secondary contexts	Adverse	Direct
Disturbance of relationships between structures, artefacts and their surroundings or contexts	Adverse	Direct
Destabilisation and erosion of sites through changes to seabed characteristics	Adverse	Indirect
Burial of sites due to re-deposited sediment, potentially protecting and promoting the favourable preservation of cultural heritage receptors	Beneficial	Indirect

1.3.1 Impacts on Submerged Prehistoric Archaeology

1.3.1.1 Construction & Decommissioning Phase

Potential Impacts

- Adverse, direct damage to both *in situ* cultural heritage assets and assets in secondary contexts
- Adverse, direct disturbance of relationships between structures, artefacts and their surroundings or contexts
- Adverse, indirect destabilisation and erosion of sites through changes to seabed characteristics
- Beneficial, indirect burial of sites due to re-deposited sediment, potentially protecting and promoting the favourable preservation of cultural heritage receptors

Secondary Impacts

- Produced by vessel footprints; direct, adverse impacts will also affect cultural heritage receptors in association with cable trenching. Jack-up legs and/or anchoring may also impact adversely upon cultural heritage receptors on or shallowly buried under, the seabed through physical damage

53 During decommissioning the cable routes will primarily be buried and/or cut and left *in situ*. In some cases it may be necessary to remove cables which would be done involving excavation of the cable route by similar methods to the construction phase. Assuming that the same area of seabed that was impacted during the laying of the cables in the construction phase was excavated to remove a cable then the impacts to cultural heritage receptors would already have taken place. However, there may be secondary impacts from the vessel footprint from jack-up legs or anchoring in surrounding areas of seabed not previously affected.

54 During decommissioning wind turbine foundations are to be cut and/or craned from the seabed. Assuming that this does not disturb additional areas of seabed out with that affected by construction activities, adverse impacts may be restricted to secondary impacts from vessel footprints.

Post-glacial Submerged Landscape Features & Fills

55 There are currently no known prehistoric artefacts or sites recorded from below Mean Low Water Spring (MLWS) in the MSA (Wessex Archaeology 2011).

56 For clarity, Table 6 from the baseline technical report (Wessex Archaeology 2011) is included here for reference:

Unit	Description
1	Recent (Holocene) seabed sediments, silty sand.
2	Late Devensian / Early Holocene fluvio-deltaic and marine sands (Forth Formation (FH), St. Andrew's Bay Member)
3	Late Devensian Till (Wee Bankie Formation)
4	Devonian Bedrock (Old Red Sandstone)

57 Unit 4 is bedrock and therefore is not considered to be of archaeological interest. There may be potential for encountering older archaeological material of Devensian age in secondary contexts which has been reworked from terrestrial contexts into Unit 3 (Wee Bankie Formation) sediments. However, because the Unit 3 sediments are glacial in origin the potential to encounter archaeological material of Devensian age is regarded as being low to negligible.

58 In general terms the upper, and lower extent of Unit 2 in the region of the proposed wind turbine locations, is in at least 20m of water. The proposed Wind Turbine locations 1 – 3 are located close to the 20 m bathymetric contour, with the rest of the proposed wind turbine locations in progressively deeper water to the east (up to *c.* 30 m bathymetric contour). Groundworks and construction activity required for the installation of the wind turbine foundations will have an additional footprint that may impact the seabed out with the footprint of the wind turbines themselves. Unit 2 sediments will be locally affected by this activity; the magnitude of the impact will be partly dependent upon the method of foundation construction.

59 In the very early Holocene, c. 10,000 BP, the positions of the westernmost wind turbines (1, 2, 3, 5, 6 and 9) may have been in, or close to, the inter-tidal zone, with the remaining wind turbines in increasingly offshore positions moving east. Sub-seabed feature WA_7505 represents a prograding series of sedimentary units. Sea level models from the region suggest that the bathymetry of this feature would have been submerged by around 10,000 BP (Wessex Archaeology 2011: Figure 7) which focuses the potential for archaeological materials roughly landwards of, and in the vicinity of the 20m bathymetric contour. Incorporating estimates of isostatic readjustment from the same sea level dataset suggests that land uplift in north-east Scotland is around 0.5 mm/yr (Gehrels 2010) which is equivalent to sediments undergoing 2.5 m of uplift from their initial position in 5,000 years which would go some way to juxtapose the depth of Unit 2 beneath more recent Unit 1 seabed sediments and using modern bathymetry as a reference point for archaeological palaeo-landscapes potential.

60 This palaeogeographical relationship indicates a reduced potential of directly impacting upon submerged archaeological landscapes that may be preserved in the vicinity of the proposed wind turbine locations within the context of the currently known period of human activity in Scotland. This potential is constrained by Holocene relative sea level modelling, isostatic readjustment and the sediments of Unit 2 and which are comparable to the St Andrews Bay Member of the Forth Formation. In addition, construction, operation and maintenance, and decommissioning impacts from associated activities such

as the footprints of vessels servicing the wind turbines and cable trenching will extend landward into areas of higher potential.

61 Five shallow geological cut and fill features were also identified (WA 7500 – 7504) during the geophysical assessment (Wessex Archaeology 2011). These features are concentrated in the south-west of the MSA and may be small, isolated infilled basins (as they do not appear on adjacent survey lines). There is some potential for archaeological material (perhaps in secondary contexts) to be found within them, but this is likely to be low. Unless directly impacted by export cabling routes, impacts to these palaeolandscape features by the development are likely to be negligible.

62 As Unit 2 deposits underlie much of the MSA and may be adversely affected by the export cables, they are potentially of high value as they form the primary sedimentary resource for preserving *in situ* early prehistoric (of Mesolithic and perhaps Upper Palaeolithic age) archaeological assets. Without further evidence clarifying the age of these sub-seabed sediments and an assessment of their archaeological contents (if present and preserved), a more detailed statement of importance is not currently possible.

63 Locally, the effect of potential sediment removal during cable installation (see section 1.2.4 for worst case) could have a major adverse impact if Unit 2 sediments are affected. However, across the development as a whole, this will be restricted to a relatively small area in the vicinity of development activities.

64 Encountering *post-glacial submerged landscape features and fills* during wind turbine foundation installation is restricted by the potential for the westernmost wind turbines to overly a previously inter-tidal zone as suggested by Holocene sea level models and palaeogeographical literature (Wessex Archaeology 2011). The scale of the impact is judged to be medium for these cases, restricted to a site-specific spatial extent. Importance cannot currently be assessed and is therefore, medium.

65 The redistribution of sediment from development activities is likely to be a beneficial impact as the protective covering of sediment is slightly increased where sediment settles out from the water column.

66 The potential impact has been assessed of **medium** magnitude, **high** sensitivity and of ***moderate*** significance.

Isolated Prehistoric Sites & Finds

67 As discussed in the archaeological baseline report for the proposed EOWDC (Wessex Archaeology 2011), there is potential for encountering isolated, chance finds of lithic scatters and other prehistoric archaeology associated with Unit 2 sediments across the MSA, and also remobilised finds in secondary contexts within the seabed sediments deriving from coastal geomorphology.

68 Within the context of the post-glacial sea-level change and associated palaeo-geography of the MSA, this potential is likely to be focused in the coastal shelf region to the west of the proposed wind turbine locations in less than 20 m of water. The route of the export cabling (a maximum of four export cables are proposed) will therefore be an important factor for assessing the impacts on cultural heritage receptors in the MSA. Unit 2 sediments are

extensively preserved across the MSA in varying thickness, beneath around 1 m of seabed sediment.

69 Although seafloor disturbance is likely to be shallow, if cable trenching and wind turbine bases interacted with Unit 2 sediments there would be a localised, major adverse impact. The depth of the cable would be between 0.6 m and 3 m. Therefore, where cable installation groundworks remove more than *c.* 1 m vertical depth of seabed sediment there is a greater potential that sediments of potential prehistoric archaeological significance will be adversely affected.

70 There is potential for encountering isolated prehistoric finds but the distribution of such material cannot currently be assessed. As a result the scale of impact is described as medium as a precaution. This receptor is primarily associated with Unit 2 sediments (Wessex Archaeology 2011) that may be adversely impacted by wind turbine foundation activities, their spatial extent is across most of the MSA, and is therefore of local-scale.

71 Under current proposals cable routes would be left *in situ* after decommissioning, with maintenance and exposed connections made safe. The significance may be reduced as impacts would already have occurred during the construction phase. Secondary impacts from vessel footprints on the seabed would be the main impact to cultural heritage assets.

72 The redistribution of sediment from development activities is likely to be a beneficial impact as the protective covering of sediment is slightly increased where sediment settles out from the water column.

73 The potential impact has been assessed of **medium** magnitude, **medium** sensitivity and therefore of ***moderate*** significance.

Table 6: Summary of Significance of adverse impacts upon prehistoric archaeology receptors.

Theme	**Receptor**	**Spatial Extent of Effect**	**Duration of Effect**	**Recoverability of the Receptor**	**Importance of the Receptor**	**Sensitivity of the Receptor**	**Magnitude of Effect**	**Significance of Impact**
Prehistoric Archaeology	Post-glacial submerged landscape features & fills	Site-specific to Local	Permanent	None	Medium	Medium	High	**Moderate**
	Isolated prehistoric sites & finds	Local	Permanent	None	Medium	Medium	Medium	**Moderate**

Table 7: Summary of Significance of beneficial impacts upon prehistoric archaeology receptors.

Theme	Receptor	Spatial Extent of Effect	Duration of Effect	Recoverability of the Receptor*	Importance of the Receptor	Sensitivity of Receptor	Magnitude of Effect	Significance of Impact
Prehistoric Archaeology	Post-glacial submerged landscape features & fills	Site-specific to Local	Temporary to long-term	-	Medium	Low	Low	Negligible
	Isolated prehistoric sites & finds	Local	Temporary to long-term	-	Medium	Low	Low	Negligible

* For beneficial impacts such as sediment redeposition settling from the water column onto cultural heritage receptors (Table 5), recoverability is not applicable.

Mitigation

74 Effective mitigation and monitoring during cable trenching and wind turbine installation activities is problematic. Sediment plumes obscure the observation of impacted cultural heritage receptors. The ephemeral nature of potential archaeological materials such as Mesolithic period microliths also precludes ease of monitoring.

75 Avoidance is seen as the primary method of mitigation for offshore developments (Wessex Archaeology 2007) where this is not practicable other methods may be required. Local and national curators may request specific mitigation strategies.

76 Following geotechnical/geoarchaeological assessment of grab samples, vibrocores and other sediment samples it may be possible to gauge the potential for encountering prehistoric archaeology assets further. However, if prehistoric archaeological assets are an important feature of the impacted sub-seabed sediments, then the significance of impact may increase from the scenario described here.

77 A finds reporting protocol should be adopted in order to record any material of potential archaeological interest discovered during all phases of development activity. A protocol for offshore developments has recently been commissioned and published by the Crown Estate (The Crown Estate/Wessex Archaeology 2010). Information from reported finds serves to enhance the National Monuments Record and allows more informed and effective management of offshore cultural heritage assets for the benefit of industry, heritage and the public.

78 The potential for encountering prehistoric archaeology is likely to be restricted to the west of the proposed wind turbine locations, in less than 20m water depth. The impact of export cabling excavated through sub-seabed sediments of archaeological potential could be reduced by geoarchaeological assessment of geotechnical cores taken for engineering purposes (Gribble

and Leather 2011). This would permit a more accurate assessment of the age and archaeological potential of the sub-seabed sediments, particularly Unit 2.

79 Mitigation during construction phase would already apply in relation to the decommissioning phase.

Residual Impacts

80 After mitigation the impacts would likely be restricted to secondary impacts from vessel footprint during the decommissioning phase.

81 After mitigation the impacts would be of ***minor*** significance.

Cumulative Impacts

- **Other Offshore Wind Developments**
    - There are no other existing or planned offshore wind farm developments in the vicinity of the MSA.
- **Maritime and Coastguard Agency Designated Anchorage**
    - Abutting the MSA to the south is the MCA anchorage (Figure 1 and 2). Cumulative impacts from anchoring within this area are unlikely to impact upon buried Prehistoric Archaeology Receptors in conjunction with vessel footprints from the EOWDC project. Consultation with the Aberdeen Harbour Board has already been recommended in Scoping Opinion (Marine Scotland 2011).
- **Commercial Fisheries Activity**
    - There may be cumulative impacts in association with commercial fisheries activities that impact the seabed, such as trawling. However, more likely in this nearshore area would be inshore fisheries activities. Scoping for the development indicates some minor fishing vessel activity in the vicinity of the MSA, partially linked to the designated anchoring area or passage en-route to other areas rather than concentrated fishing activities (AOWF 2010: Figure 14).
    - It is considered that cumulative impacts are likely to be of ***low-negligible*** significance.
- **Subsea Cables**
    - Subsea cables are present within the Blackdog Rifle range exclusion zone but impacts to cultural heritage receptors from that past development are unknown and no assessment can currently be made.
- **Port/harbour Dredging Operations**
    - Dredging activities may be undertaken for the maintenance of Aberdeen Harbour to the south of the MSA. Archaeological assets are likely to have been already be removed and impacted by earlier phases of sediment removal. New areas of dredging will be required to undergo EIA and define mitigation strategies.
- **Proposed Ocean Laboratory, EOWDC**
    - The installation of an Ocean Laboratory to the south-west of Wind Turbine 1 (shown on Figure 1 and 2) would lead to cumulative impacts of a site-specific nature. Following geophysical assessment there appears to be no anomalies or known cultural heritage assets in the given location. Cumulative impacts may be of *minor* significance depending upon the type of the foundation used (spatial extent and volume of seabed sediment disturbed or removed) and cable linkages to other elements of the proposed development. Submerged landscape features associated with Unit 2 sediments

would be most affected in a similar manner to wind turbine foundation installation impacts.
- o The potential impact has been assessed of **medium** magnitude, **high** sensitivity and of ***moderate*** significance.
- o After mitigation the impacts would be of ***minor*** significance.

Monitoring

82 ROV or suitably qualified divers may provide sufficient monitoring of enacted mitigation strategies. Geophysical survey could also be applied to monitor any development in seabed scour and other impacts to prehistoric archaeology receptors.

83 Post-decommissioning, a geophysical survey is recommended to examine the condition of the seabed following the removal of infrastructure, which may largely be the wind turbine foundations as cable routes may be left *in situ*. Geophysical survey data should be reviewed by an archaeological specialist to assess cultural heritage receptors within the development area.

1.3.1.2 Operational Phase

Potential Impacts

84 Operational impacts are likely to be restricted to secondary impacts invoked by vessel footprint. Jack-up legs and/or anchoring may also impact adversely upon cultural heritage receptors on or shallowly buried under, the seabed through physical damage. The significance may be reduced as impacts would already have occurred during the construction phase.

Mitigation

85 Mitigation during construction phase would already apply (see page 16).

Residual Impacts

86 As construction and decommissioning phase (see page 17).

Cumulative Impacts

87 As construction and decommissioning phase (see page 17).

Monitoring

88 Periodic geophysical survey is recommended to review the state of the seabed following development activities. This could be undertaken in conjunction with other development requirements such as for engineering or geotechnical purposes.

1.3.2 Impacts on Maritime Archaeology

1.3.2.1 <u>*Construction & Decommissioning Phase*</u>

Potential Impacts

- Adverse, direct damage to both *in situ* cultural heritage assets and assets in secondary contexts
- Adverse, direct disturbance of relationships between structures, artefacts and their surroundings or contexts
- Adverse, indirect destabilisation and erosion of sites through changes to seabed characteristics
- Beneficial, indirect burial of sites due to re-deposited sediment, potentially protecting and promoting the favourable preservation of cultural heritage receptors

Secondary Impacts

- Produced by vessel footprints; direct, adverse impacts will also affect cultural heritage receptors in association with cable trenching. Jack-up legs and/or anchoring may also impact adversely upon cultural heritage receptors on or shallowly buried under, the seabed through physical damage

89 During decommissioning the cable routes will primarily be buried and/or cut and left *in situ*. In some cases it may be necessary to remove cables which would be done involving excavation of the cable route by similar methods to the construction phase. Assuming that the same area of seabed that was impacted during the laying of the cables in the construction phase was excavated to remove a cable then the impacts to cultural heritage receptors would already have taken place. However, there may be secondary impacts from the vessel footprint from jack-up legs or anchoring in surrounding areas of seabed not previously affected.

90 During decommissioning wind turbine foundations are to be cut and/or craned from the seabed. Assuming that this does not disturb additional areas of seabed out with that affected by construction activities, adverse impacts may be restricted to secondary impacts from vessel footprints.

Known Wreck Sites

91 There is one known wreck site (WA 7071), and one seabed feature (WA 7072) which may be wreck debris in the MSA. Both have been verified by geophysical assessment and characterised as being *Anthropogenic origin of archaeological interest* (Wessex Archaeology 2011).

92 The single known wreck (WA 7071) is unidentified; thus importance cannot be currently assessed. The scale of the impact assessment is therefore site-specific in this case.

93 Cable trenching between wind turbine locations 8 and 9, 8 and 11 and 8 and 5 pass within around 40 m of the wreck location where buried debris may be located. There may also be positional uncertainties associated with both the position of the survey vessel at the time of data capture, and also in the position of the trenching machinery suggesting a cautious approach is advisable with this receptor (Figure 1 and 2).

94 The footprint of a gravity base foundation (40 m diameter) at Wind Turbine 8 would pass within around 40m of the wreck location where buried debris may be located. Once the skirt (up to 2m) and if an unknown width of scour protection is added, the proximity of to the wreck site may ultimately be as little as a few metres (Figure 1). There may also be positional uncertainties associated with both the position of the survey vessel at the time of data capture, and also the position of the installation vessels suggesting a cautious approach is advisable with this cultural heritage asset.

95 Depending upon the particular foundation construction methods and footprint of service vessels during operation, maintenance and decommissioning the likely interaction between this receptor and adverse impacts is likely to be high on a site-specific scale.

96 There may be secondary adverse impacts from the vessel footprint from jack-up legs or anchoring.

97 The redistribution of sediment from development activities is likely to be a beneficial impact as the protective covering of sediment is slightly increased where sediment settles out from the water column.

98 The potential impact has been assessed of **high** magnitude, **high** sensitivity and therefore of ***major*** significance.

Unknown Wreck Sites

99 There are large numbers of *recorded losses* (vessels thought to have been lost in the region, but without accurate recorded locations) in the vicinity of the MSA (Wessex Archaeology 2011). Following geophysical assessment of the seabed, the level of interaction between this receptor and impacts is thought to be low. However, there are significant numbers of magnetic anomalies on the seabed and particularly a medium-sized magnetic anomaly (WA 7070). The importance of this anomaly cannot currently be assessed but it is in close proximity to the proposed location of Wind Turbine 3 and could represent ferrous debris from an unknown wreck site.

100 The redistribution of sediment from development activities is likely to be a beneficial impact as the protective covering of sediment is slightly increased where sediment settles out from the water column.

101 The potential impact has been assessed of **low** magnitude, **high** sensitivity and therefore of ***minor*** significance.

Table 8: Summary of Significance of adverse impacts upon maritime archaeology receptors

Theme	Receptor	Spatial Extent of Effect	Duration of Effect	Recoverability of the Receptor	Importance of the Receptor	Sensitivity of the Receptor	Magnitude of Effect	Significance of Impact
Maritime Archaeology	Known wreck sites	Site-specific	Permanent	None	High	High	High	**Major**
	Unknown wreck sites	Local	Permanent	None	Low	High	Low	**Minor**

Table 9: Summary of Significance of beneficial impacts upon maritime archaeology receptors

Theme	Receptor	Spatial Extent of Effect	Duration of Effect	Recoverability of the Receptor*	Importance of the Receptor	Sensitivity of Receptor	Magnitude of Effect	Significance of Impact
Maritime Archaeology	Known wreck sites	Site specific	Temporary to long-term	-	Medium	Low	Low	Negligible
	Unknown wreck sites	Local	Temporary to long-term	-	Low	Low	Low	Negligible

* For beneficial impacts such as sediment redeposition settling from the water column onto cultural heritage receptors (Table 5), recoverability is not applicable.

Mitigation

102 Avoidance is seen as the primary method of mitigation for offshore developments (Wessex Archaeology 2007) where this is not practicable other methods may be required. Local and national curators may request specific mitigation strategies in line with current planning policies.

103 A finds reporting protocol should be adopted in order to record any material of potential archaeological interest discovered during all phases of development activity. A protocol for offshore developments has recently been commissioned and published by the Crown Estate (The Crown Estate/Wessex Archaeology 2010). Information from reported finds serves to enhance the National Monuments Record and allows more informed and effective management of offshore cultural heritage assets for the benefit of industry, heritage and the public.

104 A precautionary exclusion zone of 50 m around the visible extent of the wreck and debris is proposed in order to avoid inadvertent adverse impact to cultural heritage assets WA 7071 and WA 7072 during all phases of the project before their importance can be determined (Dix *et al*. 2007). As the wreck is

unidentified and importance cannot currently be assigned, importance is classified as **high** as a precautionary approach.

105 These precautionary exclusion zones also provide a buffer in case of positional uncertainties associated with both the position of the survey vessel and towfish at the time of geophysical data capture, and also the position of the trenching machinery.

Inter-array and export cabling

106 The inter-array cable routes between Wind Turbine 8 and 9, 8 and 11 and 8 and 5 intersect the precautionary exclusion zones, passing around 40m from the wreck position (WA 7071) (Figure 1 and 2).

107 The network of inter-array cabling routes indicates there will be repeated direct impacts from these networks of trenches. Mitigation strategies set out above for maritime archaeology receptors may offset repeated adverse impacts form the inter-array cable trenching as known wreck assets have been verified by geophysical survey.

108 Avoidance of the identifiable maritime archaeological receptors could most effectively be achieved by routing the export cabling through the area without geophysical anomalies in the south-west of the MSA (Wessex Archaeology 2011: Figure 4).

109 Further research could be undertaken on the unidentified wreck (WA 7071). The site may be unobtrusively examined by Remotely Operated Vehicle (ROV) or diver survey of the wreck site to ascertain more clearly the type, likely age, identity and importance. Integrating this with other necessary activities such as geotechnical sampling and other early-stage engineering works could provide a cost-effective solution. If the importance of the wreck can be gauged from this kind of survey, further mitigation strategies could be developed or requested by the local or national curators.

110 Up to four export cable routes are proposed passing through the same region of the MSA, but constrained between the Maritime and Coastguard Agency designated anchorage to the south, the proposed wind turbine locations to the north-east and the Blackdog Rifle range and seabed cables within the rifle range exclusion zone. They will be an area roughly 250m wide at the narrowest point. The volume of sediment removed by export cable trenching will be concentrated here, potentially creating increased significance of impact in this area. Known wrecks are absent from this region and the geophysical assessment indicates a lack of seabed anomalies. Sub-seabed palaeolandscape features are also restricted to the south. There is potential for isolated prehistoric finds within the sub-seabed sediments. A geotechnical/geoarchaeological assessment outlined above may serve as a form of mitigation for cumulative impacts to prehistoric archaeology receptors that may be encountered by export cable trenching.

111 Where redeposited sediment volumes may be more significant, such as at the margins of cable trenches, the beneficial impact of protection may reach a level where the added overburden could damage cultural heritage assets, particularly wrecks and aircraft. The suggested mitigation strategies outlined here, especially avoidance and precautionary exclusion zones, would be sufficient to prevent the beneficial impact of sediment redeposition becoming an adverse impact upon cultural heritage assets.

Wind Turbine foundations

112 Mitigation may be achieved by micro-siting the entire footprint of Wind Turbine 8 out with the precautionary exclusion zones around WA 7071 and 7072 and as a result, the inter-wind turbine cabling too. Depending upon the type of foundation and width of scour protection necessary this may be at least 20 m to the east or south-east. The configuration of inter-wind turbine cabling is relatively flexible and not all of the potential connections between wind turbines will be required. Avoidance may effectively be achieved by appropriate configuration of the cable routes outwith the precautionary exclusion zones.

113 Assuming a worst realistic case, a gravity base structure up to 40 m in diameter at the seabed with skirting and an unknown, site-specific width of scour protection would extend close to the wreck site (WA 7071). If damage is likely to occur by entering the precautionary 50 m exclusion zones then a thorough assessment of the wrecks importance is advised.

114 Repeated direct impacts will occur where cable routes and wind turbine foundations are connected. Generally the significance of impact is not thought to increase from those cited for unknown cultural heritage receptors. In site-specific cases where known cultural heritage assets are involved, i.e. wreck site (WA 7071). Both inter-array cable trenching and wind turbine foundation construction in addition to secondary impacts from attending vessel footprints may, without mitigation, repeatedly and significantly adversely impact this unidentified wreck adjacent to Wind Turbine 8 (Figure 1).

Residual Impacts

115 If avoidance of the unidentified wreck (WA 7071) and debris (WA 7072) by micro-siting Wind Turbine 8, and by association the inter-array cabling routes that could be connected to Wind Turbine 8, is undertaken then there should be no direct and likely no indirect adverse impacts upon this cultural heritage receptor.

116 If it is decided to inspect the site under a WSI in order to identify the type, identity and therefore archaeological importance of the wreck then further mitigation strategies will have to be proposed. The wreck represents a physical hazard to trenching machinery and therefore avoidance would appear to be the preferred mitigation strategy as there may be buried debris in the vicinity of the wreck.

117 After mitigation the impacts would be of ***minor-negligible*** significance

Cumulative Impacts

- **Other Offshore Wind Developments**
  - There are no other existing or planned offshore wind farm developments in the vicinity of the MSA.
- **Maritime and Coastguard Agency Designated Anchorage**
  - Abutting the MSA to the south is the MCA Designated Anchorage (Figure 1 and 2). Cumulative impacts from anchoring within this area are unlikely to impact upon Maritime Archaeology Receptors in conjunction with vessel footprints from the EOWDC project if mitigation is undertaken. Consultation with the Aberdeen Harbour Board has already been recommended in Scoping Opinion (Marine Scotland 2011).
- **Commercial Fisheries Activity**

- There may be cumulative impacts in association with commercial fisheries activities that impact the seabed, such as trawling. However, more likely in this nearshore area would be inshore fisheries activities. Scoping for the development indicates some minor fishing vessel activity in the vicinity of the MSA, partially linked to the designated anchoring area or passage en-route to other areas rather than concentrated fishing activities (AOWF 2010: Figure 14).
- It is considered that cumulative impacts are likely to be of ***low*** significance.

- **Subsea Cables**
  - Subsea cables are present within the Blackdog Rifle range exclusion zone but impacts to cultural heritage receptors from that past development are unknown and no assessment can currently be made.
- **Port/harbour Dredging Operations**
  - Dredging activities may be undertaken for the maintenance of Aberdeen Harbour to the south of the MSA. Archaeological assets are likely to have been already be removed and impacted by earlier phases of sediment removal. New areas of dredging will be required to undergo EIA and define mitigation strategies.
- **Proposed Ocean Laboratory, EOWDC**
  - The installation of an Ocean Laboratory to the south-west of Wind Turbine 1 (shown on Figure 1 and 2) would lead to cumulative impacts of a site-specific nature. Following geophysical assessment there appears to be no anomalies or known cultural heritage assets in the given location. Cumulative impacts may be of *minor* significance depending upon the type of the foundation used for the (spatial extent and volume of seabed sediment disturbed or removed) and cable linkages to other elements of the proposed development.
  - There are no known wrecks in the location of the proposed ocean laboratory and therefore no significant impacts.
  - Following geophysical assessment the potential impact upon *unknown wreck sites* has been assessed of **low** magnitude, **high** sensitivity and of ***minor*** significance.
  - After mitigation the impacts would be of ***negligible*** significance.

Monitoring

118 ROV or suitably qualified divers may provide sufficient monitoring of enacted mitigation strategies. Geophysical survey could also be applied to monitor any development in seabed scour and other impacts to known wreck receptors.

1.3.2.2 <u>*Operational Phase*</u>

Potential Impacts

119 Operational impacts are likely to be restricted to secondary impacts invoked by vessel footprint. Jack-up legs and/or anchoring may also impact adversely upon cultural heritage receptors on or shallowly buried under, the seabed through physical damage. The significance may be reduced as impacts would already have occurred during the construction phase.

Mitigation

120 Mitigation during construction phase would already apply (see page 21).

Residual Impacts

121 As construction and decommissioning phase (see page 23).

Cumulative Impacts

122 As construction and decommissioning phase (see page 23).

Monitoring

123 As construction and decommissioning phase (see page 24).

1.3.3 Impacts on Aviation Archaeology

1.3.3.1 Construction & Decommissioning Phase

Potential Impacts

- Adverse, direct damage to both *in situ* cultural heritage assets and assets in secondary contexts
- Adverse, direct disturbance of relationships between structures, artefacts and their surroundings or contexts
- Adverse, indirect destabilisation and erosion of sites through changes to seabed characteristics
- Beneficial, indirect burial of sites due to re-deposited sediment, potentially protecting and promoting the favourable preservation of cultural heritage receptors

Secondary Impacts

- Produced by vessel footprints; direct, adverse impacts will also affect cultural heritage receptors in association with cable trenching. Jack-up legs and/or anchoring may also impact adversely upon cultural heritage receptors on or shallowly buried under, the seabed through physical damage.

124 During decommissioning the cable routes will primarily be buried and/or cut and left *in situ*. In some cases it may be necessary to remove cables which would be done involving excavation of the cable route by similar methods to the construction phase. Assuming that the same area of seabed that was impacted during the laying of the cables in the construction phase was excavated to remove a cable then the impacts to cultural heritage receptors would already have taken place. However, there may be secondary impacts from the vessel footprint from jack-up legs or anchoring in surrounding areas of seabed not previously affected.

125 During decommissioning wind turbine foundations are to be cut and/or craned from the seabed. Assuming that this does not disturb additional areas of seabed out with that affected by construction activities, adverse impacts may be restricted to secondary impacts from vessel footprints.

Unknown Aircraft Crash Sites

126 There are currently no records of aircraft crash sites within the MSA (Wessex Archaeology 2011).

127 There is potential for aircraft crash sites and debris to be present in the MSA (Wessex Archaeology 2008) based on significant numbers of magnetic anomalies on the seabed and particularly WA 7070, adjacent to Wind Turbine 3. Such remains would automatically be protected under the PMRA 1986 (Wessex Archaeology 2011).

128 Importance cannot currently be assessed but the potential for encountering unknown crash sites following the geophysical assessment is gauged to be low.

129 The redistribution of sediment from development activities is likely to be a beneficial impact as the protective covering of sediment is slightly increased where sediment settles out from the water column.

130 The potential impact has been assessed of **low** magnitude, **high** sensitivity and therefore of ***minor*** significance.

Table 10: Summary of Significance of adverse impacts upon aviation archaeology receptors

Theme	Receptor	Spatial Extent of Effect	Duration of Effect	Recoverability of the Receptor	Importance of the Receptor	Sensitivity of the Receptor	Magnitude of Effect	Significance of Impact
Aviation Archaeology	Unknown aircraft crash sites	Regional	Permanent	None	Low	High	Low	**Minor**

Table 11: Summary of Significance of beneficial impacts upon aviation archaeology receptors

Theme	Receptor	Spatial Extent of Effect	Duration of Effect	Recoverability of the Receptor*	Importance of the Receptor	Sensitivity of Receptor	Magnitude of Effect	Significance of Impact
Aviation Archaeology	Unknown aircraft crash sites	Regional	Temporary to long-term	-	Low	Low	Low	Negligible

* For beneficial impacts such as sediment redeposition settling from the water column onto cultural heritage receptors (Table 5), recoverability is not applicable.

Mitigation

131 Avoidance is seen as the primary method of mitigation for offshore developments (Wessex Archaeology 2007) where this is not practicable other methods may be required. Local and national curators may request specific mitigation strategies in line with current planning policies.

132 A finds reporting protocol should be adopted in order to record any material of potential archaeological interest discovered during all phases of development activity. A protocol for offshore developments has recently been commissioned and published by the Crown Estate (The Crown Estate/Wessex Archaeology 2010). Information from reported finds serves to enhance the National Monuments Record and allows more informed and effective management of offshore cultural heritage assets for the benefit of industry, heritage and the public.

Residual Impacts

133 If avoidance of the anomaly WA 7070 is undertaken then there should be no direct and likely no indirect adverse impact upon this feature of possible archaeological interest.

134 If it is decided to inspect the site to attempt identification of the anomaly and therefore archaeological importance of the feature then further mitigation strategies will have to be proposed.

135 After mitigation the impacts would be of ***minor-negligible*** significance.

Cumulative Impacts

- **Other Offshore Wind Developments**
  - There are no other existing or planned offshore wind farm developments in the vicinity of the MSA.
- **Maritime and Coastguard Agency Designated Anchorage**
  - Abutting the MSA to the south is the MCA Designated Anchorage (Figure 1 and 2). Cumulative impacts from anchoring within this area are unlikely to impact upon Aviation Archaeology Receptors in conjunction with vessel footprints from the EOWDC project if mitigation is undertaken. Consultation with the Aberdeen Harbour Board has already been recommended in Scoping Opinion (Marine Scotland 2011).
- **Commercial Fisheries Activity**
  - There may be cumulative impacts in association with commercial fisheries activities that impact the seabed, such as trawling. However, more likely in this nearshore area would be inshore fisheries activities. Scoping for the development indicates some minor fishing vessel activity in the vicinity of the MSA, partially linked to the designated anchoring area or passage en-route to other areas rather than concentrated fishing activities (AOWF 2010: Figure 14).
  - It is considered that cumulative impacts are likely to be of ***low*** significance.
- **Subsea Cables**
  - Subsea cables are present within the Blackdog Rifle range exclusion zone but impacts to cultural heritage receptors from that past development are unknown and no assessment can currently be made.
- **Port/harbour Dredging Operations**
  - Dredging activities may be undertaken for the maintenance of Aberdeen Harbour to the south of the MSA. Archaeological assets are likely to have been already be removed and impacted by earlier phases of sediment removal. New areas of dredging will be required to undergo EIA and define mitigation strategies.
- **Proposed Ocean Laboratory, EOWDC**
  - The installation of an Ocean Laboratory to the south-west of Wind Turbine 1 (shown on Figure 1 and 2) would lead to cumulative impacts of a site-specific nature upon the unknown *aviation crash sites*. Following geophysical assessment there appears to be no anomalies or known cultural heritage assets in the given location. Cumulative impacts may be of minor significance depending upon the type of the foundation used for the (spatial extent and volume of seabed sediment disturbed or removed) and cable linkages to other elements of the proposed development. Assuming a GBS is used under the worst case scenario the magnitude of impact upon *unknown aircraft crash sites*, buried in the GBS footprint would be of high magnitude.
  - The potential impact upon unknown aircraft crash sites has been assessed of **low** magnitude, **high** sensitivity and therefore of ***minor*** significance.

- o Following mitigation outlined above specifically incorporating a finds reporting protocol this impact may be reduced to ***negligible*** significance.

Monitoring

136 ROV or suitably qualified divers may provide sufficient monitoring of enacted mitigation strategies. Geophysical survey could also be applied to monitor any development in seabed scour and other impacts to identified anomalies such as **WA 7070** in the vicinity of Wind Turbine 3.

1.3.3.2 <u>Operational Phase</u>

Potential Impacts

137 Operational impacts are likely to be restricted to secondary impacts invoked by vessel footprint. Jack-up legs and/or anchoring may also impact adversely upon cultural heritage receptors on or shallowly buried under, the seabed through physical damage. The significance may be reduced as impacts would already have occurred during the construction phase.

Mitigation

138 Mitigation during construction phase would already apply (see page 27).

Residual Impacts

139 As construction and decommissioning phase (see page 27).

Cumulative Impacts

140 As construction and decommissioning phase (see page 28).

Monitoring

141 As construction and decommissioning phase (see page 29).

1.3.4 EOWDC Future Research and Monitoring Opportunities

142 There would be beneficial research opportunities for assessing the nature and potential of submerged palaeo-landscapes of archaeological potential from geotechnical samples associated with the wind turbine locations and cable routes. This work would provide added value on local, regional and potentially national scale, to the development through publication in scientific, international journals and dissemination by other types of media to a broad audience of the public and specialists.

143 The unidentified wreck (WA 7071) also provides an opportunity to develop the study of maritime wreck sites where nothing is known about the vessel in question. This work would provide added value to the development through improving the historic environment records, publication in scientific, international journals and dissemination by other types of media to a broad audience of the public and specialists. Additionally, data from ongoing monitoring of the wreck, in conjunction with ecological monitoring for example, would provide ongoing sources of data for research and collaborative projects.

1.3.5 Summary of Impact Assessment

Table 12: Impact Assessment – Adverse Impacts

Potential Impact / Activity	Sensitivity of Receptor	Scale	Duration	Spatial Extent	Magnitude of Effect	Significance	Mitigation	Significance after Mitigation	Monitoring	Cumulative Impacts
Construction – Cable Trenching, Wind Turbine Foundations & Secondary Impacts from Vessel Seabed Footprints										
Post-glacial submerged landscape features	High	Medium	Long-term	Site-specific to Local	Medium	Moderate	Avoidance, Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	Existing subsea cabling, MCA anchorage, inshore fisheries, ocean lab
Isolated prehistoric sites & finds	High	Medium	Long-term	Local	Medium	Moderate	Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	Existing subsea cabling, MCA anchorage, inshore fisheries, ocean lab
Known wreck sites	High	High	Long-term	Site-specific	High	Major	Avoidance, Research, Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	-
Unknown wreck sites	High	Low	Long-term	Local	Low	Minor	Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	Existing subsea cabling, MCA anchorage, inshore fisheries, ocean lab

Unknown aircraft crash sites	High	Low	Long-term	Regional	Low	Minor	Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	Existing subsea cabling, MCA anchorage, inshore fisheries, ocean lab
Operation – Secondary Impacts from Vessel Seabed Footprints										
Known wreck sites	High	High	Long-term	Site-specific	High	Major	Avoidance, Research, Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	-
Decommissioning - Secondary Impacts from Vessel Seabed Footprints										
Known wreck sites	High	High	Long-term	Site-specific	High	Major	Avoidance, Research, Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	-

Table 13: Impact Assessment – Beneficial Impacts

Potential Impact / Activity	Sensitivity of Receptor	Scale	Duration	Spatial Extent	Magnitude of Effect	Significance	Mitigation	Significance after Mitigation	Monitoring	Cumulative / In-combination
Construction – Cable Trenching & Wind Turbine Foundations										
Post-glacial submerged landscape features	Low	Medium	Temporary to long-term	Site-specific to Local	Low	Negligible	-	-	Geophysical survey, ROV, finds reporting protocol	-
Isolated prehistoric sites & finds	Low	Medium	Temporary to long-term	Local	Low	Negligible	-	-	Geophysical survey, ROV, finds reporting protocol	-
Known wreck sites	Low	High	Temporary to long-term	Site-specific	Low	Negligible	-	-	Geophysical survey, ROV, finds reporting protocol	-
Unknown wreck sites	Low	High	Temporary to long-term	Local	Low	Negligible	-	-	Geophysical survey, ROV, finds reporting protocol	-
Unknown aircraft crash sites	Low	High	Temporary to long-term	Regional	Low	Negligible	-	-	Geophysical survey, ROV, finds reporting protocol	-
Operation										
-	-	-	-	-	-	-	-	-	-	-
Decommissioning										
-	-	-	-	-	-	-	-	-	-	-

1.4 Summary

144 Impacts to cultural heritage receptors have been assessed for the proposed EOWDC.

145 The significance of adverse impacts to potential prehistoric archaeology receptors, *isolated prehistoric sites and finds* and *submerged landscape features*, are assessed to be moderate. Following mitigation the significance of impacts is likely to be minor.

146 Adverse impacts relating to the damage and disturbance of known cultural heritage assets have been identified primarily with respect to the unidentified wreck (WA 7071) in close proximity to Wind Turbine 8 and associated inter-array cable routes between Wind Turbines 8 and 9, 8 and 11 and 8 and 5 (Figure 1). Without mitigation adverse impacts to this heritage asset are likely to be major. With mitigation, impacts may be avoided or significantly reduced. Further research and site inspection of this feature may be an effective method for ascertaining the archaeological importance of this unidentified wreck and ultimately the most appropriate methods for impact mitigation.

147 The significance of adverse impacts to potential maritime archaeology and aviation archaeology receptors – *unknown wreck sites* and *unknown aircraft crash sites* – are assessed to be moderate. Following mitigation the significance of impacts is likely to be minor.

148 Avoidance, where practicable, is the preferred mitigation strategy for known cultural heritage assets. Minor amendments to the position of cable trenching and the configuration or placement the foundation of Wind Turbine 8 have been outlined.

149 There is potential for encountering previously unknown archaeology in the MSA (defined in the archaeological baseline technical report prepared by Wessex Archaeology for Aberdeen Offshore Wind Farm Ltd in 2011). Strategies have been proposed to mitigate adverse impacts to these receptors.

150 Research, particularly the geoarchaeological examination of vibrocores and grab samples from sub-seabed sediments, taken for engineering or other development purposes provides a cost-effective mitigation strategy to directly investigate the age and archaeological potential of sub-seabed sediments of potential prehistoric archaeological importance. The integration of this kind of geoarchaeological analysis early in sequence of development activities is advisable to provide the most effective mitigation strategy (Gribble and Leather 2011).

151 Monitoring may be achieved through remote means such as geophysical or ROV survey. In addition, the Crown Estate has recently published a reporting protocol for finds from offshore developments (The Crown Estate/Wessex Archaeology 2010). Best-practice and effective monitoring may be partly achieved by implementing this protocol. Added value will also be provided to the National Monuments Record.

1.5 References

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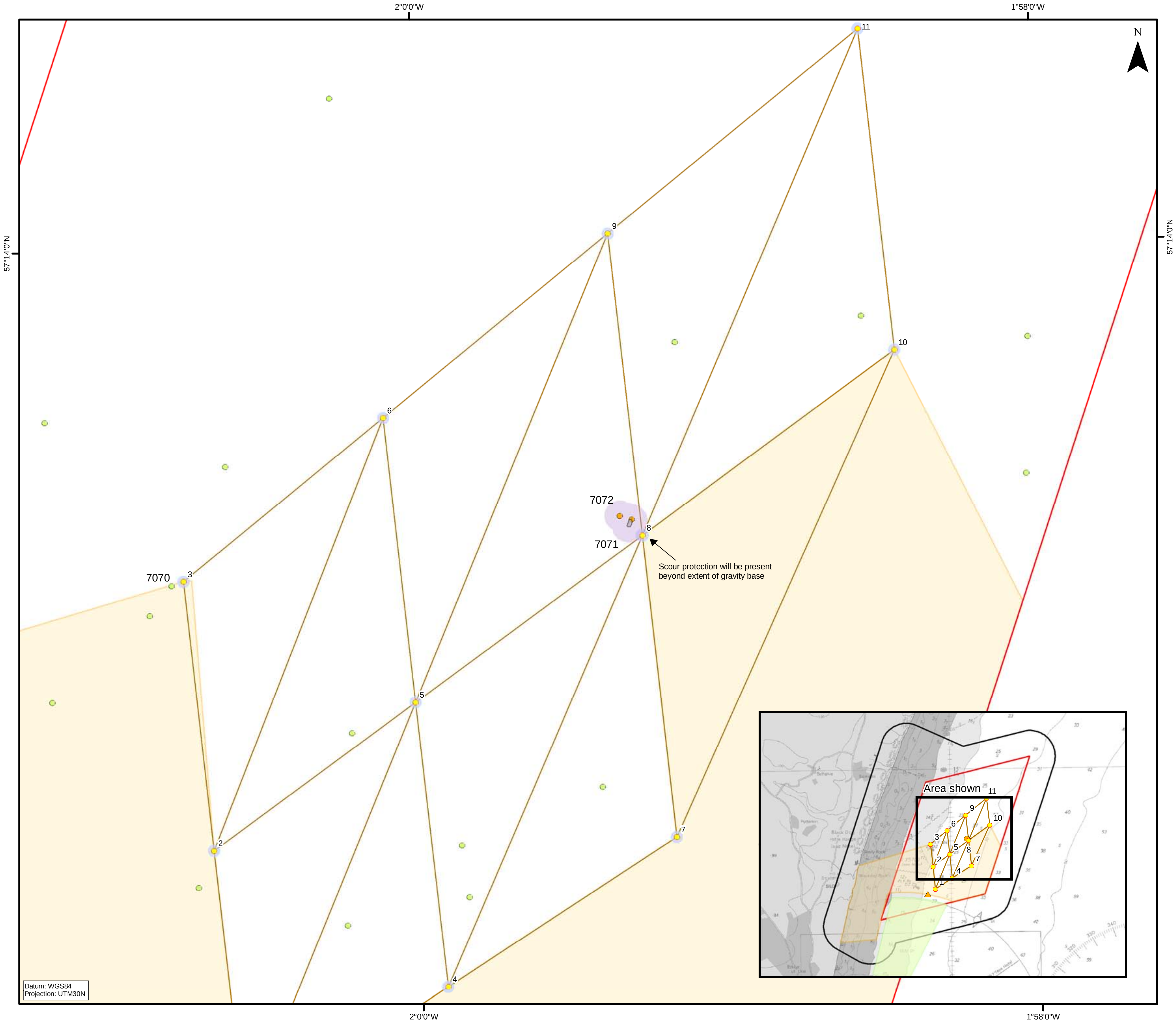


Technip areg Aberdeen Renewable Energy Group VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 1

Detail of unidentified wreck (WA 7071) and relationship to proposed cable trenching and turbine foundation 8

Legend

- Lease boundary
- Wind turbine
- Wind turbine gravity base and skirting (42 m diameter)
- Proposed ocean laboratory
- Indicative export cable corridor
- Proposed cable trench routes
- Anchorage Area
- Marine Study Area
- A2 - Uncertain origin of possible archaeological interest
- A1 - Anthropogenic origin of archaeological interest
- 7071 extents
- Precautionary exclusion zones (50 m buffer)

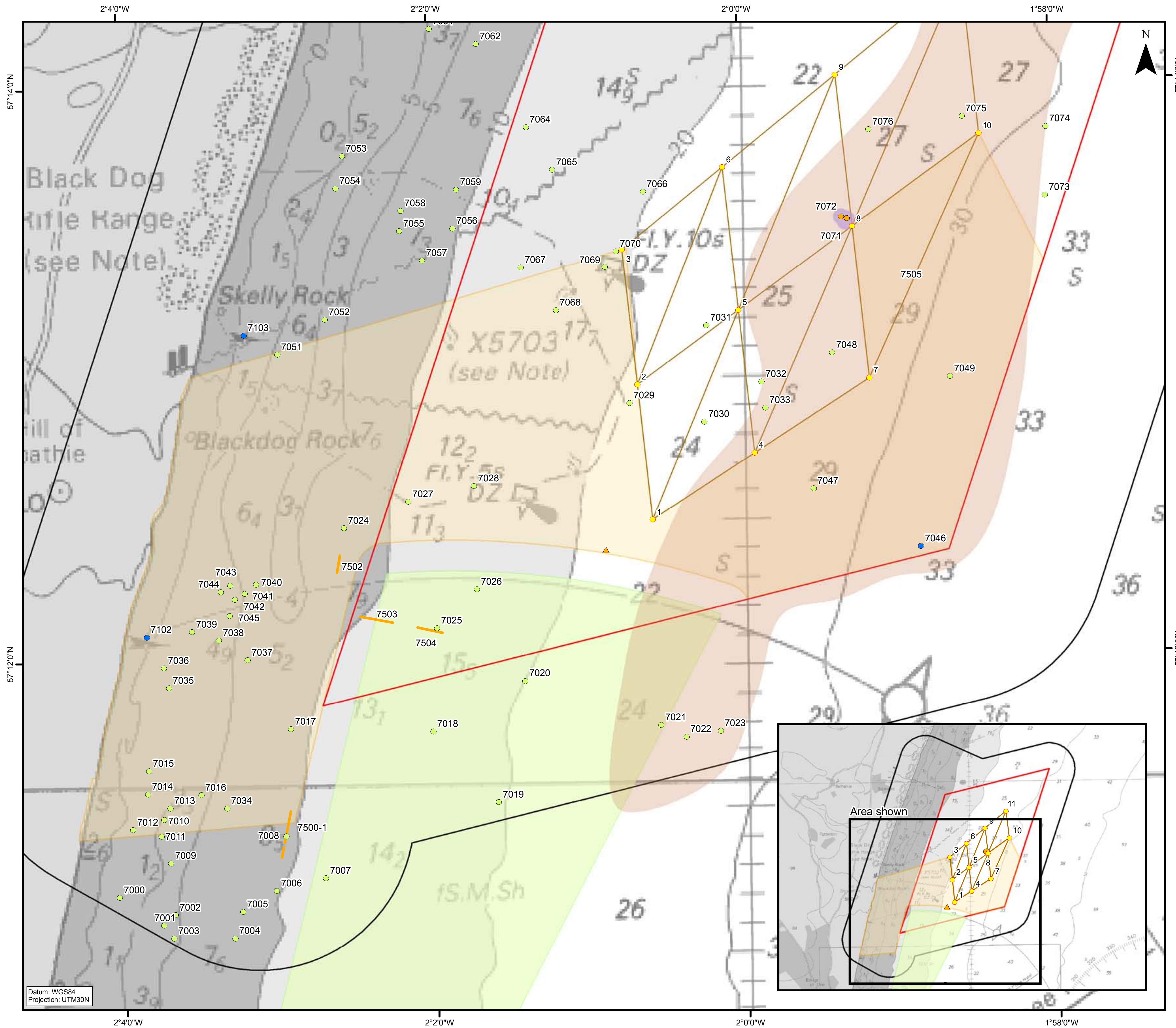
Datum: WGS84
Projection: UTM30N

Notes
1 Do not scale

0 0.2 km 0 0.2 nm Original A3 Plot Scale 1:12,500

Drg No	6129-530-PW-010		
Rev	C	Date	03/05/2011
By	KB	Layout	LABER039

Figure 1



Technip areg VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 2

Detail of indicative cable route corridor highlighting documented wrecks, seabed geophysical anomalies and sub-seabed features WA 7500 – 7505

Legend

- Lease boundary
- Wind turbine
- Proposed ocean laboratory
- Indicative export cable corridor
- Proposed cable trench routes
- Anchorage Area
- Marine Study Area
- A1 - Anthropogenic origin of archaeological interest
- A2 - Uncertain origin of possible archaeological interest
- A3 - Historic record of possible archaeological interest
- Precautionary exclusion zones (50 m buffer)
- Possible prograding reflector within Forth Formation (WA 7505)
- Possible shallow cut and fills

Datum: WGS84
Projection: UTM30N

Notes
1 Do not scale

0 0.2 km   0 0.2 nm

Original A3 Plot Scale 1:25,000

Drg No	6129-530-PW-010		
Rev	C	Date	03/05/2011
By	KB	Layout	LABER039

Figure 2

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European Offshore Wind Deployment Centre
Environmental Statement

Appendix 19.1: Seascape, Landscape and Visual Baseline Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

LDĀ DESIGN

European Offshore Wind Deployment Centre
Seascape, Landscape and Visual Impact Assessment

Baseline Technical Report
21st June 2011

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LDĀ DESIGN

2875_Baseline

Contents

LDĀ DESIGN

Version: 1.4

Version date: 21st June 2011

Comment FINAL

This document has been prepared and checked in accordance with ISO 9001:2000.

1.0 Introduction

This Baseline Technical Report sets out the existing seascape, landscape, and visual environments within an agreed study area and assesses their sensitivity to the type of change proposed. The EIA Technical Report will then determine the magnitude and significance of any change to the character of the identified regional seascape, landscape, and any areas of designated landscapes, as well as assess the potential effect upon views, visual amenity and receptor groups, and cumulative effects within the overall Zone of Theoretical Visibility (ZTV).

1.1. The Proposed Development

The lease boundary for the proposed European Offshore Wind Deployment Centre (EOWDC) covers an area of up to 20 km^2 and is located approximately 2 km east of the nearest landfall on the Aberdeenshire coast.

The deployment centre will have 11 wind turbines between 4 MW and 10 MW. The scheme has undergone numerous iterations since 2005 in terms of location and number of turbines which are discussed in the Environmental Statement (ES). The nature of the deployment centre is that it will comprise first of run turbines which may result in turbines of different heights. For the purposes of the SLVIA (e.g. ZTV, photomontages) the dimensions of the turbines have been agreed with the consultees to be assessed at the worst case scenario which is eleven 10 MW turbines with a hub height of 120 m and blade tip height of 195 m above lowest astronomical tide (LAT). As with all developments, there will be need to be an allowance for micro-siting which in this case may be up to 100m for each turbine.

It is not envisaged that the final mix of turbine heights will result in a height difference that is greater than 20-35 m between turbines. Any differences may be noticeable at closer distances and the assessment will take this into consideration. Please see Volume 3 of the ES for a figure showing a detailed layout.

An Ocean Laboratory, which could be an offshore structure associated with the deployment centre, would be subject to a separate planning application and will not be assessed as part of this seascape, landscape and visual impact assessment (SLVIA). However, as it is a foreseeable development it has been considered as part of the cumulative assessment.

Whilst the majority of the development is located offshore, the completed scheme will also require various onshore elements, including a cable route and an electricity substation. The assessment of all onshore elements associated with the proposed EOWDC and the respective effects upon the landscape, its character and constituent features and the level of visual effect will be addressed separately within the Onshore Environmental Statement and the supporting Landscape and Visual Assessment technical report. Reference is made to the anticipated effects of the construction of offshore elements in section 6.0 of the SLVIA EIA Technical Report.

1.2. The Study Area

It is accepted practice within seascape, landscape and visual assessment work that the extent of the study area is broadly defined by the visual envelope, or the Zone of Theoretical Visibility (ZTV), of the proposed development. The visual envelope represents the area of land and/or sea from within which it may be possible to see any part of the proposed development.

Within the ZTV, the actual extent of visibility of a proposed development then depends upon a variety of factors including the scale of development, the relationship between the viewpoint and the development itself, the context within which the development is seen and the prevailing weather conditions existing at any one time. To cover all the potentially significant seascape, landscape and visual effects, a 40 km radius study area around the proposed offshore wind deployment centre was agreed with Scottish Natural Heritage (SNH).

In order to undertake a full and robust assessment of the actual effects, and to assess the realistic worst-case scenario for the EOWDC development, the assessment also considers all onshore wind farms (existing, consented and in-planning) within a 60 km radius of the EOWDC. There are no other offshore wind farms within the study area. The sensitivity to change of the seascape, landscape and visual receptors has been assessed on the assumption that the consented wind farms have already been constructed.

1.3. Methodology Consultation

SNH, Aberdeen City Council (ACC), and Aberdeenshire Council (AC) were consulted from the outset with respect to the assessment methodology, study areas, viewpoint locations, and cumulative scope. Table 1.1 below gives a summary of the key consultation stages and dates. Please refer to Appendix 1 for a detailed record of consultation. The agreed methodology used within this assessment is detailed in Appendix 2.

Table 1.1 Summary of Consultation

Key Consultation Dates	Information
24th November 2009	Issue to all consultees of proposed 14 viewpoints, proposed 35km study area, SLVIA methodology including cumulative methodology, proposed cumulative sites and ZTVs.
19th December 2009	SNH response with advice on methodology, viewpoint options and study areas.
14th April 2010	Meeting with AC, ACC and SNH at SNH Offices, Aberdeen.
23rd April 2010	Meeting notes and revised viewpoint list issued incorporating all comments from meeting on 14.04.10.
28th May 2010	Revised Meeting Notes issued.
August 2010	EOWDC Request for Scoping Opinion Seascape, Landscape and Visual section highlighting approach, viewpoints and 35km study area.
29th September 2010	EOWDC Scoping Opinion – SNH response Suggestions on approach including relevant guidance and possible areas for inclusion as viewpoints and part of the study.
19th October 2010	Issue to all consultees of detailed ZTV, large scale 35km study area ZTV and viewpoint list including city centre viewpoints for review following the project layout changes.
29th October 2010	Revised viewpoint list issued to all consultees to include changes following site visit.
9th November 2010	Response from SNH to October 2010 information issued; agreement on viewpoints list with specific comments on cumulative assessment of viewpoints.
13th December 2010	Issue to all consultees of proposed cumulative methodology including sequential cumulative approach and methodology statement covering turbine phasing, turbine heights, and Ocean Laboratory.
24th January 2011	Response from SNH agreeing to the cumulative methodology, querying study area size, agreeing to Bennachie viewpoint as wireframe only due to weather constraints, and suggestion of Menie Estate viewpoint.
25th and 28th January 2011	Discussion emails on study area with SNH.
22nd February 2011	SNH response requesting 40km study area.
25th March 2011	Email to SNH for confirmation of agreement to methodologies and study area.
7th April 2011	SNH response confirming receipt of information and acceptance of 40km study area.

1.4. Key Guidance Documents

Key guidance documents that have informed the SLVIA include:

- Maritime Ireland/Wales Interreg 1994 – 1999 Guidance 'Guide to Best Practice in Seascape Assessment' (GSA, March 2001).
- 'An assessment of the sensitivity and capacity of the Scottish Seascape in relation to wind farms', (SNH commissioned Report 103, 2005).
- Guidance on the Assessment of Effect of Offshore Wind Farms: Seascape and Visual Effect Report (DTI – November 2005).
- Guidelines for Landscape and Visual Effect Assessment (Institute of Environmental Management and Assessment (IEMA) and the Landscape Institute's (LI), second edition 2002).
- Visual Representation of Windfarms Best Practice Guidance (SNH 2006, albeit published in 2007).
- Cumulative Effects on Windfarms, (SNH, 2005).
- Siting and Design of Windfarms, (SNH, December 2009).

1.5. Data Information and Sources

Table 1.2 below records the main survey information and site study data which were used in this baseline assessment.

Table 1.2 Summary of data and sources

Survey/Study	Date of Survey	Description
Seascape/landscape baseline assessment and viewpoint search.	April and October 2010	Land based driving and walking landscape character assessment of study area and establishment of locations of appropriate viewpoints.
Beaches of Northeast Scotland (SNH Commissioned Report)	1977	Environmental inventory of sand beaches, dunes and associated coastal areas of the coastline of the Moray Firth from Inverness eastwards and of the North Sea coast northwards from Inverbervie.
Landscape Character Assessment of Aberdeen (SNH)	1996	Landscape Character Assessment
South and Central Aberdeenshire: Landscape Character Assessment (SNH)	1998	Landscape Character Assessment
Banff & Buchan Landscape Assessment (SNH)	1994	Landscape Character Assessment

2.0 Landscape and Seascape Policy Context

The proposed site is located within offshore coastal waters under the jurisdiction of The Crown Estate. Within the 40 km study area there are only two councils; Aberdeenshire Council and Aberdeen City Council. Please refer to Figure 1 for the site location plan.

This section of the report identifies the relevant national and local planning policy and those statutory and non-statutory designations that apply to the study area that may be relevant to the development and landscape/seascape and visual issues. Refer to Figures 2 and 3 for an illustration of the landscape policy context

2.1. Renewable Energy

The Scottish Government has recently revised its planning statements. Scottish Planning Policy (SPP) is now one document that encompasses all the nationally important land use planning matters, including renewable energy, coastal planning, natural heritage, and historic environment. Relevant to the scheme as a whole, the extracts of the policy document discussed below provide an important overview with reference to more detailed areas pertinent to the SLVIA.

Scottish Planning Policy 'Renewable Energy' (paras. 182 – 192) sets out how the planning system should support the development of renewables and the development of spatial frameworks taking into consideration the many relevant factors including landscape and visual effects. Specifically under the heading Wind Farms, it states that '*Planning authorities should support the development of wind farms in locations where the technology can operate efficiently and environmental and cumulative impacts can be satisfactorily addressed' and 'the design and location of any wind farm development should reflect the scale and character of the landscape. The location of turbines should be considered carefully to ensure that the landscape and visual impact is minimised*'.

At a more local scale, Aberdeen Local Plan (2008) identifies its renewable energy policies under **Policy 22: Energy and Development**:

'Renewable energy development is acceptable in principle provided that …there is no significant impact on the character and amenity of the surrounding landscape or residential properties or on the ecology of the area'

2.2. Green Belt

The purpose of Green Belt allocations is to maintain landscape setting, leisure, recreation and green space. The location of the green belt in relation to Aberdeen and its setting is important, but for the purposes of this assessment it is not a consideration as the EOWDC will have no direct impact upon the green belt nor result in any compromise of its 'openness'.

2.3. Landscape Designations

SPP 'Landscape and Natural Heritage' (paras 125 – 141) gives guidance on how the Government's policies for the conservation and enhancement of Scotland's natural heritage should be reflected in land use planning. It outlines the aims of national and local landscape and natural heritage designations.

'Different landscapes will have a different capacity to accommodate new development, and the siting and design of development should be informed by local landscape character.'

'Landscapes and the natural heritage are sensitive to inappropriate development and planning authorities should ensure that potential effects, including the cumulative effect of incremental changes, are considered when preparing development plans and deciding planning applications. While the protection of the landscape and natural heritage may sometimes impose constraints on development, with careful planning and design the potential for conflict can be minimised and the potential for enhancement maximised.'

Under the above national policy the Aberdeenshire Local Plan (2006) has identified National Scenic Areas and Areas of Landscape Significance with the following policies;

Policy Env 5A, National Scenic Areas

Policy Env 5B states that *'Development that would have an adverse effect on a National Scenic Area will be refused unless the developer demonstrates:*

a) any significant adverse effects on the quality for which the area has been designated are clearly outweighed by social and economic benefits of national importance;

b) the objectives of the designation and overall integrity of the area will not be compromised.'

There are no National Scenic Areas within the study area, but two National Scenic Areas lie just beyond at Deeside & Lochnagar; and the Cairngorm Mountains. These areas are now part of the Cairngorms National Park so will be protected under the National Park designation. The areas are not included within the assessment but they are important to acknowledge with regards to the adjacent Areas of Landscape Significance which lie within the study area.

Policy Env 5B, Areas of Landscape Significance

Policy Env 5B states that *'Development within or adjacent to an Area of Landscape Significance will not be permitted where its scale, location or design will detract from the quality or character of the landscape, either in part or as a whole.'*

The closest Area of Landscape Significance (ALS) to the proposed development is on the coast, extending from Balmedie to south of Peterhead, and extending from Peterhead along the north coast. The coast to the south of Aberdeen, from Findon beyond Stonehaven is also designated as an ALS. Inland there are several ALSs, most of which are concentrated at the western edge of the study area adjacent to the Cairngorms National Park. However, there are some smaller inland ALS closer to the coast such as at Hatton of Fintray, north of Dyce, north west of Methlick, and along Deeside to the south of Aberdeen. To the south west limits of the study area an ALS covers a large area around Drumtochty Forest. The Areas of Landscape Significance within the study area are identified on Figure 2.

Aberdeen Local Plan (2008) Policy 31 – Landscape Protection outlines the objectives for retaining the landscape setting of Aberdeen.

Policy 31: Landscape Protection

Policy 31 states that: '*One of the objectives of planning for future development will be to maintain and manage aspects of Aberdeen's unique landscape setting. Development will not be acceptable unless it avoids:*

1. adversely affecting landscape character and elements which contribute to, or provide, a distinct 'sense of place' which point to being either in or around "Aberdeen" or a particular part of it;

2. obstructing views of the City's townscape, landmarks and features when seen from publicly accessible vantage points such as roads, railways, recreation areas and pathways and particularly from the main city approaches or 'gateways';

3. disturbance, loss or damage to recognised recreation, wildlife or woodland resources or to the physical links between them;

4. sprawling onto green spaces or buffers between places or communities with individual identities, and those which can provide opportunities for countryside activities.

'All developments shall respect the quality of the local landscape character and contribute towards its maintenance and enhancement in terms of siting, scale, massing, colour, design, density, orientation, materials, planting/ landscaping and boundary treatment. They should otherwise be capable of being absorbed within sites without significant adverse impacts upon existing landscape elements, including linear and boundary features or other components, which contribute to local amenity, and provide opportunities for conserving, restoring or enhancing them.'

These are key points relating to any development including the EOWDC and as part of this SLVIA the potential effects that the development may have on the landscape character will be assessed.

2.4. Historic Environment

The scope of this assessment does not cover the effects of the proposed development on individual Conservation Areas and other historic built features or their settings. These are discussed in the Cultural Heritage Assessment of the EOWDC. The general distribution of historic features and landscapes are however considered, as collectively they contribute to informing judgments on the character, historic importance and quality of the landscape. The overall effect of the development on the historic environment in so far as it contributes to defining the character of the landscape resource is also assessed. Coordination with the Cultural Heritage consultants was also undertaken so as to ensure clear separation of areas of responsibility and assessment of effects where relevant.

Conservation Areas and Gardens and Designed Landscapes within Aberdeenshire and Aberdeen are illustrated on Figure 2 and 3.The conservation areas are mostly contained to historic village centres and within Aberdeen, a large part of the town centre, Old Aberdeen, and also coastal areas such as Footdee. There are 19 registered Gardens and Designed Landscapes within the 40 km study area, the majority of which lie beyond 15km from the EOWDC. As discussed above, the Cultural Heritage chapter will assess the potential effects on these areas.

2.5. Summary of Landscape Designations and Planning Context

Table 1.3 below summarises the Areas of Landscape Significance within the 40km radius study area. Please refer to the Cultural Heritage chapter for assessment of the historic environment.

Summary Table 1.3 Landscape Designations

Landscape Designations **Areas of Landscape Significance (Aberdeenshire Policy Env 5B)**	**Approximate closest distance from nearest turbine**	**Sensitivity to proposed change**
Balmedie to Longhaven	3.5 km	High
Peterhead to Inverallochy	33 km	High
Findon to Catterline	15 km	High
River Dee Valley	13 km	High
River Don Valley	7 km	High
West of Inverurie	24 km	High
North West of Methlick	30 km	High
Drumtochty to Torphins and surrounds	36 km	High

3.0 Baseline Description

As set out in the DTI (2005) Seascape and Visual Impact Report, every seascape comprises three components: an area of sea (the marine component), a length of coastline (the coastline component); and an area of land (the landward component). Landscape starts at the coastline and includes all areas inland. The landward component of a seascape is the main factor determining the character of the seascape. Whilst landscape assessments are useful in setting out the character of the hinterland, they concentrate on the characterisation of the landward component only and do not generally address the relationship between landward elements and the sea. The seascape units at national and regional scale are therefore discussed below and show the integration of the marine coastline and the hinterland components. The landscape character areas are also discussed in reference to the wider study area.

3.1. Overview of the Wider Study Area

The study area includes a large part of the North East of Scotland which extends along the coast from Kinneff, south of Stonehaven to Crimond, near Peterhead in the north, and inland west to the Grampian Mountains. The city of Aberdeen is the main settlement within the study area on the North Sea coast approximately 5km south west at its closest point to the proposed turbines. Stonehaven and Peterhead are the main coastal towns within the study area and Ellon, Inverurie and Banchory are the main inland towns.

There are three key rivers within the study area; the Dee, Don, and Ythan. The River Dee descends from the Cairngorms to Strathdee (Deeside), and flows to the south west of Aberdeen before finally reaching the North Sea at Aberdeen Harbour. The mouth of the River Don lies to the north of Aberdeen centre between Old Aberdeen and Bridge of Don settlements. Its source is also in the Cairngorms and it winds down to Inverurie where its main tributary, the River Urie joins it. The Ythan River, a shorter course than the Dee and Don, is well known for its bird populations at its estuary which is located approximately halfway between Aberdeen and Peterhead.

The western extents of the study area consist of the fringes of the Cairngorms. This elevated landscape gradually lowers to a gently undulating topography towards the east coast. Large tracts of commercial forestry lie on the higher land and river valleys to the west and south west of the outer limits of the study area. To the north and north west there is predominantly open gently rolling agricultural land with some areas of woodland along river valleys and around estates.

The coastline varies within the study area. To the south of Aberdeen the coast rises to sea cliffs and rocky beaches. Between Aberdeen and the Ythan estuary there are long sandy beaches and sand dunes. Beyond, to the north, the land rises again to give rocky cliff coastline.

3.2. National Seascape Units

There is one national seascape unit 'Area 4: North East Coast' within the study area as identified by the SNH commissioned report (Scott et al, 2005). This comprises two seascape character types 'Mainland Rocky Coastline with Open Sea Views' and 'Deposition Coastline with Open Sea Views'.

The key characteristics of this national seascape unit are stated as;

- *Long, east-facing generally straight coastline with many small indentations and few significant headlands and with open views out to the North Sea;*
- *Mix of long broad sandy beaches backed by dunes and low cliffs/rocky coastline;*
- *Farmland predominantly backs coast; flat and low lying against deposition coast; gently rolling against rocky headlands/cliffs – some remnant heathland in places;*
- *Frequent fishing villages and harbours and several sizable urban settlements; and*
- *Industry is infrequent but large scale where it occurs.*

The SNH document identifies that the openness of sea in views gives a huge scale which turbines could relate well to. It also states that views are largely focused up and down the coast and out to sea rather than inland. However, the study discusses that although generally not a complex landform, in some localised places turbines could conflict with the natural forms of distinctive coastal features.

In conclusion the study gives the 'North East Coast' seascape unit a Low to Medium sensitivity to wind farms. It states '*Although there are a few large scale industrial features on land and the area has locally distinctive and natural coastal features, the simple landform, relatively linear coastline, general absence of focal features and expansive scale of the sea are key factors in limiting sensitivity to development. Turbines would need to be carefully sited to avoid intrusion on the setting of settlements'*

3.3. Regional Seascape Units

In order to understand the seascape in more detail for the assessment, a regional scale of seascape units is considered appropriate. At a regional scale there are no published seascape units. However, as part of this SLVIA, through a combination of fieldwork and desk based study, six regional seascape units have been identified within the 40km study area. Please refer to Figure 4. These units are primarily dictated by the change in coastal features between a deposition coastline and a rocky cliff coastline. In addition, taking into consideration marine, coastal, and coastal hinterland components, the seascape characteristics were defined and are discussed below for each regional unit as well as the key elements that combine to make the overall character distinctive from adjoining seascapes. The visual characteristics are also defined.

To the south of Aberdeen a rocky coastline extends for approximately 35 km to Inverbervie. The 'Beaches of Northeast Scotland' (SNH 1977) report describes this area as having '*high rock forms…stretches of precipitous rock faces…some of the most spectacular coastal scenery to be found anywhere in Scotland*'. The beaches can be described as '*small sandy inlets and strip beaches… often associated with rock platforms and cliff-foot situations*.'

Geologically this part of the rocky north east coast is divided where the red sandstone cliffs to the south are separated from the granite and quartzite cliffs to the north as a result of the Highland Boundary Fault which lies just north of Stonehaven. This is not easily perceivable along the coastline as it remains as steep rough slopes and cliffs alternating with small shingle bays. However, there is a more distinct change in the landform adjacent to the coast at this point. This also coincides with differing settlement patterns and therefore has divided the coastline south of Aberdeen into two seascape units, which are discussed below.

To the north, the national seascape guidance recognises the area between Girdle Ness and Collieston as deposition landscape. For the purposes of this assessment this section of coastline can be divided into two regional seascape units as the influences of Aberdeen city on the southern extents of the coast separates it from the north. North of Collieston the rocky coastline line begins and extends to Peterhead, where is becomes a deposition coastline once again.

3.3.1. Inverbervie to Stonehaven Regional Seascape Unit

This regional seascape unit lies at the southern extents of the study area, approximately 30 km at its closest point to the nearest turbine of the EOWDC and extends approximately 15 km between the towns of Stonehaven and Inverbervie. The coastline between Stonehaven and Catterline has been designated as an Area of Landscape Significance by Aberdeenshire Council (see Figure 2).

Its character is defined by an intermittently settled and often inaccessible rugged coastal edge, with open agricultural land extending inland from the precarious cliff edges. Villages and isolated houses and farms sit on the cliff tops overlooking small shingle bays. The village of Catterline is one of the few settlements which have access to the sea. The old main north-south road (A92) lies close to the coastline (between 1 km and 500 m), and a network of minor roads extends between this and the coast connecting the scattered farms and hamlets.

Although the agricultural land extends beyond 10 km inland to the slopes of the Mounth, the landward extent of this seascape unit only extends up to 2-3 km inland where the topography becomes more rolling and an increase in woodland cover prevents intervisibility with the coast. As a result the landward extent is characterised more frequently by landscape elements rather than by seascape or coastal elements. The rolling landform contributes to restricting views and intervisibility between landscape, coastal edge and the sea. Wind turbines such as the recently built Tullo Wind Farm are visible in views looking back from the coastline but they are beyond the landward extents of the seascape unit.

The rocky cliff coastline with its roughly convex shape gives exposed expansive views out to sea which gives a vast sense of scale. There are limited areas of more intimate enclosed sea views from the small inlets and bays where access is possible.

On the whole, the open, elevated character is generally harmonious although the intricate craggy cliff coastline contrasts with the relatively simplistic agricultural and settlement pattern. It is considered that, with the generally large scale landscape and expansive seaward views, this seascape unit has a Medium sensitivity to the type of change proposed.

3.3.2. Stonehaven to Girdle Ness Regional Seascape Unit

This regional seascape unit extends approximately 20 km north from Stonehaven to Girdle Ness which is a small headland at the eastern edge of Aberdeen city. Girdle Ness lies approximately 8 km from the nearest turbine of the EOWDC. The coastline within this seascape unit from Findon to Stonehaven has been designated as an Area of Landscape Significance by Aberdeenshire Council (see Figure 2).

This seascape unit has an intricate cliff coast similar to that to the south although as it is north of the Highland Boundary fault the coastal geology consists of granites and quartzite. Stacks and arches are common along the cliffs, more so than to the south of Stonehaven due to the different geology. The cliffs are also in places less severe and have a more gradual slope towards the sea.

Also, differentiating it from the seascape unit to the south, it has a much narrower landward extent and is more heavily influenced by settlement and the edge of Aberdeen. North of Stonehaven the foothills of the Grampians extend almost to the coastline and this topography has influenced the settlement pattern to exist within a narrow corridor of land along the coast, with houses right up to the cliff edges. This rolling topography of the foothills close to the coastline also prevents extensive intervisibility of the coast to considerable distances inland.

The main north-south road (A90) and the railway line lie side by side in close proximity to the coastline offering some spectacular cliff and sea views, albeit intermittent due to the rolling topography. From Stonehaven to Muchalls there are very few developments on the seaward side of this transport corridor. It is a slightly more open, flatter landscape here with connections to the sea extending further inland than elsewhere within this unit. North of Muchalls the main road tracks slightly further inland but the railway line remains along the tops of the cliffs before curving round at Nigg Bay to the centre of Aberdeen. Historic fishing villages such as Portlethen and Newtonhill have expanded in size from the cliff edges to now lie between the railway line and A90.

The northern extent of this seascape unit is considerably urban and industrial in nature and combined with the landform the landward extent is still confined to a relatively narrow area. Quarrying, industrial estates, and golf courses are present between Cove Bay and Girdle Ness. The cliffs gradually decline to an open broad sweeping shingle beach at Nigg Bay. Historic elements such as the remains of St Fittick's Church, Torry Battery, and Girdle Ness Lighthouse sit side by side industry and settlements.

Overall, this seascape unit is a relatively densely settled and urbanised area with a narrow landward element due to topography and also elements such as the railway and main A90 road. The unit gets increasingly chaotic towards the north with the industry and settlement dominating. The elevated settlements on the cliff edges are separated directly from the sea but are connected visually. Although there are no wind farms within this RSU, distant views of wind farms are available. Taking into account all these factors it is judged that this regional seascape unit has a Medium to Low sensitivity to the type of change proposed.

3.3.3. Aberdeen Beach Regional Seascape Unit

The Aberdeen Beach seascape unit extends from Girdle Ness to the mouth of the River Don. It is approximately 5 km at its nearest point to the proposed turbines of the EOWDC.

The coastal component of the seascape unit between Girdle Ness and Bridge of Don is heavily influenced by the city of Aberdeen. The harbour is located at the mouth of the River Dee and is sheltered naturally by the Girdle Ness headland. The headland provides elevated viewpoints looking across Aberdeen Bay. Engineering works across the seafront of Aberdeen such as sea walls and groynes have controlled the beach in contrast to the more natural beach and dune systems beyond the Don mouth. However, Aberdeen beach is still very accessible and used all year round, with a variety of facilities and amusements along the beach esplanade.

Behind Aberdeen beach, the Kings Links and what is left of the Queens Links are remnants of the former dune systems and are now a golf course and recreational area respectively. Between the two links areas there is a ridge called Broad Hill which appears as a grassy knoll, as surrounding settlement has reduced its prominence. However, it does provide elevated views across Aberdeen Beach. The landward extent of this seascape unit is mainly confined to the immediate edges of the city and harbour area where views across the coast are predominantly east except from Girdle Ness.

The seaward extent of this unit is linked to the harbour and as such it is a busy shipping area; commercial, industrial, large and small scale with some recreational uses. Large ships travelling to and from Aberdeen, and also those that lie within the Maritime and Coastguard Agency (MCA) designated anchorage area can be seen across the horizon from many points within the unit. These provide scale and interest to the expansive North Sea. Surfing and Windsurfing are also not uncommon along Aberdeen beach.

It is a dynamic and busy seascape which can't really be separated from the city of Aberdeen. The city influences extend from the shipping channels, groynes along the beach to the tower blocks which overlook the coast. It is judged that due to the city influences and the slightly chaotic nature, but also the visible links with the sea and land, the seascape unit has a Medium sensitivity to the type of change proposed.

3.3.4. Aberdeen Bay Regional Seascape Unit

This regional seascape unit is defined by the large crescent of sandy beaches, dunes and links that lie between the mouths of the rivers Don and Ythan. The unit extends from the mouth of the River Don approximately 18 km to Forvie Sands where the deposition coastline ends. The proposed turbines lie within the southern extents of this seascape unit.

Donmouth represents the end of Aberdeen Beach. This area has been designated as a Local Nature Reserve due to the presence of a range of birds and sea life such as grey seals. To the north, the beach changes from a narrow irregular width at Balgownie to a broad expansive beach area at Balmedie extending approximately 14 km to the Ythan estuary. Dunes and links also change further north and become gradually less modified by development pressures. Examples of development on the links and dunes areas can be found at the Royal Aberdeen and Murcar golf courses, tips, quarries and MOD firing range at Blackdog. The change can also be noted in the designation of the area of coastline from Balmedie to the north as an Area of Landscape Significance.

Visitor access to the beaches is relatively contained to the Bridge of Don, Balmedie and Newburgh areas so there are large stretches of beach and dunes which are rarely used for recreation. Balmedie Country Park is a well-used facility which includes parking, visitor centre, and decked walkways through the dunes to the beach. The dunes and links along this seascape unit generally prevent clear views to the beach from inland except from local high points. On the north side of the Ythan estuary there is an extensive triangular area of complex dune systems called The Sands of Forvie. These are a National Nature Reserve and also have Site of Special Scientific Interest (SSSI) and Special Protection Area (SPA) designations. A dynamic landscape they offer an ever changing place with localised high points offering views across the sea and inland, where there are intermittent views of the Hill of Fiddes Wind Farm.

The landward element of this part of the unit includes the coastal urban residential settlement at Bridge of Don which peters out to the industrial estates and Exhibition facilities which lie either side of the A90. This includes two vertical features; a demonstration oil drilling platform and also an observation tower which is 43 m high. Beyond these buildings to the north, the landscape becomes more open with scattered settlement; however landfill and industrial uses are common. The farmland with an open windswept character encroaches into the sandy coastal fringe where views are available across the sea. The land rises to the west to gently undulating lowlands.

The sea element of the unit is perceived as having some containment to the south and north by the visible headlands at Girdle Ness and Buchan Ness (near Peterhead), although this is beyond the unit extents. The eastern extents extend to the horizon and appear at a vast open scale. The sea within this unit is active with many large fishing vessels, container ships, and ferries travelling through the outer waters.

In contrast to Aberdeen Beach, this Regional Seascape Unit is relatively remote and harmonious, with only the industrial and commercial elements to the south of Balmedie adding a discordant element. The landscape and nature designations also need to be taken into consideration and it is judged that overall the sensitivity to the type of change proposed varies from Medium to the south of Balmedie and High to Medium in the northern extents.

3.3.5. Collieston to Peterhead Regional Seascape Unit

This regional seascape unit is predominantly defined by a rocky cliff coastline which extends from Collieston 18 km north to Peterhead. It lies approximately 15 km from the proposed development.

Its coastal component is similar to the rocky coast to the south of Aberdeen with rugged and sculpted granite cliffs and includes features such as the Bullers of Buchan blowhole. The exception to this is Cruden Bay which is a large sheltered sandy bay which lies in the centre of the unit. There are also some smaller bays such as at Collieston, at the south of the seascape unit. Much of this coastal stretch has been designated as an Area of Landscape Significance.

The landward area reaches to beyond 10 km inland where a high plateau of generally open farmland relates to the coastline. There is an area of high open land surrounding Cruden Bay which gradually declines towards Peterhead. This seascape unit has a larger, consistently open and exposed landward area than the other seascape units to the south.

Settlement is sparse along the immediate coastline and consists of mainly individual farms and hamlets along the roads. The only villages along the coast are at Collieston, Cruden, Whinneyfold and the larger Boddam which lies just south of Peterhead. Transport routes in this area include the A975 and slightly further inland the A90. The Peterhead Power Station at Boddam has two large chimneys the highest of which is 170m high and is visible from a large area, including as far as Girdle Ness. Views of distant wind farms are also possible from the landward elements of the unit. Historic elements such as the remains of Slains Castle just north of Cruden Bay are also a noticeable feature of the landscape.

The sea element to the seascape unit is active with local fishing boats inshore and larger ships and ferries travelling across the outer waters.

This unit is generally a simple, open and large scale seascape with expansive sea views. Strong vertical features such as the Peterhead Power Station, although very visible, do not dominate the whole seascape. Due to the presence of vertical features and the overall simplicity of the seascape, but also the locally designated coastline, it is considered to have a Medium sensitivity to the type of change proposed.

3.3.6. Peterhead to Fraserburgh Regional Seascape Unit

The Peterhead to Fraserburgh seascape unit consists of a stretch of dunes and beaches covering approximately 25 km on the north east corner of Aberdeenshire. The unit extends beyond the 40 km study area.

Descending from the rocky cliff line surrounding Peterhead, the coastal element of this seascape unit consists of over eight separate shallow bays of various lengths broken up by the different directions of tides. Behind the beaches the land consists of huge expanses of vegetated sand dunes. The Loch of Strathbeg, a large water body which lies in the centre of this seascape unit, is enclosed by the sand dunes and therefore quite separate from the sea. The coastal areas north of Peterhead have few if any settlements except for the prominent St Fergus Gas Terminal and the Ron lighthouse. Coastal settlements appear further round the coast at St Combs and Inverallochy near Fraserburgh.

The landward element consists of large coastal plains of farmland which due to the flat nature are not as visually connected to the sea as some of the more elevated areas. The A90 lies inland within the open plains and although the sea is generally not visible, the dune systems behind the beaches can be seen and related to, as also one is aware of the sea by the windswept landscape and exposure to coastal air.

Lying in between two large coastal industrial towns, this seascape unit, whilst having remote sandy stretches and dune systems, is heavily influenced by the industrial developments at St Fergus and the busy A90. It is therefore considered to have a Low sensitivity to the type of change proposed.

Table 1.4: Regional Seascape Unit Baseline

	Regional Seascape Unit	Approximate closest distance of coastline from nearest turbine	Sensitivity to type of change proposed
1	Inverbervie to Stonehaven	30km	Medium
2	Stonehaven to Girdle Ness	8km	Medium to Low
3	Aberdeen Beach	5km	Medium
4	Aberdeen Bay	0km	Medium (south) High to Medium (north)
5	Collieston to Peterhead	15km	Medium
6	Peterhead to Fraserburgh	35km	Low

3.4. Landscape Character

The EOWDC will not have any direct effects on the landscape character areas of the onshore parts of the study area. However, on account of the fact that turbines are tall, vertical and moving features, there is the potential for some landscape character areas to have a visual sensitivity towards them. Given this, the character areas within the study area have been assessed only on the basis of their visual sensitivities towards wind farms and on the extent to which the visual characteristics of a character area contribute to defining that landscape character. This takes into consideration '*the probability of change in the landscape being highly visible, based particularly on the nature of the landform and the extent of tree cover both of which have a major bearing on visibility*' (Countryside Agency and SNH, 2004. Topic Paper 6).

Scottish Natural Heritage commissioned landscape character assessments to cover the whole of Scotland in the early 1990s. Of relevance to this SLVIA are the South and Central Aberdeenshire Landscape Character Assessments (LCA), Aberdeen City LCA, and Banff and Buchan LCA. The following paragraphs discuss the key characteristics of the character areas identified within these assessments that lie within the study area and assesses their visual sensitivity towards the type of change proposed. In cross referencing the ZTV of the proposed development with the landscape character areas it is clear that there are entire areas which do not have any potential intervisibility with the site and therefore these have not been included in the baseline assessment.

Figures 5 and 6 illustrate all the landscape character types within the 40 km radius study area of the proposed development, including those which will not have any intervisibility with the EOWDC.

As the seascape units include the coast and relating landscape, in order to avoid duplication and confusion, the relevant landscape character areas will not be assessed separately. This therefore includes; all Coast landscape types and areas, and Potterton and Murcar landscape character areas. It is acknowledged that parts of the Eastern Agricultural Plain, Formartine Lowlands, and Garvock and Glenbervie landscape character areas also overlap with the seascape units but as these are large character areas covering an area beyond the seascape units they will still be included in the assessment.

South and Central Aberdeenshire LCA

This LCA identifies five landscape types within south and central Aberdeenshire. The 'Coastal Strip' lies closest to the development and the majority of the adjacent area is classified as 'Agricultural Heartlands'. Further to the west and south west the 'Moorland Plateaux' extends into the farmland. 'Farmed Moorland Edge' and 'Straths and Valleys' landscape types lie at the edge of the study area.

Within the 40 km study area, the main landscape type is Agricultural Heartlands which comprise of the Formartine Lowlands, Central Wooded Estates and Kincardine Plateau landscape areas which surround Aberdeen, and also the Ythan Strath Farmland, Northern Rolling Farmlands, Howe of Alford, and Garvock & Glenbervie landscape areas which are at the outer extents of the study area.

The Moorland Plateaux landscape type extends into the Agricultural Heartlands with The Mounth landscape area at the south west of the study area and the Grampian Outliers to the west.

The following paragraphs discuss the key characteristics of the Agricultural Heartland landscape areas and the Moorland Plateaux landscape areas. As only small areas of the Straths & Valleys, and Cromar Uplands landscape character types lie within the study area and when cross referencing them with the ZTV it is clear there is no intervisibility with the EOWDC, they will not be included in the assessment.

3.4.1. **Agricultural Heartlands**

Described as intensive farming on large fertile fields, the Agricultural Heartlands landscape type covers an extensive area between the coast and Grampian Mountains within the study area. The Howe of Alford character area within this type is the only one within the study area which is shown on the ZTV to have no intervisibility with the EOWDC and therefore will not be assessed.

Formartine Lowlands (LCA No.4, Figure 5)

This landscape area lies to the north of Aberdeen, east of the Formartine links and dunes. The character area extends beyond the South and Central Aberdeenshire survey to the Banff and Buchan character assessment which is discussed later.

The gently undulating and open agricultural character of this area gives expansive views across the landscape. However, plans outlined in the LCA to increase woodland cover in this area and also objectives to increase the diversity of landscape features and promote a more coherent landscape structure will reduce this existing openness in places. Existing turbines at Hill of Fiddes and Ardgrain and to a lesser degree the small single turbines at Mains of Bogfechel and Tillymaud combined with transmission lines across the area are strong vertical elements in the otherwise open landscape which lacks any significant landscape features. It is a well settled area including the large town of Ellon and also the main north south road (A90). Taking into account the above, the visual sensitivity of the Formartine Lowlands to the type of change proposed is considered Medium to Low.

Central Wooded Estates (LCA No.5, Figure 5)

This area lies between the Don and Dee valleys at the edge of the suburbs of Aberdeen extending west to the edge of the Grampian hills. As indicated by the character area's name, the wooded estates are a strong feature of this rolling landscape. There are some areas of open farmland which allow long views within the area which contrast with enclosure by woodland. Two Areas of Landscape Significance lie within this character area – one at the north eastern extents of the character area along the River Don valley, and the other to the south along the River Dee. There are a large number of towns and villages and a busy network of roads. The enclosure created by the woodland and rolling landscape and lack of any significant views out of the character area reduce the visual sensitivity to the type of change proposed to Low.

Kincardine Plateau (LCA No.6, Figure 5)

The Kincardine Plateau is an area of land to the south west of Aberdeen which is a transitional landscape between the upland areas of The Mounth and the coastal cliffs around Portlethen and Newtonhill.

This is a landscape area that does not have a strong character; it has a diverse and complex landscape pattern which is often neglected and lacks cohesion. Views out of the character area are not a key characteristic although there are exposed mounds and hills across the landscape which will provide opportunities for wider views. There is strong development pressure extending from the industrial and residential areas of southern Aberdeen. Taking the above into consideration it is judged that the visual sensitivity of the Kincardine Plateau character area to the type of change proposed is Low.

Ythan Strath Farmland (LCA No.7, Figure 5)

This landscape area is a small area which lies to the north of the Formartine Lowlands and to the east of the Northern Rolling Lowlands.

The Ythan Strath Farmland is a rural landscape with exposed hill tops and rocky outcrops contrasting with the more intensely farmed pockets. Settlement is scarce and is mainly scattered farmsteads. The area has a relatively small scale field pattern with diverse vegetation cover which adds to the rural character. The undulating landform, blocks of coniferous woodland and the large areas of estate planting at Haddo give some enclosure to the area .This intricate structure reduces the opportunities and importance of views out to the wider landscape. A three turbine wind farm at Skelmonae and a single turbine at Courtstone lie within the character area. It is judged that the Ythan Strath Farmland will have a Low visual sensitivity to the type of change proposed.

Northern Rolling Lowlands (LCA No.8, Figure 5)

The Northern Rolling Lowlands lie north east of the Formartine Lowlands and extend into the Banff and Buchan Agricultural Heartlands landscape type. It is a simple landscape consisting of a rolling landform covered by large geometric fields and woodland blocks. Settlements and farms lie in the sheltered valleys. A key characteristic is long distance views from the elevated areas out to the wider landscape. This simplistic landscape is now dotted with wind farms varying from single turbines to five turbines. They are a distinctive vertical element seen in the skyline from many areas within and outside the character area, although the undulating landscape curtails some views. The visual sensitivity to the type of change proposed is considered Low as wind farms and views of wind farms are now an established characteristic of this landscape character area.

Garvock and Glenbervie (LCA No.9, Figure 5)

This area lies to the south of the Kincardine Plateau and east of The Mounth. The Garvock and Glenbervie character area is primarily characterised by the large scale sweeping open rolling hills that give distant views across the area to The Mounth and Howe of the Mearns. There is a scattered settlement pattern and radio masts are prominent on high points. The large fields of arable and pasture are divided by fencing and there is a scarcity of hedges and dykes. There are several wind farms in the area both near the coast and in the shelter of The Mounth. The views out to the wider landscape are a key characteristic which may or may not include wind farms and other vertical features. The visual sensitivity is therefore considered to be Medium to Low to the type of change proposed.

3.4.2. **Moorland Plateaux**

The Moorland Plateaux has a 'Highland' character of exposed heather moorland with coniferous plantations. It has been divided into two main areas which are discussed below.

Grampian Outliers (LCA No.12, Figure 5)

The Grampian Outliers consists of several high points to the west of Aberdeenshire at the transition between the high mountains of the Cairngorms and the lower farmland of the north east. The outcrops at Bennachie, Hill of Fare, and the eastern edge of the Ridge of Foudland are included at the extents of the study area.

The Grampian Outliers have a generally high undulating landform with some dramatic outcrops such as at Bennachie. The mountains are mostly covered with conifer plantations with the upper slopes more open with heather moorland giving a rural and wild character. The agricultural lands on the lower slopes provide a distinct edge to the mountains. The few settlements are restricted to the lower sheltered areas. Telecommunication masts are dominant on some of the high points and wind farms lie on some of the areas outside the study area, although views of wind farms are possible to the north. The extensive panoramic views available from the promontories are an important characteristic of these areas. Therefore, these expansive elevated views, moderated by the fact that turbines are already a feature in some views, are judged to give a visual sensitivity to the type of proposed change of High to Medium.

The Mounth (LCA No.13, Figure 5)

The eastern half of The Mounth character area lies within the study area. It is surrounded by the Agricultural Heartland landscape type. The Mounth is a substantial undulating ridge that is a dominant presence in views from the south of Aberdeen. The areas within the study area are heavily forested with some exposed higher areas of heather moorland. The landscape becomes higher and more open towards the south west of the study area. The LCA describes it as having a 'wild and exposed character with commanding views into tranquil farmed lowland'. The Mid Hill Wind Farm lies within a forested part of The Mounth and there are several wind farms in the adjacent lowland areas to the south. Taking into consideration the importance of the views into the 'tranquil farmed lowland' and the presence of wind farms in some views, the visual sensitivity to the type of change proposed can be judged as being High to Medium.

Banff and Buchan Landscape Character Assessment

This LCA covers the northern extents of the study area. Within this area there are four landscape types identified; Coast, Coastal Farmland, Agricultural Heartlands, and River Valleys. The River Valley type and two areas of Agricultural Heartlands are not included as the ZTV shows there is no intervisibility with the site from these areas. The Coast is covered by the seascape units and so will not be assessed separately here.

3.4.3. **Agricultural Heartlands**

This landscape type continues from the Agricultural Heartlands type set out in the South and Central Aberdeenshire LCA. There are three character areas of this type within the study area. Wooded Areas around Old Deer, and Upland Ridges South of the Deveron character areas have not been assessed as the ZTV shows that there will be very limited if any intervisibility with the EOWDC. It is only the Agricultural Heartlands character area which will potentially have intervisibility and is discussed below.

Agricultural Heartland (Landscape Area) (LCA No.18, Figure 5)

The Agricultural Heartland landscape area is a large area of gently rolling farmland which extends to the coastal plains. It has many small settlements and also some larger villages and frequent farmsteads. The large field pattern is defined by a variety of boundary types such as fences, hedges and stone walls. It is also interspersed with small coniferous blocks and broad leaved trees. This relatively simple and large scale landscape contains several small wind farms with many more consented and lodged in the planning process. Open views of the surrounding landscape are a key characteristic of the Agricultural Heartlands. The visual sensitivity to the type of proposed change is considered Low given it is a large scale landscape with existing turbines already a feature in views within and outside of the character area.

3.4.4. **Coastal Farmland**

The Coastal Farmland type extends from the Agricultural Heartlands to the coast. There is just one area identified within our study area which is discussed below.

Eastern Coastal Agricultural Plain (LCA No.21, Figure 5)

This area links with the South and Central Aberdeenshire LCA Formartine Lowlands character area. It is a low coastal plain which gently undulates, but overall it can be described as an open and windswept area. It is predominantly agricultural land with some areas of boggy land at St Fergus Moss, Rora Moss and Moss of Cruden. There are constant views of the sea with only a few intervening conifer blocks and shelterbelts. Several small wind farms exist in this area with several more in planning. It is judged that due to the openness and characteristic views beyond the character area to the sea, the visual sensitivity to the type of proposed change is Medium to Low.

3.5. Aberdeen LCA

The Aberdeen LCA identifies five landscape character types; Major River Valley, Hills, Open Farmland, Wooded Farmland and Coast. These have been divided into 27 character areas, six of which do not have any intervisibility with the site following review of the ZTV. The three coastal areas and Murcar and Potterton areas are not discussed as they are covered by the seascape units. Therefore, the key visual characteristics of the remaining 16 character areas are described below.

3.5.1. Major River Valleys

The river valleys of the Don and the Dee are significant landscape features within the Aberdeen area. The Don valley up to where it is channelled through the city has been divided into three separate character areas, namely; Upper Don Valley, Dyce Plain, and Lower Don Valley. The ZTV shows that there is no intervisibility between the site and the Dee Valley and the Lower Don Valley character areas. The remaining valley areas are discussed below.

The Upper Don Valley (LCA No.23, Figure 6)

This area of the Don valley has a large scale valley landform which is generally enclosed with considerable areas of woodland. There are local confined views along the River Don and also short views east towards the edge of Dyce and Aberdeen. Longer distant views of hills to the west can also be seen. It is a sparsely settled area and pylon lines are dominant through the valley, as well as a large sand extraction site. The visual sensitivity of the Upper Don Valley to the type of proposed change is therefore considered Low due to the inward looking unobtrusive nature of much of the valleys length.

Dyce Plain (LCA No.24, Figure 6)

The Dyce Plain, is a more open part of the river Don valley and affords distant views from higher parts which also feature the extensive industrial estates, airport, and heliport. The visual sensitivity of the Dyce Plain to the type of proposed change is considered Low, as although it is more open, it is a chaotic area with many distracting elements in the foreground such as the airport and industrial estates.

3.5.2. Hills

Gently rounded hills form a distinctive edge to the west of the city and a small section to the south east. There are four specific character areas; Tyrebagger Hill/Kirkhill, Brimmond Hill, Gairnhill and Kincorth & Tullos hills. Gairnhill is not included in the assessment as the ZTV shows that this low hill west of Aberdeen will not have any intervisibility with the EOWDC.

Tyrebagger Hill/Kirkhill (LCA No.27, Figure 6)

Tyrebagger Hill and Kirkhill rise to 233m above ordnance datum(AOD) and lie at the north west limits of Aberdeen. The rounded hill is predominantly covered by coniferous woodland on the hill top and farmland on the lower slopes. The elevation of this area has meant it has become a landmark and it terminates views from many viewpoints from within the city and surrounding areas. Long distant views in all directions are available from the open areas around the woodland. These views include Aberdeen and the sea as well as towards the more rural west. The visual sensitivity to the type of proposed change is therefore considered to be High to Medium, taking on board the diverse elements which will exist with the views.

Brimmond Hill (LCA No.28, Figure 6)

Located to the west of Aberdeen, south of Tyrebagger and Kirkhill, Brimmond Hill rises to 266m AOD and nearby Elrick hill is 200m AOD. Their lower slopes are mostly agricultural land which opens out to moorland on the summit of Brimmond Hill, with some mixed woodland leading up to Elrick Hill's summit. Brimmond Hill has a cluster of masts on its summit which are dominant man-made features in this area and can be seen for some distance. Overall the area forms a strong, visible contrast, especially with the open moorland summits, with the adjacent urban areas. Views from the hilltops are expansive and include the Grampian Outliers to the west and across the city to the sea in the east. Distant existing wind turbines can be seen within these views to the north and north west. The character area's visual sensitivity to the type of proposed change is considered to be Medium given the characteristic hilltop views and presence of large manmade structures within the area.

Kincorth and Tullos hills (LCA No.30, Figure 6)

Kincorth and Tullos hills are a gently rounded ridge line of elevated ground to the southeast of Aberdeen which forms the southern skyline in views from the city. They have an open character dominated by heath vegetation and although predominantly used for recreation there is landfill waste on the northern side of Tullos hill and the hills are surrounding by industrial parks and residential areas. Views across the city are a key characteristic and especially towards the River Dee and Aberdeen Bay. These views take in a variety of natural and manmade elements including the vertical tower blocks at Seaton and Stockethill. Therefore, the visual sensitivity to the type of proposed change is considered Medium.

3.5.3. **Open Farmland**

Broadly corresponding with the adjoining Aberdeenshire LCA's Agricultural Heartland landscape type, the Open Farmland forms much of the immediate hinterland of the city. Murcar and Potterton character areas are not included as they lie within the Aberdeen Bay seascape unit. Also, Clinterty/West Brimmond Farmland and Anguston/Leuchar/Easter Ord character areas are not assessed as the ZTV shows there will be no intervisibility of the EOWDC with these areas.

Perwinnes (LCA No.31, Figure 6)

This area has a gently rolling landform with shallow basins at Perwinnes Moss and Corby Loch which are local nature conservation areas. It is generally higher than adjacent areas so affords distance views across the farmland and to the edges of Aberdeen. The farmland consists of mainly pasture and rough grazing with post and wire fencing with small areas of woodland. Settlement is sparse but manmade elements such as sand extraction and the radar station at Perwinnes are very visible elements within the landscape. It is judged that the visual sensitivity to the type of proposed change is Medium due to the possibility of views outside of the character area but also taking into account dominant elements such as the radar.

East Elrick (LCA No.34, Figure 6)

The East Elrick open farmland character area lies at the edge of the eastern slopes of Brimmond Hill, but is a relatively flat landscape. There are very few distinguishing elements; it is a simple agricultural landscape with sporadic trees, sparse settlement, and a network of minor roads. Extensive views out to the north are a key characteristic but landform and forest cover prevents views to the wider landscape in other directions. In addition, the masts are visible on Brimmond Hill and also the industrial estates at Dyce. Therefore, it is considered the visual sensitivity to the type of proposed change is considered Medium to Low.

Newhills (LCA No.35, Figure 6)

This is a relatively large character area which lies at the western edge of the city and extends to the slopes of Brimmond and Elrick Hills. The landform is 'saucer-shaped' which is predominantly agricultural with marshland in the lower central part. Hedgerows and extensive shelterbelts are a characteristic. Views are enclosed by the rising landform which surrounds the area but the elevation of the area does allow views towards the urban edge, Dyce industrial estate and radar station at Perwinnes. The visual sensitivity of the character area towards the type of proposed change is considered Low due to the generally enclosed nature and dominant manmade features within the long distant views that are available.

Maidencraig (LCA No.36, Figure 6)

This linear character area comprises the shallow valley of the Denburn. The open farmland includes a local nature reserve at Den of Maidencraig which has large areas of woodland planting. The landscape has a more intricate smaller scale than other areas of open farmland and some distinctive lines of trees along the main roads. It is a well settled area with the encroachment of residential developments from the edge of Aberdeen. The landform encloses the area which restricts long distant views to beyond, except for the clock tower of Woodend Hospital which is prominent in views towards the east. Therefore, the visual sensitivity of Maidencraig to the type of proposed change is considered Low.

Kingshill/Bogskeathy (LCA No.37, Figure 6)

Kingshill/Bogskeathy character area is a gently sloping plateau which is enclosed by the higher ground to the north, and coniferous plantations to the west and east. However, views to the south east towards the hills at Kincorth and Tullos are available, and the tower blocks at Stockethill can also be seen. Within the area, it is open pasture/grazing land, with some intervening blocks of coniferous woodland. The few buildings in the area are mostly located along the minor roads or edges of the character area. Taking into account the above it is considered that the visual sensitivity to the type of proposed change is Medium to Low.

Den of Leggart (LCA No.38, Figure 6)

Den of Leggart is a shallow valley landscape located on the western side of the A90 and Kincorth Hill. The open farmland consists of small scale fields bounded by stone dykes often overgrown with scrub and grasses. Views are restricted by the higher valley sides except to the north where views are directed to the western extents of Aberdeen. Long distance views beyond Northfield and Mastrick are limited. Due to the restricted and relatively short distance views, the visual sensitivity to the type of proposed change is considered Low.

Loirston (LCA No.39, Figure 6)

This character area is the southernmost area in the Aberdeen study area. It lies to the east of the A90 and south of Kincorth Hill. It has a gently rising landform which includes a lower area at Loirston Loch. There are industrial and residential areas to the north and east but elsewhere it is open farmland which lies between the A90 and the development. The urban influences are dominant and restrict any views to the wider area. Therefore it is judged the visual sensitivity to the type of proposed change is Low.

3.5.4. **Wooded Farmland**

There are five Wooded Farmland landscape areas identified within the LCA, four of which have potential intervisibility with the proposed development.

Braes of Don (LCA No.42, Figure 6)

The Braes of Don is a gently rolling landscape with a mix of woodland and pasture with distinctive shelterbelts. Grandholme moss is a natural feature on the lower ground. There is some residential development extending into the area from the south. Power lines cross the landscape from north to south and there is a network of roads across the area. Glimpsed views of the edges the Lower Don valley are available but views out are not a characteristic. Therefore the visual sensitivity towards the type of proposed change is considered Low.

Craibstone (LCA No.43, Figure 6)

This is a strongly undulating landscape which forms a distinctive approach to the city from the north west from the A96. It lies on the eastern side of Tyrebagger hill extending towards the urban edge of Dyce. This high ground restricts views towards the west but where woodland allows, views of the sea are possible, and to the city and coast to the east. Settlement is sparse and the Macaulay

Institute buildings are quite dominant. The visual sensitivity towards the type of proposed change is considered Medium given the characteristic views towards the coast.

Kingswells (LCA No.44, Figure 6)

Kingswells wooded farmland landscape area lies around the suburb of Kingswells and on the lower slopes of Brimmond Hill. There are not any large areas of woodland but it is identified as wooded due to the presence of tree clumps, boundary trees and shelterbelts. Since the LCA was written Kingswells has developed significantly and the rural nature has now become more of an urban edge character. Views to the surroundings are limited due to the surrounding higher ground except to the east where they extend further towards the city centre. Also the masts on Brimmond Hill are prominent in views. It is therefore judged that the visual sensitivity to the type of proposed change is Low.

Hazlehead (LCA No.45, Figure 6)

Hazlehead has a gently undulating landform which lies at the western extents of Aberdeen. It consists of Hazlehead woodlands, open areas of golf courses, a public park, recreational areas, school playing fields, garden centre, and also a riding school. There are few buildings and many footpaths, bridleways and minor roads. The woodland encloses the areas and views out to the wider landscape are not a characteristic. Therefore the visual sensitivity to the type of proposed change is considered Low.

Table 1.7: Landscape Character Areas Baseline

Character type	**Character area**	**Approximate closest distance to nearest turbine**	**Visual sensitivity to type of proposed change**
South and Central Aberdeenshire LCA			
Agricultural Heartlands	Formartine Lowlands	3km	Medium to Low
	Central Wooded Estates	7.5km	Low
	Kincardine Plateau	14.5km	Low
	Ythan Strath Farmland	17km	Low
	Northern Rolling Lowlands	22km	Low
	Gavock and Glenbervie	27km	Medium to Low
	Insch Basin	23km	Not within ZTV
	Howe of Alford	37km	Not within ZTV
Moorland Plateaux	Grampian Outliers	27km	High to Medium
	The Mounth	25km	High to Medium
Straths and Valleys	Deeside	30km	Not within ZTV
Farmed Moorland Edge	Cromar Uplands	33km	Not within ZTV
Coastal Strip	Formartine Links and Dunes	3km	Included within Seascape Units
	Kincardine Cliffs	10km	
	Kincardine Links	25km	
Banff and Buchan LCA			
Agricultural Heartlands	Agricultural Heartlands (area)	22.5km	Low

Character type	Character area	Approximate closest distance to nearest turbine	Visual sensitivity to type of proposed change
	Wooded Areas around Old Deer	25km	Not within ZTV
	Upland Ridges South of the Deveron	25km	Not within ZTV
Coastal Farmland	Eastern Agricultural Coastal Plain	17km	Medium to Low
River Valleys	Deveron and Upper Ythan Valley	28km	Not within ZTV
Coast	Dunes and Beaches from Fraserburgh to Peterhead	33km	Included within Seascape Units
	Cliffs of the North and South East Coasts	17km	
Aberdeen LCA			
Major River Valleys	Upper Don Valley	12km	Low
	Dyce Plain	10km	Low
	Lower Don Valley	5km	Not within ZTV
	Dee Valley	12km	Not within ZTV
Hills	Tyrebagger Hill/Kirkhill	12.5km	High to Medium
	Brimmond Hill	14km	Medium
	Gairnhill	15.5km	Not within ZTV
	Kincorth/Tullos Hills	9km	Medium
Open Farmland	Perwinnes	7km	Medium
	Potterton	4.5km	Included within Seascape Units
	Murcar	3km	
	East Elrick	13km	Medium to Low
	Newhills	10km	Low
	Maidencraig	12.5km	Low
	Kingshill/Bogskeathy	14km	Medium to Low
	Den of Leggart	12.5km	Low
	Loirston	12km	Low
	Clinterty/West Brimmond Farmland	16km	Not within ZTV
	Anguston/Leuchar/Easter Ord	17km	Not within ZTV
Wooded Farmland	Braes of Don	7km	Low
	Craibstone	11km	Medium
	Kingswells	13.5km	Low
	Hazlehead	12km	Low
	Countesswells / Milltimber / Kennerty	13km	Not within ZTV

Character type	Character area	Approximate closest distance to nearest turbine	Visual sensitivity to type of proposed change
Coast	Doonies/Cove Coast	9km	Included within Seascape Units
	Girdle Ness/Nigg Bay	8km	
	Aberdeen Links	3km	

3.5.5. **City of Aberdeen**

The heart of Aberdeen lies approximately 8km from the nearest turbine of the proposed development. The character of the landscape surrounding the city has been described above but it is also important to look at the character of the city itself. Again, the proposed development will not have a direct material effect on the city itself but only on those aspects which could potentially have a visual sensitivity. The setting of historic buildings and features within the city is discussed in Chapter 7.6 Cultural Heritage.

The Aberdeen LCA (SNH, 1996) has helpfully assessed the setting of Aberdeen as a city. It has looked at the perception of Aberdeen and its relationship to the surrounding landscape, and the landmarks of the city.

The built-up nature of cities means that long distant views out to the surroundings are often not available except from elevated areas. The LCA identifies that within the city centre there are few, if any views out to the wider area and the main visual sensitivities would be confined to those areas within the outer elevated edges of the city and the coastal edges. It is from these areas that there are opportunities for views across the whole city and the landscape setting can be appreciated. The elevated urban areas include parts of the local areas of Tullos, Kincorth, Torry, and Kaimhill at the south of Aberdeen, and Seafield, Stockethill, Northfield and Hilton to the west and north-west. Within these areas, main roads such as the A96 near Tyrebagger Hill and the A90 near Kincorth Hill allow views across the city within its setting between hills and the sea. These roads give a sense of arrival to the city. The A90 to the north of Aberdeen gives less of an overview of the whole city but the association of the coast to parts of the city is strong when approaching from the north. Other gateways can be found at the city bridges crossing the rivers Dee and Don. The coastal railway route from the south also has a sense of arrival with the contrast of the coastal cliffs to the built up area of southern Aberdeen with views across the River Dee.

Landmarks include the hills which have been discussed in the landscape character above, but also the many historic spires and towers within the city centre and also Girdle Ness lighthouse. Other more modern landmarks include several 1960's and 70's tower blocks, one cluster near the coast at Seaton and another inland at Stockethill and Northfield. These are very prominent in most views of the city. Telecommunication masts at Northfield, Brimmond Hill and radar station at Perwinnes are also features within the views of Aberdeen. Expanding large industrial areas including office developments mostly lie at either the southern side of Aberdeen at Altens and also to the north at the airport and Bridge of Don areas. Also prominent in views of the city, there is a demonstration oil drilling platform which lies on the coastal area beside the Exhibition centre, north of the city.

The visual sensitivity of Aberdeen city to the type of proposed change is judged to vary between negligible and high across the city depending on density and orientation of buildings, elevation, and existing features within open views. Specific areas will be addressed in the visual assessment.

4.0 Meteorological Context

The degree, extent and likelihood of visual effects arising from the proposed development is an amalgam of a variety of different factors, not least the prevailing weather conditions that occur at any one time and can determine changes in character and visibility with varied wind, light, tidal movements and the clarity or otherwise of the atmosphere.

Two visibility data sets were obtained from the MET Office and these are presented in Appendix 2. These show the average distances of visibility over a 30 year period taken from Dyce (Aberdeen Airport) and also offshore locations from ships in the North Sea, east of Aberdeen beyond the 60 km study area. The locations of these data sets provide a good indication of the local conditions but it is acknowledged that they cannot represent the visibility from the whole of the study area. In particular, along the coastline of the North Sea, visibility can be affected by 'haar' between April and September which may not have been picked up in the presented data sets due to their source location. Haar is a sea fog caused when warm continental air is cooled and moistened by the North Sea. These fogs are normally shallow in depth and often lift inland where it is burnt off by the sun. Haar has been recorded as present along the east of Scotland within the spring and summer of up to 14 days per month in exceptional years (North Sea Pilot, 1997; DTI, 2004).

Analysing the data sets presented in Appendix 2, the following tables (4.1 and 4.2) provide a summary of the percentage of time of visibility at the various distances listed. Please note that the offshore ship sourced data and the Dyce data are not recorded with the same distance intervals so there is limited direct comparison that can be made.

Tables 4.1 and 4.2

Dyce Meteorological Station Data	
Kilometres Visible	**% of time**
<10	19
10-15	8
15-20	9
20-25	11
25-30	13
30-35	16
35-40	8
40-45	10
>45	6

Offshore Ship Sourced Data	
Kilometres Visible	**% of time**
<10	13
10-20	22
20-50	61
>50	4

Analysing the data sets shows that there are no noticeably strong trends and, as would be expected, the percentage incidence of visibility decreases to some degree with increasing distance, notably beyond 35 km onshore at Dyce and beyond 50 km offshore, although the offshore data does not provide a detailed breakdown between 20 km and 50 km. At Dyce, 19% of the time visibility is less than 10 km which is not an insignificant period (1 day in 5), and almost 50% of the time visibility is less than 25km (every other day). However, it is acknowledged that visibility is also possible beyond 25km for 50% of the time, albeit to varying distances.

Overall, it is clear that the visibility from these particular points in the study area varies considerably and that the EOWDC will not be seen 100% of the time, even at the closer distances, and this is an important factor that should be taken into account in the assessment of the effects upon land/seascape character and visual amenity.

5.0 Baseline Visual Environment

The inherent visibility of wind farm developments and the resulting effect on the visual environment are often cited as a concern for local residents and visitors alike. The purpose of the visual assessment is to determine the visibility of the proposed development and to establish what the anticipated visual effect of the proposals would be from a range of representative viewpoints within the study area.

5.1. Zone of Theoretical Visibility

The computer generated ZTVs to nacelle and blade tip (Figures 7, 8 and 9) identify key stretches of the coastline and hinterland from which the proposed offshore wind farm development may theoretically be visible. At the baseline stage, reviewing the ZTV is important to understand the potential areas from where the development could be visible, and equally, where it won't be visible. Appendix 4 details the methodology used for creating the ZTVs.

5.2. Key Visual Receptors

A wide variety of visual receptors will be potentially affected by the proposed development. These receptors will vary considerably depending on the intricacies of the coastline and will include local residents, those travelling through the area and those visiting the area for recreational and amenity purposes. Most of these will be onshore receptors, but there is potential for offshore receptors such as those travelling or working on boats or even oil platforms. This report focuses on the following three key categories of visual receptors: local residents, the travelling public and visitors to the area. It is acknowledged that one person can fall into more than one of the three categories. Please also refer to the assessment methodology in Appendix 2.

5.2.1. Residents

Local residents are judged to have a generally High level of sensitivity to the type of change proposed where views of the proposed site are available to them. The ZTVs indicate that residents within the coastal edges and elevated areas of Aberdeen and its suburbs, with coastal villages and towns to the north of Aberdeen, are those most likely to have views of the proposed development. The coastal settlements of Blackdog and Balmedie are the nearest to the development.

5.2.2. The Travelling Public

This category of visual receptors includes both residents/commuters and those who travel to or through the study area, both on land and at sea. It is considered that this group will have an average Medium to Low level of sensitivity to the type of proposed change, depending upon the purpose and objective of the traveller, on account of the transitory nature of views in any one direction.

Roads

There are several main roads throughout the study area. The A90 is the key road which links Aberdeen to the south and also links Fraserburgh and Peterhead in the north. The A90 is the closest road to the EOWDC, running parallel to the coast, 1 km inland. The section of the A90 between Balmedie and Tipperty, to the north of the EOWDC has planning permission to be dualled, although timescales for construction are not known at this time. The A96 is the main road between Aberdeen and Inverness and extends to the north west of the city. Along Deeside, the A93 extends from Aberdeen to Banchory within the study area. The A920, A948, A947 are other main roads within the northern area of the study area and the A944 to the west of the city. There is also a network of many B roads and minor roads which cross the open farmland, becoming slightly sparser towards the western and south western extents of the study area where it is more remote and mountainous.

The proposed Aberdeen Western Periphery Route (AWPR) lies inland from Stonehaven, around the western extents of Aberdeen and turns east at Dyce to join the A90 at Blackdog, directly opposite the EOWDC. Although recently consented is it currently subject to legal challenges and therefore can't be assumed that it will be constructed. It therefore will not be included in the assessment, although reference may be made if appropriate.

Rail

The main east coast railway line terminates at Aberdeen after following the dramatic cliff coastline from Stonehaven to Nigg. At Nigg the line curves inland towards Aberdeen station to the west of the Harbour. Where cuttings and vegetation allow, the stretch of line from Stonehaven to Aberdeen allows extensive eastern views across the North Sea.

Public Paths

There are many accessible public paths and cycle routes around Aberdeenshire and the coast. Aberdeenshire Coastal Path is part of the North Sea Trail which is a route that links parts of the North Sea exposed coasts of Scotland, England, Norway, Sweden, Denmark, Germany and the Netherlands. The trail covers almost the entire Aberdeenshire coast and Aberdeenshire Council has produced 38 separate maps (of which maps 6-23 cover the study area) (The North Sea Train, undated) which detail the route and provide information on features of interest. These have been taken into consideration in the description of the seascape units and also several of the viewpoints are located on the route. The coastal routes include parts of the main roads where walking paths are not available.

Sea Routes

Aberdeen is a busy harbour, as is Peterhead, and many of the other smaller coastal villages also have frequent marine activity. Passenger ferries to Orkney and Shetland are also regular from Aberdeen. The Shipping and Navigation Assessment details the routes across the North Sea.

The Royal Yachting Association (RYA) UK Coastal Atlas of Recreational Boating (RYA, 2009) illustrates the cruising routes in the study area which are all 'medium' recreational use which means that they are '*popular routes on which some recreational craft will be seen at most times during summer daylight hours*.' Within the study area routes are shown between Stonehaven, Aberdeen and Peterhead, with other routes from further afield in the outer waters.

In RYA's response to the scoping opinion request (Aug 2010) they explain that recreational sailing within the study area mainly follows an inshore route from the Firth of Forth to Peterhead, often at night to avoid the busy harbour traffic at Aberdeen and Peterhead.

Also of importance, the RYA Position Statement of Offshore Renewable Energy Developments (RYA, 2005) recognises '*recreational activity is important to the health and wellbeing of the community as well as economic support for the local coastal economies. Retaining the undisturbed remoteness of some waters will be important in terms of its wilderness and amenity value*.' However, with the busy shipping and fishing activities in the surrounding waters of the EOWDC, the terms 'remoteness and wilderness' are not so relevant for the character of the sea in the immediate study area.

Visitors and the Tourism/Amenity Resource

This category embraces a wide variety of individual visual receptor groups whose principal preoccupation is with the enjoyment of the outdoor environment, the open countryside and the tourism / amenity resource the coastline offers. These visual receptor groups will have different objectives, and thus differing levels of sensitivity to any change in the fabric or the character of the seascape units and visual effect arising from the proposed development. On average, the sensitivity of this receptor group is likely to vary between Medium and High.

People in this receptor group include users of footways and cycle routes and visitors to coastal facilities and beaches; golfing; accommodation including hotels, caravan and camp sites; car parking; water sports, boating, and country parks.

5.3. Viewpoint Description

To help define the existing visual baseline environment, it is accepted practice to select and agree upon a number of representative viewpoints within the visual envelope of the development. The representative viewpoint locations as agreed with the consultees are illustrated on Figures 10 and 11.

The character of the existing view from the 20 representative viewpoints is described below (in approximate order of distance from the development) and the sensitivity of the identified visual receptor group to the type of proposed change is described. A synopsis of the baseline sensitivity is also detailed in the summary table at the end of the EIA Technical Report. Photographic panoramas for each viewpoint are shown in Figures WF 01-20.

5.3.1. **Viewpoint 1 – Balmedie Beach**

Balmedie Beach is a popular coastal country park located 3.51 km north west from the nearest turbine of the EOWDC, and lies within the Aberdeen Bay seascape unit. The view is representative of that available to visitors to the beach. A 180 degree view can be seen clockwise from the north round to the south, with the sand dunes precluding any views to the west. The foreground is simply a sand beach with marram grass topped dunes behind. The North Sea is the main feature of the view with often large ships travelling across the horizon which can also be static features in anchorage areas which lie in the vicinity. To the north views include the coastline curving round to the Ythan Estuary and Forvie Sands. This northern view is generally very harmonious with few obvious human influences. Views to the south extend around to the headland at Girdle Ness where the lighthouse is visible in the horizon. Aberdeen city is clear extending to the developments on the beach front. The drilling platform at the Technology Park near Bridge of Don is also visible. Overall the panoramic views from Balmedie Beach offer contrasting views to the north and south. There is a tranquil feel with only the sound of the waves and intermittent noise from helicopters and airplanes flying overhead. The immediate surroundings are unspoilt and the sand dunes shelter views inland. Therefore the sensitivity to the type of proposed change on the key receptor group of visitors to the beach is considered High.

5.3.2. **Viewpoint 2 – A90 (Harehill turn off)**

This viewpoint is 4.44 km south west from the nearest turbine of the EOWDC. It is representative of views available to travellers on the A90 and lies within the Aberdeen Bay seascape unit. The view towards the coast is generally of flat rough grazing land with manmade landfill mounds either side of the A90 breaking up open views of the North Sea. There is quite an industrial presence mostly associated with the landfill. There are scattered houses and farms within the coastal plain which has a gradual descent towards the sea. Although beyond the photographic panorama shown in Figure WF-02 Murcar Golf Club house is visible to the east at the edge of the links course and views towards Aberdeen extend across the sea to Girdle Ness. The Girdle Ness lighthouse is prominent in the skyline as are the drilling platform and tower blocks, and large industrial buildings in the foreground. It is quite a discordant view with the A90 and adjacent landfill and developments dominant in this part of the view. Therefore the sensitivity to the type of proposed change on the key receptor group of travellers on the A90 is considered to be Medium to Low.

It is also noted that the proposed AWPR would join the A90 just north of the Harehill turn off and would potentially be a dominant feature in the area.

5.3.3. **Viewpoint 3 – Jesmond Drive, Middleton Park**

This viewpoint is 7.14 km south west of the nearest turbine of the EOWDC. The viewpoint is on Jesmond Drive, just north of Oldmachar Academy and looks over a recreation ground. The view is representative of that available to local residents within Middleton Park, a residential area to the north of Aberdeen. There are building works at the edge of the recreation ground and large deciduous trees encompassing the area. The high open land at Perwinnes is just visible behind the trees. It is a relatively simple view, but active with the surrounding school, sports pitches and residential area. The sensitivity of the key receptors of local residents to the proposed type of change is therefore judged to be High.

5.3.4. **Viewpoint 4 –Whitecairns (B999)**

This viewpoint is located 8.10 km west of the nearest turbine of the EOWDC. The view is representative of that available to local residents and travellers on the B999. The viewpoint is located on a layby on a minor road at Whitecairns just off the B999, and is within the Formartine

Lowlands character area. Pasture in regular medium sized fields bounded by post and wire fencing lie in the foreground gently sloping towards the B999. The land on the east of the B999 rises considerably to a local high point of 130m AOD. This elevated land has been quarried in one area and is covered by a mix of open pasture, scrub and woodland. Settlement and industrial/farm buildings are visible on the lower enclosed land along the main road with shelterbelts and small areas of woodland. The landscape scale is medium to large with some enclosure given by the undulating land. The view, although relatively simple in components, has a discordant feel. The sensitivity of the key receptors of travellers and local residents to the type of proposed change is judged to be Medium to Low for travellers and High for residents.

5.3.5. **Viewpoint 5 – Aberdeen Beach**

This viewpoint is located on the Beach Boulevard from a point just south of the Codonas Amusement Park and is representative of views available to visitors to the beach and lies within the Aberdeen Beach seascape unit. It is 7.52 km from the nearest turbine of the EOWDC. The development along the beach front lies at a considerable height above the sand and sea. A grass embankment with occasional stepped and ramped access takes the level down from the road to another wide boulevard which lies a few meters above the beach. The beach is accessed at specific points and is divided by timber groynes at regular intervals for the length of beach to the mouth of the Don. There are also some sea defences consisting of large rocks visible at the end of the groynes. Street lighting along the beach road pulls the eye around the curved bay past the Beach Ballroom, Leisure Centre and towards the football stadium. Further around the beach the demonstration drilling platform intersects the skyline beyond the Bridge of Don. Views extend past Balmedie to Peterhead where the power station stack is just visible in the skyline. To the south the view is curtailed by Girdle Ness and the harbour. It is a diverse and active view with expansive views to the north and east. It is a large scale seascape incorporating many elements and long distant views. It is considered that the receptor group of visitors to the beach would have a High sensitivity to the type of change proposed.

5.3.6. **Viewpoint 6 – A90 (West Pitmillan turn off)**

This viewpoint is located just off the A90 at the turn off to West Pitmillan, approximately 9.31 km north west from the nearest turbine of the EOWDC. It is representative of views available to travellers on the A90. This stretch of the A90 is located on a plateau of high, gently rolling land within the Formartine Lowlands character area. There is an exposed feel with views of the sea and sand dunes at the coast available through the gentle undulations. There is a large farm at Pitmillan which is set into the landscape with shelterbelt planting behind. The agricultural land which lies either side of the road consists of large regular fields both arable and grazing with post and wire fencing. There are houses dispersed across the landscape with associated shelterbelts. The landscape here has a large open scale and is relatively uniform. The Hill of Fiddes wind turbines are visible on approach to the viewpoint but at the viewpoint are just hidden behind the hill to the west. The A90 is a busy main road and is a key part of the view, which will become a more significant feature following the planned dualling of this section of the road. The sensitivity of the key receptors of travellers on the A90 to the type of proposed change is judged to be Medium to Low.

5.3.7. **Viewpoint 7 – Torry Battery**

This viewpoint is taken from the public car park at Torry Battery on the headland which overlooks Aberdeen Harbour and the beach beyond. It is located 7.89 km south of the nearest turbine of the EOWDC. It is representative of views available to visitors to the headland and walkers on the coastal path and lies within the Aberdeen Beach seascape unit. The view encompasses the whole of Aberdeen Bay and beyond to the power station stack just visible at Peterhead. In the foreground the view is across the entrance to the Harbour and its associated industrial buildings. Aberdeen Beach is visible behind the harbour entrance wall and the city with the developments along the coast including the tower blocks at Seaton which are very visible. The rolling hills that surround Aberdeen in the west are visible behind the cityscape. As the view moves across to the east, the exhibition centre and demonstration oil drilling platform are visible in the skyline. Balmedie and the dunes can be seen extending eastwards across the horizon where the large expanse of the North

Sea becomes dominant with frequent movement of ships and boats giving some scale to the view. There is a diversity of elements within the view including a very active foreground. Therefore the sensitivity of the key receptors of visitors to the headland and coastal path walkers to the type of proposed change is considered High to Medium.

5.3.8. **Viewpoint 8 – South College Street, Aberdeen**

This city centre viewpoint is located on South College Street which runs parallel to the train station. It is located 9.19 km south west of the nearest turbine of the EOWDC and is representative of views available to workers, shoppers, and travellers. An advertising board lies alongside the footpath. The other side of the road is bounded by a concrete block wall approximately 2 m high. A ten storey office building is the main element in the view, with a red brick multi-storey car park for the Union shopping centre in the middle ground. A tall hotel building stands to the left of the car park. Thereafter, to the left of the view, just the tops of various buildings are visible above the wall. The Salvation Army Citadel granite tower is quite prominent between the tops of the buildings. Also visible is the spire of Kirk of St Nicholas. The view consists of a variety of materials and types of buildings giving a slightly discordant character. It is an active area with constant traffic and train movements. The sensitivity of the key receptors of workers, shoppers and travellers to the type of proposed change is therefore considered Low.

5.3.9. **Viewpoint 9 – Forvie Nature Reserve**

Forvie Nature Reserve is a large expanse of sand dunes on the northern side of the Ythan estuary. There are marked walking routes around and across the dunes. The viewpoint is located within the centre of the dune system on one of the paths and lies within the Aberdeen Bay seascape unit. It is approximately 10.27 km north of the nearest turbine of the EOWDC. The viewpoint is representative of those available to visitors to the nature reserve. The sand dunes are mostly colonised by grasses and in some of the more sheltered areas there are small wind sculpted trees. There is a remoteness and almost bleakness when within the dunes although the noise of the nearby main road is discernable and the helicopter flight path to the airport is directly overhead. The dunes do provide some enclosure which opens out in places and at the viewpoint location the view opens out to the curve of Aberdeen Bay to Girdle Ness and the Seaton tower blocks are visible in the horizon, although detail is hard to discern at this distance. Walking towards the west, to the visitor car park, there are some views of the Hill of Fiddes turbines. Due to the remote and generally unspoilt landscape the sensitivity of the key receptors of visitors to the type of proposed change is considered High.

5.3.10. **Viewpoint 10 – Midstocket Road/North Anderson Drive (A90)**

This viewpoint, which is 10.47 km south west of the nearest turbine of the EOWDC, is located in an area of public open space to the south of housing at Raeden, just south of Woodhill House and the Aberdeen Royal Infirmary. It is representative of the views available to local residents, and travellers on North Anderson Drive (A90). This elevated part of Aberdeen affords intermittent long distant views across Aberdeen to the coast. The foreground of the view is mostly grass with some young tree planting. Four storey housing lies at the edge of the open space and the tower blocks at Stockethill are very prominent in the skyline behind. Some of the hospital buildings are visible behind the trees including a large chimney and the tower blocks of Seaton on the coastline are visible behind. It is an active and noisy area with the main road, schools and hospital in the area. Therefore the sensitivity of the key receptors of local residents and travellers on the A90 to the type of proposed change is considered High for residents and Medium to Low for travellers.

5.3.11. **Viewpoint 11 – Leslie Road (A978), Aberdeen**

Leslie Road is aligned in a north east – south west direction which is in line with the proposed development. There are no views of the coast but the elevated position suggests that the proposed development may be visible. This viewpoint is located 8.07 km from the nearest turbine of the EOWDC and is representative of views available to local residents and travellers on the road. The road is a busy thoroughfare but it is also a well-kept residential street with terraced two storey granite houses and some bungalows. The view looks towards a busy roundabout with commercial granite properties on the other side. It is considered that the sensitivity of the key receptors of local residents and travellers to the type of change proposed is High for residents and Medium for travellers.

5.3.12. **Viewpoint 12 – Kincorth Hill**

This viewpoint is located in a local nature reserve 11.56 km from the nearest turbine of the EOWDC and is representative of the view available to walkers and visitors. It lies within the Kincorth and Tullos Hills character area. It is a local high point at 105m AOD and is surrounded by Kincorth residential area to the north, Altens industrial estate to the east and Cove Bay to the south east. The A90 runs along the western boundary. The paths around Kincorth Hill are mostly enclosed by mixed woodland and scrub with some localised clearings. The viewpoint was taken from one such clearing with a bench on the high point which overlooks Aberdeen and to the north. Trees interrupt clear views but the curve of Aberdeen Bay is visible with Torry, and harbour buildings clear in view. The tower blocks at Seaton and other dominant buildings are just visible behind the trees. The tower of Nigg Kirk unexpectedly rises from the trees into the skyline to the right of view alongside the large office buildings of Altens. The viewpoint is very much influenced by the settlement and noise of traffic from the A90, although the vegetation gives some seclusion. The sensitivity of the key receptors of visitors and walkers to the type of proposed change is therefore considered High to Medium.

5.3.13. **Viewpoint 13 – Udny Station**

This viewpoint is located east of the small village of Udny Station on a local high point. It is 12.63 km north west of the nearest turbine of the EOWDC, and is representative of the views available to local residents. The landscape is characteristic of the Formartine Lowlands agricultural land, and includes wind turbines. The Hill of Fiddes turbines are located within a kilometre of the viewpoint but are partially hidden behind coniferous shelterbelt planting. Although not visible within the photographic panorama in Figure WF-13, distant views to Ardgrain wind farm can also be seen to the north of the viewpoint. Farm buildings and a cottage are visible in the foreground. The view extends across the agricultural lands with dispersed farms and houses and areas of woodland. Wooden telegraph poles lie across the view. It is generally a harmonious view with a large open scale. It is considered that the key receptors of local residents will have a High sensitivity to the type of proposed change.

5.3.14. **Viewpoint 14 –A96 at Kirkhill Forest**

This viewpoint is representative of the views available to travellers approaching Aberdeen from the A96. Due to the lack of a safe place to stop on the carriageway the entrance to Kirkhill Forest provides a comparative view. It is 14.13 km west of the nearest turbine of the EOWDC and lies within the Kirkhill and Tyrebagger Hill landscape character area. The view extends to the North Sea and provides an approximate 90 degree view enclosed by Kirkhill Forest to the north and the embankment planting along the A96. The foreground consists of small undulating rough grazing fields with stone wall and post and wire boundaries. Farm buildings and the tops of the houses at Chapel of Stoneywood appear from behind the undulating field. The woodland at Tyrebagger is visible in the middle ground with views of the taller buildings of Aberdeen city visible in the skyline to the right of view and within the sea in the centre of view. There is a small two blade turbine clear in middle ground. The residential areas on the higher ground north of Bridge of Don are visible to the left of view with agricultural land encroaching. The sea can be seen between the Bridge of Don and Kincorth Hill, and then a short stretch from Blackdog where coniferous trees in the foreground prevent further views. There are many telegraph poles also crossing the view. The mast at Northfield is very visible behind and above the tower blocks at the right of view. It is quite a discordant view with a variety of long and short distance elements. The sensitivity of the key receptors of travellers on the A90 to the type of proposed change is therefore considered Medium to Low.

5.3.15. **Viewpoint 15 – Brimmond Hill**

This elevated viewpoint is 14.41 km west south west of the nearest turbine of the EOWDC. It is representative of the views available to walkers and visitors and is within the Brimmond Hill landscape character area. Brimmond Hill is 266 m AOD and has several telecommunication masts on its summit. There are several paths which traverse around and ascend the hill. The hill is mostly covered by heather, gorse and scrub with some grass clearings. There is a vehicle track to the top to access the masts. There is a 360 degree available view extending to the Cairngorms and the foothills in the west and south west, and the rolling agricultural heartlands to the north. In the foreground, to the north Aberdeen Airport, Tyrebagger and Kirkhill forest are clearly visible. The coastline and boats far off in the North Sea are also visible to the east. The views are far ranging and encompass rural, agricultural and city scenes. Existing wind farms are visible to the north west. Due to the expansive views and diversity of elements within the view the sensitivity of the key receptors of walkers and visitors to the type of proposed change is considered High to Medium.

5.3.16. **Viewpoint 16 – Formartine and Buchan Way nr Quilquox**

The national cycle route runs along local roads in this area. The viewpoint is located on a road near Savoch and Quilquox. It lies on elevated land which affords expansive views across the landscape. The location is 25.98 km north west of the nearest turbine of the EOWDC and is representative of the views available to local residents and cyclists. It is within the Ythan Strath Farmland landscape character area. The view is of a large scale undulating landscape with large fields with stone walls and post and wire fencing. Wind turbines are common in this area and three turbines can be seen in this view. Four turbines lie just behind the viewpoint and three are obscured by the farm in the foreground. Bennachie is clearly visible to the south with other hills in the background. The coast is not visible. There is a uniform and cohesive character to the view with consistent elements across the landscape including wind turbines. The sensitivity of the key receptors of local residents and cyclists to the type of proposed change is considered High for residents and Medium for cyclists.

5.3.17. **Viewpoint 17 –Near Netherley, east of Durris Forest**

This viewpoint is 24.99 km south west from the nearest turbine of the EOWDC. It is located at the southern end of the Kincardine Plateau character area before the land rises to become the 'The Mounth' moorland plateau. It is representative of views available to local residents. The land surrounding the viewpoint is gently undulating. The land use is mainly agricultural with permanent pasture, arable, with some scrub and shelterbelt woodland. Durris Forest lies to the south west of the viewpoint. The fields are irregular, medium to large sized bounded by either stone walls or post and wire fencing. There are many individual farms and houses dispersed across the landscape accessed by a network of minor roads. There are prominent pylons in the skyline which run north south just in front of the viewpoint. The suburbs of Aberdeen are just visible with the tower blocks at Stockethill clear in the skyline, albeit at a distance. Woodland at Maryculter and Banchory Devenick are visible on the rolling hills to the right of view. It is a slightly fragmented landscape with scrub and rough grazing breaking up the medium to large fields, and with large pylons dissecting the scene. The sensitivity to of the key receptors of local residents to the type of proposed change is therefore considered High.

5.3.18. **Viewpoint 18 – A975 near Slains Castle**

This viewpoint is located at a public car park off the A975, north of Cruden Bay. It is representative of views available to visitors to the ruins of Slains Castle. It is located 22.23 km north of the nearest turbine of the EOWDC and lies within the Collieston to Peterhead seascape unit. The view looks across large open fields with the silhouette of the ruins of Slains castle in the skyline. The south of Cruden Bay is just visible within the craggy cliffs. Open large scale fields surround the view to the west and north. There is a simplistic nature to the view but this is punctuated by dramatic elements such as the Slains ruins and the cliff coastline. The key receptors of visitors are considered to have a High sensitivity to the type of proposed change.

5.3.19. **Viewpoint 19 –Mither Tap, Bennachie,**

Bennachie is a hill range in western Aberdeenshire. The distinctive peak of Mither Tap can be seen from the coast on clear days. It is a very popular walking destination in Aberdeenshire and can take as short as an hour to get to the summit. The viewpoint is located at the top of Mither Tap and is representative views available to walkers and visitors to the area. It is 32.02 km west of the nearest turbine of the EOWDC and lies within the Grampian Outliers character area. 360 degrees views are available from this viewpoint. The views extend inland across the top of Bennachie to the Cairngorms. On a clear day it is possible to see the coast and sea, although at some distance, and beyond an expansive view of the agricultural heartlands of Aberdeenshire. There are views of other wind farms dotted around in the surrounding landscape but they appear as small elements within the wider view. The key receptors of walkers are considered to have a High to Medium sensitivity to the type of proposed change due to the elevated nature and expansive views including existing wind farms. Please note that it was not possible to take a photograph panorama from the viewpoint due to adverse weather conditions at the time of the assessment.

5.3.20. **Viewpoint 20 - A92 near Uras**

This viewpoint is 33.58km from the nearest turbine of the EOWDC. The viewpoint was chosen as representative of views available to travellers on the A92, the coastal road. The landscape lies within the 'Inverbervie to Stonehaven' seascape unit. The land is gently undulating arable and pasture which slopes towards the coast and to the extents of the cliff tops. The fields are medium to large scale surrounded by stone walls and post and wire fencing. There is dispersed settlement across the area which includes cottages and a farm within the view. Wooden telegraph poles run across the left of the view. The cliffs north of Stonehaven to Girdle Ness are visible with the farmland and coastal settlements on top. It is, overall, a simple, intact and relatively large scale landscape with expansive views across the North Sea. The sensitivity of the key receptors of travellers on the A92 to the type of proposed change is considered Medium.

Table 1.8 Representative Viewpoint Baseline

	Location	**Grid Ref**	**Distance to Nearest Turbine (EOWDC)**	**Seascape Unit / Landscape Character Area**	**Main Receptors**	**Sensitivity of receptor to the type of change proposed**
1	Balmedie Beach	398035, 818190	3.51km	Aberdeen Bay ALS	Visitors/Walkers Coastal Trail	High
2	A90 (Harehill turn off)	395061, 813041	4.44km	Aberdeen Bay/Murcar Open Farmland	Travellers	Medium to Low
3	Jesmond Drive	392533, 811500	7.14km	(Aberdeen suburbs)	Residents	High
4	Whitecairns (B999)	391988, 818158	8.1km	Formartine Lowlands	Travellers Residents	Medium to Low High
5	Aberdeen Beach	395404, 806706	7.52km	Aberdeen Beach	Visitors/Walkers Coastal Trail	High
6	A90 (West Pitmillen turn off)	397470, 824886	9.31km	Formartine Lowlands	Travellers	Medium to Low
7	Torry Battery	396465,	7.89km	Aberdeen	Visitors/Walkers	High to

	Location	Grid Ref	Distance to Nearest Turbine (EOWDC)	Seascape Unit / Landscape Character Area	Main Receptors	Sensitivity of receptor to the type of change proposed
		805730		Beach	Coastal Trail	Medium
8	South College Street	394113, 805572	9.19km	Aberdeen City	Workers, Shoppers, Travellers	Low
9	Forvie Nature Reserve	401546, 826795	10.27km	Aberdeen Bay ALS	Visitors/Walkers Coastal Trail	High
10	Midstocket Road/North Anderson Drive	391188, 806645	10.47km	(Aberdeen city)	Residents Travellers	High Medium to Low
11	Leslie Road (A978), Aberdeen	392980, 808269	8.07km	(Aberdeen city)	Residents Travellers	High Medium
12	Kincorth Hill	394033, 802824	11.56km	Kincorth and Tullos Hills	Visitors/Walkers	High to Medium
13	Udny Station	391203, 824423	12.63km	Formartine Lowlands	Residents	High
14	A96 at Kirkhill Forest	385467, 811435	14.13km	Tyrebagger Hill/ Kirkhill	Travellers	Medium to Low
15	Brimmond Hill	385634, 809120	14.41km	Brimmond Hill	Visitors/Walkers	High to Medium
16	Formartine and Buchan Way nr Quilquox	391363, 839091	25.98km	Ythan Strath Farmland	Cyclists Residents	Medium High
17	Near Netherley, east of Durris Forest	382565, 794645	24.99km	Kincardine Plateau	Residents	High
18	A975 near Slains Castle	410210, 837001	22.23km	Collieston to Peterhead ALS	Visitors/Walkers Coastal Trail	High
19	Mither Tap, Bennachie	368227, 822362	32.02km	Grampian Outliers ALS	Visitors/Walkers	High to Medium
20	A92, near Uras	387626, 781595	33.58km	Inverbervie to Stonehaven ALS	Travellers Coastal Trail	Medium

6.0 Summary

The baseline landscape, seascape and visual environments within the 40 km study area have been defined and sensitivity to the proposed development assessed.

Within the study area there are no national designated landscapes except for 19 Gardens and Designed Landscapes, two of which are within 15 km of the site. Local designations include Areas of Landscape Significance which cover a large proportion of the coast line and inland areas adjacent to the Cairngorms.

Six seascape units were defined from Inverbervie to Fraserburgh with varying sensitivities towards the proposed development. The north part of Aberdeen Bay at Forvie Sands has the highest sensitivity, assessed at High to Medium due to the remote and unspoilt dune landscape. There are however views from some places within this coastal area of existing onshore turbines and of the developed seafront of Aberdeen which reduce its sensitivity.

The sensitivity of the 38 landscape character areas within the 40 km study area to the proposed development was also assessed with regards to their visual characteristics. Those areas where views out to the sea and coastline are a key characteristic have the highest sensitivity. This includes the higher Moorland Plateau areas at the extents of the study area, and open farmland adjacent to the coastline.

The visual baseline identified key receptors of residents, travelling public (including sea travel), and visitors and tourists. Twenty viewpoints were selected through a consultation process, based on the ZTV plan, to help define the visual environment. The sensitivity to the proposed development of the main identified visual receptor group at each viewpoint was described. Fifteen of the viewpoints are located within 15 km of the site, with seven of these in and around Aberdeen. Those with highest sensitivity to the proposed development are those viewpoints where residents or visitors are the key receptors. This includes the viewpoints at Balmedie Beach, Jesmond Drive, Aberdeen Beach, Forvie Nature Reserve, Udny Station, near Netherley, and near Slains Castle.

7.0 Appendices

Appendix 1. Consultation Record

Aberdeen City Council (Robert Forbes)	
Date of Consultation	**Type and Purpose of Consultation**
24th November 2009	Letter enclosing methodology, viewpoints and ZTV, and cumulative sites for review and agreement.
18th December 2009	Requesting response to earlier letter to agree methodology, viewpoints and cumulative sites.
14th April 2010	Meeting at SNH Offices, Aberdeen to agree approach to assessment.
29th September 2010	Email to advise on upcoming consultation material to be issued shortly.
19th October 2010	Email issuing detailed ZTV, large scale ZTV and viewpoint list for review.
28th October 2010	Email from ACC confirming agreement to viewpoints and requesting a viewpoint at Girdle Ness Lighthouse.
5th November 2010	Phone call with ACC discussing the inclusion of the lighthouse as part of the cultural heritage section and retaining Torry Battery viewpoint within the SLVIA.
13th December 2010	Email issuing proposed cumulative methodology.
13th December 2010	ACC replied querying assessment of land based elements. Reply sent on same day referring to client and informing Mr Forbes we are not involved in the assessment of onshore works.
25th January 2011	Email from ACC in response to SNH comments and requesting additional viewpoints.
25th January 2011	Email to ACC to confirm that requested viewpoints are covered by nearby agreed viewpoints and within the landscape assessment.
28th January 2011	Email from ACC in response to SNH emails stating ACC was not aware of an agreed study area.

Aberdeenshire Council (Peter Fraser)	
Date of Consultation	**Type and Purpose of Consultation**
24th November 2009	Letter enclosing methodology, viewpoints and ZTV and cumulative sites for review and agreement.
14th December 2009.	Letter from AC giving other viewpoint options and further cumulative sites.
23rd December 2009	Email to AC, responding to the earlier assessment suggestions and request to join SNH for a meeting.
14th April 2010	Meeting at SNH Offices, Aberdeen to agree approach to assessment.

Aberdeenshire Council (Peter Fraser)	
Date of Consultation	**Type and Purpose of Consultation**
29th September 2010	Email to AC to advise on upcoming consultation material to be issued shortly.
19th October 2010	Email issue of detailed ZTV, large scale ZTV and viewpoint list for review.
22nd October 2010	Phone Call to AC enquiring as to any feedback to the information previously sent. Mr Fraser replied he was happy to refer to SNH.
29th October 2010	Email issue of revised viewpoint list for information.
13th December 2010	Email issue of proposed cumulative methodology for information.

Scottish Natural Heritage (Sue Lawrence)	
Date of Consultation	**Type and Purpose of Consultation**
24th November 2009	Letter to SNH enclosing methodology, viewpoints and ZTV for agreement.
14th December 2009	Email/letter from SNH giving advice on various parts of the methodology, viewpoint options and study area.
23rd December 2009	Response to SNH letter and request for meeting to discuss issues raised.
14th April 2010	Meeting at SNH Offices, Aberdeen to agree approach to assessment.
29th September 2010	Email to advise on upcoming consultation material to be issued shortly.
19th October 2010	Email issue of detailed ZTV, large scale ZTV and viewpoint list for review.
29th October 2010	Email issue of revised viewpoint list.
9th November 2010	Email response from SNH advising on further cumulative viewpoints and clarity on viewpoint locations.
9th November 2010	Email to SNH confirming viewpoint locations and agreement of including additional cumulative viewpoints.
13th December 2010	Email issue of proposed cumulative methodology
24th January 2011	Email from SNH agreeing to the cumulative methodology, querying study area size, agreeing to Bennachie viewpoint as wireframe only due to weather constraints, and suggestion of Menie Estate viewpoint.
25th and 28th January 2011	Discussion emails on study area.
22nd February 2011	SNH response requesting 40km study area.
March 2011	Phone calls - attempts to discuss requested 40km study area

Scottish Natural Heritage (Sue Lawrence)	
Date of Consultation	**Type and Purpose of Consultation**
25th March 2011	Email to SNH for confirmation of agreement to methodologies and study area.
7th April 2011	SNH response confirming receipt of information and acceptance of 40km study area.

Marine Scotland (Michael Bland)	
Date of Consultation	**Type and Purpose of Consultation**
13th December 2010	Email introduction and enquiry as to any input required from them.
7th January 2011	Email from MS requesting that they would like to see any consultation but input is left to SNH, ACC and AC.
7th January 2011	Email issue of recent consultation material.

Appendix 2. SLVIA Methodology

Introduction

LDA Design has an established methodology for carrying out Seascape, Landscape, and Visual Impact Assessments (SLVIAs) for proposed offshore wind farm developments. The methodology may be varied slightly to address site or development / context specific situations, and the terms used to describe particular levels of effect may be varied (e.g. the use of the word Substantial instead of Major – see below) at the request of the EIA coordinator in order to correlate with other assessments in an ES. The standard methodology, including likely variations, is described below along with any variations specific to this particular assessment.

Overview

The methodology employed has 4 key stages, which are described in more detail in subsequent sections, as follows:

- **Baseline** – includes the gathering of documented information; scoping of the assessment and agreement of that scope with the client, EIA coordinator and local planning authority; site visits; and, initial reports to client and/or EIA coordinator of any issues that may need to be addressed within the design.
- **Design** – where appropriate, review of initial layout/ options, turbine choice(s), and mitigation options.
- **Assessment** – includes an assessment of the seascape, landscape and visual effects of the full scheme, requiring site based work and the completion of a full report and supporting graphics.
- **Cumulative Assessment** – assesses the effects of the proposal in combination with other wind farm developments.

The general assessment methodology draws upon the established Countryside Agency methodology (Landscape Character Assessment Guidance, 2002) and other recognised guidelines, in particular the Institute of Environmental Assessment and the Landscape Institute's Guidelines for Landscape and Visual Impact Assessment, second edition 2002; Scottish Natural Heritage's 'Visual representation of Wind Farms Best Practice Guidance' (2006, albeit published in May 2007); the Guidance on the Assessment of the Impact of Offshore Wind Farms (DTI, 2005); and, the Companion Guide to PPS22 (ODPM, 2004).

Specific methodologies relevant to offshore wind farm developments are particularly relevant and the proposed methodology for the seascape assessment broadly follows the guidance set out in the Maritime Ireland/Wales Interreg 1994 – 1999 Guidance 'Guide to Best Practice in Seascape Assessment', (GSA), published in March 2001. This sets out a clear methodology for undertaking seascape characterisation and for the evaluation process, and subsequent judgements arising. The guidance document is the result of joint pilot studies carried out between Wales and Ireland and sets out a clear process for undertaking a seascape assessment. It also provides practical guidance for undertaking field survey work and the field study forms are utilised during site assessment work.

Scottish Natural Heritage commissioned a report; no.103 'An assessment of the sensitivity and capacity of the Scottish seascape in relation to wind farms' (Scott et al, 2005) to contribute to strategic guidance on identifying the Scottish seascape areas where offshore wind energy development is likely to have least effects. Based largely on the GSA guidance but with some modifications that take in to account the complex seascapes of Scotland, it identifies 33 seascape units in Scotland and describes their character and sensitivity to wind farm development.

These methodologies commonly aim to systematically appraise the existing landscape / seascape condition, to identify all the significant physical and visual characteristics and assess their quality or value as well as the perceived, visual amenity value. These then provide a baseline against which the key Seascape / Landscape and Visual effects can be predicted and evaluated and their magnitude and significance assessed in a logical and well reasoned fashion. The assessment is necessarily iterative, with stages overlapping in parts.

Methodology for Identification of Seascape Units

The Guide to Best Practice in Seascape Assessment (GSA) states clearly that:

'Seascape assessment is an extension of landscape character assessment rather than a specialism in its own right. It does not replace the need for a thorough landscape assessment on land (para 1.6).'

It is therefore important to recognise the interrelationship between, and interdependency of, the sea and land. Identified seascape units will thus, whatever their scale and extent, straddle segments of the coastline with their character being defined by both seaward and landward elements. The GSA then highlights that, whilst some key elements in seascape assessment are common to landscape assessment, there are others that are noticeably different or wholly absent from landscape character assessment work. The key differences are identified as:

- The effects of historic and cultural issues related to the marine environment
- The coastline acting as a clearly defined edge
- Variability and dynamism associated with the marine and coastal components
- Difficulties associated with understanding the scale and distance of elements set within the marine component
- Different principals of visual movement arising from the coastline and marine components
- Amenity functions and uses of the seashore
- Functions and uses of the sea

Paragraphs 2.1 – 2.7 of the GSA, review each of these in turn, in further detail, highlighting key characteristics and issues. All elements, quite correctly, need to be considered during the process of defining the geographical extent of seascape units. Worthy of particular highlight are the issues associated with visibility, both from the land towards the sea, and vice versa. Clarity of visibility is in turn determined by prevailing weather conditions including such aspects as air moisture content and air pressure. Visibility in turn, influences the visual receptor's perception of distance and there are inherent difficulties in judging both scale and distance when looking across expanses of sea. Perspective can often be condensed and misread due to an absence of reference points to provide a sense of scale. Moreover, where the immediate coastline shelves gently, a further dynamic is introduced into the view, varying according to the state of the tide and the resultant extent of exposed foreshore. This both changes the character of local areas on a regular basis and also further alters visual judgments. To accommodate all of these various elements the seascape assessment process requires sufficient time to be spent on site to enable a proper understanding of the local environment.

Chapter 4 of the GSA provides clear guidance on the identification of the spatial extent of seascape units. The GSA proposes three tiers of units, namely: national, regional and local, and notes that the smaller units will effectively 'reside' within the larger regional and national units. Clear guidance is given on both the seaward and landward extent of the various scaled seascape units as well as suggestions as to their likely lateral extent along the coastline. Whilst the landward extent of seascape units can be more readily defined due to the multitude of physical elements and the complexity of landform, it is far more difficult to define a seaward extent. Thus, visibility becomes a key component in defining the seaward extent of the seascape units which can overlap as they 'bleed out' along the coastline.

National Seascape Unit

The GSA advises that national seascape units will cover extensive sections of the coastline where there is an overriding common defining characteristic such as coastal orientation or landform. It suggests that such units will be defined by major headlands of national significance. The units are then defined as extending for up to 24km offshore and inland to the full extent of the Zone of Visual Influence (ZVI). Coastal orientation and the topography of the coastline are identified as key defining characteristics.

Regional Seascape Units

The GSA advises that the most appropriate scale for undertaking seascape characterisation in association with coastal developments, such as offshore wind farms, is the regional unit. It sets out the main recommended parameters for defining regional seascape units, which are noted as generally extending for up to 15 km offshore and inland for up to 10km. It is noted that the landward extent of the regional seascape unit may well include areas of visually dead ground i.e. areas of land that are not intervisible with the sea component of the unit.

Defining Capacity for Change

The Guide to Best Practice in Seascape Assessment defines the evaluation process, and the issues to be considered as seeking to define the capacity of a seascape unit to accommodate the changes arising from the proposed offshore wind farm development. The GSA states that 'Seascape evaluation is defined as the judgement and ranking of seascapes according to their quality, value or capacity to accommodate change'. The GSA provides key guidance as to how quality, value and the capacity to accommodate change should be evaluated and this process has been followed and applied to the identified regional seascape units.

Baseline

The baseline study establishes the planning policy context, the scope of the assessment and the key landscape/seascape and visual receptors. It includes the following key activities:

- A desk study of relevant current national, regional and local planning policy for the site and surrounding areas.
- Agreement of the main study area radius with the local planning authority and SNH. Typically this is 30 - 35km, but in the case of the EOWDC 40km study area has been requested by SNH.
- A desk study of nationally and locally designated landscapes within the agreed study area.
- A desk study of existing landscape and seascape character assessments and capacity and sensitivity studies for the site and surrounding areas, both at national, regional and local level.
- Draft Zone of Theoretical Visibility (ZTV) studies to assist in identifying potential viewpoints and to indicate the potential visibility of the proposed offshore wind farm, and therefore the scope of receptors likely to be affected. The methodology used by LDA Design in the preparation of ZTV studies is described separately within Appendix 4.
- The identification of and agreement upon, through consultation, the scope of assessment for cumulative effects.
- The identification of and agreement upon, through consultation, the number and location of representative viewpoints within the study area.
- Identification of the range of other visual receptors within the study area.
- Site visits to become familiar with the site and surrounding seascape / landscape and to identify viewpoints and receptors.

During this stage, the scheme design may not yet have been finalised and there may be a degree of iteration between this stage (particularly in respect of preparing ZTV studies and consequent changes to likely effects on receptors) whilst the design is finalised.

Design

The degree of 'design fix' for offshore schemes coming forward for assessment can vary. Often there is the need to consider a number of alternative schemes and, through consultation, to reach agreement as to which of the scheme options constitutes the worst case scenario scheme in accordance with the 'Rochdale Envelope' principals. For some sites, the turbine layout may already be fixed, in which case input to the design may be limited to advising on mitigation or an indication that adjustments to particular turbine arrangements would be desirable. In other cases, it may be that no decisions have yet been made, and therefore a range of options by way of turbine numbers, sizes and layouts could be considered, and reviewed with the client and EIA team in order to arrive at an optimum proposal that best addresses the balance between potentially conflicting issues, which will include both beneficial and adverse effects. However, it will be appreciated that

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proposals located within the more challenging offshore environments cannot always afford a significant degree of fine tuning to turbine layout.

Beyond design changes to the arrangement of turbines, including the number and size of turbines, opportunities for significant mitigation measures are inevitably limited due largely to the nature of the proposed development and the character of the receiving marine environment. The scale of development and distance from the coastline means that there are no real meaningful opportunities for incorporating other mitigation measures. However, within the evident constraints of the proposed development, mitigation measures are considered and, wherever possible, incorporated into the evolving scheme in order to best address potential effects.

The design, siting and mitigation of potential effects of the offshore substations and monitoring mast(s) will also be considered whilst the onshore grid connection routes are usually the subject of a separate application and thus do not form part of the assessment.

The documented assessment will include:

- A description of the proposed wind farm development.
- A description of the design process and any iterations of the design.
- A description of any mitigation measures incorporated within the proposals to help reduce identified potential landscape and visual effects.

Assessment

The assessment of effects includes further desk and site based work, covering the following key activities:

- The preparation of ZTVs based on the finalised design for the development.
- The preparation of computer generated wireframes showing the proposed development from the agreed representative viewpoints
- An assessment of the magnitude and significance of effects upon the seascape regional units, landscape character, landscape designations and the existing visual environment arising from the proposed development during construction, operational and decommissioning stages.
- The production of photomontages from a selection of the agreed viewpoints showing the anticipated view following construction of the proposed wind farm development.

Preparation and use of Visuals

The preparation of the ZTVs, wireframes and photomontages complies with the SNH 'Visual Representation of Wind Farms Best Practice Guidance'. The ZTVs and wireframes are used to inform the field study assessment work, providing additional detail and accuracy to observations made on site. In line with the SNH guidance, photomontages are produced in order to assist readers of the assessment in visualising the proposals, but are not used in reaching judgements of effect.

The following points should be borne in mind in respect of the ZTV study:

1. Areas shown as having potential visibility may have visibility of the development obscured by local features such as trees, hedgerows, embankments or buildings.
2. Since only the turbine hubs and blade tips have been modelled, this may be all that is visible – rather than the turbine tower. This is particularly true of areas near the edges of potential visibility.

A detailed description of the methods by which ZTVs, wireframes and photomontages are prepared is included within appendix 4.

Assessment Terminology and Judgments

The key terms used within assessments are Sensitivity, Magnitude and Significance.

Sensitivity to change is assessed for both seascape/landscape receptors such as regional seascape units, designated areas and landscape character areas, and for visual receptors (people) at agreed viewpoints. It provides an indication of the sensitivity of those receptors to the development proposed and thus gives an indication of the likelihood of unacceptable effects on those receptors.

A description of how sensitivity is assessed for each receptor type is included below. It is rated on the following scale:

- **High** – material effects are likely to arise from a development of this nature.
- **Medium** – material effects may arise from a development of this nature.
- **Low** - material effects are unlikely to arise from a development of this nature.

The Guide to Best Practice in Seascape Assessment (GSA) indicates that the sensitivity of regional seascape units to change is an important factor in assessing the significance of effects upon a particular seascape. For example, a seascape of a grand and generous scale with a limited array of constituent elements may be deemed to have a greater capacity to accommodate change and hence have a lower level of sensitivity to a particular type of development, than a more intimate seascape that might become dwarfed by large-scale development. On the other hand, the GSA also intimates, a more fragmented seascape may have an increased capacity to accommodate change (and hence a lower level of sensitivity) on account of the existence of promontories and/or high landform that assists in intermittently concealing and revealing views of a particular offshore development. There is thus a clear need to consider both the scale of the seascape and its complexity, and the degree to which views towards offshore development change or broadly remain static.

Sensitivity of Regional Seascape Unit/Landscape Character Area

- **High** - Important components or zones of particularly distinctive character susceptible to relatively small change.
- **Medium** - A seascape or landscape of moderately valued characteristics reasonably tolerant of change.
- **Low** - A relatively unimportant seascape or landscape, potentially tolerant of substantial change.

The sensitivity of seascape units, landscape character areas and landscape designations is influenced by factors including their location in relation to the proposed development.

The appraisal also identifies the degree of sensitivity to change in representative views from key receptors and more generally within the 'visual envelope' of the proposed development.

Sensitivity of Representative Visual Receptors

This is primarily a function of the expectations and occupation or activity of the receptor and the importance of the view.

- **High** - Viewers which are highly attuned to their surroundings, with proprietary interest and prolonged viewing opportunities
- **Medium** - Viewers with a moderate awareness of their surroundings
- **Low** - Viewers with a passing awareness of their surroundings

Magnitude of Effect

Magnitude of effect is assessed for all seascape, landscape and visual receptors and identifies the degree of change. It is usually rated on the following scale:

- **High** – Total or major alteration to key elements, features or characteristics, such that post development the baseline situation will be fundamentally changed.
- **Medium** - Partial alteration to key elements, features or characteristics, such that post development the baseline situation will be noticeably changed.

- **Low** – Minor alteration to key elements, features or characteristics, such that post development the baseline situation will be largely unchanged despite discernable differences.
- **Negligible** – Very minor alteration to key elements, features or characteristics, such that post development the baseline situation will be fundamentally unchanged with barely perceptible differences.

Whilst the duration of effects is also a consideration, the normal lifespan of a wind farm, though temporary, is a period of up to 25 years (or less). As this is a reasonable length of time it is not taken into account in determining magnitude. The reversibility of effects is however, a material consideration and will be referred to within the assessment.

Significance of Effect

Significance indicates the importance of the effect, taking into account the sensitivity of the receptor and the magnitude of the effect. It is usually rated on the following scale:

- **Major**– indicates an effect that is very important in the decision making process.
- **Major-Moderate** - indicates an effect that is material in the decision making process.
- **Moderate** – indicates a noticeable effect that is not material in the decision making process.
- **Minor** - indicates an effect that is peripheral in the decision making process.
- **Negligible** - indicates an effect that is akin to no change and is thus not relevant to the decision making process.

Significant effects (in terms of the EIA regulations) are those that are Major-Moderate or Major. As stated within the EIA regulations, if an effect is not significant, it should not be considered as material to the decision making process. It should also be noted that whilst an effect may be significant, and therefore material in coming to a decision, that does not necessarily mean that such an impact would be unacceptable.

Where intermediate ratings are given, e.g. “Moderate-Minor”, this indicates an effect that is both less than Moderate and more than Minor, rather than one which varies across the range. In such cases, the higher rating will always be given first; this does not mean that the impact is closer to that higher rating, but is done to facilitate the identification of the more significant effects within tables.

The process of forming a judgment of significance of effect is based upon the assessments of magnitude of effects and sensitivity of the receptor to come to a professional judgment of how important this effect is in terms of making a decision about whether consent should be granted. This judgment is illustrated by the table below:

	MAGNITUDE			
SENSITIVITY	Negligible	Low	Medium	High
High	Negligible	Moderate	Major-Moderate	Major
Medium	Negligible	Moderate-Slight	Moderate	Major-Moderate
Low	Negligible	Minor	Moderate-Minor	Moderate

Key criteria used in determining the extent of an effect include: the magnitude of the change, the spatial extent of the change, the duration of the change, the degree to which the change is reversible and, related to prevailing weather conditions, the percentage incidence of the change.

Limitations

The nature (or valency) of the effect (Positive, Neutral or Adverse) is not identified. In the case of wind farms, there are difficulties in indicating whether seascape/landscape and visual effects will be positive or adverse. Much depends upon the attitudes and predispositions of the individual. As has been shown in a number of opinion surveys, the attitudes of the general public vary widely from those who think that wind farms blight the landscape to others who feel that they are a beautiful or positive addition, in some instances regardless of the natural beauty/value of the landscape in question. In general terms there appears to be a majority view that is positive towards wind energy generation and its appearance in the seascape / countryside and this is particularly so once a wind farm is built in a particular location. In examining visual effects, it is not realistic to ignore public opinion (nor the likelihood that professionally qualified landscape architects may have differing positions) when discussing the effect upon views perceived by the public and positive/adverse judgments are therefore not made within assessments.

Making positive/adverse judgments for effects of wind farms on landscape character based on current guidance would be of questionable value, particularly if using the conventional interpretation (which is implicit in many local plan policies) that any 'out of character' development should be considered adverse. This would effectively make all wind farm developments result in adverse effects on seascape / landscape character except if they were proposed near to another wind farm. For this reason, such judgments are not included in assessments.

Landscape Character

The European Landscape Convention (2000) provides the following definition:

"*Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors*."

The Landscape Character Assessment – Guidance for England and Scotland, CA/SNH, 2002 defines landscape character as:

"*the distinct, recognisable and consistent pattern of elements in the landscape that makes one area different from another*."

It also notes that (para. 2.1):

"*Character makes each part of the landscape distinct, and gives each its particular sense of place. Whether we value certain landscapes for their distinctiveness, or for other reasons, is a separate question*."

Landscape character assessment is defined as (Natural England website – credited as a quote from the guidance):

"*the tool that is used to help us to understand, and articulate, the character of the landscape. It helps us identify the features that give a locality it's 'sense of place' and pinpoints what makes it different from neighbouring areas*."

The sensitivity of seascape regional units and landscape character areas judged is based on both the attributes of the receiving environment and the characteristics of the proposed development. Thus, the key characteristics of the seascape units / landscape character areas are considered, along with scale, openness, topography; the absence of, or presence, nature and patterns of development, settlement, landcover and land uses in forming the character. The condition of the receiving seascape / landscape, i.e. the intactness of the existing character will also be relevant in determining sensitivity. The likelihood of material effects on the seascape units / landscape character areas can be judged based on the scale and layout of the proposal and how this relates to the characteristics of the receiving seascape / landscape. Thus large-scale seascapes / landscapes are likely to be less sensitive to large scale wind farm developments, whilst some small scale, enclosed seascapes / landscapes may be highly sensitive to all but very small scale proposals.

Wind turbine developments are unusual in their effects upon seascape / landscape character as they primarily involve the addition of elements rather than any alteration to, or removal of, existing features. The introduction of a wind farm into an existing seascape / landscape adds a new feature which strongly affects the "sense of place" in its near vicinity, but with distance, the existing characteristics reassert themselves. At its most basic level, the magnitude of effect can best be understood by considering how one might perceive a particular place post-construction; i.e. If the baseline perception is "I am in a field.", then this may change to: "I am in, or at, a wind farm" (High magnitude); “I am in a field near a wind farm” (Medium); “I am in a field and I can see a wind farm over there” (Low); or remain as “I am in a field” (Negligible).

It is specifically noted within Landscape Character Assessment – Guidance for England and Scotland, CA/SNH, 2002 (para 1.14) that:

“*Landscape Character Assessment is not a tool designed to resist changes that may influence the landscape. Rather it is an aid to decision-making - a tool to help understand what the landscape is like today, how it came to be like that, and how it may change in the future*.”

In para 6.32 it describes the purpose of Key Characteristics in landscape assessment, as follows:

“*Key characteristics are those combinations of elements which help give an area its distinct sense of place. They tend in many cases to be ‘positive’ characteristics but they may also, in some cases, be ‘negative’ features which nevertheless are important to the current character of the landscape. If the key characteristics which are identified were to change or be lost there would be significant consequences for the current character of the landscape. These would usually be negative but sometimes positive where some characteristics currently have a negative influence on the character (e.g. the effects of a busy road corridor). Key characteristics should therefore be the prime targets for monitoring change and for identifying landscape indicators.*”

It follows from the above that in order to assess whether seascape / landscape character is significantly affected by a development, it should be determined how each of the key characteristics would be affected. The judgment of magnitude therefore reflects the degree to which the key characteristics and elements which form those characteristics will be altered by the proposals. Based on recent appeal decisions in relation to onshore wind farm developments, there is a general consensus that significant effects on landscape character arising from wind farms are generally confined to the immediate vicinity, being of High magnitude within up to 1km of turbines (where the turbines may become the dominant characteristic of the landscape), reducing to Medium within up to 4km (where the turbines may become one of the key characteristics of the landscape) and decreasing further thereafter. The scale of the development, the nature and sensitivity of the receiving landscape, and local ‘barriers’ in the landscape (such as breaks of topography, woodlands, settlements, and roads or rivers) will determine the exact extent of effects for each development, but in practice significant landscape effects are unlikely beyond 10km.

Landscape Designations and Value

The sensitivity of designated landscapes is assessed based on their relative value. All landscapes are valued to a greater or lesser extent, and local people generally value open countryside regardless of whether or not it is designated. However, a despoiled or degraded landscape would generally be of Low value (and corresponding Low sensitivity in this respect). Undesignated, ‘everyday’ countryside would tend to be of Medium value. Nationally designated landscapes, which enjoy statutory protection (National Parks and Areas of Outstanding Natural Beauty), have a High value (and thus a high sensitivity in this respect). Locally designated landscapes would have High-Medium value and sensitivity, as would Heritage Coasts, which though nationally designated, are protected only via local plan policy.

In considering the effects on designated areas, a number of factors need to be considered. The effects on the component seascape / landscape character areas and the effects on views from within and towards the designated area need to be understood. These effects are then considered in light of the documented “special qualities” and purposes of the designation; and the proportion of the designated area that is affected, in order to arrive at a judgment of the magnitude of effects on the designated area.

Thus the judgment of the significance of effect on designated areas takes into account the value of the landscape (via the sensitivity rating) and the degree to which the purposes of designation are affected (via the magnitude). Allowing for their lower sensitivity, significant effects on local landscape designations are unlikely to occur beyond 10km from the turbines.

Viewpoints and Visual Receptors

A wide variety of visual receptors can reasonably be anticipated to be affected by a proposed wind farm development. The Guidelines for Landscape and Visual Impact Assessment indicate that the following factors affect the sensitivity of a viewpoint: The location and context of the viewpoint; the expectations and occupation or activity of the receptor and the importance of the view. These are all interlinked considerations, as the location, context and importance of the view will influence the likely activities and expectations of the receptor. The range of visual receptors will include pedestrians, and recreational users of the surrounding landscape such as walkers, cyclists and those otherwise engaged in the pursuit of leisure activities within the visual envelope of the site, local residents, motorists, those working outdoors and other workers. All categories of receptors can potentially be affected to a greater or lesser degree by a wind farm development. The four main visual receptor groups are considered in more detail below under the headings of residents, workers, the travelling public, and visitors.

Residents

Local residents tend to have a higher level of sensitivity to changes in their landscape and visual environment than those passing through. For residents, the most important views are those from their homes, although they will also be sensitive to other views such as those experienced when travelling to work or other local destinations. However, it is these latter views, from public areas nearby houses that are of relevance to the main body of the visual impact assessment (views from private properties are considered under the Residential amenity assessment – see below).

Workers

Workers are generally less sensitive to effects as they are focused on the tasks they are carrying out. Indoor workers generally have a Low sensitivity, and outdoor workers, such as farmers, fishermen and those offering outdoor pursuits are considered to have a Low to Medium sensitivity.

The Travelling Public

This category of visual receptor group overlaps to a degree with the other categories in that it embraces local residents, workers and those who come to visit the area. This group of visual receptors will include the following:

- Motorists - For major trunk routes and motorways, the sensitivity of users will be Low, as they will be travelling at speed and will be primarily focused on achieving their destination. Users of other A-roads will have a Low to Medium sensitivity, unless these are particularly scenic or slow routes, in which case the sensitivity may be assessed as Medium. The users of local roads will have a Medium sensitivity.
- Cyclists and footpath users – These groups are addressed under the heading of visitors as they are generally less concerned with the object of reaching their destination than with the enjoyment of being outside and enjoying the landscape and available views.
- Ferry Passengers – For regular services, ferry passengers will have a Low to Medium sensitivity as they will be travelling at a relatively fast speed and may or may not have an interest in their surroundings.

Users of the roads and ferries identified above will vary in their level of sensitivity to the proposed development depending primarily upon the purpose for which they are travelling. For example, local residents and those on business will be more preoccupied with achieving their destination than in enjoying the scenery and the views available along their route. In contrast, day trippers and longer term visitors to the area are likely to be more concerned with the views they enjoy as they travel, but the speed and direction of travel and the fact that they are in a vehicle or ferry will reduce their sensitivity compared to, for example, walkers or scenic boat trips.

Visitors

This category includes several visual receptor groups, each with different objectives and levels of sensitivity to any change in the fabric or character of the landscape and views arising from the proposed development. This group includes those who are mainly concerned with enjoyment of the outdoor environment but also those who may pursue indoor recreational pursuits and is anticipated to include the following (arranged in decreasing sensitivity):

- Those whose main preoccupation is the enjoyment of scenery (High sensitivity).
- Recreational walkers and equestrians (High sensitivity)
- Those visitors engaged in cultural pursuits (High-Medium sensitivity)
- Cyclists (High-Medium sensitivity)

Residential amenity

Views from private property are not a material consideration in determining planning applications unless the proposed change is sufficiently unpleasant or intrusive to cause unacceptable harm to residential amenity. For this reason, bearing in mind the distance from the coastline of offshore wind farm developments, the effects upon individual residential properties is not assessed.

Public Footpaths

Where applicable, the effects on the visual amenity on public footpaths in the vicinity of the site are assessed. Particular reference is made to effects on National and Regional Trails and Cycle routes. Assessments are informed by viewpoints which are located on public paths and by site visits and reference to aerial photography to ascertain the likely extent and nature of views available from the routes.

Settlements

The effects on settlements are not rated in terms of their magnitude or significance as there is no proper basis for forming such a judgement as each settlement will encompass a range of visual receptors which will be affected in different ways, which might vary from no view of the turbines to very clear, close views. Therefore, effects on settlements within 5km of the site are generally described in such a way as to identify where views towards the turbines are likely to arise and what the nature of those views are likely to be. In some cases this will be further informed by a nearby viewpoint and in others it will be informed with reference to the ZTVs, aerial photography and site visits.

Cumulative Assessment

The purpose of the cumulative effect assessment is to consider the potential effects upon the seascape and visual environments in relation to the existing wind farm developments and other known consented and proposed wind farm developments in the area. It raises questions over thresholds of acceptable change (spatial and temporal) and the landscape/seascape's capacity to accept change.

The Guidelines for Landscape and Visual Effect Assessment (IEMA, 2002, 2nd edition) advises that:

'*cumulative landscape and visual effects result from additional changes to the landscape or visual amenity caused by the proposed development in conjunction with other developments (associated with or separate to it), or actions that occurred in the past, present or are likely to occur in the foreseeable future.*'

A search area from the proposed offshore wind farm site is agreed with the local authority and statutory bodies. Within the agreed radius, all relevant local planning authorities and appropriate statutory consultees are contacted to identify existing and consented wind turbine developments, both on and offshore, as well as applications yet to be determined.

The cumulative assessment does not address the magnitude or significance of the effects arising from the individual developments themselves included within the cumulative assessment, but looks at the seascape and visual effects arising from the combination of turbines at proposed offshore wind farm with one or more other wind farm developments within the parameters identified.

The cumulative assessment examines the same groups of seascape / landscape and visual receptors as the assessment for the main scheme, though different viewpoints may be used in order to better represent the likely range of effects arising from the combination of schemes. The assessment is informed by cumulative ZTVs, showing the extent of visual effects of the schemes in different colours to illustrate where visibility of more than one development is likely to arise. Cumulative wireframes are prepared which show each of the developments in different colours so that they are each readily identifiable. Cumulative photomontages are also prepared.

Cumulative Landscape and Seascape Effects

As set out above in the methodology for landscape and seascape effects, the magnitude and significance of cumulative effects on the identified landscape designations, landscape features and seascape character units are a function of the baseline sensitivity of each receptor, the number and scale of the proposed wind farms in that area and the overall size and shape of the receptor / character area. Cumulative Landscape and Seascape effects will be assessed for each receptor / character unit where they are affected by more than one of the proposed wind farms.

Cumulative Visual Effects

There are two types of cumulative effects on visual amenity, namely effects arising from combined and sequential views. In accordance with the Scottish Natural Heritage publication Cumulative Effect of Wind Farms version 2 (April 2005) these comprise:

- Combined views which 'occur where the observer is able to see two or more developments from one viewpoint. Combined visibility may either be in combination (where several wind farms are within the observer's arc of vision at the same time) or in succession (where the observer has to turn to see the various wind farms).'
- Sequential views which 'occur when the observer has to move to another viewpoint to see different developments.'

Cumulative visual effects will vary in degree depending on

- the number and sensitivity of visual receptors;
- the duration, frequency and nature of views;
- the relative effect of each individual wind farm with regard to visual amenity;

Distances

Where distances are given in the assessment, these are approximate distances between the nearest turbine and the nearest part of the receptor in question, unless explicitly stated otherwise.

Appendix 3. Meteorological Data

Met Office

Frequency analysis of Visibily for the location: 57.5N to 57.0N and 002.0w to 001.6W (offshore Aberdeen)
Period of data: January 1981 to December 2010

VISIBILITY

	0 TO 4	5 TO 19	20 TO 49	50 TO 99	100 TO 199	200 TO 399	400 TO 999	1000 TO 1999	2000 TO 4999	5000 or more	TOTAL
JAN	0	0	0	0	1	2	20	84	274	13	**394**
FEB	0	0	0	1	4	21	28	112	186	19	**371**
MAR	0	0	2	5	1	4	19	67	142	13	**253**
APR	5	2	2	4	2	4	24	64	141	16	**264**
MAY	0	1	5	5	3	11	34	92	268	15	**434**
JUN	5	4	2	5	4	25	65	121	259	15	**505**
JUL	5	8	6	11	2	19	33	100	242	28	**454**
AUG	4	13	6	12	2	11	52	134	546	20	**800**
SEP	0	2	0	12	4	6	51	141	404	13	**633**
OCT	0	0	1	0	4	9	24	88	253	29	**408**
NOV	0	0	0	0	0	12	41	124	288	18	**483**
DEC	0	0	0	1	0	1	13	53	268	14	**350**
ANNUAL	19	30	24	56	27	125	404	1180	3271	213	**5349**

VISIBILITY

	0 TO 4	5 TO 19	20 TO 49	50 TO 99	100 TO 199	200 TO 399	400 TO 999	1000 TO 1999	2000 TO 4999	5000 or more	TOTAL
JAN	0	0	0	0	0.254	0.508	5.076	21.320	69.543	3.299	**100**
FEB	0	0	0	0.270	1.078	5.660	7.547	30.189	50.135	5.121	**100**
MAR	0	0	0.791	1.976	0.395	1.581	7.510	26.482	56.126	5.138	**100**
APR	1.894	0.758	0.758	1.515	0.758	1.515	9.091	24.242	53.409	6.061	**100**
MAY	0	0.230	1.152	1.152	0.691	2.535	7.834	21.198	61.751	3.456	**100**
JUN	0.990	0.792	0.396	0.990	0.792	4.950	12.871	23.960	51.287	2.970	**100**
JUL	1.101	1.762	1.322	2.423	0.441	4.185	7.269	22.026	53.304	6.167	**100**
AUG	0.500	1.625	0.750	1.500	0.250	1.375	6.500	16.750	68.250	2.500	**100**
SEP	0	0.316	0	1.896	0.632	0.948	8.057	22.275	63.823	2.054	**100**
OCT	0	0	0.245098	0	0.980	2.206	5.882	21.569	62.010	7.108	**100**
NOV	0	0	0	0	0	2.484	8.489	25.673	59.627	3.727	**100**
DEC	0	0	0	0.286	0	0.286	3.714	15.143	76.571	4.000	**100**
ANNUAL	0.355	0.561	0.449	1.047	0.505	2.337	7.553	22.060	61.152	3.982	**100**

STATION: DYCE
LAT: 57 Deg 12 Min N
LON: 002 Deg 12 Min W
ALT: 65 metres A.M.S.L
PERIOD: 1991 TO 2010

Met Office

FREQUENCY TABLE

	MONTHS												
VISIBILITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ALL OBS
0 TO 9	0	1	21	24	10	3	5	9	4	5	1	2	85
10 TO 39	20	29	95	106	107	73	148	119	107	63	37	32	936
40 TO 99	44	72	120	158	125	132	223	211	207	119	79	77	1567
100 TO 199	104	151	179	154	133	126	204	186	234	175	107	124	1877
200 TO 299	132	219	253	239	146	127	215	229	288	215	161	140	2364
300 TO 399	199	323	369	335	230	182	284	290	294	282	215	220	3223
400 TO 499	309	338	401	373	321	242	333	295	375	355	304	341	3987
500 TO 599	383	311	422	386	314	272	303	277	404	351	369	388	4180
600 TO 699	401	315	410	399	300	267	294	259	341	376	334	412	4108
700 TO 799	370	294	339	355	236	279	252	256	284	363	305	374	3707
800 TO 899	417	367	441	406	373	342	344	340	390	410	425	482	4737
900 TO 999	173	138	171	205	149	144	155	122	136	200	160	240	1993
1000 TO 1499	1308	1014	1091	1294	1195	1124	1054	1028	1138	1233	1213	1427	14119
1500 TO 1999	1400	1156	1301	1388	1418	1282	1250	1320	1264	1500	1444	1549	16272
2000 TO 2499	1670	1425	1410	1568	1813	1752	1647	1781	1758	1701	1656	1707	19888
2500 TO 2999	1773	1642	1774	1870	2011	2077	2062	2339	2120	2027	1859	1972	23526
3000 TO 3499	2379	2126	2186	2027	2400	2335	2378	2399	2276	2345	2336	2208	27395
3500 TO 3999	1337	1186	1317	1050	1322	1355	1178	1132	847	1080	1222	1177	14203
4000 TO 4499	1657	1514	1375	1109	1335	1356	1424	1409	1204	1408	1488	1438	16717
4500 TO 4999	235	365	363	233	214	211	313	255	132	176	228	194	2919
5000 TO 5999	438	372	564	385	386	449	547	403	375	343	334	293	4889
6000 TO 6999	31	93	139	130	121	128	129	134	82	65	71	38	1161
7000 TO 29999	32	53	83	75	99	119	85	82	70	74	21	5	798
ALL OBS	**14812**	**13504**	**14824**	**14269**	**14758**	**14377**	**14827**	**14875**	**14330**	**14866**	**14369**	**14840**	**174651**

PERCENTAGE TABLE

	MONTHS												
VISIBILITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ALL OBS
0 TO 9													
10 TO 39	0.1	0.2	0.6	0.7	0.7	0.5	1	0.8	0.7	0.4	0.3	0.2	0.5
40 TO 99	0.3	0.5	0.8	1.1	0.8	0.9	1.5	1.4	1.4	0.8	0.5	0.5	0.9
100 TO 199	0.7	1.1	1.2	1.1	0.9	0.9	1.4	1.3	1.6	1.2	0.7	0.8	1.1
200 TO 299	0.9	1.6	1.7	1.7	1	0.9	1.5	1.5	2	1.4	1.1	0.9	1.4
300 TO 399	1.3	2.4	2.5	2.3	1.6	1.3	1.9	1.9	2.1	1.9	1.5	1.5	1.8
400 TO 499	2.1	2.5	2.7	2.6	2.2	1.7	2.2	2	2.6	2.4	2.1	2.3	2.3
500 TO 599	2.6	2.3	2.8	2.7	2.1	1.9	2	1.9	2.8	2.4	2.6	2.6	2.4
600 TO 699	2.7	2.3	2.8	2.8	2	1.9	2	1.7	2.4	2.5	2.3	2.8	2.4
700 TO 799	2.5	2.2	2.3	2.5	1.6	1.9	1.7	1.7	2	2.4	2.1	2.5	2.1
800 TO 899	2.8	2.7	3	2.8	2.5	2.4	2.3	2.3	2.7	2.8	3	3.2	2.7
900 TO 999	1.2	1	1.2	1.4	1	1	1	0.8	0.9	1.3	1.1	1.6	1.1
1000 TO 1499	8.8	7.5	7.4	9.1	8.1	7.8	7.1	6.9	7.9	8.3	8.4	9.6	8.1
1500 TO 1999	9.5	8.6	8.8	9.7	9.6	8.9	8.4	8.9	8.8	10.1	10	10.4	9.3
2000 TO 2499	11.3	10.6	9.5	11	12.3	12.2	11.1	12	12.3	11.4	11.5	11.5	11.4
2500 TO 2999	12	12.2	12	13.1	13.6	14.4	13.9	15.7	14.8	13.6	12.9	13.3	13.5
3000 TO 3499	16.1	15.7	14.7	14.2	16.3	16.2	16	16.1	15.9	15.8	16.3	14.9	15.7
3500 TO 3999	9	8.8	8.9	7.4	9	9.4	7.9	7.6	5.9	7.3	8.5	7.9	8.1
4000 TO 4499	11.2	11.2	9.3	7.8	9	9.4	9.6	9.5	8.4	9.5	10.4	9.7	9.6
4500 TO 4999	1.6	2.7	2.4	1.6	1.5	1.5	2.1	1.7	0.9	1.2	1.6	1.3	1.7
5000 TO 5999	3	2.8	3.8	2.7	2.6	3.1	3.7	2.7	2.6	2.3	2.3	2	2.8
6000 TO 6999	0.2	0.7	0.9	0.9	0.8	0.9	0.9	0.9	0.6	0.4	0.5	0.3	0.7
7000 TO 29999	0.2	0.4	0.6	0.5	0.7	0.8	0.6	0.6	0.5	0.5	0.1	0	0.5
ALL OBS	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Appendix 4. ZTV and Visuals Methodology

ZTV Studies

ZTV studies are prepared using the ESRI ArcGIS Viewshed routine. This creates a raster image that indicates the visibility (or not) of the points modelled. Each turbine is analysed at hub and blade tip height. Two studies are carried out, with the first using a topographic model alone, in accordance with SNH guidance. A second study is also prepared including settlements (generally mapped in at an assumed average of 7.5m above ground level) and woodlands (generally mapped in at an assumed average of 15m high above ground level). If significant deviations from these assumed heights are noted during site visits, for example young or felled areas of woodland, or significant areas of single storey development, the features concerned will be adjusted within the model. The areas of settlement and woodlands are based on the Ordnance Survey Vectormap District alpha version dataset (this equates to urban areas on a 1:25,000 Ordnance Survey plan and woodlands from the Ordnance Survey streetview 1:10,000 product).

The visibility is modelled taking into account both the curvature of the earth and light refraction, and an observer height of 2m, in accordance with SNH guidance. The ZTV also begins at 1m from the observation feature (for example the wind turbine) and will work outwards in a grid of the set resolution (generally 12.4 sq. m for Ordnance Survey Opendata Landform Panorama) until it reaches the end of the terrain map for the project.

For all plan production LDA Design will produce a ZTV that has a base and overlay of the 1:50,000 Ordnance Survey Raster mapping. The ZTV will be reproduced at a suitable recommended scale on an A1 template to encompass the study area. For printing purposes all A1 figures will be produced at 600 dpi to allow interpretation of the base map.

Ground model accuracy

Depending on the project and level of detail required, different height datasets may be used. Ordnance Survey Landform Profile (roughly linked to quality of 10K mapping) and Ordnance Survey Opendata Landform Panorama (roughly linked to the quality of 50K mapping) are supplied as raster dataset. Below is listed the different data products and their specifications:

Product	Distance Between Points	Vertical Error	Horizontal Error
LiDAR	50cm – 2m	up to +/- 10Cm	up to +/- 1cm
Derived Aerial Photography Heights	1m – 5m	up to +/- 25cm	up to +/-15cm
Ordnance Survey Landform Profile	10m	+/- 1.8m	+/- 1m
Ordnance Survey Opendata Landform Panorama	49.6m	+/- 5m	+/- 3m

For most purposes, the Ordnance Survey Opendata Landform Panorama data will be used, but on certain occasions more detailed analysis of areas close to the site may be required, in which case, ZTVs based on Ordnance Survey Landform Profile data with areas of vegetation and building footprints taken from the Ordnance Survey 1:10,000 mapping may be used. Similarly, where actual heights from obstructions and hedgerows might need to be assessed more detailed surface mapping products such as Derived Aerial Photography Heights (from Infoterra or Bluesky) or LiDAR can be used.

Wireframes

Wireframes are produced in 6 key stages:

1) Photography is undertaken by a professional photographer using a digital SLR camera and 50mm equivalent lens. A tripod (usually 1.6m high) is used to take overlapping (50%)

landscape format photographs which are joined together using Adobe Photoshop software to create a single panoramic image for each viewpoint. These are then saved at a fixed height and resolution to enable correct sizing when reproduced in the final images. The photographer also notes the GPS location of the viewpoint and takes bearings to visible landmarks whilst at the viewpoint.

2) Creation of a ground model and 3D Mesh to illustrate that model - This is created using OS landform panorama point data and KEY Terrafirma ground modelling software.

3) The addition of the turbine wireframes to the 3D model using AutoCAD- The turbines are correctly proportioned to match the nacelle height and blade lengths proposed for the development. They are also modelled to closely resemble the turbines proposed. The turbines are then inserted into the 3D model at the proposed locations, facing into the prevailing wind direction.

4) Wireframe generation – The viewpoints are added within the 3D AutoCAD model with each observer point being inserted at 2m above the modelled ground plane. The location of the landmarks identified by the photographer may also be included in the model. The view from the viewpoint is then generated using the AutoCAD camera function, creating a number of single frame images, which also include bearing markers. For cumulative wireframes, each wind farm will be shown in a different colour. As with the photographs, these single frame images are joined together using Adobe Photoshop software to create a single panoramic image for each viewpoint. These are then saved at a fixed height and resolution to ensure that they are the same size as the photographs.

5) Wireframe matching – The wireframes are matched to the photographs using a combination of the visible topography; bearings taken on site and the bearing markers; and the landmarks which have been included in the 3D model.

6) Reproduction – the wireframe images are presented on sheets which are 297mm high and the length needed to show the view. The photographs are shown at 140mm high (a viewing distance of 300mm) with the wireframes below. Data required by the SNH guidance and a location plan is also included on each sheet. Where very wide panoramas (more than 180 degrees) are required to show all of the schemes within a cumulative study, the view will be split across two sheets.

Photomontages

Photomontages are produced in 4 key stages:

1) Wireframe preparation, up to stage 5 above.

2) 3D Studio Max is used to produce a rendered 3D view of the turbines from the viewpoint. The rendering uses a pale grey colour (similar to that used for many turbines) and lighting conditions according to the time of day for the viewpoint photograph. These images are then saved at a fixed height and resolution to ensure that they are the same size as the photographs.

3) The rendered turbines are then added to the photographs in the positions identified by the wireframe (using Adobe Photoshop to overlay the photograph with both the wireframe and rendered turbines to ensure accuracy). The images are then layered to ensure that the turbines appear in front of and behind the correct elements visible within the photograph.

Reproduction – the photomontage images are presented on sheets which are 297mm high and the length needed to show the view which is usually cropped to 90 degrees of the wireframe view, focussed on the wind farm location. The photographs are shown at 200mm high (a viewing distance of 435mm). Data required by the SNH guidance and a location plan is also included on each sheet. Where very wide panoramas (more than 135 degrees) are required to show all of the schemes within a cumulative study, the view will be split across two or more sheets.

8.0 References

- Countryside Agency and Scottish Natural Heritage (2004). Topic Paper 6: Techniques and criteria for judging capacity and sensitivity.
- DTI in association with Countryside Agency, Countryside Council for Wales and Scottish Natural Heritage (2005). Guidance on the Assessment of the Impact of Offshore Wind Farms: Seascape and Visual Impact Report.
- DTI (2004), SEA 5: Strategic Environmental Assessment of Parts of the Northern and Central North Sea to the East of Scottish Mainland, Orkney and Shetland. Department of Trade and Industry.
- Hill. M, Briggs. J, Minto. P, Bagnall. D, Foley. K, Williams. A (2001). Guide to Best Practice in Seascape Assessment (GSA). Maritime Ireland/Wales Interreg 1994 – 1999;
- Institute of Environmental Management and Assessment (IEMA) and the Landscape Institute (2002). Guidelines for Landscape and Visual Impact Assessment, Second edition.
- North Sea Pilot (1997)
- Scottish Natural Heritage (2005). Cumulative Assessment of Wind Farms, Version 2.
- Scottish Natural Heritage 103 (2005). An assessment of the sensitivity and capacity of the Scottish Seascape in relation to wind farms. Commissioned Report 103.
- Scottish Natural Heritage (2006). The Visual Assessment of Windfarms Best Practice.
- The North Sea Trail/NAVE North Sea Trail Project, Funded by Interreg 111b North Sea Programme. www.northseatrail.org . Aberdeenshire Coastal Path Guide and Maps www.aberdeenshire.gov.uk/outdooraccess/coastal_path/guide_maps
- Royal Yachting Association: Position Statement of Offshore Renewable Energy Developments (December 2009).
- Royal Yachting Association: UK Coastal Atlas of Recreational Boating (Jan 2009), Second Edition.

European Offshore Wind Deployment Centre
Environmental Statement

Appendix19.2: Seascape, Landscape and Visual EIA Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

LDĀ DESIGN

European Offshore Wind Deployment Centre
Seascape, Landscape and Visual Impact Assessment

EIA Technical Report
21st June 2011

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LDĀ DESIGN

21st June 2011

Contents

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21st June 2011

Version: 1.4

Version date: 21st June 2011

Comment FINAL

This document has been prepared and checked in accordance with ISO 9001:2000.

1.0 Introduction

The Seascape, Landscape and Visual Impact Assessment (SLVIA) considers the potential effects that the EOWDC will have on the existing seascape, landscape, and visual environment. The purpose of the assessment is to determine the sensitivity, magnitude, and therefore significance of any change to the character of the regional seascape, landscape, and any areas of designated landscapes, as well as the potential effect upon views, visual amenity and receptor groups within the overall Zone of Theoretical Visibility (ZTV).

The Baseline Report (see Appendix xxx) sets out the existing seascape, landscape and visual baseline environment and identified its sensitivity to the type of change proposed. This impact assessment section describes the nature of the anticipated change upon the regional seascape units, landscape character areas and landscape designations within the study area and upon a number of agreed representative visual receptors and assesses the magnitude and significance of the anticipated changes.

The cumulative seascape, landscape, and visual effects of the proposed development with the existing, consented and in-planning wind farms are assessed for the study area. The 'in-planning' wind farms are those that have had a planning application submitted which has not yet been determined at the time of writing the assessment (18th March). The report also discusses the cumulative effects of the potential Ocean Laboratory structure, although this would be subject to a separate planning application.

1.1. Consultation

Consultation to agree upon the assessment methodology and a number of other important parameters regarding the scope of the SLVIA took place with Scottish Natural Heritage, Aberdeen City Council, and Aberdeenshire Council. The Baseline Report and its Appendix 1 provides a summary of the key stages of consultation and also provides a detailed record of all consultation which took place on the SLVIA throughout the project.

1.2. Key Guidance Documents

Key guidance documents that have informed the SLVIA include:

- Maritime Ireland/Wales Interreg 1994 – 1999 Guidance 'Guide to Best Practice in Seascape Assessment' (GSA), published in March 2001.
- 'An assessment of the sensitivity and capacity of the Scottish Seascape in relation to wind farms', (SNH commissioned Report 103, 2005).
- Guidance on the Assessment of Effect of Offshore Wind Farms: Seascape and Visual Effect Report (DTI – November 2005).
- Guidelines for Landscape and Visual Effect Assessment (Institute of Environmental Management and Assessment (IEMA) and the Landscape Institute's (LI), second edition 2002).
- Visual Representation of Windfarms Best Practice Guidance (SNH 2006, albeit published in 2007).
- Cumulative Effects on Windfarms, (SNH, 2005).
- Siting and Designing Windfarms in the Landscape (SNH, December 2009).

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1.3. Data Information and Sources

Table 1.1 below records the main survey information and site study data that were used in this assessment. Please also see the Baseline Report for additional baseline assessment survey information.

Table 1.1 Summary of data and sources

Survey/Study	Date of Survey	Description
Seascape/landscape and visual receptor assessment work	February 2011	Land based driving and walking seascape and landscape receptors and viewpoints assessment
Beaches of Northeast Scotland (SNH Commissioned Report)	1977	Environmental inventory of sand beaches, dunes and associated coastal areas of the coastline of the Moray Firth from Inverness eastwards and of the North Sea coast northwards from Inverbervie.
Landscape Character Assessment of Aberdeen (SNH)	1996	Landscape Character Assessment
South and Central Aberdeenshire: Landscape Character Assessment (SNH)	1998	Landscape Character Assessment
Banff and Buchan Landscape Assessment (SNH)	1994	Landscape Character Assessment

2.0 Impact Methodology

The full assessment methodology is set out in the Appendix 2 of the Baseline Report and a summary of the methods used to assess impacts is discussed below.

2.1. Sensitivity

The sensitivity to the proposed change was assessed in the baseline report for both seascape and landscape receptors such as regional seascape units, landscape character areas, landscape designations and for visual receptors (people) at agreed viewpoints. It identified the sensitivity of those receptors to the type of development proposed and thus gives an indication of the likelihood of unacceptable effects on those receptors.

2.2. Magnitude

The magnitude of effect is assessed for all seascape, landscape and visual receptors and identifies the degree of change arising as a result of the proposed development. It is rated on the following scale;

- High – Total or major alteration to key elements, features or characteristics, such that post development the baseline situation will be fundamentally changed;
- Medium - Partial alteration to key elements, features or characteristics, such that post development the baseline situation will be noticeably changed;
- Low – Minor alteration to key elements, features or characteristics, such that post development the baseline situation will be largely unchanged despite discernable differences; and
- Negligible – Very minor alteration to key elements, features or characteristics, such that post development the baseline situation will be fundamentally unchanged with barely perceptible differences.

The spatial extent of the effect for the purposes of the SLVIA is assessed at a regional scale for seascape and landscape effects, and local effects for specific viewpoints.

The duration of effects is also a consideration, and the lease for the EOWDC site is for 22 years. Given this, the lifespan is not taken into account in determining the magnitude of any effects within the SLVIA. The reversibility of effects is, however, a material consideration and will be referred to within the assessment.

2.3. Significance

The process of forming a judgment regarding the significance of effect is based upon the assessments of magnitude of effects and the sensitivity of the receptor. Professional judgment of how the importance is then used to assess the importance of the impact is informed by Table 2.1.

Table 2.1 Matrix for Significance of Effect

	MAGNITUDE			
SENSITIVITY	Negligible	Low	Medium	High
High	Negligible	Moderate	Major-Moderate	Major
Medium	Negligible	Moderate-Minor	Moderate	Major-Moderate
Low	Negligible	Minor	Moderate-Minor	Moderate

2.3.1. Implications of Significance

The Significant effects (in terms of the EIA (Scotland) Regulations 1999) are those that are Major or Major-Moderate. As stated within the EIA Regulations, if an effect is not significant, it should not be considered as material to the decision making process. It should also be noted that whilst an effect may be significant, and therefore material in coming to a decision, that does not necessarily mean that such an effect would be unacceptable.

Where intermediate ratings are given, e.g. "Moderate-Minor", this indicates an effect that is both less than Moderate and more than Minor, rather than one which varies across the range. In such cases, the higher rating will always be given first; this does not mean that the impact is closer to that higher rating, but is done to facilitate the identification of the more significant effects within tables.

2.4. Cumulative and In-combination

As set out in Appendix 2 of the Baseline Report, there are two types of cumulative effects on visual amenity, namely effects arising from combined and sequential views. In accordance with the Scottish Natural Heritage publication Cumulative Effect of Wind Farms version 2 (April 2005) these comprise:

- Combined views which 'occur where the observer is able to see two or more developments from one viewpoint. Combined visibility may either be in combination (where several wind farms are within the observer's arc of vision at the same time) or in succession (where the observer has to turn to see the various wind farms).'
- Sequential views which 'occur when the observer has to move to another viewpoint to see different developments.'

The assessment of cumulative effects for the SLVIA of the EOWDC takes into consideration the large number of other wind farms (existing, consented or in-planning) within a 60 km radius study area. As of March 18th 2011, there are 48 existing or consented and 24 in-planning wind farms or single turbines (over 50 m hub height) within the study area. Please see Appendix 1 which lists the name, number of turbines and height of each wind farm considered in the cumulative assessment. Figure 12 shows the wind farm locations.

Cumulative landscape and seascape effects will be assessed for each receptor/character unit where there is potential for more than one wind farm to have an effect. As set out in the methodology for landscape and seascape effects, the magnitude and significance of cumulative effects on the identified landscape designations, landscape features and seascape character units are a function of the baseline sensitivity of each receptor, the number and scale of the wind farms in that area and the overall size and shape of the receptor/character area.

Please refer to Appendix 2 of the Baseline Report which details the agreed methodology for the assessment of cumulative effects of EOWDC with one or more turbines.

Due to the large number of wind farms within the study area (none of which are closer than 10km to the EOWDC), the process for producing the ZTVs has undergone much research and development for this project. The ZTVs of all 72 wind farms have been processed and overlaid with the EOWDC ZTV. The resulting images are shown in Figures 13 to 18. Figures 13 and 14 show the existing and consented wind farms overlaid with the in-planning wind farms and EOWDC. Figures 15 to 18 show a more detailed analysis by illustrating the number of sites or the number of turbines visible with the EOWDC. Through colour grading of the number of turbines or number of sites visible (on separate figures) a clearer picture is given of the main areas of 'in combination' effects with the EOWDC. To increase the legibility of this information the ZTVs of the other wind farms are only shown where they overlap with the EOWDC ZTV and the other areas without EOWDC are shown as a beige colour. Due to the number of sites and as they are all further than 10km away from the EOWDC it is not practical to identify individual site ZTVs but the locations of wind farms are identified on the plans for reference.

The potential sequential cumulative effects upon receptors along the main roads within the study area are illustrated using diagrammatic graphs which show the distance to each relevant wind farm and the length of road from which these wind farms will be theoretically visible. Please refer to section 4.3 in this report, Figure 19 and Appendix 2 of this report.

2.5. Worst Realistic Case

For the purposes of the SLVIA it was agreed with the consultees that the worst case scenario dimensions of the turbines would be eleven 10 MW turbines with a hub height of 120 m and blade tip height of 195 m above the lowest astronomical tide (LAT). The nature of the deployment centre is that it will be used to test first of run wind turbines which may result in turbines of different heights. It is not envisaged that any final mix of turbine heights will result in height difference that is greater than 20-35 m between turbines. This difference, however, may be potentially noticeable at specific locations and the assessment will take this into consideration through the production of wireframes modelled with the different turbine heights from a selection of viewpoints. Please see section 5.1 of this report.

3.0 Seascape and Landscape Effects

Whilst it also considers construction and decommissioning effects, the SLVIA is primarily concerned with the operational effects as these will have the most potentially significant effects due to the duration of this stage. The potential impacts during operational phases on the seascape and landscape are discussed below. Each impact has been assessed in its own subsection taking into consideration direct and indirect impacts as well as cumulative impacts.

Please refer to section 6.0 of this report for discussion on the seascape, landscape and visual effects during construction and decommissioning.

For the purposes of establishing intervisibility of the EOWDC with the seascape units and landscape character areas the Zone of Theoretical Visibility (ZTV) plans were reviewed. Please refer to Figures 7, 8, and 9 for the EOWDC ZTVs and also Figures 12 to 18 for the cumulative ZTVs.

The magnitude and subsequent significance of any effects arising from the proposed EOWDC upon the existing seascape and landscape resource is related to the capacity of the regional seascape unit or landscape character area to accommodate the type of change proposed and its sensitivity to the proposed change. As explained in section 2 of this report and Appendix 2 of the Baseline Report, this is assessed using the recognised Landscape Institute / Institute of Environmental Management and Assessment evaluation process, which looks at the physical form and attributes of the seascape, its quality, its sensitivity and the range of visual receptor groups that characterise the individual seascape units or character areas. The magnitude of effect upon seascape and landscape character takes into account the scale, extent and duration of the effect. Please refer to Figures 4, 5, and 6 which shows the seascape unit locations and landscape character areas.

3.1. Seascape Effects

3.1.1. Inverbervie to Stonehaven Regional Seascape Unit

This regional seascape unit (RSU) embraces the rocky coastline from Stonehaven to Inverbervie which lies just beyond the study area. It lies approximately 30 km at its closest point to the nearest turbine of the EOWDC. The ZTVs indicate that the theoretical extent of visual exposure to the proposed development is limited to the sea and a short coastal stretch from Stonehaven to Crawton. There are also limited areas of intervisibility on local high ground. The convex curve of the coastline beyond Crawton prevents any intervisibility with the coast or inshore waters.

The coastal area south of Stonehaven with intervisibility has the characteristic large scale agricultural land sloping towards the tops of the cliffs with a few isolated farms and houses. At this specific point the ground opens out towards the north and east and views of the coastline to Girdle Ness can be seen. Elsewhere in the RSU, the expansive sea views are generally focussed towards the east. Within the sea element, the EOWDC will be seen more clearly than on land, but with a backdrop of the Aberdeen Bay coastline and rolling farmland.

Taking account of the distance to the EOWDC development, the limited intervisibility from the majority of the landward element, the open and large scale character including existing onshore wind farms, this will reduce the potential for the EOWDC to affect the character of the seascape unit. Where visible it will only be a minor indistinct and distant element.

As a result the magnitude of impact upon the Inverbervie to Stonehaven RSU is considered to be Negligible. When combined with a Medium sensitivity to the proposed change, the overall significance of effect is assessed to be Negligible, with no direct effects upon the attributes of this seascape unit, and only a limited effect upon distant views from a short stretch of coastline and sea area.

Cumulative Impacts

The cumulative ZTVs show that visibility of wind farms is a baseline characteristic of this seascape unit. St John's Hill and Tullo Wind Farm, as closest to the RSU, will be dominant in views inland. There are only minor areas on land from where the EOWDC will be seen in combination with other wind farms which as shown on Figure 17 could be up to 10 existing or consented wind farms. There are no in-planning wind farms visible from this RSU. The majority of these other wind farms are closer in proximity to the seascape unit than the EOWDC and they will be only potentially seen together from a few areas on land and to a larger extent at sea. However, the EOWDC will continue to be a minor, indistinct element in these views and therefore the significance of cumulative effects on the Inverbervie to Stonehaven RSU will be Negligible.

3.1.2. Stonehaven to Girdle Ness Regional Seascape Unit

Extending approximately 20 km north of Stonehaven to Girdle Ness, this regional seascape unit is at closest 8 km from the nearest turbine of the EOWDC. The ZTVs indicate that the shape of the coastline and also the landform around Kincorth and Tullos Hills prevent much of the land and coastal elements of the RSU having intervisibility with the proposed development. Visibility is therefore limited on land to the local high points along the coast and at the edge of Aberdeen, including Girdle Ness. Due to the slight curve in the coastline between Stonehaven and Girdle Ness most of the inner shore area will not have any intervisibility but further offshore the vast open sea will afford views back to land with the EOWDC in views to the north.

At the south of the RSU, the areas of intervisibility on land are limited to sporadic, high, open agricultural land which will predominantly have views toward the east. Moving closer to Aberdeen, the coast and land element of the RSU becomes more densely settled and it is only from the open Tullos Hill and Girdle Ness that views of the development will be clearly visible.

Any visibility of the proposed development would be seen in context with the heavily built up settlement and transport corridors which lie inland from the RSU. Effects on the sea element of the RSU will potentially be greater nearer the northern extents of the unit. However, overall intervisibility from the sea with the EOWDC will not alter the perception of scale and the key characteristics of this seascape unit, which already include distant views of existing wind farms.

It is therefore assessed that there will be a Low magnitude of effect on the character of this regional seascape unit. As the level of sensitivity to the proposed change is judged to be Medium to Low, the significance of effect on this RSU is assessed as Moderate-Minor to Minor with no direct effects upon the attributes of this seascape unit, and only a limited effect upon views from the northern extents.

Cumulative Impacts

The existing baseline of this RSU includes views of wind farms, with the recently consented Meikle Carewe wind farm closest at 5km from the coastline. Clusters of existing and consented wind farms to the south and also to the north of the RSU are theoretically visible, with those to the south more dominant in views due to their closer distance. The addition of the EOWDC will add to combined visibility within the offshore extents of the RSU and only very small areas on land. Figure 16 shows that the combined visibility of the in-planning turbines with the EOWDC is very limited within this RSU both offshore and onshore. This is due to the nearest in-planning turbines (Woodlands Farm) being located at over 20km from northern extents of the RSU.

It is judged that the magnitude of cumulative effect on the Stonehaven to Girdle Ness regional seascape unit is Low given that the majority of the area has potentially existing views of wind farms and the presence of the EOWDC will only marginally increase the areas visible to wind farms and at a considerable distance. As the level of sensitivity to the proposed change is judged to be Medium to Low, the significance of cumulative effect on this RSU is assessed as Moderate-Minor to Minor.

3.1.3. Aberdeen Beach Regional Seascape Unit

This regional seascape unit is approximately 5 km at its nearest point from the closest turbine of the EOWDC. It is short stretch of deposition coastline which is characterised by the influence of Aberdeen city and its harbour. The ZTV illustrates that the majority of this area will have intervisibility with the proposed development. Only localised areas such as behind the Beach Boulevard and areas behind settlements and beach development will have limited views.

This seascape unit is typically dominated by the wide variety of seafront development, including the harbour and sea defences and the movement of sea traffic to and from the harbour. Often large numbers of ships sit for several days or weeks within the Maritime and Coastguard Agency (MCA) designated anchorage area which lies within the inshore waters. These factors all combine to make it a dynamic and slightly chaotic seascape which will assist in reducing the visual influence of the proposed development.

It is therefore judged that the magnitude of impact on the character of the Aberdeen Beach RSU is High to Medium. As the level of sensitivity to the proposed change is judged to be Medium, the significance of effect on the visual aspects of this RSU is assessed as Major-Moderate to Moderate, with no direct effect on the attributes of this seascape unit.

Cumulative Impacts

There are no wind farms within this seascape unit, however there is an existing baseline of distant views of existing and consented wind farms from the offshore part of the unit. The cumulative ZTV (Figure 17) shows that between 1 and 6 km offshore, there is the potential for combined visibility of up to six other existing and consented wind farms with EOWDC, the closest at Tillymaud and Hill of Fiddes, approximately 15km from the coastline within the RSU. The number of wind farms visible increases gradually the further offshore so that at the sea limits of the unit (24 km offshore, GSA, 2001), the ZTV shows that there is potential to see up to 30 existing or consented wind farm sites.

A similar pattern applies to the in-planning wind farms (Figure 18) where combined visibility with EOWDC starts approximately 6km from the coastline and gradually increases to over 12 sites at the offshore extents of the RSU. The closest in-planning turbines at Woodlands Farm are also approximately 15km from the coastline.

All of the existing and consented and in-planning wind farms except EOWDC will be at considerable distances from the areas of shown combined visibility and they will not be prominent elements in views from offshore.

The ZTVs show that the majority of the seaward extents of this unit have existing intervisibility with onshore wind farms but at some distance so the addition of EOWDC in close proximity to the unit has individual effects as identified above but it is judged will only have a Low to Negligible magnitude of cumulative effect due to the scale and distance of the existing, consented and in-planning turbines. As the level of sensitivity to the proposed change is judged to be Medium, the significance of cumulative effect on this RSU is assessed as Moderate-Minor to Negligible.

3.1.4. Aberdeen Bay Regional Seascape Unit

The proposed development lies within the southern part of the Aberdeen Bay regional seascape unit. This RSU stretches along the sandy coast from Donmouth to the Ythan estuary. The southern extents of the unit are more influenced by Aberdeen and its suburbs and the seascape becomes more remote towards Forvie Sands.

The ZTVs show that almost all this seascape unit will have intervisibility with the proposed development. However, the undulating sand dunes, which are a key characteristic of the area, will have marginally less intervisibility.

The proposed turbines will be a dominant feature of the seascape unit and will become a new characteristic within the sea aspect, although distant views of existing and consented onshore wind farms are possible from the RSU. The northern section of the seascape unit will remain more remote from the turbines but a visual link will exist. It is therefore considered that the magnitude of impact on the character of the Aberdeen Bay is High. Elements such as the A90, drilling platform, observation tower and views of the city, combined with the active sea traffic will assist in reducing the effect to some degree. As the sensitivity to the proposed change is judged to be Medium in the south and High to Medium in the north, the significance of effect on this RSU is assessed as Major-Moderate in the south, and Major to Major-Moderate in the north.

Cumulative Impacts

The EOWDC will be the only wind farm within the Aberdeen Bay seascape unit and the existing and consented sites ZTV (Figure 17) shows that the majority of the land, coastline and inshore waters of the Aberdeen Bay seascape unit will only have views of the EOWDC. Just beyond 1km offshore the ZTV shows that there is potential for combined views of 1 or more existing and consented wind farms which gradually increase to 28 other wind farms at the sea extents of the unit. The closest existing wind farm is the Hill of Fiddes which lies approximately 7km from the coastline within this RSU.

The in-planning wind farms will increase the number of wind farms visible with the EOWDC by potentially 12 sites at the sea extents of the unit, but does not alter the overall areas of wind farm visibility. Woodlands Farm is the closest in-planning wind farm at over 10km from the coastline.

Within an approximate 30 km radius from this seascape unit there are 24 existing and consented wind farms and 15 in-planning wind farms. The majority of these wind farms are single turbines or three turbine schemes, with the exception of a couple which have five turbines, and Meikle Carewe which will have 12 turbines.

Hill of Fiddes, Ardgrain, Tillymaud, Mains of Bogfechel, and the in-planning Woodlands Farm and Hill of Fechel turbines are the closest wind farms to the seascape unit.. They will have the potential to have the greatest cumulative effects combined with the EOWDC in views from the offshore areas of this seascape unit. Also, the in-planning Peterhead Harbour turbines will be the nearest turbines to the coast and although approximately 22km from this seascape unit, there is potentially a greater link with the EOWDC given the location.

The majority of the wind farms sites identified have a hub height of around approximately 60 m and blade tip of 100 m. As the EOWDC will have a maximum hub height of 120 m, the scale difference may be more apparent in this seascape unit than the other units due to the closer proximity of the sites. Given this size difference, the existing and consented wind farms will be much more recessive in views from the sea element of the unit and focus will be on the EOWDC.

It is judged that as potential views of wind farms from the outer sea element of the seascape unit is already a characteristic of the unit albeit at some distance, the presence of the EOWDC will mostly be confined to individual effects and the magnitude of cumulative effects will be Low to Negligible. As the sensitivity to the proposed change is judged to be Medium in the south and High to Medium in the north, the significance of cumulative effect on this RSU is assessed as Moderate-Minor to Negligible in the south, and Moderate to Moderate-Minor to Negligible in the north.

3.1.5. Collieston to Peterhead Regional Seascape Unit

This regional seascape unit is approximately 15 km north of the proposed development at its closest point and consists of the rocky stretch of coastline extending from the north of Forvie Sands to Peterhead, including Cruden Bay. The ZTVs illustrate that there will be intervisibility with the proposed development across the majority of the seascape unit except for Cruden Bay due to its sheltered nature from the surrounding higher land. To the north of Cruden Bay the inshore coastal waters will be screened from views of the EOWDC due to the orientation of the coastline and intricate cliffs.

This RSU has a large open scale which already includes large vertical features such as the power station stack and onshore turbines, and has an active outer sea element. The EOWDC will therefore not be a fundamental change to the character of the seascape unit and views of the proposed turbines will be accommodated to some degree by the vast scale of the seascape.

It is therefore judged that the magnitude of impact on the character of the RSU is Medium to Low. As the sensitivity to the proposed change is considered Medium, the significance of effect on the Collieston to Peterhead RSU is assessed as Moderate to Moderate-Minor with no direct effects upon the attributes of this seascape unit, and only limited effects upon views towards the south.

Cumulative Impacts

The cumulative ZTVs illustrate that the majority of the Collieston to Peterhead RSU already has potential views of onshore existing and consented wind farms. However, there are no wind farms within the unit itself. The ZTVs also show that only a sliver of coastline and inner coastal waters will have views of EOWDC only.

Figure 12 shows that Ardgrain, West Knock Farm, and Bruxiehill are the closest existing wind farms to the seascape unit, lying approximately 5 to 10 km from the land extents. The in-planning turbines at Peterhead Harbour and single turbine at Middleton of Rora lie close to the northern extents of the seascape unit.

On the land element of the unit where EOWDC is potentially visible, Figure 17 shows that combined views of up to 28 existing and consented wind farms may be possible. This is mainly on small areas of higher open exposed coastal land. In these areas, which lie to the south of the seascape unit, the greatest cumulative effects would be with Ardgrain and Hill of Fiddes as the closest wind farms to the area and EOWDC. The other wind farms further inland such as Skelmonae, Bruxiehill and West Knock Farm may be visible but will be more recessive in views. The in-planning wind farms will also affect a similar land area to the existing and consented turbines with EOWDC with up to 10 wind farms visible on the higher points.

The sea element of the seascape unit is less exposed to existing and consented wind farms in the inner waters but theoretical views of turbines gradually increases up to 28 sites towards the sea extents of the unit. The in-planning wind farms will slightly increase this number in the same areas as shown on Figure 18 with the exception of Peterhead Harbour turbines. These turbines will be visible with the EOWDC in the inner coastal waters (1 to 5km offshore) from the northern extents of the seascape unit.

The EOWDC will be at a similar distance to the seascape unit as the other closest wind farms in the area (except for the in-planning Peterhead Harbour turbines), but will be more visible due to its size and offshore location. Views of wind farms are a characteristic of the seascape unit and the addition of EOWDC will add another wind farm which, at this distance from the unit, will be noticeable in the southern extents but not a dominant feature.

It is therefore judged that the magnitude of cumulative impact on the character of the RSU is Medium to Low. As the sensitivity to the proposed change is considered Medium to Low, the significance of cumulative effect on the Collieston to Peterhead RSU is assessed as Moderate to Moderate-Minor to Minor.

3.1.6. **Peterhead to Fraserburgh Regional Seascape Unit**

This seascape unit lies at the outer extents of the study area, 35 km from the nearest EOWDC turbine, and embraces the north eastern corner deposition coastline of Aberdeenshire between Peterhead and Fraserburgh. The ZTV shows that the regional seascape unit would have no intervisibility with the proposed development except for the outer sea area. It can be considered at the distance from the proposed development that it would appear as a minor element within the expansive views from within the outer sea extents, where views of closer onshore existing and consented wind farms may also be possible.

Therefore it is judged that the magnitude of impact on the character of the Peterhead to Fraserburgh RSU is Negligible. As the sensitivity to the proposed change is considered Low, the significance of effect on this RSU is assessed as Negligible.

Cumulative Impacts

As judged in the above assessment, the extent of theoretical visibility of the EOWDC only affects the offshore regions of the seascape unit. Within this area the cumulative ZTVs show that up to 18 existing and consented and up to 12 in-planning wind farms would be also visible in the offshore waters with the EOWDC. As the EOWDC will be a minor, if discernable, element within this sea area, the cumulative impacts of the EOWDC on the Peterhead to Fraserburgh regional seascape unit, can also be judged as being of Negligible significance.

3.2. Landscape Effects

The following paragraphs discuss the effects of the EOWDC on the landscape character areas within the study area. As outlined in the Baseline Report there were several character areas identified which do not have any intervisibility with the site and these have not been included in the assessment. The EOWDC ZTVs (Figures 7 to 9) and cumulative ZTVs (Figures 13 to 18) have been referred to in the assessment of the effects. Please refer to Figures 5 and 6 for location of the character areas.

South and Central Aberdeenshire LCA

3.2.1. **Agricultural Heartlands: Formartine Lowlands** (LCA No.4, Figure 5)

The Formartine Lowlands landscape character area is the closest of the Agricultural Heartland landscape type to the proposed development, at just over 3 km from the nearest EOWDC turbine, extending inland approximately 20 km. The ZTV shows that the majority of the area up to 15 km inland will have intervisibility with the proposed turbines, becoming patchy at the western extents as the undulating landscape becomes more pronounced.

The EOWDC will be dominant in the characteristic expansive views for much of the eastern side of this character area but overall the generally large open scale of the Formartine Lowlands character area gives an ability to accommodate such views. Aims for increasing woodland cover as suggested in the Aberdeenshire LCA, and existing vertical features such as existing wind farms and pylons will also reduce any effects.

It is therefore judged the magnitude of impact on the Formartine Lowlands is High to Medium. As the sensitivity to the type of development proposed is Medium to Low, the significance of effect on this character area is Major-Moderate to Moderate to Moderate-Minor.

Cumulative Impacts

The cumulative ZTVs illustrate that almost all of the Formartine Lowlands has existing exposure to wind farms. However, the addition of EOWDC will extend the potential visibility of wind farms to the south eastern edge and corner of the character area where no wind farms are currently visible. Within the character area there are four existing and consented small wind farms at Hill of Fiddes, Ardgrain, Tillymaud (single turbine), and Mains of Bogfechel (single turbine) and in-planning single turbine at Mosseye, Hill of Fechel and two turbines at Woodlands Farm. There are also many other small wind farms and single turbines to the north west of this character area which will have a theoretical visual influence on this area.

The ZTV in Figure 17 shows that towards the north west of the Formartine Lowlands, there would be areas of potential combined visibility of EOWDC with up to 30 existing and consented wind farms on the local high points, but the majority of the visibility with EOWDC would be up to 6 wind farms. Figure 18 shows that up to 12 in-planning wind farms may also be visible from the same areas.

The addition of the EOWDC will increase the number of turbines visible from a large part of this character area. The three turbine wind farms at Hill of Fiddes and Ardgrain are quite noticeable existing features and it is these two sites which will potentially have the greatest cumulative effect with EOWDC on the character area due to their proximity to each other.

It is judged that the magnitude of cumulative effect on the Formartine Lowlands character area is Medium due to EOWDC extending the number of turbines visible in an area which already has a large exposure to wind farms. As the sensitivity to the type of development proposed is Medium to Low, the significance of cumulative effect on this character area is Moderate to Moderate-Minor.

3.2.2. **Agricultural Heartlands: Central Wooded Estates** (LCA No.5, Figure 5)

The enclosed nature of this character area is confirmed by the ZTV as there are very limited areas of intervisibility with the EOWDC, the nearest turbine of which lies 7.5 km away. The largest of these areas is on the east facing slopes of Auchronie Hill, north west of Westhill, at approximately 20 km from the EOWDC. Taking into account this is the only considerable area of intervisibility within the wider character area, it is considered on the whole, the magnitude of impact on the Central Wooded Estates is Negligible. As the sensitivity to the proposed change is Low, the significance of effect on this character area is Negligible.

Cumulative Impacts

The cumulative ZTV figures confirm that there is very little existing visibility of wind farms within the Central Wooded Estates in comparison to the wider study area. The few very small areas of intervisibility with the EOWDC also have visibility of up to 20 other existing and consented wind farms and 12 in-planning wind farms. As above, whilst there is potential for cumulative effects within these small areas, the majority of the character area would not have any, and as such the significance of effect on the Central Wooded Estate character area can be judged as Negligible.

3.2.3. **Agricultural Heartlands: Kincardine Plateau** (LCA No.6, Figure 5)

This triangular character area which lies between the upland areas of the Mounth and edge of Aberdeen is approximately 14.5 km from the nearest turbine of the EOWDC at its closest point. The ZTVs illustrate that there will be some intervisibility with the proposed development on the exposed inland north facing slopes around Muirskie and Auchlunies.

The magnitude of impact on the Kincardine Plateau is judged as Low to Negligible as the lack of strong characteristics and influence of the suburbs of Aberdeen reduce the impact of any views of the proposed development. As the sensitivity to the type of development proposed is Low, the significance of effect on this character area is assessed as Minor to Negligible.

Cumulative Impacts

The cumulative ZTVs show that there would be very little cumulative impacts in the Kincardine Plateau character area given the few areas of intervisibility with the EOWDC. There are no existing or consented wind farms within the area but there will be the potential for some combined views of the EOWDC with up to 18 existing and consented and up to 6 in-planning wind farms. As these areas of intervisibility are on mostly north east facing slopes it is judged that the wind farms will be those in the north, the nearest of which are the cluster of turbines around Udny at just over 20 km from the character area. It may also include Meikle Carewe Wind Farm which is the closest to the character area but lies to the south.

The addition of the EOWDC will have limited cumulative effects mostly confined to the elevated north east facing land at the south of the area where the majority of the wind farms will be at a considerable distance that they would be minor elements in the views. Therefore it is judged that the magnitude of cumulative impact on the Kincardine Plateau is Low to Negligible. As the sensitivity to the type of development proposed is Low, the significance of cumulative effect is assessed as Minor to Negligible.

3.2.4. **Agricultural Heartlands: Ythan Strath Farmland** (LCA No.7, Figure 5)

The ZTVs illustrate that the exposed hill tops of the Ythan Strath Farmland, will have intervisibility with the EOWDC which lies approximately 17 km at its closest point to the nearest turbine and 30 km at it's furthest. Views of the EOWDC will be within a wider context at this distance and elevation. The sheltered wooded estates and small scale field patterns with diverse vegetation cover will preclude large areas of this character area from extensive views out towards the EOWDC.

Taking the above into account, and the existing turbines already included in views, reduces the magnitude of impact on the Ythan Strath Farmland to Medium to Low. As the sensitivity to the type of proposed development is Low, the significance of effect on this character area is assessed as Moderate-Minor to Minor.

Cumulative Impacts

Figure 12 shows that Ythan Strath Farmland has a single turbine at Courtstone, four existing turbines at Skelmonae, with a three turbine extension to Skelmonae currently in planning. There are also other existing wind farms that surround the area.

The cumulative ZTVs show that the entire Ythan Strath Farmland already has exposure to existing, consented and in-planning wind farms. The addition of the EOWDC does not expose any new areas to wind farms but will add to the combined views on the exposed hill tops. Figure 17 illustrates that within these areas up to 30 existing and consented and up to 14 in-planning wind farms will potentially be seen with the EOWDC.

As the EOWDC lies between 17km and 30km from this character area and will be potentially seen from only the exposed hill tops where wind farms are very much an existing characteristic and in closer proximity, it is judged that the magnitude of cumulative impact is Low. As the sensitivity to the type of proposed development is Low, the significance of cumulative effect on this character area is assessed as Minor.

3.2.5. **Agricultural Heartlands: Northern Rolling Lowlands** (LCA No.8, Figure 5)

The Northern Rolling Lowlands character area lies approximately 22 km at its closest point to the nearest turbine of the EOWDC. The ZTV illustrates that the characteristic long distant views from the elevated farmland will potentially include the proposed development. Turbines are a feature of this landscape and at this distance it is unlikely the EOWDC turbines would be seen within the sea but as a minor feature in the horizon behind the undulating landforms and within an expansive view.

It is therefore judged the magnitude of impact on the Northern Rolling Lowlands is Low. As the sensitivity to the type of development proposed is Low, the significance of effect on this character area is assessed as Minor.

Cumulative Impacts

The cumulative ZTVs show that similar to the adjacent Ythan Strath Farmland, the whole of this character area has intervisibility with wind farms. Within the Northern Rolling Lowland, there are existing and consented small wind farms or single turbines at Balquhindachy, Haddo, St Johns Well, Denhill, and Hill of Easterton. St Johns Well Extension and Hillhead are the only wind farms in planning within the character area.

The Northern Rolling Lowlands is also surrounded by a large number of wind farms on all sides especially to the north and west. The addition of the EOWDC does not increase the area exposed to wind farms but will add to the combined cumulative views on the small areas of elevated areas. Figures 17 and 18 show that in these limited areas up to 30 existing and consented and up to 20 in-planning wind farms could potentially be seen. All of these wind farms lie closer to the area than the EOWDC and, as concluded above, views of the EOWDC would be limited and at some distance.

Taking into account the above and that a large part of the area will not have any visibility of the EOWDC, it is judged the magnitude of cumulative impact on the Northern Rolling Lowlands is Low to Negligible. As the sensitivity to the type of development proposed is Low, the significance of cumulative effect on this character area is assessed as Minor to Negligible.

3.2.6. **Agricultural Heartlands: Garvock and Glenbervie** (LCA No.9, Figure 5)

This character area lies just south west of Stonehaven, 27 km from the nearest EOWDC turbine at its closest point and extends beyond the 40 km study area. The ZTV illustrates that intervisibility will be limited to a few northern elevated slopes specifically at Bruxie Hill (which has existing transmitters) and also St John's Hill, which will soon support 9 turbines. Overall, the majority of the study area will not have any intervisibility with the EOWDC, and the key characteristics of views towards the Mounth and Howe of Mearns will be unaffected by the proposed development. Therefore, the magnitude of impact on the Garvock and Glenbervie character area is judged as Negligible. As the sensitivity to the type of development proposed is Medium to Low, the significance of effect on this character area is assessed as Negligible.

Cumulative Impacts

The cumulative ZTVs show that where there is limited intervisibility with the EOWDC, there will also be views of up to 14 consented and existing and up to 6 in-planning wind farms. These are limited to the highest points where the closer St Johns Hill, Hillhead of Auquhirie, Clochnahill, Jacksbank, and Droop Hill will be potentially dominant in view and the EOWDC will be recessive in comparison. It is therefore concluded that the significance of cumulative effects of the EOWDC on the Garvock and Glenbervie character area is Negligible.

3.2.7. **Moorland Plateaux: Grampian Outliers** (LCA No.12, Figure 5)

The ZTV illustrates that only the exposed upland areas of the Grampian Outliers will have intervisibility with the proposed development. The majority of the areas are forested which will prevent any views out to the wider area, but the extensive panoramic views from the promontories will have clear views of the proposed development. As these wide ranging views are elevated but at closest approximately 27 km from the nearest turbine of the EOWDC, the turbines will only be a minor element in often 360 degree views and will not be a dominant feature.

Therefore, the magnitude of impact on the Grampian Outliers can be judged as Negligible. As the sensitivity to the type of development proposed is High to Medium, the significance of effect on this character area is assessed as Negligible.

Cumulative Impacts

The cumulative ZTVs illustrate that at the highest points of the Grampian Outliers, over 30 existing and consented and up to 14 in-planning wind farms could potentially be visible. The majority of these wind farms will be closer to the character areas than the EOWDC and potentially be more noticeable in the available views. The addition of EOWDC would be a minor element, if discernable, within panoramic views where large numbers of turbines are already an existing characteristic.

Therefore, it can be judged that there will be Negligible cumulative effects on the Grampian Outliers character area.

3.2.8. **Moorland Plateaux: The Mounth** (LCA No.13, Figure 5)

The Mounth lies approximately 25km at its closest point to the nearest turbine of the EOWDC and extends beyond the study area. As it is a heavily forested area the only areas of intervisibility with the proposed development as illustrated on the ZTVs are the exposed north and north east facing slopes. The EOWDC may be a noticeable element from the nearest of these areas, but from the majority of views it will be minor if discernable at all.

As the majority of the character area will not have any visibility of the EOWDC it is considered that overall the wild and exposed character will not be changed by the proposed development. An existing wind farm at Mid Hill and the consented Meikle Carewe turbines will also be characteristics of this landscape, reducing any impact the EOWDC might have. Therefore, the magnitude of impact on The Mounth is judged as Negligible. As the sensitivity to the type of development proposed is High to Medium, the significance of effect on this character area is assessed as Negligible.

Cumulative Impacts

Figure 17 illustrates that there is potential for combined visibility of the EOWDC and up to 30 existing and consented and up to 14 in-planning wind farms within The Mounth. These are limited to small areas of high open exposed ground, in particular an area north of Mid Hill wind farm, and also the immediate surroundings to Meikle Carewe. The majority of the wind farms visible will be at a considerable distance to the north and it is most likely that the several existing and consented wind farms which lie to the south of The Mounth will be those potentially with the greater cumulative effect. As discussed above, the EOWDC may be a noticeable element from some of these areas, but given the distance and proximity of other wind farms, it will be recessive within any views.

For the same reasons as identified above, the significance of cumulative effect on The Mounth character area is assessed as Negligible.

Banff and Buchan LCA

3.2.9. **Agricultural Heartlands: Agricultural Heartlands (area)** (LCA No.18, Figure 5)

This character area lies approximately 22.5 km at its closest point to the nearest turbine of the EOWDC, extending to beyond 40 km. The ZTVs show that there is a continuous area of intervisibility with the proposed development extending from north of the Ythan river to just south of Cuminestown. The ZTVs also show another area of potential intervisibility to blade tip only which lies between Brucklay Castle, and New Pitsligo. These areas consists of the characteristic large field patterns with frequent farmstead and houses scattered across the elevated south east facing slopes with open views of the surrounding landscape. Any views of the EOWDC will be seen within these expansive views.

The majority of the character area however will not have any intervisibility with the proposed development and combined with the distance from the coast and existing wind farms in the area, the magnitude of impact on the Agricultural Heartland character area is judged as Low to Negligible. As the sensitivity to the type of development proposed is Low, the significance of effect on this character area is assessed as Minor to Negligible.

Cumulative Impacts

The ZTVs illustrate that the majority of the Agricultural Heartlands character area has existing exposure to wind farms. Within the 40 km study area there are existing turbines at Skelmonae, Newstead, Auchtygills Farm, and Clayfords Farm, with a further four sites in planning. Figures 17 and 18 illustrate that up to 30 existing and consented and up to 14 in planning wind farms will be potentially visible with EOWDC from the limited areas identified above.

The addition of the EOWDC gives the potential for combined effects on a small part of the overall character area. As the EOWDC lies beyond 22 km from the character area, it is considered that whilst it may be seen in views from this area, it will be a minor element and any cumulative effect would be minimal.

Therefore, the magnitude of cumulative impact on the Agricultural Heartland character area is judged as Low to Negligible. As the sensitivity to the type of development proposed is Low, the significance of cumulative effect on this character area is assessed as Minor to Negligible.

3.2.10. **Coastal Farmland: Eastern Coastal Agricultural Plain** (LCA No.21, Figure 5)

The Eastern Coastal Agricultural Plain with open views to the surroundings is approximately 17 km at its closest point to the nearest turbine of the EOWDC and extends north to beyond Fraserburgh. This character area overlaps with the land extents of the Collieston to Peterhead seascape unit. The ZTVs show that the southern extent of the Eastern Coastal Agricultural Plain up to Peterhead has a high level of intervisibility with the proposed development except for an area around and west of Cruden Bay. The proposed development will be clear in views to the south from this area albeit at over 17 km away. However, it is only a small area of the overall character area which will have intervisibility with the proposed development.

It is therefore judged that the magnitude of impact on the Eastern Coastal Agricultural Plain is Medium to Negligible. As the sensitivity to the type of development proposed is Medium to Low, the significance of effect on this character area is assessed as Moderate to Moderate-Minor to Negligible.

Cumulative Impacts

The cumulative ZTV illustrates that the Eastern Coastal Agricultural Plain is theoretically exposed to wind farms across the entire area except for around Cruden Bay. The southern end of the Eastern Coastal Plain has sporadic combined theoretical visibility of up to 20 existing and consented and up to 10 in-planning wind farms with the EOWDC. There are no wind farms within the southern extents of the Eastern Coastal Plain but within the 40 km study area, there are three existing and consented and four proposed wind farms.

The addition of EOWDC will expose some new areas to wind farms in the southern part of the character area but these are limited and adjacent to areas where combined views of other wind farms may be possible. As the character area lies near the coast, the views of the EOWDC will most likely take in the sea and potentially the turbines will be viewed as a separate element to the onshore wind farms in this case.

Taking into account the above, the distance between the EOWDC and the character area, and also that the majority of the character area will not have any intervisibility with the EOWDC, it is judged that the magnitude of cumulative impact on the Eastern Coastal Agricultural Plain is Low to Negligible. As the sensitivity to the type of development proposed is Medium to Low, the significance of cumulative effect on this character area is assessed as Moderate-Minor to Minor to Negligible.

Aberdeen LCA

3.2.11. **Major River Valleys: The Upper Don Valley (Aberdeen)** (LCA No.23, Figure 6)

The enclosed wooded valley of the upper Don area is approximately 12 km at its closest point to the nearest turbine of the EOWDC. The ZTVs illustrate that the Upper Don Valley has limited intervisibility with the proposed development and these areas of intervisibility are restricted to blade tip views only on the higher east facing valley sides. As much of the valley is inward looking and elements such as the sand extraction and pylons lines are dominant, it is judged that the key characteristics of this area will not be affected by the limited blade tip views of the EOWDC and the magnitude of impact on the Upper Don Valley is assessed as Negligible. As the sensitivity to the type of development proposed is Low, the significance of effect on this character area is assessed as Negligible.

Cumulative Impacts

The cumulative ZTVs show that except for a tiny sliver of land, there will be no cumulative effects within this character area. It is therefore considered that overall there will be negligible cumulative effects on the Upper Don Valley.

3.2.12. **Major River Valleys: Dyce Plain** (LCA No.24, Figure 6)

The open flat characteristics of the Dyce Plain, which lies approximately 10 km from the nearest turbine of the EOWDC, allow distant views across the landscape. The ZTV shows that the majority of this area will have intervisibility with the EOWDC with some blade tip only visibility adjacent to Dyce. The industrial and commercial activities around Aberdeen Airport will distract and will reduce the prominence of any visibility of the turbines within views to the east.

Therefore, the magnitude of impact on the Dyce Plain character area is judged as Medium. As the sensitivity to the proposed development is Low, the significance of effect on this character area is assessed as Moderate-Minor.

Cumulative Impacts

The cumulative ZTV shows that there are no views of other wind farms except for a small area south of the airport runway where 1 to 2 other consented and existing wind farms and 1 to 2 in-planning wind farms may be seen in combination with the EOWDC. These will most likely be the cluster of turbines in-planning and existing and consented at Udny and the Hill of Fiddes turbines, which lie approximately 10 km to the north.

Given that the majority of the character area will only have visibility of EOWDC the cumulative effects on the character will be limited. It is therefore judged the magnitude of cumulative effect is Low to Negligible. As the sensitivity to the proposed development is Low, the significance of cumulative effect on this character area is assessed as Minor to Negligible.

3.2.13. **Hills: Tyrebagger Hill/Kirkhill** (LCA No.27, Figure 6)

Tyrebagger Hill and Kirkhill lie at their closest point approximately 12.5 km from the nearest turbine of the EOWDC. As much of this landscape character area is covered by woodland it is only the lower open slopes to the east and to the north where the ZTV illustrates that there would be potential intervisibility with EOWDC. The hills lie directly west of the EOWDC and views of the turbines would be seen behind a foreground of the industrial and commercial development around the airport, which would reduce the impact to some degree.

Taking into account the above and that as the woodland is the main characteristic of this area which would remain unaffected by the presence of the EOWDC, it is judged that the magnitude of impact on Tyrebagger and Kirkhill is Low. As the sensitivity to the proposed development is High to Medium, the significance of effect on this character area is assessed as Moderate to Moderate-Minor.

Cumulative Impacts

The cumulative ZTVs show that there is a small area of potential cumulative visibility on the northern open slopes of Kirkhill. Figure 17 shows that up to 14 existing and consented and up to 12 in-planning wind farms are potentially visible from this area. Within this number, the closest turbines, at approximately 8 – 10 km to the north, will be at Mains of Bogfechel, Tillymaud, Hill of Fiddes, and in-planning turbines at Woodlands Farm, Hill of Fechel, and

Mosseye. Views of these wind farms would be to the north of the character area and the EOWDC would lie to the east in a different part of the view.

As this area of potential combined visibility is limited and covers only a small part of the character area, it is judged that the magnitude of cumulative effects is Low. As the sensitivity to the proposed development is High to Medium, the significance of effect on this character area is assessed as Moderate to Moderate-Minor.

3.2.14. **Hills: Brimmond Hill** (LCA No.28, Figure 6)

The ZTV illustrates that the north and eastern slopes of Brimmond Hill, and only the northern slopes of the adjacent Elrick Hill will be exposed to the proposed development. This character area lies approximately 14 km from the nearest EOWDC turbine. Extensive 360 degree panoramic views are experienced from the top of Brimmond Hill and the EOWDC turbines would be discernable and part of the view but would not dominate. The expansive views also include other wind farms in the wider area, and the masts and pylons on Brimmond Hill which are a strong feature. Also, the ZTVs show a large part of the character area will not have any intervisibility with the EOWDC.

It is therefore judged that the overall magnitude of impact on Brimmond Hill character area is Low. As the sensitivity to the proposed development is Medium, the significance of effect on this character area is assessed as Moderate-Minor.

Cumulative Impacts

The cumulative ZTVs show that from the top of Brimmond Hill there is the potential to see over 30 consented or existing wind farms, and potentially up to 16 in-planning wind farms in combination with the EOWDC. On the lower north and east slopes this number gradually reduces to up to 4 sites for both consented and existing and in-planning wind farms.

The addition of EOWDC will not increase the areas on Brimmond Hill exposed to wind farms due to the elevated nature. However, the EOWDC will become visible in part of the 360 view where no other existing, consented or in-planning wind farm will be seen and as the closest, will be the most discernable. The EOWDC will add to the perception of wind farms being a strong characteristic of the surrounding area but will not fundamentally alter the key elements of the Brimmond Hill character area.

Therefore it is judged that the magnitude of cumulative impact on Brimmond Hill character area is Medium to Low. As the sensitivity to the proposed development is Medium, the significance of effect on this character area is assessed as Moderate to Moderate-Minor.

3.2.15. **Hills: Kincorth and Tullos Hills** (LCA No.30, Figure 6)

The Kincorth and Tullos Hills lie approximately 9 km from the nearest turbine of the EOWDC. The open northerly aspects of this area of elevated land to the south of Aberdeen will have intervisibility with the proposed turbines as shown on the ZTV. The characteristic heathland cover of Tullos Hill enables clear views towards the sea, however, Kincorth Hill is more enclosed with young woodland planting and there are only a few open areas where long distant views can be seen. The turbines will be a discernable feature within the view but will not alter the key characteristics of Kincorth and Tullos Hills.

It is therefore judged that the magnitude of impact on the visual aspects of the Kincorth and Tullos Hills character area is Medium. As the sensitivity to the proposed development is Medium, the significance of effect on this character area is assessed as Moderate.

Cumulative Impacts

The cumulative ZTVs show that Kincorth and Tullos Hills may have views of up to 4 existing and consented and up to 2 in-planning wind farms combined with EOWDC. The areas of combined visibility are predominantly on the north facing slopes which indicate that the other wind farms in view are to the north, rather than those to the south of Aberdeen.

Therefore, the closest existing and consented wind farms to the character area Hill of Fiddes, Tillymaud, and Mains of Bogfechel which lie approximately 20 km to the north. The in-planning Woodlands Farm and Hill of Fechel will also be at a similar distance. The relatively small size and scale of these turbines will mean at this distance that they will not be easily perceived in views where the EOWDC in comparison will be a noticeable feature.

It is therefore judged that the magnitude of cumulative impact is Low. As the sensitivity to the proposed development is Medium, the significance of effect on this character area is assessed as Moderate-Minor.

3.2.16. **Open Farmland: Perwinnes** (LCA No.31, Figure 6)

The ZTV illustrates that except for the lower land surrounding Corby Loch, the whole of the Perwinnes open farmland will potentially have intervisibility with the proposed turbines. Long distance views can be afforded to the surrounding landscape and at approximately 7 km from the nearest turbine of the EOWDC, the turbines will be a dominant feature in views towards the east.

The EOWDC will be a noticeable change in views out from the Perwinnes Open Farmland. Other strong visual elements such as sand extraction, and the radar station, will help to some degree in reducing the effects of the EOWDC on the character area.

It is therefore judged that the magnitude of impact on the visual aspects of the Perwinnes character area is High to Medium. As the sensitivity to the proposed development is Medium, the significance of effect on this character area is assessed as Major-Moderate to Moderate.

Cumulative Impacts

The cumulative ZTVs illustrate that there is potential for combined intervisibility with up to 18 existing and consented and up to 4 in-planning wind farms within the Perwinnes Open Farmland. These areas are located on the higher land to the east of the B997, near the radar station, and also south east of Corby Loch. The closest visible wind farms are most likely to include the cluster around Udny and Hill of Fiddes turbines, at approximately 10 km north of the character area and also Meikle Carewe which is 20 km to the south. However, the potential for cumulative effects with Meikle Carewe are limited due to distance and intervening settlements.

The EOWDC will be a relatively dominant feature in views from this character area in comparison to the smaller turbines identified above, which although theoretically visible will not be particularly noticeable features.

It is judged that the overall magnitude of cumulative impact on the visual aspects of the Perwinnes character area is Low. As the sensitivity to the proposed development is Medium, the significance of cumulative effect on this character area is assessed as Moderate-Minor.

3.2.17. **Open Farmland: East Elrick** (LCA No.34, Figure 6)

East Elrick open farmland is defined as a small area on the eastern slopes of Brimmond Hill between Newhills and Craibstone character areas. It lies approximately 13 km from the nearest turbine of the EOWDC. The ZTV shows that there will be visibility of the EOWDC across the whole area except for where a woodland block on higher land precludes views behind. Although the turbines will potentially be noticeable in the view, the foreground elements such as the suburbs of Dyce, Bucksburn and Bridge of Don will be active and distracting elements.

It is therefore judged that the magnitude of impact on the visual aspects of the East Elrick character area is Medium. As the sensitivity to the proposed development is Medium to Low, the significance of effect on the visual characteristics of this area is assessed as Moderate to Moderate-Minor.

Cumulative Impacts

The cumulative ZTVs show that there is potentially some combined visibility with EOWDC and up to 4 existing and consented and up to 4 in-planning wind farms. As the land gently slopes towards the EOWDC, the closest wind farms within the views are most likely to be those in the north at Hill of Fiddes, Tillymaud, Mains of Bogfechel, Hill of Fechel and Woodlands Farm. EOWDC would potentially be seen with these wind farms within a 90 degree view but given their relatively small size and at approximately 15 km away, they would only be minor elements with the view with EOWDC a much more noticeable element.

It is therefore judged that the magnitude of cumulative impact on East Elrick character area is Low. As the sensitivity to the proposed development is Medium to Low, the significance of cumulative effect on the visual characteristics of this area is assessed as Moderate-Minor to Minor.

3.2.18. **Open Farmland: Newhills** (LCA No.35, Figure 6)

The elevation of the Newhills character area allows views towards the coast. It lies approximately 10 km from the nearest turbine of the EOWDC. The ZTV illustrates that the majority of this area will be exposed to views of the EOWDC with some areas sheltered by development at Bucksburn and Northfield. The Bucksburn valley is also sheltered from views. The surrounding landscape and urban and industrial influences are a characteristic of the views from this area and the EOWDC turbines will a noticeable feature behind.

However, it will not fundamentally change the overall character of the area, and it is therefore judged that the magnitude of impact on Newhills is Medium to Low. As the sensitivity to the proposed development is Low, the significance of effect on this character area is assessed as Moderate-Minor to Minor.

Cumulative Impacts

As this area is relatively open and elevated with views predominantly towards the east and north, the ZTV shows that there is potential for combined visibility of up to four other wind farms and the EOWDC. Assessing the ZTV, the closest wind farms to the north and east are Hill of Fiddes, Mains of Bogfechel, Ardgrain and Courtstone turbines, at approximately 15 km, 15 km, 22 km and 22 km respectively from the character area.

At these distances and due to the size and number of turbines they will not be a strong feature within the view in comparison to the EOWDC, and it is judged that the magnitude of cumulative impact would be Low. As the sensitivity to the proposed development is Low, the significance of cumulative effect on the Newhills character areas is assessed as Minor.

3.2.19. **Open Farmland: Maidencraig** (LCA No.36, Figure 6)

The Maidencraig open farmland lies approximately 12.5 km at its closest point to the nearest turbine of the EOWDC. The ZTV illustrates that the western and southern extent of the Maidencraig character area will not have any views of the development. The higher open land to the east of Kingswells will be more exposed and therefore views of the turbines will be available. They will be noticeable features, but seen behind the active foreground of the city. Views may include the Woodend Hospital tower and the turbines but they will not be in the same portion of view.

It is therefore judged that the magnitude of impact on the Maidencraig character area is Medium to Low. As the sensitivity to the proposed development is Low, the significance of effect on this character area is assessed as Moderate-Minor to Minor.

Cumulative Impacts

The cumulative ZTV shows that there is potential for combined visibility of up to 11 existing and consented and up to 2 in-planning wind farms on a small area of high ground east of Kingswells within this character area. The closest wind farms to this area are approximately 20 km away to the north and south and given the small turbine height of the majority of the wind farms in the area, it is unlikely that any of these would be major elements in the view.

Taking the above into account and the small part of the character area which is potentially exposed to combined views, the magnitude of cumulative impact is judged as Low. As the sensitivity to the proposed development is Low, the significance of effect on this character area is assessed as Minor.

3.2.20. **Open Farmland: Kingshill/Bogskeathy** (LCA No.37, Figure 6)

The Kingshill/Bogskeathy character area has north/north east facing slopes which opens the area up to views towards the proposed development. It lies approximately 14 km from the nearest turbine of the EOWDC. The ZTV shows that the turbines will be visible for the majority of this area where woodland does not preclude views. These views are wide ranging and will encompass a variety of elements of which the EOWDC turbines will be one part.

It is therefore judged that the magnitude of impact on the Kingshill/Bogskeathy character area is Low. As the sensitivity to the proposed development is Medium to Low the significance of effect on this character area is assessed as Moderate-Minor to Minor.

Cumulative Impacts

The cumulative ZTVs illustrate that there will be only a small part of this character area exposed to combined views of EOWDC with up to 2 consented and existing wind farms and 2 in-planning wind farms. As with the character areas above, the cumulative wind farms lie beyond 12 km from the area, and given the height and number of turbines, they will be small elements within the view if discernable at all.

Therefore, the overall magnitude of cumulative impact on the Kingshill/Bogskeathy character area is judged as Negligible. As the sensitivity to the proposed development is Medium to Low the significance of cumulative effect on this character area is assessed as Negligible.

3.2.21. **Open Farmland: Den of Leggart** (LCA No.38, Figure 6)

The Den of Leggart character area lies approximately 12.5 km south of the nearest turbine of the EOWDC. The ZTV illustrates that views from this narrow character area will be sporadic due to the roads and developments which enclose this area to some degree. The area is most exposed at is northern extents as the landform descends to the River Dee and also at a high point at the southern end at the A90/A956 junction. The turbines may be a noticeable feature but will not dominate views from this area.

It is therefore judged that the magnitude of impact on the Den of Leggart character area is Low. As the sensitivity to the proposed development is Low the significance of effect on this character area is assessed as Minor.

Cumulative Impacts

The cumulative ZTV shows that the elevated southern section of the Den of Leggart character area will have potential combined views of EOWDC with up to 4 existing and consented wind farms and up to 4 in-planning wind farms. The closest wind farms lie at Hill of Fiddes, approximately 20 km to the north and Meikle Carewe approximately 10 km to the south. Hill of Fiddes and nearby other wind farms will be minor elements in the view at their scale and distance from the character area. Views of Meikle Carewe will be in the opposite direction to the EOWDC, and given both their distances from the character area, the cumulative effect would not compromise the character of the area.

It is therefore judged that the overall magnitude of cumulative impact on the Den of Leggart character area is Negligible. As the sensitivity to the proposed development is Low the significance of effect on this character area is assessed as Negligible.

3.2.22. **Open Farmland: Loirston** (LCA No.39, Figure 6)

The Loirston study area is enclosed by Kincorth Hill residential development and the A90 on its west, north and east sides. It lies approximately 12 km to the south of the nearest turbine of the EOWDC. The ZTV shows that there is potentially some intervisibility with EOWDC but this is mostly limited to the high land adjacent to the A90 where views across the city will be seen and the turbines will be a noticeable but not dominant part of this view.

It is therefore judged that the magnitude of impact on the Loirston character area is Low. As the sensitivity to the proposed development is Low the significance of effect on this character area is assessed as Minor.

Cumulative Impacts

The Loirston Open Farmland has potential combined visibility with up to 20 existing and consented and up to 2 in-planning wind farms. These are limited to the raised area south of Loirston Loch. As with the Den of Leggart character area, the closest wind farms lie at Hill of Fiddes to the north and Meikle Carewe to the south, and similarly the cumulative effects are limited to a small area where any views of wind farms will be at some distance and will not detract from the character of the area.

It is therefore judged that the magnitude of cumulative impact on the Loirston character area is Negligible. As the sensitivity to the proposed development is Low the significance of cumulative effect on this character area is assessed as Negligible.

3.2.23. **Wooded Farmland: Braes of Don** (LCA No.42, Figure 6)

The Braes of Don area lies approximately 7 km at from the nearest turbine of the EOWDC. The ZTV illustrates that, due to its wooded nature and lower valley, the Braes of Don has only a limited area to the south from where there would be potential intervisibility with the proposed development. As views out to the wider landscape are not a key characteristic, the limited available views of turbines would not fundamentally affect the wooded character.

It is therefore judged that there would be Low to Negligible magnitude of impact. As the sensitivity to the type of development proposed is Low, the significance of effect on the Braes of Don will be Minor to Negligible.

Cumulative Impacts

The cumulative ZTV shows that the majority of the area has no intervisibility with other wind farms and EOWDC. However there is a strip of land near Whitestripes where Figures 17 and 18 show that there could be combined visibility of up to 12 existing and consented wind farms and up to 4 in-planning wind farms with EOWDC.

Given the small size of area potentially affected and the closest wind farm to the character area is approximately 15 km away, it is judged that the magnitude of cumulative impact is Negligible. As the sensitivity to the type of development proposed is Low, the significance of cumulative effect on the Braes of Don will be Negligible.

3.2.24. **Wooded Farmland: Craibstone** (LCA No.43, Figure 6)

Craibstone wooded farmland lies approximately 11 km from the nearest turbine of the EOWDC. Intervisibility with the proposed development as demonstrated by the ZTV is sporadic given the generally wooded nature of the character area. On the more open northern side of this character area there will be views of the EOWDC which will also include the Aberdeen Airport, Dyce and Perwinnes radar station in the foreground. The turbines will be a noticeable feature in these views but will not fundamentally change the characteristics of the area.

It is therefore judged that the magnitude of impact on the Craibstone character area is Medium to Low. As the sensitivity to the proposed development is Medium the significance of effect on this character area is assessed as Moderate to Moderate-Minor.

Cumulative Impacts

The cumulative ZTVs illustrate some very small areas of combined views of up to 2 other existing and consented wind farms with the EOWDC in the Craibstone character area. There are no in-planning wind farms visible. Similar to the adjacent areas where combined visibility is possible, it is most likely to be views of Hill of Fiddes and Mains of Bogfechel turbines, which lie approximately 13 km to the north of the area.

As these areas of combined visibility are very limited and the turbines lie at a considerable distance away where they will not be clearly discernable given the foreground elements, the magnitude of cumulative impact is judged as Negligible. As the sensitivity to the proposed development is Medium the significance of effect on this character area is assessed as Negligible.

3.2.25. **Wooded Farmland: Kingswells** (LCA No.44, Figure 6)

The Kingswells wooded farmland lies approximately 13.5 km from the nearest turbine of the EOWDC. This character area is shown by the ZTV to have intervisibility with the proposed development on the open northern and eastern areas. The sporadic woodland cover will prevent some views and where the turbines are visible, they will be a noticeable feature but the foreground of the city and its suburbs will reduce their prominence.

It is therefore judged that the magnitude of impact on the Kingswells character area is Medium to Low. As the sensitivity to the proposed development is Low the significance of effect on this character area is assessed as Moderate-Minor to Minor.

Cumulative Impacts

The cumulative ZTVs illustrate that within the Kingswells character area there is a limited area of combined visibility of EOWDC with up to 4 other existing and consented wind farms and up to 6 in-planning wind farms. Analysis of the ZTV shows that the closest wind farms are the cluster around Udny and Hill of Fiddes, and Miekle Carewe to the south all approximately 15 km from the character area. At this distance and given the size and number of turbines they will be difficult to discern in views from this area.

Given the above and as it is only a limited areas of combined visibility it is judged that the magnitude of cumulative impact is Negligible. As the sensitivity to the proposed development is Low the significance of cumulative effect on this character area is assessed as Negligible.

3.2.26. **Wooded Farmland: Hazlehead** (LCA No.45, Figure 6)

The Hazlehead wooded farmland lies approximately 12 km from the nearest turbine of the EOWDC. The ZTV illustrates that this area will have limited intervisibility with the proposed development, restricted to the open recreational fields where woodland doesn't preclude views out. In these views the turbines will be noticeable but not prominent due to the city and surrounding development in the foreground.

It is therefore judged that the magnitude of impact on the Hazlehead character area is Low to Negligible. As the sensitivity to the proposed development is Low the significance of effect on this character area is assessed as Minor to Negligible.

Cumulative Impacts

As the cumulative ZTVs illustrate that there are no views of other wind farms within this area there are no cumulative effects.

3.3. Areas of Landscape Significance

Eight 'Areas of Landscape Significance' within the 40 km study area were identified in the baseline report. The effect of the EOWDC on these areas is discussed below. Please refer to Figure 2 for the location of these areas, and also ZTV Figures 7, 8 and 12 to 18.

3.3.1. **Coastal: Balmedie to Longhaven ALS**

This area lies within the Aberdeen Bay and Collieston to Peterhead seascape units. It is approximately 3.5 km at its closest point to the nearest turbine of the EOWDC and over 25 km away at the northern extents. Views of the sea and coastline are an important characteristic of this ALS. The ZTV illustrates that this coastal ALS will have intervisibility with the proposed development for most of its length, excluding the area around Cruden Bay, where surrounding high land precludes views. There will be also some patchy areas where sand dunes and local high points preclude views. The EOWDC lies to the south of this area, so only those views looking towards the south will include the turbines and this, in most locations will also take into account the backdrop of Aberdeen and its suburbs.

The EOWDC will not directly affect the physical characteristics of the ALS, but will have an impact on the visual characteristics, mainly towards the south of the ALS where the turbines will be more dominant in views. The magnitude of impact will ease with distance from the site and it is therefore considered the magnitude of impact will vary from High to Negligible. As the sensitivity to the proposed development is High, the significance of effect on this ALS is assessed as Major to Negligible.

Cumulative Impacts

The cumulative ZTVs illustrate that the coastal ALS area from Balmedie to the Ythan estuary will only have views of the EOWDC.

North of the Ythan estuary within the Forvie Sands area of the ALS there are potentially combined views of up to 22 existing and consented and up to 10 in-planning wind farms with the EOWDC. Hill of Fiddes and Ardgrain are the closest existing wind farms to this specific part of the ALS, at approximately 7 km and 10 km respectively. Ardgrain and Hill of Fiddes are noticeable elements but will be seen in a different portion of the view to the EOWDC. The large numbers of other wind farms potentially visible (including in-planning) from this part of the ALS lie over 15 km to the north west and therefore not particularly noticeable given also the relatively small size and number of their turbines. The nearest turbine of the EOWDC to the area of high cumulative intervisibility at Forvie Sands is approximately 10 km away.

As there is an existing cumulative baseline, the addition of the EOWDC will not add a new feature, but will potentially extend the area where wind farms are visible so that the perception of wind farms increases from this part of the ALS.

At the northern extents of the ALS there are some limited areas of combined visibility with the EOWDC of up to 6 existing and consented wind farms and up to 6 in-planning wind farms. Within this part of the ALS, the closest wind farms are at Ardgrain, West Knock Farm, Bruxiehill, and in-planning Middleton of Rora and Peterhead Harbour turbines, all approximately 15km away except for Peterhead Harbour which will be 5 km from the ALS. The EOWDC at this point will be approximately 21 km to the south. Given the greater distances to the wind farms, whilst the turbines may be visible, they will be minor elements within the view and the addition of the EOWDC will not significantly increase cumulative effects in this area.

Overall, cumulative effects within the Balmedie to Longhaven ALS are limited to the area around the Ythan estuary and Forvie Sands. The addition of the EOWDC will extend the area currently exposed to wind farms and in combination with Ardgrain and Hill of Fiddes turbines there is the potential for wind farms to become a characteristic of this part of the ALS. However, given the size and location of the existing wind farms, they will not be dominant elements in views from this area.

Therefore, the magnitude of cumulative impact on the ALS as a whole is considered to be Low. As the sensitivity to the proposed development is High, the cumulative significance of effect on this ALS is assessed as Moderate.

3.3.2. Area of Landscape Significance – Coastal: Peterhead to Inverallochy ALS

The ZTV illustrates that there would be no intervisibility with the EOWDC within this ALS and therefore there will be no magnitude of impact and no significant effects.

Cumulative Impacts

As there is no intervisibility with the EOWDC, there will be no cumulative effects on this ALS.

3.3.3. Coastal: Findon to Catterline ALS

This area of landscape significance consists of the coastal strip between the railway line and the cliffs from Findon to Catterline which at its closest will be just over 15 km from the nearest turbine of the EOWDC. It lies within both the Inverbervie to Stonehaven and Stonehaven to Girdle Ness seascape units. The ALS will have sporadic areas of intervisibility with the EOWDC. These areas are the open exposed elevated parts of the coastline within which the turbines will be visible in views to the north seen behind Girdle Ness headland.

Views of the sea and coastline are important to this ALS which is on an elevated rocky coastline but the EOWDC will not be sited within the main field of view i.e. it is not directly located off this part of the coast. Taking this into account and that there are only small areas of intervisibility over 15 km in distance from the EOWDC, it is judged that overall the magnitude of impact on the ALS is Negligible. As the sensitivity to the proposed development is High, the significance of effect on this ALS is assessed as Negligible.

Cumulative Impacts

The cumulative ZTVs show that there are only very limited areas of combined visibility of EOWDC and existing and consented wind farms along this coastal ALS. The majority of these small areas lie to the south of the ALS, beyond 30 km from the EOWDC, and include views of up to 12 existing and consented wind farms but no in-planning wind farms.

As the EOWDC lies at a distance from the southern extents of the ALS where the turbines would only be just discernable, and there are only very limited areas of combined visibility, it is judged the magnitude of cumulative impacts would be Negligible. As the sensitivity to the proposed development is High, the significance of cumulative effect on this ALS is assessed as Negligible.

3.3.4. Inland: River Dee Valley ALS

The ZTV illustrates that there would be no intervisibility with the proposed development within this ALS which follows the sheltered River Dee valley. Therefore it is judged that there will be no magnitude of impact and no significant effects.

Cumulative Impacts

As there is no intervisibility with the EOWDC, there will be no cumulative effects on this ALS.

3.3.5. Inland: River Don Valley ALS

This area of landscape significance lies within the Central Wooded Estates landscape character areas, along the northern side of the River Don valley. Its eastern extents lie approximately 7 km from the nearest turbine and at furthest is approximately 17 km west. The ZTV illustrates that for the majority of the area there will be limited or no visibility with the proposed development. The main area of intervisibility is the eastern extents on the open farmland close to Corby Loch.

As only a small area of this ALS would be exposed to the proposed development and views in and along the valley will remain unchanged, it is judged that overall the magnitude of impact on the ALS would be Negligible. As the sensitivity to the proposed development is High, the significance of effect on the ALS is Negligible.

Cumulative Impacts

The cumulative ZTVs illustrate that there is only a tiny sliver of combined visibility with up to 2 existing and consented wind farms, but the majority of the ALS has no visibility of other wind farms within this ALS, therefore it is judged there will be Negligible cumulative effects on this ALS.

3.3.6. Inland: West of Inverurie ALS

This area consists of mostly high ground within the Grampian Outliers and Central Wooded Valleys landscape character areas. It lies approximately 24 km at its closest point to the nearest turbine of the EOWDC and extends beyond the 40 km study area.

The intervisibility with the EOWDC is limited to the highest open areas and much of the forestry cover on the lower slopes precludes long distant views out to the coast. Where views are available they are expansive and include many natural and manmade features such as wind farms. The EOWDC will be a minor element within the view and will not alter the character of this ALS.

It is therefore judged that the magnitude of impact on this ALS is Negligible. As the sensitivity to the proposed development is High, the significance of effect on this ALS is assessed as Negligible.

Cumulative Impacts

The cumulative ZTVs illustrate that most of the ALS is exposed to views of wind farms and the addition of EOWDC will add to small areas of combined visibility from the high promontories and some open elevated land near Inverurie. There are a large number of existing, consented and in-planning wind farms and single turbines which surround this ALS and the addition of the EOWDC will potentially extend the visibility of wind farms to a portion of views where no other wind farm currently lies.

However, as the EOWDC lies at closest 24km from the ALS, and will be a minor element within overall views which include closer wind farms and a large numbers of turbines, it is judged that the magnitude of cumulative impact is Negligible. As the sensitivity to the proposed development is High, the significance of cumulative effect on this ALS is assessed as Negligible.

3.3.7. Inland: North West of Methlick ALS

This small ALS covers a short stretch of the Ythan river valley and two of its small tributaries north west of Methlick. It lies approximately 30 km north west of the nearest turbine of the EOWDC.

The ZTV shows that this is a wooded valley area and that there is no intervisibility with the EOWDC, except for a small area of blade tip visibility on a valley slope. Taking this into account, distance from the EOWDC, and that views within the valley will remain unchanged, it is judged that the magnitude of impact is Negligible. As the sensitivity to the proposed development is High, the significance of effect on this ALS is assessed as Negligible.

Cumulative Impacts

The cumulative ZTVs show that there will be combined visibility of up to 26 other wind farms in the small area of intervisibility with the EOWDC in this ALS. However, as it is a very limited area and given the river valley character will not be altered, there will be Negligible cumulative effects on this ALS.

3.3.8. Inland: Drumtochty to Torphins and Surrounds ALS

This Area of Landscape Significance lies 36 km from the nearest EOWDC turbine at its closest point and covers much of The Mounth character area, extending beyond the 40 km study area. The ZTV show that intervisibility with the EOWDC is limited to the open highest points of the north east facing slopes, and much of this is blade tip visibility only. It is considered at this distance that if seen, the EOWDC will be a very minor element within extensive views. Therefore, it is judged that the overall magnitude of impact is Negligible. As the sensitivity to the proposed development is High, the significance of effect on this ALS is assessed as Negligible.

Cumulative Impacts

The cumulative ZTVs show that where there is potential intervisibility of the EOWDC, views of over 30 existing and consented and up to 16 in-planning wind farms are theoretically visible. Mid Hill and Meikle Carewe are the closest wind farms at approximately 1km and

10km respectively at their closest point. However, the majority of the wind farms potentially seen in combination with EOWDC will be further than 30 km to the north. Taking these distances into consideration and that EOWDC will only be a minor element if seen at all; it is judged that there will be a Negligible magnitude of cumulative effect. As the sensitivity to the proposed development is High, the significance of cumulative effect on this ALS is assessed as Negligible.

3.4. Summary of Seascape and Landscape Effects

Receptor	Approx. Distance to nearest EOWDC turbine	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect	Magnitude of Cumulative Impact	Significance of Cumulative Effect
Regional Seascape Units						
Inverbervie to Stonehaven	30 km	Medium	Negligible	Negligible	Negligible	Negligible
Stonehaven to Girdle Ness	8 km	Medium to Low	Low	Moderate-Minor to Minor	Low	Moderate-Minor to Minor
Aberdeen Beach	5 km	Medium	High to Medium	Major-Moderate to Moderate	Low to Negligible	Moderate-Minor to Negligible
Aberdeen Bay	0 km	Medium (south) High to Medium (north)	High	Major-Moderate (south) Major to Major-Moderate (north)	Low to Negligible	Moderate-Minor to Negligible (south) Moderate to Moderate-Minor to Negligible (north)
Collieston to Peterhead	15 km	Medium	Medium to Low	Moderate to Moderate-Minor	Medium to Low	Moderate to Moderate-Minor to Minor
Peterhead to Fraserburgh	35 km	Low	Negligible	Negligible	Negligible	Negligible
Aberdeenshire and Banff & Buchan LCA						
Formartine Lowlands	3 km	Medium to Low	High to Medium	Major-Moderate to Moderate to Moderate-Minor	Medium	Moderate to Moderate-Minor

Receptor	Approx. Distance to nearest EOWDC turbine	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect	Magnitude of Cumulative Impact	Significance of Cumulative Effect
Central Wooded Estates	7.5 km	Low	Negligible	Negligible	Negligible	Negligible
Kincardine Plateau	14.5 km	Low	Low to Negligible	Minor to Negligible	Low to Negligible	Minor to Negligible
Ythan Strath Farmland	17 km	Low	Medium to Low	Moderate-Minor to Minor	Low	Minor
Northern Rolling Lowlands	22 km	Low	Low	Minor	Low to Negligible	Minor to Negligible
Garvock and Glenbervie	27 km	Medium to Low	Negligible	Negligible	Negligible	Negligible
Grampian Outliers	27 km	High to Medium	Negligible	Negligible	Negligible	Negligible
The Mounth	25 km	High to Medium	Negligible	Negligible	Negligible	Negligible
Agricultural Heartlands (area)	22.5 km	Low	Low to Negligible	Minor to Negligible	Low to Negligible	Minor to Negligible
Eastern Coastal Agricultural Plain	17 km	Medium to Low	Medium to Negligible	Moderate to Moderate-Minor to Negligible	Low to Negligible	Moderate-Minor to Minor to Negligible
Aberdeen LCA						
Upper Don Valley (Aberdeen)	12 km	Low	Negligible	Negligible	Negligible	Negligible
Dyce Plain	10 km	Low	Medium	Moderate-Minor	Low to Negligible	Minor to Negligible
Tyrebagger Hill/Kirkhill	12.5 km	High to Medium	Low	Moderate to Moderate-Minor	Low	Moderate to Moderate-Minor
Brimmond Hill	14 km	Medium	Low	Moderate-Minor	Medium to Low	Moderate to Moderate-Minor
Kincorth and Tullos Hills	9 km	Medium	Medium	Moderate	Low	Moderate-Minor

Receptor	Approx. Distance to nearest EOWDC turbine	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect	Magnitude of Cumulative Impact	Significance of Cumulative Effect
Perwinnes	7 km	Medium	High to Medium	Major-Moderate to Moderate	Low	Moderate-Minor
East Elrick	13 km	Medium to Low	Medium	Moderate to Moderate-Minor	Low	Moderate-Minor to Minor
Newhills	10 km	Low	Medium to Low	Moderate-Minor to Minor	Low	Minor
Maidencraig	12.5 km	Low	Medium to Low	Moderate-Minor to Minor	Low	Minor
Kingshill/Bogskeathy	14 km	Medium to Low	Low	Moderate-Minor to Minor	Negligible	Negligible
Den of Leggart	12.5 km	Low	Low	Minor	Negligible	Negligible
Loirston	12 km	Low	Low	Minor	Negligible	Negligible
Braes of Don	7 km	Low	Low to Negligible	Minor to Negligible	Negligible	Negligible
Craibstone	11 km	Medium	Medium to Low	Moderate to Moderate-Minor	Negligible	Negligible
Kingswells	13.5 km	Low	Medium to Low	Moderate-Minor to Minor	Negligible	Negligible
Hazlehead	12 km	Low	Low to Negligible	Minor to Negligible	None	None
Areas of Landscape Significance						

Receptor	Approx. Distance to nearest EOWDC turbine	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect	Magnitude of Cumulative Impact	Significance of Cumulative Effect
Balmedie to Longhaven	3.5 km	High	High to Negligible	Major to Negligible	Low	Moderate
Peterhead to Inverallochy	33 km	High	None	None	None	None
Findon to Catterline	15 km	High	Negligible	Negligible	Negligible	Negligible
River Dee Valley	13 km	High	None	None	None	None
River Don Valley	7 km	High	Negligible	Negligible	Negligible	Negligible
West of Inverurie	24 km	High	Negligible	Negligible	Negligible	Negligible
North West of Methlick	30 km	High	Negligible	Negligible	Negligible	Negligible
Drumtochty to Torphins and surrounds	36 km	High	Negligible	Negligible	Negligible	Negligible

4.0 Visual Effects

The approach to undertaking the visual assessment is to first establish the extent of the ZTV for the development and then to determine how visible the proposals would be from a range of representative viewpoints and visual receptor groups and the extent of effects upon general visual amenity within the visual envelope. The methodology for this is detailed within Appendices 2 and 4 of the Baseline Report. The ZTVs illustrated in Figures 7 ,8 and 9 indicate the theoretical worst case scenario in terms of the extent of visual exposure. Figure 7 shows the ZTV produced with a bare ground model whilst the ZTVs in Figure 8 and 9 have modelled in settlement and woodlands to give a more realistic scenario. However, in reality, the extent of visual effects arising from the proposed development over land will be greatly reduced due to the subtleties of intervening landform (including, for example, the sand dunes), built form (e.g. all settlements) and localised vegetation (including hedgerows and other blocks of woodland) which are not picked up on the data sets used for ZTV construction. A built model of Aberdeen city and its suburbs has been included within the ZTVs (Figures 8 and 9) which provides a more detailed picture of the visual effects across the city but, as above, the visual effects from the proposed development will still be reduced to some extent by localised details. Prevailing weather conditions will also further influence the actual extent of visibility (please see section 4.0 of the Baseline Report for further information on the average visibility distances).

4.1.1. Overview of Visual Effects on the 40km Study Area

The areas of greatest theoretical visual effect arising from the proposed EOWDC will be along the stretch of coastline and sea adjacent to the turbines within a 5 km radius. Within a 10 km radius the ZTVs show that the majority of the landscape and seascape will have theoretical visibility of the EOWDC. Visibility on land becomes patchier between 10 and 15 km. In the north west, where the land becomes more undulating, there is a linear stretch along the A947 where there is no visibility of the EOWDC at all. The 15km radius includes the whole of Aberdeen and the ZTV shown in Figure 9 gives a greater understanding of the theoretical effects on the city and is discussed later.

Beyond the 15 km radius, theoretical visibility on land is much more intermittent between the south and west and is limited to the local high areas and parts of the more elevated Mounth. To the north and north east there are larger swathes of theoretical visibility which stop at approximately 27 km from the EOWDC. In the north west, the main areas of theoretical visibility extend to just within the 40 km radius study area on the elevated farmland areas. Directly to the east, the visibility is more intermittent and mainly centred on the areas of high ground of the Grampian Outliers.

Beyond the 40 km radius study area, theoretical visibility is very limited and is mostly on small areas of exposed high ground.

The larger scale ZTV in Figure 9 shows that the city centre and harbour area are shown to have very limited theoretical visibility of the EOWDC due to the dense built up nature of the city.

The northern suburbs of Denmore, Middleton Park and Bridge of Don are closest to the EOWDC and most of the open areas and houses with aspects to the coast will have theoretical visibility of the EOWDC. The residential areas of Hilton, Kittybrewster, Rosehill, Middlefield, Cummings Park, Northfield, and Heathryfold which lie on the elevated land on the northern side of Aberdeen which slopes towards the EOWDC will also have theoretical visibility of the turbines.

The coastal edge of Seaton, and obviously the tower blocks, will have views out towards the proposed turbines, but there will be more restricted views within Old Aberdeen and Tillydrone.

The southern elevated side of Aberdeen including Seafield, Garthdee, Kaimhill, Ferryhill, Kincorth and Torry also are shown by the ZTV to have theoretical visibility of the EOWDC.

In reality, due to the densely built up nature of cities there will be few places within Aberdeen, except the coast and views from tower blocks, where clear views of the turbines will be seen. Visibility will be generally limited to glimpsed views between buildings and where roads are aligned with the EOWDC and to those areas where there are no added screening effects from roadside trees and other existing vegetation.

4.1.2. Overview of Cumulative Visual Effects on the 60km Study Area

The cumulative effects for a 60 km study area have been illustrated by the ZTVs in Figures 13 to 18. Figure 12 shows the locations of the 72 wind farms/single turbines within the study area at the time of writing. There are no wind farms within 10 km of the EOWDC and within 20 km there are only four existing and consented and two in-planning sites, none of which are over 3 turbines in size and are not higher than 62 m to hub and 102 m to blade tip. Between 20 and 30 km the number of turbines increases in the north, and there is one wind farm in the south at Meikle Carewe which is the largest in turbine number at this distance with 12 turbines, but is only 70 m high to blade tip. There are a broad cluster of wind farms in the south between 30 and 45km from the EOWDC which include the 25 turbines at Mid Hill and 7 and 9 turbine farms at Tullo and St John's Hill respectively. To the north west of the EOWDC between 20 and 60 km there is an even spread of wind farms, mostly single turbines or small wind farms up to 5 turbines. The exceptions to this are the larger wind farms at Glens of Foudland (20 turbines), Mains of Dummuie (7 turbines), Clashindarroch (18 turbines) and Kildrummy (8 turbines) which all lie in the more remote areas of Aberdeenshire, beyond 40 km from the EOWDC. The vast majority of all the wind farms in the study area, existing, consented, or in-planning, have a maximum hub height of approximately 80 m and maximum blade tip height of approximately 100 m.

Figure 13 shows the combined effects of EOWDC with the existing and consented wind farms and the in-planning wind farms. Figure 14 shows this at a larger scale for an approximate 20 km radius study area. These ZTVs indicate that the majority of the study area has theoretical visibility of one or more wind farms, however only a relatively small area has visibility of the EOWDC on its own (see the blue areas on the ZTVs). This is confined to the immediate coastal areas within 10 km and some patchier areas west of Aberdeen and north east of Ellon. Figure 13 also shows that the west and south west parts of the study area are exposed mainly to existing or consented wind farms with limited areas of combined visibility with the EOWDC. The north east corner of Aberdeenshire is illustrated as having almost complete coverage of theoretical visibility of both existing, consented and in-planning wind farms which the EOWDC will add to, but not significantly increase the area.

Figures 15 and 16 have been produced to show the number of existing, consented or in-planning turbines theoretically visible from any one point where the EOWDC is also theoretically visible. This varies between one turbine to over 125 turbines for existing and consented sites and between 1 turbine and over 50 turbines for in-planning sites. Figures 17 and 18 illustrate the number of wind farm sites visible with the EOWDC, which varies between 1 and over 30 existing and consented sites and between 1 and 26 in-planning sites. All four figures show clearly where the highest areas of theoretical combined visibility are possible. On land, these areas are typically located on higher ground, where slopes are facing towards the site. These areas include the coastal farmland south of Cruden Bay, the elevated land either side of the River Ythan, a ridgeline south east of Old Meldrum, and sporadic areas on promontories within the wider extents of the study area.

The ZTVs illustrate that a large proportion of the greatest combined visibility is located offshore, where visibility theoretically increases to a point where almost all sites could be visible approximately 30km from the coast, directly east of the EOWDC. It is however considered very unlikely that the majority of the turbines would be seen at this distance given that in reality their average size will reduce their prominence and intervening vegetation or buildings which are not modelled into the ZTVs will preclude some views.

4.2. Viewpoints

The following analysis refers to the 20 agreed representative viewpoints referred to in the baseline conditions. Reference should be made to the existing panoramas and wireframes (Figures WF1-10) and to the photomontages (Figures PM1-20) which illustrate the existing and proposed view for each viewpoint.

Cumulative impacts are discussed for each viewpoint (see also Figures 12-18) and cumulative wireframes were created for viewpoints 13, 15, 16, 18 and 19 (CW Figures). As there are many wind farms shown within some of these wireframes to avoid text obscuring the visuals only some of the wind farms have been identified by name to aid orientation. Please also refer to Figure 12 which shows the wind farm locations.

Please note that the timing of the on-site survey work driven by project programme and inclement weather meant that the photographs for viewpoints were taken on two separate occasions in November and January. Unfortunately light levels are limited at this time of year and the location of EOWDC in relation to viewpoints has meant that photographs of those viewpoints in the north and north west were unavoidably taken into low sun.

4.2.1. **Viewpoint 1: Balmedie Beach** (WF-01 and PM-01)

The wireframe and photomontage illustrate that the 11 turbines will be clearly visible from this viewpoint and will occupy 51 of the illustrated 200 and 135 degree views to the south. The closest turbine will be 3.51 km from the viewpoint. The turbines will have a fairly regular arrangement across the horizon but there is an overlap of two turbines in the centre of the group, and the northern turbine appears slightly separate from the other turbines.

The turbines will be dominant in views to the south towards Aberdeen and Girdle Ness. They will be seen on the horizon with open sea behind, approximately 20 degrees to the left of Girdle Ness. On a clear day the proposed development could give an impression of enclosing Aberdeen Bay as there is a relatively small gap of open horizon between the southern turbine and Girdle Ness headland. When visibility is not good enough to see Girdle Ness or Aberdeen Beach, Balmedie Beach becomes more remote in nature and the turbines may appear more dominant. However, the constant movement of ships to and from the harbour and within the designated anchorage area does distract the eye and give scale to the seascape. Walking along the beach from Balmedie towards Forvie Sands, the turbines will not be visible and the view of the more remote sands and coastline will remain intact.

The magnitude of visual impact arising from the proposed development is assessed as High. When combined with the High sensitivity to the change proposed of the key receptor group of walkers on the coastal trail and beach users, the significance of effect is assessed to be Major.

Cumulative Impacts

There will be no other wind farms visible from this location and therefore no cumulative effects.

4.2.2. **Viewpoint 2: A90 -Harehill turn off** (WF-02 and PM-02)

The wireframe and photomontage show that the turbines will occupy 30 degrees of the illustrated 135 and 90 degree views and be a prominent element within the view. The nearest turbine will be 4.44 km from the viewpoint. The turbines will have a regular composition with no overlapping or large spaces between them. The photomontage shows that the three northern turbines will have their bases obscured by the landfill area. Farmsteads and shelterbelts also break up a clear view of the turbines.

At the relatively close distance the turbines lie from the viewpoint they will be a prominent feature of the view and although there are some intervening elements, at this close distance the magnitude of visual impact arising from the proposed development is judged as High. When combined with a Medium to Low sensitivity to the change proposed on the key receptor group of travellers on the A90, the significance of effect is assessed to be Major-Moderate to Moderate.

It should be noted that if the proposed AWPR is constructed, it will be a dominant feature in the foreground of this view. The road position won't obscure views of the turbines, but it will be a significantly distracting element.

Cumulative Impacts

There are no other wind farms visible from this viewpoint and therefore no cumulative effects.

4.2.3. **Viewpoint 3: Jesmond Drive, Middleton** (WF-03)

The wireframe shows that the turbines occupy 18 degrees of the illustrated 135 degree view shown and the bases would be partially obscured by landform. The nearest turbine would be 7.14 km from the viewpoint. The turbines would appear in two groups with a regular arrangement and no overlapping. However, the photograph shows that the turbines are not likely to be visible above the trees with only potential for the very tips of the blades to be seen during the winter months. For this reason, a photomontage was not constructed for this viewpoint.

As the turbines will be screened from view the magnitude of visual impact arising from the proposed development is assessed as Negligible. As the key receptor group of local residents have a High sensitivity to the proposed change, the significance of effect is assessed to be Negligible.

As the ZTV (Figure 9) illustrates, the Middleton area has a high theoretical visibility with the EOWDC and although at this specific viewpoint there would be Negligible effects, it is acknowledged that the turbines may be clearer in views nearby.

Cumulative Impacts

There are no other wind farms visible from this viewpoint and therefore no cumulative effects, however, it is noted that in nearby locations up to 4 existing and consented and up to 2 in-planning wind farms may theoretically be visible. This is likely to include the closest existing and consented wind farms at Hill of Fiddes, Tillymaud, and Mains of Bogfechel and in-planning wind farms at Woodlands Farm and Hill of Fechel. They all lie between 13-15 km away from the viewpoint, and given the built up nature and existing mature trees which surround the area, it is unlikely that they will be noticeable elements.

4.2.4. **Viewpoint 4: B999 Whitecairns** (WF-04 and PM-04)

The wireframe illustrates that the turbines will sit just below the horizon and partially behind the raised landform that lies between the viewpoint and the site. The turbines will occupy 26 degrees of the illustrated 135 and 90 degree views and appear in six groups consisting of 1, 2, 2, 3, 2, and 1 turbine, left to right. The turbines in the middle four groups will be overlapping. The closest turbine is 8.1 km from the viewpoint.

The photomontage shows that the existing shelterbelts and other vegetation will obscure most of the column length of the turbines but the hub and blades will be a noticeable element in the view. The hillside to the left of the turbines, and the coniferous trees to the right, frame the view of the turbines to some extent, potentially slightly increasing their prominence. However, existing features such as the quarried hillside, and closer vertical elements such as pylons and telegraph poles distract the viewer to some degree.

It is therefore judged that the magnitude of visual impact arising from the proposed development is assessed as Medium. As the key receptor groups of travellers on the B999 sensitivity to the proposed change is Medium to Low, and the residents have a High sensitivity, the significance of effect is assessed to be Moderate to Moderate-Minor for road users, and Major-Moderate for local residents.

Cumulative Impacts

There are no other wind farms visible from this viewpoint and therefore no cumulative effects. However it is noted that Hill of Fiddes and Tillmaud Wind Farms lie within 10 km of the viewpoint and may be seen from nearby locations in succession with the EOWDC as they lie in opposite directions.

4.2.5. **Viewpoint 5: Aberdeen Beach** (WF-05 and PM-05)

The wireframe and photomontage show that the turbines will occupy approximately 12.5 degrees of the illustrated 200 and 135 degree views and will be arranged in a relatively tight group with some overlapping and the outer turbines slightly separated from the main group. The closest turbine is 7.52 km from the viewpoint.

The turbines will appear in the open sea with the distant coastline to Peterhead just left of the wind farm. They will be a prominent feature on the horizon and like the many ships which sit or travel through the bay they will give a sense of scale and feeling of slight enclosure to the bay area. The presence of the turbines will not alter the immediate view of the beach and views of Balmedie beach and more distant coastline can be experienced without the turbines in the frame. Although prominent, the turbines will not feel incongruous within this active coastal view.

It is therefore assessed that the magnitude of visual impact arising from the proposed development is High to Medium. As the key receptor group of visitors to the beach have a High sensitivity to the proposed change, the significance of effect is assessed to be Major to Major-Moderate.

Cumulative Impacts

There are no other wind farms visible from this viewpoint and therefore no cumulative effects.

4.2.6. **Viewpoint 6: A90 -West Pitmillan turn off** (WF-06 and PM-06)

The turbines are illustrated in the wireframe as occupying 17 degrees of the illustrated 135 and 90 degree views. They appear in distinct groupings of 2, 3, 3 and 3 turbines with only the last group showing some overlapping of blades. The closest turbine is 9.31 km from the viewpoint.

The photomontage shows that the three turbines to the right of view will be almost completely obscured by the gently rising landform and also the adjacent three turbines will be partially obscured so that only the hubs and blades are visible. The bases of the other turbines will be screened but top of the column and blade tips will be visible appearing over the open fields and sporadic trees. The visible turbines will be a discernable moving element within the large scale, relatively uniform view. However, the view is not devoid of existing movement with the traffic on the A90 and also the three Hill of Fiddes turbines nearby.

It is therefore judged that as the view will remain largely unchanged, the magnitude of visual impact arising from the proposed development is Medium to Low. As the sensitivity of travellers on the A90 to the proposed change is Medium to Low, the significance of effect is assessed to be Moderate to Moderate-Minor to Minor.

Cumulative Impacts

The cumulative ZTVs illustrate that there is up to 4 existing and consented wind farms visible from the viewpoint location. The existing three Hill of Fiddes turbines lie approximately 3 km to the west of this viewpoint and the three Ardgrain turbines lie approximately 9 km to the north. The consented Tillymaud single turbine will be 9 km to the west. From site visits there are no wind farms visible with EOWDC in the angle of view shown, but the Hill of Fiddes turbines are evident appearing behind the viewpoint and Ardgrain are potentially visible to the north.

The addition of the EOWDC to the 360 view available from this viewpoint will extend the presence of turbines to a new part of the view. The four wind farms will only be visible in succession and not in the same portion of view. As the Hill of Fiddes Wind Farm is much closer to this viewpoint and a prominent element, the more distant and obscured EOWDC and Ardgrain turbines will be less conspicuous.

The magnitude of cumulative visual impact is therefore judged as Low. As the sensitivity of travellers on the A90 to the proposed change is Medium to Low, the significance of cumulative effect is assessed to be Moderate-Minor to Minor.

4.2.7. **Viewpoint 7: Torry Battery** (WF-07 and PM-07)

The wireframe and photomontage show that the turbines will appear in five groups spread evenly across the horizon occupying 12 degrees of the illustrated 200 and 135 degree views. The closest turbine is 7.89 km from the viewpoint. The viewpoint is almost directly in line with the rows of the turbines so that the central group's three turbines overlap very closely. The turbine groups on either side gradually fan out, and the western turbine will be seen on its own.

The proposed development lies within a sea space framed by the harbour entrance walls. The turbines could therefore be perceived as having more of a visual relationship with the harbour and shipping activity than the coastline beyond. The turbines are prominent in the view but not considered out of place with the active seascape. They cover a small section of the expansive view and views of the sandy coastline to the west and also the more open remote sea to the east can be experienced without the turbines in the focal point.

Therefore, the magnitude of visual impact arising from the proposed development is assessed as High to Medium. As the key receptor group of visitors and coastal walker's sensitivity is High to Medium, the significance of effect is assessed to be Major to Major-Moderate to Moderate.

Cumulative Impacts

The cumulative ZTVs show that up to 6 existing and consented wind farms may theoretically be visible from this viewpoint at Torry Battery. The closest wind farms to the viewpoint are at Hill of Fiddes, Tillymaud, Mains of Bogfechel, Ardgrain and Meikle Carewe. There is unlikely to be views of Meikle Carewe given the orientation of the viewpoint and intervening landform. The three turbines of Hill of Fiddes are closest at 20 km, which given the relatively small size of turbine and as shown by the lack of visibility in the photograph, would be minor elements within the view. It is therefore judged that the magnitude of cumulative effect would be Negligible. As the key receptor group of visitors and coastal walker's sensitivity is High to Medium, the significance of effect is assessed to be Negligible.

4.2.8. **Viewpoint 8: South College Street, Aberdeen** (WF-08)

The wireframe shows that the turbines are evenly arranged in seven groups with overlapping turbines and single turbines occupying 10.5 degrees of the illustrated 135 degree view. The closest turbine is 9.19 km from the viewpoint. The wireframe also shows that half of the turbines will be partially obscured by landform. In reality the photograph shows that the buildings and structures in the city centre will obscure views of all the turbines, and for this reason a photomontage has not been constructed. It may however, be possible to see blade tips from the higher floors of the adjacent flats and offices.

Therefore, the magnitude of visual impact arising from the proposed development is assessed as Negligible. As the key receptor group of workers, travellers and shoppers has a Low sensitivity to the proposed change, the significance of effect is assessed to be Negligible.

Cumulative Impacts

There are no other wind farms visible from this viewpoint and therefore no cumulative effects.

4.2.9. **Viewpoint 9: Forvie Nature Reserve** (WF-092 and PM-09)

The wireframe illustrates that the turbines will occupy 11.5 degrees of the illustrated 200 and 135 degree views and the bases of nine of the turbines will be obscured by the landform. The closest turbine will be 10.27 km from the viewpoint. The wind farm will be arranged in three groups of 2, 3, and 6 turbines. The two turbines at the left of view will appear separate from the other two groups and will be fully visible on the horizon.

The photomontage shows that all but two of the turbines will be clearly seen above the sand dunes. The remaining 9 turbines will have just the hub and blades visible. Those turbines that are visible will be a prominent vertical feature appearing above the simple dune landscape and will be a noticeable change. The turbines will appear in the same general portion of view as the Seaton tower blocks and coastal development at Aberdeen (when seen on a clear day) so the EOWDC will not extend the influence of manmade elements to other more remote parts of Forvie Sands within this view. It should also be noted that the ever evolving nature of sand dunes will mean that over time the turbines may become more visible or more hidden from this viewpoint.

Taking into account the above it is judged that the visible turbines are a noticeable feature but the view will largely remain unchanged, therefore the magnitude of visual impact arising from the proposed development is Medium. As the key receptor group of visitors and walkers have a High sensitivity to the type of change proposed, the significance of effect is assessed to be Major-Moderate.

Cumulative Impacts

At this specific viewpoint within Forvie Sands there are no other existing and consented or in-planning wind farms visible. However, within nearby areas of the sand dunes there is potential for views up to 18 existing and consented wind farms and up to 4 in-planning sites. The closest of these are at Hill of Fiddes and Ardgrain, with a larger number beyond 10 km to the north and east of Forvie Sands. The wind farms will be seen in a different portion of view to the EOWDC turbines, so that any cumulative effects would be in succession. As discussed above, the EOWDC will be a noticeable feature and whilst there would be no cumulative effects from the viewpoint itself, the addition of EOWDC in views from the Forvie Sands will potentially increase the perception of wind farms as a feature of the surrounding landscape.

4.2.10. **Viewpoint 10: Midstocket Road/North Anderson Drive** (WF-10 and PM-10)

The wireframe shows that the turbines appear in three distinct groups evenly arranged across 9 degrees of the illustrated 135 and 90 degree views. The closest turbine is 10.47 km from the viewpoint.

The photomontage shows that the group of three turbines to the right will be clearly visible above the hospital buildings in the gaps between the foreground housing and trees. The other turbines will potentially be seen interspersed between chimneys and trees and as a result will be less noticeable. Overall, the turbines will be discernable but will be a minor element within a busy and fragmented view and the view will remain largely unchanged.

It is therefore assessed that the magnitude of visual impact is Low. As the key receptor groups of local residents and travellers on the A90 have a High and Medium to Low sensitivity, respectively, to the proposed change, the significance of effect is assessed to be Moderate for residents and Moderate-Minor to Minor for travellers.

Cumulative Impacts

There are no other wind farms visible from this viewpoint and therefore no cumulative effects.

4.2.11. **Viewpoint 11: Leslie Road (A978), Aberdeen** (WF-11 and PM-11)

Leslie Road is aligned with the turbine site and the wireframe shows the wind farm as three groups occupying 11 degrees of the illustrated 95 and 90 degree views. The closest turbine will be 8.07 km from the viewpoint.

The photomontage shows that the buildings at the end of the street will obscure all but the blade tips of the turbines. The gap created by the hipped roofs of the buildings in the background will potentially allow more of the blades to be seen and the movement will be discernable.

Given that only the tips of the blades will be seen but movement may be a distracting visual element, it is assessed that the magnitude of visual impact is Low. As the key receptor group of local residents and travellers have a High and Medium sensitivity to the proposed change respectively, the significance of effect is assessed to be Moderate for residents, and Moderate-Minor for travellers along Leslie Road.

Cumulative Impacts

There are no other wind farms visible from this viewpoint and therefore no cumulative effects.

4.2.12. **Viewpoint 12: Kincorth Hill** (WF-12 and PM-12)

The wireframe illustrates that the eleven turbines will appear as almost one group across 8.5 degrees of the illustrated 135 and 90 degree views, with the three turbines to the west slightly apart from the rest. There will be some overlapping of blades and the turbine bases will be below the horizon. The closest turbine will be 11.56 km from the viewpoint.

The turbines lie beyond the end of the distant coastline and into the open sea and will be a noticeable element within the busy active view. The landform and vegetation to the left and right of the view frames Aberdeen Bay so that the turbines are a central focus thus increasing their prominence to some degree. However, there are also many distracting elements in views of the city and the consistent shipping activity to and from the harbour.

As the turbines will be a noticeable feature which will cause a partial alteration to the view the magnitude of visual impact is judged as Medium. As the key receptor group of walkers and visitors have a High to Medium sensitivity to the proposed change, the significance of effect is assessed to be Major-Moderate to Moderate.

Cumulative Impacts

There are no other wind farms clearly visible from this specific point on Kincorth Hill, however the cumulative ZTVs illustrate it should be possible to see up to 4 existing and consented and up to 2 in-planning wind farms. The closest wind farm will be the consented Meikle Carewe which lies approximately 15 km to the south of the viewpoint. However, the surrounding vegetation and landform at the viewpoint doesn't allow views to the south. The closest wind farms to the north are beyond 20 km away and given the relatively small scale of turbines, they will be difficult to discern.

It is therefore judged that the magnitude of cumulative visual impact at this viewpoint is Negligible. As the key receptor group of walkers and visitors have a High to Medium sensitivity to the proposed change, the significance of effect is assessed to be Negligible.

4.2.13. **Viewpoint 13: Udny Station** (WF-13 and PM-13)

The wireframe illustrates that the turbines will occupy 17 degrees of the illustrated 200 and 135 degree views and will be in a generally regular arrangement with the northern three turbines slightly further apart. The closest turbine will be 12.63 km from the viewpoint.

The photomontage shows that only the hub and blades of three of the turbines and blades from five of the turbines will be visible above the rolling agricultural landscape. The other three turbines will be screened completely by existing vegetation. The visible turbines will be a minor element within the expansive view but at this relatively close distance the movement of the blades will be detectable and potentially draw the eye towards them. However, overall it will be a minor alteration to the view which already has views of the closer turbines at Hill of Fiddes.

It is therefore assessed that the magnitude of visual impact is Medium to Low. As the key receptor group of local residents have a High sensitivity to the proposed change, the significance of effect is assessed as Major-Moderate to Moderate.

Cumulative Impacts (Cw-13)

The wireframe in Figure CW13 shows the exiting situation of Hill of Fiddes turbines and the EOWDC, with no other turbines visible in the view. The existing three turbines at Hill of Fiddes lie just over 1 km from the viewpoint, two of which can be seen emerging from a coniferous shelterbelt to the left of the view. The cumulative ZTVs shows that from very close to the viewpoint up to 12 existing and consented and up to 6 in-planning wind farms may theoretically be visible. These will include the single turbines at Mains of Bogfechel and Tillymaud, and in-planning turbines at Woodlands Farm and Hill of Fechel, which lie to the west, between approximately 4 km and 8 km away from the viewpoint. The other wind farms potentially seen from this area lie beyond 10 km away to the north and west. In reality local vegetation around the viewpoint will obscure clear views of many of these turbines given their relatively small size.

Therefore the main potential for cumulative effect from this viewpoint lies with the addition of the EOWDC with the existing Hill of Fiddes turbines. Whilst not visible at the exact viewpoint, there is also potential for the Tillymaud turbine as the next closest turbine to be a noticeable feature within the immediate area. The EOWDC will increase the perception of wind farms being part of the landscape and within a new section of view that does not already have views of turbines. However, as the wireframe shows, the EOWDC turbines will be partially obscured which will reduce cumulative visual effects.

Therefore, the magnitude of cumulative visual impact is judged as Low. As the key receptor group of local residents have a High sensitivity to the proposed change, the significance of effect is assessed as Moderate.

4.2.14. **Viewpoint 14: A96/Kirkhill Forest** (WF-14 and PM-14)

The wireframe illustrates that the turbines will occupy 12 degrees of the illustrated 135 and 90 degree views and will be in a regular arrangement. They will sit slightly below the horizon with the blades protruding above. The closest turbine will be 14.13 km from the viewpoint.

The landform naturally opens up to show the sea from this area, but at this specific point, the photomontage shows that the forestry will obscure views of the northern six turbines. The remaining visible turbines will be seen with two partially obscured by vegetation. The turbines will appear as if they were on land at this point with views of the sea behind. They appear in a separate section of the view to the city which, with prominent tower blocks, is potentially more of a focus in the view than the turbines.

It is considered that the views of the turbines from the adjacent A96 would be more obscured at this point and due to the direction of the road will be more focused on Aberdeen but further south clearer views could be possible.

As the turbines will be noticeable, albeit half of them and the view will remain largely unchanged, it is assessed that the magnitude of visual impact is Low. As the travellers have a Medium to Low sensitivity to the proposed change, the significance of effect is considered Moderate-Minor to Minor.

Cumulative Impacts

The cumulative ZTVs show that there are no other wind farms visible from this viewpoint and therefore there will be no cumulative effects.

4.2.15. **Viewpoint 15: Brimmond Hill** (WF-15 and PM-15)

The wireframe shows that the turbines will appear below the horizon across 10 degrees of the illustrated 200 and 135 degree views. They will be regularly spaced with the three southern turbines slightly further apart from the others. The closest turbine will be 14.41 km from the viewpoint.

The photomontage shows that the turbines will be clearly visible within the inshore waters and will lie between Aberdeen city and Perwinnes radar station, a small but prominent point in the view. The turbines will appear beyond the open rolling farmland between the visible settlements at Aberdeen and Dyce.

There are many elements in this part of the view which includes the frequent movement of helicopters and planes to and from Dyce. The turbines will add to this dynamic landscape as a noticeable feature in the sea. Overall, as this viewpoint encompasses a 360 degree view, the majority of the view will remain unchanged, and elements such as the masts on top of Brimmond Hill will still be a dominant feature.

It is therefore judged that the magnitude of visual impact of the proposed development is no more than Medium. As the key receptors of walkers have a High to Medium sensitivity to the proposed change, the significance of effect is judged as Major-Moderate to Moderate.

Cumulative Impacts (CW-15)

The cumulative ZTVs show that from this viewpoint there is the potential to see over 30 consented or existing wind farms, and potentially up to 16 in-planning wind farms in combination with the EOWDC. The cumulative wireframe (Figure CW15) illustrates the existing, consented and in-planning wind farms which are dotted across the landscape in views to the north. Please note that only a selection of the wind farms in the wireframe have been named to aid orientation. Views to the south are obscured to some degree by intervening forestry.

In the views to the west, north and north east from this elevated position the wireframe shows that theoretically the large majority of the in-planning and existing and consented wind farms are visible. However, most of these will not be discernable with the naked eye and lie below the horizon where existing vegetation and settlement will obscure views.

The most noticeable turbines, albeit only just visible in the photograph and in site visits are the existing Hill of Easterton three turbines which are on a similar elevation to Brimmond Hill and are just clear in the skyline, above Kirkhill Forest, at 24 km to the north west. The Hill of Fiddes turbines lie closest to the viewpoint at 17.5 km and the hub and blades can be just made out appearing behind the undulating landform to the left of one of the Brimmond Hill masts. The wireframe and photograph shows that although there are many existing wind farms in the landscape, there is limited visibility with the majority of them. Given this limited intervisibility of the existing wind farms, the in-planning wind farms most likely to be visible at this point would be the single turbines at Mosseye, Hill of Fechel, Mains of Balquhain and the two turbines at Woodlands Farm.

The extensive views from Brimmond Hill encompass a wide variety of land use and the existing turbines visible are not prominent features. Although a large number of turbines are theoretically visible, the relatively small height, small turbine numbers and distance from the viewpoint reduce cumulative visual effects. The addition of the EOWDC will be seen in a separate part of the view to any other wind farms and as the turbines will be viewed entirely in the sea, this further disconnects it to any other views of turbines. Taking this into account and the larger scale of turbines, the magnitude of cumulative impact of EOWDC within existing and consented and in-planning wind farms at this viewpoint is judged as Low. As the key receptors of walkers have a High to Medium sensitivity to the proposed change, the significance of cumulative effect is judged as Moderate to Moderate-Minor.

4.2.16. **Viewpoint 16: Formartine and Buchan Way, nr Quilquox** (WF-16)

The wireframe shows that the turbines will occupy 7.5 degrees of the illustrated 200 degree view. They will appear at similar heights and an arrangement of groupings of 2, 3, 3 and 3 will be discernable elements in the view. The closest turbine will be 25.98 km from the viewpoint.

The photograph illustrates that intervening landform is likely to obscure the bottom of the turbine columns but they will be a noticeable element in the horizon but within a small part of an expansive panoramic view. The wireframe illustrates that the turbines would be seen with a backdrop of the sea, but due to the visibility on the day the photograph was taken, the sea and coastal landform is not discernable in the photograph and the turbines appear as if on land. Wind farms at Ardgrain and Hill of Fiddes are prominent in the view and lie either side of the EOWDC. The EOWDC turbines, if visible, will appear at a similar height to the Hill of Fiddes at this distance.

The magnitude of visual impact of the proposed development is therefore assessed as Low. As the key receptors of local residents and cyclists have a High and a Medium sensitivity respectively to the proposed change, the significance of effect is judged as Moderate for local residents and Moderate-Minor for cyclists.

Cumulative Impacts

Figure CW16 presents a cumulative wireframe which illustrates the many wind farms theoretically and actually visible from this viewpoint. The cumulative ZTVs illustrate that up to 18 existing and consented and up to 4 in-planning wind farms may theoretically be visible from this viewpoint.

As shown in the photograph and wireframe, the existing wind farms at Ardgrain and Hill of Fiddes are the most visible of existing wind farms in the area and sit either side of the EOWDC turbines. The wireframe also indicates that Tillymaud, Mains of Bogfechel, and the in-planning turbines at Woodlands Farm, Mains of Balquhain and Hill of Fechel will be seen to the right of the view. Mid Hill and even Meikle Carewe Wind Farms are shown to be theoretically visible, but at over 50 km away it is very unlikely. The four turbines at Skelmonae although not shown in the wireframe, lie at close proximity to the north west of the viewpoint. There are also other wind farms such as St John's Well and Hill of Easterton which are visible nearby

Within this area of Aberdeenshire wind farms have now become a characteristic feature of the landscape as demonstrated by the wireframe and photograph. The addition of the EOWDC at this viewpoint which will be at a similar scale in the view to the existing turbines will contribute to this character and sit comfortably within the view. Therefore it is judged that the magnitude of cumulative impact is Low. As the key receptors of local residents and cyclists have a High and a Medium sensitivity respectively to the proposed change, the significance of cumulative effect is judged as Moderate for local residents and Moderate-Minor for cyclists.

4.2.17. **Viewpoint 17: Minor road near Netherley and Durris Forest** (WF-17 and PM-17)

The wireframe illustrates that the turbines will occupy 4 degrees of the illustrated 135 and 90 degree views and appear in an evenly spaced line of turbines on the horizon. The closest turbine will be 24.99km from the viewpoint.

The photomontage shows that at this distance from the proposed development, the turbines will be noticeable but not dominant within the wider panoramic view. The landform obscures most of the columns of the turbines and the power lines in the foreground lie across some of the turbines at this point. The tower blocks seen on the horizon are more prominent than the turbines due to their mass, but will be slightly smaller in height that the turbines.

Taking into account the above, and as the turbines will be a relatively minor element within an expansive and fragmented view, it is judged that the magnitude of visual impact is Low to Negligible. As the key receptor group of local residents have a High sensitivity to the proposed change, the significance of effect is assessed to be Moderate to Negligible.

Cumulative Impacts

The cumulative ZTV illustrates that there are up to 2 existing and consented and up to 2 in-planning wind farms theoretically visible from this viewpoint. This will most likely include the consented Meikle Carewe Wind Farm which lies 3 km to the south of this viewpoint. Although the turbine size is not particularly large (70 m blade tip), at 3 km away, the Meikle Carewe Wind Farm will be a dominant feature. The addition of the EOWDC which as discussed above will be noticeable, but not in the same portion of view, and therefore cumulative effects with Meikle Carewe would be limited to successional views only.

The nearest in-planning wind farm is Woodlands Farm at just under 30 km to the north, and it is unlikely given the scale of turbines that they would be a discernable element.

It is therefore considered that overall the magnitude of cumulative visual impact on this viewpoint is Low to Negligible. As the key receptor group of local residents have a High sensitivity to the proposed change, the significance of effect is assessed to be Moderate to Negligible.

4.2.18. **Viewpoint 18: A975 near Slains Castle** (WF-18 and PM-18)

The wireframe illustrates that the turbines will occupy 5 degrees of the illustrated 135 and 90 degree views. They will appear in front of the headland in five separate groups with overlapping turbines. The closest turbine will be 22.23 km from the viewpoint.

The photomontage shows that the turbines will be a noticeable feature within the view appearing above the distant headland but not taller than the intervening landform to the right of view. This landform will partially obscure the columns of the three turbines to the right of view. The turbines will be a similar height to the ruins of Slains Castle but will be recessive in comparison to the bulk of the ruins.

The generally simplistic nature of the view with large open fields and strong features such as Slains castle and the cliff coastline, increases the prominence of the EOWDC turbines within a small section of the overall view, but the majority of the view will remain unchanged.

Therefore the magnitude of visual impact is considered overall to be Low. As the key receptor group of visitors to Slains Castle and the coastline have a High sensitivity to the proposed change, the significance of effect is assessed to be Moderate.

Cumulative Impacts

The cumulative ZTVs illustrate that up to 4 existing or consented and up to 2 in-planning wind farms may be theoretically visible from this viewpoint. The wireframe in Figure CW18 identifies that Ardgrain Wind Farm is the closest existing turbines within this portion of the view at just over 12 km away, but as shown on the photograph they are not easily discernable. The wind farms shown behind the EOWDC are all beyond 50 km from the viewpoint and in reality would not be seen due to distance and intervening vegetation and built form.

The other wind farms in close proximity to the viewpoint but which lie behind the viewpoint (not shown on wireframe) are the three turbines at West Knock Farm 14 km to the north west, and the single turbine at Bruxiehill, 14 km to the north of the viewpoint. The in-planning Peterhead Harbour and Middleton of Rora turbines lie beyond 10 km to the north.

The existing, consented, and in-planning wind farms lie at considerable distances from this viewpoint and due to their relatively small scale they are not easily visible. The EOWDC will not be seen in combination with the other wind farms, and even in succession other wind farms will not be a noticeable feature of the view.

The addition of the EOWDC will increase the number of wind farms theoretically visible but given the separation and distance to each wind farm at this viewpoint, the magnitude of cumulative impact is judged to be Low to Negligible. As the key receptor group of visitors to Slains Castle and the coastline have a High sensitivity to the proposed change, the significance of cumulative effect is assessed to be Moderate to Negligible.

4.2.19. **Viewpoint 19: Mither Tap, Bennachie** (WF-19)

Due to the time of year the assessment was undertaken, photographs were not able to be taken from this viewpoint, so only a wireframe was constructed.

The wireframe shows that the turbines would appear spread in six groups across 7 degrees of the illustrated 200 degree view. The closest turbine will be 32.02km from the viewpoint. Only the very tips of the blades will be visible above the horizon, with the majority of the turbines seen with the backdrop of the sea.

Site visits have shown that the surrounding landuse and development will most likely obscure much of the turbines in views on a clear day when the coast is visible. They will also be a very minor element within the expansive 360 degree views possible from this high viewpoint, where existing turbines are a common feature.

It is therefore judged that the magnitude of visual impact will be Low to Negligible. As the key receptor group of walkers have a High to Medium sensitivity to the proposed change, the significance of effect is assessed to be Moderate to Moderate-Minor to Negligible.

Cumulative Impacts

The wireframe (Figure CW19) clearly shows the number of wind farms within the distant landscape that are theoretically visible from this viewpoint. The cumulative ZTVs also show that over 30 existing and consented and up to 18 in-planning wind farms theoretically could be visible from this promontory.

However, site visits have shown that it is only the closest of these turbines which are discernable with many of the single turbines and small wind farms recessive within the undulating farmland landscape. The vast majority of the wind farms lie to the west, north and north east of the viewpoint, the closest of which are approximately 11 km away. Those to the south lie closest at 30 km to the viewpoint.

The EOWDC will lie beyond an area of landscape (Central Wooded Estates character area) to the east of the viewpoint which does not have any wind farms, existing or proposed. If seen, the EOWDC can be perceived as having a stronger relationship with the northern wind farms and that it is quite separated from the southern wind farms, closest of which is Meikle Carewe (approximately 35 km away), which will also be difficult to discern at this distance.

As is has been assessed that the EOWDC will be a minor element within the overall view when visible, the addition of the EOWDC with the existing, consented and in-planning turbines will not significantly alter the expansive views available at Bennachie, so that the magnitude of cumulative impact is judged to be Negligible. As the key receptor group of walkers have a High to Medium sensitivity to the proposed change, the significance of cumulative effect is assessed to be Negligible.

4.2.20. **Viewpoint 20: A95 near Uras** (WF-20 and PM-20)

The wireframe illustrates that the turbines will appear just above the headland, with blade tips only visible, and will occupy 3.5 degrees of the illustrated 135 and 90 degree views. The closest turbine will be 33.58 km from the viewpoint.

The photomontage shows that it is very difficult to see the turbine blades above the headland and perhaps only on days when the sun is shining on the blades will they be discernable, and then they will be a very minor element within the open landscape.

The large scale landscape with relatively simple components will remain unchanged by the presence of the turbines and therefore the magnitude of visual impact is assessed as Negligible. As the key receptor group of travellers on the A92 have a Medium sensitivity to the proposed change, the significance of effect is considered Negligible.

Cumulative Impacts

The cumulative ZTVs illustrate that there will be no other wind farms visible from this view point and as such, there will be no cumulative effects.

4.3. Effects upon Visual Receptor Groups

The Baseline Report provides an outline of the range of visual receptor groups who can reasonably anticipated to be affected by the proposed EOWDC development. The effects upon these receptors are discussed below.

4.3.1. Local Residents

The closest residents to the proposed EOWDC site are those living in Blackdog and Balmedie. There are also individual properties at Tarbothill Farm, Wester Hatton and Hatton which lie along the section of coast between the A90 and the turbines. The turbines will lie at just over 3 km from all of these settlements. The EOWDC turbines will be a prominent feature for residents when travelling to and from their homes. Only those houses with outlooks towards the sea are likely to see the turbines consistently. Many of the houses in these areas are orientated to shelter from the cold east coastal winds and therefore will be less affected by views of the turbines.

However, at this close distance, the turbines will fundamentally alter any available views of those residents whose properties are orientated towards the sea and the magnitude of visual impact on these residents is judged to be High. As they have a High sensitivity to the proposed change, the significance of effects is assessed as Major.

Cumulative Effects

There are no existing, consented or in-planning wind farms which lie in close proximity to the settlements identified above and therefore there would be no significant cumulative effects of the EOWDC with another wind farm on the local residents.

4.3.2. Travelling Public - Rail

Passengers on trains arriving at Aberdeen will potentially have intermittent views of the EOWDC where it is visible above and in-between the city's buildings, as illustrated by the ZTVs. Cuttings and embankments are not modelled into the ZTV so although theoretically there may be visibility around Tullos Hill, this is most likely curtailed by the cuttings. Rail passengers are also restricted to some degree in their angle of view and it is only where the rail line curves around the coastline before Aberdeen that the side of the train would face the direction of the EOWDC.

It is therefore judged that there will be an overall Negligible magnitude of impact on rail passengers. As their sensitivity to the type of development proposed is Medium to Low, the significance of effect is assessed as Negligible.

Cumulative Effects

Where it has been identified above that there is potential visibility of the EOWDC, there will be no combined views of other wind farms. Whilst there is potential for the rail passengers to view wind farms along the stretches of rail line south of Aberdeen, the potentially short intermittent views of the EOWDC will not significantly add to any sequential cumulative effects and it is therefore considered that the magnitude of cumulative impact would be Negligible. As their sensitivity to the type of development proposed is Medium to Low, the significance of cumulative effect is assessed as Negligible.

4.3.3. Public Paths

The Aberdeenshire Coastal Path will be exposed to the EOWDC for much of its length between Girdle Ness and Peterhead. The turbines will become a consistent feature when travelling along the route, as the path generally keeps close to the coastline. Local topography and coastal features may interrupt views to some extent but overall the magnitude of visual effect on the walkers on the coastal path will be High within the areas around Aberdeen Beach and Aberdeen Bay, but will reduce to Low and Negligible with distance. As they have a High to Medium sensitivity to the proposed change, the significance of effect will be Major to Major-Moderate reducing to Moderate-Minor to Negligible with distance from the EOWDC.

Cumulative Effects

It can be expected that the main focus of the users of the coastal path will be the sea and coastline, with any long views inland a secondary aspect to the experience of the route. Within the areas identified above where the EOWDC will potentially have a High magnitude of effect there will be no other wind farms visible in the coastal views. There is potential for the inland existing, consented and in-planning wind farms to be seen but these will not be dominant in views from the coast as most lie beyond 7km from the coast. It is only the north east corner between Peterhead and Fraserburgh where existing, consented and in-planning turbines lie closer to the coast and the flatter coastal plain allows clearer views. However, in these areas, views of the EOWDC are limited if visible at all.

It is therefore judged that the magnitude of cumulative effect on the walkers on the coastal path will be Negligible. As they have a High to Medium sensitivity to the proposed change, the significance of cumulative effect will be Negligible.

4.3.4. Travelling Public - Sea Routes

The Orkney/Shetland passenger ferries leave Aberdeen on a regular basis. The route will pass in close proximity to the turbines and the EOWDC will be a prominent feature at the start or end of the passage. The overall magnitude of impact is judged as Low as it will be a temporary visual impact, and for a small proportion of the ferry's overall route. As the passengers on the Ferry will have a Medium to Low sensitivity to the proposed change, the overall significance of effect is considered Moderate-Minor to Minor although it is accepted that, on passing the EOWDC the magnitude of effect will be temporarily High, and therefore the significance of effect would temporarily be Major-Moderate to Moderate.

There are many fishing, commercial, and industrial ships which use Aberdeen Harbour and these will have views of the turbines when leaving or arriving. Many of the ships sit out for lengths of time in MCA designated anchorage area in the vicinity of the proposed EOWDC site, so they will be potentially the closest visual receptors to the proposed development. Smaller fishing vessels from the local village harbours may be more affected as they do not travel as far offshore as the larger ships and may have visibility of the EOWDC for the duration of their fishing trips. However, as they will be focussed on their line of work and due to their generally transient nature, effects would be reduced. It is judged that the magnitude of effect is overall Medium. As the workers on the ships would have a generally Low sensitivity to the type of change proposed, the significance of effect is assessed as Moderate-Minor.

Recreational sailing and yachting are not common in the immediate waters around the EOWDC, mainly due to the amount and size of harbour traffic in the area. Those sailors using the cruising routes in the wider area may have some visibility of the turbines. They would have a Medium sensitivity to the type of development proposed as they although they may have an interest in their surroundings, which already include a relatively high level of marine activity; they also will be concentrating on the sailing or racing. The magnitude of effect is overall judged as Medium, but it is accepted that there may be a temporarily High magnitude of effect when the vessels pass in close proximity to the EOWDC. The significance of effect is therefore overall Moderate, and temporarily Major-Moderate when in close proximity to the EOWDC.

Cumulative Effects

The EOWDC will be the only wind farm within the North Sea in the study area. Existing and consented onshore turbines are already potentially seen at a distance from offshore but are not prominent or easily discernable features. The proposed in-planning wind farms slightly increase the number of wind farms potentially visible but apart from the turbines at Peterhead Harbour and those in-planning between Peterhead and Fraserburgh, they are not any closer to the coast than existing wind farms. The combined effects of EOWDC and the existing, consented and in-planning wind farms is therefore limited by this distance and the smaller scale of the onshore wind farms. It is judged that the cumulative effects of EOWDC on offshore receptors will be Negligible. Taking into account the various sensitivities of the offshore receptors, the magnitude of cumulative effect will still be Negligible.

4.3.5. Visitors to the Area

Apart from those using the coastal path (as discussed above), visitors to the area with greatest potential to be affected by the EOWDC would be those visiting Aberdeen Beach, Balmedie Beach, and Forvie Sands. The effects on receptors at these locations are discussed in the viewpoint assessment.

4.4. Sequential Visual Effects on Main Roads

The theoretical sequential cumulative visual impact on a selection of main roads, as agreed with the consultees, has also been assessed using data obtained from the ZTV and transferred to graphs. These illustrate the number of wind farm sites that may theoretically be visible at mile intervals along the routes and indicate the distances from these locations to the various identified wind farms. These graphs are shown in Appendix 2 and should be read in conjunction with Figure 19 which identifies the agreed routes.

Each graph is necessarily at a different scale that relates to the distance to the various wind farms within the vicinity of each particular route. Miles are indicated along the horizontal axis on the graphs, rather than kilometres, as the majority of people more readily relate to these when travelling. However, kilometre distances have also been shown for ease of reference.

It should be noted that the graphs only illustrate point data at discrete mile intervals. They do not record continuous visibility along the routes and as such there remains the possibility that further views of the EOWDC and other wind farms may also, although not necessarily, be available between these mile intervals. In these instances where the graph does not show a wind farm as visible, there is most likely no visibility, or the visibility could be intermittent, or, if continuous, it will be for less than a mile. Where visibility is shown, the graphs present a worst case scenario of theoretical visibility as represented by the ZTVs. In reality this visibility will be limited due to distance, intervening local vegetation, road cuttings and embankments which would not have been modelled in the ZTV, and the orientation of the particular wind farm in relation to the direction of travel.

4.4.1. A90

The A90 is the main road from the south to Aberdeen, and to Peterhead and Fraserburgh in the north. The ZTV shows that within the study area to the south of Aberdeen, visibility of the EOWDC is limited until the junction with the A956 where the road occupies a high point and views of Aberdeen city are very clear. Visibility will be intermittent as the A90 goes through Aberdeen with only glimpse views of EOWDC available from a few high points (such as where the A90 runs to the west of Kincorth and the Anderson Drive section of the A90 between Mastrick and Middlefield). As the A90 reaches the northern side of Aberdeen (at Bridge of Don) clear views of the EOWDC will be seen. This visibility when travelling north extends to just beyond Balmedie.

Travelling south from Peterhead, the first stretches of potential visibility will occur at Longhaven to just east of Auchiries, approximately 25 km from the EOWDC. Visibility is then limited until Toll of Burness where views of EOWDC will potentially be clear until a lower stretch of road east of Ellon where the topography limits any views. As the road rises again just after the roundabout with the B9005, views of the EOWDC are again potentially possible and, apart from a few dips in the road precluding views, the visibility of the EOWDC continues all the way to Balmedie.

In reality, site assessment has shown that localised cuttings and roadside vegetation will reduce visibility of the EOWDC from a number of areas where the ZTV suggests potential visibility. Both distance to the proposed development and the orientation of the view will also play a part in reducing any visual effects. It is therefore judged that overall the magnitude of impact on the users of the A90 is High for the section of road in the immediate vicinity of the proposed development (approximately <5 km) reducing to Medium around Ellon in the north and Aberdeen in the south, and Low to Negligible elsewhere. As the sensitivity of road users to the type of development is Medium to Low, the significance of effect is Major-Moderate to Moderate within approximately 5 km, Moderate to Moderate-Minor around Ellon and Aberdeen, and Minor to Negligible elsewhere.

Cumulative Impacts

Reference should be made to graphs 01 to 06, and Figure 19 which illustrate the sequential cumulative effects on the A90 of the proposed development with other wind farms within a 60 km radius. For the purposes of clearly showing the effects, the A90 has been split into three sections; South, Aberdeen Trunk Road, and North. There are also separate graphs for existing, consented and in-planning wind farms.

A90 South (Graphs 01 and 02)

As described above, the south section of the A90 will have limited, if any, views of EOWDC and the graph illustrates that there will be no other wind farms visible at two points where the EOWDC is theoretically visible. The graph suggests however that, travelling on the A90 from the limits of the 60 km radius study area which starts at Stracathro Services, there will be potentially views of 11 existing or consented wind farms and 1 in-planning wind farm at various points along the road and therefore there is the potential for EOWDC adding to the sequential cumulative effects that already arise from the existing wind farms. The in-planning wind farm is the extension to Skelmonae which is potentially only visible at one point, approximately 38 km north of the A90 and at this distance will be most unlikely to be seen from the road.

The existing or consented wind farm graph suggests that around Laurencekirk to Stonehaven there may be potential combined and sequential visibility of up to eight sites for most of this stretch between distances of 1 and 15 km from the road. Beyond 2 miles north of Stonehaven the graph shows that views of wind farms decreases and it is only Meikle Carewe that is potentially visible within 15 km of the A90 between Stonehaven and the A93 Junction before Aberdeen.

A90 Aberdeen (Graphs 03 and 04)

The 3 mile section of the A90 which routes through Aberdeen is shown by the graphs to have theoretically combined views of Mid Hill, Hillhead of Auquhirie (and extension), Clochnahill, Meikle Carewe wind farms, and EOWDC. Clochnahill, Mid Hill and Hillhead of Auquhirie (and extension) will lie beyond 25 km from the road and will be seen in the opposite direction to the EOWDC. Meikle Carewe will also be seen in the opposite direction to the EOWDC, but will be between 15 and 20 km from the road.

However, the experience on site indicates that at present there is no obvious visibility of the more distant existing wind farms and views towards EOWDC will be intermittent and limited.

A90 North (Graphs 05 and 06)

On the northern stretch of the A90, the graphs suggest that there could be up to 20 existing and consented wind farms and up to 9 in-planning wind farms not including the EOWDC theoretically visible along the length, although eight existing and consented, and one in-planning wind farms will be beyond 40 km from this stretch of the A90 and can therefore safely be presumed to be unlikely to be detected by those travelling the route. The graphs also suggest that, from Peterhead to Bridge of Don, there will theoretically almost be a continuous view of wind farms. Those most likely to be seen along the road in conjunction with the EOWDC include Ardgrain, Hill of Easterton, Hill of Fiddes, Tillymaud, and Mains of Bogfechel. The in-planning Peterhead Harbour, Woodlands Farm, Mosseye and Hill of Fechel turbines will also be theoretically visible from a large stretch of the A90 and will also contribute to the overall sequential effects.

A90 Overview

The graphs and ZTVs show that whilst there is little combined visibility of the EOWDC with other wind farms for the majority of the A90 the EOWDC will extend the potential sequential visibility of wind farms to stretches of the road which currently do not have views of wind farms. This is more pronounced in the northern section of the A90, compared to the southern section where the EOWDC has limited intervisibility with the road.

Overall, the graphs indicate that there theoretically will be views of wind farms for the majority of the A90 route identified in the graphs. However, the majority of the onshore turbines are not higher than 60 m hub/100 m blade tip and site assessment has found that in reality the existing wind farms do not have a large visual envelope or presence when travelling the route. Whilst the graphs are helpful in understanding the theoretical scenario they do show the worst case scenario. Site investigation along the routes indicated that, when travelling at the appropriate road speed, it is only those turbines within a reasonably close distance of the route that will really be perceived.

It is therefore judged that the overall magnitude of sequential cumulative impact of the EOWDC on the A90 is Medium. As the sensitivity of travellers on the A90 to the type of development proposed is Medium to Low, the significance of sequential cumulative effect is assessed as Moderate to Moderate-Minor.

4.4.2. **A920**

The A920 has been assessed as one continuous road, 39 miles long, from Cairnborrow to Ellon. The graphs and ZTVs show that visibility of EOWDC is not theoretically possible until 2 miles east of Old Meldrum, at which point it will be 20 km away and along the course of the road to the east it will not be closer than 15 km. The ZTV shows there will be intermittent visibility and at some points this will be limited to blade tip only. Site assessment also confirmed that much of this road is enclosed by roadside vegetation and in reality views of EOWDC would be much more restricted than is shown by the ZTV.

It is therefore judged that the magnitude of sequential impact on the travellers using the A920 is Low to Negligible. As the sensitivity of the travellers to the type of development proposed is Medium to Low, the significance of sequential cumulative effect is assessed as Moderate-Minor to Minor to Negligible.

Cumulative Impacts (Graphs 07 and 08)

The graphs show that there are 30 existing and consented wind farms potentially visible along this stretch of road, and a further 15 in-planning wind farms, not including the EOWDC. In the eastern stretch where the EOWDC is potentially visible, the graph shows that there could be combined views of Hill of Fiddes, Ardgrain, Hill of Easterton, Tillymaud, and Skelmonae. These wind farms would lie considerably closer to the A920 than the EOWDC, at distances of between 3 and 15km. The in-planning wind farms which would be seen in combination with the EOWDC include Hill of Fechel, Mosseye, Woodlands Farm, Skelmonae Extension, and Hillhead, Oldmeldrum turbines. Again, these would all lie noticeably closer to the route than the EOWDC.

The A920 is potentially exposed to wind farms along its entire length with very few gaps. The addition of EOWDC will not extend the sequential views but will potentially give combined cumulative effects. As judged above, however, views of EOWDC are limited and therefore combined cumulative effects would also be limited.

It is therefore judged that the magnitude of cumulative impact on the travellers on the A920 is Low to Negligible. As the sensitivity of the travellers to the type of development proposed is Medium to Low, the significance of cumulative effect is assessed as Moderate-Minor to Minor to Negligible.

4.4.3. **A93**

The A93 is a main road which follows the River Dee for much of its length towards Ballater. The ZTV shows that due to its sheltered valley enclosure there is no intervisibility of the EOWDC along any of the A93 within the study area and therefore no visual effects.

Cumulative Impacts

As there are no visual effects arising from EOWDC along this road there will be no cumulative effects. Although not included in the appendix, graphs were produced and they confirmed that only Mid Hill and Meikle Carewe would be seen along the A93with no visibility of EOWDC.

4.4.4. **A947**

The A947 is the main road that links Banff and Aberdeen via the towns of Turriff and Oldmeldrum. The ZTVs suggest that there are only a few locations along this road which will have potential intervisibility with the EOWDC. These are located at a couple of local high points just north of Oldmeldrum and some high land between Oldmeldrum and Newmachar. There is also potential visibility at Dyce, although local residential and industrial development will obscure some views.

As the visibility of the EOWDC is from very limited areas and for short stretches of the route, the magnitude of impact on travellers along the A947 is considered Low to Negligible. As the sensitivity of travellers to the proposed type of change is Medium to Low, the significance of effect is assessed as Moderate-Minor to Minor to Negligible.

Cumulative Impacts (Graphs 09 and 10)

The graphs illustrate that there are potentially 36 existing and consented wind farms, and 18 in-planning wind farms theoretically visible along the A947, not including the EOWDC. Ardgrain, Hill of Fiddes, Mains of Bogfechel, Skelmonae, and Tillymaud will potentially be seen in combined views with the EOWDC. The in-planning Hill of Fechel, Skelmonae Extension, Bogenjohn Farm, St Fergus Moss and Woodlands Farm turbines are also shown on the graphs to be visible with the EOWDC.

The majority of the A947 is shown by the graphs to have visibility of wind farms, especially the stretch between Fyvie and Oldmeldrum which has the potential to see up to 21 wind farms at once. However, site assessment has shown that while there are views of some of these wind farms, roadside vegetation and development obscures clear views from long stretches of the road.

The sequential cumulative effect along the A947 can already be judged to be high without the EOWDC turbines. The addition of EOWDC will potentially extend the sequential effects for a short length of the eastern section of the road. This short stretch of visibility is considered to be insignificant enough that the sequential cumulative effect arising from the inclusion of EOWDC is not overall increased. Therefore it can be concluded that the magnitude of cumulative impact of the EOWDC is Negligible. As the sensitivity of the traveller on the A947 to the proposed change is Medium to Low, the significance of cumulative effect is assessed as Negligible.

4.4.5. **A948**

The A948 connects New Deer with Ellon and is 14 miles long. The ZTV and graphs show that the EOWDC will be visible for the southern 3 miles before it joins the A90 at Ellon. The proposed turbines will be approximately 15 km at their closest to the road. There will be no intervisibility with the site along the rest of the route.

As the EOWDC will be clearly visible in views along only the southern extents of the road, where roadside vegetation and development permits, the magnitude of effect on travellers on the A948 is considered Medium for this stretch and Negligible elsewhere. As the sensitivity of travellers to the proposed change is Medium to Low, the significance of effect is assessed as Moderate to Moderate-Minor to Negligible.

Cumulative Impacts (Graphs 11 and 12)

The graphs suggest that the A948 is theoretically exposed to 26 existing and consented wind farms and 13 in-planning sites, not including the EOWDC. The majority of these sites are potentially visible between Auchnagatt and Ellon, with up to 20 wind farms theoretically visible at once within a short stretch, 4 miles north of Ellon.

EOWDC is first visible at 11 miles from New Deer, and the graphs suggest that there would also be combined visibility of Mains of Bogfechel, Hill of Fiddes, Ardgrain, Tillymaud, and Haddo Wind Farms. Hill of Fechel, Mosseye, Skelmonae Extension, and Woodlands Farm would be the only in-planning wind farms seen in combination with the EOWDC. These would all, except Haddo and Hill of Easterton, lie closer to the road than the EOWDC.

The addition of the EOWDC does not expose new stretches of the A948 to visibility of wind farms. There will be combined visibility of EOWDC at the southern end of this road which will add to the number of wind farms sequentially viewed. It is therefore judged that the magnitude of cumulative effects on travellers is Low. As the sensitivity of travellers to the proposed change is Medium to Low, the significance of cumulative effect is assessed as Moderate-Minor to Minor.

4.4.6. **A96**

The A96 is the main road linking Inverness and Aberdeen via Inverurie and Huntly. The ZTV shows that the EOWDC will only be visible at the southern extents of this road from Dyce to the edge of Aberdeen city centre. Apart from potential blade tip visibility within an area around Kintore, there will be no visibility of the EOWDC from the A96.

Given this, it is judged that the magnitude of visual impact upon travellers along the A96 will be Medium from the identified southern extents only but Negligible from all other sections of the route. As the sensitivity of travellers to the proposed change is Medium to Low, the significance of visual effect is assessed as Moderate to Moderate-Minor to Negligible.

Cumulative Impacts (Graphs 13 and 14)

The graphs suggest that views are theoretically available of up to 17 existing and consented wind farms and 8 in-planning sites, not including the EOWDC at various points along the A96's length. The graphs also suggest that the EOWDC will be potentially visible in the southern section of the road where no other wind farms will be visible except for a short section where combined views may be possible with the single turbine at Mains of Bogfechel.

Starting at Huntly, the existing large wind farms at Glens of Foudland and Mains of Dummuie are very visible as well as the smaller Hill of Tillymorgan Wind Farm. Beyond these wind farms the in-planning graph shows that Newton of Fortrie, Hospital Wood, Auchinderran, Backhill of Yonderton and Hillhead (Bonnykelly) wind farms will be visible within a 2 miles stretch.

Travelling south east, between Kirkton of Culsalmond and Inverurie the smaller wind farms at Hill of Easterton, Gordonstown Hill and single turbines at Hill of Burns and Cowhill become visible within 20km from the road. In addition, the in-planning Hillhead (Old Meldrum) and Mains of Balquhain will be visible within 20km of the road.

From Inverurie the existing, consented and in-planning turbines gradually diminish and it is only the existing Mains of Bogfechel which is potentially seen within 15 km of the road before the EOWDC starts to become visible.

The addition of the EOWDC will thus result in limited combined cumulative effects on the A96 but, as it will be visible along a stretch of the A96 where no existing, consented or in-planning wind farms will be visible, it can be considered that it will extend the existing sequential cumulative effects for the length of the road within the study area. However, the visibility of wind farms between Kirkton of Culsalmond and Dyce is limited as the smaller wind farm sites gradually lie beyond 10 km from the road and site assessment confirmed that roadside vegetation and development will prevent extensive continuous views across the surrounding landscape.

It is therefore judged that the magnitude of sequential cumulative impact on the travellers on the A96 is Medium. As the sensitivity of travellers to the proposed change is Medium to Low, the significance of effect is assessed as Moderate to Moderate-Minor.

4.5. Visual Effects at Night

The turbines at EOWDC will be marked to be visible by day and by night, with prevailing visibility conditions, and will be lit in accordance with the International Association of Lighthouse Authorities (IALA) standards and as specified by Trinity House. For aviation purposes it is proposed that turbines will be lit in accordance with the Civil Aviation Authority (CAA) requirements.

The turbine lighting has a visible range of 5 nautical miles (NM) (approximately 9 km). As a result the coastal areas from Newburgh to Girdle Ness will potentially have additional visual glare or night glow where views of the EOWDC are available. However, views out to sea will be compromised to a degree, within most of this area, by the light spillage from existing lighting associated with the urban areas, road lighting, harbour, and lighthouses and especially the ships in the designated anchorage area. At the time of the assessment site visit, it was noted that there were over 20 large ships in the designated anchorage area and at night their lighting was very prominent where views of the bay are possible. The lighting of the turbines would therefore not be isolation and would only extend the existing presence of lights in the sea.

The significance of visual effects of the EOWDC at night is therefore considered not to exceed what has already been assessed for the daytime.

4.6. Summary Table of Visual Effects

Receptor	Approx. Distance to nearest EOWDC turbine	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect	Magnitude of Cumulative Impact	Significance of Cumulative Effect
Vpt 1 Balmedie Beach	3.51 km	High	High	Major	None	None
Vpt 2 A90 (Harehill)	4.44 km	Medium to Low	High	Major-Moderate to Moderate	None	None
Vpt 3 Jesmond Drive, Middleton	7.14 km	High	Negligible	Negligible	None	None
Vpt 4 B999 Whitecairns	8.1 km	High (residents) Medium to Low (travellers)	Medium	Major-Moderate (residents) Moderate to Moderate-Minor (travellers)	None	None
Vpt 5 Aberdeen Beach	7.52 km	High	High to Medium	Major to Major-Moderate	None	None
Vpt 6 A90 (West Pitmillan)	9.31 km	Medium to Low	Medium to Low	Moderate to Moderate-Minor to Minor	Low	Moderate-Minor to Minor
Vpt 7 Torry Battery	7.89km	High to Medium	High to Medium	Major to Major-Moderate to Moderate	Negligible	Negligible
Vpt 8 South College Street, Aberdeen	9.19 km	Low	Negligible	Negligible	None	None
Vpt 9 Forvie Nature Reserve	10.27 km	High	Medium	Major-Moderate	None	None
Vpt 10 Midstocket Road/North Anderson Drive	10.47 km	High (residents) Medium to Low	Low	Moderate (residents) Moderate-Minor to	None	None

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Receptor	Approx. Distance to nearest EOWDC turbine	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect	Magnitude of Cumulative Impact	Significance of Cumulative Effect
		(travellers)		Minor (travellers)		
Vpt 11 Leslie Road (A978) Aberdeen	8.07 km	High (residents) Medium (travellers)	Low	Moderate (residents) Moderate-Minor (travellers)	None	None
Vpt 12 Kincorth Hill	11.56 km	High to Medium	Medium	Major-Moderate to Moderate	Negligible	Negligible
Vpt 13 Udny Station	12.63 km	High	Medium to Low	Major-Moderate to Moderate	Low	Moderate
Vpt 14 A96/Kirkhill Forest	14.13 km	Medium to Low	Low	Moderate-Minor to Minor	None	None
Vpt 15 Brimmond Hill	14.41 km	High to Medium	Medium	Major-Moderate to Moderate	Low	Moderate to Moderate-Minor
Vpt 16 Formartine and Buchan Way, near Quilquox	25.98 km	High (residents) Medium (cyclists)	Low	Moderate (residents) Moderate-Minor (cyclists)	Low	Moderate (residents) Moderate-Minor (cyclists)
Vpt 17 Minor Road near Netherley and Durris Forest	24.99 km	High	Low to Negligible	Moderate to Negligible	Low to Negligible	Moderate to Negligible
Vpt 18 Slains Castle	22.23 km	High	Low	Moderate	Low to Negligible	Moderate to Negligible
Vpt 19 Mither Tap, Bennachie	32.02 km	High to Medium	Low to Negligible	Moderate to Moderate-Minor to Negligible	Negligible	Negligible
Vpt 20 A92, Mill of Uras	33.58 km	Medium	Negligible	Negligible	None	None

Receptor	Approx. Distance to nearest EOWDC turbine	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect	Magnitude of Cumulative Impact	Significance of Cumulative Effect
Visual Receptor Groups						
Local Residents	Within 5 km	High	High (if orientated towards the EOWDC)	Major	None	None
Travelling Public - Rail	>9 km	Medium to Low	Negligible	Negligible	Negligible	Negligible
Travelling Public – Coastal Path	>3 km	High to Medium	High to Low to Negligible with distance	Major to Major-Moderate reducing to Moderate-Minor to Negligible with distance	Negligible	Negligible
Travelling Public - Ferry	>1 km	Medium to Low	Low (overall) High (when passing in close proximity)	Moderate-Minor to Minor (overall) Major-Moderate to Moderate (when passing in close proximity)	Negligible	Negligible
Shipping/Fishing	>1 km	Low	Medium	Moderate-Minor	Negligible	Negligible
Recreational Sailing	>1 km	Medium	Medium (overall) High (when passing in close proximity)	Moderate (overall) Major-Moderate (when passing in close proximity)	Negligible	Negligible
Sequential Effects on Roads						

Receptor	Approx. Distance to nearest EOWDC turbine	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect	Magnitude of Cumulative Impact	Significance of Cumulative Effect
A90	4 km	Medium to Low	High within 5 km, reducing to Medium around Ellon and Aberdeen, and Low to Negligible elsewhere.	Major-Moderate to Moderate within approximately 5 km, Moderate to Moderate-Minor around Ellon and Aberdeen, and Minor to Negligible elsewhere.	Medium	Moderate to Moderate-Minor
A920	15 km	Medium to Low	Low to Negligible	Moderate-Minor to Minor to Negligible	Low to Negligible	Moderate-Minor to Minor to Negligible
A93	12 km	Medium to Low	None	None	None	None
A947	10 km	Medium to Low	Low to Negligible	Moderate-Minor to Minor to Negligible	Negligible	Negligible
A948	15 km	Medium to Low	Medium to Negligible	Moderate to Moderate-Minor to Negligible	Low	Moderate-Minor to Minor
A96	11 km	Medium to Low	Medium to Negligible	Moderate to Moderate-Minor to Negligible	Medium	Moderate to Moderate-Minor

5.0 Other Assessment Considerations

5.1. Varying Turbine Heights

As the nature of the deployment centre is that it will be used to test emerging wind turbine technologies the turbines erected may be of varying heights. At this stage, two potential indicative scenarios of heights have been identified; Turbines 1 to 6 could have a hub height of 100 m and blade tip height of 160 m above LAT, Turbines 7 to 11 could have a hub height of 120 m and blade tip height of 195 m above LAT (as per the worst case scenario). This would give a hub height difference of 20 m and blade tip difference of 35 m. To understand the visual impacts of these height variations, wireframes were also created for Viewpoints 1, 2, 5, 7, 12 and 15. Please see Figures TH1-3.

The wireframes illustrate that the height difference will be difficult to discern at even the closest distance and that the identified variations in turbine height will not significantly alter the view. As is shown in Viewpoint 7 and 12 which show the eastern five turbines being larger, it is mostly in views from the south or north where the turbines height difference will be seen. Elsewhere, the distance between the turbines will offset the turbine height difference and, due to the influences of perspective, it will not be a noticeable difference. It is therefore concluded that the potential height variations would not increase the significance of impacts already identified in the assessment of the worst case scenario.

5.2. Potential Ocean Laboratory

The potential Ocean Laboratory would be subject to a separate planning application but has been included in this section as there may be cumulative impacts. The potential Ocean Laboratory could consist of a 120 m high mast and platform unit (20 x 20 x 4 m) and which could lie in the water south of the EOWDC turbines. Whilst the exact potential Ocean Laboratory details had yet to be confirmed at the time of this assessment, the dimensions given above were used to model the structure into wireframes for viewpoints 1, 2, 5, 7, 12 and 15 (Figures OL1-3) as locations where it could potentially be seen in full at relatively close distances. Please note that in reality the mast element of the Ocean Lab structure would be less dominant than shown on the wireframes.

The following paragraphs discuss the visual impacts of the Ocean Laboratory in combination with the EOWDC turbines at the aforementioned viewpoints.

5.2.1. **Viewpoint 1** (OL-01 top)

The top wireframe in Figure OL-01 illustrates the location and approximate structure of the potential Ocean Laboratory in views from Balmedie Beach, viewpoint 1. It slightly extends the extent of the EOWDC development across the view but, due to distance it will appear as the smallest element. The base platform has the potential to draw the eye to a lower section of the view than the adjacent turbine blades. As a static structure in comparison to the movement of the turbines, it will appear as a separate but not incongruous element to the view.

5.2.2. **Viewpoint 2** (OL-01 bottom)

The bottom wireframe in Figure OL-01 illustrates the proposed location and approximate structure of the potential Ocean Laboratory from the A90 – Harehill turn off, viewpoint 2. The platform will be the main focus of the laboratory and as the wireframe shows it will be seen below the horizon line with a backdrop of sea. The structure will extend the extent of the EOWDC across the view consistent with the spacing of the turbines. By its nature, the potential Ocean Laboratory will be seen as a separate element to the turbines, but at this viewpoint the distance to it and spacing with the turbines allow it to sit comfortably within the view.

5.2.3. **Viewpoint 5** (OL-02 top)

The top wireframe in Figure OL-2 illustrates the location and approximate structure of the potential Ocean Laboratory from Aberdeen Beach, viewpoint 5. The wireframe illustrates that the potential Ocean Laboratory will be nearer the viewpoint than the turbines and lie in front of the centre of the turbine group. It will therefore not extend the visible development across the view but will interrupt the rhythm of turbines and blades as the platform structure is a strong element below the adjacent turbine blades.

5.2.4. **Viewpoint 7** (OL-02 bottom)

The bottom wireframe in Figure OL-2 illustrates the location and approximate structure of the potential Ocean Laboratory from Torry Battery, viewpoint 7. The wireframe illustrates that the potential Ocean Laboratory will lie within a gap of the evenly spaced turbine group. The platform will be seen with a backdrop of land, just above the sea level. As in Viewpoint 5, the Ocean Laboratory will interrupt the rhythm of the turbine spacing and the platform will potentially be a noticeable feature in contrast to the turbines.

5.2.5. **Viewpoint 12** (OL-03 top)

The top wireframe in Figure OL-3 illustrates the location and approximate structure of the potential Ocean Laboratory from Kincorth Hill, viewpoint 12. The wireframe illustrates that from this viewpoint the potential Ocean Laboratory will sit between two turbines in the centre of the group. The platform will be seen with a backdrop of sea and due to the spacing of the turbines seen from this viewpoint; the structure will be less noticeable than if it were separate from the group.

5.2.6. **Viewpoint 15** (OL-03 bottom)

The bottom wireframe in Figure OL-3 illustrates the location and approximate structure of the potential Ocean Laboratory from Brimmond Hill, viewpoint 15. The wireframe illustrates that the potential Ocean Laboratory will lie at the southern end of the turbines and will be seen with a backdrop of the sea, with no protrusion into the skyline. At this viewpoint which is looking down on to the proposed development, the platform of the potential Ocean Laboratory will blend into the seascape, reducing its visual impact.

5.3. Menie Estate

Although a private estate, due to the high profile of the proposed developments at the Menie Estate the impacts of the EOWDC on the estate have been discussed by EOWDC with Trump Estates in October and November 2010 with further discussion in March 2011. A brief summary of the potential visual and landscape effects are set out below. These have been informed by both desk based study and the proximity of the Balmedie viewpoint (viewpoint 1).

The Menie Estate lies to the north west of the turbines, approximately 4 km at its southern extents from the nearest turbine of the EOWDC. Views from the estate to the south east will include views of the turbines, which will be similar to those illustrated for Viewpoint 1 – Balmedie Beach. However, whilst at 4km the turbines will be a feature in views from within the estate, the turbines are not anticipated to result in any unacceptable effects upon residential amenity or the immediate setting of the Estate.

In terms of any perceived potential effects upon residential amenity within the Estate, findings at recent Public Inquiries indicate that any potentially significant (i.e. oppressive or overbearing views) are only likely to exist within 1 km of a proposed development.

6.0 Construction, Decommissioning, and Mitigation

6.1. Construction Phase

During the construction phase the effect of increased activity of construction vessels travelling to the site, the presence of jack-up barges and the progressive construction of the wind turbines will constitute the main effect, albeit temporary. During this phase there will be some minor effects on the surrounding seascape. There will also be minor effects on the associated visual receptors and general visual amenity, during construction operations, which although temporary may be more significant than during the operational stages due to the increase in activity and vessel movements.

The additional effects arising from marine vessel activity associated with the cable installation, cargo barges or transportation of materials, including land based or harbour construction activity, are also considered to be relatively insignificant as there is an existing baseline of marine activity in the area.

6.2. Decommissioning Phase

During the decommissioning phase, there will also be visual effects associated with the decommissioning activity. This will be similar to that of the construction phase and relatively insignificant due to the existing baseline of marine activity in the area. As the anticipated length of decommissioning will be slightly less than for the construction phase, these impacts will be more temporary than for the construction period. Following the decommissioning stage there would be no residual effects on the seascape, landscape or visual receptors.

6.3. Mitigation

The inherent characteristics of the proposed development suggest that there are very limited opportunities for incorporating mitigation measures for seascape, landscape and visual effects. However, beneficial mitigation is included in the layout of the turbines and the size of the proposed development. The scheme incorporates integral mitigation measures to minimise the risk of aesthetically visually uncomfortable turbine arrangements.

Also, careful consideration is given to the colour of the turbines in order to ensure that they remain moderately recessive visually, albeit within the parameters of ensuring sufficient visibility for vessels out at sea. There is a need to balance the objective of reducing their visibility with the existing standard requirements for ensuring visibility of structures out at sea. Thus, the need to paint the lower sections of the turbine columns yellow, in accordance with Trinity House Lighthouse Service requirements, is unavoidable.

7.0 Summary

7.1. Seascape Effects Summary

The scale and extent of the proposed EOWDC, located just over 2 km east off the coast, will inevitably affect the surrounding seascape and landscape environments. The primary source point of the effects will be the eleven turbines.

The turbine columns are necessarily large structures which will be introduced into the existing seascape character of the area which currently does not include any offshore wind structures.

Being sited out at sea, the turbines are to be placed within an immediate receiving environment that has both the scale and simplicity of form to, not only accommodate the development, but also to provide it with an appropriate contextual setting. Thus, although the turbines are in themselves of a substantial scale, visual aesthetics and the nature of the receiving environment, that includes an expansive horizon line, big skies, simple composition and linear form of views, and the general scale of the seascape, indicates that they are not inappropriate to offshore locations.

Whilst any direct physical effects arising from the principal offshore components will be limited for the majority of the seascape and landscape resource, there will be a range of indirect visual effects upon the various identified regional seascape units, landscape character areas, and designated coastal landscapes within the study area.

The proposed EOWDC site will be located within the Aberdeen Bay regional seascape unit which will thus, carry the greatest effect arising from the EOWDC development. The EOWDC will be a prominent feature within the seascape unit and will become a defining characteristic. However, the scale of the seascape unit and the presence of existing marine activity and prominent man made elements along the coast will assist with reducing the overall extent of the effect locally to Major to Major-Moderate in the north and Major-Moderate in the south of the seascape unit.

Given the distance between the proposed site and the coastline, the wind turbines will also be theoretically visible from the five other regional seascape units and will thus have a degree of indirect effect upon the visual attributes of their character. A combination of distance; the nature and scale of these units; and, the fact that effects are confined to visual influence only; will, however, assist with reducing the overall extent of effect to Major-Moderate to Moderate at Aberdeen Beach, no more than Moderate between Stonehaven to Girdle Ness and Collieston to Peterhead, with Negligible effects beyond.

The landscape character areas defined for the study area will also experience a range of effects on their visual characteristics. The most significant effects of Major-Moderate to Moderate will be upon the Perwinnes Open Farmland and Major-Moderate to Moderate to Moderate-Minor on the Formartine Lowlands which both lie adjacent to the coastline, and due west of the EOWDC, where views across the sea are a key characteristic. The more elevated inland character areas encompass far ranging and expansive views within which the EOWDC will be a noticeable element, but not dominant, and therefore will not result in any significant effects.

The EOWDC will have a Major to Negligible effect on the locally designated Area of Landscape Significance which lies along the coast from Balmedie to Longhaven, extending to, at its closest, 3 km from the nearest turbine. However, significant effects will reduce to Negligible the further north within this ALS and it is noted that there will be no effects on the ALS at Cruden Bay due to the surrounding topography.

7.2. Visual Effects Summary

The proposed eleven turbines have a maximum nacelle height of 120 m above LAT, with a maximum height to blade tip of 195 m. They will thus be seen, both individually and collectively, as large visual elements set within a simple open setting, comprised predominantly of sea, coastal edge and sky. As they are close to land, in the wider study area, where visible, they will be seen with or without the sea context rising above the predominantly undulating landscape. The turbines will also be seen; admittedly by a far fewer number of visual receptor groups, in views from the sea where they will be seen against a backdrop of either the Aberdeenshire deposition coastline with farmland behind or against the complex and dynamic coastline extending from Aberdeen city and Girdle Ness headland.

Inland, theoretical visibility is highest primarily to the north and north west of the site from within the more open undulating landscape. The city and its suburbs, combined with the more pronounced landform to the south and west, substantially limit views of the EOWDC from within these areas of Aberdeenshire. The visual effects arising from the offshore turbines will be greatest when seen in exposed views within an approximate 15 km radius of the site and extending north along the coast from those locations where there are clear views of the EOWDC. This is demonstrated by the assessment of Major and Major-Moderate effects upon many of the receptors at the representative viewpoints within this distance. However, as the viewpoint assessment also illustrates, there are not necessarily significant effects at close distances as views of the turbines can be easily obscured by local topography, vegetation, and buildings.

The visual effects will ease considerably with distance from the site. However, given the size of the turbines, they will still be a noticeable feature from the northern coastline at distances of up to 20kmas demonstrated by Viewpoint 18. At similar distances inland from the EOWDC the landform and components of the landscape will obscure or reduce the prominence of the turbines so that they will only be a minor element in the view. The significant number and diversity of built elements sited intermittently along the coastline near the EOWDC site will also help to absorb the visual profile of the proposed turbines within distant views.

The magnitude and extent of visual effects is also reduced as the proposed development will be seen to shift from being the main focus of view (such as at Viewpoint 1 at Balmedie Beach) to occupying a more peripheral or oblique position within the field of view from other viewpoints.

The visual impact on Aberdeen is limited by the densely built up nature of a city and only in the more open elevated areas are the turbines likely to be visible, but then with a busy and complex foreground which will help to moderate any significant effects.

Any visual effects on receptors within the sea will be temporary due to the generally transient nature of views available from marine vessels making passage. There will, however, be temporary Moderate effects on those receptors out at sea, such as recreational sailors, who have an interest and enjoyment in the surrounding seascape.

Upon evaluation, the visual effects arising from the proposed EOWDC development have not been found to be inappropriate. Although the presence of the turbines will fundamentally change the views from the nearby coastline, and where visibility permits, they will be a noticeable but minor feature in views for distances of up to approximately 20 km on land, the extent of visibility of the EOWDC is relatively constrained as evidenced by the ZTV plans Offshore, the EOWDC will be a noticeable feature for a considerable distance across the expansive open sea and will thus provide an identifiable focal point and visual reference within the maritime setting.

Upon consideration the overall visual effect is therefore considered to be Moderate with only localised and isolated areas of more significant effect.

Due to the individual turbine spacing, the potential height differences of the turbines as proposed will not be significantly noticeable even at the closest viewpoints.

7.3. Cumulative Effects Summary

The assessment of cumulative effects found that, due to the offshore location of the EOWDC, and that the majority of the many wind farms within Aberdeenshire are located beyond 20 km from the site, the combined and successional cumulative effects were mostly Minor or Negligible and no more than Moderate in significance for visual, seascape and landscape cumulative effects.

As a consequence of being the closest (11-19 km) to the EOWDC, the existing and consented Hill of Fiddes, Ardgrain, Tillymaud, Mains of Bogfechel turbines and the in-planning Woodlands Farm and Hill of Fechel are the most frequent existing or consented wind farms to be seen in theoretical views with the EOWDC. However, these wind farms, at approximately half the height of EOWDC and with only between 1 and 3 turbines, have a relatively confined visual envelope which reduces the cumulative effect.

Although there are no significant combined cumulative effects, the sequential cumulative effects of EOWDC are potentially greater given the large number of wind farms in the study area.

The sequential assessment of visibility from the main roads within the study area showed that the EOWDC would potentially extend the visibility of turbines further than currently exists along the A90 and A96 thus creating Moderate to Moderate-Minor sequential effects along these roads. Along the other key routes studied, the EOWDC will become part of an existing sequential effect and not significantly add to it.

The proposed Ocean Laboratory will potentially bring about greater cumulative effects with the EOWDC turbines than any of the other wind farms within the study area. Due to the depth of the platform structure, it will be a noticeable, but not incongruous, element in views from the coastline, and from elevated positions where the base of the turbines can be seen. As illustrated by the viewpoints beyond 10 km, the platform will become less of a discernable feature at further distances. Please note that the potential Ocean Laboratory will be subject to a separate planning application.

8.0 Appendices

Appendix 1. Cumulative Wind Farm List

Cumulative Wind Farm Data 60 km radius study area			
Existing and Consented Wind Farms*	**Hub Height**	**Blade Tip Height**	**Number of Turbines**
Hill of Fiddes	62	102	3
Ardgrain	55.6	79.6	3
Mains of Bogfechel	53	79	1
Hill of Easterton	49	75	3
Skelmonae	55	77	4
Mid Hill	110	125	25
Hill of Tillymorgan	55.6	79.6	3
Haddo	55	93.5	2
St John's Well	55.6	79.6	3
Balquhindachy	49	75	3
Courtstone	56.5	93.5	1
Cowhill	55.6	79.6	1
Hill of Burns	55.6	79.6	1
Kildrummy	60	93	8
Little Byth	56	80	3
Old Maud	55.6	79.6	1
Denhill	55	93.5	1
Gordonstown Hill	59	100	5
Glens of Foudland	48	78	20
West Knock Farm	55.6	79.6	3
Newstead	56	80	1
Cairn Hill	46	76	3
Mains of Hatton	46	76	3
West Cockmuir	54.5	79.6	1
Clochnahill	50	81	4
Redbog	54.5	79.6	2
Hillhead of Auquhirie	57	92.5	3
St John's Hill	60	100	9
Cairnmore	50	81	4
Gairnieston	62.5	99.5	1
Mains of Drummuie	47	80	7
Strath of Brydock	62.5	99.5	3

Cumulative Wind Farm Data 60 km radius study area			
Existing and Consented Wind Farms*	**Hub Height**	**Blade Tip Height**	**Number of Turbines**
Tullo	60	100	7
Toux Farm	50	74	1
Upper Wheedlemont Farm	55	81	2
Bruxiehill	49	80	1
House O'Hill	54.5	79.6	3
Droop Hill	64.5	100	2
Herscha Hill	49	80	1
Miekle Carewe	46	70	12
Clashindarroch	70	110	18
Clayfords Farm	65	100	1
Auchtygills Farm	65	100	1
Jacksbank (Drumlithie)	60	100	3
Hillhead of Auquhirie extension	57	92.5	3
Castle of Auchry	50	74	3
Greenhill Croft	64	99.5	2
Tillymaud (Udny Community)	56	80	1
*Data current on March 18th 2011to the best of our knowledge.			

Cumulative Wind Farm Data 60 km radius study area			
In-Planning Wind Farms*	**Hub Height**	**Blade Tip Height**	**Number of Turbines**
Mosseye	38	55	1
Cairncake	55	80	2
Gellybrae and Royston	57	92.5	3
Oldwhat Mains	57	92.5	1
Mains of Balquhain	54	80	1
St Fergus Moss	60	100	3
Middleton of Rora	55	81	1
Gowanfold Farm	55.6	79.6	2
Hallmoss Farm	55.6	79.6	1
Hill of Fechel	55	79	1
St John's Wells Extension	55	79	3
Newton of Fortrie	64	98	3
Redbog Extension	54.5	79.6	2
Woodlands Farm	54	80	2
Bogenjohn Farm	64	99.5	3
Auchinderran Farm	55.6	79.6	3
Backhill of Yonderton, Turriff	64	99.5	2
Hillhead, Oldmeldrum	61	99.5	1
Hillhead, Bonnykelly	61	99.5	2
Blackhills, Cushnie	71	99.5	3
Cairnmore Extension	50	81	5
Skelmonae Extension	60	93.5	3
Peterhead Harbour	64	99.5	2
Hospital Wood, Auchterless	64	99.5	1
*Data current on March 18th 2011to the best of our knowledge.			

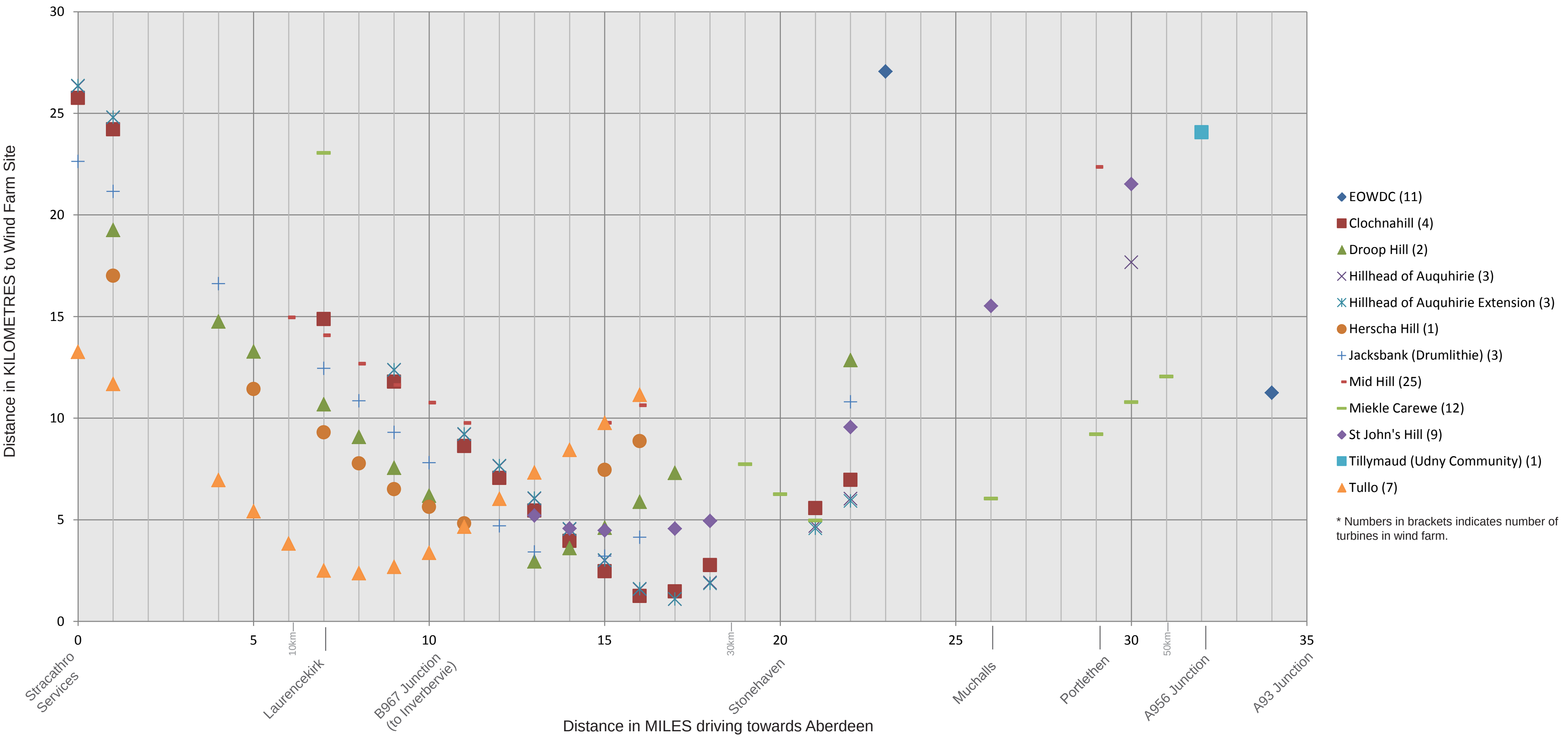
LDĀ DESIGN

Appendix 2. Sequential Graphs and Plan

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

EXISTING AND CONSENTED WIND FARMS

A90S

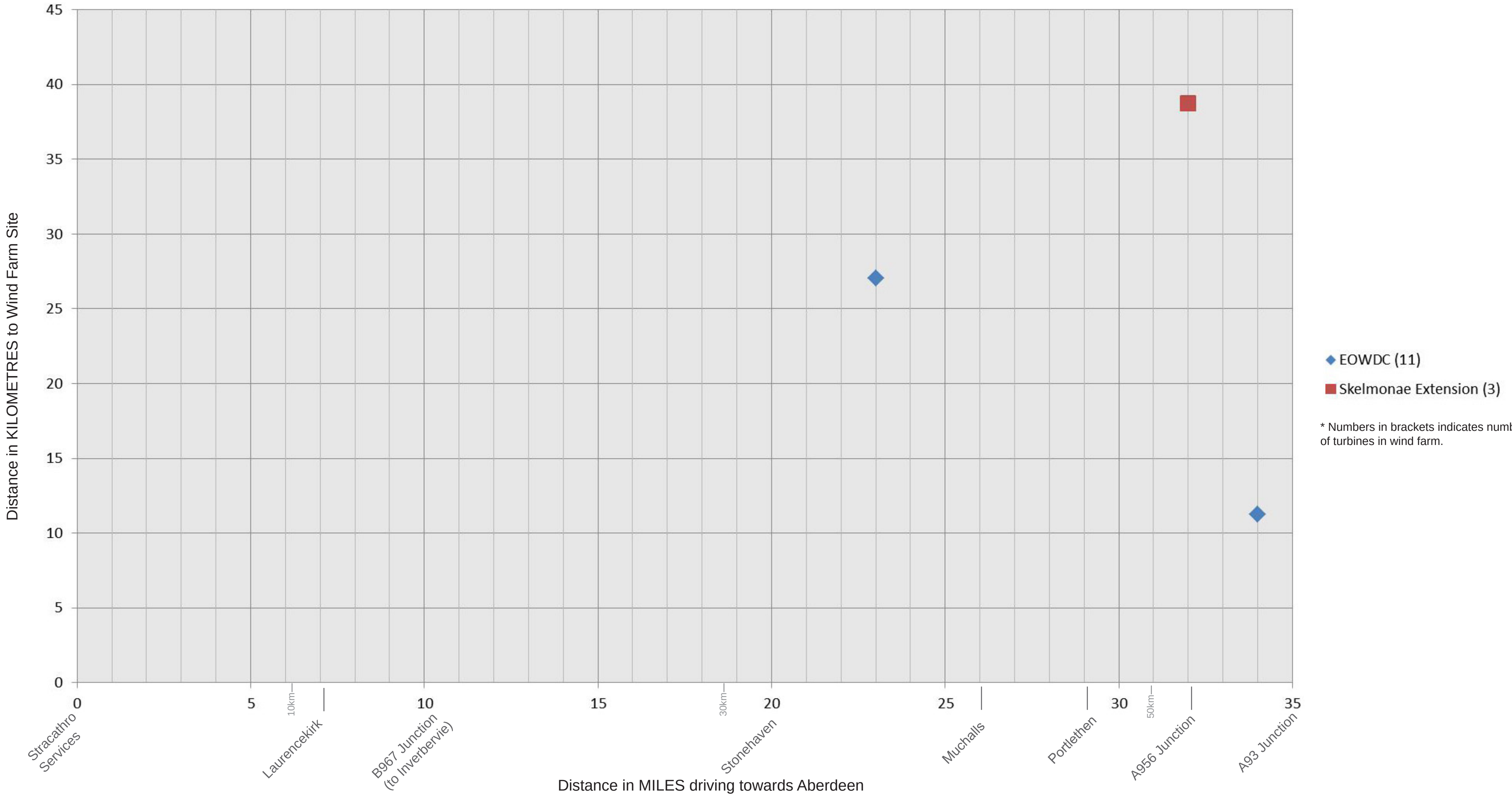


GRAPH 01

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

IN-PLANNING WIND FARMS

A90S



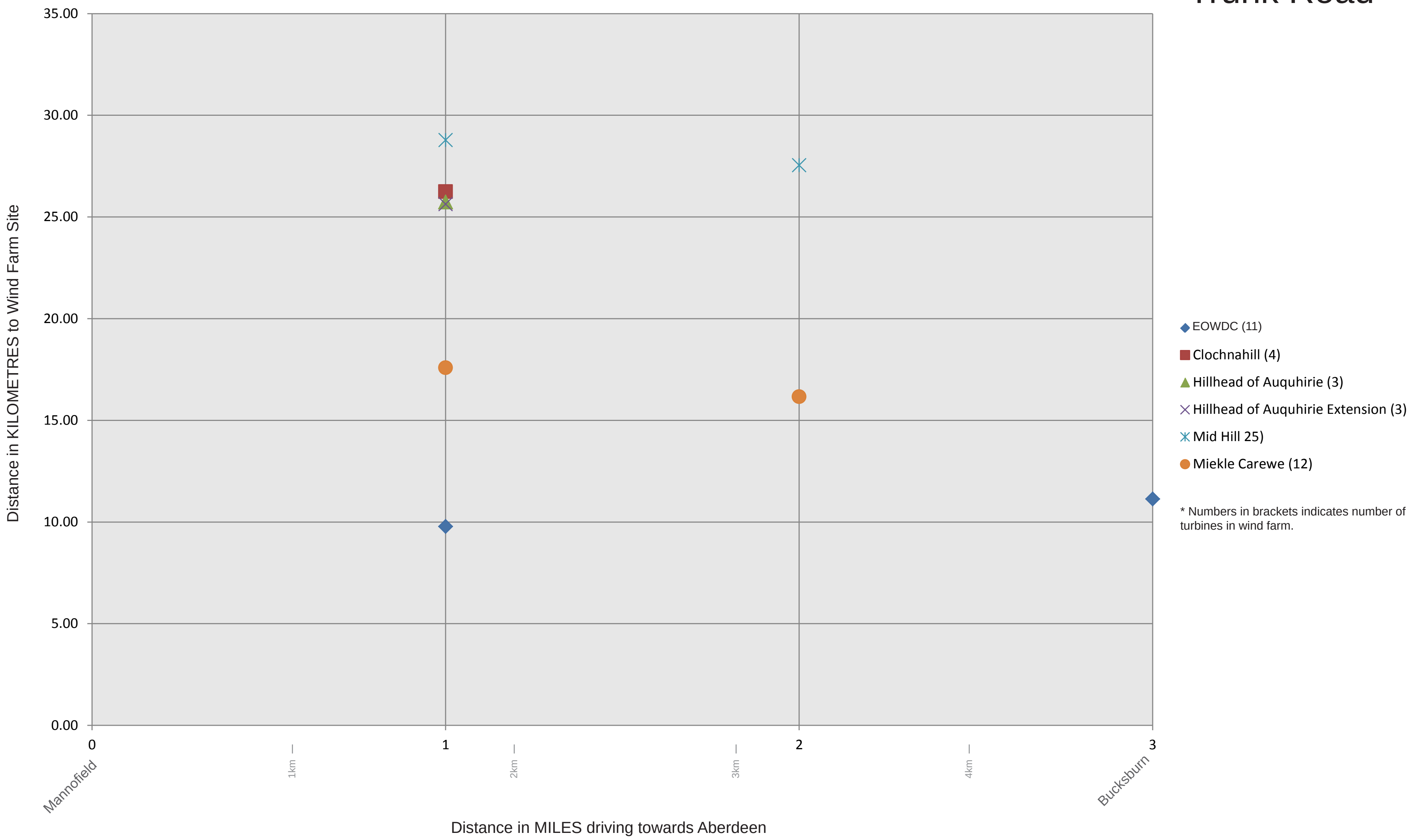
* Numbers in brackets indicates number of turbines in wind farm.

GRAPH 02

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

EXISTING AND CONSENTED WIND FARMS

A90
Aberdeen
Trunk Road

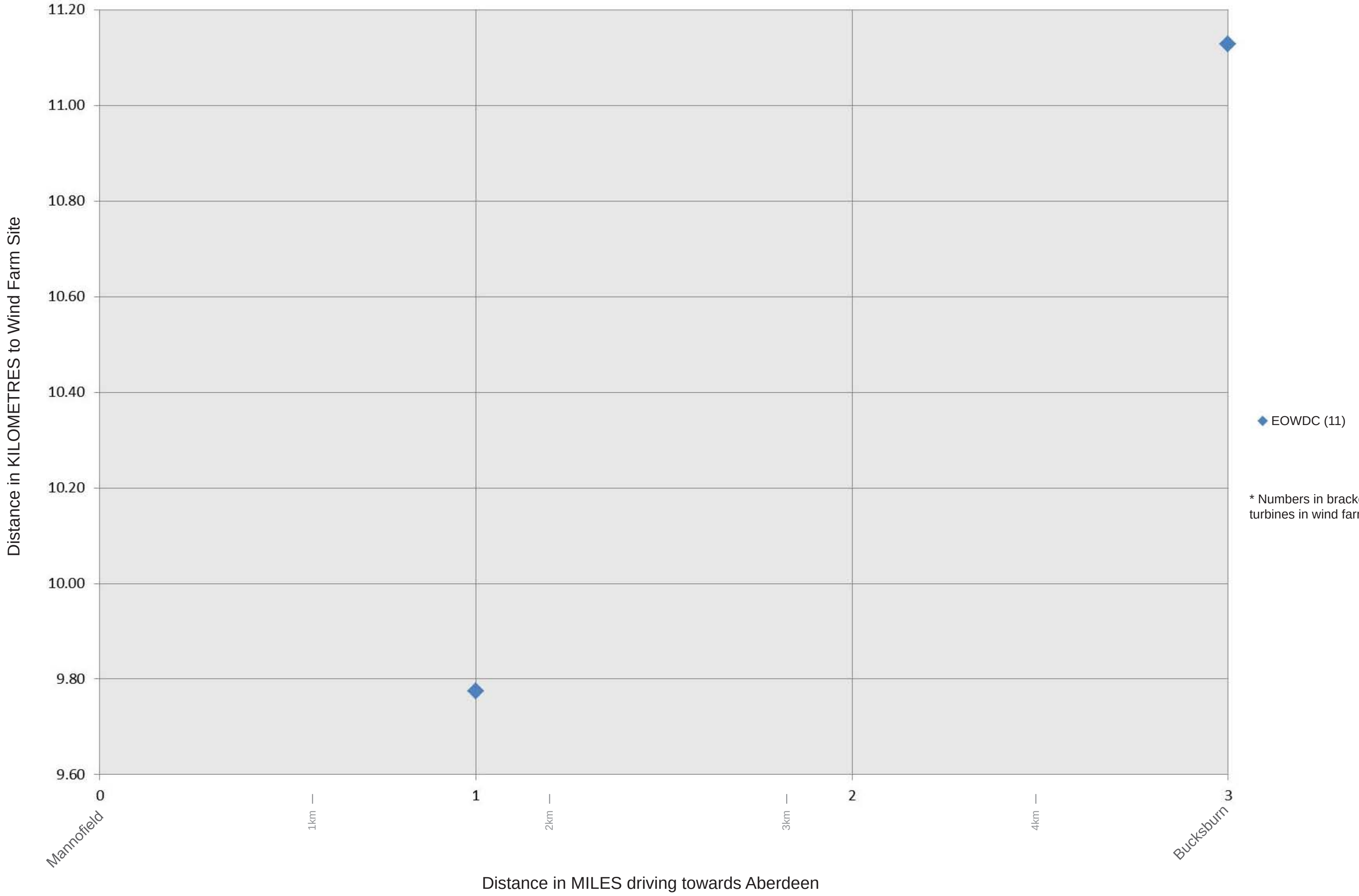


GRAPH 03

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

IN-PLANNING WIND FARMS

A90
Aberdeen Trunk Road



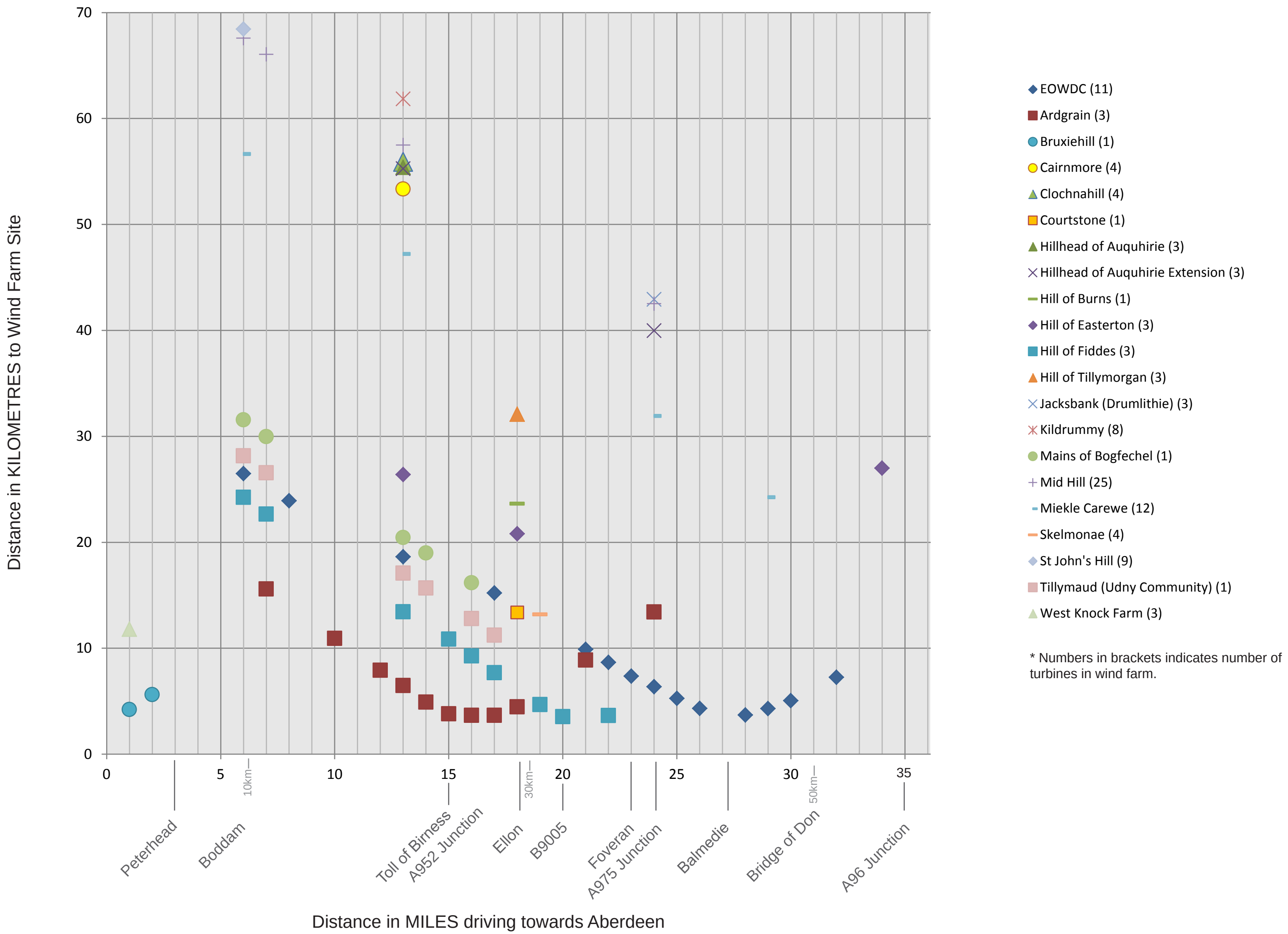
* Numbers in brackets indicates number of turbines in wind farm.

GRAPH 04

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

EXISTING AND CONSENTED WIND FARMS

A90N

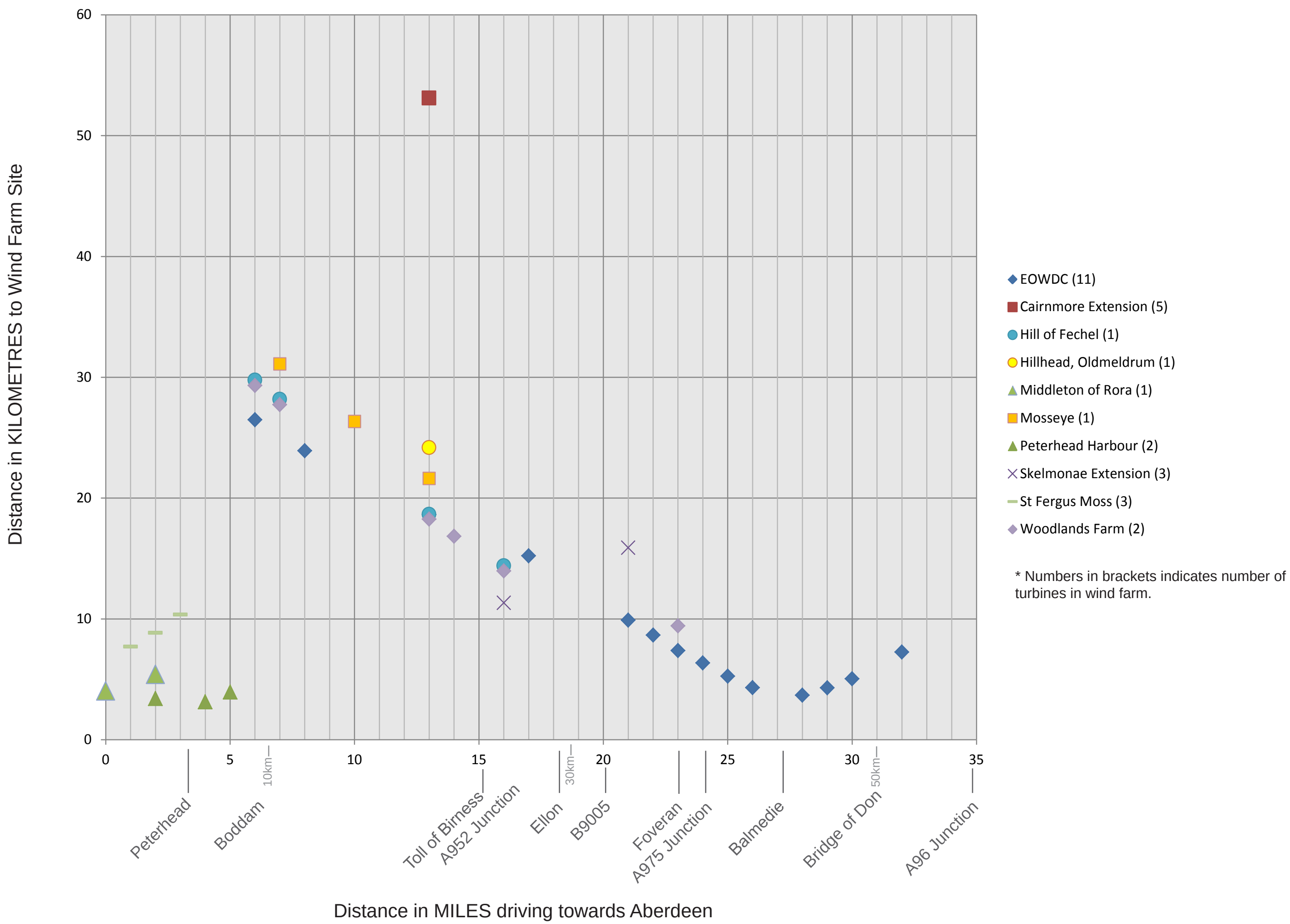


GRAPH 05

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

IN-PLANNING WIND FARMS

A90N

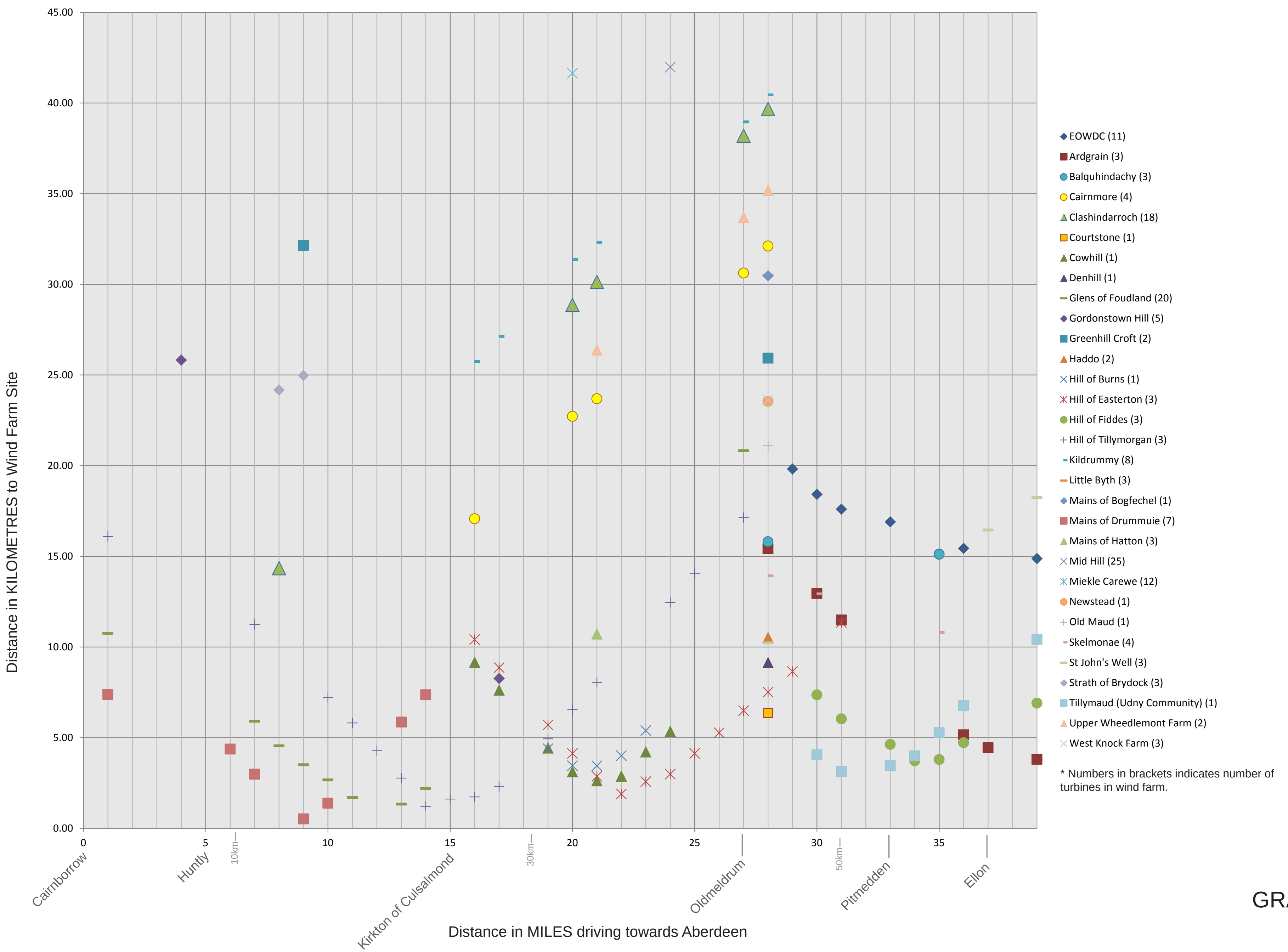


GRAPH 06

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

EXISTING AND CONSENTED WIND FARMS

A920

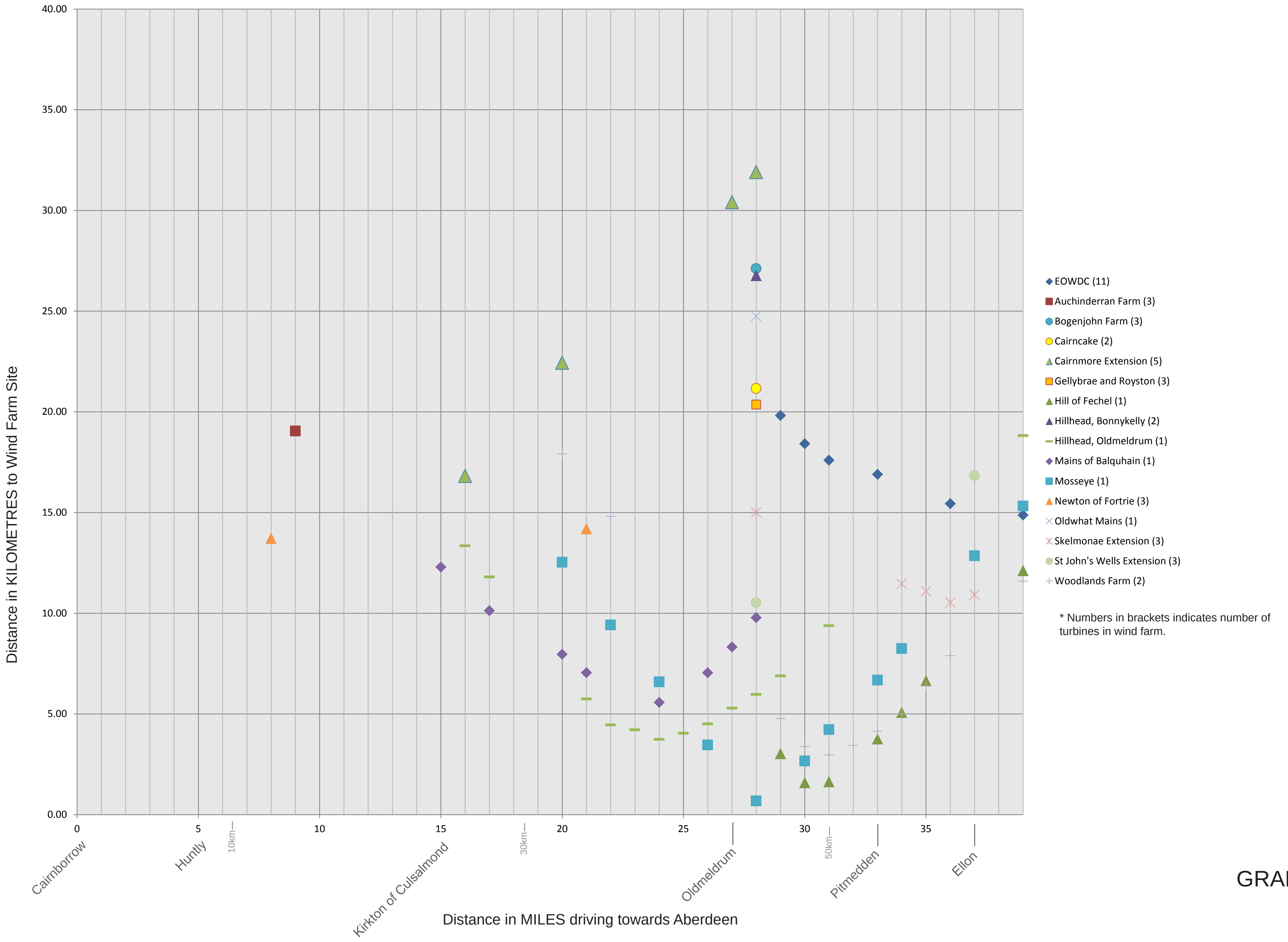


GRAPH 07

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

IN-PLANNING WIND FARMS

A920

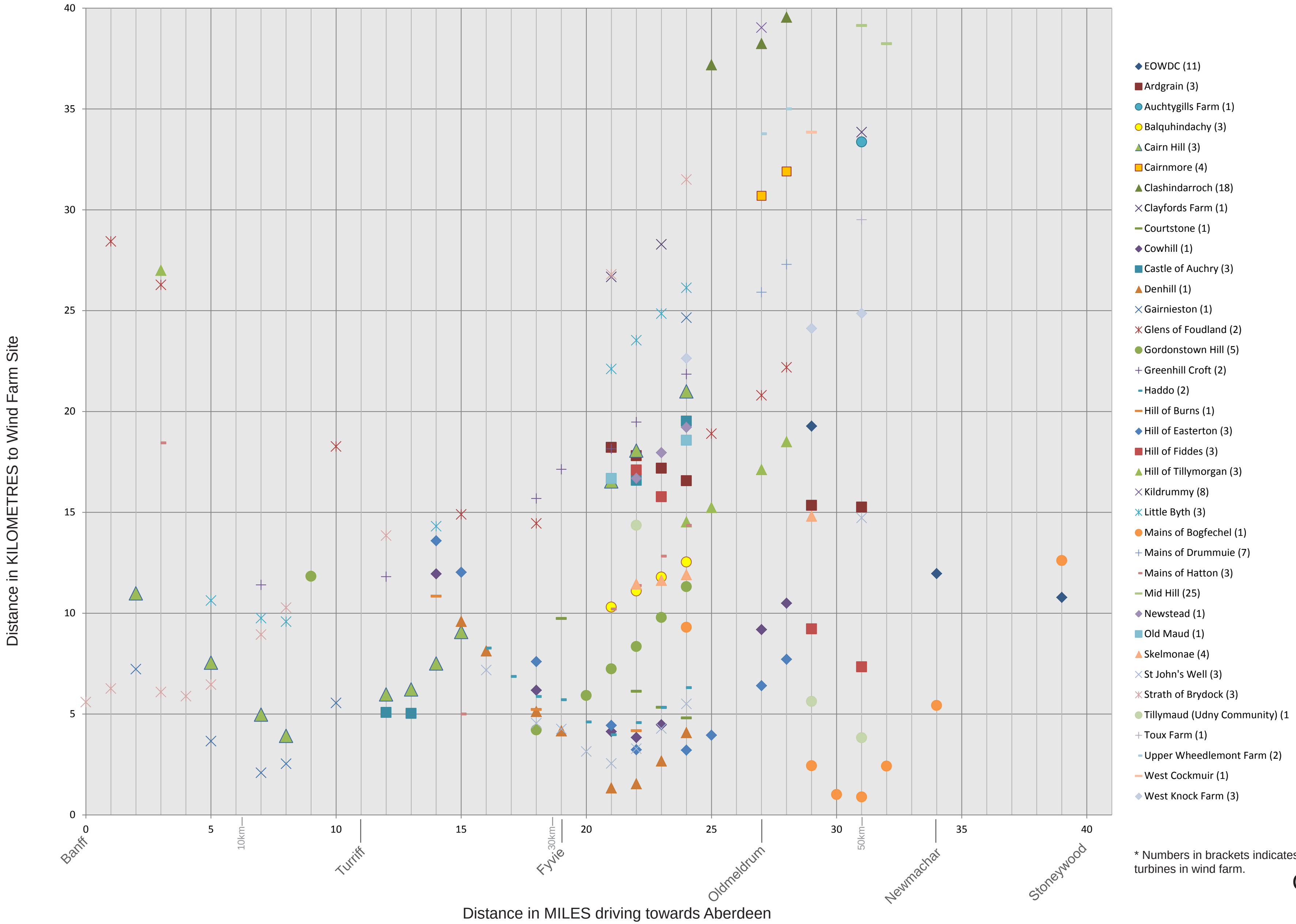


GRAPH 08

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

EXISTING AND CONSENTED WIND FARMS

A947



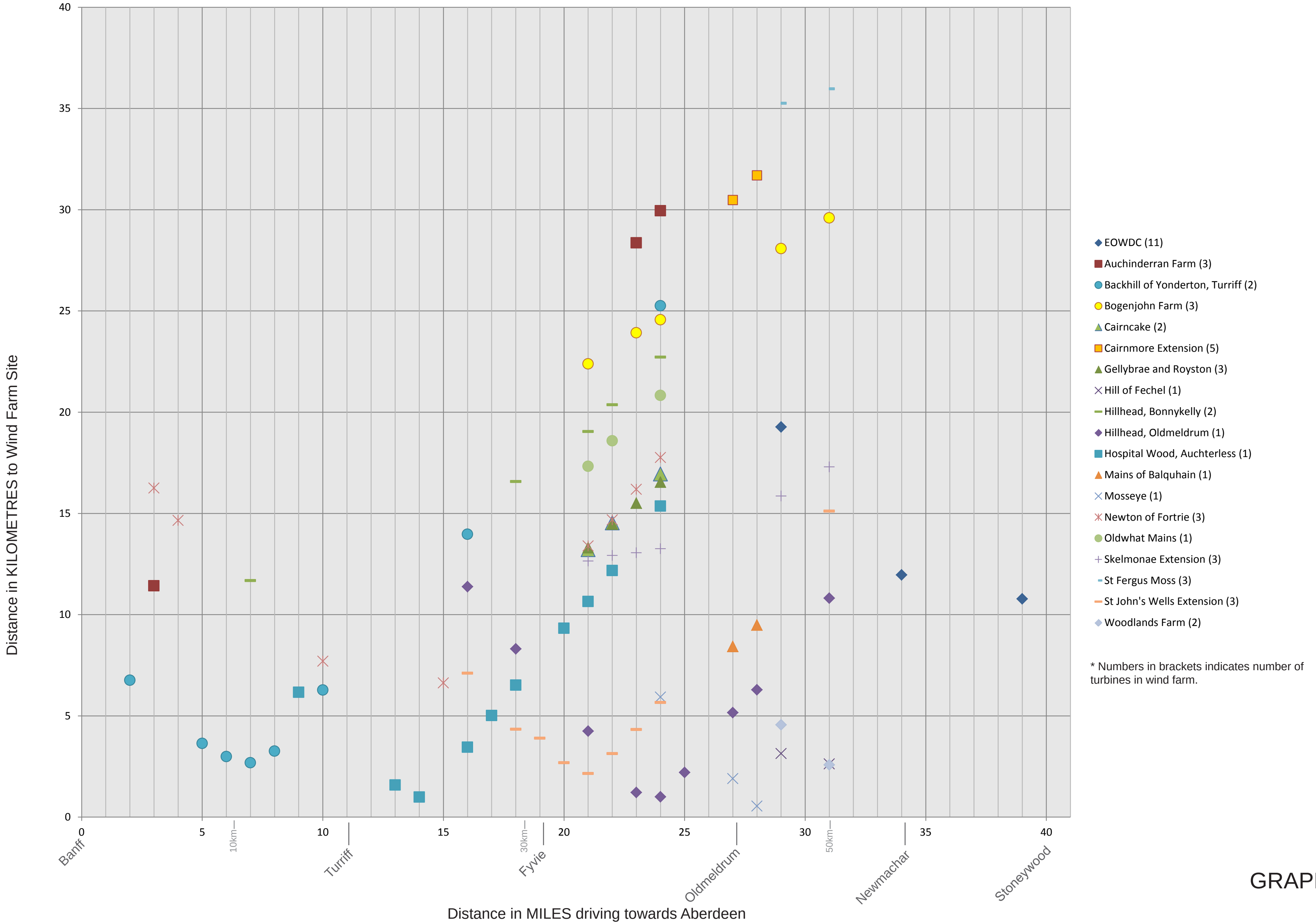
* Numbers in brackets indicates number of turbines in wind farm.

GRAPH 09

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

IN-PLANNING WIND FARMS

A947

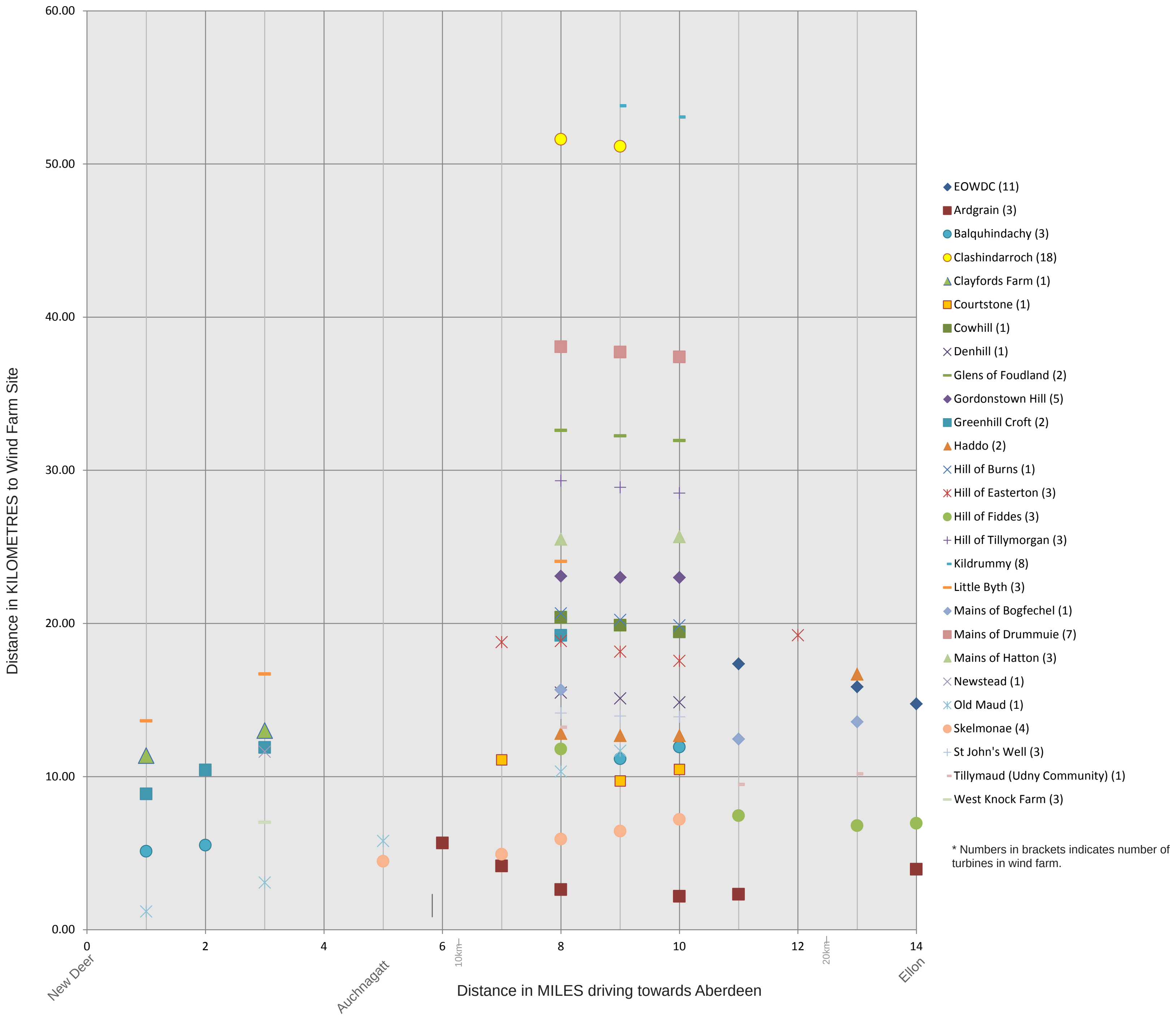


GRAPH 10

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

EXISTING AND CONSENTED WIND FARMS

A948

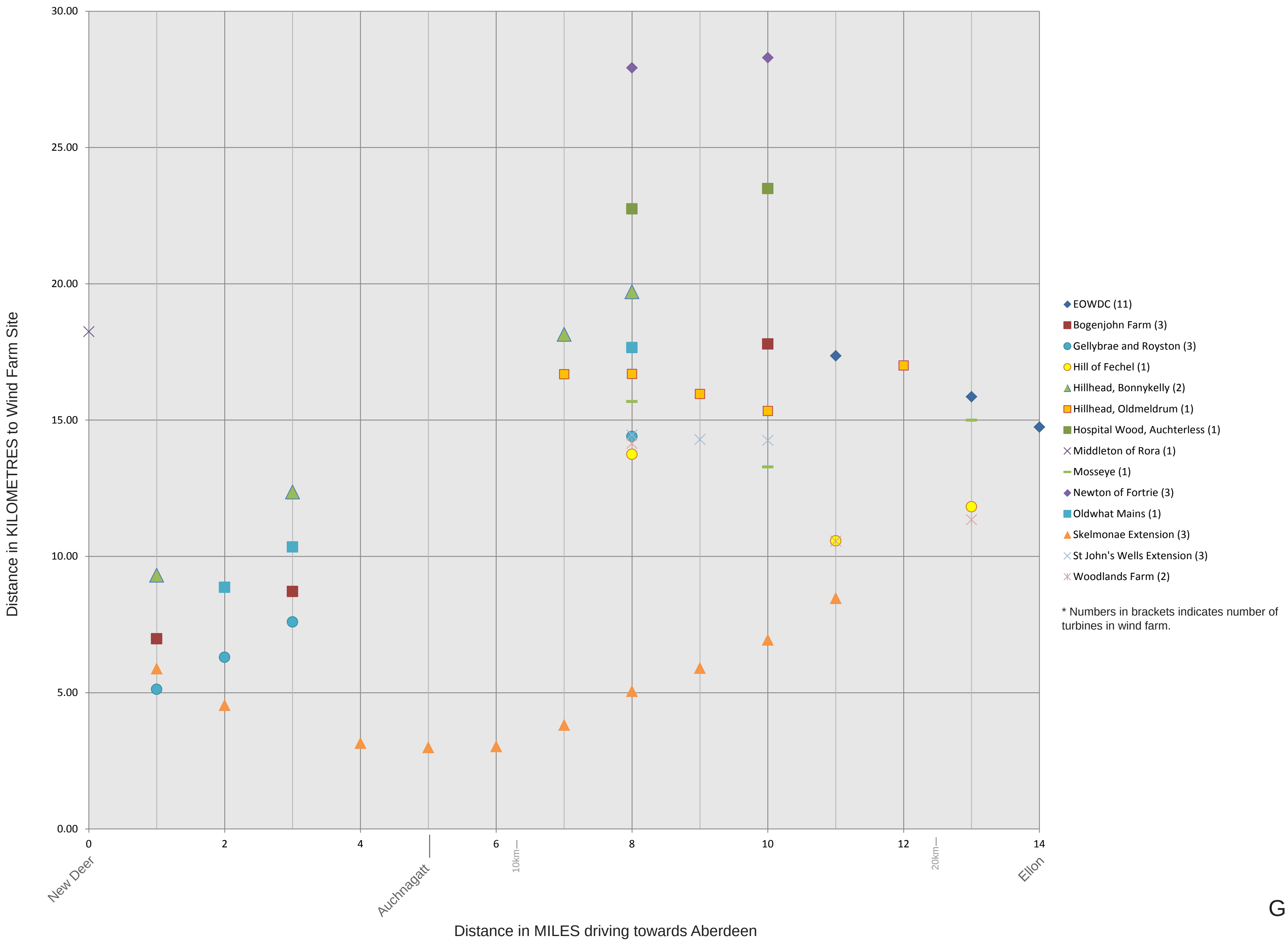


GRAPH 11

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

IN-PLANNING WIND FARMS

A948

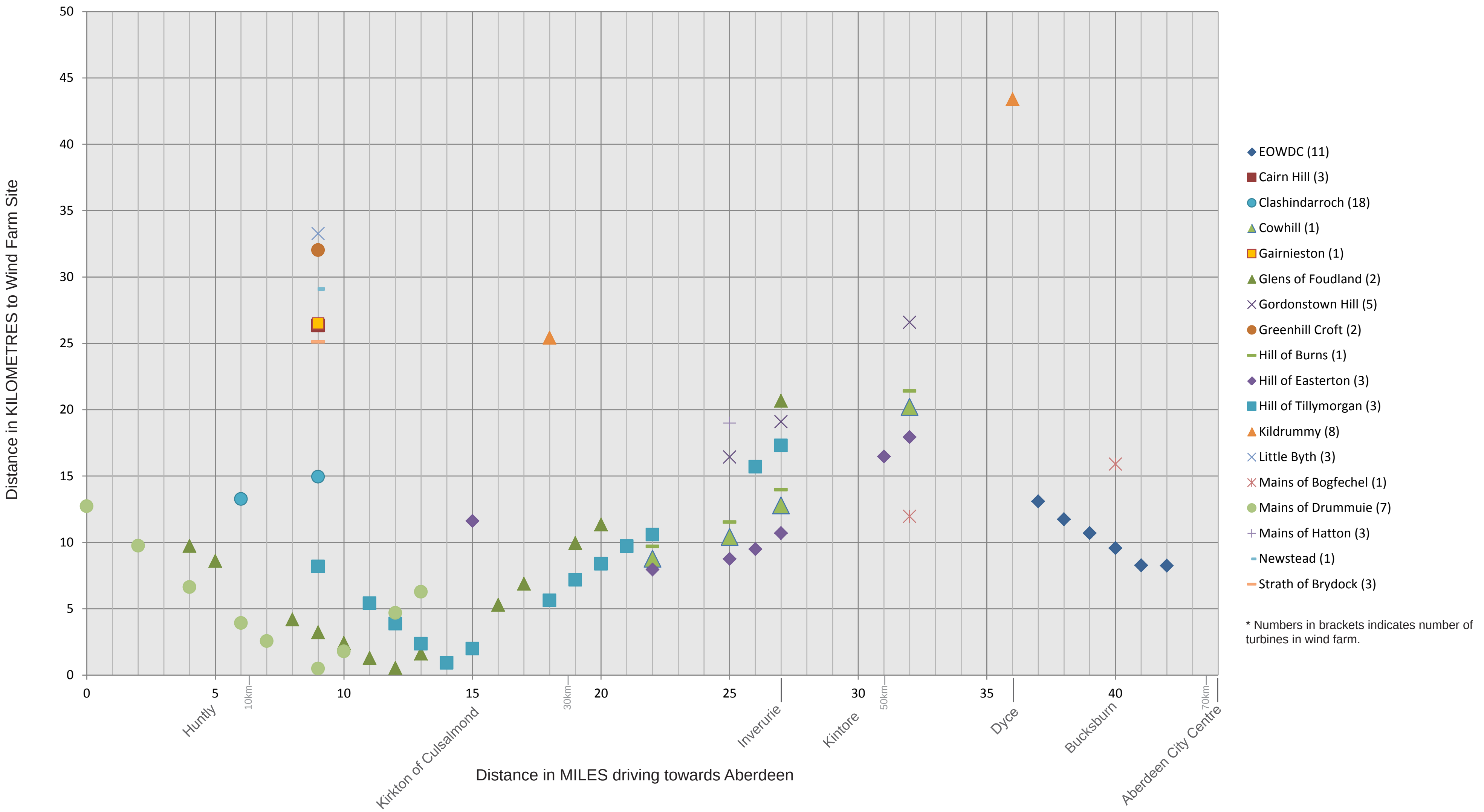


GRAPH 12

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

EXISTING AND CONSENTED WIND FARMS

A96

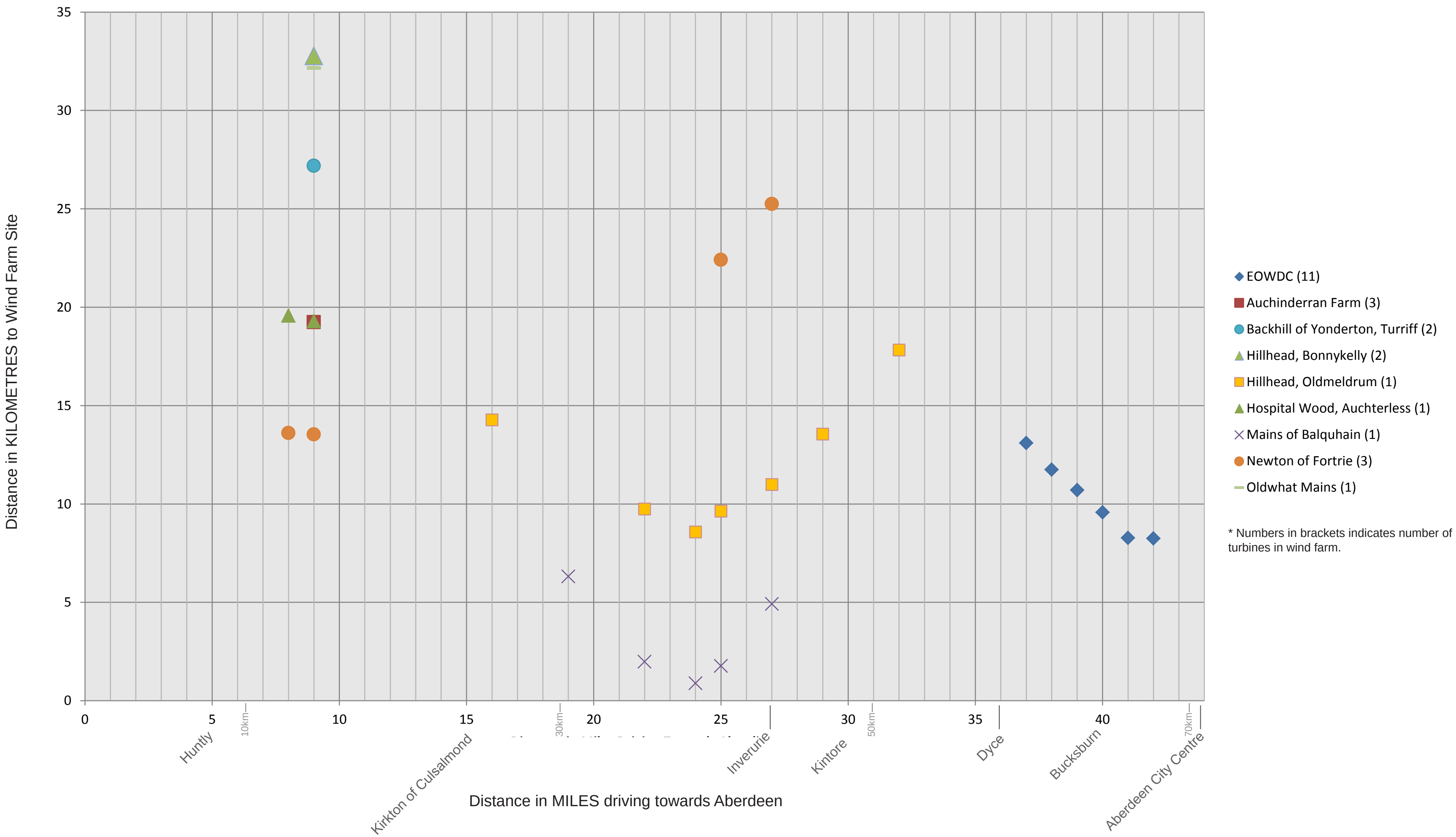


GRAPH 13

EOWDC - CUMULATIVE SEQUENTIAL ROAD ANALYSIS GRAPHS

IN-PLANNING WIND FARMS

A96



* Numbers in brackets indicates number of turbines in wind farm.

GRAPH 14

9.0 References

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European Offshore Wind Deployment Centre

Environmental Statement

Appendix 20.1: Cultural Heritage Baseline Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

1 CULTURAL HERITAGE ASSESSMENT

1.1 Information for the Non-Technical Summary

1 The cultural heritage baseline study initially gathered data regarding nationally important cultural heritage assets within 10 km of the European Offshore Wind Deployment Centre (EOWDC) and selected assets beyond this distance, by means of desk-based research and site visits. This data in conjunction with Zones of Theoretical Visibility (ZTVs) produced for the Seascape and Landscape Visual Impact Assessment (SLVIA) have been used to identify those assets that may be subject to setting impacts.

2 A wide range of cultural heritage assets is present in the study area, with asset types as diverse as prehistoric burial cairns, a medieval cathedral, 19^{th} century mills and 20^{th} century halls of residence present. This diversity reflects the long history of Aberdeen as a settlement and the intensive history of settlement in the fertile coastal strip of Aberdeenshire. Of the assets considered 14 have been identified as being potentially subject to setting impacts, all of these lie outside Aberdeen City. Assets within Aberdeen itself have been found to have no intervisibility with the EOWDC that could potentially result in setting impacts.

1.2 Introduction

3 The Cultural Heritage Setting Assessment considers the potential effect of the EOWDC upon the setting of onshore cultural heritage assets of national importance. This report details the results of the baseline study undertaken in order to identify onshore cultural heritage assets that may be subject to setting impacts.

4 The baseline report details the approach to data gathering and the results of consultation. It summarises relevant legislation, planning policy and guidance and identifies nationally important assets in the study areas. It then goes on to identify those assets where there is potential for impacts upon setting and their cultural significance. Detailed descriptions of setting and intervisibility are presented as part of the Cultural Heritage Environmental Impact Assessment (EIA) Technical Report.

1.2.1 Methodology Consultation

5 The following consultation was undertaken

- Aberdeen City Council

Aberdeen City Council was approached in order to establish whether they had specific concerns or requirements for data to be provided, in particular visualisations. Comments were also invited upon the proposed scope of the assessment.

Robert Forbes, The Planning Officer, indicated that he did have some concern regarding potential impacts upon the setting of Girdle Ness Lighthouse, and requested that visualisations from elevated points to the south and south-west of the lighthouse were provided in order to help assess the potential impact upon views of the lighthouse.

The potential impact upon the setting of the lighthouse has been assessed using wireframes and a site visit. The wireframes are presented within this report along with photographs illustrating various views of the lighthouse. However, photomontages (visualisations) have not been prepared. The wireframes give an adequate demonstration of the scale of the turbines in relation to the lighthouse in views from the south, whilst the photomontages for the Torry Battery and Kincorth Hill viewpoints (SLVIA Viewpoints 07 & 12 respectively) provide an indication of the EOWDC's appearance from the vicinity of the lighthouse and from high ground to its southwest. The inclusion of photomontages for Nigg Bay would not afford any substantive information that is not available from that presented here.

The Archaeology Unit indicated that all consultation was to be undertaken through the Planning Officer.

- Aberdeenshire Council Archaeology Service

Aberdeenshire Council Archaeology Service was approached in order to establish whether they had specific concerns or requirements for data to be provided, in particular visualisations. Comments were also invited upon the proposed scope of the assessment.

The Archaeology Service indicated that it had no concerns regarding potential setting impacts.

- Historic Scotland

Historic Scotland was approached in order to establish whether they had specific concerns or requirements for data to be provided, in particular visualisations. Comments were also invited upon the proposed scope of the assessment.

No specific concerns were noted. However, it was suggested that the assessment be accompanied by visualisations to illustrate the potential impact upon the setting of Straloch Garden and Designed Landscape (GDL), Hare Cairn and Forvie Chruch and deserted village, as well as those proposed for the Seascape, Landscape and Visual Impact Assessment (SLVIA) for south of Dunnottar Castle (A92 near Uras) and Torry Battery. It was suggested that assets in the vicinity of Straloch GDL, such as Tillygreig hut-circles (SM12450) be considered.

Visualisations have been included for Torry Battery (Viewpoint 07 of SLVIA) and from near Forvie Church (Viewpoint 09 of SLVIA). No visualisations have been presented for Straloch GDL or Dunnottar Castle, as there is no intervisibility, or Hare Cairn or Tillygrieg hut-circles, as there is no potential for a significant impact upon its setting from the EOWDC.

- Scottish Natural Heritage (SNH)

SNH was approached in order to establish whether they had specific concerns or requirements for data to be provided, in particular visualisations.

Comments were also invited upon the proposed scope of the assessment (e-mail dated 1st March 2011). SNH had indicated early in the project's lifespan that impacts upon the setting of cultural heritage assets should be considered by the Environmental Statement (ES).

SNH indicated that the proposed scope of the study was acceptable (e-mail dated 25th March 2011) and did not require any further visualisations.

1.2.2 Key Guidance Documents

6 The following guidance documents have been referred to:

- COWRIE (2007a) *Historic Environment Guidance for the Offshore Renewable Energy Sector*
- COWRIE (2007b) *Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy*
- Historic Scotland (2008) *Scottish Historic Environment Policy (SHEP)*
- Historic Scotland (2009) *Assessment of Impact upon the setting of the Historic Environment Resource*
- Historic Scotland (2010) *Managing Change in the Historic Environment: Setting*

1.2.3 Data Information and Sources

7 Two concentric study areas have been used to gather and present the baseline data:

- Inner study area (Environmental Statement (ES) Figures 20.1, 20.2 and 20.3): This extends 10 km from the outermost proposed turbines. Within it data has been gathered for all designated nationally important assets (scheduled monuments , Category A-listed buildings and Inventory Gardens and Designed Landscapes (GDL)) and conservation areas; and
- Outer study area: this extends 40 km from the proposed turbines to take in the area for which the Zone of Theoretical Visibility (ZTV) has been prepared for the SLVIA. Within it assets specifically identified by consultees as being of concern have been considered.

8 There is no guidance regarding appropriate study areas for cultural heritage setting impact assessments. The study area has been defined in order to take in those assets that are most likely to be affected by the proposed development. Assets further inshore are less likely to be affected as their setting is less likely to relate to the sea.

9 Data were gathered from the following data sources:

- Databases of designated assets held by Historic Scotland;
- National Monuments Record of Scotland (NMRS);
- Aberdeen City Council Sites and Monuments Record (SMR); and
- Aberdeenshire Council Historic Environment Record (HER)

10 Assets are referred to by the reference number associated by their designation. Scheduled monument numbers (officially 'Ancient Monument

Index Numbers') are prefixed 'SM' and numbers referring to listed buildings (officially 'Historic Building Numbers') are prefixed 'LB'. Where an asset is both scheduled and listed it is referred to by its scheduled monument number.

11 The results of the desk-based study were augmented by site visits undertaken on 8th and 9th March 2011.

1.3 Baseline Description

1.3.1 Scheduled Monuments in the Inner Study Area

12 There are 18 scheduled monuments in the inner study area. These are predominantly prehistoric in date, with cairns, settlement remains and standing stones present. However, amongst the schedulings are later assets, including medieval chapels, St Machar's cathedral and Torry Battery. These are summarised in Table 1 and their locations shown on ES Figure 20.1.

TABLE 1 Scheduled Monuments in the Inner Study Area

SM No	NAME
1907	Mote Hill, palisaded settlement and cairn
3275	The Temple Stones, stone circle NE of Potterton House
3277	Hare Cairn, cairn 600m W of Keir
3282	Bishops' Manor, manor house and chapel
3283	Dubford, standing stone 400m N of
4055	Tullos Cairn, cairn
4060	Crab's Cairn, cairn
4263	Lang Stane, standing stone, Hilton Drive
7124	Old Aberdeen Market Cross
7644	Forvie Church and deserted village (site of)
9215	Torry Battery, battery 130m ESE of Old South Breakwater
10400	St Fittick's Church, Aberdeen
10403	Balnagask motte, Baxter Place, Aberdeen
10424	Aberdeenshire Canal, remains of, Station Road, Woodside, Aberdeen
12433	Home Farm Cottage, cairn 325m N of
12452	Foucausie, hut circle 250m SSE of
12541	Sands of Forvie, hut circles and ring cairn 1020m E of East Cottage
90001	St Machar's Cathedral and graveyard

13 The schedulings are scattered throughout the inner study area, though most are located in Aberdeen or nearby (ES Figure 20.1). Six are within Aberdeen itself (SM 1907, 4263, 7124, 10403, 10424 & 90001), whilst four lie in open ground to the south-east (SM 4055, 4060, 9215 & 10400).

1.3.2 Category A-Listed Buildings in the Inner Study Area

14 There are 86 Category A-listed buildings within the inner study area, though there are only 62 individual listings, as several listings take in more than one building (Table 2, ES Figures 20.2 and 20.3). Of these 83 are within Aberdeen or its suburbs. Consequently, the buildings present are predominantly churches and eighteenth and nineteenth century townhouses and similar urban building types. However, also present are buildings that reflect Aberdeen's maritime and industrial heritage, with buildings such as the

Custom House (LB19982) and the Grandholm Works (LB18985) present. Also later dwellings have been listed, such as Rosemount Square (LB 20471), a block of local authority flats completed in 1948, and Crombie Halls, student accommodation completed in 1960.

15 Outside Aberdeen, there are three Category A-listed buildings. These are Girdle Ness Lighthouse (LB 20078), Orrok House (LB 2778) and the Turing Slab (LB 9166), a medieval stone in Foveran Parish Church.

TABLE 2 Listed Buildings in the Inner Study Area

Listed Building Number	Name
LB 2778	Orrok House
LB 9166	Foveran Parish Church Turing Slab
LB 18985	Grandholm Works, Old Spinning Mill, Wing Mill, Engine and Turbine Houses
LB 19937	Belmont Street, former St Nicholas Congregational Church
LB 19940	Schoolhill and Belmont Street, former Triple Kirks Churches, including Steeple and former East Free Church
LB 19941	Broad Street and Queen Street, Greyfriars John Knox Church
LB 19943	Kings College Chapel, College Bounds
LB 19946	33 King Street, Aberdeen Arts Centre
LB 19953	King Street, St Andrew's Cathedral (Episcopal)
LB 19957	St. Machar's Cathedral, Chanonry
LB 19961	Spital, St Margaret of Scotland Chapel and former Convent including 17 Spital
LB 19964	Carden Place at Albert Terrace, St Mary's Church (Episcopal), including gatepiers and boundary walls
LB 19966	Union Street, Back Wynd, Schoolhill and Correction Wynd, The Kirk of St Nicholas Uniting (Church of Scotland and United Reformed)
LB 19967	Union Street, 9 Back Wynd, Schoolhill and Correction Wynd, St Nicholas Churchyard, including boundary walls and gatepiers
LB 19977	Concert Hall, Advocates' Hall
LB 19978	Schoolhill and Blackfriars Street, Art Gallery including War Memorial and Cowdray Hall, Robert Gordon's College Archway and former Gray's School of Art
LB 19982	35 Regent Quay, Custom House
LB 19983	27,29,31 King Street, including Railings
LB 19990	Castle Street and 2 Broad Street, Town House, including Municipal Offices, Court Houses and Tolbooth
LB 19991	Union Street, South Silver Street and Golden Square, Music Hall
LB 19992	Old Aberdeen Town House, High Street, Old Aberdeen.
LB 19995	Aberdeen Royal Infirmary Woolmanhill
LB 19999	Castlegate, Mercat Cross
LB 20005	Elphinstone, Bishop, Memorial, King's College Grounds, College Bounds, Old Aberdeen.
LB 20065	Westburn Road and Argyll Place, Victoria Park, Fountain
LB 20067	Brig O' Balgownie over River Don
LB 20073	Wellington Suspension Bridge over River Dee, at Craiglug
LB 20078	Girdle Ness Lighthouse
LB 20082	Little Belmont Street, former Old Town's School
LB 20088	Schoolhill, Robert Gordon's College including North gates and

Listed Building Number	Name
	boundary walls
LB 20096	Broad Street, Marischal College
LB 20098	12 and 14 Devanha Gardens, Devanha House, including Piers and boundary walls
LB 20108	Westburn Road and Cornhill Road, Westburn Park, Westburn House, including Railings
LB 20156	Broad Street, Provost Skene's House, including Archway and South Building
LB 20162	5 Castle Street (former Clydesdale Bank)
LB 20174	53 Castle Street, Sheriff Court Annex and High Court of Justiciary (Formerly Bank of Scotland)
LB 20186	Chanonry, 9 (West Side) Mitchell Hospital Old Aberdeen
LB 20186	Chanonry, 9 (West Side) Mitchell Hospital Old Aberdeen
LB 20288	Don Street, 20, 22 (East Side) Bede House, Old Aberdeen.
LB 20299	Don Street, (N.W. Side) "The Chapter House" "Cruickshanks Lodgings"
LB 20331	1 Great Northern Road, The Northern Hotel
LB 20333	Guild Street and 1 Trinity Street, Tivoli Theatre
LB 20334	62, 62a and 62b Hamilton Place at Whitehall Road, including gatepiers and boundary walls
LB 20335	64, 64a, 66, 66a and 66b Hamilton Place, including gatepiers and boundary walls
LB 20336	68, 68a and 70 Hamilton Place, including gatepiers and boundary walls
LB 20337	72 Hamilton Place, including gatepiers, boundary walls and Provosts Lamps
LB 20338	74 and 76 Hamilton Place, including gatepiers and boundary walls
LB 20339	78 and 80 Hamilton Place, including gatepiers and boundary walls
LB 20340	82, 82a and 84 Hamilton Place, including gatepiers and boundary walls
LB 20341	86, 86a, 88 and 88a Hamilton Place, including gatepiers and boundary walls
LB 20342	90 and 92 Hamilton Place, including gatepiers and boundary walls
LB 20343	94, 94a and 96 Hamilton Place, including gatepiers and boundary walls
LB 20360	High Street, 81 (West Side) Old Aberdeen.
LB 20374	High Street, 96 (East Side) Old Aberdeen
LB 20471	1-13 (Inclusive Numbers) Rosemount Square, at Leadside Road, South Mount Street, Richmond Street and Kintore Place
LB 20484	48 and 50 Shiprow (including former House of Provost Ross)
LB 20573	Union Terrace, 1, 2, 3 and 146 Union Street
LB 20605	Rosemount Viaduct, His Majesty's Theatre
LB 20628	79 Hamilton Place at Blenheim Place, including gates, gatepiers and boundary walls
LB 20629	98 Hamilton Place at Fountainhall Road, including gatepiers and boundary walls
LB 20673	Guild Street Aberdeen Railway Station and road over bridge
LB 43908	Maberly Street, Broadford Works With Returns To Ann Street and Hutcheon Street
LB 50016	Crombie Halls of Residence, Meston Walk

1.3.3 Gardens and Designed Landscapes in the Inner Study Area

16 There are no gardens or designed landscapes appearing in the Inventory in the inner study area (ES Figure 20.4).

1.3.4 Conservation Areas in the Inner Study Area

17 There are ten conservation areas in the inner study area. All but one of these is located within Aberdeen (ES Figure 20.4). They vary greatly in character, including areas as diverse as Old Aberdeen, Union Street and Fortdee. The exception is Kingseat Hospital, this was built in 1904 and was the first village hospital in Britain, taking in 'pauper lunatics' from Aberdeen. The following conservation areas lie within the inner study area:

- Kingseat Hospital
- Albyn Place/Rubislaw
- Bon-Accord Crescent/Crown St.
- Ferryhill
- Footdee
- Great Western Road
- Marine Terrace
- Old Aberdeen / Balgownie
- Union Street
- Rosemount/Westburn

1.3.5 Assets Considered in the Outer Study Area

18 Six assets in the outer study area have been considered; Straloch GDL (ES Figure 20.4), a 19th century park appearing in the Inventory of Gardens and Designed Landscapes, Tillygreig hut-circles (ES Figure 20.1, SM 12450) Dunnottar Castle (ES Figure 20.1, SM 986), which is scheduled and Category A-listed and three scheduled cairns to the south of Aberdeen (ES Figure 20.1, SM 4125, SM 4126 & SM 12342). The first three have been included as they were raised in Historic Scotland's response to the Request for Scoping Opinion, whilst the last have been included because of their location near the summit of a hill immediately outside the inner study area.

19 Other designated parks and gardens in the outer study area have been considered but the ZTV indicates that these will have no substantive intervisibility with the EOWDC and hence are not considered further.

1.3.6 Assets that May be Subject to Setting Impacts

20 Assets that may be subject to setting impacts have been identified by way of desk-based research and site visits. Given the distance of the proposed EOWDC from the shore, approximately 2 km, potential setting impacts are restricted to those that may result from visual change. Therefore the Zone of Theoretical Visibility (ZTV) generated for the SLVIA has been used in order to help identify assets where the wind turbines will be visible or, where relevant, views of assets that will be affected, within a distance of 40 km from the proposed turbines. A version of the ZTV, based on a Digital Surface Model (DSM), has been used, which takes into account obstructions such as buildings. The assets that may potentially be affected by the proposed

EOWDC are detailed below. The assets are considered from north to south in the following order: scheduled monuments, listed buildings, conservation areas and GDLs.

21 Forvie Church and deserted village (ES Figure 20.1, SM7644) comprise the remains of a medieval church and village buried by sand dunes. The church and adjacent huts were excavated and left exposed by archaeologists in the 1950s, but most of the village remains covered by sand dunes. The buried remains have exceptional potential in terms of their value as a source of data regarding medieval society, economy and material culture as they have been unaffected by later development or farming. The cultural significance of the site resides in its potential as a data source. The asset is surrounded by the Sands of Forvie, an extensive sand dune system, and lies some 300 m from the shoreline. The proposed EOWDC turbines will be visible from the church at a distance of 10 km.

22 To the west of Forvie Church, lie a scheduled ring cairn and hut-circles (ES Figure 20.1, SM12541), some 800 m from the shoreline. Only two of the 19 hut-circles recorded in 1950 are now visible, the remainder having been covered by sand-dunes. As with the medieval site, there is potential for exceptional preservation and the site therefore has great potential as a data source and its cultural significance resides in this potential. The proposed EOWDC will be visible to the south, at a distance of 9.8 km.

23 Tillygrieg hut-circles (ES Figure 20.1, SM12450) comprise the scheduled upstanding remains of two Late Bronze Age or Iron Age date. They are located near the top of a gentle east-facing slope and are surrounded by farmland. They are unusually well-preserved for this part of Aberdeenshire and have potential to yield information regarding settlement history and economy. The upstanding remains are slight and no more than 0.3 m in height, as such they are not visible in the wider landscape. The proposed EOWDC turbines will be partially visible to the south-east of the hut-circles, at a distance of 13.9 km.

24 Hare Cairn (ES Figure 20.1, SM3277) is a Bronze Age burial cairn located on the top of a small hillock. The surrounding field is given over to pasture. It has been partially excavated, but survives as an appreciable mound with exposed kerb. Despite the disturbance it has potential to yield data regarding Bronze Age burial practices. The cairn's cultural significance resides in its value as a potential data source and in its potential to provide a tangible link to the past. The proposed EOWDC turbines will be fully visible to the south-east of the cairn, at a distance of 4.8 km.

25 The Temple Stones (ES Figure 20.1, SM3275) comprises the remains of a recumbent stone circle. It is located on the shoulder of a hill, overlooking the Milden Burn to the south. Many of the stones have been removed and only the recumbent stone remains in situ, the pillar stones are present but have fallen over. Of the rest of the stone circle only one stone remains. The recumbent stone lies at the south-west of the monument. Stones cleared from the surrounding field have been dumped behind the recumbent stone. Despite its fragmentary survival there is potential for subsurface features to yield information regarding the construction and history of use of the stone circle and, by extension, contemporary ritual practices and its cultural significance resides in this potential. The proposed EOWDC turbines will be visible to the east at a distance of 4.3 km.

26 Dubford Stone (ES Figure 20.1, SM3283) is a single standing stone, which is thought to be the final remnant of a recumbent stone circle. The stone is located in an improved pasture field on a natural shelf. Despite its fragmentary survival there is potential for subsurface features to yield information regarding the construction and history of use of the stone circle and, by extension, contemporary ritual practices and its cultural significance resides primarily in this potential. The proposed EOWDC will be fully visible to the east at a distance of 5.5 km.

27 Torry Battery (ES Figure 20.1, SM9215) comprises the remains of a coastal battery built in the mid-19th century to protect the entrance to Aberdeen Harbour and control Aberdeen Bay. It was manned during both World Wars and also saw use as temporary housing for civilians in the 1930s, who had become homeless as a result of the economic crisis. The battery's cultural significance resides in importance as tangible link to the past, providing visible evidence of Britain's response to external threat, Aberdeen's importance as a port and of historic military tactical thinking. Its role as civilian housing adds further to this, as the battery provides a link to the results of the economic crisis of the 1930s. The proposed EOWDC will be fully visible to the north-east of the Battery at a distance of 7.9 km

28 To the south of Aberdeen is a ridge. Located on the higher parts of this are five scheduled Bronze Age burial cairns (ES Figure 20.1). Two of these, Tullos cairn (SM4055) and Crab's cairn (SM4060) lie within the inner study area. Immediately outside the study area lies Baron's cairn (SM4126), while further southwest are Cat Cairn (SM4125) and Loirston cairn (SM12342). These survive as substantial mounds and are surrounded by unimproved grassland and gorse. The cairns' cultural significance relates to their potential as sources of data regarding contemporary burial practice and their potential as a tangible link to the past, as the visitor will appreciate to some degree the relationship of the cairns to the landscape that they overlook and the inter-relationship between the various cairns, which is indicative of the surrounding area having been intensively occupied in the Bronze Age. The proposed EOWDC turbines will be fully visible to the north of the cairns at a distance of at least 9.6 km.

29 Orrok House (LB2778) is a country house built between 1770 and 1782. The house is surrounded by its wooded policies, which have been laid out in order to retain an open aspect to the south, and is approached by way of a short driveway from the north. The house is located on a gentle south-facing slope and its policies are surrounded by arable fields. The house's cultural significance relates to its architectural quality and its completeness as a late 18th century house with policies. The proposed turbines will be fully visible from the area of the house at a distance of 5.6 km. They will be located to the south-east of the house.

30 Girdle Ness Lighthouse (LB20078) was designed by Robert Stevenson and built in1833. It was fitted with a new double light system and in 1860 was described by the Astronomer Royal as 'the best lighthouse that I have seen'. The lighthouse stands at the eastern end of Girdle Ness, between Greyhope Bay and Nigg Bay. The lighthouse's cultural significance rests in its technological importance, its direct relationship with the Stevenson family and hence the development of Scottish lighthouses. However, it also has aesthetic value as a prominent landmark, isolated on the headland. The

proposed turbines will be fully visible to the north-east of the lighthouse at a distance of 7.9 km.

1.3.7 Assets with No Potential for Setting Impacts

31 Following desk-based study and site visits, it is considered that there is no potential for impacts upon the setting of the assets detailed below. Reference to the ZTV and site visits has established that the proposed EOWDC will not be visible from the assets listed in Table 3, below nor will views from a third location relevant to the setting of these assets be affected.

Table 3 Assets with No Potential for Setting Impacts

Reference number	**Name**
-	Kingseat Hospital conservation area
-	Albyn Place/Rubislaw conservation area
-	Bon-Accord Crescent/Crown St. conservation area
-	Ferryhill conservation area
-	Footdee conservation area
-	Great Western Road conservation area
-	Marine Terrace conservation area
-	Old Aberdeen / Balgownie conservation area
-	Union Street conservation area
-	Rosemount/Westburn conservation area
GDL346	Straloch
SM986	Dunnottar Castle
SM1907	Mote Hill, palisaded settlement and cairn
SM3282	Bishops' Manor, manor house and chapel
SM4263	Lang Stane, standing stone, Hilton Drive
SM7124	Old Aberdeen Market Cross
SM10400	St Fittick's Church, Aberdeen
SM10403	Balnagask Motte
SM10424	Aberdeenshire Canal, remains of, Station Road, Woodside, Aberdeen
SM12433	Home Farm Cottage, cairn 325m N of
SM12452	Foucausie, hut circle 250m SSE of

Reference number	Name
SM90001	St Machar's Cathedral and graveyard
LB18985	Grandholm Works, Old Spinning Mill, Wing Mill, Engine and Turbine Houses
LB19937	Belmont Street, former St Nicholas Congregational Church
LB19940	Schoolhill and Belmont Street, former Triple Kirks Churches, including Steeple and former East Free Church
LB19941	Broad Street and Queen Street, Greyfriars John Knox Church
LB19943	Kings College Chapel, College Bounds
LB19946	33 King Street, Aberdeen Arts Centre
LB19953	King Street, St Andrew's Cathedral (Episcopal)
LB19957	St. Machar's Cathedral, Chanonry
LB19961	Spital, St Margaret of Scotland Chapel and former Convent including 17 Spital
LB19964	Carden Place at Albert Terrace, St Mary's Church (Episcopal), including gatepiers and boundary walls
LB19966	Union Street, Back Wynd, Schoolhill and Correction Wynd, The Kirk of St Nicholas Uniting (Church of Scotland and United Reformed)
LB19967	Union Street, 9 Back Wynd, Schoolhill and Correction Wynd, St Nicholas Churchyard, including boundary walls and gatepiers
LB19977	Concert Hall, Advocates' Hall
LB19978	Schoolhill and Blackfriars Street, Art Gallery including War Memorial and Cowdray Hall, Robert Gordon's College Archway and former Gray's School of Art
LB19982	35 Regent Quay, Custom House
LB19983	27,29,31 King Street, including Railings
LB19990	Castle Street and 2 Broad Street, Town House, including Municipal Offices, Court Houses and Tolbooth
LB19991	Union Street, South Silver Street and Golden Square, Music Hall
LB19992	Old Aberdeen Town House, High Street, Old Aberdeen.
LB19995	Aberdeen Royal Infirmary Woolmanhill
LB19999	Castlegate, Mercat Cross
LB20005	Elphinstone, Bishop, Memorial, King's College Grounds, College Bounds, Old Aberdeen
LB20065	Westburn Road and Argyll Place, Victoria Park, Fountain
LB20067	Brig O' Balgownie over River Don
LB20073	Wellington Suspension Bridge over River Dee, at Craiglug
LB20082	Little Belmont Street, former Old Town's School
LB20088	Schoolhill, Robert Gordon's College including North gates and boundary walls
LB20096	Broad Street, Marischal College
LB20098	12 and 14 Devanha Gardens, Devanha House, including Piers and boundary walls
LB20108	Westburn Road and Cornhill Road, Westburn Park, Westburn House, including Railings
LB20156	Broad Street, Provost Skene's House, including Archway and South Building
LB20162	5 Castle Street (former Clydesdale Bank)
LB20174	53 Castle Street, Sheriff Court Annex and High Court of Justiciary (Formerly Bank of Scotland)
LB20186	Chanonry, 9 (West Side) Mitchell Hospital Old Aberdeen
LB20186	Chanonry, 9 (West Side) Mitchell Hospital Old Aberdeen

Reference number	Name
LB20288	Don Street, 20, 22 (East Side) Bede House, Old Aberdeen
LB20299	Don Street, (N.W. Side) "The Chapter House" "Cruickshanks Lodgings"
LB20331	1 Great Northern Road, The Northern Hotel
LB20333	Guild Street and 1 Trinity Street, Tivoli Theatre
LB20334	62, 62a and 62b Hamilton Place at Whitehall Road, including gatepiers and boundary walls
LB20335	64, 64a, 66, 66a and 66b Hamilton Place, including gatepiers and boundary walls
LB20336	68, 68a and 70 Hamilton Place, including gatepiers and boundary walls
LB20337	72 Hamilton Place, including gatepiers, boundary walls and Provosts Lamps
LB20338	74 and 76 Hamilton Place, including gatepiers and boundary walls
LB20339	78 and 80 Hamilton Place, including gatepiers and boundary walls
LB20340	82, 82a and 84 Hamilton Place, including gatepiers and boundary walls
LB20341	86, 86a, 88 and 88a Hamilton Place, including gatepiers and boundary walls
LB20342	90 and 92 Hamilton Place, including gatepiers and boundary walls
LB20343	94, 94a and 96 Hamilton Place, including gatepiers and boundary walls
LB20360	High Street, 81 (West Side) Old Aberdeen
LB20374	High Street, 96 (East Side) Old Aberdeen
LB20471	1-13 (Inclusive Numbers) Rosemount Square, at Leadside Road, South Mount Street, Richmond Street and Kintore Place
LB20484	48 and 50 Shiprow (including former House of Provost Ross)
LB20573	Union Terrace, 1, 2, 3 and 146 Union Street
LB20605	Rosemount Viaduct, His Majesty's Theatre
LB20628	79 Hamilton Place at Blenheim Place, including gates, gatepiers and boundary walls
LB20629	98 Hamilton Place at Fountainhall Road, including gatepiers and boundary walls
LB20673	Guild Street Aberdeen Railway Station and road over bridge
LB43908	Maberly Street, Broadford Works With Returns To Ann Street and Hutcheon Street
LB50016	Crombie Halls of Residence, Meston Walk
LB9166	Foveran Parish Church Turing Slab

1.4 Summary

The baseline study has sought to identify nationally important onshore cultural heritage assets that may be subject to setting impacts resulting from the proposed EOWDC. The study utilised desk-based research and site visits to establish baseline conditions and identify those assets from which the proposed EOWDC will be visible or where the proposed EOWDC would be visible in views relevant to the appreciation of the asset’s setting. Fourteen such assets were identified and have been carried through to impact assessment. These comprise a diverse range of scheduled monuments and listed buildings, including prehistoric burial cairns and standing stones, a late 18th century house and a coastal battery and lighthouse dating to the 19th century.

1.5 GAZETTEER OF SCHEDULED MONUMENTS & LISTED BUILDINGS

Ref. No.	Name	Description	Status	NGR
SM 1907	Mote Hill, palisaded settlement and cairn	Conical mound located in Seaton Park in Aberdeen. Excavation has revealed this not to be a motte but remains of an Iron Age enclosed settlement	Scheduled Monument	393664, 808866
SM 3275	The Temple Stones, stone circle NE of Potterton House	Recumbent stone circle - though the flankers to the recumbent stone have fallen. Several of the stones bear cup-marks	Scheduled Monument	395290, 816360
SM 3277	Hare Cairn, cairn 600m W of Keir	Flat topped cairn which has seen some past disturbance enclosed by a modern dyke	Scheduled Monument	395523, 817652
SM 3282	Bishops' Manor, manor house and chapel	Remains of a manor complex which survive as the turf covered wall footings of at least 3 buildings	Scheduled Monument	391168, 814284
SM 3283	Dubford, standing stone 400m N of	Standing stone c 1.85m high, located in field. The stone fell in 1993 and was re-erected in May 1993	Scheduled Monument	394005, 813098
SM 4055	Tullos Cairn, cairn	Remains of a massive burial cairn 20m in diam and stands 2m high (another 3 cairns are located in the close vicinity indicating it may be part of a relict prehistoric funerary landscape)	Scheduled Monument	395902, 804103
SM 4060	Crab's Cairn, cairn	Circular burial cairn, 14m in diam. Damaged by wartime installations. A short cist containing an urn was found in the cairn in the late 18th century (another 3 cairns are located in the close vicinity indicating it may be part of a relict prehistoric funer	Scheduled Monument	396325, 803750
SM 4263	Lang Stane, standing stone, Hilton Drive	Substantial standing stone c3m high, prob Neolithic or BA date (major local landmark)	Scheduled Monument	392236, 808358
SM 7124	Old Aberdeen Market Cross	Market cross of Old Aberdeen - formerly stood in front of the Town House at the north end of High Street - moved but now returned to its original position. The only original part of this cross is the Knop with four coats of arms of Bishop Gavin Dunbar surmounted by (the remains of) crouching beasts which dates to the 16th century the rest of the cross	Scheduled Monument	393914, 808469

Ref. No.	Name	Description	Status	NGR
SM 7644	Forvie Church and deserted village (site of)	The remains of a 12th century church which became ruinous by the 15th century and a nearby medieval settlement of square huts. This site was partially excavated in 1953	Scheduled Monument	402033, 826594
SM 9215	Torry Battery, battery 130m ESE of Old South Breakwater	Remains of a military battery built between 1857-61. It later served as a training ground and staffed throughout WWI & WWII. The extant remains include the perimeter wall, the gateway and the guardhouse	Scheduled Monument	396543, 805631
SM 10400	St Fittick's Church, Aberdeen	Former parish church and its graveyard founded between 1189 and 1199. The building was reconstructed and enlarged in the 18th century before being abandoned in 1829	Scheduled Monument	396274, 804964
SM 10403	Balnagask motte, Baxter Place, Aberdeen	Medieval motte visible as a substantial grass covered mound, located in a modern housing estate. This motte would have originally held a prominent position overlooking the Dee Estuary and Nigg Bay but now enclosed by the SE outskirts of Aberdeen	Scheduled Monument	395743, 805110
SM 10424	Aberdeenshire Canal, remains of, Station Road, Woodside, Aberdeen	Remains of a section the Aberdeenshire Canal and a bridge, visible as an earthwork and an upstanding structure respectively. Well preserved - drained section of drained canal located within a grass covered playing field	Scheduled Monument	392249, 809025
SM 12433	Home Farm Cottage, cairn 325m N of	A stoney mound built on top of a natural knoll this is the remains of a probable neolithic or Bronze Age cairn. It has been slightly clipped by the modern road to its east	Scheduled Monument	394703, 816514
SM 12450	4 Tillygreig Cottages, hut circles 540m and 570m W of	The remains of two hut circles of late Bronze-Age or Iron-Age date. They are visible as two low, grass-covered penannular stony banks lying on a gentle east facing slope, at 170 m above sea level	Scheduled Monument	388100, 822500
SM 12452	Foucausie, hut circle 250m SSE of	Hut circle visible as a low scrub and tree covered pennanular stoney bank	Scheduled Monument	390778, 811903
SM 12541	Sands of Forvie, hut circles and ring cairn 1020m E of East Cottage	A complex of prehistoric remains including 2 Late bronze Age or Iron Age hut circles and a Bronze Age ring cairn	Scheduled Monument	401061, 826334

Ref. No.	Name	Description	Status	NGR
SM 90001	St Machar's Cathedral and graveyard	The parts of this cathedral that are not in ecclesiastical use as the parish church are scheduled. This includes the ground underlying the whole of the Cathedral and the surrounding graveyard. The first cathedral on this site was begun c1130-1165	Scheduled Monument	393915, 808761
LB 2778	Orrok (Or Orrock) House	1781-2 3 storey gabled main block with single storey roofed wings of same depth	Category A Listed Building	396401, 819560
LB 9166	Foveran Parish Church Turing Slab	Medieval stone bearing two incised armoured figures (cf Kinkell, qv) beneath a canopy. Located within Foveran Parish Church	Category A Listed Building	398494, 824141
LB 18985	Grandholm Works, Old Spinning Mill, Wing Mill, Engine And Turbine Houses	1793-4 Flax spinning mill, adjoining wing mill, engine and wheel house with associated water systems, turbines and pumps	Category A Listed Building	392570, 809602
LB 19937	Belmont Street, Former St Nicholas Congregation al Church	1865 2 storey, 5 bay Italian Romanesque former chapel	Category A Listed Building	393945, 806236
LB 19940	Schoolhill And Belmont Street, Former Triple Kirks Churches, Including Steeple And Former East Free Church	1844, Partially ruinous remains of formerly three adjoining Gothic post-disruption churches	Category A Listed Building	393883, 806293
LB 19941	Broad Street And Queen Street, Greyfriars John Knox Church	1903 Perpendicular Gothic Church	Category A Listed Building	394290, 806424
LB 19943	Kings College Chapel, College Bounds	16th century Aisleless, ashlar (freestone) built, 122' 6" x 28', 6 bays and 3-sided apse with stout buttresses large traceried windows N-side and apse, small windows high up on S Squat S.W. tower with crown top, 99' high	Category A Listed Building	393956, 808149

Ref. No.	Name	Description	Status	NGR
LB 19946	33 King Street, Aberdeen Arts Centre	1829-30 landmark Greek Revival symmetrical, rectangular plan former church with dominant advanced giant Ionic tetra style portico to N (entrance elevation), surmounted by square-plan clock tower with circular top stage, based on Lysicrates Monument	Category A Listed Building	394409, 806519
LB 19953	King Street, St Andrew's Cathedral (Episcopal)	1816-17 with later additions and alterations Perpendicular Gothic Cathedral	Category A Listed Building	394473, 806471
LB 19957	St. Machar's Cathedral, Chanonry	Nave and ruins of transepts and crossing	Category A Listed Building	393920, 808785
LB 19961	Spital, St Margaret Of Scotland Chapel And Former Convent Including 17 Spital	1892 restored 20th century. Convent complex incorporating small Gothic chapel, a convent wing, pair of later 19th century classically detailed houses linked to earlier convent by internal corridor	Category A Listed Building	394056, 807407
LB 19964	Carden Place at Albert Terrace, St Mary's Church (Episcopal), Including Gatepiers And Boundary Walls	1862-4 with 20th century additions and restoration. Simple medieval plan gothic church	Category A Listed Building	392866, 805949
LB 19966	Union Street, Back Wynd, Schoolhill And Correction Wynd, The Kirk Of St Nicholas Uniting (Church Of Scotland And United Reformed)	1755, 1835-7, 1875-7. Early burgh church in city centre location incorporating some 12th and 15th century fragments	Category A Listed Building	394073, 806302

Ref. No.	Name	Description	Status	NGR
LB 19967	Union Street, 9 Back Wynd, Schoolhill And Correction Wynd, St Nicholas Churchyard, Including Boundary Walls And Gatepiers	Dating from 16th century city centre graveyard surrounding Kirk of St Nicholas	Category A Listed Building	394086, 806184
LB 19977	Concert Hall, Advocates' Hall	1869 2 storey and basement, 5 bay classical Advocates Hall	Category A Listed Building	394343, 806375
LB 19978	Schoolhill And Blackfriars Street, Art Gallery Including War Memorial And Cowdray Hall, Robert Gordon's College Archway And Former Gray's School Of Art	1885 Art Gallery with 1905 sculpture court. Renaissance-style buildings	Category A Listed Building	393884, 806372
LB 19982	35 Regent Quay, Custom House	1771 Custom House, 3 storey and basement 5-bay townhouse	Category A Listed Building	394588, 806185
LB 19983	27,29,31 King Street, Including Railings	1818-1840 2 storey and basement, 12 bay Classical building comprising former Medico-Chirurgical Hall, County Records Office and Private House. Constructed as three separate buildings but appear to form one unit	Category A Listed Building	394422, 806436
LB 19990	Castle Street And 2 Broad Street, Town House, Including Municipal Offices, Court Houses And Tolbooth	1615-29 & 1868-74 House, Court House & Tolbooth. Flemish medieval turreted Town House incorporating remaining part of 17th century Tolbooth	Category A Listed Building	394370, 806358

Ref. No.	Name	Description	Status	NGR
LB 19991	Union Street, South Silver Street And Golden Square, Music Hall	1820 with 19th and 20th century additions and restoration. Monumental tall single storey 5 bay neo-Greek Aberdeen civic building	Category A Listed Building	393745, 806064
LB 19992	Old Aberdeen Town House, High Street, Old Aberdeen.	1788 3 Storey House, 1721 coat of arms from previous building	Category A Listed Building	393915, 808479
LB 19995	Aberdeen Royal Infirmary Woolmanhill	Hospital complex centred on neo-classical main block of 1833-40	Category A Listed Building	393710, 806470
LB 19999	Castlegate, Mercat Cross	1686, repaired 1821-2 Mercat Cross situated in centre of Castlegate	Category A Listed Building	394496, 806380
LB 20005	Elphinstone, Bishop, Memorial, King's College Grounds, College Bounds, Old Aberdeen.	1926 Tomb chest with recumbent bronze, subsidiary figure groups	Category A Listed Building	393943, 808152
LB 20065	Westburn Road And Argyll Place, Victoria Park, Fountain	1878 octagonal fountain in centre of large circular pool	Category A Listed Building	392703, 806789
LB 20067	Brig O' Balgownie Over River Don	Dated 1314-18, repaired circa 1444, largely rebuilt early 17th century with further repairs in 19th and 20th centuries Road bridge over the River Don	Category A Listed Building	394129, 809606
LB 20073	Wellington Suspension Bridge Over River Dee, At Craiglug	1829-31 with later alterations Depressed arch suspension bridge over the River Dee	Category A Listed Building	394316, 804968
LB 20078	Girdleness Lighthouse, Greyhope Road, Including Fog Signal At South Side At NJ 9724 0530	1833 Robert Stevenson Circular tapered with corbelled gallery 3rd. floor and top; iron cupola. Main light altered 1847 and 1890.Approach flanked by flat roofed single storey lodges with archway between	Category A Listed Building	397159, 805348

Ref. No.	Name	Description	Status	NGR
LB 20082	Little Belmont Street, Former Old Town's School	1840-41 Monumental single storey former school building in the late Greek Revival Style	Category A Listed Building	393985, 806250
LB 20088	Schoolhill, Robert Gordon's College Including North Gates And Boundary Walls	1731-1732 Classical hospital building set in extensive grounds with 1830-32 alterations and additional wings	Category A Listed Building	393880, 806496
LB 20096	Broad Street, Marischal College	19th century Tudor-Gothic collegiate complex based around a central quadrangle and courtyard	Category A Listed Building	394240, 806535
LB 20098	12 And 14 Devanha Gardens, Devanha House, Including Piers And Boundary Walls	1813 2 Storey and basement, 5-bay Regency House	Category A Listed Building	393910, 805030
LB 20108	Westburn Road And Cornhill Road, Westburn Park, Westburn House, Including Railings	1839 with later 19th century addition, Single storey 3 bay House	Category A Listed Building	392676, 807055
LB 20156	Broad Street, Provost Skene's House, Including Archway And South Building	16th-17th 4 storey U-plan town house	Category A Listed Building	394198, 806385
LB 20162	5 Castle Street (Former Clydesdale Bank)	1839-42, 3 storey 6 and 2 bay classical former bank building with impressive Corinthian columned quadrant corner entrance portico	Category A Listed Building	394422, 806361

Ref. No.	Name	Description	Status	NGR
LB 20174	53 Castle Street, Sheriff Court Annex And High Court Of Justiciary (Formerly Bank Of Scotland)	1801 additions 1859 5x5 bay Classical former bank on prominent sloping corner site	Category A Listed Building	394436, 806307
LB 20186	Chanonry, 9 (West Side) Mitchell Hospital Old Aberdeen	Dated 1801,Single Storey H-plan	Category A Listed Building	393826, 808671
LB 20288	Don Street, 20, 22 (East Side) Bede House, Old Aberdeen.	1676 3 storey house	Category A Listed Building	393953, 808529
LB 20299	Don Street, (N.W. SIDE) Chr(39)The Chapter House chr(39) Chr(39)CRUICKSHANKS Lodgingschr(39)	1653-5 2 storey L plan House	Category A Listed Building	394021, 809633
LB 20331	1 Great Northern Road, The Northern Hotel	1938 purpose built 47 bedroom hotel on corner site with art deco detail	Category A Listed Building	393042, 807944
LB 20333	Guild Street And 1 Trinity Street, Tivoli Theatre	1872 -1909 3 storey, 7 bay theatre with striking Venetian Gothic polychromatic round arched entrance	Category A Listed Building	394189, 806033
LB 20334	62, 62a And 62b Hamilton Place At Whitehall Road, Including Gatepiers And Boundary Walls	1885 1887 2 bay villa with Egypto-Greek detailing	Category A Listed Building	392440, 806338

Ref. No.	Name	Description	Status	NGR
LB 20335	64, 64a, 66, 66a And 66b Hamilton Place, Including Gatepiers And Boundary Walls	1885 4 bay double villa with Egypto-Greek detailing	Category A Listed Building	392429, 806332
LB 20336	68, 68a And 70 Hamilton Place, Including Gatepiers And Boundary Walls	1886 4 bay double villa with Egypto-Greek detailing	Category A Listed Building	392396, 806318
LB 20337	72 Hamilton Place, Including Gatepiers, Boundary Walls And Provosts Lamps	1890 2 storey 3 bay villa	Category A Listed Building	392389, 806311
LB 20338	74 And 76 Hamilton Place, Including Gatepiers And Boundary Walls	1887 4 bay double villa with Egypto-Greek detailing	Category A Listed Building	392369, 806303
LB 20339	78 And 80 Hamilton Place, Including Gatepiers And Boundary Walls	1886 4 bay double villa with Egypto-Greek detailing	Category A Listed Building	392359, 806299
LB 20340	82, 82a And 84 Hamilton Place, Including Gatepiers And Boundary Walls	1886 4 bay double villa with Egypto-Greek detailing	Category A Listed Building	392330, 806290

Ref. No.	Name	Description	Status	NGR
LB 20341	86, 86a, 88 And 88a Hamilton Place, Including Gatepiers And Boundary Walls	1885 4 bay double villa with Egypto-Greek detailing	Category A Listed Building	392314, 806284
LB 20342	90 And 92 Hamilton Place, Including Gatepiers And Boundary Walls	1886 2 storey and attic 4 bay double villa with Egypto-Greek detailing	Category A Listed Building	392294, 806276
LB 20343	94, 94a And 96 Hamilton Place, Including Gatepiers And Boundary Walls	1886 1887 4 bay double villa with Egypto-Greek detailing	Category A Listed Building	392290, 806274
LB 20360	High Street, 81 (West Side) Old Aberdeen.	c1780 2-storey 3-window quoin ends, centre pediment; centre arched and traceried window at 1st, architraved doorway with rectangular fanlight and ogee tracery	Category A Listed Building	393868, 808366
LB 20374	High Street, 96 (East Side) Old Aberdeen	1623 restored 2 storey and attic 4 window rubble with lean to wing	Category A Listed Building	393931, 808425
LB 20471	1-13 (Inclusive Numbers) Rosemount Square, At Leadside Road, South Mount Street, Richmond Street And Kintore Place	1947-8, 4Storey semi-oval-plan block of local authority flats	Category A Listed Building	393331, 806463

Ref. No.	Name	Description	Status	NGR
LB 20484	48 And 50 Shiprow (Including Former House Of Provost Ross)	1593 with later additions to W pair of rare and early 3-storey townhouses, now part of the Aberdeen Maritime Museum complex	Category A Listed Building	394364, 806204
LB 20573	Union Terrace, 1, 2, 3 And 146 Union Street.	1885 Renaissance style terrace	Category A Listed Building	393874, 806102
LB 20605	Rosemount Viaduct, His Majesty's Theatre	Theatre dated 1904-6 with 20th century alterations and refurbishments	Category A Listed Building	393748, 806368
LB 20628	79 Hamilton Place At Blenheim Place, Including Gates, Gatepiers And Boundary Walls	1894 2 storey 2 bay rectangular plan villa	Category A Listed Building	392366, 806252
LB 20629	98 Hamilton Place At Fountainhall Road, Including Gatepiers And Boundary Walls	1891 2 bay square plan villa with Egypto-Greek detailing	Category A Listed Building	392271, 806266
LB 20673	Guild Street Aberdeen Railway Station And Road Overbridge	Single Storey railway station 1913-20, with near central Beaux-Arts 5 bay polygonal entrance pavilion with full length cast iron cantilevered canopy	Category A Listed Building	394152, 805889
LB 43908	Maberly Street, Broadford Works With Returns To Ann Street And Hutcheon Street	1808 with 19th and 20th century additions. Large group of textile manufacturing and storage buildings	Category A Listed Building	393560, 806922

Ref. No.	Name	Description	Status	NGR
LB 50016	Crombie Halls Of Residence, Meston Walk	1957-60 large complex of residential buildings	Category A Listed Building	393806, 808115

European Offshore Wind Deployment Centre
Environmental Statement

Appendix 20.2: Cultural Heritage EIA Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

1 CULTURAL HERITAGE

1.1 Information for the Non-Technical Summary

1 The potential impact of the EOWDC has been considered in relation to the setting of all nationally important designated cultural heritage assets within 10 km of the turbines and selected assets beyond this limit.

2 Potential impacts of greater than negligible significance have been identified in five cases: Hare Cairn, the Peterseat cairns, Torry Battery, Orrok House and Girdle Ness Lighthouse. The first three are Scheduled Monuments, whilst the latter two are Grade A-listed buildings.

3 The impacts upon Hare Cairn, the Peaterseat cairns, Torry Battery and Orrok House have been assessed as being of minor significance and those upon Girdle Ness Lighthouse as being of minor to moderate significance. No mitigation is proposed in relation to these impacts and they will persist throughout the lifetime of the EOWDC and cease upon decommissioning.

1.2 Introduction

4 The Cultural Heritage Setting Impact Assessment considers the potential impact of the EOWDC upon the setting of onshore cultural heritage assets. Such impacts may result from the proposed EOWDC appearing in views related to the setting of cultural heritage assets, and only those assets where this may occur have been carried through to the impact assessment.

5 Impacts have been assessed with reference to current guidance and are considered in terms of the asset's cultural significance.

1.2.1 Methodology Consultation

6 The following consultation was undertaken

- Aberdeen City Council

Aberdeen City Council was approached in order to establish whether they had specific concerns or requirements for data to be provided, in particular visualisations. Comments were also invited upon the proposed scope of the assessment.

Robert Forbes, The Planning Officer, indicated that he did have some concern regarding potential impacts upon the setting of Girdle Ness Lighthouse, and requested that visualisations from elevated points to the south and south-west of the lighthouse to be provided in order to help assess the potential impact upon views of the lighthouse.

The potential impact upon the setting of the lighthouse has been assessed using wireframes and a site visit. The wireframes are presented within this report along with photographs illustrating various views of the lighthouse. However, photomontages (visualisations) have not been prepared. The wireframes give an adequate demonstration of the scale of the turbines in relation to the lighthouse in views from the south, whilst the photomontages for the Torry Battery and Kincorth Hill viewpoints (SLVIA Viewpoints 07 & 12 respectively) provide an indication of the EOWDC's appearance from the vicinity of the lighthouse and from high ground to its southwest. The inclusion of photomontages for Nigg Bay would not afford any substantive information that is not available from that presented here.

The Archaeology Unit indicated that all consultation was to be undertaken through the Planning Officer.

- Aberdeenshire Council Archaeology Service

Aberdeenshire Council Archaeology Service was approached in order to establish whether they had specific concerns or requirements for data to be provided, in particular visualisations. Comments were also invited upon the proposed scope of the assessment.

The Archaeology Service indicated that it had no concerns regarding potential setting impacts.

- Historic Scotland

Historic Scotland was approached in order to establish whether they had specific concerns or requirements for data to be provided, in particular visualisations. Comments were also invited upon the proposed scope of the assessment.

No specific concerns were noted. However, it was suggested that the assessment be accompanied by visualisations to illustrate the potential impact upon the setting of Straloch Garden and Designed Landscape (GDL), Hare Cairn and Forvie Chruch and deserted village, as well as those proposed for the Seascape, Landscape and Visual Impact Assessment (SLVIA) for south of Dunnottar Castle (A92 near Uras) and Torry Battery. It was suggested that assets in the vicinity of Straloch GDL, such as Tillygreig hut-circles (SM12450) be considered.

Visualisations have been included for Torry Battery (Viewpoint 07 of SLVIA) and from near Forvie Church (Viewpoint 09 of SLVIA). No visualisations have been presented for Straloch GDL or Dunnottar Castle, as there is no intervisibility, or Hare Cairn or Tillygrieg hut-circles, as there is no potential for a significant impact upon its setting from the EOWDC.

- Scottish Natural Heritage (SNH)

SNH was approached in order to establish whether they had specific concerns or requirements for data to be provided, in particular visualisations. Comments were also invited upon the proposed scope of the assessment (e-mail dated 1st March 2011). SNH had indicated early in the project's lifespan that impacts upon the setting of cultural heritage assets should be considered by the Environmental Statement (ES).

SNH indicated that the proposed scope of the study was acceptable (e-mail dated 25th March 2011) and did not require any further visualisations..

1.2.2 Key Guidance Documents

7 The following guidance documents have been referred to:

- COWRIE (2007a) *Historic Environment Guidance for the Offshore Renewable Energy Sector*
- COWRIE (2007b) *Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy*
- Historic Scotland (2008) *Scottish Historic Environment Policy (SHEP)*
- Historic Scotland (2009) *Assessment of Impact upon the setting of the Historic Environment Resource*
- Historic Scotland (2010) *Managing Change in the Historic Environment: Setting*

1.2.3 Data Information and Sources

8 Two concentric study areas have been used to gather and present the baseline data:

- Inner study area (Environmental Statement Figure 20.1, 20.2, 20.3): This extends 10 km from the outermost proposed turbines. Within it data has been gathered for all designated nationally important assets (scheduled monuments, Category A listed buildings and Inventory Gardens and Designed Landscapes (GDL)) and conservation areas; and
- Outer study area: this extends 40 km from the proposed turbines to take in the area for which the Zone of Theoretical Visibility (ZTV) has been prepared for the SLVIA. Within it assets specifically identified by consultees as being of concern have been considered.

9 There is no guidance regarding appropriate study areas for cultural heritage setting impact assessments. The study area has been defined in order to take in those assets that are most likely to be affected by the proposed development; assets further inshore are less likely to be affected as their setting is less likely to relate to the sea.

10 Data were gathered from the following data sources:

- Databases of designated assets held by Historic Scotland;
- National Monuments Record of Scotland (NMRS);
- Aberdeen City Council Sites and Monuments Record (SMR); and
- Aberdeenshire Council Historic Environment Record (HER)

11 Assets are referred to by the reference number associated by their designation. Scheduled monument numbers (officially ‘Ancient Monument Index Numbers’) are prefixed ‘SM’ and numbers referring to listed buildings (officially ‘Historic Building Numbers’) are prefixed ‘LB’. Where an asset is both scheduled and listed it is referred to by its scheduled monument number.

12 The results of the desk-based study were augmented by site visits undertaken on 8^{th} and 9^{th} March 2011.

1.2.4 Impact Methodology

1.2.4.1 Significance Criteria

13 During the construction, operation and decommissioning phases of developments, the setting of cultural heritage assets may be affected. There is considerable debate over definitions of setting and approaches to the assessment of setting impacts (Lambrick, 2008), with no standardised industry-wide approach. Historic Scotland has produced a guidance note on setting as part of its 'Managing Change in the Historic Environment' series of documents. This states that

Setting should be thought of as the way in which the surroundings of a historic asset or place contribute to how it is experienced, understood and appreciated.

14 Hence setting is not simply the visual envelope of the asset in question. Rather, it is those parts of the asset's surroundings that are relevant to the cultural significance of the asset. In general, there will be an appreciable historical relationship between the asset and its setting, either in terms of a physical relationship, such as between a castle and the natural rise that it occupies, or a more distant visual relationship, such as a designed vista or the view from, for example, one Roman signal station to another. Some assets' cultural significance will relate to an aesthetic relationship with their surroundings which may result from design or be fortuitous. In such instances the relevant landscape elements will be considered to form part of the asset's setting. The cultural significance of assets has been considered in terms of the values described in Scottish Historic Environment Policy (SHEP HS 2008, 58):

- Intrinsic - those relating to the fabric of the asset;
- Contextual – those relating to the monument's place in the landscape or in the body of existing knowledge; and
- Associative – more subjective assessments of the associations of the monument, including with current or past aesthetic preferences.

15 Most setting impacts will relate to contextual and associative values.

16 The sensitivity of a cultural heritage asset to changes in its setting can be evaluated in the first instance by reference to any relevant designation, whereby assets designated as nationally important will generally be considered the most sensitive. Consequently, the assessment has focussed on nationally important cultural heritage assets in the study areas which are considered in relation to impacts upon setting, with other assets being considered where, in the assessor's professional opinion, there is potential for significant impacts or where they have been raised by consultees. Following reference to the designation of the asset, sensitivity can be more finely assessed by reference to the importance of the asset's surroundings, to its character and value as a cultural heritage asset and the appreciation of its value. Also taken into account is the extent to which an asset is visible on the ground. Some assets may have a well-defined and appreciable setting but the asset itself is barely perceptible; such assets will generally be less sensitive than those that are readily appreciable.

17 Table 1 is a general guide to the attributes of cultural heritage assets of high, medium, low or negligible sensitivity to setting impacts. It should be noted

that not all the qualities listed need be present in every case and professional judgement is used in balancing the different criteria.

Table 1 Guideline Criteria for Assessment of Sensitivity of a Cultural Heritage Asset to Effects on its Setting

Sensitivity	Guideline Criteria
High	The asset has a clearly defined setting that is readily appreciable on the ground and is vital to its significance or the appreciation thereof. The asset will generally be readily appreciable on the ground.
Medium	The asset's significance and the appreciation thereof relate to some extent to its setting. The asset will generally be appreciable on the ground.
Low	The asset's surroundings have little relevance to its significance or the appreciation thereof. The asset is difficult to identify on the ground or its setting is difficult to appreciate on the ground.
Negligible	The asset is imperceptible in the landscape and its significance or the appreciation thereof does not relate to its surroundings.

18 The magnitude of an impact reflects the extent to which relevant elements of the setting of the cultural heritage asset are changed by the development and the effect that this has upon the significance of the asset and the appreciation thereof. Guideline criteria for assessing magnitude are described in Table 2. As with other criteria presented, this is intended as a general guide and it is not anticipated that all the criteria listed will be present in every case.

19 The following are guides to the assessment of magnitude of impact based on those provided by Historic Scotland (2009):

- *Obstruction of or distraction from key views.* Some assets have been sited or designed with specific views in mind, such as the view from a Roman signal station to an associated fort or a country house with designed vistas. The obstruction or cluttering of such views would reduce the extent to which the asset could be understood and appreciated by the visitor. Developments outside a key view may also distract from them and make them difficult to appreciate if they are particularly prominent. In such instances the magnitude is likely to be greatest where views have a particular focus or a strong aesthetic character.

- *Changes in prominence.* Some assets are deliberately placed in prominent locations in order to stand out from the surrounding landscape, for example prehistoric cairns are often placed to be silhouetted against the sky and churches in some areas are deliberately placed on ridges in order to be highly visible. Developments can reduce such prominence and therefore reduce the extent to which such assets can be appreciated.

- *Changes in landscape character.* A particular land use regime may be essential to the appreciation of an asset's function, for instance the fields surrounding an Improvement period farmstead are inextricably linked to its appreciation. Hence, changes in land use can leave the asset isolated and reduce its value. In some instances, assets will have aesthetic value or a sense of place that is tied to the surrounding landscape character.

- *Duration and reversibility of impact.* Effects that are short term or readily reversible are generally of lesser magnitude than those that are long term or permanent.

- *Effects upon a defined setting.* These will be of greater magnitude than those that affect unrelated elements of the asset's surroundings or incidental views to or from an asset that are unrelated to the appreciation of its value.

20 It should be noted that the assessment of magnitude will be based on the interplay of these factors. No single factor will be taken to over-ride other factors, for instance an adverse impact that would be of high magnitude will not generally be reduced to low magnitude, simply on the grounds that it is reversible. It should also be noted that whilst the development may be present within the visual envelope of an asset this does not automatically mean there is an impact on the setting of the asset. Where this is the case, the reasoning behind this will be given.

Table 2: Criteria for Assessment of Magnitude of an Effect on the Setting of a Cultural Heritage Asset

Magnitude	Guideline Criteria
High beneficial	The contribution of setting to the cultural heritage asset's significance is considerably enhanced as a result of the development; a lost relationship between the asset and its setting is restored, or the legibility of the relationship is greatly enhanced. Elements of the surroundings that detract from the asset's cultural heritage significance or the appreciation of that significance are removed.
Medium beneficial	The contribution of setting to the cultural heritage asset's significance is enhanced to a clearly appreciable extent as a result of the development; as a result the relationship between the asset and its setting is rendered more readily apparent. The negative impact of elements of the surroundings that detract from the asset's cultural heritage significance or the appreciation of that significance is appreciably reduced.
Low beneficial	The setting of the cultural heritage asset is slightly improved as a result of the development, slightly improving the degree to which the setting's relationship with the asset can be appreciated.
Negligible	The contribution of the asset's surroundings to its cultural significance is changed, but in such a way that the change is barely perceptible.
Low adverse	The contribution of the setting of the cultural heritage asset to its significance is slightly degraded as a result of the development, but without adversely affecting the interpretability of the asset and its setting; characteristics of historic value can still be appreciated, the changes do not strongly conflict with the character of the asset, and could be easily reversed to approximate the pre-development conditions.
Medium adverse	The contribution of the setting of the cultural heritage asset to its significance is reduced appreciably as a result of the development and cannot easily be reversed to approximate pre-development conditions. Relevant setting characteristics can still be appreciated but less readily.
High adverse	The contribution of the setting of the cultural heritage asset to its significance is effectively lost or substantially reduced as a result of the development, the relationship between the asset and its setting is no longer readily appreciable.

1.2.4.2 Significance

21 The significance of an impact on a cultural heritage asset is assessed by combining the magnitude of the impact and the sensitivity of the cultural heritage asset. The matrix in Table 3 provides a guide to decision-making but is not a substitute for professional judgement and interpretation, particularly

where the sensitivity or impact magnitude levels are not clear or are borderline between categories. Predicted impacts of major or moderate significance equate to potentially significant impacts in terms of the EIA Regulations.

Table 3: Guideline Criteria for Assessing the Significance of Effects on Cultural Heritage Assets

Magnitude	**Sensitivity**			
	Negligible	**Low**	**Medium**	**High**
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

1.2.5 Implications of Significance

22 Where the significance is classified as moderate or major this is considered to be a potentially significant effect. It should be noted that significant effects need not be unacceptable or reversible.

1.2.6 Cumulative Impact Assessment Methodology

23 For the purposes of the cumulative impact assessment the potential effect of adding the Ocean Laboratory to the EOWDC has been considered. The potential cumulative impacts of the EOWDC with other wind farms (consented/operational and proposed) have also been considered. In keeping with the approach used in the SLVIA wind farms up to a distance of 60 km from the EOWDC have been considered.

24 Aggregate extraction, existing and planned subsea cables and pipelines and established fishing activities have not been considered as these activities will not result in any visual change that might result in an impact upon setting.

25 Navigation and shipping have not been considered further as these are considered to be a neutral part of the baseline conditions.

26 Offshore oil and gas installations have not been considered further as all such installations are over 40 km from the shore and hence have no impact upon the setting of cultural heritage assets.

1.2.7 Worst Realistic Case

27 The impact assessment has been undertaken with reference to the largest turbines within the Rochdale Envelope; eleven 10 MW turbines with a hub height of 120 m and blade tip height of 195 m above LAT. The variations in height that will occur as different turbines are deployed will have no substantive effect on the assessment, as the potential impacts upon setting relate to the visibility of turbines rather than their aesthetic appearance.

1.3 Impact Assessment

28 No differentiation has been drawn between setting impacts during the construction, operation and decommissioning phases as the magnitude of impact and hence significance will be the same for all phases. Clearly, there will be increased shipping traffic during the construction and decommissioning phases and the vessels present will be of a different type to those currently operating. However, the ships will be operating in a body of water in which a substantial number of large vessels operate and, as such, it is considered that this will not constitute an impact upon setting.

29 The potential for impacts to occur has been considered for all assets identified by the baseline study as having potential intervisibility with the EOWDC; fourteen such assets have been identified.

1.3.1 Potential Impacts

1.3.1.1 Forvie Church and Deserted Village (SM7644, near to Viewpoint 09 SLVIA))

30 Forvie Church and deserted village (SM7644) comprise the remains of a medieval church and village buried by sand dunes. The church and adjacent huts were excavated and left exposed by archaeologists in the 1950s, but most of the village remains covered by sand dunes. The exposed remains are not visible in the wider landscape. The associated buried remains have exceptional potential in terms of their value as a source of data regarding medieval society, economy and material culture as they have been unaffected by later development or farming. The asset is surrounded by the Sands of Forvie, an extensive sand dune system, and lies some 300 m from the shoreline. The surrounding dunes restrict views out from the church, though the sea can be glimpsed to the south.

31 The surroundings of the asset make very little contribution to the experience and understanding of the asset, as the dunes make it impossible to understand how the settlement related to its surroundings, but it is part of a heritage trail and is therefore visited by the public. The site’s significance relates almost entirely to its intrinsic value as a data source, though the adjacent sand dunes are relevant to an appreciation of how the church has survived undisturbed. The setting of the church is therefore defined as the dunes surrounding it and it is considered that the church is of low to medium sensitivity to impacts upon setting.

32 The proposed EOWDC turbines will be visible from the vicinity of the church at a distance of approximately 10 km. The degree of visibility will vary greatly depending upon the viewer’s location and in much of the area around the church the proposed turbines will be at least partially screened from view. Viewpoint 09 of the SLVIA is nearby and gives an indication of the degree of visual change.

33 The turbines will lie outside the church’s setting and will in no way affect the extent to which it can be experienced or understood. It is considered therefore that there will be a degree of visual change, but that this will constitute an impact of at most negligible magnitude upon the setting of the church.

34 The church is considered to be of at most medium sensitivity to impacts upon setting and the impact is considered to be of negligible magnitude, the church's cultural significance and the potential for that significance to be appreciated will remain unchanged. The impact upon its setting is therefore considered to be of **negligible** significance. The impact will finish upon decommissioning.

1.3.1.2 Forvie Ring Cairn and Hut-circles (SM12541)

35 Forvie ring cairn and hut-circles (SM12541) lie among the Sands of Forvie, some 800 m from the shoreline. Only two of the 19 hut-circles recorded in 1950 are now visible, the remainder having been covered by sand-dunes. As with Forvie Church, there is potential for exceptional preservation and the site has great potential as a data source. The exposed structures cannot be seen from more than a few metres away. The surrounding dunes restrict views in most directions, with open views only being available inland.

36 The surrounding dunes completely mask any relationship that the asset may have had with its surroundings. Again the surrounding dunes are relevant to an understanding of the site formation processes at work and consequently the dunes are considered to form the asset's setting and it is concluded that the ring cairn and hut-circles are of low sensitivity to setting impacts.

37 The EOWDC will be partially visible to the south, at a distance of 9.8 km. The proposed turbines will lie outside the setting of the asset and will not affect the appreciation of the asset.

38 The cultural significance of the cairn and hut-circles will be undiminished by the presence of the turbines. It is concluded that there will be an impact of negligible magnitude upon their setting and with a low sensitivity that this will constitute an impact of **negligible** significance. The impact will finish upon decommissioning.

1.3.1.3 Tillygrieg hut-circles (SM12450)

39 Tillygrieg hut-circles (SM12450) comprise the scheduled upstanding remains of two Late Bronze Age or Iron Age date. They are located near the top of a gentle east facing slope and are surrounded by farmland. They are unusually well-preserved for this part of Aberdeenshire and have potential to yield information regarding settlement history and economy. The upstanding remains are slight and no more than 0.3 m in height; as such they are not visible in the wider landscape.

40 The hut-circles were built by farmers who worked the surrounding land. The broader landscape does not contribute to their cultural significance or their appreciation thereof. The adjacent farmland constitutes their setting and they are considered to be of low sensitivity to setting impacts.

41 The proposed EOWDC turbines will be partially visible to the south-east of the hut-circles, at a distance of 13.9 km. They will be seen beyond a line of pylons that occupies the foreground of views east form the hut-circles.

42 The cultural significance of the hut-circles will be undiminished by the presence of the turbines. It is concluded that there will be an impact of

negligible magnitude upon their setting and with a low sensitivity this will constitute an impact of **negligible** significance. The impact will finish upon decommissioning.

1.3.1.4 *Hare Cairn (SM3277)*

43 Hare Cairn (SM3277) is a Bronze Age burial cairn located on the top of a small hillock. The surrounding field is given over to pasture. It has been partially excavated, but survives as an appreciable mound with exposed kerb. Despite the disturbance it has potential to yield data regarding Bronze Age burial practices. The cairn's cultural significance resides in its value as a potential data source and in its potential to provide a tangible link to the past. The latter is considered further below.

44 The cairn's elevated location makes it a prominent feature in the surrounding landscape. Similarly, extensive views are available form the cairn over the surrounding farmland. It is evident that the cairn has been placed in order to be prominent in the farming landscape. The setting of the cairn is therefore defined as the knoll upon which it is located and the surrounding farmland. The views to and from the cairn are important to an understanding of the cairn's function and its designed relationship with its surroundings and it is considered to be of high sensitivity to impacts upon setting.

45 The proposed turbines will be fully visible to the south-east of the cairn, at a distance of 4.8 km. The cairn lies over 2 km from the coast and the proposed turbines will be seen beyond the coastal fringe in which the town of Balmedie is visible, as is the A90.

46 The presence of the proposed turbines in views eastwards from the cairn will not affect the contribution of the cairn's surroundings to its experience, appreciation or understanding. The cairn's prominence will not be changed – the proposed turbines will not be visible in combination with the cairn from land to the west – nor will they affect the degree to which the cairn's relationship with the farmland to its west can be appreciated. It is concluded that the proposed turbines will lie outside the setting of the cairn.

47 The cultural significance of the cairn will be undiminished by the presence of the turbines. It is concluded that there will be an impact of negligible magnitude upon its setting and with a high sensitivity that this will constitute an impact of **minor** significance. The impact will finish upon decommissioning..

Mitigation

48 No mitigation is proposed in relation to the impact upon the setting of the Hare Cairn.

Residual Impacts

49 No mitigation is proposed in relation to impacts upon the setting of Hare Cairn and the predicted impacts will remain adverse and of minor significance. The impact will finish upon decommissioning.

Cumulative Impacts

50 The potential for cumulative impacts to result from the EOWDC and the potential Ocean Laboratory has been considered. The Ocean Laboratory could comprise a 120 m mast with a platform 20 m above LAT. It could be

located to the south of the proposed EOWDC turbines. It has been concluded that there will be no cumulative impact. The predicted impact relates to the proposed turbines appearing as large structures in views from the cairn. The Ocean Laboratory would be seen amongst the turbines and would not alter the effect.

51 The potential for cumulative impacts to arise from the EOWDC and onshore wind farms has been considered. The cumulative ZTV (SLVIA Figure 15) indicates that up to two other consented wind farms will theoretically be visible from the cairns. The closest will be approximately 7.5 km to the north. The indicative ZTV for proposed wind farms (SLVIA Figure 16) indicates that up to two proposed wind farms will be visible from the cairns, the closest of which will lie some 15 km away. Given the distance and that both the EOWDC and the other wind farms lie outside the setting of the cairn, it is concluded that there is no potential for cumulative impacts.

1.3.1.5 The Temple Stones (SM3275)

52 The Temple Stones (SM3275) comprise the remains of a recumbent stone circle. It is located on the shoulder of a hill, overlooking the Milden Burn to the south. Many of the stones have been removed and only the recumbent stone remains *in situ*, the pillar stones are present but have fallen over. Of the rest of the stone circle only one stone remains. The recumbent stone lies at the southwest of the monument. Stones cleared from the surrounding field have been dumped behind the recumbent stone. Despite its fragmentary survival there is potential for subsurface features to yield information regarding the construction and history of use of the stone circle and, by extension, contemporary ritual practices and its cultural significance resides in this potential.

53 Located on top of a ridge, the Temple Stones command wide views over the rolling agricultural land to the north and west, over the golf course to the east to the coastal lowlands and the North Sea. As with the current example, recumbent stone circles are generally orientated towards the south or south-west in order that the recumbent stone and pillars would frame the “moon and in some cases they may also have faced the winter sun” (Bradley 2005, p111). In some instances topographic features are also framed. The setting of the stones is defined as the ridge upon which they are located. There is no clear relationship with land beyond this, though it must be assumed that the view to the south-west was important. Because of its mutilated condition, it is difficult to understand the relationship of this asset with the wider landscape but its relationship with the ridge is still clear and the key alignment is still apparent. It is concluded that it is of medium sensitivity to setting impacts

54 The EOWDC will be visible to the east at a distance of 4.3 km. The proposed turbines will not affect the contribution of the surroundings to the Temple Stones cultural significance. They lie outside its setting and well away from the key south-westerly alignment of the stones.

55 The cultural significance of the stones will be undiminished by the presence of the turbines. It is concluded that there will be an impact of negligible magnitude upon its setting and with a medium sensitivity this will constitute an impact of **negligible** significance. The impact will finish upon decommissioning.

1.3.1.6 Dubford Stone (SM3283)

56 Dubford Stone (SM3283) is a single standing stone, which is thought to be the final remnant of a recumbent stone circle. The stone is located in an improved pasture field on a natural terrace. Despite its fragmentary survival there is potential for subsurface features to yield information regarding the construction and history of use of the stone circle and, by extension, contemporary ritual practices and its cultural significance resides primarily in this potential. The stone's location commands extensive views over the surrounding farmland to the south and the sea is visible to the east. A number of modern features are prominent in the surrounding landscape, in particular the city of Aberdeen is visible to the south.

57 The stone's surroundings make little contribution to its cultural significance and there are no clear relationships with land beyond the terrace upon which it is located. If the identification of the site as a recumbent stone circle is correct, it may be assumed that the key alignment was to the south or south-west. However, this is no longer appreciable on the ground. The setting of the stone is therefore defined as the field in which it is located. The stone's relationship with the terrace upon which it is located is clear, but there are no demonstrable relationships with land beyond the terrace; the very incomplete survival of the asset making it impossible to discern key alignments. Consequently, it is concluded that the stone is of low sensitivity to impacts upon setting.

58 The proposed EOWDC will be fully visible to the east at a distance of 5.5 km. The turbines will lie outside the setting of the stone and well away from the probable southward alignment of the asset in its original form.

59 The visibility of the proposed turbines from the standing stone will not affect the extent to which it can be understood or appreciated or the contribution of its surroundings to its cultural significance. It is concluded that there will be an impact of negligible magnitude upon its setting and with a low sensitivity this will constitute an impact of **negligible** significance. The impact will finish upon decommissioning..

1.3.1.7 Peterseat Cairns (SM4055, SM4060, SM4125, SM4126 & SM12342)

60 The cairns to the south of Aberdeen around Peterseat are considered as a group, as the setting and sensitivity of the individual cairns and the magnitude of impact is essentially the same in all cases.

61 Tullos cairn (SM4055), Crab's cairn (SM4060) and Baron's cairn (SM4126) lie at the northern end of a gorse-covered ridge, which overlooks Aberdeen and Aberdeen Bay to the north. Cat Cairn and Loirston cairn (SM4126 and SM12342 respectively) lie further along the ridge to the southwest. The southern part of the ridge is occupied by light industrial units. The cairns survive as substantial mounds and are located on natural eminences upon the ridge. They command extensive views across Aberdeen to the north. It must be assumed that the cairns were placed in order to be prominent in views from the wider landscape, most probably settlement and farmed land in the area of the River Dee; an area that is now covered by housing. In such views they were probably sky-lined, though this is no longer the case, owing to the cairns' degraded state and the gorse.

62 The cairns' cultural significance relates primarily to their potential as sources of data regarding contemporary burial practice and their potential as a tangible link to the past, as the visitor will appreciate to some degree the relationship of the cairns to the landscape that they overlook and the inter-relationship between the various cairns. The latter will help the visitor appreciate the long history of human activity in the Aberdeen area. The setting of the cairns is therefore defined as the ridge that they occupy and to a lesser degree the lower land to the north, which they were intended to overlook. Views of the cairns in the wider landscape are not possible but views from the cairns are relevant to their appreciation as they allow the visitor to understand how the cairns might have fitted into the wider prehistoric landscape. The cairns are considered to be of high sensitivity to impacts upon setting as the intended visual relationship with the land that they overlook is appreciable to a substantial degree and the spatial relationship between the cairns suggests that they form a relict Bronze Age funerary landscape, resulting in additional group value.

63 The proposed turbines will be fully visible to the north of the cairns with the nearest at a distance of at least 9.6 km. They will be seen beyond the coastal fringe, which is largely occupied by modern housing and other buildings, including blocks of flats and other large structures.

64 The proposed turbines will lie outside the setting of the cairns and will not affect the appreciation of their relationship with their surroundings or their contribution to its cultural significance. It is considered that there will be an impact of negligible magnitude upon their setting and with a high sensitivity this will constitute an impact of **minor** significance. The impact will finish upon decommissioning.

Mitigation

65 No mitigation is proposed in relation to the impact upon the setting of the Peterseat cairns.

Residual Impacts

66 No mitigation is proposed in relation to impacts upon the setting of the Peterseat cairns and the predicted impacts will remain adverse and of minor significance. The impact will finish upon decommissioning.

Cumulative Impacts

67 The potential for cumulative impacts to result from the EOWDC and the potential Ocean Laboratory has been considered. The Ocean Laboratory could comprise a 120 m mast with a platform 20 m above LAT. It could be located to the south of the proposed EOWDC turbines. It has been concluded that there will be no cumulative impact. The predicted impact relates to the proposed turbines appearing as large structures in views from the cairns. The Ocean Laboratory would be seen amongst the turbines and would not alter the effect.

68 The potential for cumulative impacts to arise from the EOWDC and onshore wind farms has been considered. The cumulative ZTV (SLVIA Figure 15) indicates that up to two other consented wind farms will theoretically be visible from the cairns. The closest will be over 20 km away. The indicative ZTV for proposed wind farms (SLVIA Figure 16) indicates that up to two proposed wind farms will be visible from the cairns, the closest of which will lie some 15 km away. Given the distance and that both the EOWDC and the

other wind farms lie outside the setting of the cairns, it is concluded that there is no potential for cumulative impacts.

1.3.1.8 *Torry Battery (SM9215, Viewpoint 07 SLVIA)*

69 Torry Battery (SM9215) comprises the remains of a coastal battery built in the mid-19th century to protect the entrance to Aberdeen harbour and Aberdeen Bay. It was manned during both World Wars and also saw use as temporary housing for civilians in the 1930s, who had become homeless as a result of the economic crisis. It is located on the headland of Girdle Ness and overlooks the entrance to the harbour, which lies immediately to the north (Plate 1). To the northwest, Aberdeen can be seen stretching up the coast, while to the east Girdle Ness Lighthouse is prominent. Most of the view northwards is occupied by the sea.

70 The Battery's cultural significance resides in its importance as a tangible link to the past, providing visible evidence of Britain's response to external threat, Aberdeen's importance as a port and, given its long history of use, of the development of military tactics and technology. Its role as civilian housing adds further to this, as the battery provides a link to the results of the economic crisis of the 1930s.

71 Much of this significance is intrinsic to the fabric of the Battery but contextual values are also very important and the relationship between the battery and its surroundings contributes to these values. Its position overlooking the entrance to Aberdeen's Harbour and the bay beyond is significant in the understanding of its operation and function. The Battery also has associative value and its rather isolated and exposed location adds to an appreciation of the plight of families housed here during the 1930s. The setting of the battery is therefore defined as the headland upon which it is located, the entrance to Aberdeen Harbour, which it has been placed to overlook and defend, and Aberdeen Bay, which its guns covered.

72 The EOWDC will be fully visible to the north-east of the Battery at a distance of 7.9 km (see photomontage SLVIA Viewpoint 07). The proposed turbines will be seen in a body of water that sees substantial numbers of shipping movements, with the sea providing a backdrop. SLVIA Viewpoint 07 is located at the gate to the carpark adjacent to the Battery. This location is slightly lower than the Battery itself. The photomontage shows that the wind turbines will be seen as a well-balanced arrangement with proposed turbines occurring in five groupings.

73 The Battery is of high sensitivity to setting impacts as it is a readily appreciable asset that has a clear relationship with its surroundings that adds greatly to the visitor's understanding and appreciation of the asset's history and function. This contributes to the Battery's contextual value. The location also adds to its associative value as it contributes to the visitor's appreciation of life for the Battery's inhabitants, in particular during its time as temporary housing.

74 The presence of the EOWDC will introduce large modern structures into the setting of the Battery. While this will constitute a visual impact that is of High to Moderate magnitude (see SLVIA of the EOWDC), the magnitude of impact upon setting will be substantially less. The proposed turbines will not be seen in a context entirely free of other large modern features, rather they will be

seen with a substantial number of other modern features – rig support vessels, flats in Aberdeen, the harbour infrastructure and large retail units to the north of Footdee. The nearest proposed turbine will be 7.9 km from the Battery and will not affect the Battery's dominance of the harbour entrance. The proposed turbines will break up the view across the bay, but given that they will occupy some 12 degrees of the 200 degree view, their distance from the Battery and that the horizon will be clearly visible between the five groupings, the relationship between the Battery and the bay will remain readily appreciable; it will still be possible to experience the views across the bay and hence understand that the Battery's guns covered the whole bay. The EOWDC will not affect views of the Battery from the wider landscape, nor will it affect the relationship between the Battery and the headland element of its setting or the entrance to the harbour. It is therefore considered that the impact upon the setting of Torry Battery will be of negligible magnitude and adverse.

75 It is concluded that the impact of the EOWDC on the setting of the Torry Battery which is of high sensitivity and of negligible magnitude, will be potentially adverse and of **minor** significance as the setting will be altered by the development but this will not reduce the extent to which it contributes to the cultural significance of the Torry Battery. The impact will finish upon decommissioning.

Mitigation

76 No mitigation is proposed in relation to the impact upon the setting of Torry Battery.

Residual Impacts

77 No mitigation is proposed in relation to impacts upon the setting of Torry battery and the predicted impacts will remain adverse and of minor significance. The impact will finish upon decommissioning.

Cumulative Impacts

78 The potential for cumulative impacts to result from the EOWDC and the potential Ocean Laboratory has been considered. The Ocean Laboratory could comprise a 120 m mast with a platform 20 m above LAT. It could be located to the south of the proposed EOWDC turbines. It has been concluded that there will be no cumulative impact. The predicted impact relates to the proposed turbines appearing as large structures in views from the Torry Battery. The Ocean Laboratory would be seen amongst the turbines and would not alter the effect.

79 The potential for cumulative impacts to arise from the EOWDC and onshore wind farms has been considered. The cumulative ZTV (SLVIA Figure 15) indicates that up to two other consented wind farms will theoretically be visible from Torry Battery. The closest will be over 20 km away. Given the distance and that the other wind farms lie outside the setting of the Battery, it is concluded that there is no potential for cumulative impacts. The indicative ZTV for proposed wind farms (SLVIA Figure 16) indicates that no proposed wind farms will be visible.

1.3.1.9 Orrok House (LB2778)

80 Orrok House (LB2778) is a country house built between 1770 and 1782. The house is surrounded by its wooded policies, which have been laid out in order

to retain an open aspect to the south, and is approached by way of a short driveway from the north. The house is located on a gentle south-facing slope and its policies are surrounded by arable fields (Plate 2).

81 The house's cultural significance relates to its architectural quality and its completeness as a late 18th century house with policies. It therefore combines intrinsic, contextual and associative values. The house's surrounding contribute to all of these values. The policies contribute to the intrinsic and value, as the house presents a good example of a late 18th century country house complete with original planting. The surrounding rich agricultural land and farm-buildings are relevant to an appreciation of the wealth of the area. The house and policies is prominent in views from land to the south and the house is clearly intended to look out over these. The setting of the house is therefore defined at the small hill upon which it stands and the fields that it overlooks to the south. Views relevant to the appreciation of the relationship with its setting are those to the south from the house and those of the house from the south. There are no natural or artificial focal points in the views from the house.

82 The proposed turbines will be fully visible from the south of the house at a distance of 5.6 km. They will be located to the south-east of the house. They will be seen as a group. The foreground of the views will be composed of rolling farmland with the wooded hills to the north of Balmedie visible in the middle distance. The proposed turbines will appear in the background of these views.

83 The house is a readily appreciable asset and its relationship with its surroundings is likewise readily appreciable. It is considered to be of high sensitivity to impacts upon setting.

84 The proposed EOWDC will introduce large modern features into the view from the house; the proposed turbines will lie outside the setting of the house but within a view that is relevant to it. The view is currently dominated by agricultural land. However, they will appear in the background beyond the agricultural land and there is no evidence that the view has in anyway been composed in terms of framing or focal points etc. Rather the house appears to have been placed in order to command panoramic views. The turbines will therefore not disrupt these views, but will simply add another element to them.

85 It is concluded that the impact of the EOWDC upon the setting of Orrok House, which is of high sensitivity and will be of negligible magnitude, will be of **minor** significance and will cease upon decommissioning. The impact will finish upon decommissioning.

Mitigation

86 No mitigation is proposed in relation to the impact upon the setting of Orrok House.

Residual Impacts

87 No mitigation is proposed in relation to impacts upon the setting of Orrok House and the predicted impacts will remain adverse and of minor significance. The impact will finish upon decommissioning.

Cumulative Impacts

88 The potential for cumulative impacts to result from the EOWDC and the potential Ocean Laboratory has been considered. The Ocean Laboratory could comprise a 120 m mast with a platform 20 m above LAT. It could be located to the south of the proposed EOWDC turbines and therefore will be at the rear of the array when viewed from Orrok House. It has been concluded that there will be no cumulative impact. The predicted impact relates to the proposed turbines appearing as large structures in views from Orrok House. The presence of the Ocean Laboratory would be seen amongst the turbines and would not alter the effect.

89 The potential for cumulative impacts to arise from the EOWDC and onshore wind farms has been considered. The cumulative ZTVs for consented and proposed wind farms (SLVIA Figures 15 & 16 respectively) indicate that no other wind farms will be visible from Orrok House. It is concluded that there is no potential for cumulative impacts upon the setting of Orrok House.

1.3.1.10 <u>*Girdle Ness Lighthouse (LB20078)*</u>

90 Girdle Ness Lighthouse (LB20078) was designed by Robert Stevenson and built in1833. It was fitted with a new double light system and in 1860 was described by the Astronomer Royal as ‘the best lighthouse that I have seen’. The lighthouse stands at the eastern end of Girdle Ness, between Greyhope Bay and Nigg Bay. Aberdeen Bay and the North Sea occupy views to the north and east (Plates 3 & 4). Immediately adjacent are lattice work towers (Plate 5) In views to the west the foreground is occupied by the bleak headland, beyond which Aberdeen is visible. The lighthouse is a prominent landmark being highly visible from the south, across Nigg Bay, and from points to the west, including Torry Battery. In these views the pristine white vertical form of the lighthouse is seen in contrast to the low rugged form of the headland, with the sky providing a backdrop (Plate 6).

91 The lighthouse’s cultural significance comprises intrinsic, contextual and associative elements. Its intrinsic value relates to its technological importance, while its contextual and associative values relate to its direct relationship with the Stevenson family and, hence, the development of Scottish lighthouses, its relationship with the entrance to the harbour and its prominence in the surrounding landscape and importance as a landmark. Consequently, the setting of the lighthouse comprises:

- The headland upon which it is located, as this is relevant to both the contextual and associative values as its flat form contributes to the prominence of the lighthouse and hence its functional and aesthetic characteristics;
- The harbour entrance which is visible to the west as this relates the lighthouse to the other elements of Aberdeen’s maritime heritage;
- The sea to the north, east and south as the lighthouse is clearly inextricably linked to the sea.

92 The proposed turbines will be fully visible to the northeast of the lighthouse at a distance of 7.9 km. Their appearance will vary depending on the location of the viewer, but from the lighthouse and land to its south, the locations that are of greatest relevance to the impact assessment, the proposed turbines will be

seen as five groupings. From some locations to the south the proposed turbines will lie directly behind the lighthouse, but from most of the coastal road they will be seen to the left. The wireframes demonstrate that the lighthouse will appear substantially larger than the turbines in views from its south. From the lighthouse itself and from elevated locations to its south the the proposed turbines will be seen with the many large ships that currently operate from Aberdeen Harbour and frequently anchor in the area to the east of the mouth of the River Don, Aberdeen Harbour Board figures indicate that it handles almost 9000 vessels use the harbour annually. The photomontage presented for the viewpoint at Torry Battery (Viewpoint 07 SLVIA) shows how this may appear.

93 The lighthouse is of high sensitivity to impacts upon setting. It is a prominent feature and its surroundings contribute to many aspects of its significance.

94 The proposed turbines will be located in Aberdeen Bay and hence within the setting of the lighthouse. Although this will affect views from the lighthouse, this will not constitute an impact upon setting as the relationship of the lighthouse with its surroundings or the degree to which this relationship can be understood and appreciated will be unchanged. However, views of the lighthouse from the south will be affected in ways that will constitute an impact upon setting. The proposed turbines will be seen in combination with the lighthouse in these views. From a very limited area they will be seen directly behind the lighthouse. This will only occur in a small part of Greg Ness. The appearance of the turbines in combination with the lighthouse will reduce to some extent the dominance of the lighthouse as the proposed turbines will also be white vertical features. However, the turbines will be located 7.9 km from the lighthouse, hence in views across Nigg Bay they will be over 9 km from the viewer, while the lighthouse will be 1.2 km or more away. The lighthouse will appear taller than the turbines in such views. The lighthouse's relationship with its surroundings will remain readily appreciable, however, its dominance of certain views will be reduced by the presence of the turbines and hence the aesthetic element of its associative value may be considered to be reduced, though this will depend on the preferences of the viewer. Given the turbines' distance from the lighthouse, the lighthouse will remain the dominant feature on the headland and in views from the south and the vertical form of the turbines will match that of the lighthouse.

95 The potential impact of the EOWDC upon the setting of the lighthouse, which is of high sensitivity, has been assessed as of low magnitude. Following the application of professional judgement, it is concluded that the impact will be of **minor** to potentially **moderate** significance. This conclusion has been reached because the impact relates to the aesthetics of views of the lighthouse from a limited area to the south and that for the majority of views there will be little or negligible impact. However, it is also recognised that the magnitude of the aesthetic impact will depend largely on the viewer's predisposition towards wind turbines, rather than, for example, the creation of visual discordance or a reduction in the lighthouse's contribution to a valued view. The extent to which the lighthouse's functional relationship with its surroundings will remain unchanged. The impact will finish upon decommissioning.

Mitigation

96 No mitigation is proposed in relation to the impact upon the setting of Girdle Ness lighthouse.

Residual Impacts

97 No mitigation is proposed in relation to impacts upon the setting of Girdle Ness lighthouse and the predicted impacts will be of minor to moderate significance. The potential impact will finish upon decommissioning.

Cumulative Impacts

98 The potential for cumulative impacts to result from the EOWDC and the potential Ocean Laboratory has been considered. The Ocean Laboratory could comprise a 120 m mast with a platform 20 m above LAT. It could be located to the south of the proposed EOWDC turbines. It has been concluded that there will be no cumulative impact. The predicted impact relates to the proposed turbines appearing as large structures in views of the lighthouse. The Ocean Laboratory would be seen amongst the turbines and would not alter the effect.

99 The potential for cumulative impacts to arise from the EOWDC and onshore wind farms has been considered. The cumulative ZTV (SLVIA Figure 15) indicates that up to two other consented wind farms will theoretically be visible from the area of the lighthouse. The closest will be over 20 km away. Given the distance, it is concluded that there is no potential for cumulative impacts. The indicative ZTV for proposed wind farms (SLVIA Figure 16) indicates that no proposed wind farms will be visible.

Monitoring

100 No monitoring is proposed.

1.3.2 Summary of Impact Assessment

58 The results of the impact assessment are summarised in Table 4.

TABLE 4
Impact Assessment

Potential Impact / Activity	**Sensitivity of Receptor**	**Magnitude of Effect**	**Significance**	**Mitigation**	**Significance after Mitigation**	**Monitoring**	**Cumulative / In-combination**
Impact upon setting of Torry Battery	High	Negligible	Minor	None proposed	Minor	None proposed	None
Impact upon setting of Orrok House	High	Negligible	Minor	None proposed	Minor	None proposed	None
Impact upon setting of Girdle Ness Lighthouse	High	Low	Minor to moderate	None proposed	Minor to moderate	None proposed	None
Impact upon setting of Peterseat cairns	High	Negligible	Minor	None proposed	Minor	None proposed	None
Impact upon setting of Hare Cairn	High	Negligible	Minor	None proposed	Minor	None proposed	None
Impact upon setting of other assets	Low - Medium	Negligible	Negligible	None Proposed	Negligible	None proposed	None

1.4 Summary

101 The potential impact of the EOWDC has been considered in relation to all nationally important designated cultural heritage assets within 10 km of the proposed turbines and selected assets beyond this.

102 Potential impacts of greater than negligible significance have been identified in five cases: Hare Cairn, the Peterseat cairns, Torry Battery, Orrok House and Girdle Ness Lighthouse. The first three are Scheduled Monuments, whilst the latter two are Grade A-listed buildings.

103 The impacts upon Hare Cairn, the Peaterseat cairns, Torry Battery and Orrok House have been assessed as being of minor significance and those upon Girdle Ness Lighthouse as being of minor to moderate significance. No mitigation is proposed in relation to these impacts and they will persist throughout the lifetime of the EOWDC and cease upon decommissioning.

1.5 Plates

Plate 1: View north from Torry Battery (SM9215)

Plate 2: View to south-east from near Orrok House (LB2778)

Plate 3: Girdle Ness Lighthouse (LB20078) from the south-west

Plate 4: View to north from Girdle Ness Lighthouse (LB20078)

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114 **Plate 5: View north to Girdle Ness Lighthouse (LB20078) from the coastal road**

115 **Plate 6: View north to Girdle Ness Lighthouse (LB20078) across Nigg Bay**

European Offshore Wind Deployment Centre

Environmental Statement

Appendix 21.1: Commercial Fisheries Baseline Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

European Offshore Wind Deployment Centre (EOWDC)

Commercial Fishing Aspects

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Ref	Issue	Checked	Approved	Issue Date
SJA5	Final	J.H.M.,P.J.M.	S.J.A.	12/04/2011

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1	e	Edwina Sleightholme

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1.0 Introduction

Given below is the description of the commercial fishing baseline for the proposed European Offshore Wind Deployment Centre (EOWDC) development, taking into account FEPA, CPA, Defra and CEFAS requirements as specified in the 2004 Guidelines (Cefas, 2004) and BWEA 2004 Recommendations (BWEA, 2004).

In the case of the wild salmon and sea trout fisheries, the combination of the regional socio-economic importance of these activities and the potential significance of the impacts from the proposed development are such that they have been separately assessed.

As there is no single data source or recognised model for establishing commercial fisheries baselines within small, discrete sea areas such as wind farm sites the following description of the baseline has, therefore, been derived using data and information from a number of sources.

2.0 Summary

To date, there have been very low levels of fishing activity within the proposed EOWDC site, largely as a result of the poor productivity of the area. Four local vessels have been identified as operating within the general area of the site, all of which are inshore demersal trawlers. These vessels range between 8 and 11 m in length, three of which register their home ports as Aberdeen. The fishing grounds of these vessels were stated to be between Aberdeen Harbour Fairway Buoy and the buoys off the Black Dog Firing Range, with the main target species being plaice. In addition to trawling, these three vessels have the capacity to deploy creel (potting) gears. The fourth vessel fishing the area, whose home port is Peterhead, fishes on a part time basis and only occasionally visits the site to trawl for plaice. From the consultation undertaken and the evidence obtained, it is apparent that the area of the proposed EOWDC site constitutes only a small proportion of the fishing grounds of these vessels.

Analysis of Vessel Monitoring System (VMS) plot data from over 15m vessels suggests that vessels with plots recorded within the site are steaming through it to more productive fishing grounds further afield. The nearest scallop dredging areas are on the Bennachie ground, which lies in the deeper offshore waters beyond Aberdeen Bay. The nearest nephrops grounds are identified well to the south of the site, off the coast of Montrose. Potting, largely by virtue of the habitat requirements of the main target species, is concentrated in areas to the south and north of the site.

3.0 Study Area(s)

The study area for the assessment of commercial fishing intensity and values is shown in Figure 3-1 below. The approach has been to follow a focus from a larger regional area down to the local area and the specific area of the site.

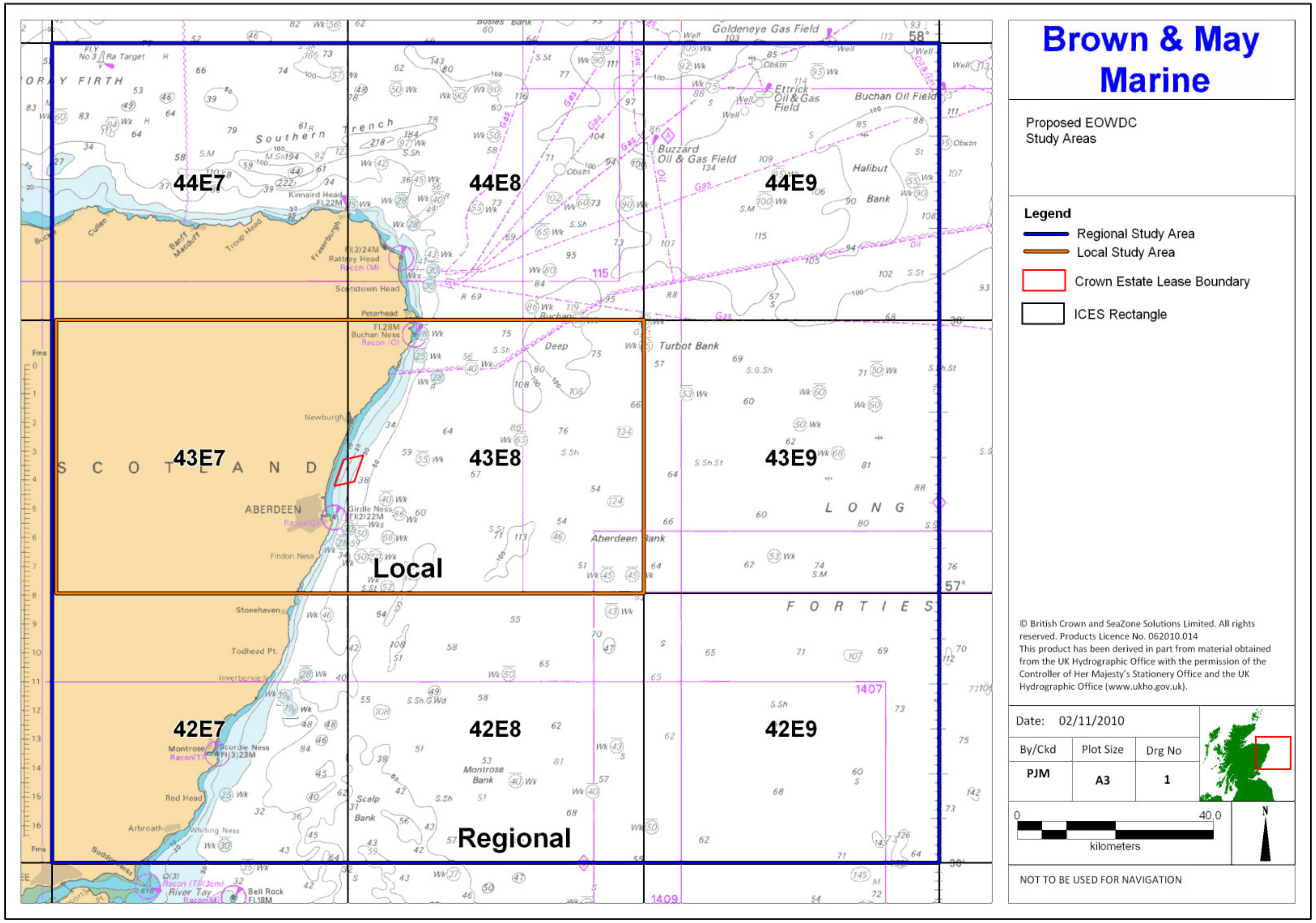


Figure 3-1 Proposed EOWDC Study Areas

4.0 Methodology

4.1 Consultation

Consultation with the relevant local fishermen was principally undertaken by the Scottish Fishermen's Federation (SFF) between 2008 and 2010. The SFF represents approximately 90% of Scottish fishermen.

Four vessels were identified as fishing in the development area and direct consultation was undertaken with the skippers of these vessels, who along with the District Fisheries Officer provided valuable contributions to this report.

The information gathered through consultation has been verified by:

- Michael Sutherland, John Watt and John Ewan; of the Scottish Fishermen's Federation (SFF)
- Ian Balgowan; President Scottish Inshore Whitefish Producers

4.2 Key Guidance Documents

The following documents have been referenced for both the Baseline and Impact Assessments:

- Offshore Wind Farms, Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements - Version 2; Cefas, MCEU, Defra, DTI, June 2004
- Strategic Environmental Assessment(SEA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Volume 1: Environmental Report; Marine Scotland 2010
- UK Offshore Energy – Strategic Environmental Assessment; DECC, January 2009
- Recommendations for Fisheries Liaison; FLOW, May 2008
- Fisheries Liaison Guidelines – Issue 5; UK Oil & Gas, 2008
- Guidelines to Improve Relations between Oil & Gas Industries and Near-shore Fishermen, UKOOA (renamed UK Oil & Gas), August 2006
- Fishing & submarine Cables – Working Together, International Cable Protection Committee (CPC), February 2009
- Options and Opportunities for Marine Fisheries Mitigation Associated with Wind farms, COWRIE 2010.
- Scoping Response -Marine Scotland (15.12.10)

4.3 Data Sources, Sensitivities and Qualifications

The principal sources of data and information used were:

- International Council for the Exploration of the Sea (ICES)
- Marine Management Organisation (MMO)
- Marine Scotland, Marine Scotland Science (MS)
- Scottish Fisheries Protection Agency (SFPA)
- European Fisheries Commission (Europa)

Analysis of the data and information sources used for the commercial fishing assessment are subject to the following qualifications, limitations, sensitivities and gaps:

4.3.1 International Council for the Exploration of the Sea (ICES) Statistical Rectangles

ICES statistical rectangles are the smallest spatial unit used for the collation of fisheries statistics used by the EC and member states. The boundaries of ICES rectangles align to 1˚ of longitude and 30' of latitude. As is apparent from Figure 3-1 above, however, the areas of ICES rectangles are large relative to the area of the proposed EOWDC site, which is situated on the border of ICES rectangles 43E7 and 43E8. Evaluation of fisheries statistics by ICES rectangle should therefore recognise the small proportion of the statistical rectangles that the proposed EOWDC site covers.

4.3.2 MMO Fisheries Statistics

The MMO collects and collates fisheries data by ICES rectangle. The principal source of data comes from the European Commission (EC) daily log sheets that all vessels over 10m are required to complete and submit.

Vessels of under 10 m in length are currently not obliged to submit daily log sheets, although voluntary submissions can be made. In addition, local fisheries officers undertake dockside checks on vessels under 10 m. The "Registration of Buyers and Sellers of First Sale Fish and Designation Auction Site Scheme" introduced in 2005 and the reporting requirements of the "Shellfish Entitlement Scheme" introduced in 2004, have further contributed to the validity of fisheries data for the under 10 m fleet. The MMO fisheries statistics for this category, especially in years prior to the introduction of the Scheme, in some cases underestimate the true levels of fishing in areas where a large percentage of the activity is by vessels within this category.

It should be noted that vessels referred to as "foreign" in the MMO fisheries data only include foreign vessels landing into UK ports. Foreign vessels fishing in the area but landing into non-UK ports are not recorded. The values given for foreign vessels should therefore not be taken as an indication of the total foreign activity.

4.3.3 MMO Surveillance Sightings

Surveillance sightings in UK waters are recorded by fishery protection aircraft and surface craft as a means of policing fisheries legislation. These data provide a good indication of the relative distribution of fishing activity by method and nationality but should not be taken as a quantitative assessment of fishing activity, given the low frequency of the flights over an area, which are generally once a week and only during daylight hours.

4.3.4 MMO UK Satellite Tracking (VMS) Data

All EU registered fishing vessels of more than 15 m in overall length are monitored by satellite tracking. The positions of the vessels are transmitted approximately every 2 hours via satellite link to the MMO and other national EU control centres. The MMO receives information on all UK vessels irrespective of location, and of foreign vessels within UK waters. The MMO cannot however disclose data on foreign vessels without prior permission from the regulating body of the applicable member state and disclosure of UK vessels' identities is restricted under the Data Protection Act (1998).

There has also been a change in MMO policy with regards to the release of individual vessel coordinates data even if the vessel's identities are withheld. Instead the number of plots by vessel type in a grid of rectangles of approximately 70 $n.m^2$ is provided. The 2009 data have therefore been presented separately from the 2005-2008 datasets given the differences in format.

5.0 Fisheries Controls and Legislation

Whilst the international aspect of European fisheries negotiation, such as the setting of quotas, remains a reserved power, the implementation of fisheries regulations is devolved to the Scottish Parliament, and administered by Marine Scotland.

5.1 Fishing Vessel Licenses

All vessels engaged in commercial fishing must hold a valid licence. The system is designed to prevent increases in both fleet numbers and catching capacities through a system of vessel capacity units (VCUs). In addition to limiting any further increases in fishing vessel numbers, decommissioning schemes have, over the past 20 years, resulted in significant reductions in the numbers of UK and certain other member states' fleets.

5.2 Territorial Limits

Member States' territorial fishing limits extend out to 12 nm. With some exceptions, access within 6n.m of the coast is restricted to the vessels of that Member State. The only vessels from other member states allowed access within the UK's 6-12nm limit are those with historic rights.

Figure 5-1 below shows there are no historic rights for other Member State's vessels within Scotland's 12 nm limit off the east coast and hence within the area of the proposed EOWDC site.

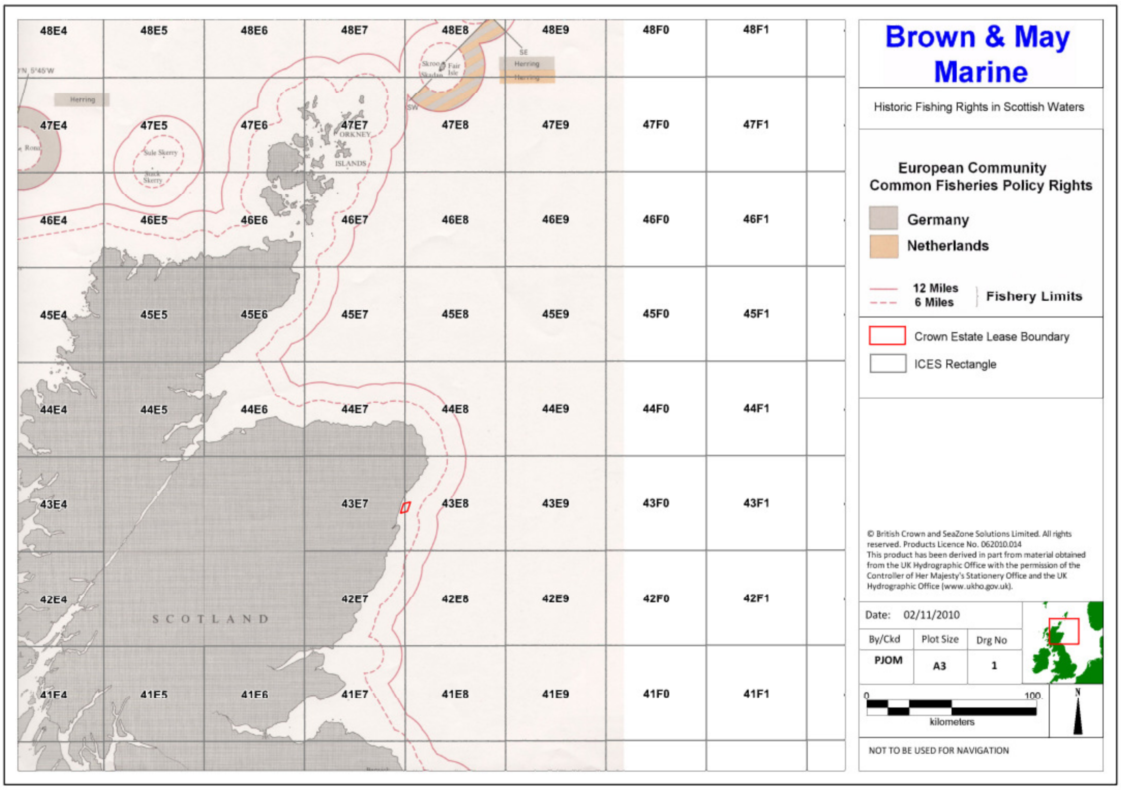


Figure 5-1 Historic Fishing Rights in Scottish Waters (Source: Admiralty Chart Q6385)

There is however, a number of UK flagged and licensed fishing vessels under foreign ownership, which could in theory have rights to fish within the UK 12 n.m limit.

5.3 Quota Restrictions

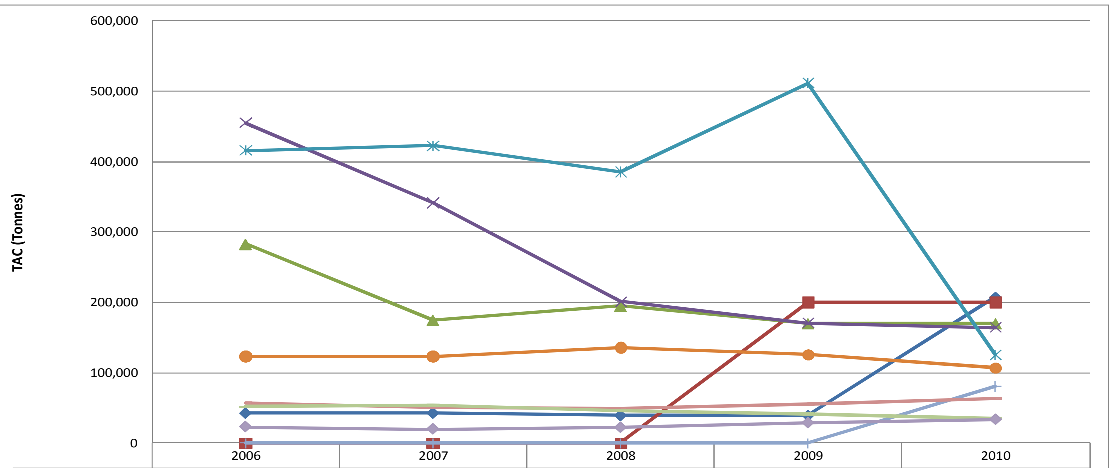
The Scottish Executive manages quotas for fish stocks and controls the activities of fishing vessels and fishing effort (days at sea) in the Scottish waters of the North Sea, West of Scotland and Faroese waters, plus all inshore fisheries within the 12 nm territorial limit (Scottish Government, 2010b). Such controls and regulations have had, and will continue to have, direct and indirect impacts on existing and future commercial fisheries baselines.

The principal remit of the EC Common Fisheries Policy (CFP), ratified in the early 1980's, is the long-term conservation of fish stocks in EU waters. A central element of the CFP is the system of quotas by ICES area and sub-area. Species identified as requiring management are defined as pressure stocks. Annual Total Allowable Catches (TACs) are allocated for each pressure stock by area or sub-area.

National, regional and individual quotas for the over 10 m fleet are assigned on the basis of historical rights and track records. Vessel quotas are in effect tangible assets which can and are sold or leased, and national quotas can, and have been, exchanged or swapped between member states.

The system of quotas has however been criticized as a conservation measure despite being in place for more than 20 years as the primary stock conservation measure of the CFP. It is recognised that regulation by quotas encourages the discarding of either undersized or over quota fish at sea. In recognition of such failings, the CFP is currently under review, which could result in significant changes to future fisheries management policies and legislation.

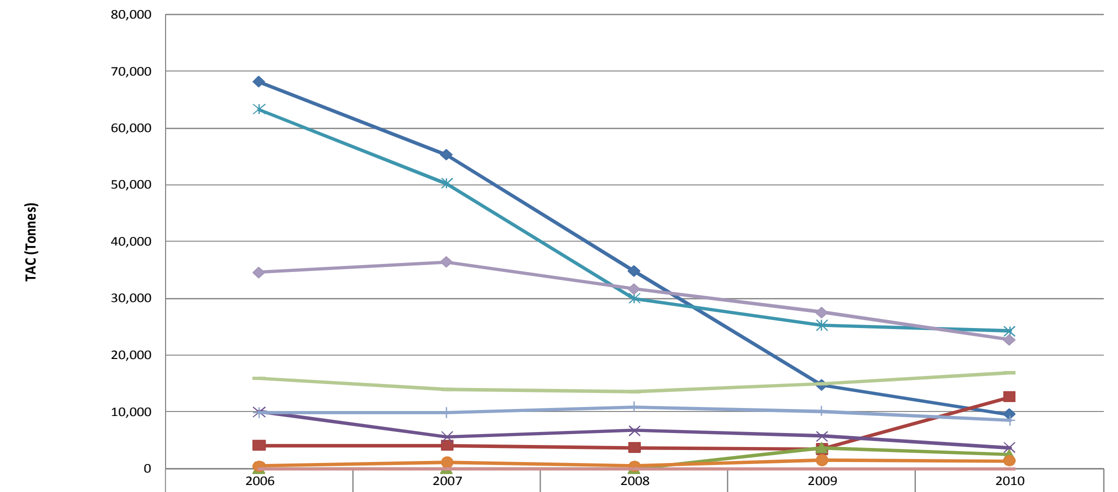
Figure 5-2 and Figure 5-3 overleaf illustrate patterns of progressively reducing TACs and UK quotas in ICES Area IV (North Sea) for the principal pressure stock species since 2006. Blue whiting are the species caught in greatest numbers in the North Sea.



	2006	2007	2008	2009	2010
Horse Mackerel	42,727	42,727	39,309	39,309	207,335
Sandeel	0	0	0	200,000	200,000
Sprat	282,700	175,000	195,000	170,000	170,000
Herring	454,751	341,063	201,227	171,000	164,300
Mackerel	415,824	422,551	385,366	511,287	125,756
Saithe	123,250	123,250	135,900	125,934	107,044
Norway Pout	0	0	0	0	81,000
Plaice	57,441	50,261	49,000	55,500	63,825
Haddock	51,850	54,640	46,444	42,110	35,794
Cod	23,205	19,957	22,152	28,798	33,552

Year

Figure 5-2 Total Allowable Catches of Principal Pressure Stock Species in the North Sea (ICES Area IV) (Source: Europa)



	2006	2007	2008	2009	2010
Blue Whiting	68,161	55,283	34,759	14,670	9,535
Horse Mackerel	4,101	4,104	3,721	3,470	12,671
Sandeel	0	0	0	3,660	2,379
Sprat	10,010	5,562	6,659	5,705	3,690
Herring	63,333	50,279	30,025	25,275	24,223
Mackerel	451	1,092	462	1,463	1,395
Saithe	9,895	9,895	10,911	10,110	8,435
Norway Pout	0	0	0	0	0
Plaice	15,887	13,987	13,626	14,975	16,951
Haddock	34,574	36,466	31,672	27,507	22,698

Figure 5-3 Annual UK Quotas of Principal Pressure Stock Species in the North Sea (ICES Area IV) (Source: Europa)

5.4 Effort (Days at Sea) Restrictions

Over 10 m vessels are also subject to days at sea (effort) limitations as part of the EC's policy of reducing fishing effort in EU waters. The regulation (Annex V, Council Regulation (EC) No 2287/2003) is somewhat complex and relates to gear type, mesh size and elected management periods. In essence, vessels using demersal whitefish gears are restricted to the equivalent of 14-15 days a month at sea.

5.5 Shellfish Entitlements

Since 2004 vessels must also be specifically licensed to catch crabs and lobsters. Under these arrangements, shellfish entitlements allowing unrestricted amounts of crabs and lobsters to continue to be caught were issued to owners of licensed vessels that had a track record of landing over a particular weight of these species per year. It is a condition of vessels of 10 m and under with shellfish entitlement that they submit weekly log sheets for crab and lobster landings.

5.6 Under 10 metre Fleet

The under 10 m fishing fleet has not, as yet, been subject to the same levels of restrictions upon their activities as the over 10 m sector. They are now however also subject to sea area and quota restrictions for certain species mainly as part of the 'Cod Recovery Programme'. Table 5-1 below shows the under 10 m quota allocations for 2010, 2009, 2008 and 2007.

Table 5-1 Under 10m Final Quota Allocations (Source: MMO)

Species	2010 Quota (Tonnes)	2009 Quota (Tonnes)	2008 Quota (Tonnes)	2007 Quota (Tonnes)
North Sea Cod	588.0	561.3	403.1	281.0
North Sea Haddock	127.9	80.5	131.6	175.2
North Sea Sole	110.5	275.7	342.1	278.1
North Sea Plaice	40.4	40.7	54.2	43.3
North Sea Whiting	321.9	355.5	89.8	660.6
North Sea Skate and Rays	103.1	106.3	265.1	209.3
North Sea Lemon Sole/ Witches	22.2	23.2	72.6	62.6
North Sea Turbot/ Brill	10.6	15.0	17.9	22.7
North Sea Dab/ Flounder	19.4	18.9	18.7	17.6

5.7 Regional and Local Fishing Restrictions

Restrictions upon fishing activities in addition to those transposed from EU and UK law are known as Scottish Statutory Instruments (SI), a form of secondary legislation in Scotland, created by the Scotland Act 1998, and used to exercise devolved powers.

There are no local fishing restrictions within the 3 nm limit specific to the Aberdeen Bay area (Figure 5-4). Fishing activity is instead constrained by other factors, such as species abundance and the avoidance of traffic entering and leaving the harbour.

In a wider regional context, the following fishing restrictions are imposed in the areas defined in Figure 5-4:

- Aberdeen to Mons Craig – Use of mobile or active gear is prohibited between 1st October and 31st March each year
- Mons Craig to Doolie Ness –Use of mobile or active gear prohibited all year
- Doolie Ness to Lang Craig – Use of mobile or active gear is prohibited between 1st October and 31st March each year within one mile and between 1st April and 30th September each year within one half mile
- Lang Craig to Arbroath - Use of mobile or active gear prohibited all year

In addition restrictions are placed on scallop dredging activity in terms of the number of dredges a vessel can operate. This activity is stated as predominantly taking place in areas to the south and east of the proposed EOWDC site (SFPA, 2007).

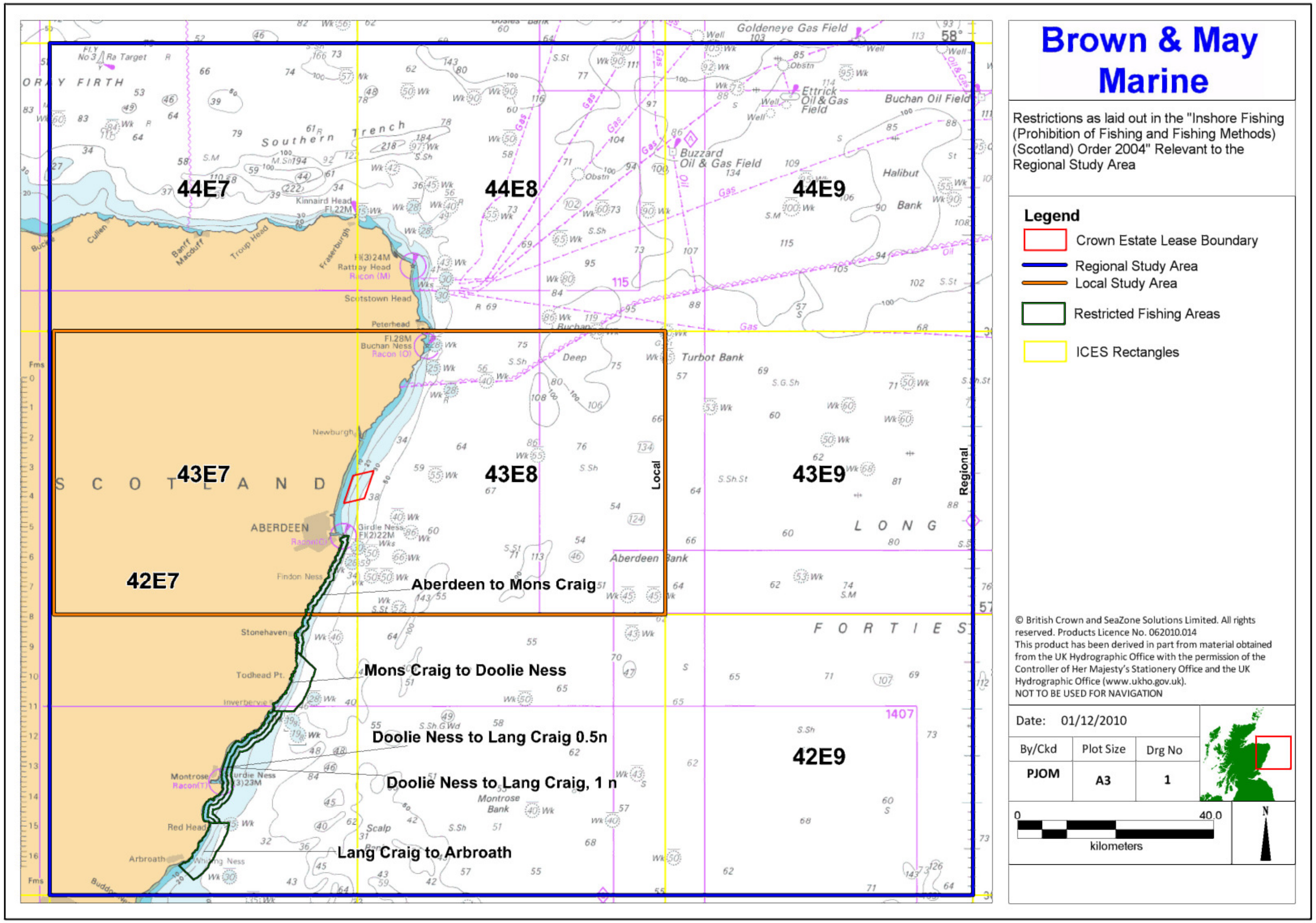


Figure 5-4 Restrictions as laid out in the "Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 2004" relevant to the Regional Study Area

6.0 Commercial Fishing in Scotland and Aberdeen

6.1 National Context

The following information has been taken from the Scottish Sea Fisheries Statistics (SSFS) 2009 and Marine Scotland publicly available information sources.

Since 1983 the structure and capacity of the UK and Scottish fishing fleets have been primarily dictated by the EU Common Fisheries Policy (CFP). Between 1997 and 2002 the Multi Annual Guidance Programme (MAGP) within the CFP was devised to manage fleet structures. In effect, fishing by method was restricted by capacity limits and effort reduction targets. When this programme ended it was replaced by member state level controls which impose effort level ceilings through a system of exit/entry restrictions. In essence, fleet capacity cannot be increased, allowing vessels only to enter the fleet when an equivalent or larger capacity has exited the fleet.

One of the most significant impacts upon the Scottish fleet in recent years has been the two successive decommissioning schemes in 2001-2002 and 2003-2004, under which 165 vessels were removed from the national demersal fleet.

In 2010 the Scottish Government introduced Licence Parking as a measure to help the fleet adjust to current, restrictive conditions. The principle is to enable multiple existing fishing licenses to be combined and placed upon a single fishing vessel – thus sharing it – in order to reduce fixed and variable costs over both the short and long term. Alternatively, those wishing to leave the industry may be bought out and their effort concentrated on remaining vessels (under previous licensing rules this was not possible). The process of ‘parking’ is however reversible; a parked license can be ‘unparked’. Over 40 vessels have applied for this scheme to date. In consultation with industry stakeholders and the Scottish Fisheries Council, Ministers have now also introduced a publicly funded (co-funded by the European Fisheries Fund) fleet resilience grant scheme aimed at disposing of those vessels made dormant through license parking.

6.1.1 Scottish Landings Values

Table 6-1 lists the ports included within the three port districts, Fraserburgh, Peterhead and Aberdeen, in the region of the proposed development.

Table 6-1 Ports within the East Coast Port Districts of Fraserburgh, Peterhead and Aberdeen (Scottish Government, 2010a)

Fraserburgh	Peterhead	Aberdeen
Fraserburgh	Boddam	Aberdeen
Gardenstown	Peterhead	Arbroath
Macduff	Port Errol	Catterline
Pennan		Gourdon
Portsoy		Johnshaven
Rosehearty		Montrose
Sandhaven & Pitullie		Stonehaven
Whitehills		

Figure 6-1 below gives the 2009 total landings values for all vessels into Scottish ports by district and species group.

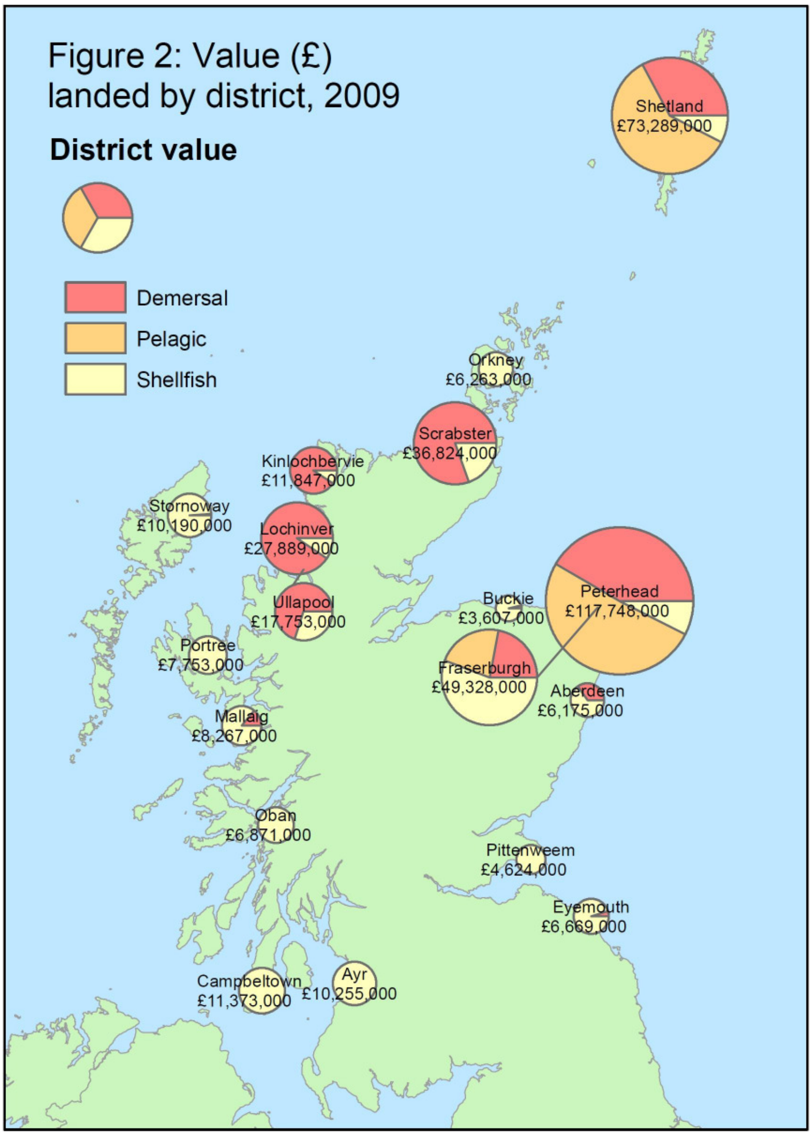


Figure 6-1 Total Landings Values (£) into Scottish ports by Port District, 2009 (Extracted from: Scottish Government, 2010a) ("Figure 2" in the picture refers to the report from which it was taken)

The 2009 total landings values show Peterhead (£117,748,000) to be the most important port district in Scotland and indeed within the UK, followed by Fraserburgh (£49,328,000) and Scrabster (£36,824,000) respectively. Aberdeen port district is fifteenth, with a 2009 total landings value of £6,175,000.

6.1.2 District Fleet Sizes

Table 6-2 shows that at the end of 2009 2,174 active fishing vessels were recorded as based in Scotland, a reduction of 31 (-1.4%) from 2008, which is the smallest fleet recorded for Scotland since the Second World War. Reductions occurred in 11 of the 18 districts, with losses mainly in the North West, including the Isles. Five districts saw an increase in vessel numbers, Oban (+6), Eyemouth (+5), Aberdeen (+3), Orkney (+2) and Kinlochbervie (+1).

Table 6-3 below gives fleet numbers by length for the three port districts in the region of the proposed EOWDC site. The majority of vessels based in Aberdeen are under 10 m, whereas fleets in Peterhead and Fraserburgh consist mainly of over 10 m vessels.

Table 6-2 Vessel Numbers by District (2005-2009) (Scottish Government, 2007; 2008; 2009; 2010a)

	Number of active vessels					
District	2005	2006	2007	2008	2009	Change between 2005-2009
Eyemouth	110	98	100	95	100	-10
Pittenweem	102	101	108	120	117	+15
Aberdeen	93	93	92	92	96	+3
Peterhead	98	99	104	107	100	+2
Fraserburgh	217	221	214	226	220	+3
Buckie	73	79	78	87	85	+12
Wick	123	120	128	129	129	6
Orkney	161	153	155	150	152	-9
Shetland	195	185	177	182	182	-13
Stornoway	311	303	281	267	258	-53
Lochinver	18	18	15	15	14	-4
Kinlochbervie	26	26	25	23	24	-2
Ullapool	69	67	69	85	82	+13
Mallaig	84	71	69	65	59	-25
Oban	140	132	129	123	129	-11
Campbeltown	162	161	155	137	135	-27
Ayr	161	158	153	157	149	-12
Portree	143	139	139	145	143	0
Total	**2,286**	**2,224**	**2,191**	**2,205**	**2,174**	**-112**

Table 6-3 Vessel Numbers by Length Division and Port District, 2009 (Scottish Government, 2010a))

Port District	10metres & Under	>10 <15 metres	15 <18 metres	18 <25 metres	25 <35 metres	35 <50 metres	50 metres +	Total
Eyemouth	73	16	3	7	1	-	-	100
Pittenweem	100	13	2	2	-	-	-	117
Aberdeen	81	8	-	5	2	-	-	96
Peterhead	46	-	2	24	19	5	4	100
Fraserburgh	102	11	14	59	22	1	11	220
Buckie	45	5	3	25	5	2	-	85
Scrabster	110	12	2	3	2	-	-	129
Total East Coast	557	65	26	125	51	8	15	847

6.2 Aberdeen

6.2.1 Historic Context

The fishing industry was the mainstay of Aberdeenshire's economy for much of the 1800 and 1900's. By 1892 it was Scotland's leading whitefish port (Aberdeen Maritime Museum, 2007). Trawling employed over 1,000 people (on boats as well as dockside) in 1900, a number that had doubled to more than 2,000 by 1910. Haddock was the most important species landed, followed by cod.

Aberdeen's importance as Scotland's premier fishing port remained high throughout the early and mid 1900's. In 1956 Aberdeen continued to land over 75% of Scotland's total whitefish catch and was known as a 'distant water port', with vessels fishing grounds as far afield as Faroese and Icelandic waters.

In the years spanning from the 1950's to the 1970's, a series of disputes and confrontations arose amongst fishing interests active in the grounds around Iceland. In 1958, Iceland, concerned about the over exploitation of declining fish stocks, increased its fishing limits from 4 to 12 nm. Among the foremost affected were UK registered vessels. In 1972 a second dispute ensued following Iceland extending its territorial fishing limits to 50 nm. An agreement, lasting for 2 years was reached the following year limiting UK vessel access through the implementation of certain restrictions. However, when this agreement ended in 1975 the third and most confrontational 'Cod War' commenced. This culminated in Iceland threatening NATO with the closure of a base at Keflavik. A six month agreement was reached to restrict British vessels, after which time they were excluded from Iceland's 200 nm. limit, an outcome that heralded the demise of the UK's distant water fleet based at Aberdeen and other ports.

Aberdeen's fishing industry suffered a further setback in the mid to late 70's when many fishing vessel owners, suffering from a general downturn in the industry, transferred their vessels from Aberdeen to Fraserburgh or Peterhead. This was primarily due to Aberdeen's status as a 'dock labour' port, whereby all vessels landing into the port had to use the unionised dock labour for discharging their catch. By relocating to other ports vessels were able to make significant cost savings through the crews landing their own catches.

After the decline of the distant water fleet, the relative importance of the home fleet increased, and until around 15 years ago there were approximately 40 active full-time fishing vessels operating out of Aberdeen (Sutherland, 2007). Measures were however implemented by the EU in response to declining fish stocks that required a reduction in fishing effort. As a further response to the EU requirement of a reduction in fishing effort, the UK introduced decommissioning policies in Scotland in 2001 and 2002 (Section 6.1). This had a negative effect on the structure of the Aberdeen fishing fleet. There were no restrictions upon the age of vessels being decommissioned and frequently relatively new vessels were withdrawn, leaving an ageing industry in decline (Sutherland, 2007).

6.2.2 Aberdeen Port Today

The rapid expansion of oil and gas interests in the North Sea in the 1970's saw Aberdeen become the principal service port for the UK's offshore oil and gas industries. Where before the majority of the docks were given over to fishing vessels, there now remains only one fish quay – Commercial Quay. Although the market now handles significantly reduced quantities of fish, some vessels registered to other ports still land into Aberdeen. The port also has an important general maritime trade (in timber and grain, for example) as well as some naval activity.

There remain a number of fish processing plants in Aberdeen, with fish brought in by road transport from other ports in the north and west.

Interests within the fishing industry, notably the Scottish Fishermen's Federation (SFF), have derived benefits from the offshore oil and gas industries, which over the last 30 years have pursued a policy of deploying fishing vessels for oil-based work. The success of this diversification has contributed to the SFF establishing a Services Company which sources crew and vessels for work such as guard vessel duties and Marine Mammal Observation (MMO) duties.

7.0 MMO Fisheries Statistics

7.1 Landings Values by ICES Rectangle

7.1.1 Regional Study Area

Figure 7-1 and Figure 7-2 below illustrate the relative values of UK commercial fishing by method and species in comparison the ICES rectangles covering the regional area.

It can be seen that ICES rectangle 43E7, within which the inshore part of the proposed EWODC site is located has significantly lower landings values than other ICES rectangles in the region, largely due to its very small sea area. Rectangles to the north of the site contain the highest average landings values within the regional area. Bottom otter trawling for nephrops and whitefish is the principal fishing method undertaken in the regional study area, concentrated mainly in the northern rectangles, followed by scallop dredging by boat dredge mainly in the southern rectangles. Potting is generally deployed in inshore areas.

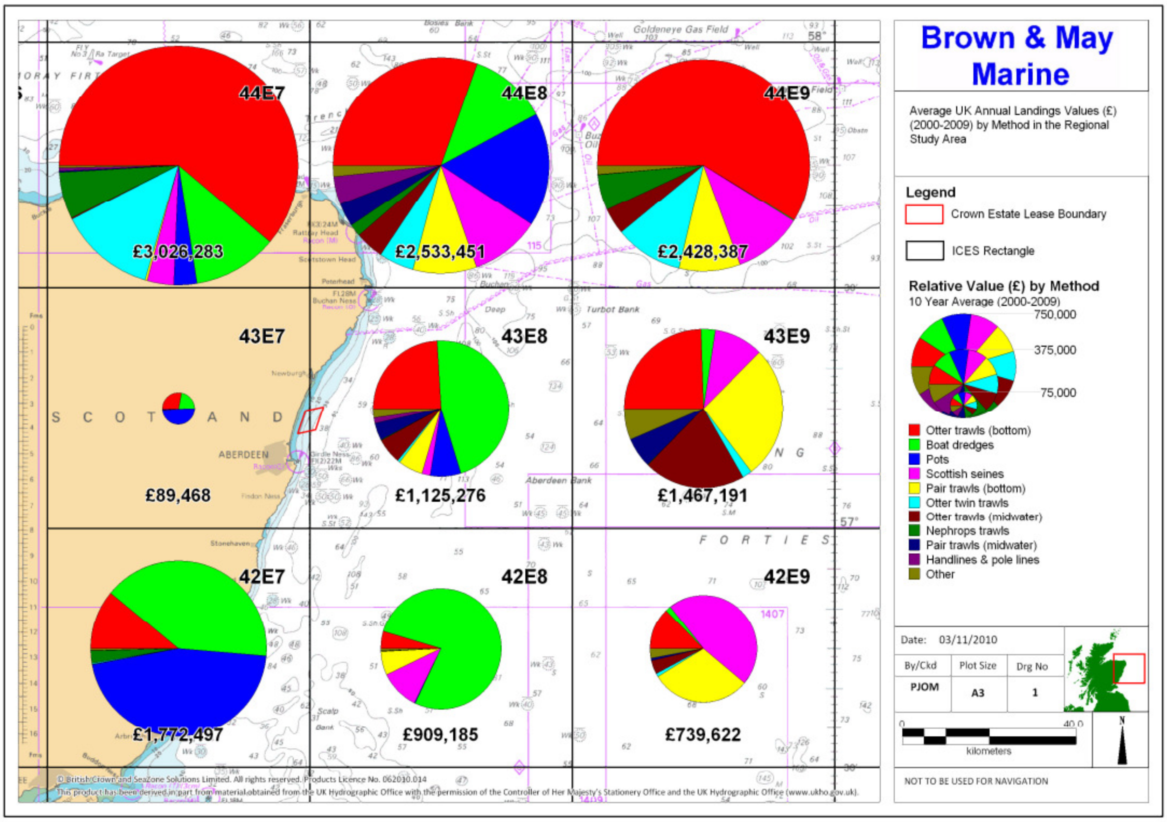


Figure 7-1 Averaged UK Annual Landings Values (2000-2009) by Method in the Regional Study Area

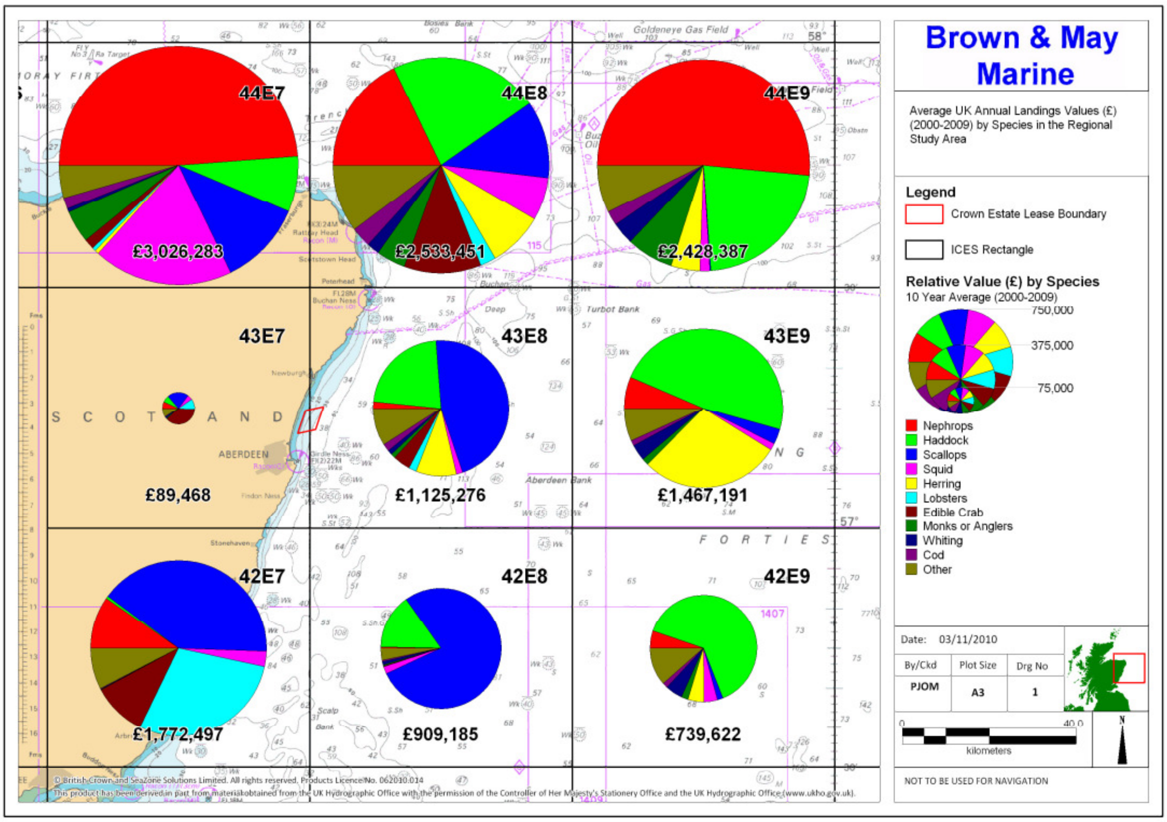


Figure 7-2 Averaged UK Annual Landings Values (2000-2009) by Species in the Regional Study Area

7.1.2 Local Study Area

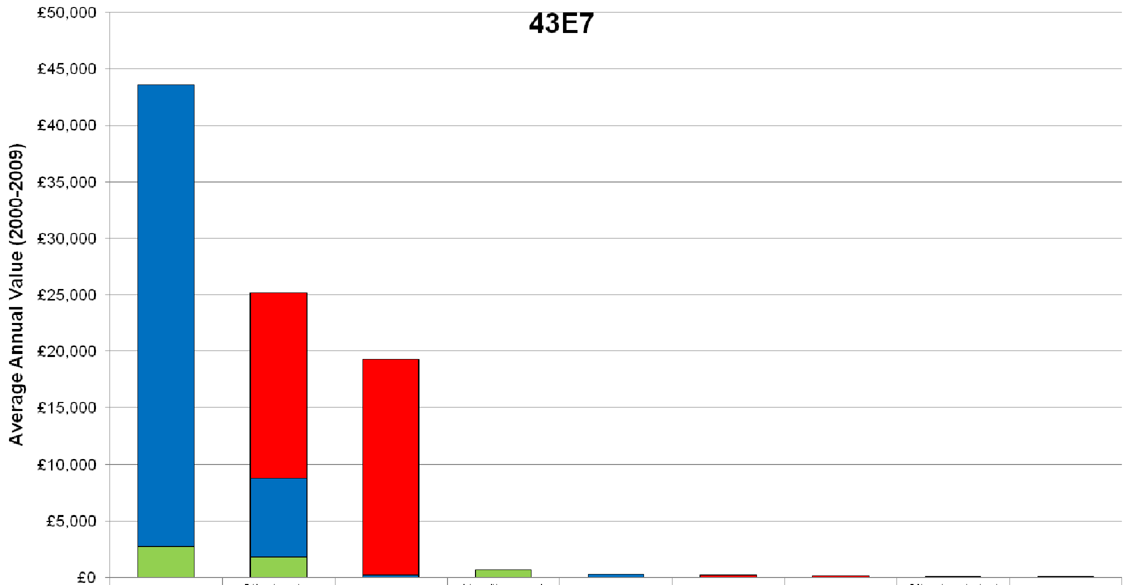
ICES Rectangle 43E7

Figure 7-3 and Figure 7-4 below give the 10 year averaged annual values of landings by method and species for 43E7, the rectangle in which the inshore part of the proposed EOWDC site is located. These indicate that the majority of the value of fishing in the area of the proposed EOWDC site in 43E7 is from: potting for crab and lobsters; bottom otter trawling for whitefish and nephrops; and dredging for scallops, respectively. Other methods such as hand lines and pole lines, gillnets and Scottish seines recorded only low values.

Whereas the value of potting is largely derived from 10-15 m vessels, a greater percentage of the value of bottom otter trawling is from the 15 m and over fleet. Nearly all the value from boat dredging is derived from 15 m and over vessels.

There has been no foreign vessel activity recorded within ICES rectangle 43E7.

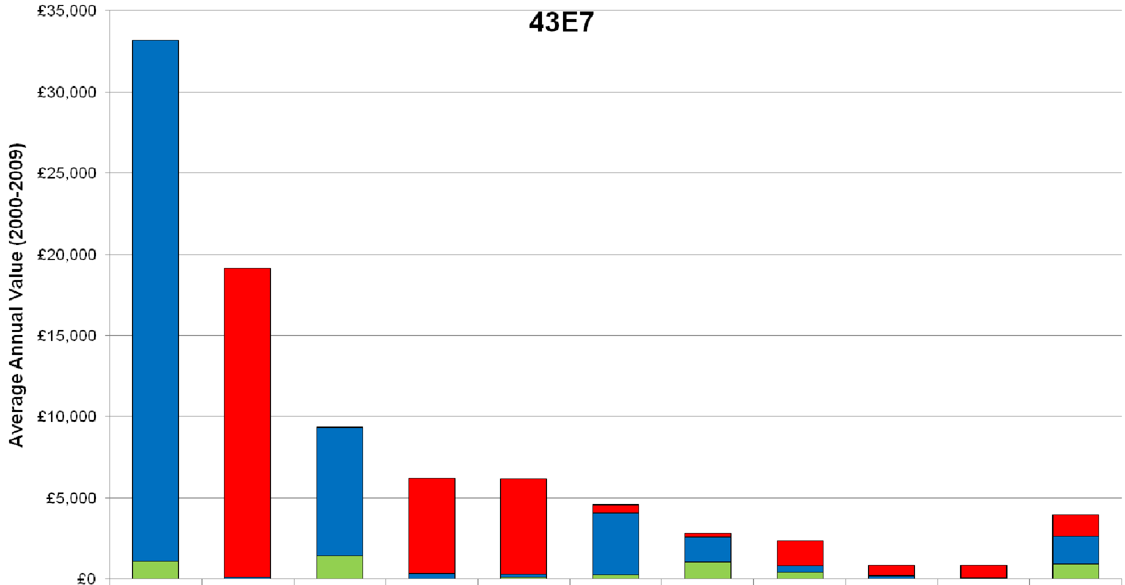
Figure 7-5 and Figure 7-6 give the annual landings values by method and species from ICES rectangle 43E7. Potting values have increased significantly since 2004, being consistently the highest value method since 2005, however this may be due to the introduction of shellfish entitlements in 2004 and the requirement for weekly catch returns. Bottom otter trawling, which had the highest average landings between 2000 and 2003 had seen a marked decline in the years following. There are significant fluctuations in the annual landings values for a number of principal species between 2000 and 2009. Edible crab, not generating particularly high landings values between 2000 and 2003 overall, had a significant increase in the following years, peaking in 2007 at £67,030. This in turn, coincided with a peak in potting, and the highest recorded value for one species in the 10 year period. Similarly, scallops, targeted by boat dredges, which previously had low landings values levels, experienced a sharp peak in 2004 with relatively high values subsequently.



	Pots	Otter trawls - bottom	Boat dredges	Handlines and pole-lines	Gillnets	Scottish seines	Otter twin trawls	Other trawls (not specified)	Nephrops trawls
Non-UK	£0	£0	£0	£0	£0	£0	£0	£0	£0
15m and over	£0	£16,469	£19,042	£0	£0	£216	£128	£0	£0
10m-15m	£40,893	£6,938	£233	£0	£253	£0	£0	£0	£19
U10m	£2,717	£1,823	£0	£666	£3	£0	£0	£67	£0

Method

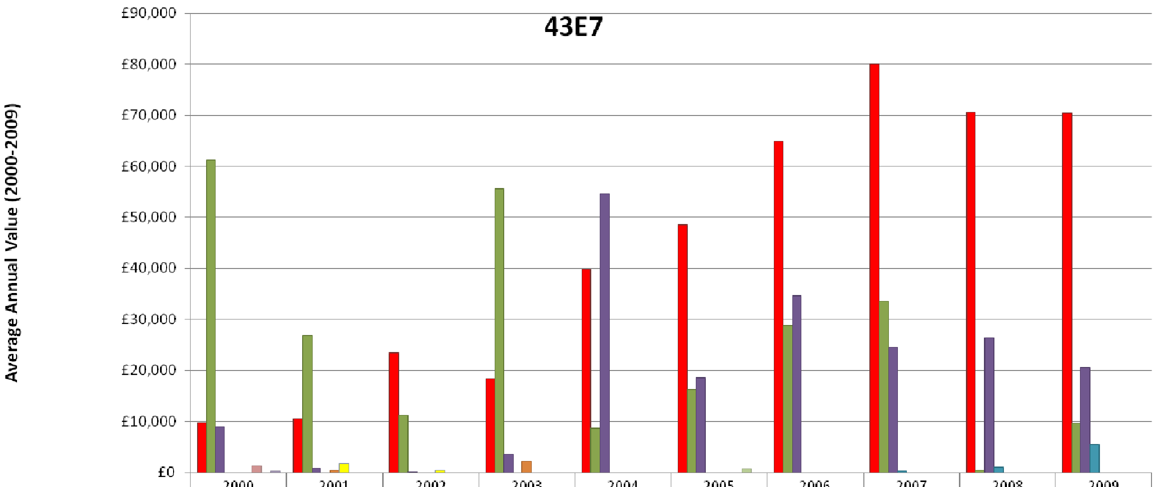
Figure 7-3 Averaged Annual Values (10 Year) by Method for 43E7, 2000-2009 (Source: MMO)



	Edible Crab	Scallops	Lobsters	Nephrops	Haddock	Squid	Plaice	Lemon Sole	Monks or Anglers	Whiting	Other
Non-UK	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0
15m and over	£0	£19,036	£8	£5,891	£5,847	£521	£238	£1,541	£646	£805	£1,322
10m-15m	£32,089	£118	£7,868	£323	£200	£3,820	£1,548	£387	£218	£52	£1,715
U10m	£1,085	£0	£1,478	£0	£102	£226	£1,022	£435	£0	£3	£926

Species

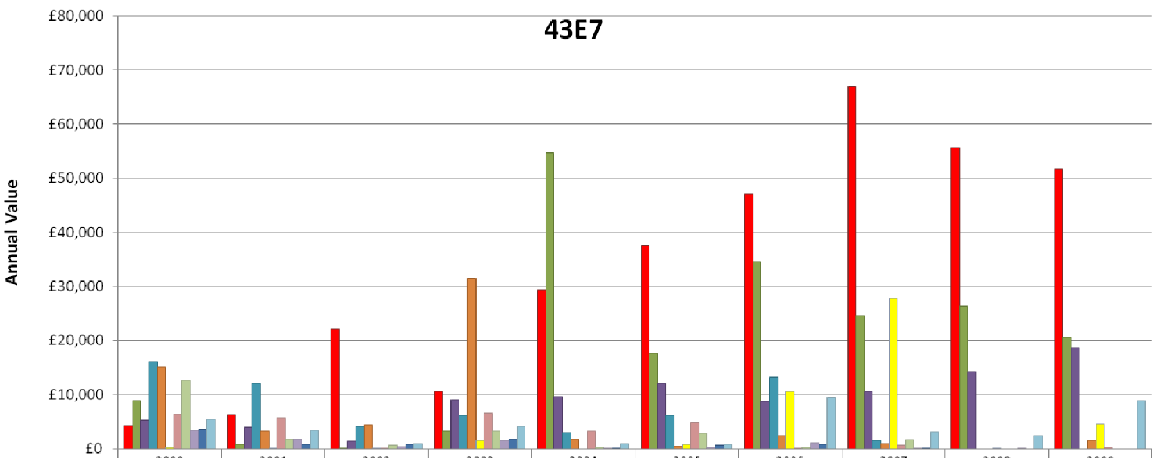
Figure 7-4 Averaged Annual Values (10 Year) by Species for 43E7, 2000-2009 (Source: MMO)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Pots	£9,654	£10,402	£23,468	£18,415	£39,767	£48,563	£64,936	£79,972	£70,595	£70,331
Otter trawls - bottom	£61,203	£26,889	£11,253	£55,505	£8,702	£16,300	£28,890	£33,527	£445	£9,590
Boat dredges	£8,884	£837	£133	£3,559	£54,673	£18,551	£34,631	£24,553	£26,330	£20,599
Handlines and pole-lines	£0	£0	£0	£0	£0	£0	£0	£200	£1,066	£5,398
Gillnets	£0	£383	£0	£2,174	£0	£0	£0	£0	£0	£0
Scottish seines	£0	£1,744	£415	£0	£0	£0	£0	£0	£0	£0
Otter twin trawls	£1,285	£0	£0	£0	£0	£0	£0	£0	£0	£0
Other trawls (not specified)	£0	£0	£0	£0	£0	£673	£0	£0	£0	£0
Nephrops trawls	£185	£0	£0	£0	£0	£0	£0	£0	£0	£0

Year

Figure 7-5 Total Annual Landing Values by Method for 43E7, 2000-2009 Not Including Foreign Vessels (Source: MMO)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Edible Crab	£4,328	£6,308	£22,172	£10,630	£29,410	£37,490	£47,137	£67,030	£55,606	£51,620
Scallops	£8,884	£837	£133	£3,318	£54,673	£17,641	£34,571	£24,553	£26,330	£20,599
Lobsters	£5,326	£4,038	£1,328	£9,087	£9,649	£11,982	£8,787	£10,585	£14,138	£18,618
Nephrops	£16,018	£12,071	£4,125	£6,143	£2,938	£6,081	£13,257	£1,506	£0	£0
Haddock	£15,129	£3,297	£4,383	£31,483	£1,797	£556	£2,378	£996	£0	£1,466
Squid	£231	£93	£147	£1,505	£0	£810	£10,595	£27,760	£12	£4,514
Plaice	£6,364	£5,712	£148	£6,607	£3,319	£4,894	£100	£715	£0	£226
Lemon Sole	£12,612	£1,879	£705	£3,315	£280	£2,876	£260	£1,704	£0	£0
Monks or Anglers	£3,429	£1,823	£384	£1,500	£30	£245	£1,070	£125	£30	£0
Whiting	£3,517	£799	£762	£1,878	£60	£683	£791	£110	£0	£0
Other	£5,374	£3,400	£982	£4,187	£986	£827	£9,510	£3,169	£2,318	£8,874

Year

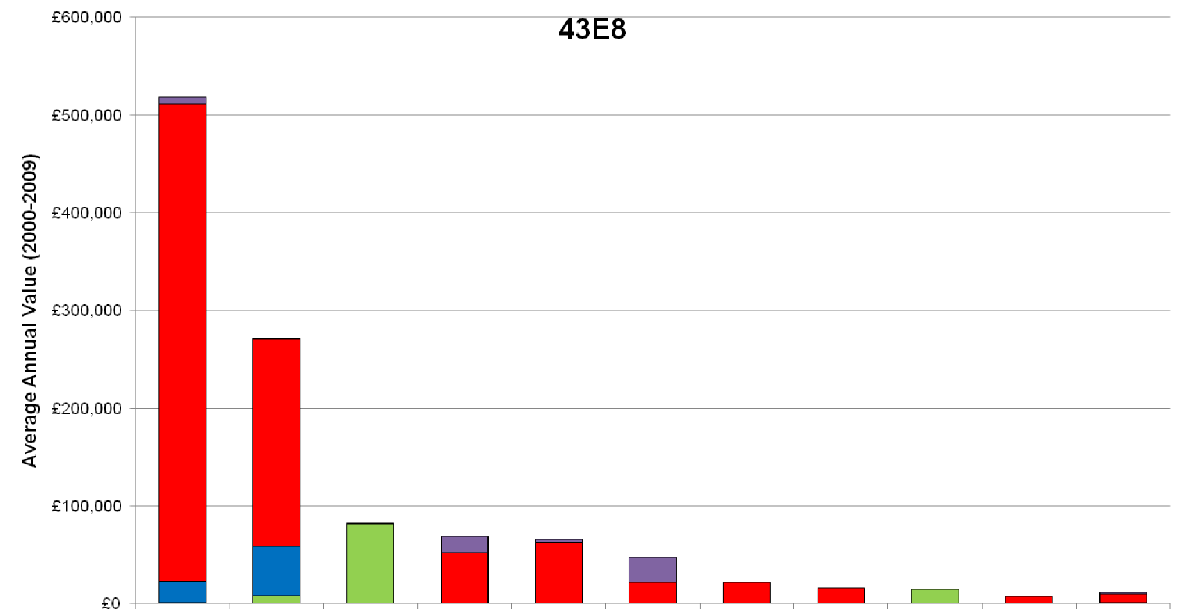
Figure 7-6 Total Annual Landing Values by Species for 43E7, 2000-2009 Not Including Foreign Vessels (Source: MMO)

ICES Rectangle 43E8

Figure 7-7 and Figure 7-8 give the 10 year averaged annual values of landings by method and species for 43E8, within which the eastern section of the proposed EOWDC site is partially located.

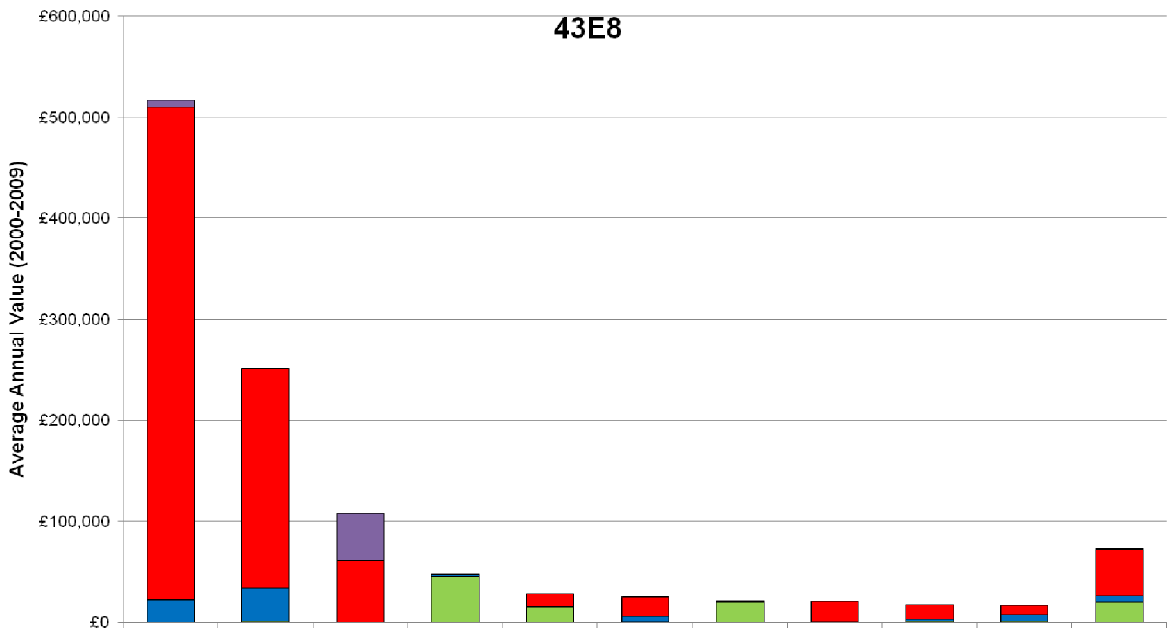
It can be seen from Figure 7-7 and Figure 7-8 that the large majority of mechanical dredging and bottom otter trawling is by the 15m and over fleet. As is reflected in Figure 7-8, vessels employing these methods target scallops and whitefish respectively. There are low levels of pelagic activity by foreign vessels. Creel fishing (potting), shown in Figure 7-7 is undertaken almost exclusively by the under 10 m fleet.

Figure 7-9 and Figure 7-10 below give the annual landings values by species from ICES rectangle 43E8. Boat dredging for scallops and bottom trawling for whitefish have the overall highest landings values for the 10 year period between 2000 and 2009, with the former having significantly higher landings values than any other method since 2005. However, since a peak of annual landings of haddock by bottom trawling in 2004 of £752,470, landings values for the following years have dropped significantly.



	Boat dredges	Otter trawls - bottom	Pots	Otter trawls - midwater	Pair trawls - bottom	Pair trawls - midwater	Scottish seines	Pair seines	Handlines and pole-lines	Otter twin trawls	Other
Non-UK	£7,134	£719	£0	£16,249	£3,306	£25,596	£0	£0	£0	£0	£1,413
15m and over	£488,595	£212,108	£0	£52,424	£62,229	£21,633	£21,782	£16,151	£0	£6,798	£8,551
10m-15m	£21,949	£50,289	£1,046	£0	£315	£0	£0	£0	£0	£477	£532
U10m	£781	£8,060	£81,441	£57	£0	£0	£0	£0	£15,016	£0	£626

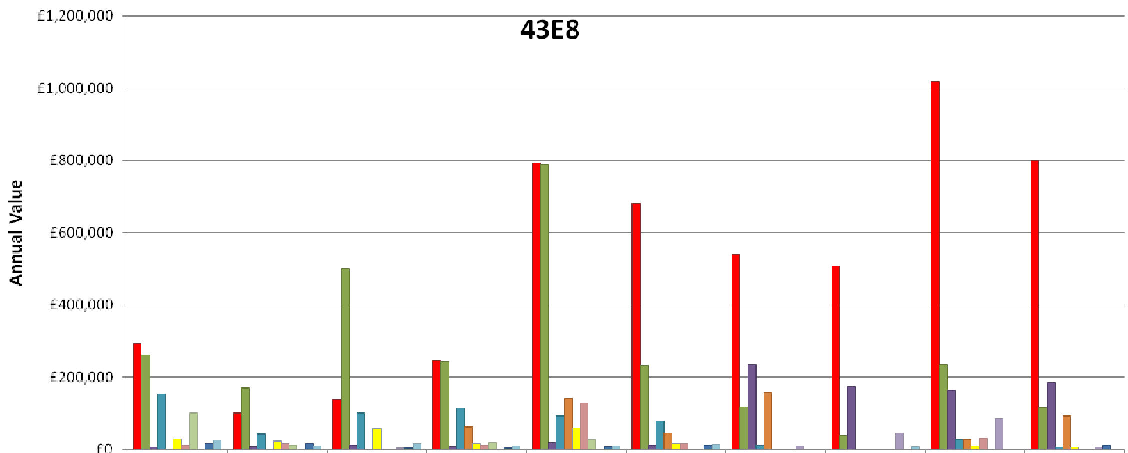
Figure 7-7 Averaged Annual Values (10 Year) by Method for 43E8, 2000-2009 (Source: MMO)



	Scallops	Haddock	Herring	Edible Crab	Mackerel	Lemon Sole	Lobsters	Cod	Nephrops	Squid	Other
Non-UK	£7,134	£0	£46,565	£0	£0	£0	£0	£0	£0	£0	£719
15m and over	£488,094	£216,803	£61,284	£0	£13,632	£19,547	£63	£19,881	£14,858	£9,693	£46,415
10m-15m	£21,949	£32,853	£0	£805	£2	£5,436	£315	£518	£1,087	£5,975	£5,667
U10m	£0	£1,095	£1	£45,952	£15,143	£618	£20,203	£39	£1,568	£1,285	£20,076

Species

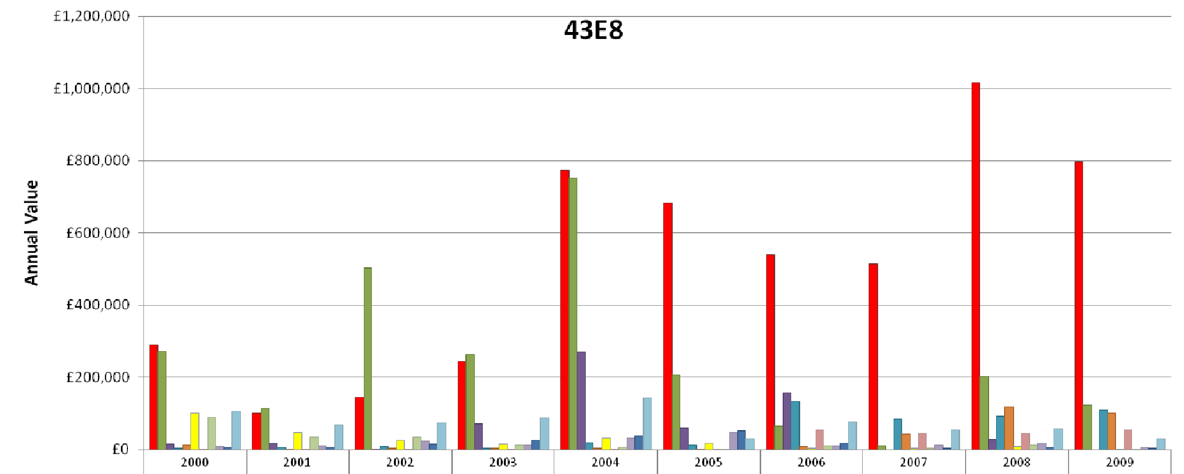
Figure 7-8 Averaged Annual Values (10 Year) by Species for 43E8, 2000-2009 (Source: MMO)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Boat dredges	£292,888	£101,450	£137,447	£245,183	£792,603	£679,363	£539,550	£507,783	£1,016,870	£800,108
Otter trawls - bottom	£261,443	£170,357	£500,372	£242,805	£787,881	£231,674	£119,171	£38,408	£235,830	£116,631
Pots	£5,518	£8,320	£11,180	£8,771	£17,786	£12,868	£235,868	£174,301	£164,527	£185,733
Pair trawls - bottom	£151,741	£41,414	£101,636	£113,928	£93,169	£78,291	£12,654	£0	£26,239	£6,367
Otter trawls - midwater	£844	£0	£0	£62,133	£140,851	£43,628	£156,630	£0	£28,015	£92,707
Scottish seines	£28,806	£23,148	£56,536	£16,024	£59,966	£17,032	£0	£0	£10,041	£6,266
Pair trawls - midwater	£12,402	£15,750	£0	£12,410	£128,767	£15,831	£0	£0	£31,168	£0
Pair seines	£101,710	£13,089	£0	£18,902	£27,808	£0	£0	£0	£0	£0
Handlines and pole-lines	£0	£0	£3,195	£2,399	£0	£0	£9,075	£44,561	£86,018	£4,913
Otter twin trawls	£16,713	£16,842	£2,641	£3,172	£7,016	£13,168	£0	£0	£0	£13,199
Other	£25,997	£10,951	£17,040	£9,938	£10,305	£14,981	£0	£7,872	£0	£0

Year

Figure 7-9 Total Annual Landing Values by Method for 43E8, 2000-2009 Not Including Foreign Vessels (Source: MMO)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Scallops	£289,661	£101,450	£143,314	£244,246	£772,709	£681,997	£539,550	£514,720	£1,015,645	£797,140
Haddock	£270,996	£113,617	£503,519	£262,997	£752,470	£206,989	£63,947	£9,290	£201,668	£122,017
Herring	£13,246	£15,750	£3	£70,661	£269,647	£59,459	£156,630	£0	£27,459	£0
Edible Crab	£3,929	£5,019	£7,686	£4,000	£18,070	£11,080	£132,541	£83,054	£93,008	£109,195
Mackerel	£11,252	£32	£3,499	£3,355	£2,444	£123	£6,967	£42,330	£117,476	£100,290
Lemon Sole	£100,500	£47,630	£25,493	£14,251	£32,612	£16,693	£4,570	£4,237	£7,871	£2,145
Lobsters	£1,313	£1,116	£2,111	£1,891	£1,032	£1,715	£53,810	£45,339	£44,009	£53,481
Cod	£90,025	£34,384	£34,595	£11,091	£6,236	£1,193	£9,631	£3,839	£11,221	£2,161
Nephrops	£7,036	£9,053	£23,496	£11,716	£30,731	£47,538	£10,866	£12,293	£17,049	£5,359
Squid	£5,026	£5,624	£13,228	£24,547	£38,565	£51,180	£16,588	£3,638	£6,668	£4,469
Other	£105,079	£67,646	£73,102	£86,909	£141,638	£28,868	£77,847	£54,185	£56,634	£29,666

Year

Figure 7-10 Total Annual Landing Values by Species for 43E8, 2000-2009 Not Including Foreign Vessels (Source: MMO)

7.2 Fishing Values by Landing Port

Table 7-1 below gives the average value for rectangles 43E7 and 43E8 by port, relative to the total landings into each port. It can be seen that, with the exception of Boddam and Port Erroll (see Figure 10-1), both rectangles constitute only a small proportion of each port's total landings. In addition, as a result of the very small area of rectangle encompassed by the proposed EOWDC site, it is considered that the majority of fishing activity within rectangles 43E7 and 43E8 is undertaken in areas outside this site.

Table 7-1 Relative Values of Landings by Port from 43E7 and 43E8 (10 yr avg, 2000-2009)

		43E7		43E8	
Port	**Avg Total Port Value**	**Value**	**% of Port Total**	**Value**	**% of Port Total**
Aberdeen	£12,482,442	£71,118	0.6%	£437,262	3.5%
Peterhead	£85,703,602	£7,802	0.0%	£436,479	0.5%
Fraserburgh	£40,502,160	£3,574	0.0%	£52,184	0.1%
Ijmuiden	£17,796,997	£0	0.0%	£38,675	0.2%
Boddam	£27,283	£30	0.1%	£24,433	89.6%
Buckie	£3,200,018	£171	0.0%	£20,805	0.7%
Eyemouth	£3,633,178	£101	0.0%	£16,622	0.5%
Arbroath	£839,533	£5,372	0.6%	£11,156	1.3%
Montrose	£233,401	£47	0.0%	£9,594	4.1%
Port Erroll	£14,650	£0	0.0%	£7,316	49.9%
Lochinver	£34,115,956	£0	0.0%	£3,963	0.0%
Macduff	£1,412,012	£17	0.0%	£2,972	0.2%
Stonehaven	£96,023	£130	0.1%	£1,567	1.6%
Grimsby	£5,660,109	£0	0.0%	£1,534	0.0%
Hartlepool	£1,447,672	£0	0.0%	£1,483	0.1%
Other Ports	£43,514,281	£1,106	0.0%	£4,813	0.0%

7.3 Fishing Effort by Port

Table 7-2 and Table 7-3 show the annual fishing effort (days fished/year) by port and vessel size category, for ICES rectangles 43E7 and 43E8 respectively. As is stated above, it is considered that the majority of activity will be undertaken in areas of the rectangles outside of proposed EOWDC site.

Table 7-2 Annual Fishing Effort (days fished / year) in 43E7

	Year										10 Year Average
Port	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	
Under 10 Metres											
Aberdeen	7	6	0	5	14	40	0	1	26	0	**9.9**
Peterhead	0	0	0	0	0	9	0	7	0	3	**1.9**
Cove (Aberdeen)	0	0	0	0	0	0	0	0	16	0	**1.6**
Stonehaven	0	0	0	0	0	0	3	0	10	0	**1.3**
Fraserburgh	0	0	0	0	0	0	0	0	0	5	**0.5**
Boddam	0	0	0	0	0	0	2	0	0	0	**0.2**
Arbroath	0	0	0	0	1	0	0	0	0	0	**0.1**
Buckie	0	0	0	0	0	0	0	0	0	1	**0.1**
U10m Total	**7**	**6**	**0**	**5**	**15**	**49**	**5**	**8**	**52**	**9**	**15.6**
10m - 15m											
Aberdeen	27	67	159	169	195	204	190	203	162	148	**152.4**
Peterhead	0	0	0	0	0	0	6	4	0	0	**1**
Fraserburgh	0	0	0	0	0	4	0	2	0	0	**0.6**
Gourdon	1	0	0	0	0	0	0	3	0	0	**0.4**
Pittenweem	0	0	0	0	0	0	0	1	0	0	**0.1**
Buckie	0	0	0	0	0	0	0	1	0	0	**0.1**
Arbroath	0	0	0	0	1	0	0	0	0	0	**0.1**
Montrose	0	0	0	1	0	0	0	0	0	0	**0.1**
10m-15m Total	**28**	**67**	**159**	**170**	**196**	**208**	**196**	**214**	**162**	**148**	**154.8**
15m and over											
Aberdeen	41	1	6	34	26	2	16	15	12	13	**16.6**
Arbroath	27	15	4	9	0	1	3	0	0	0	**5.9**
Peterhead	2	1	1	2	9	7	8	1	7	3	**4.1**
Fraserburgh	0	0	3	2	0	2	4	4	0	1	**1.6**
Rosehearty	0	0	0	0	0	0	3	0	0	0	**0.3**
Wick	2	0	0	0	0	0	0	0	0	0	**0.2**
Eyemouth	1	0	0	0	0	0	1	0	0	0	**0.2**
Macduff	0	0	0	0	0	1	0	0	0	0	**0.1**
Buckie	0	0	0	0	1	0	0	0	0	0	**0.1**
Montrose	0	0	0	0	1	0	0	0	0	0	**0.1**
15m and over Total	**73**	**17**	**14**	**47**	**37**	**13**	**35**	**20**	**19**	**17**	**29.2**
Overall Total	**108**	**90**	**173**	**222**	**248**	**270**	**236**	**242**	**233**	**174**	**199.6**

Table 7-3 Annual Fishing Effort (days fished / year) in 43E8

Port	Year										10 Year Average
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	
Under 10 Metres											
Peterhead	84	38	28	22	83	34	393	675	439	441	223.7
Boddam	0	0	0	0	0	0	421	241	280	172	111.4
Fraserburgh	0	0	51	0	0	1	0	129	396	2	57.9
Port Erroll	0	0	0	0	0	0	196	58	40	37	33.1
Aberdeen	0	2	0	9	8	7	62	0	25	21	13.4
Stonehaven	0	0	0	0	0	0	36	0	0	0	3.6
Arbroath	0	0	0	0	0	0	23	0	0	6	2.9
Burghead	0	0	0	0	0	0	0	11	4	0	1.5
Montrose	0	0	0	0	0	0	5	0	0	0	0.5
Gourdon	0	0	0	0	0	0	5	0	0	0	0.5
Rosehearty	0	0	0	0	0	0	0	3	1	0	0.4
Johnshaven	0	0	0	0	0	0	4	0	0	0	0.4
Unknown	0	0	0	0	0	0	0	0	0	2	0.2
Helmsdale	0	0	0	0	0	0	1	0	0	0	0.1
Pittenweem	0	0	0	0	0	0	1	0	0	0	0.1
St Monance	0	0	0	0	1	0	0	0	0	0	0.1
U10m Total	**84**	**40**	**79**	**31**	**92**	**42**	**1147**	**1117**	**1185**	**681**	**449.8**
10m-15m											
Aberdeen	91	67	16	67	99	48	14	6	16	7	43.1
Peterhead	73	1	18	22	70	8	14	0	14	30	25
Fraserburgh	0	0	8	0	3	10	3	1	0	0	2.5
Buckie	0	0	0	0	0	2	6	0	0	6	1.4
Dunbar	0	0	0	0	0	0	0	1	0	0	0.1
North Shields	0	0	1	0	0	0	0	0	0	0	0.1
Stonehaven	1	0	0	0	0	0	0	0	0	0	0.1
Macduff	0	0	0	0	0	0	1	0	0	0	0.1
Gourdon	0	0	0	0	1	0	0	0	0	0	0.1
10m-15m Total	**165**	**68**	**43**	**89**	**173**	**68**	**38**	**8**	**30**	**43**	**72.5**
15m and over											
Aberdeen	218	150	236	86	473	165	140	175	305	145	209.3
Peterhead	185	77	89	139	221	239	141	70	111	205	147.7
Fraserburgh	17	17	7	20	47	31	27	21	26	51	26.4
Buckie	23	6	17	17	16	6	11	7	7	11	12.1
Arbroath	12	3	12	5	20	10	2	0	1	6	7.1
Eyemouth	0	12	4	13	16	14	4	2	1	3	6.9
Montrose	0	0	0	0	10	19	0	5	0	0	3.4
Macduff	5	0	1	1	11	0	4	1	3	3	2.9
Ijmuiden	1	1	0	1	7	2	3	0	1	0	1.6
Hartlepool	0	0	4	0	0	0	0	4	0	0	0.8
Grimsby	1	1	5	0	0	1	0	0	0	0	0.8
Burntisland	0	0	0	0	0	0	0	0	0	5	0.5
Scrabster	1	1	0	2	0	0	0	0	0	0	0.4
Wick	2	0	0	0	0	0	0	0	1	0	0.3
North Shields	0	0	0	1	0	2	0	0	0	0	0.3
Blyth	0	0	0	0	2	0	0	0	0	0	0.2
Troon and Saltcoats	0	0	0	0	2	0	0	0	0	0	0.2
Lossiemouth	0	0	0	1	0	0	0	0	0	0	0.1
West Mainland (Shetland)	0	0	0	0	0	1	0	0	0	0	0.1
Unspecified Danish Port	0	0	0	1	0	0	0	0	0	0	0.1
Lochinver	1	0	0	0	0	0	0	0	0	0	0.1
15m and over Total	**466**	**268**	**375**	**287**	**825**	**490**	**332**	**285**	**456**	**429**	**421.3**
Non UK											
Aberdeen	0	0	0	0	0	0	0	0	4	21	2.5
Peterhead	0	0	0	0	2	8	2	0	3	0	1.5
Lochinver	1	0	0	0	0	0	0	0	0	0	0.1
Buckie	0	0	0	0	0	0	1	0	0	0	0.1
Non UK Total	**1**	**0**	**0**	**0**	**2**	**8**	**3**	**0**	**7**	**21**	**4.2**
Overall Total	**716**	**376**	**497**	**407**	**1092**	**608**	**1520**	**1410**	**1678**	**1174**	**947.8**

7.4 Fisheries Seasonality

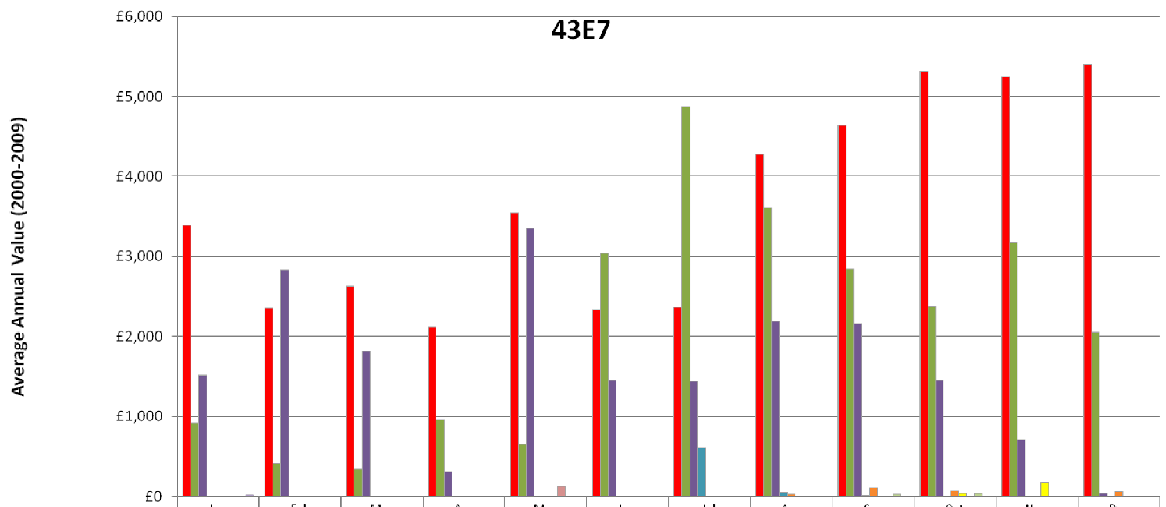
Figure 7-11 – Figure 7-14 give the averaged (2000-2009) monthly landings values by method and by species for rectangles 43E7 and 43E8, not including foreign vessels.

ICES Rectangle 43E7

Figure 7-11 and Figure 7-12 show that values of creel fishing (potting), targeting crab and lobster, is higher in the second half of the year. Bottom otter trawl landings, targeting haddock and plaice, are highest between June and November, with a peak in July. Dredging for scallops is highest in May, with very low levels in the final months of the year. There is a seasonal summer otter trawl fishery for squid between July and October.

ICES Rectangle 43E8

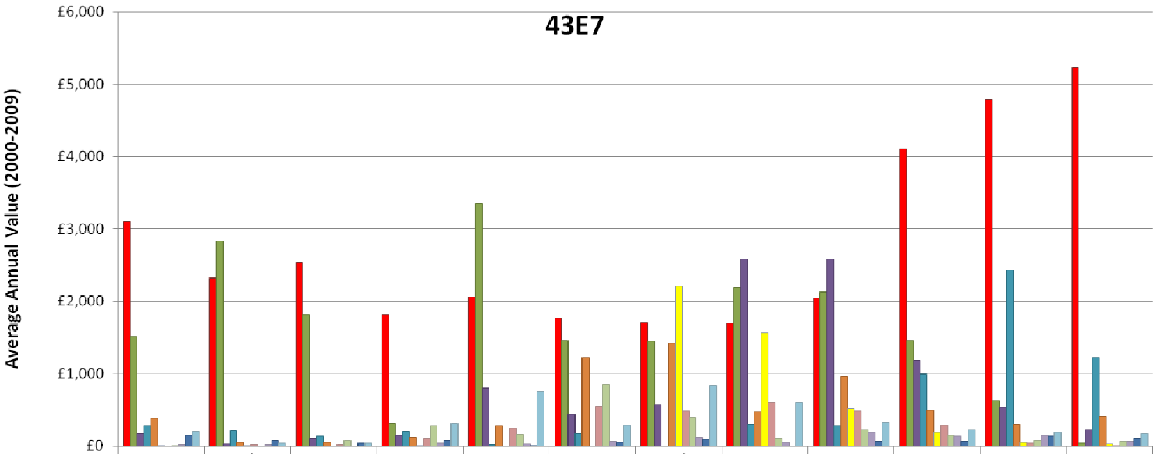
The seasonality patterns described for ICES rectangle 43E7 above, are broadly repeated in rectangle 43E8 (Figure 7-13 and Figure 7-14), although this rectangle records far higher monthly landings values. The scallop fishery appears less erratic than in 43E7, with a gradual increase in landings from the beginning of the year to a peak in June, tailing off again in the latter months. Bottom otter trawling is highest in the summer months and the latter half of the year, with very low recorded activity in April. Creel fishing (potting) activity, in comparison both to the other methods employed in the rectangle and to the amount of activity in 43E7, is low. There is a short, seasonal fishery for herring in August and September.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pots	£3,389	£2,350	£2,630	£2,123	£3,547	£2,330	£2,367	£4,282	£4,635	£5,317	£5,245	£5,397
Otter trawls - bottom	£921	£411	£345	£953	£650	£3,037	£4,870	£3,601	£2,840	£2,377	£3,178	£2,048
Boat dredges	£1,513	£2,831	£1,813	£313	£3,351	£1,457	£1,440	£2,193	£2,156	£1,457	£715	£37
Handlines and pole-lines	£0	£0	£0	£0	£0	£0	£602	£52	£13	£0	£0	£0
Gillnets	£0	£0	£0	£0	£0	£0	£0	£25	£110	£65	£0	£55
Scottish seines	£0	£0	£0	£0	£0	£0	£0	£0	£0	£41	£174	£0
Otter twin trawls	£0	£0	£0	£0	£128	£0	£0	£0	£0	£0	£0	£0
Other trawls (not specified)	£0	£0	£0	£0	£0	£0	£0	£0	£30	£37	£0	£0
Nephrops trawls	£19	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0

Month

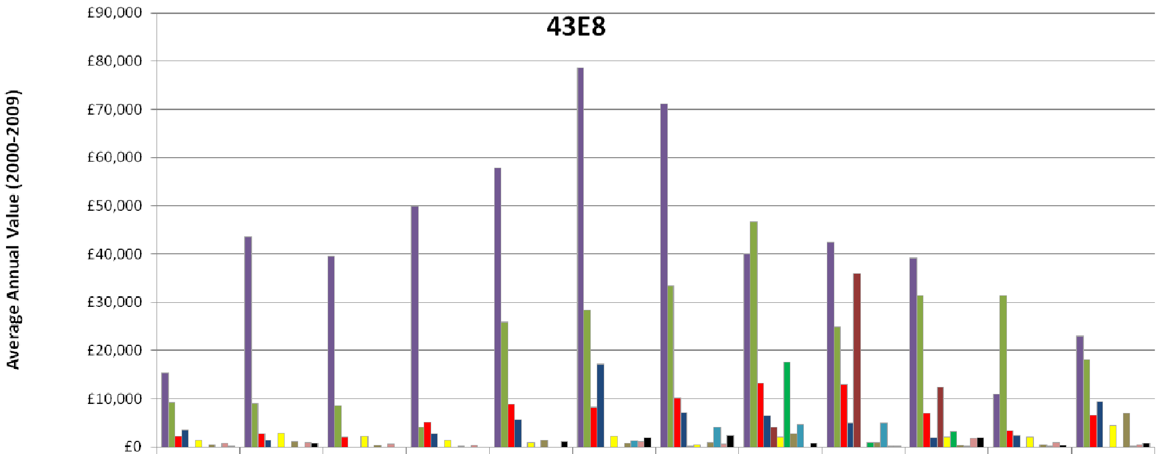
Figure 7-11 Average Seasonality (10 Year) by Method 43E7 Not Including Foreign Vessels (Source: MMO)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Edible Crab	£3,104	£2,322	£2,533	£1,815	£2,059	£1,769	£1,708	£1,695	£2,042	£4,109	£4,790	£5,228
Scallops	£1,513	£2,831	£1,813	£313	£3,351	£1,457	£1,440	£2,193	£2,126	£1,457	£624	£37
Lobsters	£172	£29	£99	£142	£795	£441	£573	£2,581	£2,578	£1,187	£536	£221
Nephrops	£280	£209	£132	£202	£12	£165	£0	£294	£281	£994	£2,431	£1,213
Haddock	£388	£49	£54	£111	£275	£1,214	£1,421	£473	£961	£498	£301	£403
Squid	£4	£3	£0	£0	£0	£0	£2,209	£1,563	£513	£188	£55	£31
Plaice	£0	£14	£15	£105	£241	£542	£478	£598	£484	£291	£36	£4
Lemon Sole	£10	£0	£68	£278	£153	£845	£398	£106	£225	£147	£70	£64
Monks or Anglers	£20	£18	£0	£39	£33	£56	£116	£54	£187	£134	£145	£61
Whiting	£149	£76	£39	£75	£3	£51	£96	£0	£63	£65	£137	£106
Other	£201	£42	£36	£308	£754	£284	£838	£596	£323	£225	£187	£169

Month

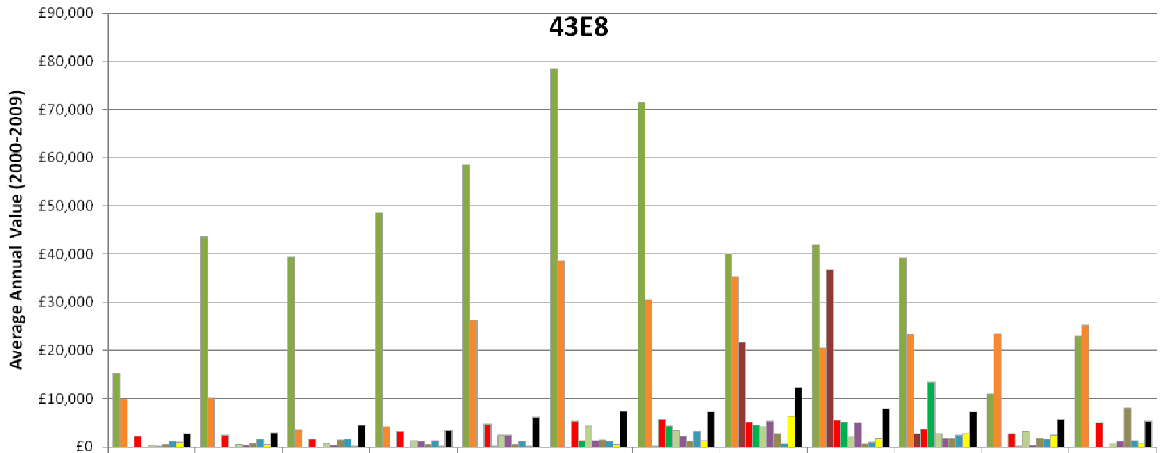
Figure 7-12 Average Monthly Landing Values (10 Year) by Species, 43E7 Not Including Foreign Vessels (Source: MMO)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boat dredges	£15,283	£43,596	£39,493	£49,842	£57,805	£78,627	£71,133	£39,925	£42,477	£39,186	£10,998	£22,960
Otter trawls - bottom	£9,187	£9,081	£8,454	£3,916	£25,894	£28,243	£33,285	£46,614	£24,869	£31,401	£31,424	£18,088
Pots	£2,283	£2,721	£2,020	£5,150	£8,902	£8,243	£10,094	£13,312	£12,888	£6,946	£3,271	£6,657
Pair trawls - bottom	£3,426	£1,375	£0	£2,739	£5,691	£17,099	£7,042	£6,349	£5,038	£1,958	£2,408	£9,420
Otter trawls - midwater	£0	£0	£0	£0	£0	£0	£141	£4,052	£35,884	£12,403	£0	£0
Scottish seines	£1,381	£2,796	£2,163	£1,341	£923	£2,129	£464	£2,001	£0	£2,016	£2,039	£4,528
Pair trawls - midwater	£0	£0	£0	£0	£0	£0	£0	£17,604	£912	£3,117	£0	£0
Pair seines	£405	£1,090	£317	£26	£1,326	£725	£985	£2,753	£912	£279	£401	£6,933
Handlines and pole-lines	£0	£0	£0	£0	£0	£1,199	£4,042	£4,566	£4,991	£75	£89	£53
Otter twin trawls	£718	£877	£602	£204	£0	£1,047	£636	£0	£40	£1,670	£977	£504
Other	£16	£782	£0	£0	£1,016	£1,923	£2,405	£726	£27	£1,862	£189	£761

Month

Figure 7-13 Average Seasonality (10 Year) by Method 43E8 Not Including Foreign Vessels (Source: MMO)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Scallops	£15,112	£43,494	£39,402	£48,616	£58,481	£78,429	£71,519	£39,925	£41,927	£39,182	£10,995	£22,960
Haddock	£9,886	£10,134	£3,545	£4,121	£26,271	£38,455	£30,478	£35,309	£20,512	£23,361	£23,419	£25,260
Herring	£0	£0	£0	£0	£0	£0	£84	£21,660	£36,796	£2,745	£0	£0
Edible Crab	£2,146	£2,336	£1,615	£3,201	£4,582	£5,262	£5,660	£5,105	£5,448	£3,742	£2,752	£4,909
Mackerel	£0	£0	£0	£0	£26	£1,310	£4,353	£4,499	£5,103	£13,447	£40	£0
Lemon Sole	£310	£472	£801	£1,273	£2,307	£4,251	£3,338	£4,165	£2,125	£2,704	£3,201	£652
Lobsters	£77	£236	£274	£1,084	£2,311	£1,229	£2,140	£5,337	£4,939	£1,708	£247	£1,003
Cod	£450	£793	£1,330	£416	£380	£1,377	£1,036	£2,644	£604	£1,758	£1,651	£8,000
Nephrops	£1,099	£1,497	£1,568	£1,191	£1,123	£1,058	£3,232	£659	£902	£2,395	£1,606	£1,185
Squid	£966	£453	£106	£40	£27	£422	£1,201	£6,312	£1,781	£2,693	£2,330	£624
Other	£2,654	£2,904	£4,408	£3,276	£6,048	£7,443	£7,187	£12,288	£7,902	£7,179	£5,556	£5,313

Month

Figure 7-14 Average Seasonality (10 Year) by Species, 43E8 Not Including Foreign Vessels (Source: MMO)

8.0 Satellite Tracking

Since January 2005, all European Community vessels over 15 m in length have been fitted with satellite tracking equipment which transmits the vessels' position a minimum of every 2 hours to the relevant Member States' fisheries authorities. Each Member States' Fisheries Monitoring Centre (FMC) monitors the activities of their fishing vessels to ensure compliance with fisheries legislation.

All UK satellite data is still collected in one dataset by the MMO. The data was obtained from the MMO in CSV format.

It is recognised that satellite data is only indicative of the activity of certain types of fishing vessels, i.e. those over 15 m in length. Furthermore, the data do not specify whether a vessel is fishing or steaming. Position plots of vessels that are stationary in port have not been included.

Figure 8-1 overleaf provides an overview of the relative density of activity by UK over 15 m fishing vessels. It can be seen that the proposed EOWDC site is situated in an area of low recorded density, with higher levels of activity in the north and south. Table 8-1 provides the numbers of vessels, and the 2 hourly position plots of those vessels, tracked within the proposed EOWDC site for the same period.

Table 8-2 gives a breakdown of the individual vessels recorded by satellite tracking inside the proposed EOWDC site in 2008. As can be seen, the numbers of plots is very low, indicating that vessels are steaming through the proposed EOWC site to and from more distant fishing grounds.

Figure 8-2 and Figure 8-3 show the tracks of the vessel identified by the MMO as GBR66, in 2008, the vessel obtaining the highest plot count within the proposed EOWDC site. Figure 8-2 shows the vessel tracks in the regional area and Figure 8-3 shows the vessel tracks within the proposed EOWDC site, respectively. Whilst it is possible, given the pattern of sightings (Figure 8-3), that this vessel may have undertaken some occasional trawling to the north of the proposed EOWDC site, it would appear that the immediate site vicinity sustains, at most, only a very small proportion of total activity of this vessel.

Figure 8-4 shows the range of activity of the vessel identified as GBR842 between 2005 and 2006, demonstrating that the vessel's fishing grounds are in areas considerably further offshore than the area of the proposed EOWDC site. Figure 8-5 suggests that the tracks recorded through the proposed EOWDC site can be attributed to the vessel steaming.

As a result of the different data set provided for satellite tracked vessels in 2009 (previously discussed), Figure 8-6 to Figure 8-8 separately show activity for this period. Figure 8-6 provides the density of over 15 m vessels for all methods. Figure 8-7 and Figure 8-8 show the density by scallop dredging and demersal trawling for whitefish, respectively – the principal fishing methods undertaken in the area by the over 15 m fleet. As with previous years, these figures show higher levels of activity located in grounds further offshore. Again it is likely that the majority of sightings that occurred within the rectangle that encompasses the proposed EOWDC site are a result of vessels steaming to grounds to the north and east of the site, as consultation with local fishermen and the SFF confirms that no scalloping dredging or trawling by over 15 m vessels occurs within the site.

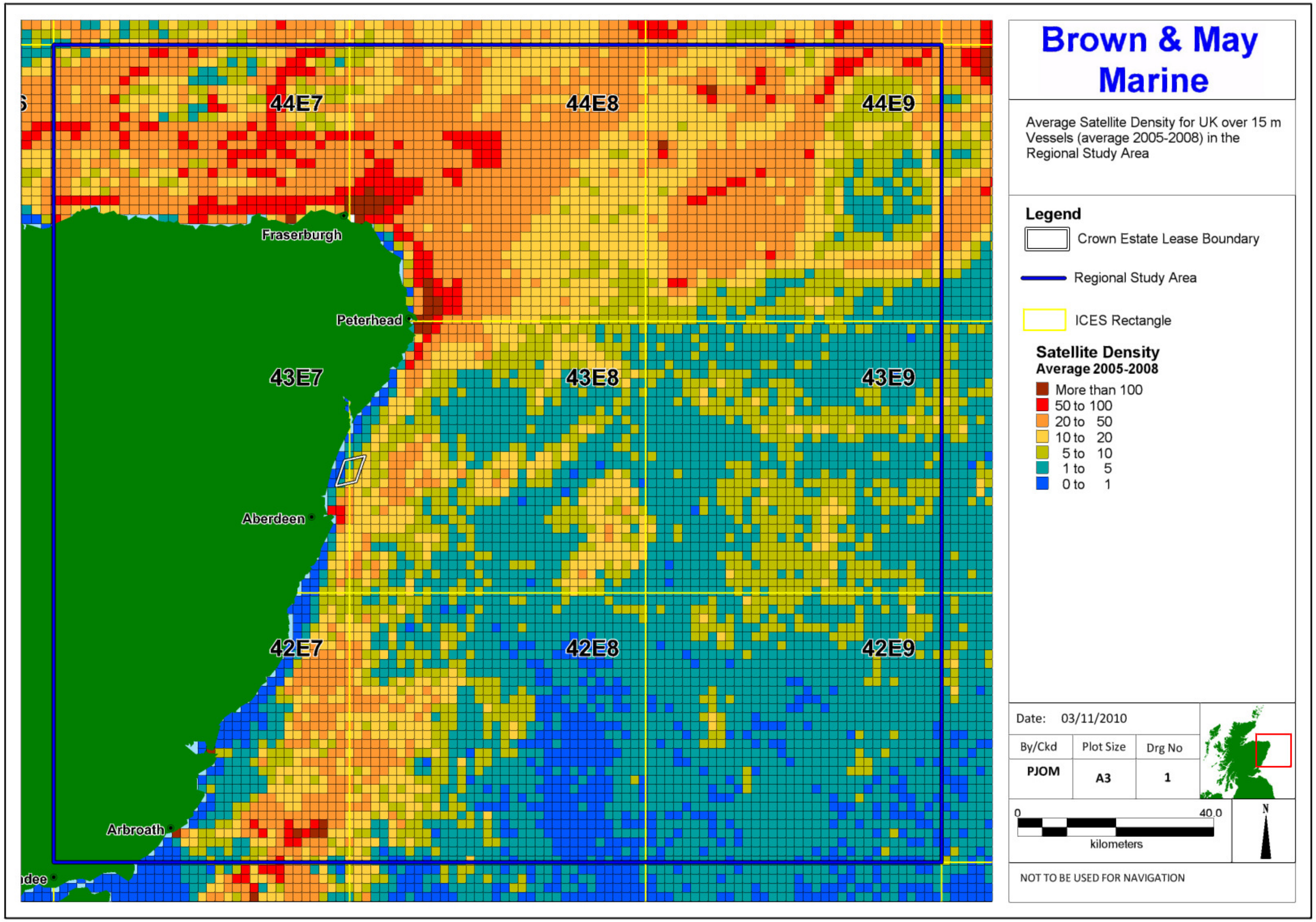


Figure 8-1 Average Satellite Density of UK over 15 m Vessels (average 2005 – 2008) in the Regional Study Area

Table 8-1 Numbers of Vessels and 2-Hourly Position Plots of Vessels Tracked within the Proposed EOWDC Site, 2005-2008 (Source: MMO)

	2005		2006		2007		2008	
Method	No. Vessels	No. Plots	No. Vessels	No. Plots	No. Vessels	No. Plots	No. Vessels	No. Plots
BOTTOM SEINER (ANCHOR/DANISH/FLY/SCOTS)	4	5	0	0	0	0	0	0
DEMERSAL STERN TRAWLER	3	3	0	0	0	0	0	0
NULL	22	45	22	49	18	34	19	45
PAIR TRAWLER (ALL)	2	2	0	0	0	0	0	0
PURSE SEINER	1	2	0	0	0	0	0	0
SCALLOP DREDGER (FRENCH/NEWHAVEN)	1	1	1	1	0	0	1	1
SIDE TRAWLER (PELAGIC/DEMERSAL)	3	11	0	0	0	0	0	0
Total	**36**	**69**	**23**	**50**	**18**	**34**	**20**	**46**

Table 8-2 Individual Vessel and Plots inside the Proposed EOWDC Site in 2008

Vessel	Type	Count in Proposed EOWDC Site
GBR66	Unidentified	11
GBR134	Unidentified	7
GBR231	Unidentified	6
GBR144	Unidentified	3
GBR354	Unidentified	3
GBR95	Unidentified	2
GBR145	Unidentified	1
GBR152	Unidentified	1
GBR189	Unidentified	1
GBR222	Unidentified	1
GBR23	Unidentified	1
GBR260	Unidentified	1
GBR278	Unidentified	1
GBR298	Unidentified	1
GBR317	Unidentified	1
GBR35	Unidentified	1
GBR37	Scallop Dredger	1
GBR380	Unidentified	1
GBR385	Unidentified	1
GBR7	Unidentified	1

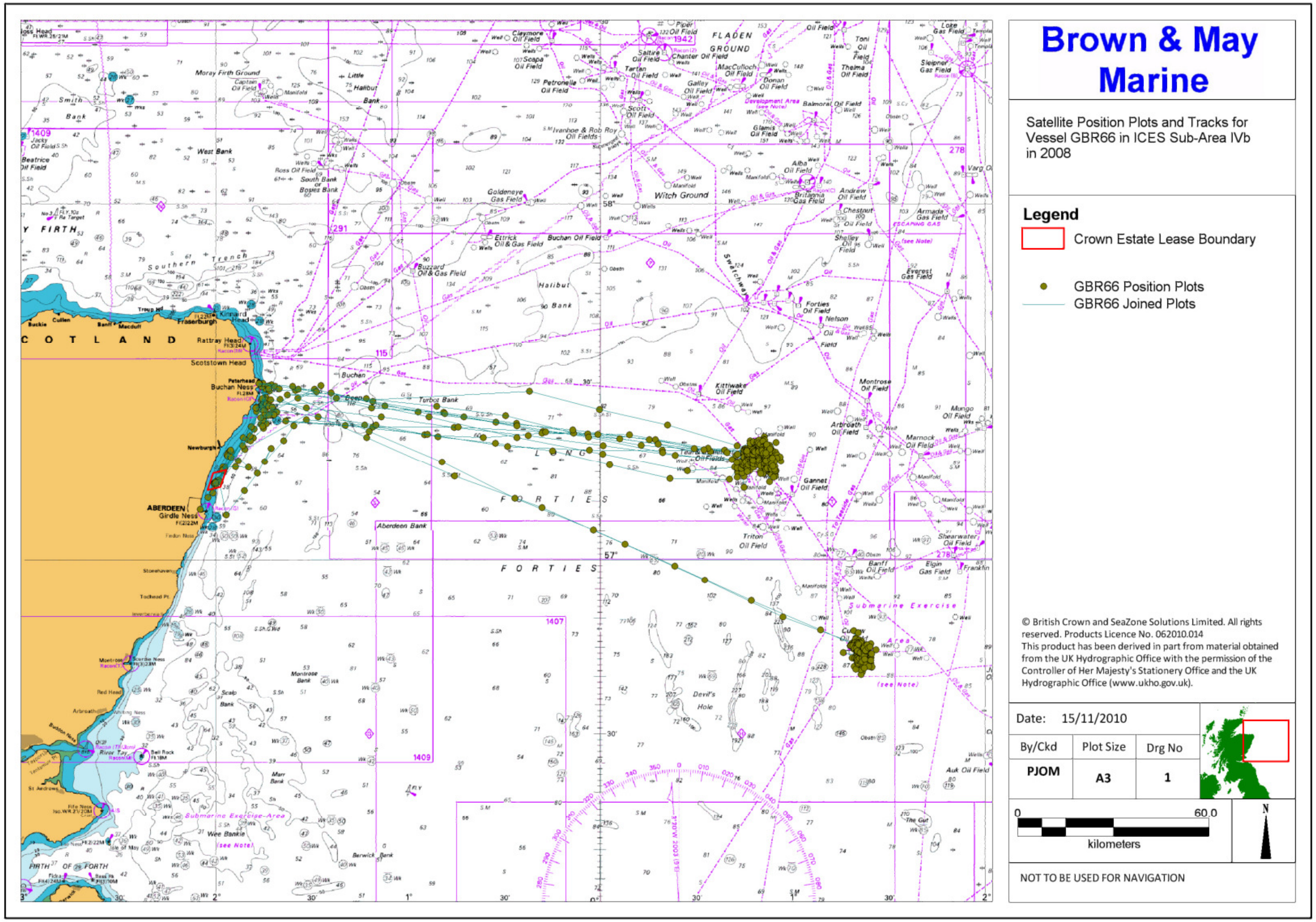


Figure 8-2 Satellite Position Plots and Tracks for Vessel GBR66 in ICES Sub Area IVb (Central North Sea) in 2008

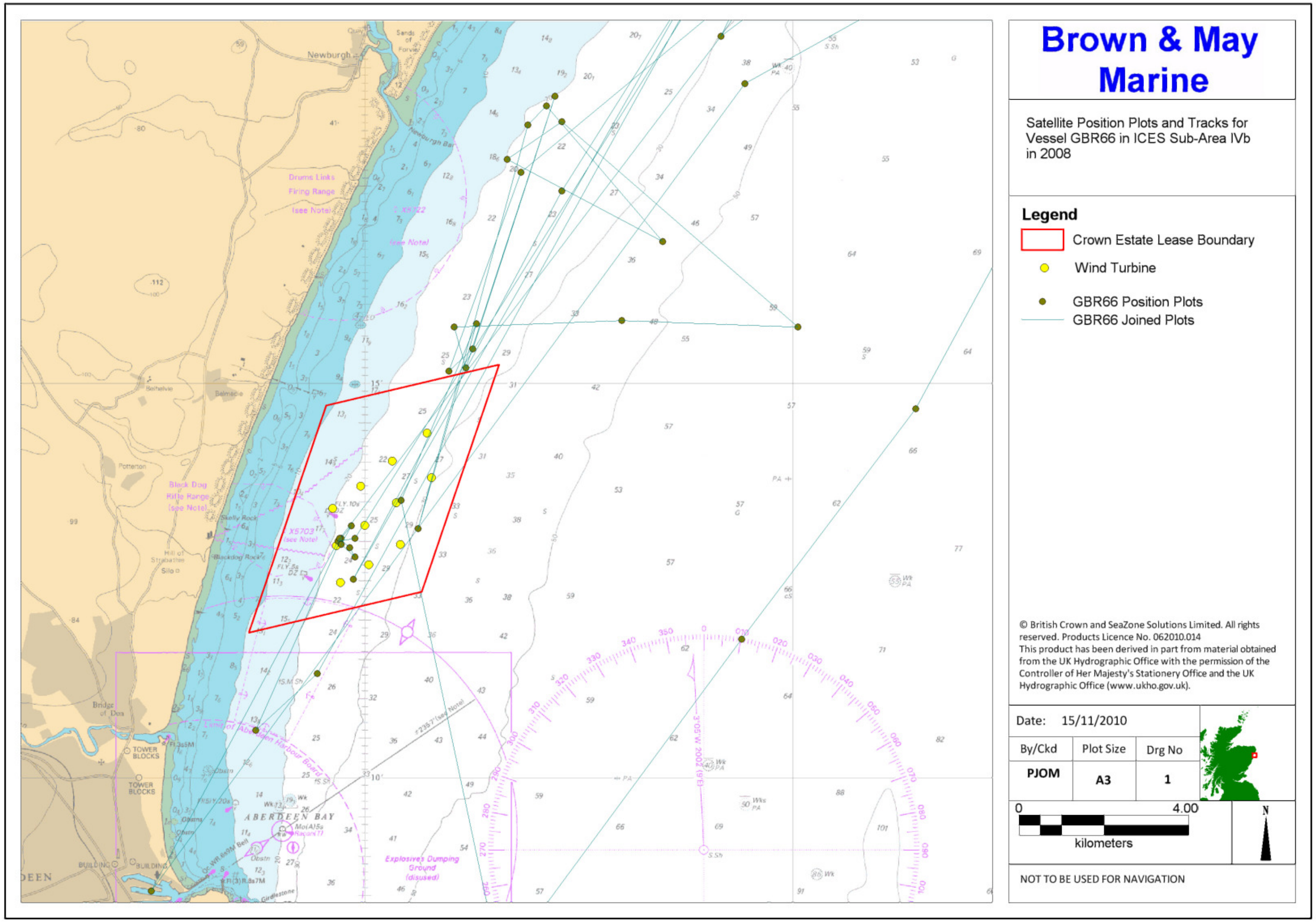


Figure 8-3 Satellite Position Plots and Tracks for Vessel GBR66 in ICES Sub Area IVb (Central North Sea) in 2008

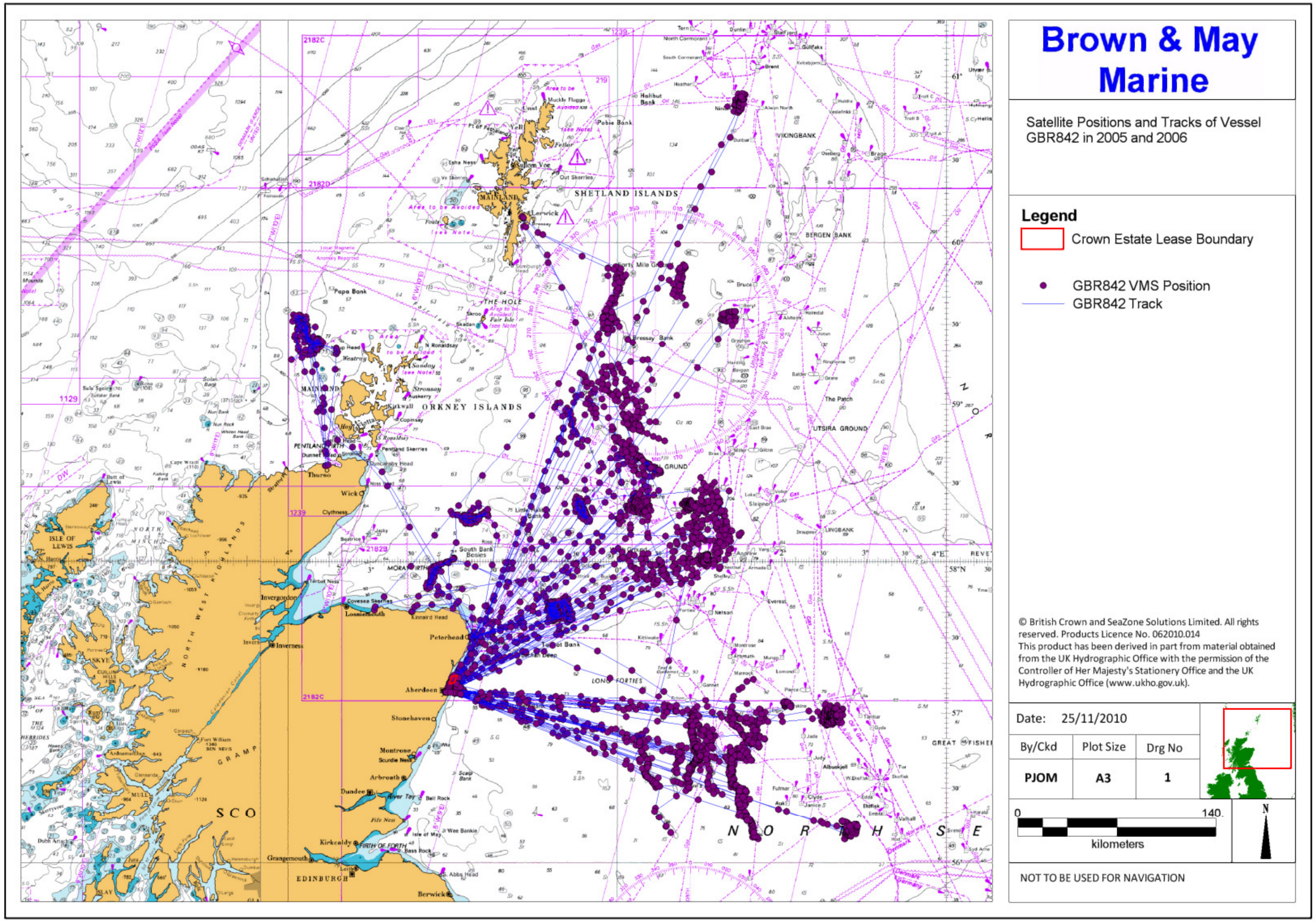


Figure 8-4 Satellite Position Plots and Tracks of Vessel GBR842 in 2005 and 2006

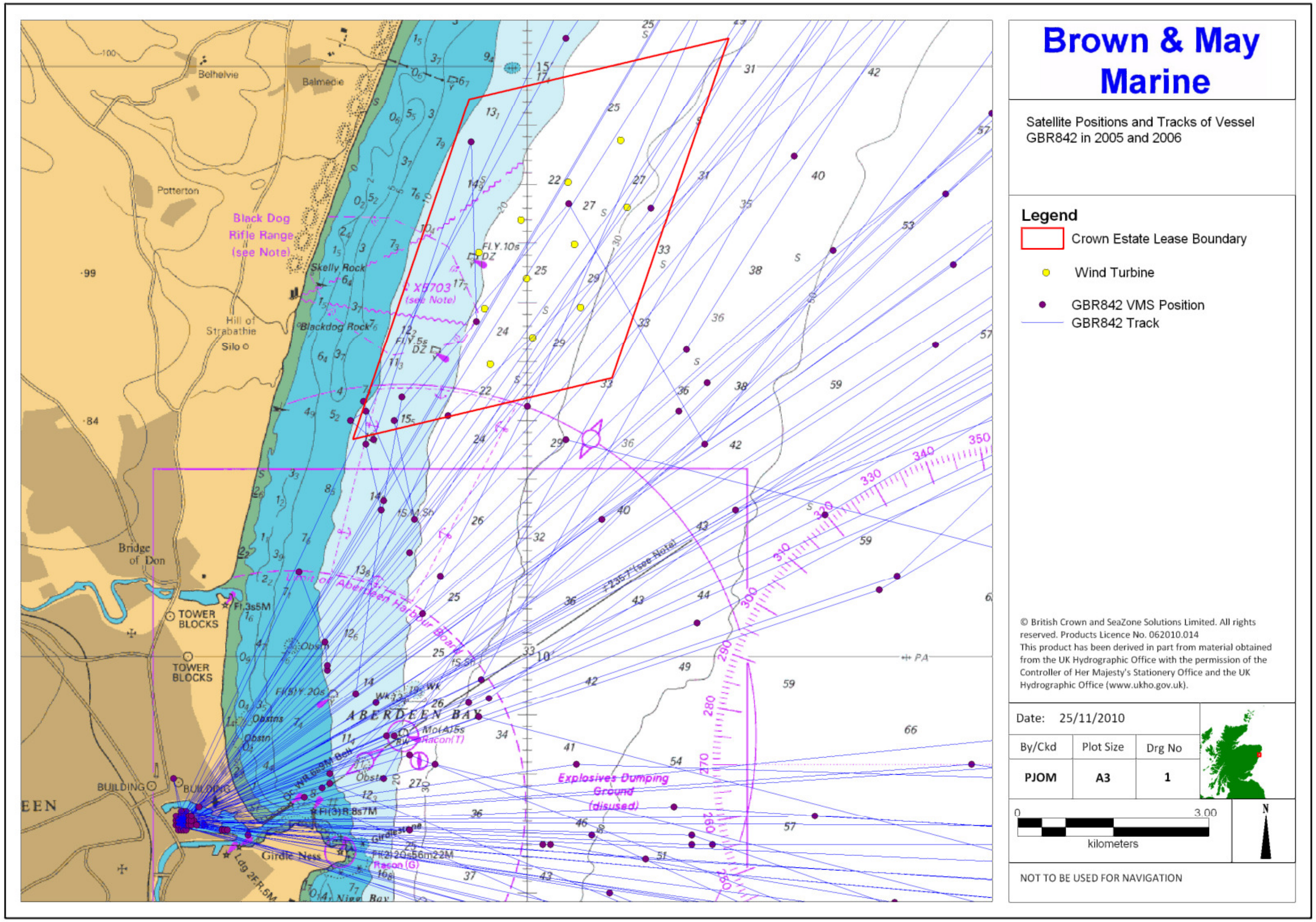


Figure 8-5 Satellite Position Plots and Tracks of Vessel GBR842 in 2005 and 2006

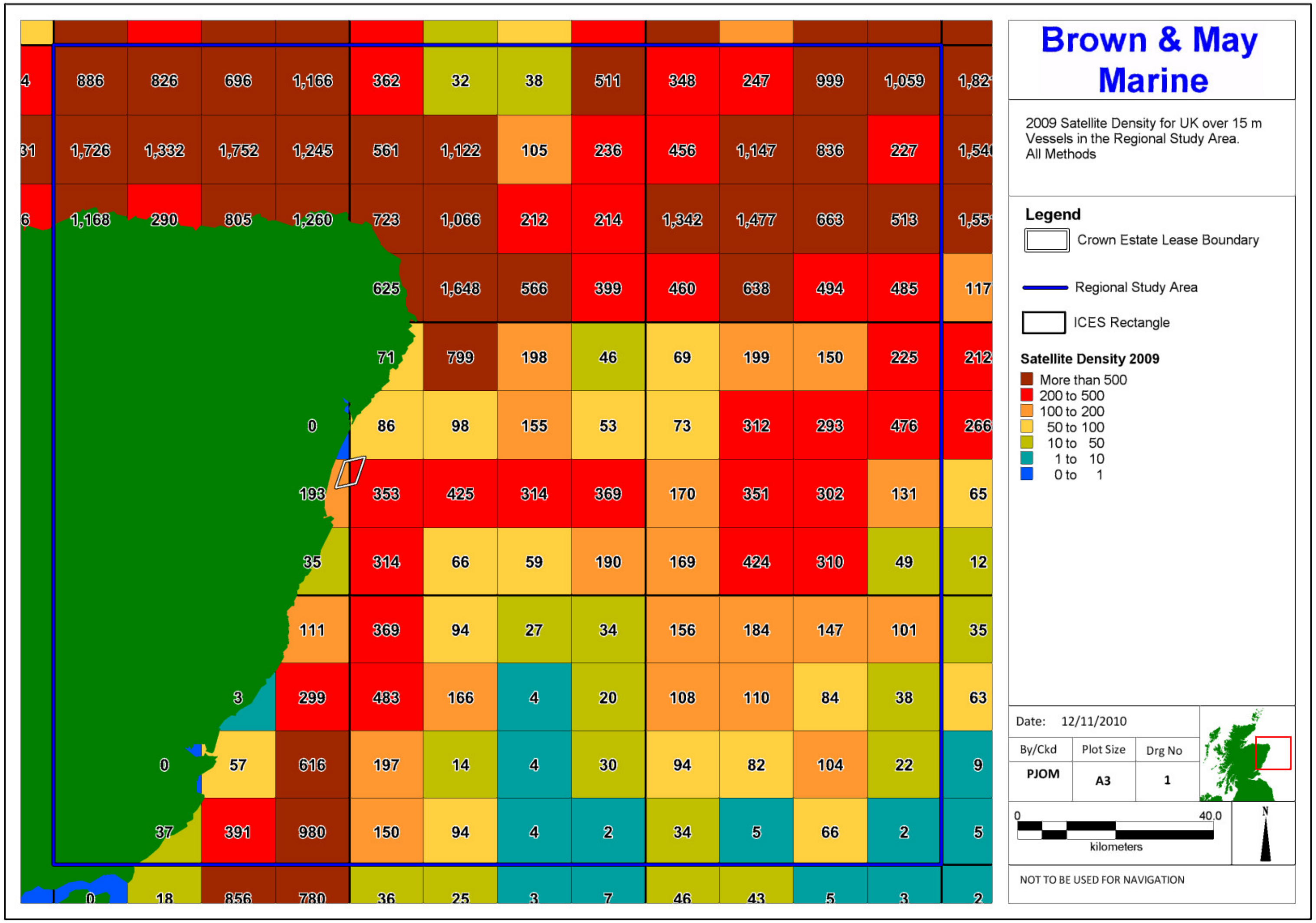


Figure 8-6 2009 Satellite Density for UK over 15 m Vessels in the Regional Study Area, All Methods

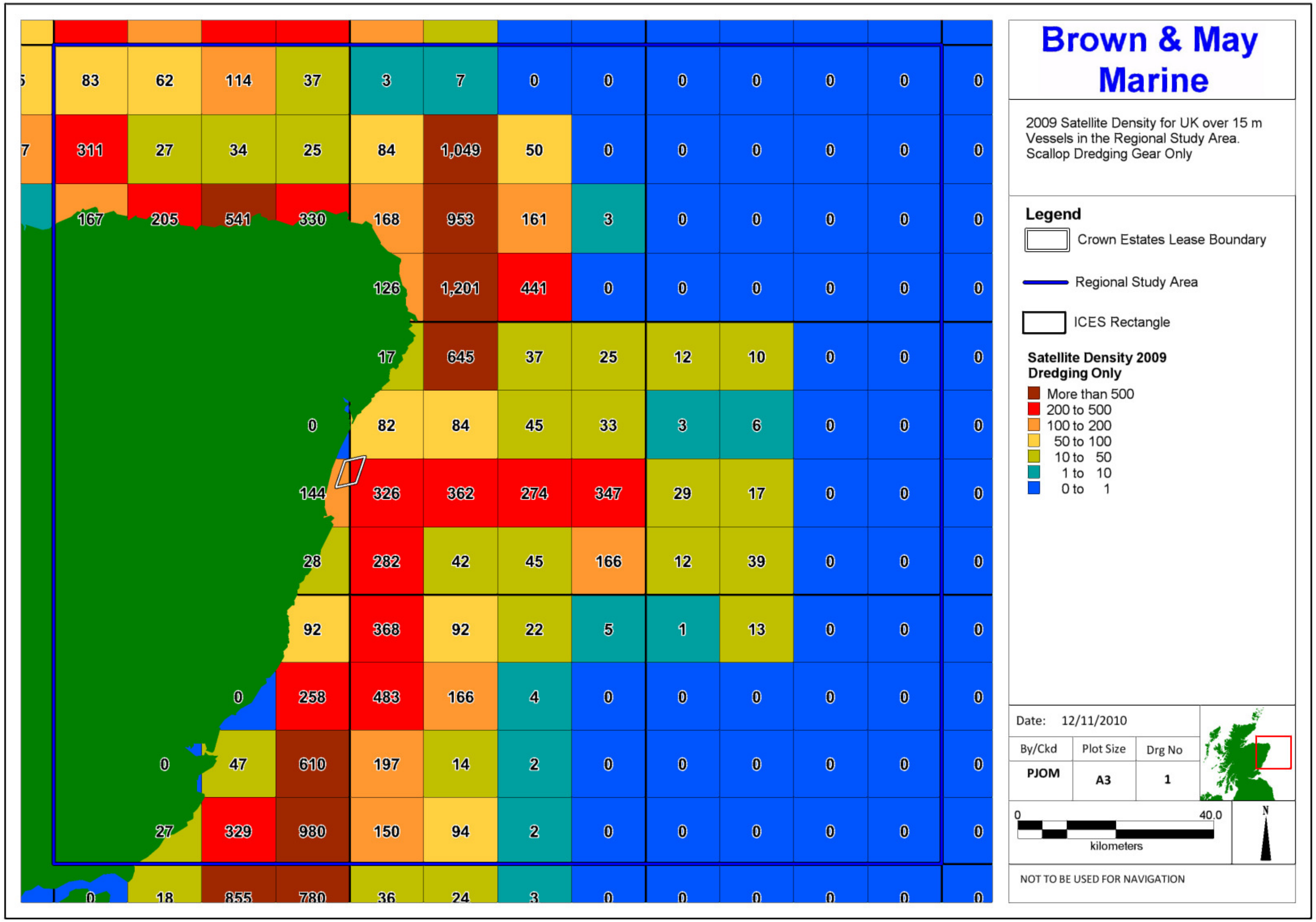


Figure 8-7 2009 Satellite Density for UK over 15 m Vessels in the Regional Study Area, Scallop Dredging Gear only,

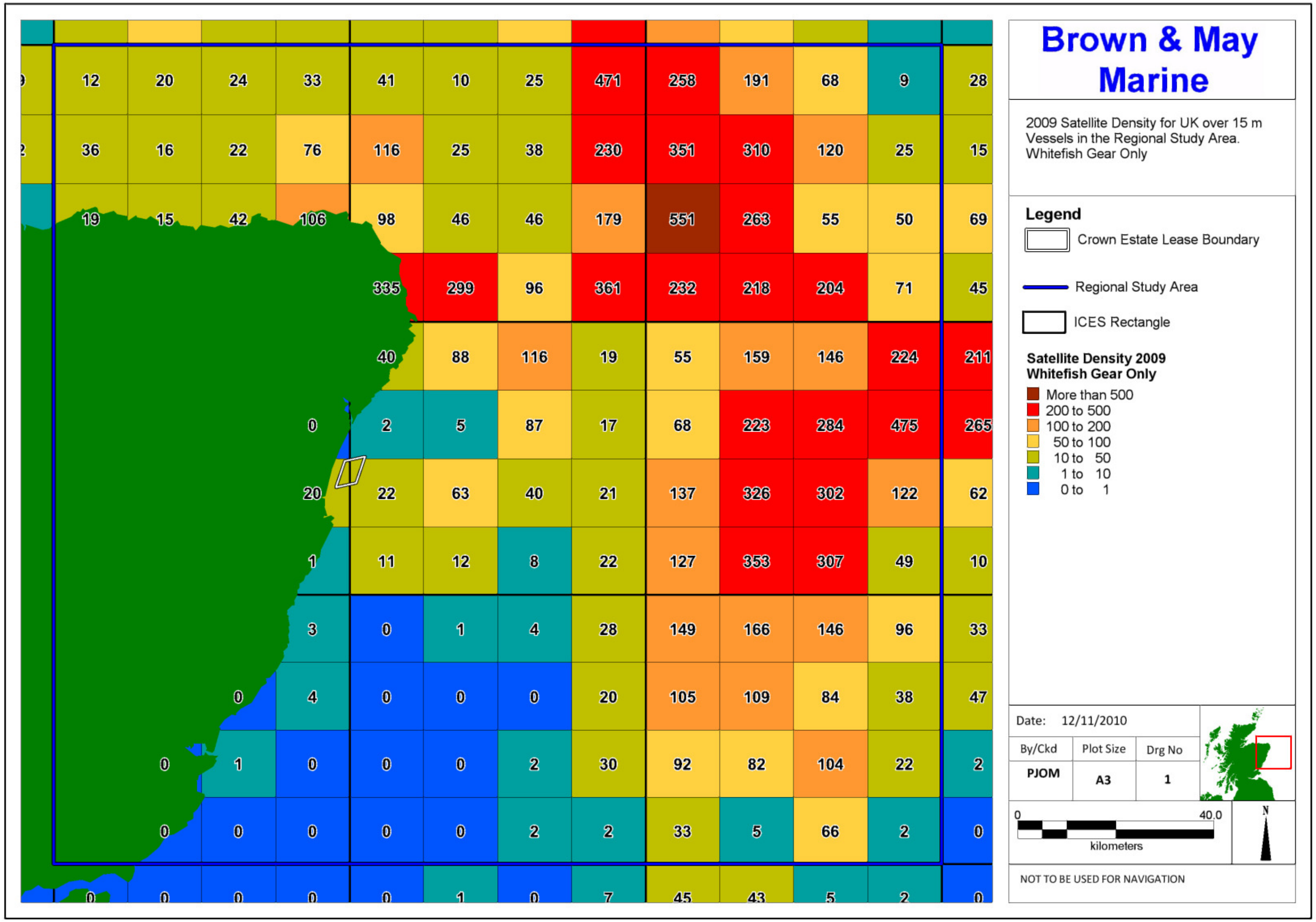


Figure 8-8 2009 Satellite Density for UK over 15 m Vessels in the Regional Study Area, Whitefish Gear only,

9.0 Fisheries Surveillance

Figure 9-1 gives the positions of vessels identified by Fisheries Protection surveillance by nationality. As shown, in this ten year period only 1 vessel was recorded within the proposed EOWDC site. No foreign vessels were observed in proximity to the proposed EOWDC site.

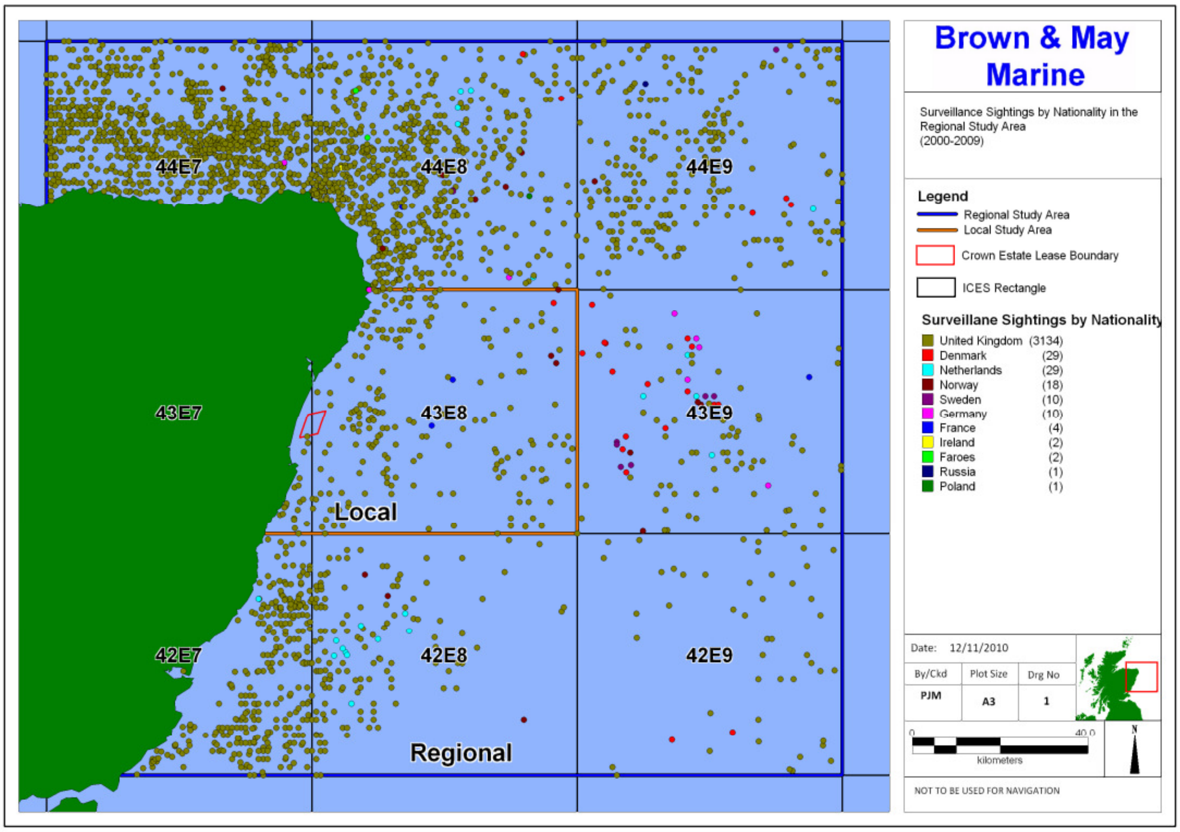


Figure 9-1 Surveillance Sightings by Nationality in the Regional Study Area (2000-2009) (Source: MMO)

Figure 9-2 shows the surveillance sightings by method. The majority of vessel categories observed in the vicinity of the proposed EOWDC site are demersal trawlers, scallop dredgers and potters/whelkers. Those labelled “Null” are vessels where the fishing method was unidentified.

The sightings plotted in Figure 9-1 and Figure 9-2 should however be taken in the context of the frequency of the surveillance patrols. Patrols over a particular area are generally at no more than weekly intervals and undertaken during daylight hours. These figures can therefore only be taken as a general indicator of the relative spatial distribution of different types of activity.

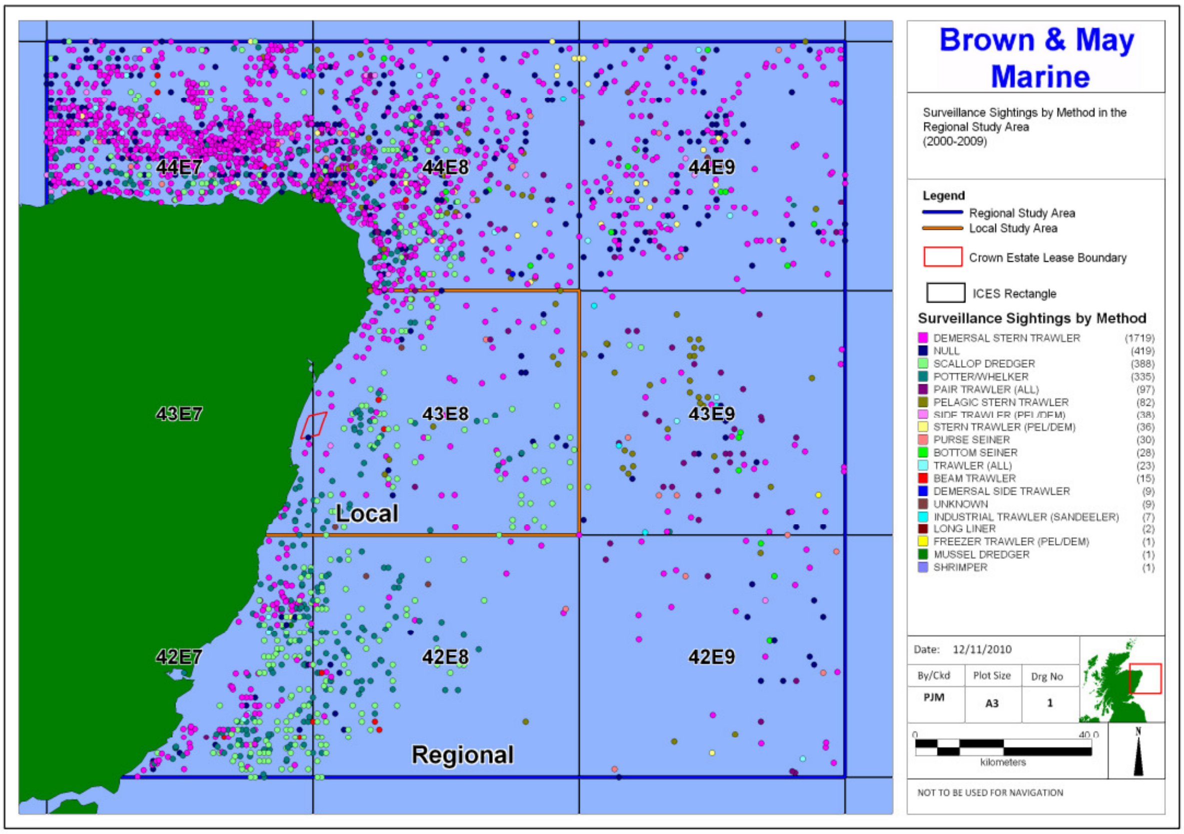


Figure 9-2 Surveillance Sightings by Method in the Regional Study Area (2000-2009) (Source: MMO)

10.0 Fishing Vessels, Methods, Operating Patterns and Practices

The information given in this section was gathered by the Scottish Fishermen's Federation (SFF) on the behalf of Brown and May Marine Ltd. A series of fieldwork trips and consultation with local fishermen was undertaken to ascertain the types, levels and locations of fishing activity in the regional area encompassing the proposed EOWDC site. The information was primarily gathered between 2008 and 2010.

10.1 Vessels by Port

Fishing vessels based at ports which could potentially be affected by the proposed EOWDC development extend from Port Erroll (Cruden Bay) in the North to Gourdon Bay in the south (Figure 10-1 below). Within this area Aberdeen is the largest harbour. A number of the small ports and harbours are used only during the spring, summer and autumn months by both full and part-time vessels as well as a number of small vessels, undertaking jigging, or rod fishing, or laying a few pots.

A common feature of these smaller harbours is their exposure to the easterly gales which are a feature of a north-east Scottish winter. The photographs given in Figure 10-2 to Figure 10-8 below show ports and vessels in the area of the proposed EOWDC.

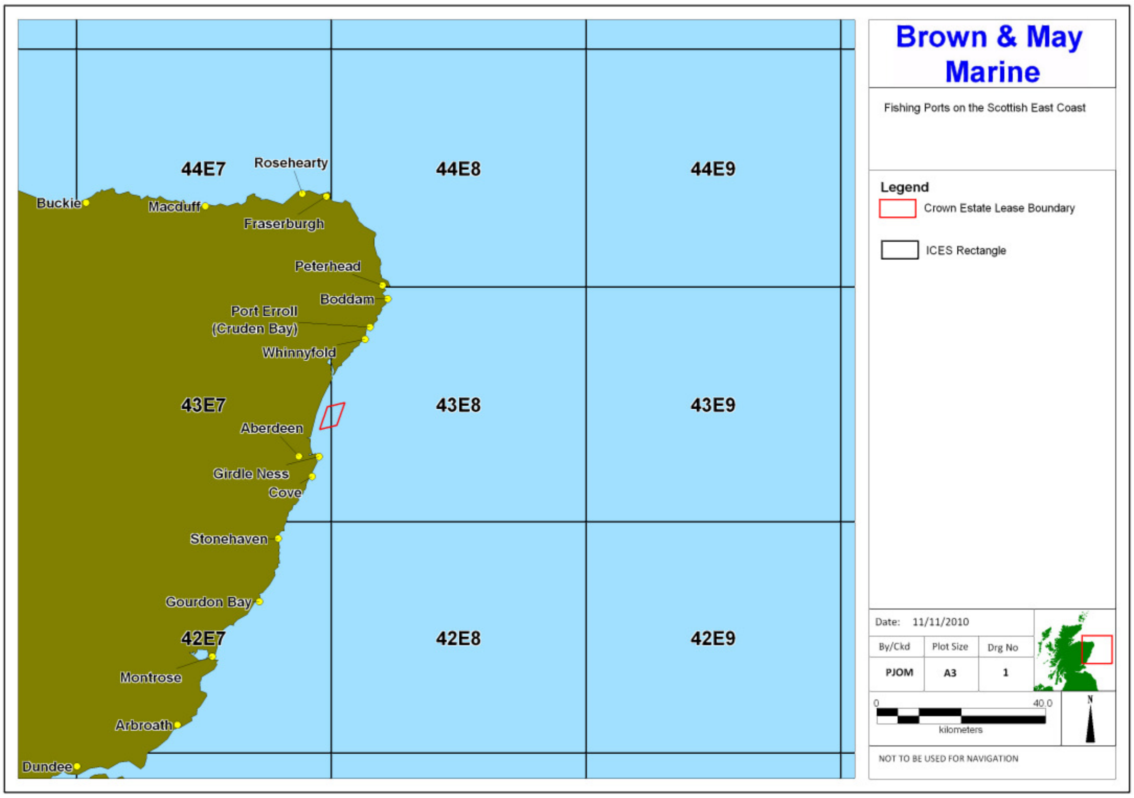


Figure 10-1 Fishing Ports on the Scottish East Coast

Figure 10-2 Inshore Craft berthed in Aberdeen

Figure 10-3 Boats Hauled out at Cruden Bay

Figure 10-4 Cove Harbour

Figure 10-5 Potter in Stonehaven Harbour

Figure 10-6 Vessels in Stonehaven Harbour

Figure 10-7 Gourdon Harbour

Figure 10-8 Demersal Otter Trawlers in Gourdon Bay Harbour

10.2 Fishing Methods

Figure 10-9 shows the fishing areas as identified through consultation with fishing interests in the area of the proposed EOWDC site.

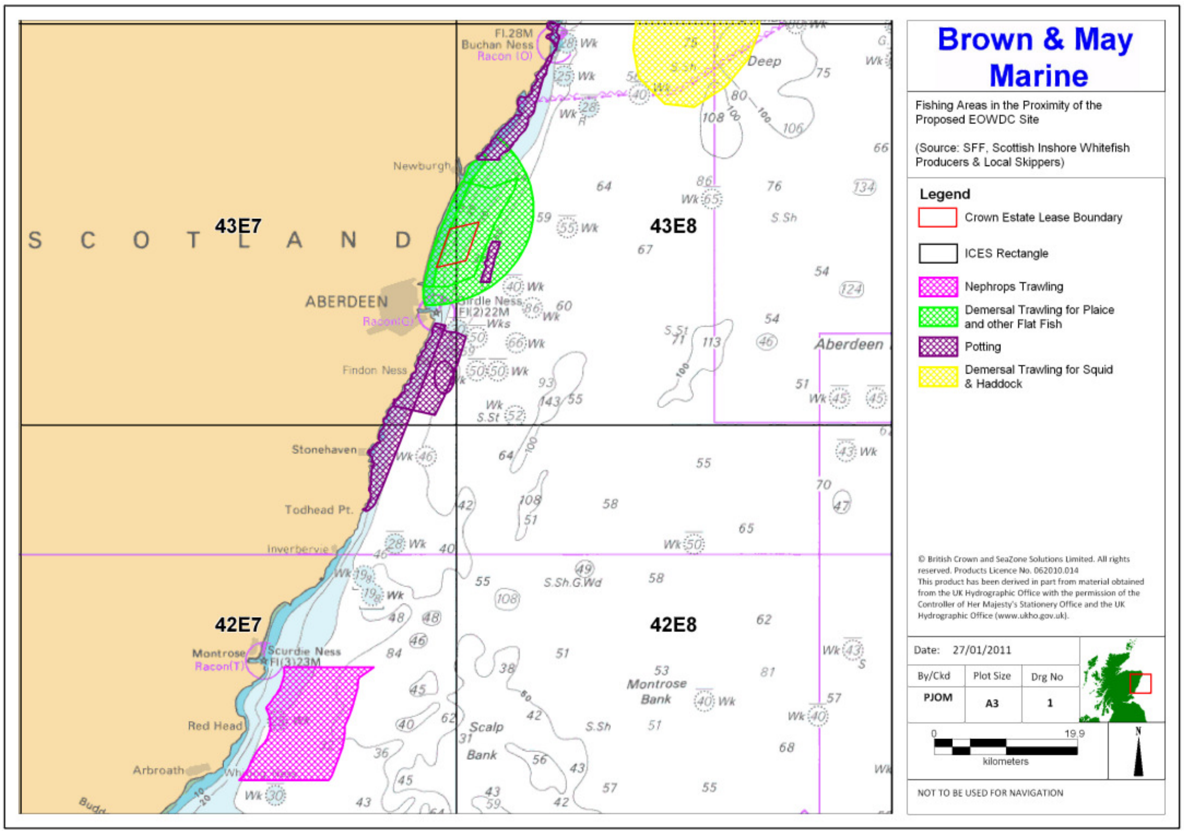


Figure 10-9 Fishing Areas in the proximity of the Proposed EOWDC Site

10.2.1 Demersal (bottom) Trawling

Demersal trawling is the most common fishing method in Scottish waters in terms of vessel numbers. Basic operating principles are the same throughout, with vessels towing one or more trawl nets, the lateral openings of which are affected by the trawl doors. The ratio of towing warp paid out to water depth is generally 3:1. Tow duration may vary from a single pass over a fish mark to tows of up to 5 hours. Towing speeds vary between 2 knots and 4 knots.

There is demersal trawling for whitefish in the general area around the proposed EOWDC site. In the past vessels from ports north of Aberdeen trawled the bay between Girdle Ness and Cruden Skares, just off the coast of Whinnyfold (Figure 10-1), for flat and roundfish, however, these vessels now target the more lucrative and reliable nephrops fisheries further offshore. Bottom trawling for flatfish, specifically for plaice, is the only trawling activity undertaken within the boundaries of the proposed EOWDC site, largely as a result of seabed substrate, which is sandy, homogenous ground largely devoid of features. This activity is restricted to a maximum of three to four inshore vessels during the summer. Figure 10-9 shows the principle demersal trawling grounds in and adjacent to the proposed EOWDC site. A few of the Aberdeen skippers also charter their vessels for rod and line fishing on wrecks to supplement their commercial fishing income.

10.2.2 Potting

Pots, or creels, are essentially traps baited to catch shellfish such as lobster, crab or nephrops. They are generally deployed in inshore waters, although some larger vessels will fish offshore areas. The priority of this fishery is the delivery of live catch. The scale of this activity can range from a 'hobbyist' fisherman setting 20 pots, to the long range vivier crabber which may set several hundred creels and keep crabs alive in purpose-built onboard vivier tanks.

Although it has been possible in the past to target brown crab in the Aberdeen Bay area, this activity has declined considerably as the port's uses have changed. It was stated by the Aberdeen District Fisheries Officer in 2010 that no part of the proposed EOWDC site is used by creel boats (Fraser, 2010). This is principally due to the risks associated with the large volume of marine traffic transiting, anchoring or sheltering in the bay. Potting activity for crab and lobster is generally concentrated approximately 5 nm to the north and south of the proposed EOWDC site.

The low levels of potting activity in the proposed EOWDC site are also attributed to the low productivity of the area. Higher concentrations of potting however occur in the coastal zones to the north and south of the site (Figure 10-9).

Due to the majority of vessels being smaller, local craft which are susceptible to weather limitations, activity normally takes place in the spring and summer, although some fish all year round.

10.2.3 Scallop Dredging

Vessels generally tow between one and two beams onto which a number of dredges are attached, depending on vessel size, engine power and winch capacity. The principal type of dredge used is the English 'Springer' type whereby the scallops are 'raked' from the seabed by steel teeth that are attached along the leading edge of the dredges which penetrate the seabed to a depth of approximately 20cms.

By virtue of their activity, scallop vessels are extremely migratory, fishing one location before moving to another and finally returning when the ground is thought to have recovered. In this way most of the suitable grounds around Scotland are fished. The Bennachie ground, which lies in the deeper offshore waters beyond Aberdeen Bay, is, at times, also fished for scallops. There is currently no evidence of scallop dredging occurring in the proposed EOWDC site.

10.2.4 Jigging and Hand Lining

As the name suggests, hand lining is fishing by hand using a multi-hooked line. Jigging is much the same except a mechanical, and generally computerised, jigger is used. The hooks are rigged with feathers or fish-like lures and 'jigged' up and down a few inches to attract the target species, which are pelagic fish or squid. This method is predominantly undertaken inshore, but larger craft may target shoaling fish further offshore. A further variation on hand-lining, known as 'ripper' is used to target cod and pollack on wrecks and pinnacles.

This method, as with potting, is for the most part undertaken in summer months and is carried out by a variety of small craft, both by professional and part-time fishermen. It was stated that there is very little jigging for mackerel within the boundaries of the proposed EOWDC site (pers comm, Ian Balgowan, 4th April 2008).

10.3 Vessels Active within the Proposed EOWDC Site

It was stated by the Aberdeen District Fisheries Officer that four vessels have been identified operating on occasions within and around the proposed EOWDC site (Fraser, 2010). Figure 10-10, Figure 10-12, Figure 10-13 and Figure 10-14 provide photographs of these vessels, with accompanying basic vessel specifications. All of these vessels are configured to undertake demersal trawling. In addition several of the vessels operate pots. Two of the vessels stated their activities were concentrated between the Aberdeen Harbour Fairway Buoy and the buoys off the Black Dog Firing Range, in the summer months between May and October. These vessels operate out of Aberdeen port. The two remaining vessel operate out of Peterhead and visit the area only occasionally, and also in the summer months.

SKUA II

Figure 10-10 Inshore Demersal Otter Trawler and Potter, Skua II

Registration	A17
Home Port	Aberdeen
Length	8.27m
Engine	130HP
Trawl Footrope	14m grass rope
Trawl Doors	Bison V, 760mm
Towing Depth	5.5 – 55m
Trawling Season	May to August

Figure 10-11 illustrates the trawl tows of Skua II, one of the four trawlers stated as operating in the proposed Eowdc site site. It can be seen that the majority of the vessel's fishing grounds lie inshore of the western boundary of the proposed EOWDC site.

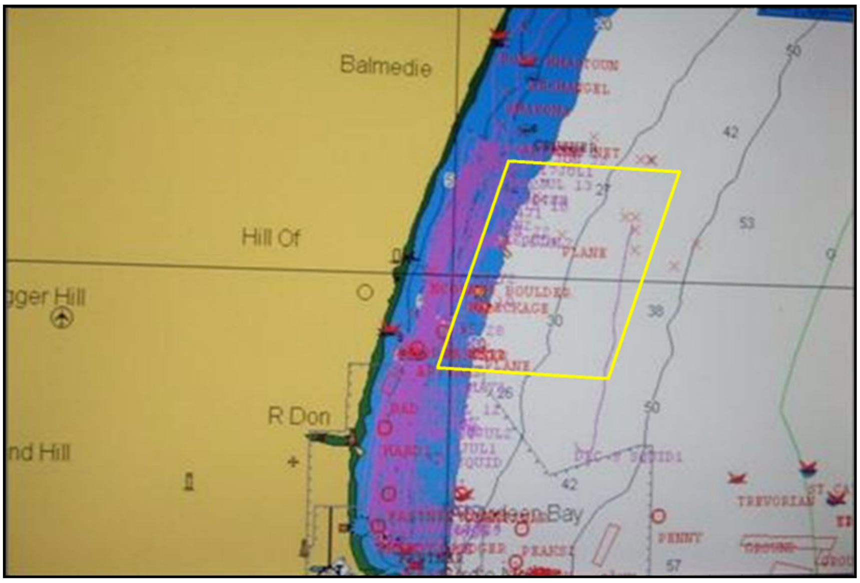


Figure 10-11 Skua II's tow tracks (in pink), taken from the vessel's electronic chart plotter (2008)

TERN

Figure 10-12 Potter and Inshore Demersal Trawler, Tern

Registration	A879
Home Port	Aberdeen
Length	9.99
Engine	98HP
Trawl Footrope	18m rubber-leg rope
Trawl Doors	1500mm
Towing Depth	9 – 55m
Trawling Season	May to October

Maddy Marie

Figure 10-13 Potter and Inshore Demersal Trawler, Maddy Marie

Registration	PD320
Home Port	Peterhead
Length	9.36 m
Engine	161HP
Trawling Season	May to October

Boy Paul

Figure 10-14 Inshore Demersal Trawler, Boy Paul, BM447

Registration	BM447
Home Port	Peterhead
Length	9.7m
Engine	119HP
Trawling Season	May to August (Flatfish); September to April (Squid & Haddock)

11.0 Future Fisheries

At present no new fisheries are foreseen in the area surrounding Aberdeen Bay, and in all probability there is unlikely to be an increase in either fishing effort or vessel numbers. It is also possible that increasing conservation concerns will lead to the implementation of designated protected marine conservation areas which will conceivably have the effect of enforcing further restrictions upon certain commercial fishing activities.

There exists the possibility that fishing practices within the proposed EOWDC site could change during its operational life. An example is the appearance of large shoals of squid inshore during the summer in the Moray Firth, providing a valuable fishery which previously did not exist. Furthermore, squid has been recorded at low levels in inshore areas in the proximity of the proposed EOWDC site. It is however considered that this species favours rockier grounds and that the substrate in Aberdeen Bay is not suitable.

Finally, future environmental and/or economic constraints may force fishermen to alter or amend current fishing practices. It is possible that vessels may be reconfigured with alternative gear, either to target the same species, or a different fishery.

12.0 References

Aberdeen Maritime Museum, (2007) Aberdeen Industry: A brief historical overview [Online] Available from http://www.aberdeenconferences.com/media/toolkit/Aberdeen_History.pdf Accessed: 10/03/2011

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European Offshore Wind Deployment Centre

Environmental Statement

Appendix 21.2: Commercial Fisheries EIA Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

European Offshore Wind Deployment Centre (EOWDC)

Commercial Fishing
Impact Assessment

Undertaken by
Brown & May Marine Ltd

Reference	Date of Issue	Issue Type	Checked	Approved
EOWDC-CFIA01	14/06/2011	FINAL	SJA/PJM/SX	SJA

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Commercial Fisheries

Information for the Non-Technical Summary

Commercial fishing activities in the region within which the proposed EOWDC site is situated are considered to be at relatively low levels. Potting for crab and lobsters; demersal otter trawling for whitefish and nephrops; and dredging for scallops, account for the majority of the activity within the regional area.

With regards to the local area, from consultation with the Scottish Fishermen's Federation (SFF), local fishermen and the District Fishery Officer, it is understood that only four, 11-metre and under demersal trawlers actively fish in the area of the site, targeting mainly flatfish. Two of the vessels operate out of Aberdeen and two from Peterhead (Section 10.3 Baseline Assessment).

Whilst larger trawlers operating out of Aberdeen may transit through the site, in view of the operating costs of these larger vessels, the area of the site is not sufficiently productive to justify such vessels actually fishing within it.

The principal fishing grounds for potting are located further south and to the north of the site (Section 10.2 Baseline Assessment). During consultation with local potting skippers, it was stated that the proposed EOWDC site is not recognised as a productive potting ground.

In view of the limited number of turbines proposed, the small area of the site and the low level of fishing activity within it, the overall impacts on commercial fishing are expected to be negligible, although for a small number of local vessels, the potential impacts may be of minor significance.

Introduction

In the absence of published guidelines from Marine Scotland regarding the impacts that could potentially be sustained by commercial fishing via the introduction of offshore renewable developments in Scottish waters, the impacts requiring assessment for the proposed EOWDC development are as specified in the Cefas/MCEU (2004) Guidelines, which are as follows;

- Adverse impacts on commercially exploited species
- Complete loss of or restricted access to traditional fishing grounds
- Safety issues for fishing vessels
- Interference with fisheries activities
- Increased steaming times to fishing grounds
- Presence of seabed obstacles and obstruction
- Any other concerns raised by local fishermen and fishing organisations

The assessments of the above impacts are addressed separately for the construction/decommissioning phases and operational phase in terms of site specific and cumulative effects.
It is considered that the potential impacts associated with the decommissioning phase will be of no greater significance than those of the construction phase, and in view of the absence of piling will, in reality, be less.

Methodology Consultation

Consultation with local fishermen and other stakeholders was principally undertaken by the Scottish Fishermen's Federation (SFF) between 2008 and 2010. The SFF represent approximately 90% of Scottish fishermen.

In addition, direct consultation was undertaken with the skippers and owners of the vessels who were identified as fishing in the area of the development, and the District Fisheries Officer, between October 2010 and January 2011.

The individuals and organisations consulted were:

- Aberdeen District Fisheries Office (281010);
- Fisheries Research Services (211107);
- Scottish Fishermen's Federation (211107);
- Sydney McLean – Boy Paul – Peterhead (170111);
- Ricky Greenhowe – Skua II- Aberdeen (170111);
- John Anderson – Tern – Aberdeen (170111);
- Stuart Willox – Maddie Marie – Peterhead (170111); and
- Scottish Inshore Fish Producers Association (December 2007 &150211).

Key Guidance Documents

For both the baseline and impact assessments account has been taken of the following;

- Offshore Wind Farms, Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements - Version 2; Cefas, MCUE, Defra, DTI, June 2004
- Strategic Environmental Assessment (SEA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Volume 1: Environmental Report; Marine Scotland 2010
- UK Offshore Energy – Strategic Environmental Assessment; DECC, January 2009
- Recommendations for Fisheries Liaison; FLOW, May 2008
- Fisheries Liaison Guidelines – Issue 5; UK Oil & Gas, 2008
- Guidelines to Improve Relations between Oil & Gas Industries and Near-shore Fishermen, UKOOA (renamed UK Oil & Gas), August 2006
- Fishing & Submarine Cables – Working Together, International Cable Protection Committee (CPC), February 2009
- Options and Opportunities for Marine Fisheries Mitigation Associated with Wind Farms, COWRIE 2010.
- Scoping Response -Marine Scotland (15.12.10)

Data Information and Sources

The principal data and information sources used were:

- International Council for the Exploration of the Sea (ICES)
- Marine Management Organisation (MMO)
- Marine Scotland, Marine Science (MS)
- Scottish Fisheries Protection Agency (SFPA)
- European Fisheries Commission (Europa)
- Brown & May Marine in-house databases

Impact Assessment Methodology

The assessment aims to describe the magnitude of effect for each potential impact (i.e. the change created by an activity in terms of its spatial extent, duration and scale) and the sensitivity of each receptor (i.e. the environmental resources that would be affected) based on its importance and recoverability. The effect and sensitivity of the receptor are then used to derive the significance of each potential impact. The criteria used in the assessment are given below:

Spatial Extent of Effect

- A national/international effect
- A regional effect
- A local, site specific effect including within 5km of the site

Duration of Effect

- A long term/permanent effect (more than 10 years)
- A medium effect (existing for 5 to 10 years)
- A short term effect (existing for 1 to 5 years)
- A temporary effect (existing for less than 1 year)

Scale of Effect

- Above accepted standards/guidelines
- Within accepted standards/guidelines
- Where there are no standards/guidelines available, the impact relative to background conditions

Recoverability of the Receptor

- High
- Medium
- Low or None

Importance of the receptor (taking into account international, national and regional legislation, and function within the ecosystem)

- High

- Medium
- Low or None

The impact significance is then given as ***MAJOR, MODERATE, MINOR*** or ***NEGLIGIBLE*** guided by the matrix given in Table 1.

Table 1 Matrix Used to Guide Significance Ratings of Impacts

		Sensitivity of Receptor			
		VERY HIGH	**HIGH**	**MEDIUM**	**LOW**
Magnitude of Effect (based on spatial, duration and scale)	**VERY HIGH**	Major	Major	Major	Moderate
	HIGH	Major	Major	Moderate	Minor
	MEDIUM	Major	Moderate	Moderate	Minor
	LOW	Moderate	Minor	Minor	Negligible
	NEGLIGIBLE	Minor	Negligible	Negligible	Negligible

Certain elements of the following assessments are based upon incomplete knowledge and data gaps. In such instances, the assessment may be based upon a number of assumptions and, therefore, a degree of uncertainty will exist.

Implications of Significance

Where the significance for a potential impact is classified as ***MODERATE*** *to* ***MAJOR*** or ***MAJOR****,* it is considered to be a potentially significant effect. It should be noted however that significant effects may not be unacceptable as their effect may be reversible. A ***NEGLIGIBLE*** significance is assigned to a potential impact if it produces no discernible effect on the environment resource in question.

Cumulative and In-combination Impact Assessment Methodology

The cumulative impact assessments have applied the same methodology and potential impacts outlined above.

In view of the limited number of vessels and their operational ranges in relation to the locations of designated Special Areas of Conservation (SAC) and Special Protected Areas (SPA) it is considered that there will be no in-combinations effects as defined under the Habitats Regulations Appraisal (HRA). Any impacts relating to salmon are dealt with in the EOWDC Salmon and Seat Trout Impact Assessment.

Cumulative impact assessments have been undertaken on all existing and any reasonably foreseeable project/development activities. The following elements that are considered to have the potential to contribute to cumulative impacts are;

- **Other Offshore Wind Farms**

The closest wind farm developments to the EOWDC site are the proposed Firth of Forth developments 58 km to the south and the Moray Firth developments 117 km to the north.

- **Shipping and Navigation**

The potential cumulative impacts associated with commercial shipping and navigation are discussed in Section 15 (Shipping and Navigation).

- **Offshore Oil Developments**

Currently available information suggests that within the foreseeable future, there will be no oil and gas exploration or production activities within the general area of the proposed EOWDC site which would contribute to cumulative effects. This activity has therefore been scoped out of the cumulative assessment process.

- **Introduction of Marine Protected Areas (MPAs)**

The Marine (Scotland) Act has established powers for the development of Marine Protected Areas (MPAs) in the seas around Scotland. These areas have yet to be defined so at present it is unclear as to the potential location of any future MPAs. It is however likely, given the nature of the seabed in the general area of EOWDC site, that no MPAs will be designated and as such will not contribute to a cumulative effect.

In terms of other spatial restrictions, as mentioned in the Baseline Assessment, there are no local fishing restrictions within 3 nm limit specific to the Aberdeen Bay area; however the use of mobile or active gear is prohibited during certain times of the year in four areas to the south of the site. These have therefore been scoped out of the cumulative assessment process.

- **Aggregate Dredging**

The Middle Bank licensed dredging area in the Firth of Forth, approximately 150 km from the EOWDC site is the closest licensed dredging area. It should also be noted however that at present it is not active. This activity has therefore been scoped out of the cumulative assessment process.

- **Other Offshore Works**

Due to erosion in Aberdeen Bay, the foreshore required beach replenishment works, with 70,000 cubic tonnes of material dredged from local offshore areas between July and August 2006. It is expected that such works will be required every five to seven years (pers. comm. FRS, 2007). It is therefore possible that beach replenishment works may occur within the general area of the EOWDC site during its lifespan.

- **Ocean Laboratory**

It is proposed that an Ocean Laboratory may be installed within the site and will be subject and separate application and EIA. As such, at this stage it will only be assessed in terms of its cumulative effect.

Assessment of Impacts against a Changing Baseline

A number of factors unrelated to the proposed EOWDC development may cause changes to the commercial fishing baseline over the life of the project. For instance, the trend in UK commercial fishing over the last 30 years has been one of decline. This trend, with specific reference to Aberdeen, is detailed further in the Baseline Assessment (Section 6.0).

Worst Realistic Case

As mentioned above, current trends in fishing indicate that levels of activity are unlikely to increase over the lifetime of the project. The impact assessment therefore assumes the current baseline as the worst realistic case in terms of the levels and types of fishing activity.

For the majority of impacts, the realistic worst case site layout is assumed to be the highest density of wind turbines within the site, i.e. 11 wind turbines, giving a minimum distance between turbine towers of 790 m. In terms of the smallest navigable distance between structures, the worst case would be jacket foundations which, with the implementation of 100 m safety zones, would leave spacing between turbines of 550 m. At present 50m safety zones around turbines are planned, which is in-line with other UK offshore wind farm sites. It is possible, however, that this zone could be up to 100 m and therefore 100 m should be assumed as worst case. A 200 m anchor exclusion is also planned around cables.

Impact Assessment

Adverse Impacts on Commercially Exploited Species

Construction & Decommissioning Phase

Potential Impacts

As discussed in Section 9 (Marine Ecology), the principal impacts which could adversely affect commercially exploited species, which are confined to the construction and decommissioning phases, are noise and vibration and habitat loss. Potting for crabs and lobsters, demersal otter trawling for whitefish and nephrops, and dredging for scallops accounted for the majority of the commercial fishing activity in the regional study area by recorded landings values.

Available research into the effects of noise and vibration suggests that the impacts on the main target species in the area of the development are not considered to be on the same scale as for hearing specialists such as clupeids (Nedwell & Howell, 2004). It is however accepted that fish and mobile shellfish species, such as crabs and lobsters, may temporarily vacate the site or a part of it as a result of noise or vibration disturbance.

The potential impacts on salmonids are discussed separately within the salmon and sea trout assessment for the proposed EOWDC.

As only 11 turbines are to be installed, the number of piling events will be small. Under normal conditions, based on data from wind farms constructed to date, the duration of piling individual foundations typically varies between 20 minutes and thirteen hours. For the purposes of assuming a worst case scenario, five days is taken as the theoretical maximum duration for the installation of a single foundation, with the worst case actual piling time being 24 hours continuous (further details in Chapter 3, Description of the Proposed Development).

Research at the Horns Rev Offshore Wind Farm also suggests that it is unlikely that there would be any significant long-term detrimental effect on the relevant commercial fish and shellfish stocks (Hydit *et al*., 2006). To date, within UK waters, there is no available research data regarding the recovery time of localised shellfish stocks following piling. Observations of potters in, for example, the operational Barrow Offshore Wind Farm, however, suggest that within a matter of months, crabs and lobsters return to an operational site in sufficient quantities to support resumption of commercial potting activities, indicating no longer term adverse impacts. Figure 1 shows a 10 metre potter which recommenced working in the operational Barrow wind farm site within a matter of months following completion of construction works.

Figure 1 10 metre Fishing in the Barrow Wind Farm

The installation of turbines and the laying and burial of the intra-field and export cables, is, as stated in Section 9, not expected to increase suspended sediment concentrations to levels which would have any significant adverse impact on commercially exploited species.

It is predicted that potential impact of the proposed EOWDC on commercially exploited species will be of *MEDIUM* sensitivity, *LOW* magnitude and therefore of *MINOR* significance.

Mitigation

In order to minimise, as far as is practically possible, any potential impacts from piling noise, in line with standard practice, soft start piling will be employed.

Residual Impacts

In view of the above, it is predicted that the potential site specific impact will be localised, temporary and at worst of *MINOR* significance and confined to the local area.

It is likely that the decommissioning phase would be over a shorter time frame than construction and would not involve piling. The impacts are therefore expected to be of lower significance than during the construction phase.

Cumulative Impacts

Other Offshore Wind Farms

The potential cumulative impact of noise and vibration and increased sediment concentrations, as a result of piling and cable burial activities from other offshore wind farm developments, is discussed in Section 9 (Marine Ecology). The closest wind farm developments to the EOWDC site are the proposed Firth of Forth developments 58 km to the south and the Moray Firth developments 117 km to the north. It is unlikely all three developments would be under construction or decommissioning at the same time. The potential cumulative impact has therefore been assessed to be of *NEGLIGIBLE* magnitude, *LOW* sensitivity and therefore of *NEGLIGIBLE* significance.

Shipping & Navigation

The principal impact which could adversely affect commercially exploited species during the construction or decommissioning phase is noise. This is discussed in Section 9 (Marine Ecology), which predicts the contribution to cumulative effects to be of *LOW* sensitivity, *LOW* magnitude and, as such, of *NEGLIGIBLE* significance.

Other Offshore Works

It is unlikely that beach replenishment works in Aberdeen Bay would coincide with the construction or decommissioning phase of the EOWDC. Should this occur however, the comparative sediment levels from the foundation piling and cable installations would be low, localised and over a short duration so that the contribution to cumulative effects would be of *LOW* magnitude with *LOW* sensitivity and therefore of *NEGLIGIBLE* significance.

Ocean Laboratory

In view of the limited number of wind turbines, the contribution of an additional piling event for the construction of the offshore Ocean Laboratory to cumulative effects is expected to be of *LOW* magnitude, *LOW* sensitivity and therefore of *NEGLIGIBLE* significance.

Operational Phase

Potential Impacts

As discussed in Section 9 (Marine Ecology), there is little evidence to suggest that the principal commercially targeted species, i.e. flatfish, in the proposed EOWDC site would be adversely affected by the electro-magnetic effects of inter-array and export cables.

It is therefore predicted that the potential impact will be of *LOW* magnitude, *LOW* sensitivity and therefore of *NEGLIGIBLE* significance.

Mitigation

The presence of foundation structures will provide refuge for mobile species and increase the surface area for colonisation of prey species and/or for the settlement of juvenile shellfish. The addition of scour protection, if used, would provide additional habitat and shelter for commercially important fish and shellfish species, thus resulting in a *BENEFICIAL* impact.

A study (Linley *et al*., 2007) undertaken on behalf of BERR on the reef effects of offshore wind farms supported this and provided the following findings:

- The structures may result in new habitat opportunities, extending the distributions of some mobile species such as crabs, lobsters and finfish, thereby enhancing the productivity of these populations and subsequently commercial fishing in the area;

- There is evidence to indicate that juveniles of some species such as whiting, crabs and lobsters preferentially use rocky reefs as a habitat which suggests that the scour protection on turbines may offer direct benefits to these species;

- The high niche diversity (including interstitial spaces between rocks) is likely to promote recovery from storm events, reduce predation and support a more bio-diverse community than could be expected from unprotected turbines.

Sampling programmes undertaken at the Horns Rev and Nysted Offshore Wind Farms concluded that the hard substrate around turbine bases was beneficial to the reproduction and growth of native mobile species such as crabs, providing shelter and nursery grounds (presented by S. Leonhardt at the Danish Monitoring Programme Conference, November 2006).

Residual Impacts

The residual impact of the proposed EOWDC on commercially exploited species during its operational phase is likely to be *NEGLIGIBLE* significance and in some cases potentially *BENEFICIAL* which in turn could have a *BENEFICIAL* effect for certain fishing methods such as potting.

Cumulative Impacts

As the operational EOWDC is expected to have no significant adverse impacts on commercially exploited species, it will therefore not make any contribution to cumulative effects.

Complete Loss of or Restricted Access to Traditional Fishing Grounds

Construction & Decommissioning Phase

Potential Impacts

The complete loss of, or restricted access to, traditional fishing grounds was the primary concern raised by local fishermen actively fishing in the area of the proposed EOWDC site. A significant adverse impact would only occur if there were no alternative local fishing areas of similar productivity. As shown by the Baseline Assessment, the levels of activity within the site are low and confined to very few local vessels. In addition, the overall area of the site is small and the construction phase over a relatively short period. As such, the potential impact has been assessed to be of *LOW* magnitude, *MEDIUM* sensitivity and therefore of *MINOR* significance for those local vessels known to fish the area.

Mitigation

Whilst construction safety procedures and schedules have yet to be finalised, it is envisaged that an exclusion zone will be in operation during the construction of the EOWDC. As a worst case approach, this would include a 500 m zone around all inter array cable, foundation and turbine installation works. In practice, it may be that smaller sections of the site would be subject to the exclusion zone at any one time. Similarly, during the export cable burial works, vessels not associated with the EOWDC would be expected to keep 500 m away from all cable installation works. Export cable burial is expected to take approximately 52 hours in total at 500 m/hour for a maximum length of 26 km.

On-going liaison will be maintained to ensure fishermen are informed of construction/decommissioning vessels schedules and routes.

Residual Impacts

In the national and regional contexts, the impact of loss of fishing area will be of *NEGLIGIBLE* significance. In the case of the four local vessels identified as fishing the area of the EOWDC site and export cable route the temporary residual impact is expected to be of *MINOR* significance.

Cumulative Impacts

Other Offshore Wind Farms

In view of the limited number of vessels actively fishing in the area, their operational ranges, and that the closest wind farm developments are 58 km and 117 km from the proposed EOWDC site, it is considered that the potential cumulative impact will be of *NEGLIGIBLE* magnitude, *LOW* sensitivity and subsequently of *NEGLIGIBLE* significance.

Shipping & Navigation

The potential cumulative effect with shipping and navigation is discussed in Section 15 (Shipping and Navigation) however, overall, it is considered to be *NEGLIGIBLE* magnitude, *LOW* sensitivity and therefore of *NEGLIGIBLE* significance.

Other Offshore Works

If beach replenishment works in Aberdeen Bay were to occur during the construction or decommissioning phase of the project, in view of the number of vessels involved, the potential impact would be of short duration and localised and as such considered to be of *NEGLIGIBLE* significance.

Ocean Laboratory

The cumulative effect of an additional piling event for the construction of the offshore Ocean Laboratory is expected to be of *LOW* magnitude, *LOW* sensitivity and therefore of *NEGLIGIBLE* significance.

Operational Phase

Potential Impacts

An adverse impact will only occur if fishing vessels which previously fished the site could not return to it once construction activities had been completed. As previously stated, only four demersal trawlers, who fish the area for only part of the year, have the potential to be impacted. The evidence given in the Baseline Assessment also suggests that the majority of these vessels fishing areas are inshore of the site.

As such in the national and regional contexts, the potential impact for larger vessels has been assessed to be of *LOW* magnitude, *LOW* sensitivity and subsequently of *NEGLIGIBLE* significance. In the case however, of the four local vessels identified as fishing the area of the EOWDC site, the impact is expected to be of *MEDIUM* magnitude, *MEDIUM* sensitivity and consequently of *MODERATE* significance.

Mitigation

Evidence from UK wind farms has shown that demersal trawling and certain other fishing methods can resume within operational wind farms. A minimum blade clearance height of 22 m is in excess of the air height of the largest UK fishing vessels. Figure 2 shows a 10 metre demersal trawler fishing inside the Kentish Flats Offshore Wind Farm and Figure 3 is a photograph taken onboard a 24 metre demersal trawler hauling its net inside the Barrow Offshore Wind Farm.

Figure 2 10 metre Vessel Fishing in the Kentish Flats Offshore Wind Farm

Figure 3 24 metre Vessel Fishing in Barrow Offshore Wind Farm

Residual Impacts

Whilst fishing may resume within the operational site once the construction exclusion zones have been removed, with some modifications to towing patterns and gears, there will be a small loss of fishing area resulting from the safety zones around the turbines which could result in an adverse impact of *MINOR* significance on the four local vessels known to fish the area.

This may however be compensated by increased concentrations of fish attracted into the site as a consequence of the addition of underwater structures, which has been shown to be the case in the Kentish Flats Offshore Wind Farm (pers. comm. Whitstable skippers 2011) The residual loss of fishing area is therefore considered to be of *NEGLIGIBLE* significance and there may in fact be potentially *BENEFICIAL* effect for certain methods.

Cumulative Impacts

Other Offshore Wind Farms

In view of the limited number of vessels actively fishing in the area, their operational ranges, and that the closest wind farm developments are 58 km and 117 km from the proposed EOWDC site, it is considered that potential cumulative impacts will be of *NEGLIGIBLE* magnitude*, LOW* sensitivity and subsequently of *NEGLIGIBLE* significance.

Shipping & Navigation

The potential cumulative impacts with commercial shipping and navigation are discussed in Section 15 (Shipping and Navigation) and are assessed to be of *NEGLIGIBLE* magnitude*, LOW* sensitivity and therefore of *NEGLIGIBLE* significance*.*

Other Offshore Works

If beach replenishment works in Aberdeen Bay were to occur, it could result in some temporary loss of close inshore fishing areas. As such the cumulative impact has been assessed to be of *LOW* magnitude*, LOW* sensitivity and therefore of *NEGLIGIBLE* significance.

Ocean Laboratory

The cumulative effect of an offshore Ocean Laboratory is expected to be of *NEGLIGIBLE* magnitude, *LOW* sensitivity and therefore of *NEGLIGIBLE* significance.

Safety Issues for Fishing Vessels

Construction & Decommissioning Phase

Potential Impacts

In line with standard practice, construction exclusion zones will be in place around all offshore construction activities from which all vessels other than construction vessels will be excluded. Risks to fishing vessels safety would therefore only occur if infringements of these safety zones occurred. It should also be recognised that in line with standard maritime practice, the ultimate responsibility in regards to safety lies with the master of a vessel. With compliance with the imposed safety zones, the safety risks to fishing vessels should be within acceptable limits. This issue is considered further within the Navigational Risk Assessment (appendix 15.1).

Mitigation

Obligatory formal notices (Notice to Mariners), fisheries liaison and distribution channels will be established to ensure that construction and safety information is efficiently and effectively disseminated to the relevant skippers and vessel owners.

It is also envisaged that the Scottish Fishermen's Federation (SFF), who have over 30 years experience in dealing directly with oil interests in the North Sea, will play an important role in fisheries liaison and information distribution.

The Navigation Risk Assessment (Section 15) considers that, providing skippers of fishing vessels are aware of, and respect, safety exclusion zones, the safety risks during construction would be within acceptable limits.

Operational Phase

The safety issues associated with the operational phase are discussed in Section 15 which considers that with appropriate mitigation in place any potential impacts are deemed to be of low significance.

Providing standard offshore safety procedures are implemented and skippers of fishing vessels adhere to them, the safety risks would be considered to be within acceptable limits.

Interference to Fishing Activities

Construction & Decommissioning Phase

Potential Impacts

All of the potential impacts included in this assessment could be considered to cause interference to fishing activities. The only other impact yet to be considered is the potential navigational conflicts which may arise between construction/decommissioning/survey vessels and fishing vessels such as the fouling of static gear marker buoys and dhans or causing trawlers to change their towing directions. Due to the low number of fishing vessels in the proposed EOWDC area the potential impact has been assessed to be of *LOW* magnitude, *MEDIUM* sensitivity and therefore of *MINOR* significance.

Mitigation

Where possible, construction and decommissioning vessels will adhere to established transit routes. On-going liaison will also be maintained to ensure fishermen are informed of construction vessels schedules and routes.

Contractors laying and trenching the export cable will also be obliged to adhere to standard fisheries notification and liaison procedures as specified by the International Cable Protection Committee (ICPC).

Liaison will also be undertaken to identify the locations of static gears to provide contractors with the required information in order to enable them to avoid conflicts with static gears.

Residual Impacts

With the procedures described above, residual impact is expected to be of *NEGLIGIBLE* significance.

Cumulative Impacts

Taking into consideration the limited number of vessels actively fishing in the area, the distance from other developments and activities, and with adherence to standard procedures and on-going liaison, the potential of cumulative interference effects are predicted to be of *NEGLIGIBLE* significance.

Operational Phase

Residual Impacts

It is predicted that, with adherence by maintenance vessels to the same procedures as described above for construction vessels, the impact will be of *NEGLIGIBLE* significance.

Cumulative Impacts

Similarly, as with the construction and decommissioning phases, there is not expected to be any significant cumulative effects.

Increased Steaming Times to Fishing Grounds

Construction & Decommissioning Phase

Potential Impacts

The implementation of safety exclusion zones, described above, could in theory, result in short-term increases in steaming distances and times, and therefore higher operational costs. In the worst case, the entire site would be closed to all vessels, including fishing vessels for the duration of construction and decommissioning activities. The experience of the construction of wind farms in the UK to-date however indicates that this is unlikely to be the case with exclusion zones being temporary and transitory around specific construction activities.

Figures 8.1 to Figures 8.8 in the Baseline Assessment give examples of 15 metre and over UK fishing vessels entering and exiting Aberdeen harbour through the area of the proposed EOWDC site in transit to fishing grounds further afield. It can be seen that these vessels steam to fishing grounds often in excess of 200 nm from Aberdeen Harbour and any increase in overall steaming distances and times due to deviations around the site would be considered to be minimal. As such the potential impact has been assessed to be of *LOW* magnitude, *LOW* sensitivity and subsequently of *NEGLIGIBLE* significance.

In the case of the smaller local vessels, a significant proportion of their traditional fishing grounds are located inshore of the EOWDC site, as indicated by the example of plotter tracks shown in the Baseline Assessment (Figure 10.11). It is however accepted that during the construction and decommissioning phases, there may be occasions when the presence of safety exclusion zones may temporarily increase the steaming times of local vessels with a history of fishing in and around the EOWDC site area. As a result, the potential impact is considered to be of *LOW* magnitude, *MEDIUM* sensitivity and subsequently of *MINOR* significance.

Mitigation

During the construction and decommissioning phases, the appropriate notifications will be provided, and on-going liaison will be maintained, to keep skippers of fishing vessels informed of the schedule of the imposition of exclusion zones around construction and decommissioning activities.

Residual Impacts

In the case of the larger class of vessels, whose fishing grounds are considerable distances from the site, it is predicted that the impact on steaming times will be of *NEGLIGIBLE* significance. For the smaller local vessels the temporary impact will be of *MINOR* significance.

Cumulative Impacts

Other Offshore Wind Farms

The potential cumulative impacts are considered to be of *NEGLIGIBLE* significance, with a *NEGLIGIBLE* magnitude and *LOW* sensitivity, as the closest wind farm developments are 58 km and 117 km from the proposed EOWDC site.

Shipping & Navigation

The potential cumulative impacts with commercial shipping and navigation are discussed in Section 15 (Shipping and Navigation) and expected to be of *NEGLIGIBLE* magnitude, *LOW* sensitivity and therefore of *NEGLIGIBLE* significance.

Other Offshore Works

If beach replenishment works in Aberdeen Bay were to occur at the same times as construction and decommissioning activities, it could result in some temporary increases to steaming times. As such the potential cumulative impacts has been assessed to be of *LOW* magnitude*, LOW* sensitivity and therefore of *NEGLIGIBLE* significance.

Ocean Laboratory

The cumulative effect of an offshore Ocean Laboratory is expected to be of *NEGLIGIBLE* magnitude, *LOW* sensitivity and therefore of *NEGLIGIBLE* significance.

Operational Phase

Potential Impacts

An adverse impact on steaming times would only occur if fishing vessels were prohibited or were unable to safely steam through the operational EOWDC site. Consultation undertaken by the SFF with fishermen and their representatives has identified concerns regarding the safety of steaming through operational wind farms.

The worst case scenario of 11 turbines with jacket foundations would result in a minimum navigable distance between turbine centres of 550 m, this allows for a 100 m exclusion zone and turbine base. This distance is substantially greater than many commercial harbour approach channels and entrances, including Aberdeen Harbour.

As a result the potential impact is predicted to be of *LOW* magnitude*, LOW* sensitivity and therefore of *NEGLIGIBLE* significance.

Mitigation

As stated above, there is evidence to show that fishing vessels fish within operational wind farms where the distance between turbine rows range from 500 m to 700 m, e.g. Kentish Flats Offshore Wind Farm and Barrow Offshore Wind Farm. It is therefore reasonable to assume that in the appropriate conditions it should be possible for fishing vessels to steam through the EOWDC site.

Residual Impacts

As fishing and other vessels should be able to steam through the operational site, the impact on steaming times and distances during the operational phase is predicted to be of *NEGLIGIBLE* significance.

Cumulative Impacts

As the potential impact of the operational site on steaming times and distances has been assessed to be of *NEGLIGIBLE* significance, there is no potential for cumulative impacts.

Presence of Seabed Obstacles and Obstructions

Construction & Decommissioning Phase

Potential Impacts

Waste or debris left on the seabed by construction or decommissioning vessels could result in damage or loss of fishing gears, as well as representing a safety hazard. Offshore works such as cable trenching, construction vessel anchoring or jack up legs can produce seabed obstructions which have caused fastenings and damage to fishing gears.

As such, the potential impact is considered to be of *HIGH* sensitivity, *LOW* to *HIGH* magnitude and therefore of *MINOR to MAJOR* significance.

Mitigation

Contractors engaged will be contractually obliged and monitored to ensure compliance and adherence to company and standard offshore policies prohibiting the discarding of objects or waste at sea. They will also be required to report and recover any accidentally dropped objects. Furthermore seabed obstructions and spoils identified during post-construction monitoring, which might represent a hazard to fishing, will be rectified.

Residual Impacts

With compliance to obligatory standards by contractors and, if necessary, the implementation of rectification measures, the residual impacts are expected to be within acceptable limits and as such to be of *NEGLIGIBLE* significance.

Cumulative Impacts

As the impacts associated with construction and decommissioning phases of the EOWDC site are considered to be of *NEGLIGIBLE* significance, there is no potential for cumulative effects.

Operational Phase

As maintenance contractors will be under the same contractual obligations as construction and decommissioning contractors, the cumulative impacts of seabed obstacles will be the same as for the construction and decommissioning phases, i.e. of *NEGLIGIBLE* significance.

EOWDC Future Research and Monitoring Opportunities

The proposed EOWDC is designated as a development site in close proximity to a major fishing port; as such Marine Scotland's research facility offers opportunities for projects to be undertaken to research practical measures for enhancing the co-existence between operational wind farms and commercial fishing. Such projects could include:

- Trials using local fishing vessels to demonstrate the most appropriate and effective operating practices within operational wind farms for a variety of fishing methods.

- Sampling surveys using local fishing vessels to monitor potential reef effects during the operational phase.

- Trials into the practical and commercial viability of other fishing methods not currently used in the area by local vessels but which could be feasibly and productively deployed within operational wind farms.

Summary of Impact Assessment

A summary of the various impacts assessed above is given in Table 2. As is apparent, the overall impact of the proposed EOWDC on commercial fishing is expected to be very small, being for the most part *NEGLIGIBLE* and in the few cases where discernable impacts might occur, they will be of no more than of *MINOR* significance.

In the national and regional contexts, in view of the limited number of turbines and the comparatively small area of the site, and relatively low levels of fishing activity, it is to be expected that the overall impact on commercial fishing will be so low as to be of *NEGLIGIBLE* significance.

With regards to the local context, the Baseline Assessment has determined that only four local vessels fish the site area and export cable route to any significant extent, and the fishing effort that does occur is at relatively low levels and seasonal. Whilst there could be some temporary impacts of *MINOR* significance associated with loss of fishing area during the construction and decommissioning phases, every endeavour will be made to liaise with skippers to mitigate these as far as is practically possible.

Once operational, it is expected that fishing will be able to resume within the site, however, changes in operating patterns maybe required, such as changing established towing patterns and some gear modifications e.g. shortening the fleet lengths of potting gear and fixed nets. It is possible, that as found in the operational Kentish Flats and Barrow Offshore Wind Farms, there may be a beneficial reef effect whereby fishermen can exploit concentrations of fish and shellfish attracted into the site.

As stated above, the EOWDC is to be an experimental site and should practical trials into the coexistence between commercial fishing and the operational site be undertaken, local vessels, provided they are suitably certified, could be used for the undertaking of such trials.

As discussed in chapter 9 (marine ecology) the principal impacts which could adversely affect commercially exploited species during the construction and decommissioning phases are noise, vibration and habitat loss and suspended sediment. After mitigation these impacts are deemed, at worst, to be of *MINOR* significance and confined to the local area. There is little evidence to suggest that the principal commercially targeted species, i.e. flatfish, in the proposed EOWDC site would be adversely affected by the electro-magnetic effects of inter-array and export cables during the operational phase, the potential impact is therefore deemed to be of *NEGLIGIBLE* significance.

Cumulative impacts are, for the most part, expected to be of *NEGLIGIBLE* significance. This is a consequence of the little offshore development, either existing or planned, in the vicinity of the site. Furthermore, as the EOWDC development is expected to result in very few impacts above *MINOR* significance, and those which do occur would be temporary and localised, the contribution of the development to cumulative impacts is expected to be minimal.

Table 2 Environmental Impact Assessment Summary Matrix

Potential Impact/ Activity	Receptor	Spatial extent	Duration	Magnitude	Probability of effect occurring	Sensitivity	Significance level	Mitigation measures and rationale	Significance level after mitigation
CONSTRUCTION AND DECOMMISSIONING									
Adverse impacts on commercially exploited species	All vessels	Local	Temporary	Low	Uncertain	Medium	Minor	Use of appropriate engineering techniques, e.g. soft start piling. Low sensitivity of principal target species.	Minor
Complete loss of, or restricted access to traditional fishing grounds	Larger vessels Local vessels	Local	Temporary	Low	Certain	Low Medium	Negligible Minor	Effective, on-going liaison	Negligible for larger vessels Possibly minor for local vessels
Safety issues for fishing vessels	All vessels	Local	Temporary	Low to High	Unlikely	High	Minor to major if collision occurred	Implementation and adherence to standard offshore safety procedures. Involvement of the SFF for liaison and information distribution.	Within acceptable limits
Interference to fishing activities	All vessels	Local	Temporary	Low	Unlikely	Medium	Minor	Construction vessels using existing shipping routes. On-going liaison informing skippers of construction vessels schedules and routes.	Negligible
Increased steaming times to fishing grounds	Larger vessels Local vessels	Local	Temporary	Low	Unlikely Likely	Low Medium	Negligible Minor	Transitory, short term exclusion areas around construction activities within the site. Limited numbers of potentially impacted vessels. Low probability of a significant number of steaming routes likely to be affected.	Negligible for larger vessels Possibly minor for local vessels

Potential Impact/ Activity	Receptor	Spatial extent	Duration	Magnitude	Probability of effect occurring	Sensitivity	Significance level	Mitigation measures and rationale	Significance level after mitigation
Presence of seabed obstacles and obstructions	All vessels	Site-specific	Temporary	Low to High	Uncertain	High	Minor to major if fastening occurred	Contractors are required to report and recover any accidentally dropped objects. Seabed obstructions and spoils identified during post-construction monitoring, which might represent a hazard to fishing, will be rectified.	Within acceptable limits
Restriction of access during laying of export cables	All vessels	Local	Temporary	Low	Certain	Low to medium	Negligible, possible minor for some local vessels	Short duration and small transitory area of exclusion. Limited numbers of potentially affected vessels.	Negligible, possibly minor for some local vessels
OPERATIONAL									
Adverse impacts on commercially exploited species	All vessels	Local	Temporary	Low	Unlikely	Low	Negligible	The presence of underwater structures will provide refuge for mobile species and increased surface area for colonisation of prey species and/or the settlement of juvenile shellfish. Scour protection, if used, will likely offer additional habitat for species by providing shelter and nursery grounds.	Negligible to beneficial
Complete loss of, or restricted access to traditional fishing grounds	Larger vessels Local vessels	Local	Permanent	Low Medium	Unlikely Likely	Low Medium	Negligible Moderate	Certain fishing practices may resume within the operational site with some modification to operating practices.	Negligible to beneficial Minor

Potential Impact/ Activity	Receptor	Spatial extent	Duration	Magnitude	Probability of effect occurring	Sensitivity	Significance level	Mitigation measures and rationale	Significance level after mitigation
Safety issues for fishing vessels	All vessels	Site-specific	Permanent	Low to High	Unlikely	High	Minor to Major if collision occurred	Implementation and adherence to standard offshore safety procedures.	Within acceptable limits
Interference to fishing activities	All vessels	Local	Permanent	Low	Unlikely	Medium	Minor	Maintenance vessels using existing shipping routes. On-going liaison informing skippers of maintenance vessels schedules and routes.	Negligible
Increased steaming times to fishing grounds	All vessels	Local	Permanent	Low	Unlikely	Low	Negligible	Potential for fishing vessels to steam through the site in favourable conditions. Limited numbers of potentially impacted vessels. Low probability of a significant number of steaming routes likely to be affected.	Negligible
Presence of seabed obstacles and obstructions	All vessels	Site-specific	Temporary	Low to High	Uncertain	High	Minor to Major if fastening occurred	Contractor obligations and standard offshore practices should have removed obstructions and obstacles. Any scour protection rock placement would be adjacent to wind turbine bases.	Within acceptable limits
Damage to fishing gear/vessels from exposed cables	All vessels	Site-specific	Temporary	Low to High	Unlikely	High	Minor to Major	Cable burial to at least 0.6 m depth. Implementation and adherence to standard offshore safety procedures. Cable route surveys. Temporary exclusion zones until issues are rectified.	Negligible to Minor

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European Offshore Wind Deployment Centre

Environmental Statement

Appendix 22.1: Salmon and Sea Trout Baseline Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

European Offshore Wind Deployment Centre Salmon and Sea Trout Ecology and Fisheries Baseline Assessment

Undertaken by

Brown & May Marine Ltd

Ref	Issue Type	Date of Issue	Checked	Approved
SST-EFBL-BMM02	FINAL	09/05/2011	SX/JHM/SJA	SJA

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1.0 Introduction

The following document describes the current salmon and sea trout ecology and fisheries baseline assessment for the proposed European Offshore Wind Deployment Centre (EOWDC).

Scottish salmon populations are recognised as being of national and international importance (Malcolm *et al.*, 2010). In addition to their ecological value, salmon and sea trout are species of importance from a socioeconomic perspective on a local, regional and national level in Scotland.

2.0 Summary

2.1 Ecology

Salmon and sea trout smolts migrate seawards in the spring, generally from April to June. The seaward migration in both species is thought to be an active process with fish swimming close to the surface and it does not appear to be a period of acclimation when moving from fresh to salt water.

Salmon post-smolts make limited use of the estuarine environment moving quickly to the open sea towards their feeding grounds. Limited research carried out to date suggests post-smolts may travel relatively close to the coast in the initial phases of their migration.

Salmon originating in rivers from Aberdeenshire southwards are thought to migrate back from their feeding grounds through the North Sea, approaching the coast as far south as Northumberland and then start a northerly coastal migration towards their home rivers. Grilse (one sea winter salmon) enter the rivers from early summer until shortly before spawning in autumn, whilst multi sea winter salmon enter the rivers over a greater period of time.

Unlike salmon, sea trout post-smolts are not believed to travel to distant waters to feed; instead they generally remain in coastal waters. In the North East region sea trout generally enter the rivers from June to September with peak runs varying between rivers.

2.2 Fisheries

The right to fish for salmon in Scotland is a heritable right, whether in inland waters or at sea. The fisheries are managed by their owner or leaseholder under a framework of regulations laid down by central government. Under Scottish legislation the term salmon applies to both salmon and sea trout.

In the salmon fishery districts located in close proximity to the proposed EOWDC, the Ythan, Don and Dee, the majority of the total salmon and sea trout catch comes from the rod-and-line fishery. Net fisheries are however of relative importance in other districts within the regional area, such as the Ugie and more significantly the Esk.

The Don is the salmon fishery district located in the immediate vicinity of the proposed EOWDC. The majority of the reported catch in the district is by rod-and-line, a high percentage of which is by catch and release. Reported catches by the net fishery are comparatively low, with no net-and-coble currently taking place in the district and fixed engines recording very low reported catches in recent years.

3.0 Study Area

For the purposes of this assessment the study area has been defined on a local, regional and national scale (Figure 3.1). The local area comprises the zone relevant to the salmon fishery district located in the immediate vicinity of the EOWDC, the Don, whilst the regional area includes all the salmon fishery districts within the North East region; Ugie, Ythan, Don, Dee and Esk. Given the migratory behaviour of salmon and sea trout and the relative importance of the fishery across the country, a national focus has also been briefly described.

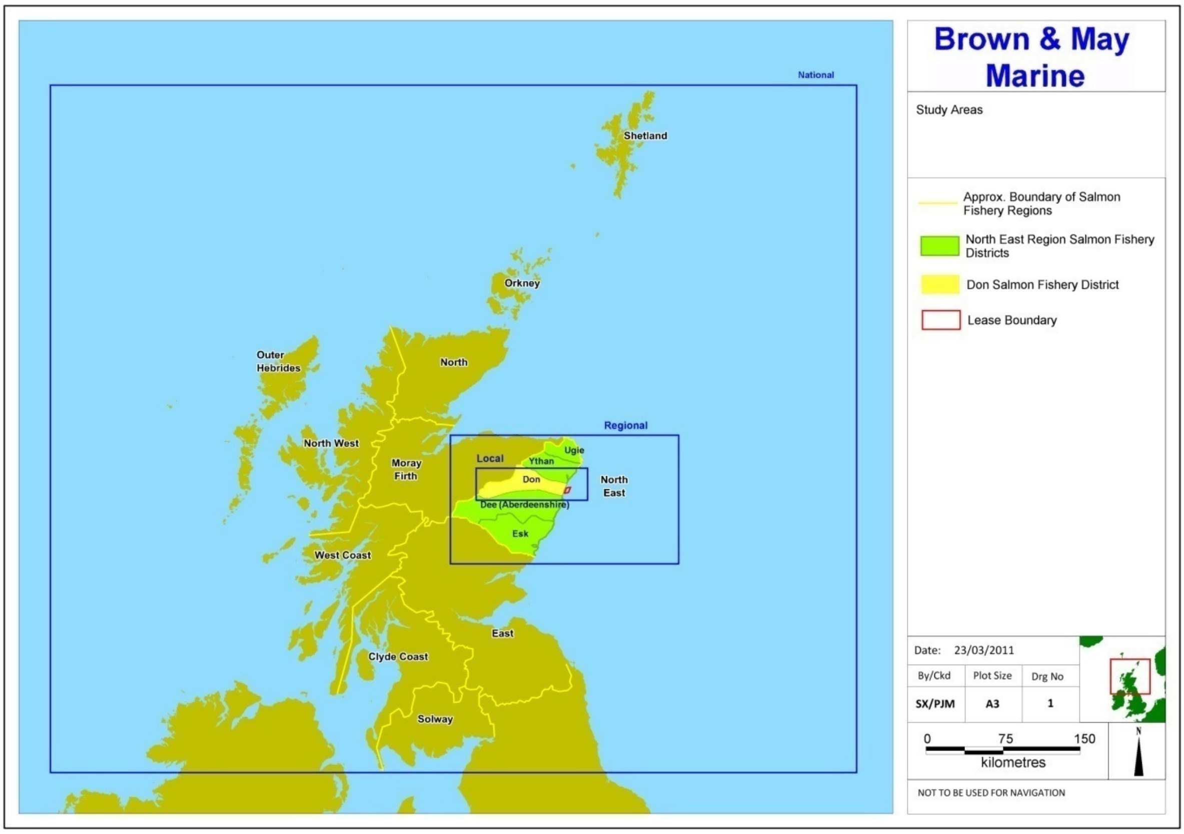


Figure 3.1 Study Areas

4.0 Methodology

4.1 Consultation

Consultation meetings were held with all the District Salmon Fishery Boards located within the North East region and with representatives of the netting fishery in the North East.

These were as follows:

- Ugie District Salmon Fishery Board (26/10/2010)
- Ythan District Salmon Fishery Board (26/10/2010)
- Don District Salmon Fishery Board (27/10/2010)
- Dee District Salmon Fishery Board (17/01/2011)
- Esk District Salmon Fishery Board (27/10/2010)
- Usan Fisheries (Montrose) (17/02/2011)

In addition to the above meetings, questionnaires were circulated to all the salmon district fishery boards in Scotland, through the Association of Salmon Fishery Boards (ASFB), and to netsmen, through the Salmon Net Fishing Association of Scotland. This process was aimed at gathering information at a national level and to note the main concerns of the boards and the netsmen with regards to wind farm developments in Scotland. At the time of writing, a sample of 14 salmon boards, netsmen and other organisations have completed and returned the questionnaires (See Appendix 01).

Consultation with coastal netting individual right holders will be undertaken once the location of the export cable is defined.

4.2 Key Guidance Documents

The following guidance documents have been used for undertaking this baseline assessment:

- Strategic Environmental Assessment (SEA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Volume 1: Environmental Report; Marine Scotland 2010
- Offshore Wind Farms, Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements - Version 2; Cefas, MCUE, DTI, June 2004.
- Marine Scotland Scoping Response (December 2010 and January 2011 update)
- Scottish Natural Heritage Scoping Response (29/09/2010)
- Scottish Environment Protection Agency Scoping Response (24.09.2010)
- UK Offshore Energy – Strategic Environmental Assessment; DECC, January 2009
- Recommendations for Fisheries Liaison; FLOW, May 2008

4.3 Data and Information Sources

There is no standard guidance for the establishment of salmon and sea trout fisheries baseline assessments in relation to offshore wind farm developments. A range of different data and information sources have therefore been used to inform this assessment. These are as follows:

- Marine Scotland Science (MSS)
- Association of Salmon Fishery Boards (ASFB)
- Salmon Net Fishing Association of Scotland
- North East Region District Salmon Fishery Boards and Fisheries Trusts
- Atlantic Salmon Trust
- Scientific papers and other relevant publications

4.4 Data & Information Sensitivities, Limitations and Gaps

4.4.1 MSS Salmon & Sea Trout Fisheries Catch Statistics

MSS catch statistics divide salmon catches into "salmon" and "grilse". In this context, the term salmon refers to multi-sea-winter salmon (MSW) whilst grilse refers to one-sea-winter salmon (1SW).

Each fishery in Scotland is required to provide the number and total weight of salmon and grilse and sea trout caught and retained in each month of the fishing season.

Rod and line fisheries are also required to provide the monthly numbers and total weight of those salmon, grilse and sea trout which were caught and released back into the river, this practice is known as “catch and release”. As a result, MSS catch data for the rod and line fishery is broken down into two categories, “rod and line” and “catch and release”. It should be noted that the total catch by the rod and line fishery is in effect the sum of the catches recorded in both categories. Where appropriate, data from both categories have been combined to give an indication of the total rod and line catch. Similarly, the catch by net and coble and fixed engines (bag and stake nets) has been combined in some instances to provide an indication of the total catch by the net fishery.

The catch data used for the purposes of this assessment are as reported. It is recognised that there may be a degree of error within the catch dataset due to misclassification of fish between the grilse and salmon categories. In addition, further errors as a result of misreporting of catches may also exist. The data used are as provided by Marine Scotland Science on 08/10/2010.

The catch data used in this report are Crown copyright, used with the permission of Marine Scotland Science. Marine Scotland is not responsible for interpretation of these data by third parties.

4.4.2 Salmon Fishery Regions and Districts

Each salmon fishery district applies its own voluntary or statutory conservation code, closure times, policies and regulations and has in place different management and conservation schemes (e.g hatcheries, fish counters, water quality control and monitoring schemes). In addition, different districts include varying numbers of rivers and tributaries within their jurisdictions and have different catchment areas.

The areas and names of some districts have changed over time. In the regional study area, for example, catch statistics are collected for the South Esk, North Esk and Bervie districts separately, however, these districts were superseded by the Esk Salmon Fishery District and abolished in 1988 (S.I, 1998/ 994). For the purposes of this assessment the former, smaller districts will be used as they provide a better spatial resolution for analysis of catch data.

The boundaries of the salmon fishery regions and districts could not be provided by MSS as GIS data layers as a result of third party copyright ownership of these data. The district and region boundaries shown in the charts provided in this report were produced by geo-referencing a raster image. These should therefore be taken as approximate and for illustrative purposes only.

4.4.3 Data Gaps

There is limited information available to date to accurately define the migratory routes and patterns of Scottish salmon and sea trout. Furthermore, the spatial resolution of the available data and information does not allow for the numbers and the origin of the fish potentially migrating through or near the proposed EOWDC to be evaluated.

It is also recognised, that current knowledge on salmon exceeds that of sea trout. As a result some aspects of the ecology assessment given below have been covered in greater detail for salmon than for sea trout.

5.0 Salmon & Sea Trout Ecology Baseline Assessment

5.1 Introduction

Atlantic salmon *(Salmo salar)* and sea trout *(Salmo trutta)* are anadromous migratory species which utilise both freshwater and marine habitats during their life cycles. Both are species of the family *Salmonidae*, being commonly referred to as salmonids.

Atlantic salmon is widely distributed within the EU, from Portugal in the south to Sweden and Finland in the north. The UK salmon population, however, comprises a significant proportion of the total European stock, with Scottish rivers being a European stronghold of the species (JNCC, 2010). The distribution of salmon rivers in Scotland is shown in Figure 5.1 below.

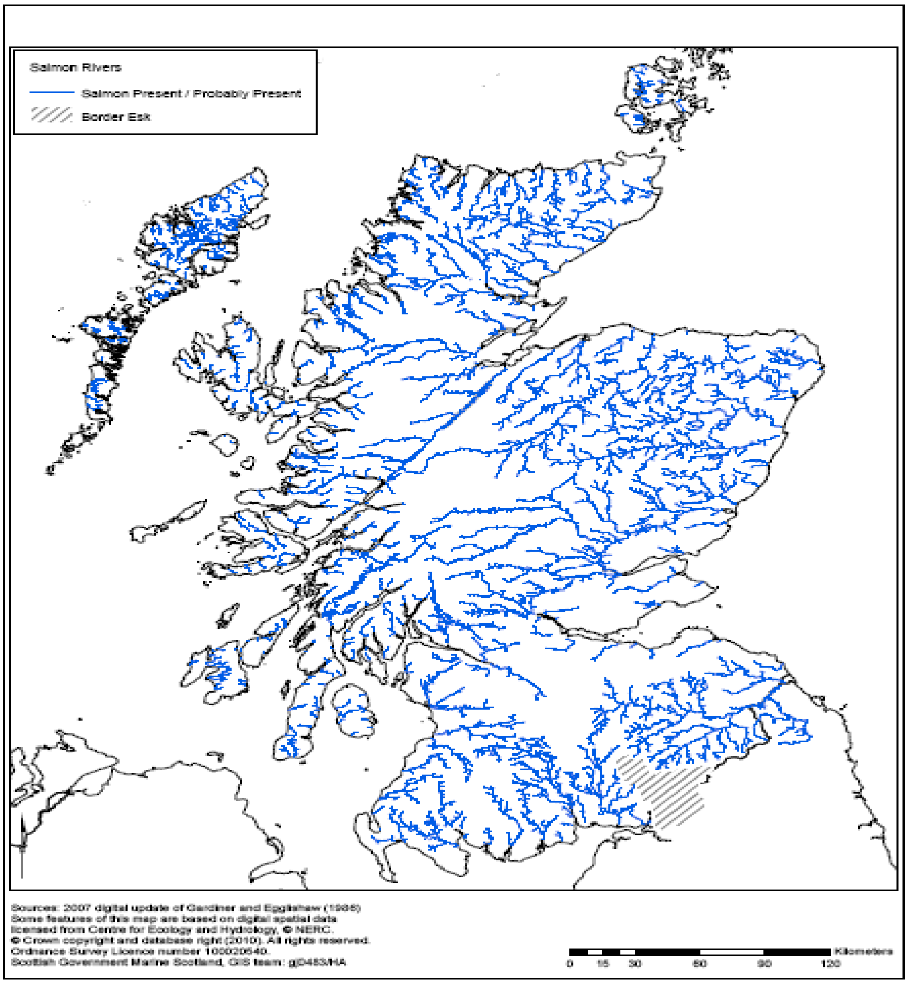


Figure 5.1 Distribution of Salmon Scottish Rivers. Updated from original salmon distribution map of Gardiner and Egglishaw (1985) (Source: Malcolm *et al*., 2010)

Sea trout is the migratory form of the common and widely distributed brown trout. Both forms are recognised as the same species and are present together with Atlantic salmon in many Scottish rivers. The distribution of sea trout in western Europe extends from north Portugal to the White Sea and Cheshkaya Gulf, including Iceland and the Baltic Sea (Elliott, 1994).

5.2 Life cycle

5.2.1 Salmon

The early development of Atlantic salmon takes place in freshwater, where they undergo a number of physiological changes to become 'smolts', the form in which they migrate to sea.

Spawning takes place in late autumn in the rivers. Eggs are deposited in redds (nests excavated by the females in gravelly substrates). The eggs hatch the following early spring.

Newly hatched salmon, known as 'alevins', remain hidden in the riverbed gravels feeding from the attached yolk sac. Once the yolk sac has been depleted the alevins are known as 'fry' and start feeding on small invertebrates. Salmon fry grow quickly during the first year increasing in size to become 'parr'.

Parr remain in the river for one to four or five years, depending on water temperatures and food availability. In Scottish rivers they most commonly stay in the river for two or three years

In spring, once parr have reached a length of 12-14 cm, they undergo a transformation both externally and internally, which allows them to adapt to salt water. They are then known as 'smolts'. Smolts move down rivers in April to June to start their oceanic migration. Once they enter the sea they are known as post-smolts, until the spring of the following year (Malcolm *et al*., 2010)

After one or more years feeding at sea salmon return to their home rivers to spawn, this generally occurs in late autumn or early winter. The amount of time spent at sea prior to the spawning migration varies from one winter for 'grilse' to up to four for 'multi-sea-winter' salmon (MSW).

Once they have spawned salmon are known as "kelt". Whilst the majority of Atlantic salmon (90-95%) die following their first spawning, some individuals survive and may spawn up to seven or more times during their lifetime. The majority of repeat spawners, however, survive to spawn only once or twice in their lifetime (Flemming, 1996). The survivors are predominantly female and return to sea to feed between spawning (Mills *et al*., 2003).

A summary of the basic salmon life-stage terminology is given in Table 5.1 below.

Table 5.1 Basic salmon life-stage terminology (Hendry & Cragg-Hine, 2003)

Development Stage		Description
1	Alevin	From hatching to end of dependence on yolk sac for primary nutrition
2	Fry	From independence of yolk sac to end of first summer
3	Parr	From end of first summer to migration as smolt
4	Smolt	Fully silvered juvenile salmon migrating to sea
5	Post-smolt	From departure from river to end of first winter in the sea
6	Grilse	Adult salmon after first winter in sea
	Multi-sea-winter (MSW)	Adult salmon after more than one winter in sea, commonly referred to as "spring" fish when entering river before June
7	Kelt	Spent or spawned adult

5.2.2 Sea trout

The life cycle of the sea trout is similar to that of Atlantic salmon. Spawning generally occurs between mid October and January. Smolting takes place in spring once a threshold size is reached. Most sea trout populations in the UK become smolts after two or three years in the river (AST, 2010a). Smolts leave the river around the same time as salmon, between April and early June (SNH, 2010). Female individuals are more likely to become smolts and migrate to sea (MSS, 2010a; SNH, 2010).

Most sea trout return to the rivers after twelve or more months at sea. These can be seen in the rivers between May and October (SNH, 2010) and are often found together in the same redds as brown trout as spawning time approaches in late autumn (MSS, 2010a).

Some immature fish return to the rivers after only a few months at sea, often in July and September (SNH, 2010). These are small fish, regionally known as 'finnock', 'herling' or 'whitling' and are found feeding in most Scottish estuaries as they move in and out with the tide (MSS, 2010a). Many gather in larger rivers and lochs, not necessarily in their natal systems, and over-winter in fresh water before returning to the sea in spring.

Unlike salmon, a significant proportion of spent sea trout kelts survive and make their way back to sea to recover and grow (SNH, 2010). Once they start to return they are annual spawners. There is however evidence of alternate year spawning as opposed to annual spawning in some stocks with long distance migrations (Solomon, 2007).

Some individuals return to the sea soon after spawning (mid October-December) whilst others remain in the rivers and estuaries, migrating out in the spring (AST, 2010a).

5.3 Migrations

A summary of the information currently available on salmon and sea trout migrations, primarily based on the review paper "Review of Migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: implications for the development of marine renewables", recently published by MSS (Malcolm *et al.* 2010), including a number of other relevant research publications, is given below. The migratory patterns and behaviour of salmon and sea trout in the vicinity of the proposed EOWDC has been the primary focus.

5.3.1 Salmon

5.3.1.1 Smolt and Post-Smolt Migration

The beginning of the down river migration of smolts is thought to be related to environmental factors such as temperature and water flow (McCormick *et al.*, 1998). The importance of these factors may however be variable and stimulate migration in different ways (Carlsen *et al*., 2004). Downstream migration within the river is mainly nocturnal and often triggered by increases in flow (Hendry & Cragg-Hine, 2003; Moore *et al.*, 1998a). In addition, social factors, such as the presence of other migrants in the river, may also play a role (Hansen & Jonsson, 1985; Hvidsten *et al*., 1995).

It is believed that salmon smolts use environmental cues in the rivers related to favourable ocean conditions allowing them to arrive at sea at an appropriate time (Hvidsten *et al*., 2009). Smolts from upper tributaries generally start migration earlier than those from lower tributaries, resulting in a synchronised sea entry of smolts from the same watershed (Stewart *et al.* 2006). Timing in the spring migration may therefore play an important role in salmon post-smolt survival at sea (Aas *et al.*, 2011).

Studies of the movement of Atlantic salmon post-smolts indicate active, directed swimming during migration, rather than passive drifting, with fish generally moving close to the surface (Lacroix *et al*., 2005; Lacroix *et al.*, 2004). It is suggested that there is no apparent period of acclimation required when moving from fresh to saltwater (Moore *et al.*, 1998a; Lacroix and McCurdy, 1996). Post-smolts are believed to make limited use of the estuarine habitat, moving rapidly to the open ocean (Marschall *et al*., 1998; Moore *et al*., 1998a, Malcolm *et al*., 2010). Limited existing data suggest that they usually swim close to the surface (1-3m depth) and make irregular dives down to 6.5m depth (Davidsen *et al.* 2008). A preference for warmer water layers, irrespective of salinity concentrations, has also been suggested (Plantalech manel-la *et al*., 2009).

Studies undertaken within fjords in Norway (Thorstad *et al*., 2004) suggest salmon post-smolts do not use the immediate near-shore areas during migration, the mean reported distance to shore being 370m. Similarly, tagging experiments carried out by Finstad *et al*. (2005) in the same area, found salmon used the full width of the fjord and travelled rapidly. Further studies undertaken in Canada, (Lacroix *et al*., 2005) in the Bay of Fundy, showed that fish travelled near the coast at a distance 2.5-5km from shore.

It should be noted that the current knowledge on salmon post-smolt migration and behaviour is principally based on the results of experiments and research carried out in Canada and Norway which have been summarised above. The lack of data specific to salmon post-smolts originating from Scottish rivers makes predictions of their behaviour in coastal waters difficult and speculative. Furthermore, Scottish coastal waters, especially in the case of the east coast rivers where there are no substantial bays or sea lochs (fjords), differ substantially from the locations where studies have been carried out in Canada and Norway.

It is also recognised that the migratory behaviour of post-smolts may vary depending on their river of origin. A recent study undertaken by Plantalech manel-la *et al.* (2011) found differences in early marine migratory behaviour between salmon from two different stocks and it was suggested that the distance that a salmon travels to reach the open coastline may influence its early marine migratory behaviour and performance.

The information given above, despite its limitations, provides an indication of the likely behaviour of salmon post-smolts during migration. As identified in Malcolm *et al*. (2010*)* the common findings across the research carried out to date can be summarised as follows:

- Post-smolts were always observed to migrate rapidly and actively towards open marine areas after leaving their home river
- Post-smolts did not appear to follow nearby shores closely, although this may occur in areas where coastal currents are substantial.
- Limited information on swimming depths suggests post-smolts generally use shallow depths (generally 1-3m, but up to 6m).

Data and information are also lacking to accurately define the routes followed, the areas used and the behaviour of salmon post-smolts in distant waters. The available information on the distribution and abundance of salmon at sea is principally based on records of tagging experiments from the West Greenland and Faroese fisheries (Shelton *et al*., 1997; Malcolm *et al*., 2010). A summary of relevant available information on salmon distribution in the sea and their behaviour is given below.

Post-smolts are thought to move in schools whilst heading off to deep-sea feeding area (Shelton *et al.*, 1997; Mills *et al.*, 2003). The best known feeding locations are in the Norwegian Sea and the waters off southwest Greenland, however, there are believed to be many other sub-arctic feeding areas. MSW salmon undertake longer migrations than grilse, which tend not to travel beyond the Faroe Islands and the southern Norwegian Sea (Mills *et al*., 2003).

The results of tagging experiments of salmon post-smolts suggest they travel rapidly over long distances. Studies in the Faroe-Shetland Channel (Shelton *et al*, 1997) found minimum progression rates of 7-30km/day; similarly, data from the North Sea the Norwegian Sea and the Barents Sea, indicate minimum progression rates of between 6 and 24km/day (Holm *et al*., 2003).

Historic recapture data from smolts tagged in Scottish rivers (Dee, Tay and North Esk), and data from the Girnock Burn (a tributary of the Dee) recorded between 1968 and 1982, suggest that at least some of the Scottish MSW salmon use the north-western Atlantic Area, around West Greenland (Malcolm *et al*., 2010).

Data recorded from the East Greenland and Irminger Sea fisheries, suggest these areas are of less importance to Atlantic salmon in general, and Scottish salmon in particular. This should however be taken in the context of the limited data that are available for these areas (Malcolm *et al*., 2010).

Information derived from smolt and adult salmon tagging studies (Jakupsstovu, 1988; Hansen and Jacobsen, 2003) also suggest Scottish salmon make use of sea areas around the Faroes. Hansen and Jacobsen (2003) found Scottish salmon tend to be more prevalent around the Faroes in the autumn rather than in the winter, including fish from the Spey, Brora, Tay, North Esk and Dee. In addition, whilst the Scottish salmon found in West Greenland, East Greenland and Irminger are thought to mainly be MSW fish, studies carried out around the Faroes suggest that both 1SW (grilse) and MSW salmon occur in the area, depending on the zone fished and the time of the year (Malcolm *et al*., 2010).

5.3.1.2 Pre-spawning Migration

The timing and duration of the pre-spawning migration of Atlantic salmon varies from river to river. It depends on the distance from the sea to the spawning areas and the degree of interaction between hydrologic regimes, the geomorphology of the river network and stream temperatures (Tetzlaff *et al.*, 2008).

Salmon of different sea-ages tend to return at different times of year and often spawn in different parts of a river (Potter and Ó Maoiléidigh, 2006). In most countries salmon runs tend to only take place at specific times of the year, normally during late summer and autumn. In Scotland, however, salmon enter the rivers throughout the year, resulting in the existence of a range of salmon runs. This is of importance to the salmon fisheries as it provides fishing opportunities over extended periods of time (MSS, 2010b).

In Scotland, the majority of grilse (1SW salmon) enter the rivers from early summer until shortly before spawning in autumn and early winter. Many of the MSW salmon also enter rivers over that same period of time, however, for the Scottish MSW salmon class as a whole, river entry occurs over a greater period of time, extending back to the autumn months of the year before spawning (Youngson *et al*., 2002). Based on the time of the year when the fish enter the river, salmon can be broadly classified as winter, spring, summer and autumn salmon.

In addition the quality of salmon varies depending on the run, with large spring-running MSW salmon being particularly highly prized (Potter and Ó Maoiléidigh, 2006). In the past, spring salmon runs made a major contribution to the Scottish fisheries, especially to those of the east coast and its rivers. Concern on the state of this component of the stock has, however, risen in recent years, as it has declined more significantly than other stock components (Potter and Ó Maoiléidigh, 2006; MSS, 2003; Youngson *et al*., 2002; Smith *et al*., 1998).

River entry is thought to be highly dependent on flow conditions. Research undertaken in the late 1980s in the Fowey estuary, and more recently in the Avon, indicated that fish have to wait for suitable river conditions, particularly elevated flows, before they enter freshwater and that, provided there are suitable holding areas, fish may remain in the estuary for long periods (Potter and Dare, 2003; Potter, 1988). Studies carried out in the Dee (Smith & Johnstone, 1996) found that fish enter and ascend the river relatively quickly during elevated river flows and that river entry may be delayed during periods of drought. This scenario was also noted at consultation meetings with the North East Region Salmon Fishery Boards (Consultation meeting, 2010a-d; Consultation meeting, 2011a).

The return migration in adult salmon is, as described for post-smolts, an active process with fish generally being found swimming near the surface (1-5m depth) and occasionally diving to greater depths (Aas *et al*., 2011). There does not appear to be a required period of acclimation during the transition from salt to fresh water (Hogåsen, 1998) and provided that river conditions are favourable, river entry seems to take place quickly (Thorstad *et al.,* 1998).

Studies carried out in Iceland on the migratory pattern of homing Atlantic salmon in coastal waters (Sturlaugsson and Thorisson*,* 1997) found that salmon migrated close to the coast, with some individuals entering into estuaries (most often for brief periods), and even into rivers (for up to more than one day) on their way to their natal streams. The depth records suggested that in general salmon migrated in the uppermost few metres. A diurnal rhythm in vertical movements was also noted, with salmon staying deeper at night and closest to the surface at noon.

The review paper by Malcolm *et al.* (2010), suggests a range of potential migratory routes for salmon in Scottish coastal waters, primarily using the results of adult fish tagging studies and the spatial distribution of tag returns from adult fish tagged as smolts as they left Scottish rivers. In this exercise the assumption that fish would return to their river of origin is needed. A summary of the findings of Malcolm *et al.* (2010) is given below.

The spatial distribution of tag recaptures from fish caught and marked in the Northumberland drift net fishery during 1977 was studied by Potter and Swain (1982). Based on these data, it was found a strong northward migration of salmon from Northumberland as far north as Aberdeenshire, with decreasing recaptures in regions further north. Potter and Swain (1982) concluded that 94% of the fish caught in the North East of England drift net fishery were heading to Scottish rivers.

Similarly, salmon tagging studies carried out near Montrose (Pyefinch and Woodward, 1955; Shearer, 1958) also suggest a predominant northerly movement as far as the south of the Moray Firth.

Whilst the information provided above supports the idea of a general northward migration of salmon in coastal areas around the proposed EOWDC site, given that this information is based on recaptures of tagged adult fish, rather than smolts, it is not possible to be certain of the river of origin of the fish recaptured. The results of smolt tagging studies carried out in the Girnock Burn (1968-81) on the Aberdeenshire Dee, however, also suggest an overall northward direction of travel in coastal waters around the east coast of Scotland for both grilse (1SW salmon) and MSW salmon.

The northward movement based on the results of Potter and Swain (1982) and the tagging studies in the Girnock Burn (1968-81) is illustrated in Figure 5.2 and Figure 5.3 respectively, as presented in Malcolm *et al*. (2010).

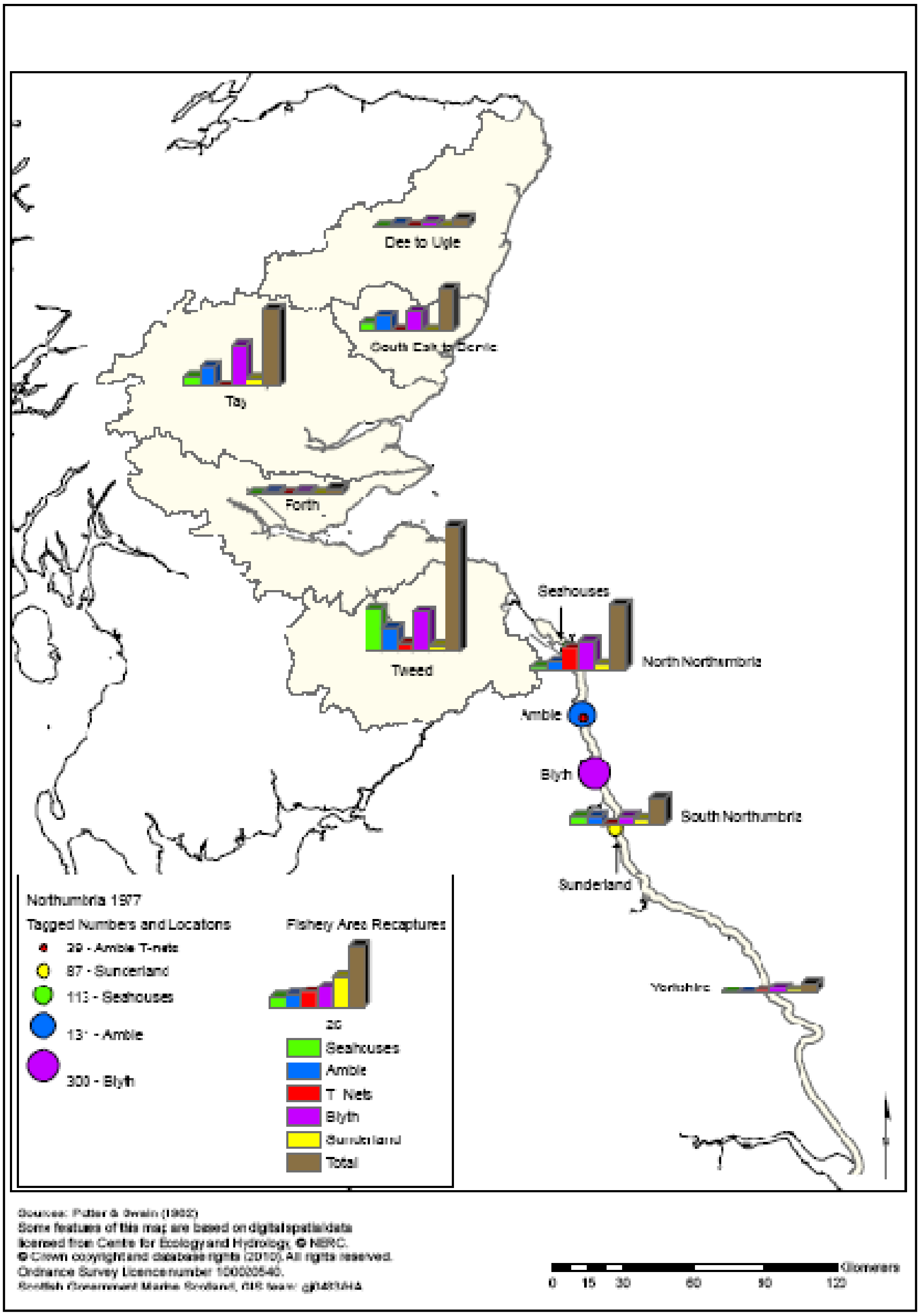


Figure 5.2 Coastal Movement of Salmon caught in the North East England Drift Net Fishery (after Potter and Swain, 1982). Tagging locations are shown as coloured circles; the size of circles is proportional to the number of fish tagged. Bar charts indicate the number of fish recaptured, colour coded by tag location (Source: Malcolm *et al*., 2010)

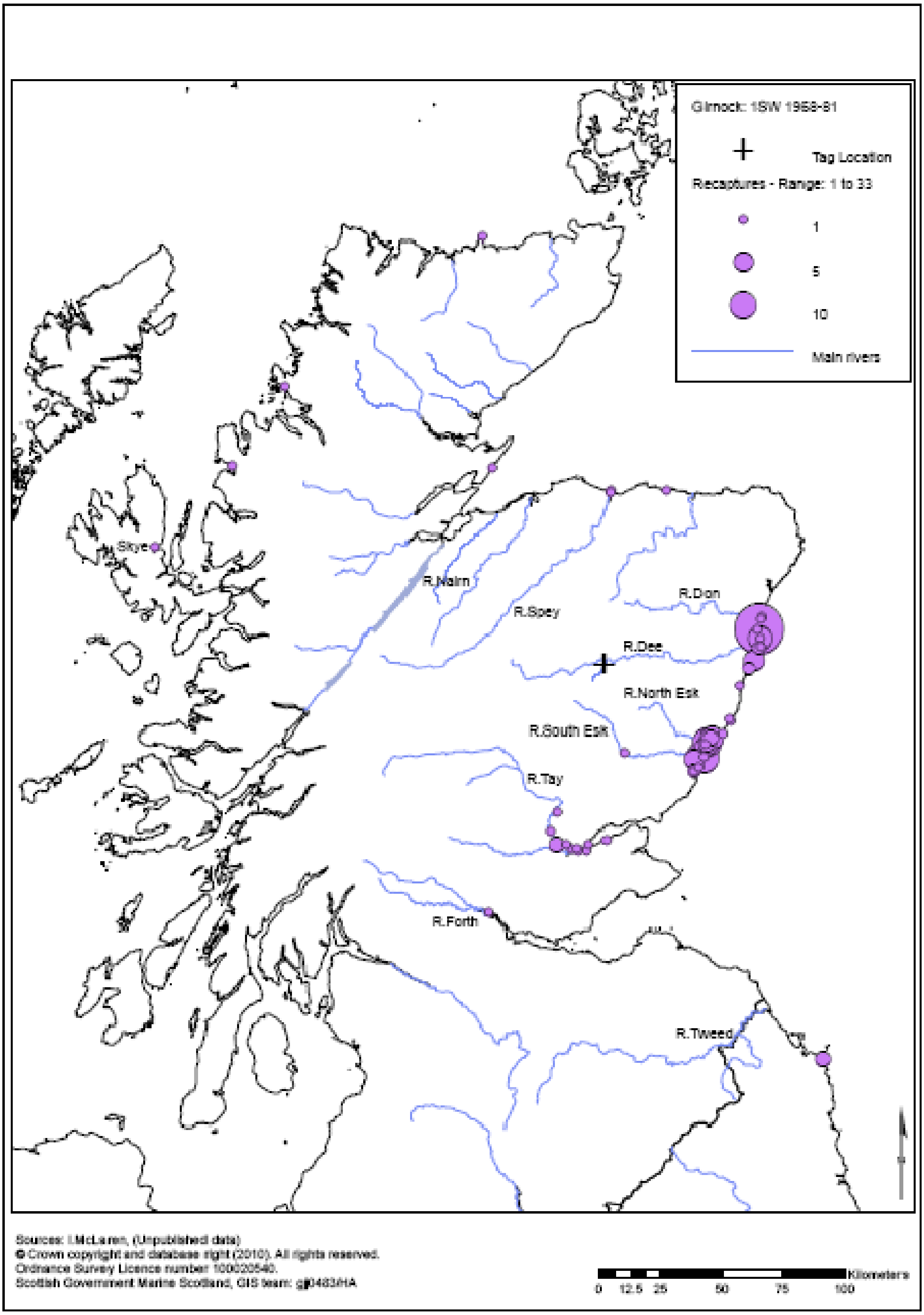


Figure 5.3 Distribution of Recaptures of 1SW (grilse) tagged in the Girnock Burn as Smolts (1986-81). Circle sizes are proportionate to the number of recaptures from a particular location (Source: Malcolm *et al.*, 2010)

Considering the results of the studies mentioned above, it appears reasonable to assume that for salmon originating in the North East coast rivers, the general direction of coastal movement is northerly and coastal migration may start as far south as the north east coast of England. This is in line with the model of adult salmon migration proposed by Shearer (1992) where it was suggested that from Aberdeenshire southwards, fish travel in a northerly direction having migrated south past their home rivers through the North Sea and approach the coast around Northumberland (Malcolm *et al*., 2010).

Whilst it is likely that the majority of salmon migrating in coastal waters around the proposed EOWDC originated in nearby rivers, given the complexity of the movements recorded from studies in other Scottish regions (Malcolm *et al*., 2010), where in some cases salmon were found migrating both northwards and southwards, it is difficult to assess the potential for this coastal area to be used by salmon originating elsewhere in Scotland. An indication of the general patterns of adult salmon movement around the Scottish coast based on the information provided above and further studies carried out in other regions around Scotland, is given in Figure 5.4 below (Source: Malcolm *et al*., 2010).

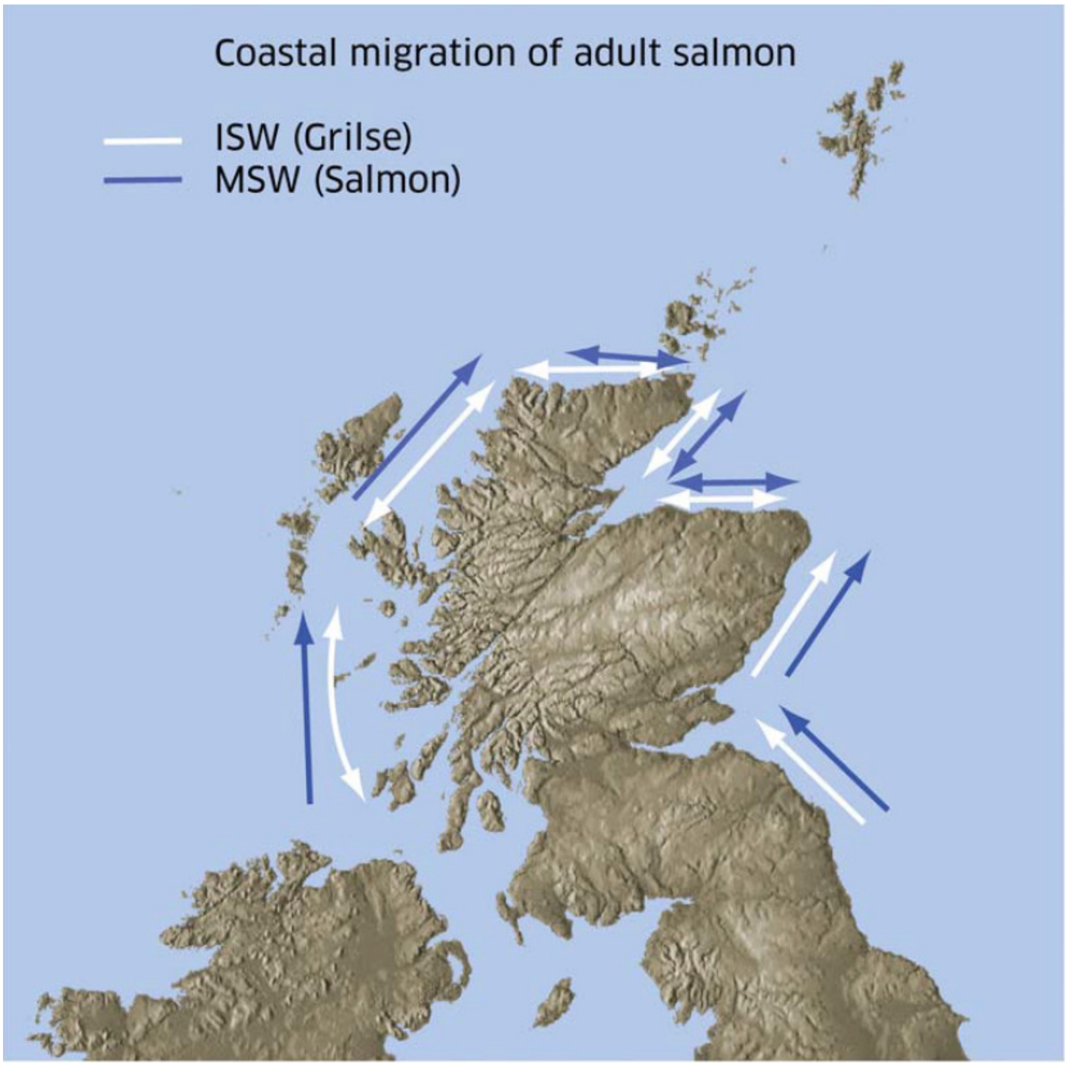


Figure 5.4 Dominant directions of Travel for Atlantic Salmon (1SW and MSW) in Scottish coastal waters based on tagging studies (Source: Malcolm *et al*., 2010)

5.3.2 Sea Trout

5.3.2.1 Smolt and Post-smolt Migration

Seaward migration in sea trout, like in salmon, is thought to be an active process (Thorstad *et al*., 2004; Thorstad *et al*., 2007). Tagging studies carried out in the River Conwy, North Wales (Moore *et al.,* 1998b) found sea trout smolts migrating seawards on ebb tides and swimming close to the surface. In addition, the movements in the lower portion of the estuary were found to be indicative of active directed swimming and it was suggested that there was no apparent period of acclimation when moving from fresh to saltwater.

As mentioned in Section 5.2.2 above, most sea trout smolts are thought to leave the river around April and early June. Information gathered by Pratten and Shearer (1983) in the River North Esk, found the peak of the sea trout smolt migration to occur usually in May or June.

Sea trout differ from Atlantic salmon in that generally they do not venture off to distant feeding grounds in the sea, but instead, remain in coastal areas. A range of migratory strategies have however been observed in sea trout stocks, including estuary residence, local coastal movements and extensive open sea migration (Solomon, 2007).

Detailed tracking studies on the migration of sea trout post-smolts have been carried out in sea lochs, in the west coast of Scotland (Pemberton, 1976a; Middlemas *et al*., 2009) and in Norwegian fjords (Finstand *et al*., 2005; Thorstad *et a*l., 2007). The results of these studies suggest a relatively local movement with sea trout remaining within sea lochs and fjords during the first couple of months at sea (Malcolm *et al*., 2010).

In the east coast of Scotland, data on sea trout post-smolts is scarce, being principally derived from tagging studies carried out in the North Esk. Studies by Pratten and Shearer (1983) found that the majority of reported recaptures were from the Montrose area, although numerous examples of tagged sea trout travelling appreciable distances (>100km) along the coast were also found. In addition, four tagged fish were recaptured in excess of 500km from the North Esk, three off the Scandinavian coast and one in the River Barvas, North West Lewis. Further research by Shearer (1990) in the North Esk, concluded that most sea trout post-smolts were probably staying within a short distance of the Esk rivers, although some recaptures were observed as far north as the river Spey and as far south as the River Tweed (Malcolm *et al*., 2010).

5.3.2.2 Spawning Migration

As previously discussed for salmon, river entry in sea trout is also thought to be related to flow conditions, with fish having to wait for suitable river conditions, particularly elevated flows, before entering the freshwater habitat (Potter and Dare, 2003; Consultation Meeting. 2010a-d; Consultation Meeting, 2011a).

Timing in river entry is also variable in sea trout. Based on information gathered in consultation meetings undertaken with the North East region Salmon Fishery Boards and the analysis of MSS salmon and sea trout catch statistics, it appears that the main sea trout runs in the North East salmon fishery region occur in the summer months from June to September, with peak runs varying between rivers. Similarly, information gathered in the North Esk (Pratten and Shearer, 1983) where the sea trout population was sampled by means of a stationary trap, found that finnock (post-smolts) returning to fresh water in the year of their smolt migration where moving upstream from July onwards, with a peak of movement occurring in the autumn. The same study found the main run of adult sea trout occurred between July and October.

The information available to date, does not allow for common patterns, behaviour or routes, either in general or for particular rivers, to be determined. Whilst tagging studies carried out in the east coast suggest that sea trout generally remain in their local area, it appears clear that sea trout exhibit a wide range of migrations (Malcolm *et al*., 2010). The findings of the principal studies carried out in the regional study area are summarised below.

Nall (1935) analysed the findings of tagging studies carried out between 1914 and 1935 along the east coast of Scotland. In the majority of cases, recaptures were made within the local estuarine, river or firth areas, with very few distant recaptures being observed (within 40 miles). As previously explained (Section 5.3.2.1), studies undertaken by Pratten and Shearer (1983) and Shearer (1990) in the Montrose area, found similar patterns, with the majority of fish being found in adjacent rivers, although longer migrations were also observed.

The distribution of sea trout recaptures from tagging programmes in the rivers North Esk, South Esk and Bervie is illustrated in Figure 5.5, as presented in Malcolm *et al.* (2010).

Little is known about the behaviour during migration around Scottish coastal and distant waters. Research carried out in Norway indicates a preference for swimming at depths below 3m, however, within the same study, records of sea trout at depths up to 28m were also observed (Rikardsen, 2007).

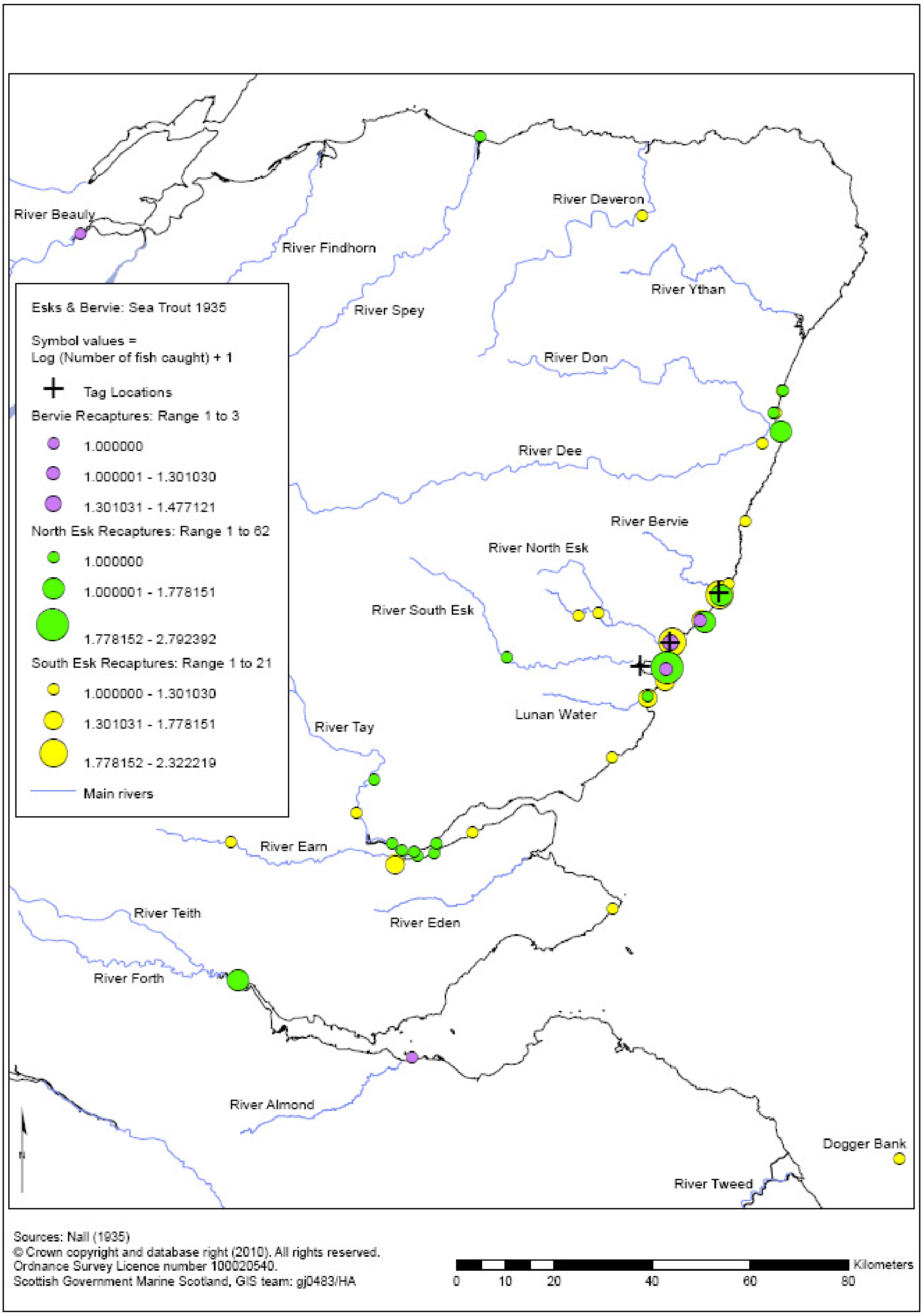


Figure 5.5 Map showing the distribution of sea trout recapture locations from tagging programmes in the rivers North Esk, South Esk and Bervie (Malcolm *et al.,* 2010)

5.3.3 Navigation and Orientation

Olfaction is thought to play an important role in the orientation of salmonids and it is widely accepted that the final phase of the spawning migration is primarily governed by olfactory discrimination of home-stream water (Hasler and Scholz, 1983; Døving *et al*., 1985).

In addition to olfactory stimuli, salmonids are known to be capable of sensing magnetic cues during certain types of spatial activity (Chew and Brown, 1989; Taylor, 1986). In Atlantic salmon, biomagnetic particles, particularly associated with the lateral line, which are of a size suitable for magnetoreception are believed to allow them to follow a rough compass heading, facilitating orientation with respect to the geomagnetic field during the oceanic phase of their migration (Potter and Dare, 2003; Lohmann *et al.,* 2008a).The presence of magnetoreceptors and the ability to use the geomagnetic field for spatial orientation has also been documented in sea trout (Formicki *et al.*, 1997; Formicki *et al.,* 2004).

Based on the ability of salmonids to identify both olfactory and magnetic cues, it has been hypothesised that both olfactory and magnetic mechanisms may play a role in navigation and orientation in salmonids, and that these may function sequentially over different spatial scales (Lohmann *et al*., 2008b).

In line with the above, research carried out in Norway (Hansen *et al.,* 1993) suggest the existence of two phases to the homing migration of maturing Atlantic salmon from the feeding areas to their home rivers; a first phase with crude navigation from the feeding areas toward the Norwegian coast and a second phase with more precise navigation in coastal and estuarine waters towards their home rivers. Similarly, research undertaken in Iceland (Sturlaugsson *et al*., 2009) suggests the existence of behavioural differences in salmon orientation in offshore and inshore areas related to increased use of olfactory sense in inshore areas. The study also found that fixed direction all the way from offshore areas to the home fjord area or home estuary could not explain their migration and it was suggested that shoreline orientation is of importance once the shore has been approached. Based on their findings, the authors recommend the spawning migration of salmon at sea to be divided into three phases in relation to the different orientation behaviour in offshore, inshore and estuarine areas.

It is recognised that there is limited information available to date to describe in detail the navigation and orientation mechanisms used by salmon and sea trout during their marine migration. Furthermore, comprehensive and robust scientific literature specific to salmon and sea trout originating from Scottish rivers is lacking in this field.

5.4 Feeding

Salmon and sea trout seaward migration is thought to be related to increased growth rates at sea derived from the existence of greater feeding opportunities in the marine environment (Haugland *et al.,* 2006; Rikardsen *et al*., 2006). A review of the feeding habits and diet of salmon and sea trout at sea is given below.

5.4.1 Salmon

Atlantic salmon are generalist and opportunistic predators of zooplankton and nekton at the ocean surface (Jacobsen and Hansen, 2001, Lacroix and Knox, 2005, Haugland *et al*., 2006). They feed on a variety of small fish including capelin, herring, sandeels and sprats in addition to other surface-living small components of the zooplankton, principally crustaceans (Mills *et al.,* 2003).

Studies carried out in fjords and coastal areas in Norway suggest salmon start to feed on marine organisms immediately after their transition to saltwater and found salmon post-smolts largely feeding on small fish (0-group), with sandeel and herring being of importance as prey items. Blue whiting was found to be of importance as a prey only in the slope current that transports larvae from its spawning areas west of UK into the North and Norwegian Seas (Haugland *et al*., 2006).

Research based on stomach contents of wild and escaped farmed salmon in the North East Atlantic (Jacobsen and Hansen, 2001) found evidence of selective foraging in salmon. Jacobsen and Hansen (2001) results suggest that fish species were preferred over crustaceans and amphipods over euphausiids. In addition, a relation between sea age and food habits was also found, where larger salmon (3+SW) tended to be more piscivorous than smaller fish.

Research carried out in the Baltic Sea (Karlsson *et al.,* 1999) also suggests seasonal changes in feeding habits, with salmon primarily feeding on sprat in the winter from January to April, and herring and spined stickleback later in the year.

Jacobsen and Hansen (2001) also found seasonal variations in feeding habits, with amphipods, euphausiids and mesopelagic shrimps being the principal food sources in autumn, whilst in the winter mesopelagic fish were important. It has been suggested (Rikardsen *et al*., 2004) that spatial and temporal differences in prey availability may be related to geographical differences in feeding habits in salmon.

5.4.2 Sea Trout

Sea trout at sea feed on a variety of organisms, changing gradually from small crustaceans to small fish such as sandeels and sprat (Potter and Dare, 2003; MSS, 2010a). Food preferences are thought to be dependent on habitat, season and fish size and age (Knutsen *et al*., 2001).

Studies carried out in Mulroy Bay in the Irish Sea, suggest that as sea trout increases in fork length their diet tends to include more fish and fewer crustaceans (Fahy, 1985). Similarly, investigations by Pemberton (1976b) in North Argyll sea lochs found that young fish, principally clupeids and sandeels, featured more in the diet of larger trout (≤21 cm) than in the smaller size range.

Seasonal studies of the feeding of sea trout in fjords in northern Norway (Rikardsen *et al.,* 2006) found sea trout feeding on marine crustaceans and polychaetes during early and late winter, whilst in summer and autumn their principal prey items were small fish such as juvenile herring. This is in line with the findings of Pemberton (1976b), which suggest that benthic feeding (crustacean and annelids) was more important in winter, while midwater and surface organisms (young fish and insects) were preferred in the summer. In addition, Pemberton (1976b) suggested a diel feeding pattern, with bottom feeding being greatest during the day and midwater and surface feeding increasing between sunset and sunrise.

5.5 Conservation Status

Atlantic salmon (*Salmo salar*) is listed in Annexes II and V of the EU Habitats Directive as a species of European importance and Annex III of the Bern Convention. The protection given to salmon through the Habitats Directive, however, is restricted to freshwater habitats, as marine and estuarine sites are excluded from selection. Similarly, salmon at sea is not protected under the Bern Convention.

Through the implementation of the Habitats Directive and as a result of the European importance of Scotland's salmon populations, 11 Scottish rivers have been designated as Special Areas of Conservation (SACs), with salmon being a primary reason for the selection of the site (Figure 5.6). Two of the aforementioned SACs are located within the regional study area: the River Dee and the River South Esk. These rivers' SACs support high quality salmon populations. Furthermore, as a result of a high proportion of the rivers being accessible to salmon, both the South Esk and the Dee support the full range of life-history salmon types found in Scotland with sub-populations of spring, summer salmon and grilse all being present (JNCC, 2010).

In addition to the protection given under the EC Habitats Directive, Atlantic salmon is listed as a UK Biodiversity Action Plan (BAP) priority species and is protected at the international level by the North Atlantic Salmon Conservation Organization (NASCO), an inter-governmental organisation devoted to the conservation, restoration, enhancement and rational management of wild salmon in the North Atlantic (Curd, 2010).

Sea trout (*Salmo trutta*) is not subject to the same level of protection as salmon in Europe, although it is listed as a UK BAP priority species and, in Scotland, is currently protected under the same conservation legislation as Atlantic salmon. This is a result of the definition of the term salmon in the Scottish legislation; under the Salmon (Scotland) Act (1986) salmon means: *"all migratory fish of the species Salmo salar and Salmo trutta and commonly known as salmon and sea trout respectively or any part of any such fish"*

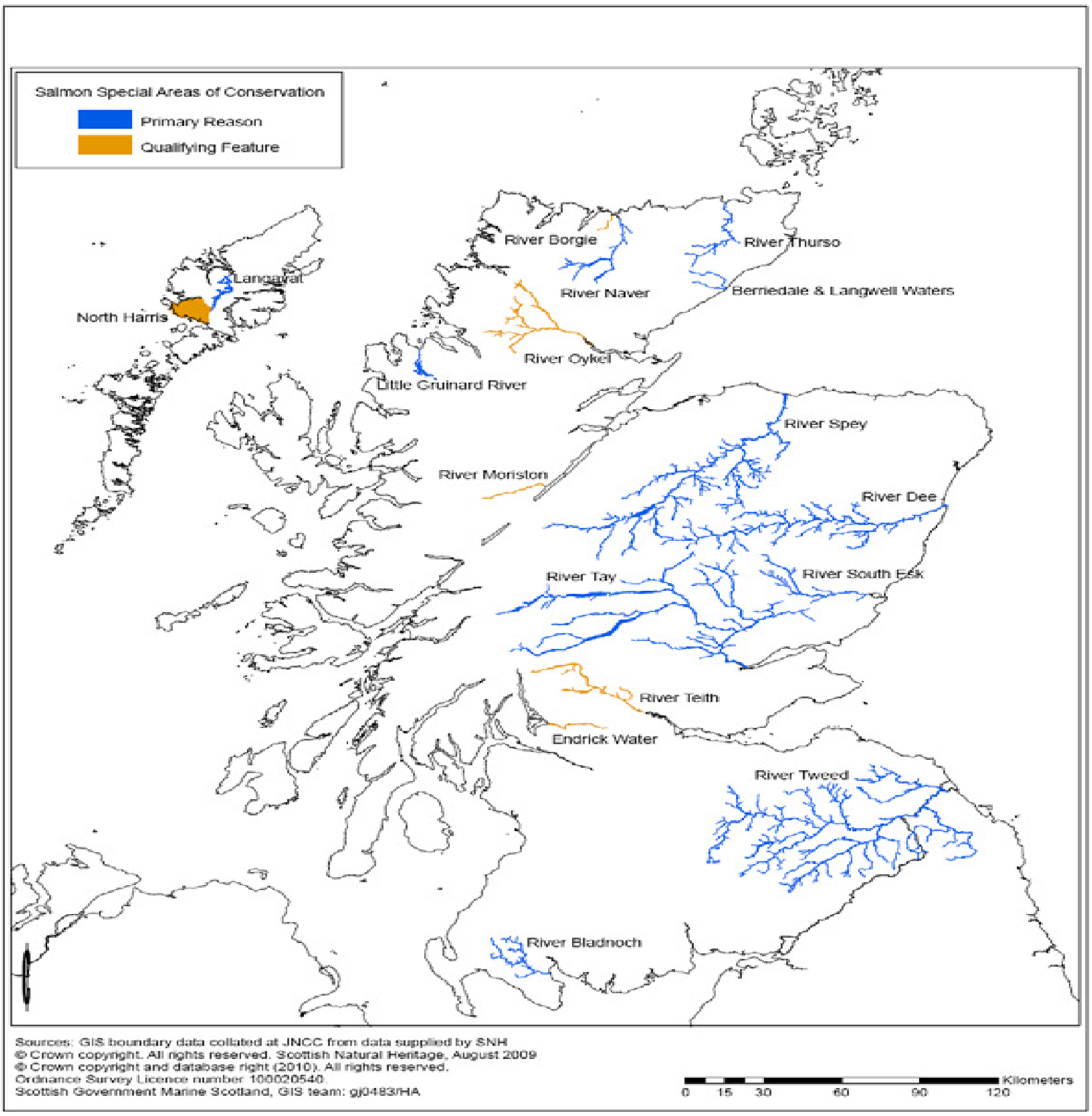


Figure 5.6 Distribution of Special Areas of Conservation (SACs) for Atlantic Salmon (Source: Malcolm *et al.*, 2010)

5.6 Threats to Salmon and Sea Trout

Salmon and sea trout populations are subject to a number of threats in both the freshwater and marine phases. In fresh water, degradation of juvenile and spawning habitat, and land use, in particular intensive agriculture, are thought to be having the greatest effect, whilst in the marine phase, there is concern over the recent decline in post-smolt marine survival rates (Hendry and Cragg-Hine, 2003; ICES, 2009). As a result, Atlantic salmon stocks are currently under threat across their northern hemisphere range and sea trout populations in decline throughout the United Kingdom (Crawley, 2010).

A summary of the main threats that salmon and sea trout are exposed to in the rivers, coastal and marine environments is given below (AST, 2010b; Curd, 2010).

Rivers

- Predation by birds
- Pollution and poor habitat
- Obstructions such as dams, weirs and culverts
- Disease
- Poor angling practices
- Poachers

On the coast

- Interceptory mixed stock nets
- Fish farms - sea lice, disease and escaped farmed salmon
- Pollution

At sea

- Climate changes affecting feeding and survival opportunities (e.g changes in sea surface temperatures)
- Increased predation by seals
- Fishing, including indirectly through over-exploitation of their food resource (e.g sandeel) and directly through unintentional capture when fishing for other species such as herring and mackerel.

The majority of threats to salmon and sea trout in the rivers are being addressed in Scotland through the implementation of river management and water quality schemes, the removal of obstructions, the establishment of fishing codes of practice and other such initiatives.

Efforts made within the rivers to maintain and conserve salmon and sea trout stocks are however limited in their effectiveness as a result of stock management measures implemented in coastal waters and in the high seas and by changes in the status of the stocks caused by sea mortality and other factors. In this context, two aspects of relevance are the persistence of Multi Stock Fisheries (MSFs) in Scotland, which target fish from more than one stock/river (e.g coastal netting), and the current trend of increased post-smolt mortality at sea (Hansen & Queen, 1999).

5.6.1 Multi Stock Fisheries

The exploitation of salmon and sea trout by MSFs holds particular problems to the implementation of management practices. The fisheries can be damaging because they have potential to intercept any salmon or sea trout in their vicinity, regardless of where those fish are heading or the strength of the population in their natal rivers (Crawley, 2010).

5.6.2 Increased Marine Mortality

Increased marine mortalities in post-smolts are thought to be related to climatic variations such as the increase in sea surface temperature (SST) (Beugrand and Reid, 2003; Friedland *et al*., 2009; Friedland *et al.,* 2000; Todd *et al.*, 2008).

Salmon populations are also of concern due to the sharp decline in growth condition observed in recent years in 1SW salmon (grilse) and MSW salmon (Todd *et a*l., 2008; Davidson and Cove, 2010). The growth reductions are thought to be indicative of recent and large-scale ecological shifts in the Easter North Atlantic epipelagic ecosystem and the likely importance of bottom-up control in the food web (Todd *et al*., 2008).

5.6.3 Current Research Initiatives

A number of initiatives have been implemented by NASCO and ICES to improve knowledge about the distribution and migration of salmon at sea, which in turn may help to understand mortality of salmon during their marine phase (ICES, 2009). The international co-operative SALSEA programme, adopted in 2004 was designed to improve the understanding of the migration and distribution of salmon at sea in relation to feeding opportunities and predation. In 2008, the SALSEA-Merge project was launched as part of the SALSEA Programme, aiming to advance understanding of stock specific migration and distribution patterns and overall ecology of the marine life of Atlantic salmon and gain an insight into the factors resulting in recent increases in marine mortality, by merging genetic and ecological investigations.

In line with the SALSEA-Merge project, Rivers and Fisheries Trusts of Scotland (RAFTS), the Scottish Government's Marine Scotland Directorate an all the fisheries Trusts around Scotland, have commenced a collaborative programme of genetic work, "Focusing Atlantic Salmon Management on Populations" (FASMOP), with the aim of understanding the structuring of river stocks of Atlantic salmon into breeding populations. In addition, MSS's Research Project "Development of a General Spatial Model of Within River Population Structuring in Scottish Atlantic salmon (POPMOD), using molecular genetic data on salmon information collected by MS, and through SALSEA-Merge and FASMOP, is anticipated to provide a general model which can be used to predict population structuring within any Scottish salmon river and evaluate the potential for using genetic estimates for monitoring the conservation status of breeding populations.

Research initiatives such as the Moray Firth Sea Trout Project (MFSTP) are also currently in place to address the decline in sea trout stocks and gather further information on the life history and the marine phase of this species.

6.0 Salmon and Sea Trout Fisheries Baseline Assessment

6.1 Introduction

Salmon and sea trout form an important part of Scotland's natural heritage. In addition, they support and maintain the existence of commercial and recreational fisheries which are of importance to the Scottish economy. A study undertaken by the Scottish Executive (Radford *et al.,* 2004) estimated that game and coarse anglers spent a total of £131m in Scotland of which 65% (£73m) corresponded to salmon and sea trout fishing. In 2008, the annual value of salmon fisheries to the Scottish economy was estimated at £120m (ASFB, 2010a).

It should be noted that the definition of salmon under the Salmon Act (1986) includes both Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta*). Where applicable, the term may subsequently be used to describe both species.

6.2 Salmon Fishing Rights, Administration and Regulations

6.2.1 Fishing Rights

The right to fish for salmon in Scotland, whether in inland waters or at sea, is a heritable right. The taking of salmon without the right or written permission to do so is prohibited under the Salmon and Freshwater Fisheries (Protection) (Scotland) Act, 1951.

The rights originally belonged to the Crown Estate, however as with land, the Crown Estate has made grants of salmon fishing to others and ownership is now widely distributed among private individuals, companies, local authorities and others. The rights can be bought, sold or leased independently of land except in Orkney and the Shetlands (Williamson, 1991).

The Crown Estate still owns areas along the coast and in rivers, many of which are still let. Since the late 1980s, however, the Crown Estate has supported a policy of conservation by retaining coastal netting stations in hand and unlet. There are therefore, no longer any coastal netting stations let by the Crown Estate and none are actively fished (The Crown Estate, 2010); the existing working netting stations were therefore granted or sold the heritable title by the Crown Estate before the late 1980s (Crawley, 2010).

6.2.2 Fisheries Administration

Salmon fisheries in Scotland, both inland and at sea, are managed by their owner or leaseholder under a framework of regulations laid down by central government.

For the purposes of salmon fishery management Scotland is divided into 54 statutory Salmon Fishery Districts each with a catchment area including a river or group of rivers (ASFB, 2010b). Today, almost without exception, every district has formed a District Salmon Fisheries Board (DSFB) made up of the owners or leaseholders of the fishing rights. These boards manage the rivers and coastal netting zones, being able to appoint bailiffs with the power to enforce regulations and restrictions, as well as establishing other practices for improving and maintaining fish stocks, and monitoring and controlling river conditions. Each salmon fishery in each district has a value, which is calculated by the district assessor (Consultation Meeting, 2010b-c). Individual boards are self-financing and generally raise money by taxing rights' owners within their district. This often works on a sliding scale, according to the number of fish caught. In 1999 the government made a revision to the constitution of the boards to allow for wider representation, by bodies such as the Scottish Environment Protection Agency, Scottish Natural Heritage or others such as local angling clubs and associations (ASFB, 2010b).

Salmon fishery districts as formalised by the Salmon Fisheries (Scotland) Acts 1862-1868, are shown in Figure 6.1. As explained in Section 4.4.2 above, some districts have been joined together and superseded by larger districts, resulting in the current 54 districts.

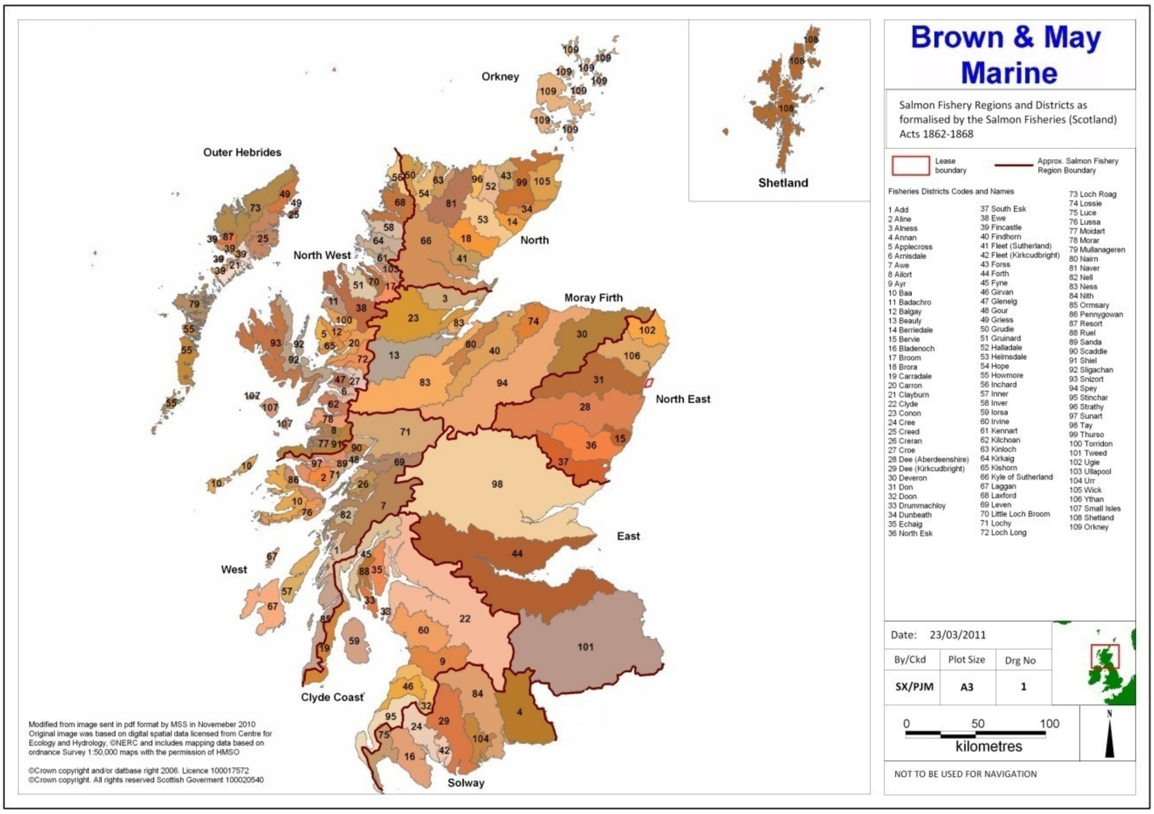


Figure 6.1 Salmon Fishery Regions and Districts in Scotland

Boards hold powers relating to the introduction of new regulations on the fishery, the purchase of property to acquire rod or net fisheries, the imposition of fishery assessments on the fishery proprietors, etc (SPICe, 2000). Whilst the Boards themselves have no ability to make legal restrictions on fishing, applications are made to Scottish Ministers by the boards for changes and new regulations to be introduced.

In addition to the Boards, the Scottish Executive Environment and Rural Affairs Department (SEERAD) oversees the fishery as a whole, promoting legislation and making regulations under the various Salmon and Fisheries Acts passed by the devolved government. The Inspector of Salmon and Freshwater Fisheries monitors the effects of legislation and the operation of the fisheries. Marine Scotland (who has taken on the roles and responsibilities of the former Scottish Fisheries Protection Agency) enforces regulations at sea and helps the District Boards with local, coastal enforcement (Williamson, 1991); Marine Scotland Science's Freshwater Fisheries Laboratory provides scientific advice on salmon and their fisheries.

6.3 Fisheries Regulations

6.3.1 General

All Scottish salmon fisheries are closed for a minimum of 168 days a year. Actual dates may vary but are mostly from late August to mid February, depending upon individual District Board policy.

Angling may continue for a few weeks either side of this. Weekly close times are also nationally enforced, being 24 hours (Sunday) in the case of angling and 60 hours for all other methods.

It is prohibited to take juvenile salmon (not including trout). There is a minimum mesh size of 90mm for nets, to enable smolts to escape.

There is no limitation on fishing effort within open fishing periods. There are however restrictions in place which act as indirect controls: restrictions imposed on the various fishing methods (discussed in Section 6.4); the exclusive right of the salmon fishermen through ownership or tenancy to decide fishing effort in their fishery; and regulations established and enforced by individual District Boards.

Salmon fisheries are saleable and netsmen or companies may acquire fishing rights over relatively large areas. Other interested parties may also purchase rights. For example, the Atlantic Salmon Conservation Trust has historically bought coastal sites to close them down as a conservation measure in order to halt coastal netting activities. Similarly, rod-and-line interests may buy up river netting rights to close them down, often through the district boards.

6.3.2 Inland waters

The only lawful fishing methods in inland waters are rod-and-line and net-and-coble. Fixed nets/engines are prohibited.

6.3.3 At sea

It is prohibited to catch fish by enmeshment. Troll or long-lining is also illegal. Effectively the only lawful methods are net-and-coble, fixed engines (bag and skate nets) or rod-and-line.

6.4 Fishing Methods

The principal legal methods for catching salmon in Scotland are as follows:

- Fixed Engines (Bag and Skate Nets)
- Net-and-coble
- Rod-and-line

In inland waters, salmon can also be caught using a cruive (a sort of trap) where expressly permitted by the Crown Estate. This is however, very rare (SPICe, 2000).

6.4.1 Fixed Engines (Bag and Stake Nets)

Bag and stake nets are the most common types of gear used to catch salmon in Scottish coastal waters and are commonly referred to as fixed engines. Salmon fishing using this method is not permitted in inland waters (rivers above the estuary limits).

Bag nets are set to fish just below the surface in rocky coasts where they will not ebb dry at low tide. They may be set singly or in a line extending seawards from the shore. The entire net or line of nets is not permitted to extend more than 1,300m from the mean low water mark, excluding mooring warps or anchors. The nets must not be operated between 6pm Friday until 6am Monday. Catches are generally removed from the nets at slack tide (Galbraith and Rice, 2004; SI 1992/1974).

No part of the nets may be set with the purpose of catching fish by entanglement. The minimum mesh net size is 90mm. Nets are designed to target fish swimming close to the surface while following the coastline. The gear is made up of two principal elements, the trap and the leader. The trap is approximately 13.5m wide and 4.5m deep at the mouth, tapering to about 3m in width and 2.5m in depth at the head. The leader may not exceed 300m in length.

Stake nets are similar in design and operation to the bag nets except that they are set on sandy beaches, supported on stakes driven into the sand, where the receding tide exposes the nets. The maximum allowed leader length and total gear length are similar to those specified for bag nets. The configuration of a typical bag net is shown in Figure 6.2 below.

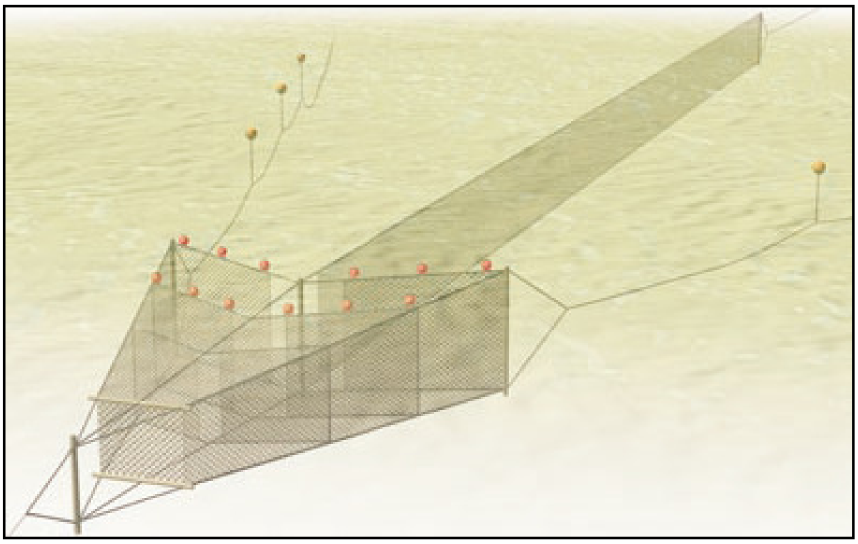


Figure 6.2 Bag Net showing the Trap, the Leader and Moorings

6.4.2 Net-and-Coble

Traditionally nets are operated from cobles, small flat bottomed, open boats, with a shore party assisting in operations. A member of the shore party holds the upstream hauling rope and the net is paid out from the stern of the vessel, as shown in Figure 6.3. The net must not be stationary or allowed to drift at any time and must be constantly 'swept', surrounding the fish and drawing them towards the shore. No other objects or obstructions may be used to aid fishing and adjacent netting operations must be at least 50m apart (Galbraith and Rice, 2004).

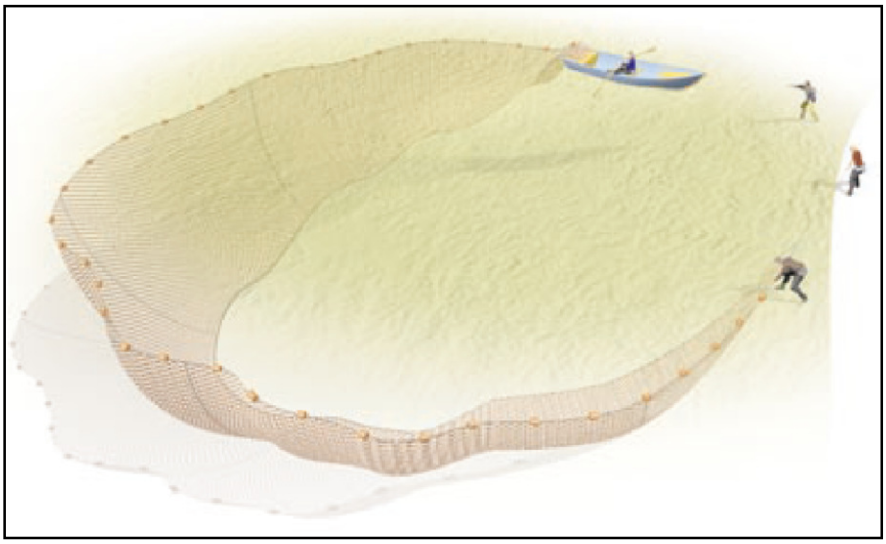


Figure 6.3 Net-and-coble Fishing

Net-and-cobles are generally operated in estuaries and the lower reaches of rivers, although small numbers are also used in coastal waters (Potter and Ó Maoiléidigh, 2006).

6.4.3 Rod and Line

At present, recreational rod-and-line fishing is the most common method of fishing for salmon. The Salmon and Freshwater Fisheries (Consolidation) (Protection) (Scotland) Act 2003, defines rod and line as: "*a single rod and line (used otherwise than as a set line or by way of pointing, or by striking or dragging for fish) with such bait or lure as is not prohibited".* DSFBs can apply to Scottish Ministers for regulations specifying baits and lures that may not be used for rod-and-line fishing in their district to be made whilst in some cases voluntary restrictions are set by the boards. Usually the restrictions prohibit the use of shrimps, prawns or worms as bait and the use of lures bearing multiple sets of hooks (SPICe, 2000). The use of fish roe, fire or light as bait or lure is also prohibited (Salmon and Freshwater Fisheries (Consolidation) (Protection) (Scotland), 2003)

Salmon and sea trout are generally not caught by rod-and-line at sea, but along river beats. Most DSFBs operate and police a catch and release policy. Due to increasing popularity, the sport makes a significant contribution to both local and regional economies.

6.5 Fisheries Data

The information given in this section is principally based on reported catches of salmon, grilse and sea trout recorded from 1952 to 2009 by region and by salmon fishery district within the North East region from 2000 to 2009. These were kindly provided by Marine Scotland Science. In addition, information gathered during the consultation process has also been included in this section where appropriate.

It should be noted that the analysis and interpretation of the fisheries statistics given below is not intended as an assessment of the abundance or state of the stocks but as an indication of the underlying population trends and the relative importance of the salmon and sea trout fisheries by region, fishery district and method.

6.5.1 National

6.5.1.1 Historical Data

This section provides an overview of historical catch data by species for the rod-and-line (including catch and release) and the net fishery (net-and-coble and fixed engines) in Scotland from 1952 to 2009.

Overall current salmon catches by rod-and-line (including catch and release) are in line with historical levels whilst for grilse there has been an increase in the total annual catch, especially during the second half of the data series. It is believed that increases in rod-and-line popularity may have to some extent kept catch values within historical levels. The overall trend in sea trout catches by the rod-and-line fishery, however, appears to be one of a decline (Figure 6.4).

Catches by the net fishery (net-and-coble and fixed engines), have also shown a marked decline in the last decades with respect to historical levels (Figure 6.5). The decline in catches observed for the net fishery is associated with a decrease in fishing effort most likely caused by, the buyout and closure of coastal netting stations, changes in abundance of salmon and the fall in the market price of wild salmon caused by competition from the aquaculture industry, among other factors (MSS, 2008). The decrease in netting effort may also have, to some extent, contributed to the catch levels observed in the rivers by the rod-and-line fishery.

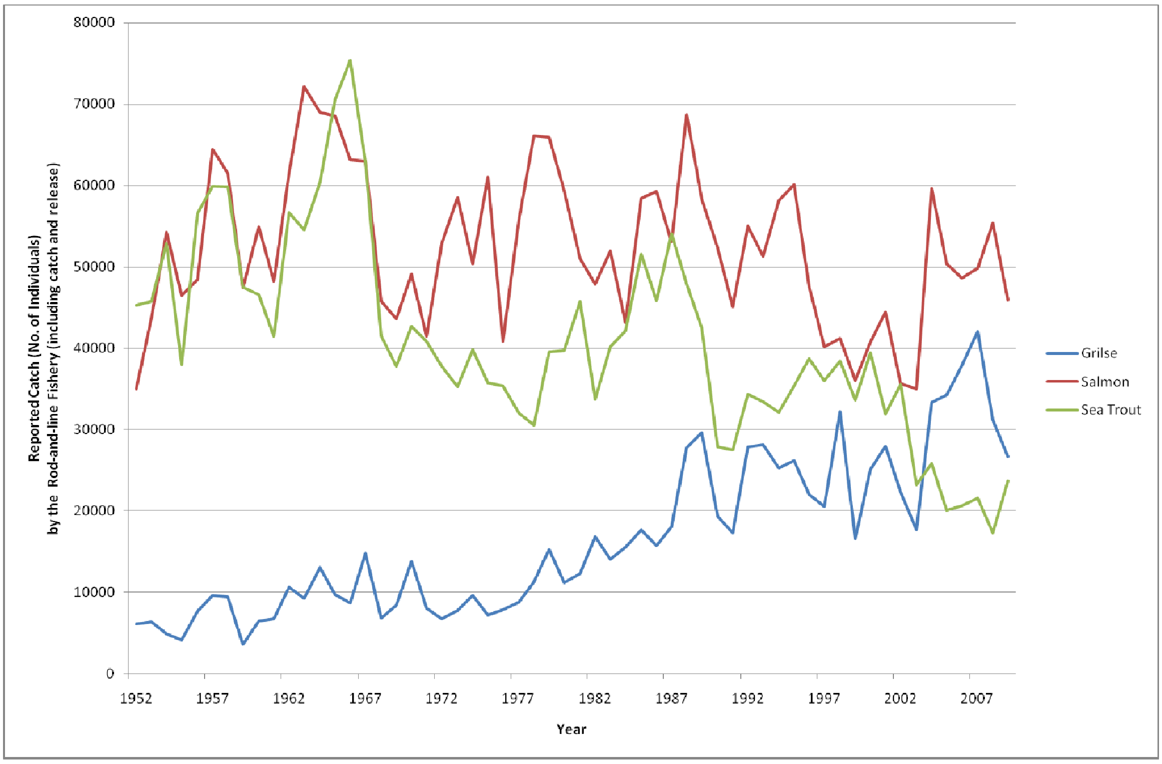


Figure 6.4 Rod-and-line Fishery (including Catch & Release) Reported Catches (1952-2009)

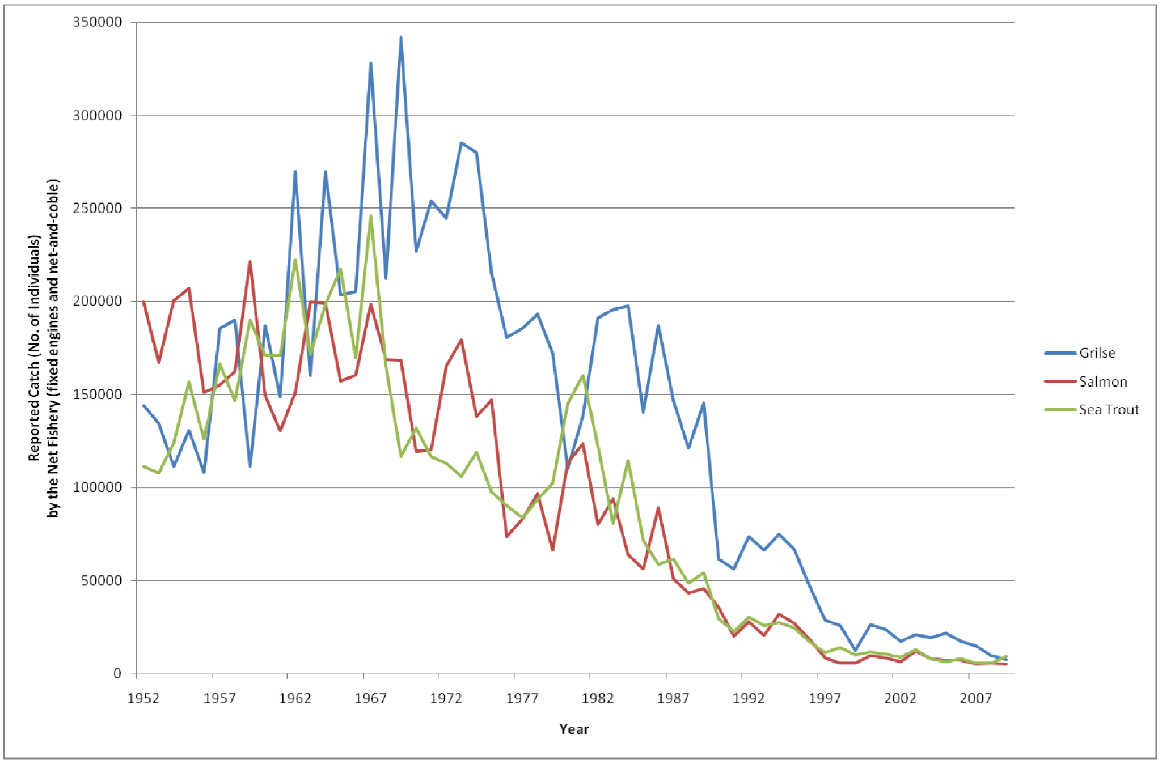


Figure 6.5 Net Fishery (Fixed Engines and Net-and-coble) Reported Catches (1952-2009)

6.5.1.2 Current Trends

An indication of the current salmon, grilse and sea trout catches by fishery region in the national context is given in Figure 6.6 below. This shows annual reported catches (average 2000-2009) for salmon, grilse and sea trout by fishery region.

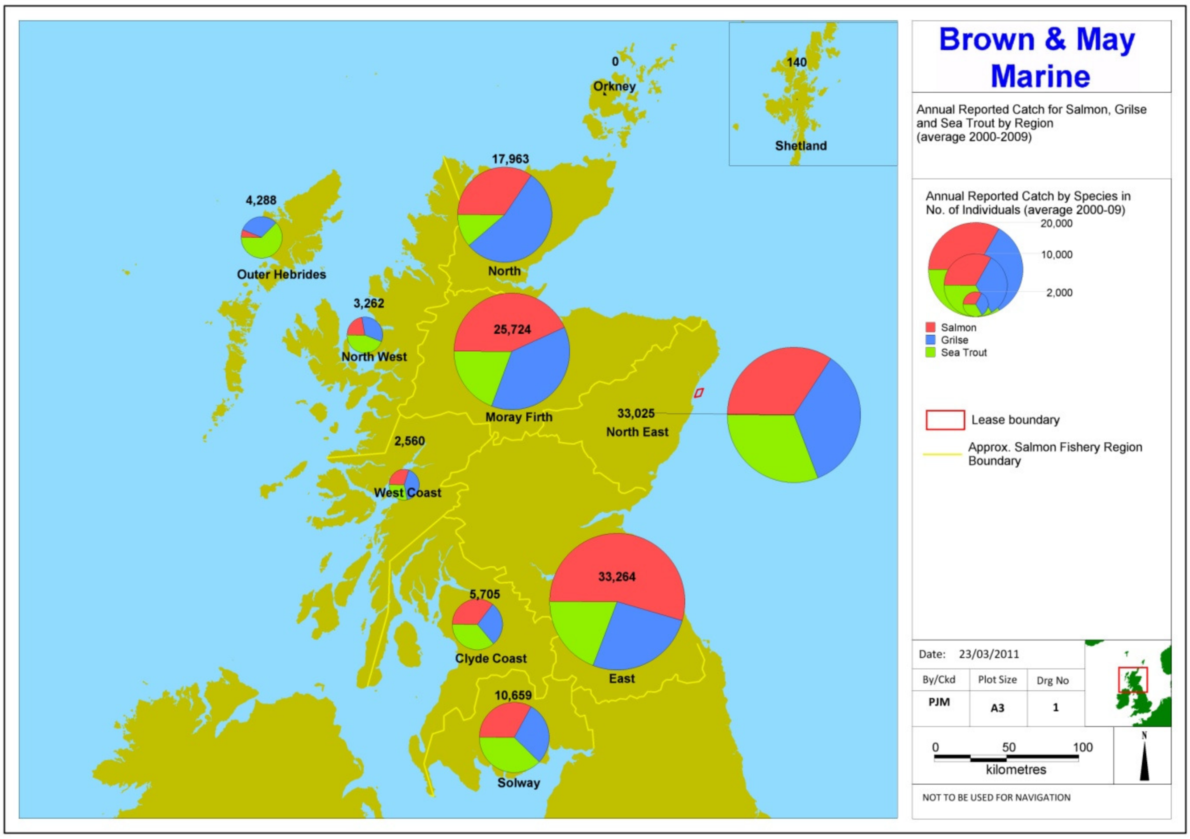


Figure 6.6 Annual Reported Catch (No. of Individuals) by Species and Region (average 2000-2009)

As it is apparent from Figure 6.6, reported catches are greater in the east coast of Scotland. The North East region shows the second highest annual catch (average 2000-2009) in Scotland.

The principal fishing methods used by fishery region are illustrated in Figure 6.7.This shows annual catch (all species combined) by method and region (average 2000-2009). Rod-and-line (including catch and release), accounts for the majority of the average annual catch in most regions, however netting by fixed engines and net-and-coble is also of relevance in some regions.

The netting component of the total catch is of special importance in the North East Region, where the combined catch by fixed engines and net-and-coble accounts for a similar percentage of the total catch (50.3%) than that recorded by the rod-and-line fishery (including catch and release) (49.7%). It should be noted that the majority of the catches by both fixed engines and net-and-coble in this region come from the Esk district. The current netting fishery in the Esk is discussed in further detail in 6.5.3 below.

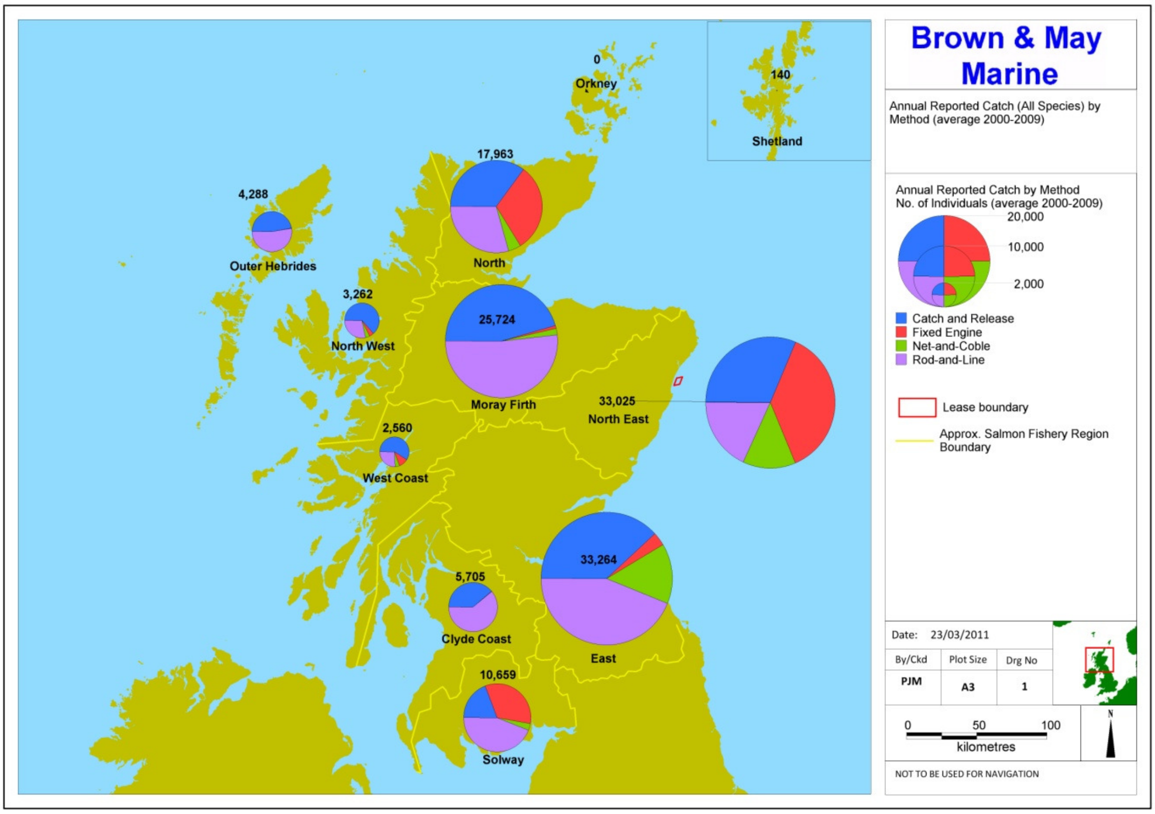


Figure 6.7 Annual Reported Catch (No. of Individuals) by Method and Region (average 2000-2009)

6.5.2 Regional

6.5.2.1 Catches by District

The annual reported catch (average 2000-2009) by salmon fishery district within the North East region is shown in Figure 6.8 and Figure 6.9 by species and method respectively. Note that for the Esk district, catch statistics are broken down by former district (North Esk, South Esk and Bervie).

The Esk and the Dee account for the majority of the catches for all species within the North East region. The Dee shows the highest annual catch for salmon whilst the North Esk and South Esk have the highest grilse catch.

Overall sea trout records catches are similar to those recorded for salmon in the region. In the Ythan and the Ugie, the two districts with the lowest annual catches however, sea trout accounts for a relatively high percentage of the total catch.

Rod-and-line is the principal fishing method in the Dee, the Don and the Ythan, a high percentage of which is by catch and release, particularly in the Dee and the Don.

Fixed engines account for the majority of the catch in the Esk district, especially in the South Esk. In the Don, the Ythan and to a lesser extent the Ugie, fixed engines also account for a relatively important percentage of the total catch. Net-and-coble represents a significant component of the North Esk's and Ugie's annual total catch. The Dee is the only district within the North East region where there is no netting activity, with no reported catches by either fixed engines or net-and-coble.

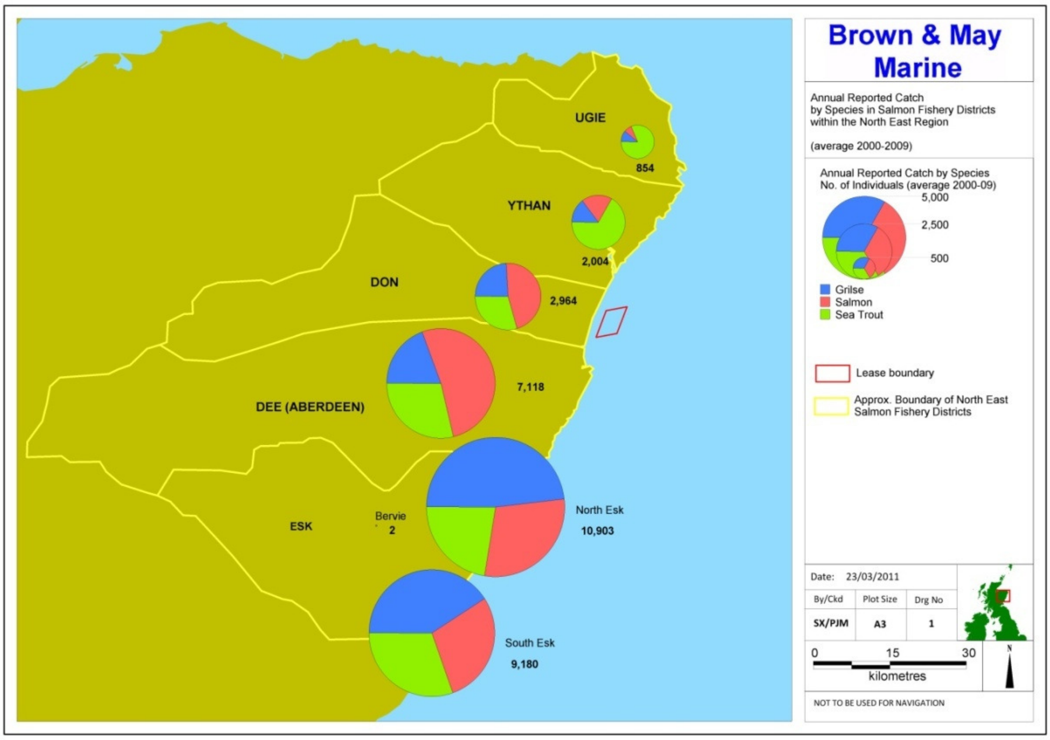


Figure 6.8 Annual Catch (No. of Individuals) by Species in Salmon Fishery Districts within the North East Region (average 2000-2009)

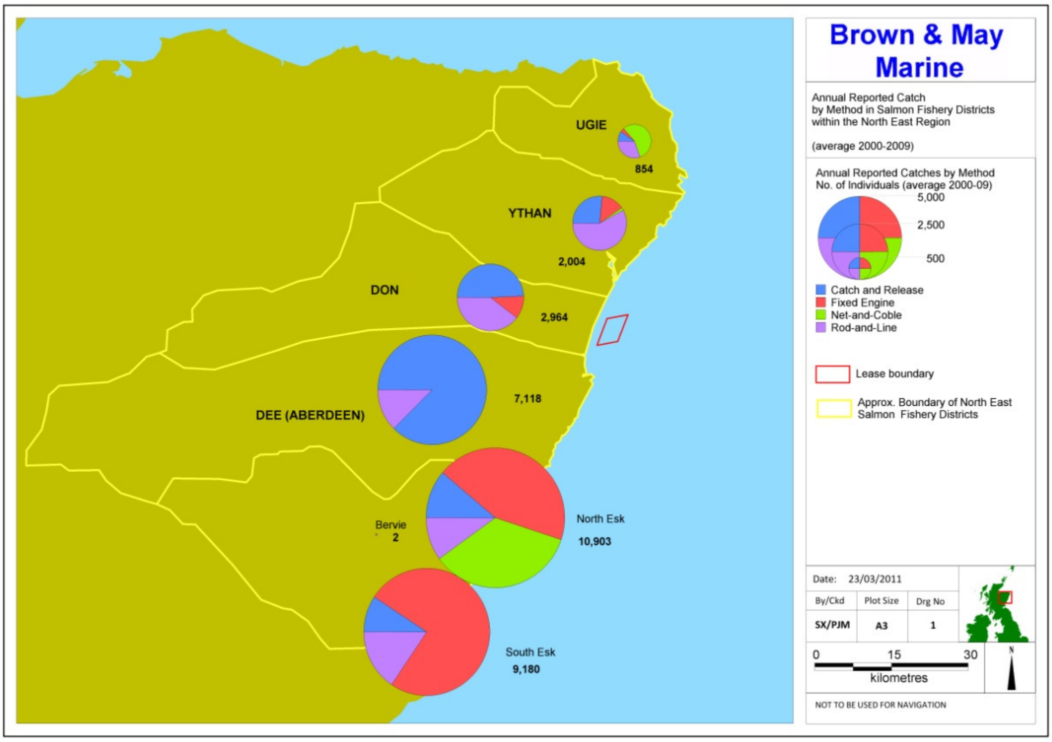


Figure 6.9 Annual Reported Catch (No. of Individuals) by Method in Salmon Fishery Districts within the North East Region (average 2000-2009)

6.5.2.2 Seasonality and Annual Variation

An indication of the seasonality and annual variation of the rod-and-line (including catch and release) and the net fisheries (separated into net-and-coble and fixed engines) by species and district is illustrated in Figure 6.10 to Figure 6.15 below, based on monthly reported catches averaged for the period 2000-2009 and total annual catches for the same period.

Rod-and-line Fishery Seasonality

Salmon catches peak in October in all the districts with the exception of the Dee, where peak catches are recorded in September. In the Dee, relatively high catch values are also shown from March to June, suggesting spring salmon runs to be of importance to the overall rod-and-line fishery in the district. The catch values recorded in the Don, the North Esk the South Esk during the spring also suggest that spring salmon account for a relatively important proportion of the total salmon catch in these districts.

Grilse are principally caught from June to October with peak catches recorded from August to October. Sea trout are caught from May to October with high catches recorded in June, July and August (Figure 6.10).

Rod-and-line Fishery Annual Variation

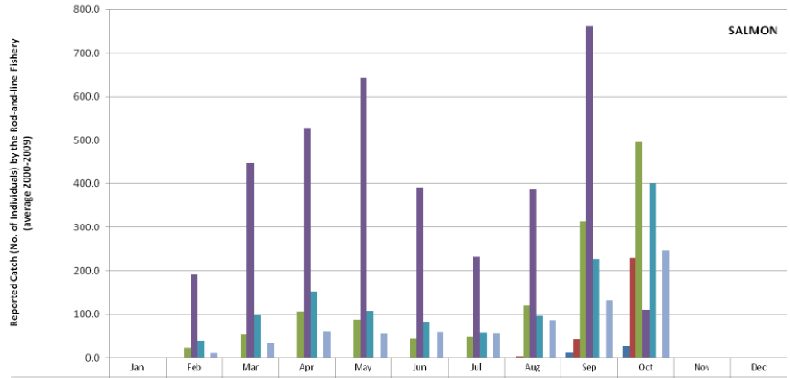
There has been a marked increase in the rod-and-line catches of salmon and grilse in the Dee. The total salmon catch in 2009 more than doubled that from 2000 in this district.

In the Don, overall, there has been a slight decrease in salmon catches whilst for grilse, catches have remained relatively constant. The highest catches for both salmon and grilse in the Don were recorded in 2004.

In the North Esk salmon catches have shown slight fluctuations over the years, whilst for grilse there has been a significant increase in the total catch by rod-and-line, with 172 grilse caught in 2000 compared to 1,144 in 2009.

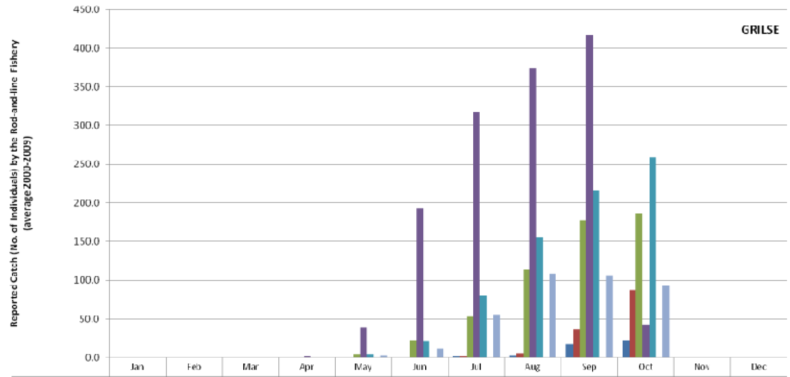
Salmon and grilse catches have remained relatively constant in the Ythan and the South Esk from 2000 to 2009, with high values recorded between 2004 and 2005.

The general trend in sea trout catches is one of a decline in all the districts, principally as a result of the decrease in catch values recorded between 2000 and 2003 (Figure 6.11).



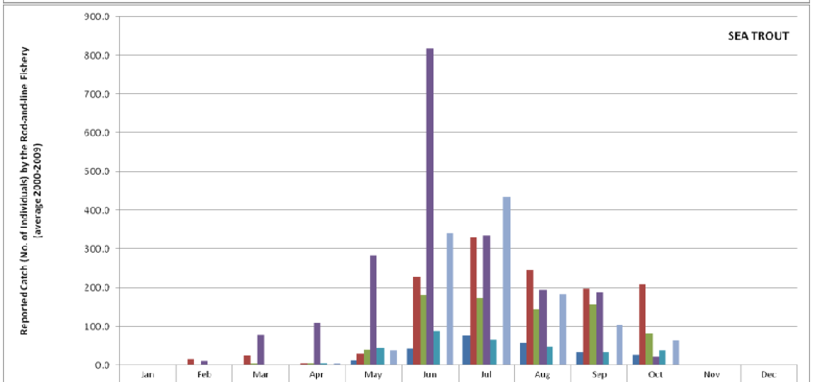
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ugie	0.0	0.1	0.0	0.0	0.0	0.0	0.0	1.4	12.9	27.9	0.0	0.0
Ythan	0.0	0.2	0.1	0.0	0.8	0.0	0.5	2.8	43.6	228.6	0.0	0.0
Don	0.0	23.3	53.1	105.8	87.6	45.0	48.4	120.3	313.6	495.3	0.0	0.0
Dee (Aberdeenshire)	0.0	190.6	446.9	527.9	643.8	391.8	230.9	386.6	761.4	109.9	0.0	0.0
North Esk	0.0	39.2	97.3	152.1	108.1	82.8	59.1	96.7	226.7	400.2	0.0	0.0
Bervie	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.7	0.0	0.0
South Esk	0.0	10.3	33.5	62.0	55.0	59.8	57.6	87.3	131.4	246.4	0.0	0.0

Month



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ugie	0.0	0.0	0.0	0.0	0.3	0.5	1.7	2.6	18.1	22.5	0.0	0.0
Ythan	0.0	0.0	0.0	0.0	0.0	0.1	1.7	6.0	36.5	86.8	0.0	0.0
Don	0.0	0.0	0.0	0.7	4.2	22.3	52.9	113.6	177.3	186.3	0.0	0.0
Dee (Aberdeenshire)	0.0	0.0	0.1	1.6	38.9	193.9	317.0	374.7	416.9	42.8	0.0	0.0
North Esk	0.0	0.0	0.0	0.2	3.7	21.3	80.1	155.8	215.7	258.9	0.0	0.0
Bervie	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
South Esk	0.0	0.0	0.0	0.3	2.5	11.1	55.7	108.5	106.2	92.7	0.0	0.0

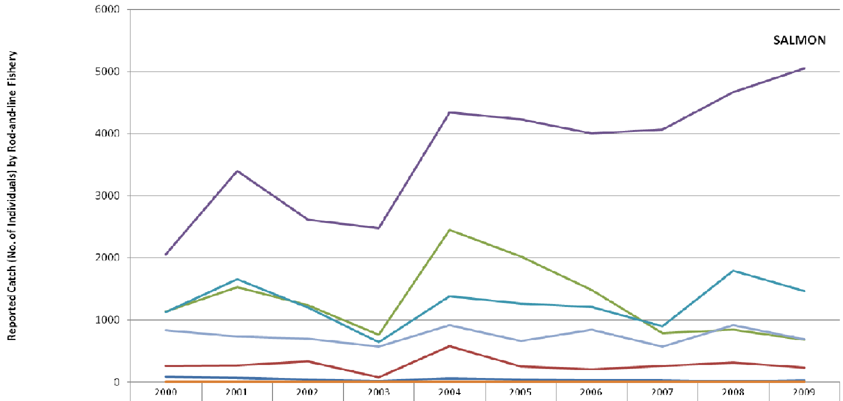
Month



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ugie	0.0	1.0	0.9	1.4	13.3	43.7	76.3	58.0	34.7	26.0	0.0	0.0
Ythan	0.0	15.4	24.2	7.0	28.2	227.0	331.8	244.7	197.1	210.3	0.0	0.0
Don	0.0	0.7	3.1	6.7	40.3	179.8	172.6	144.5	154.6	83.4	0.0	0.0
Dee (Aberdeenshire)	0.0	11.5	77.3	109.6	284.2	818.6	335.4	195.2	189.2	21.0	0.0	0.0
North Esk	0.0	0.1	1.1	6.1	44.3	87.8	65.8	47.9	35.0	39.5	0.0	0.0
Bervie	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.6	0.2	0.0	0.0
South Esk	0.0	0.2	1.6	4.7	39.0	341.1	434.4	183.6	103.5	65.7	0.0	0.0

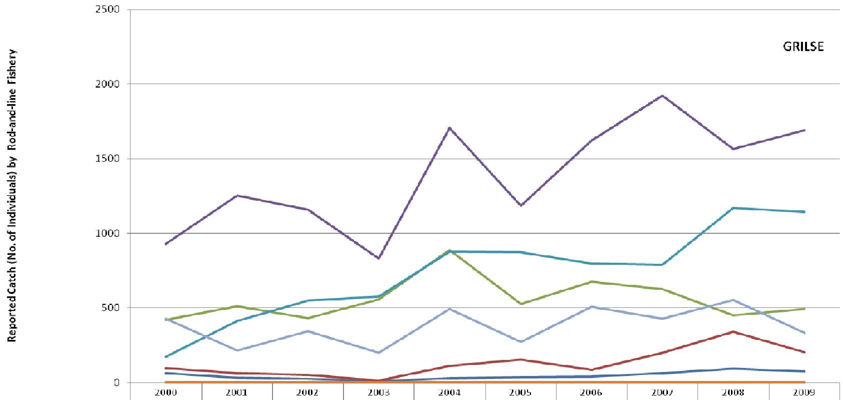
Month

Figure 6.10 Seasonality of the Catch (average 2000-09) by the Rod-and-Line Fishery (including catch and release)



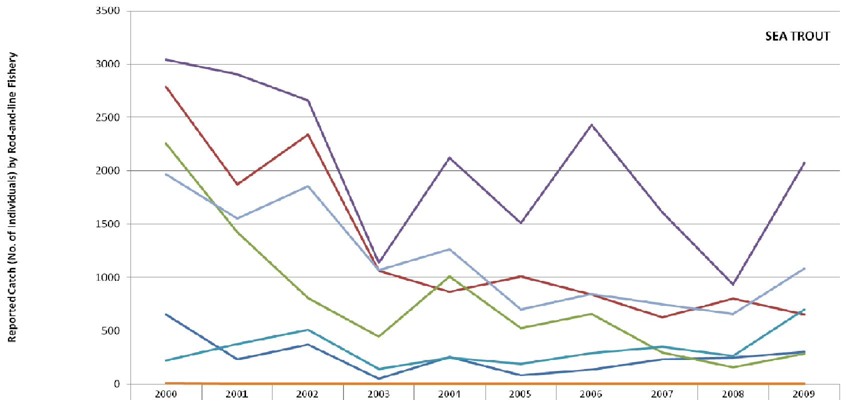
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Ugie	83	70	39	24	62	39	34	32	13	27
Ythan	258	264	332	79	576	251	206	261	310	229
Don	1133	1528	1235	761	2453	2025	1483	786	839	681
Dee (Aberdeenshire)	2054	3400	2612	2480	4339	4229	4000	4067	4669	5048
North Esk	1127	1660	1195	640	1379	1261	1210	895	1789	1466
Bervie	0	0	0	0	1	0	0	0	2	6
South Esk	832	736	699	572	917	663	842	574	913	685

Year



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Ugie	63	33	25	8	28	34	38	63	93	72
Ythan	97	61	50	12	112	153	87	198	339	202
Don	419	512	430	556	887	526	675	626	450	492
Dee (Aberdeenshire)	930	1254	1156	830	1707	1185	1620	1922	1563	1692
North Esk	172	412	551	576	875	873	795	789	1170	1144
Bervie	0	0	0	0	1	0	0	0	1	0
South Esk	428	213	345	200	492	272	506	429	554	331

Year



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Ugie	651	229	372	50	254	84	135	230	249	299
Ythan	2786	1870	2342	1063	866	1011	840	627	801	651
Don	2253	1425	807	445	1011	523	659	294	157	283
Dee (Aberdeenshire)	3045	2902	2660	1134	2122	1510	2428	1611	934	2074
North Esk	221	374	506	142	247	189	287	346	264	700
Bervie	6	1	0	0	0	0	0	0	0	2
South Esk	1968	1550	1855	1069	1266	699	844	747	657	1083

Year

Figure 6.11 Annual Variation (2000-2009) of Catches by the Rod-and-Line Fishery (including Catch and Release)

Net-and-coble Fishery Seasonality

As previously mentioned within the North East region, net-and coble principally takes place in the North Esk and to lesser extent in the Ugie and the Ythan (See Figure 6.9 above).

In the North Esk peak catches of salmon are recorded in May, however June, July and August also record relatively high catches. Similarly, grilse catches peak in July and August. The highest sea trout catches are recorded from May to July peaking in June.

In the Ugie the highest salmon and grilse catches are recorded in July and August. Sea trout, the species accounting for the majority of the catch in the district, is caught in relatively high numbers from May to July, peaking in June.

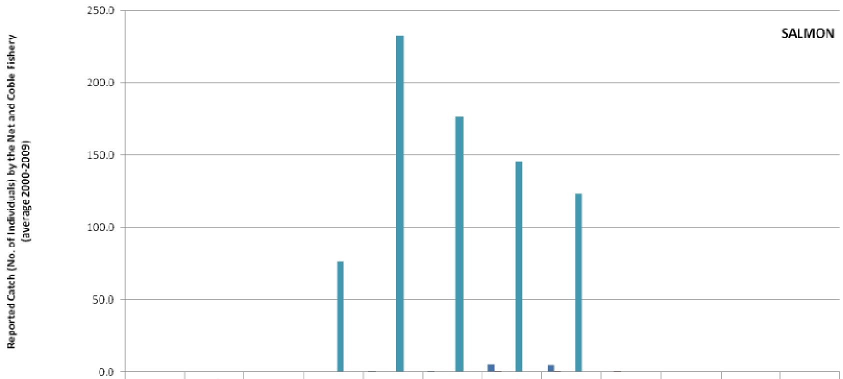
In the Ythan, salmon and grilse catches by net-and-coble are comparatively low. The limited catches recorded by this method in this district, correspond to sea trout principally, and are mainly recorded from May to September with peak catches in August (Figure 6.12).

Net-and-coble Fishery Annual Variation

In the North Esk, salmon catches by net-and-coble have fluctuated from 2000 to 2007, with a significant increase recorded in the last two years. Grilse catches have also changed over the years with peaks in 2000 and 2005, followed by lows in 2004 and 2007. Sea trout catches in this district showed a marked decreased from a peak in 2001 through 2005. The trend has been one of an increase since then, especially in the last year (2009) which records the highest annual catch in the ten year period under consideration.

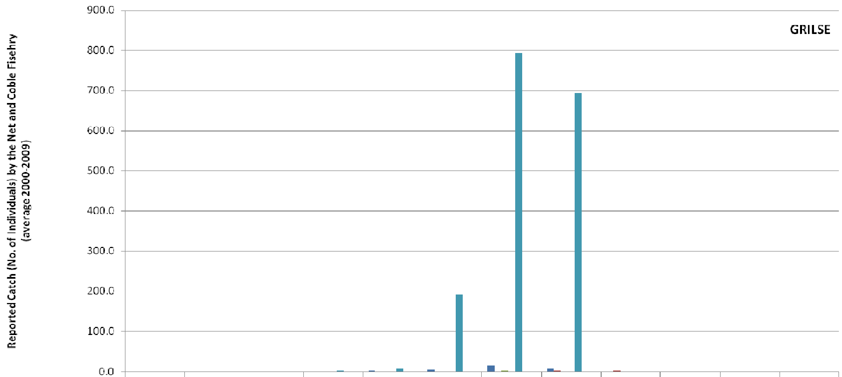
In the Ugie, no salmon and grilse were caught from 2000 to 2003 by net-and-coble. Since 2004 both species have been caught in relatively low numbers, ranging from 9 to 27 fish per year for salmon and 14 to 127 fish per year for grilse. Sea trout, the principal species in terms of catch in the Ugie, was caught in relatively high numbers from 2000 to 2006 with annual catches ranging from 378 to 782 fish. The catch for this species has however decreased since 2006, with a total of 50 and 66 fish caught in 2008 and 2009, respectively.

In the Ythan, salmon and grilse catches by net-and-coble have been very low from 2000 to 2009, ranging from 0 to 6 fish caught per year. Sea trout catches, have also been relatively low, ranging from 56 to 0 fish caught per year. The lowest sea trout catches within the period under consideration have been recorded in 2008 and 2009 with 6 and 0 individuals caught respectively (Figure 6.13).



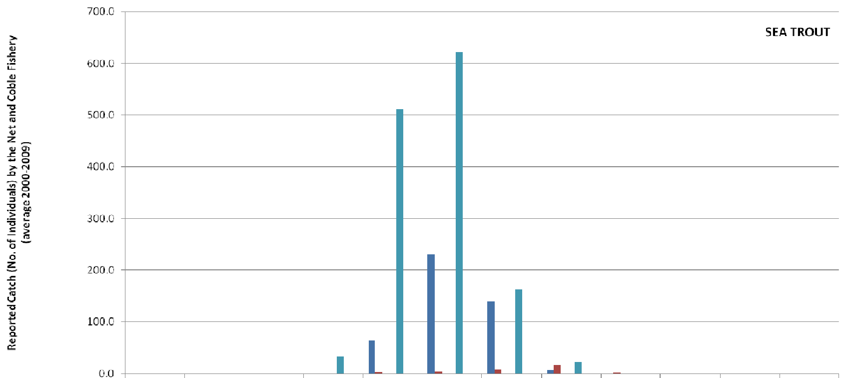
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ugie	0.0	0.0	0.0	0.0	0.3	0.9	5.3	4.9	0.0	0.0	0.0	0.0
Ythan	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.3	0.0	0.0	0.0
Don	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dee (Aberdeenshire)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
North Esk	0.0	0.0	0.0	76.3	232.9	176.5	146.1	123.5	0.0	0.0	0.0	0.0
Bervie	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South Esk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Month



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ugie	0.0	0.0	0.0	0.0	1.2	5.1	14.3	7.0	0.0	0.0	0.0	0.0
Ythan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
Don	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Dee (Aberdeenshire)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
North Esk	0.0	0.0	0.0	0.4	6.4	192.5	792.9	692.6	0.0	0.0	0.0	0.0
Bervie	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South Esk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

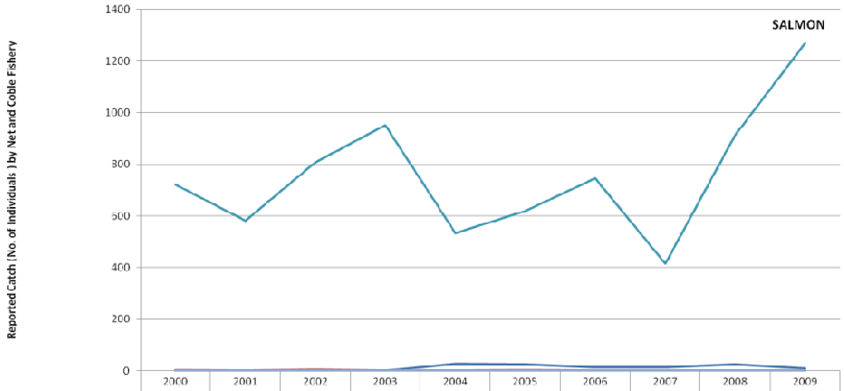
Month



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ugie	0.0	0.0	0.0	0.0	62.3	230.5	139.5	5.4	0.0	0.0	0.0	0.0
Ythan	0.0	0.0	0.0	0.0	3.0	4.0	7.7	16.0	1.0	0.0	0.0	0.0
Don	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dee (Aberdeenshire)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
North Esk	0.0	0.0	0.0	32.2	510.5	620.8	162.9	22.8	0.0	0.0	0.0	0.0
Bervie	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South Esk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

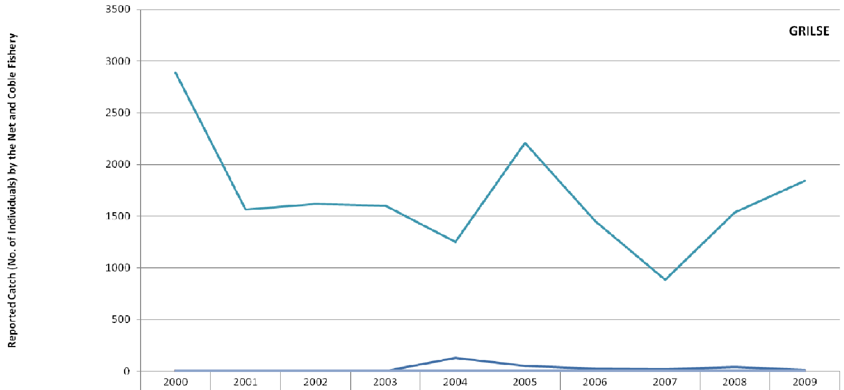
Month

Figure 6.12 Seasonality of the Catch (average 2000-2009) by the Net-and coble Fishery



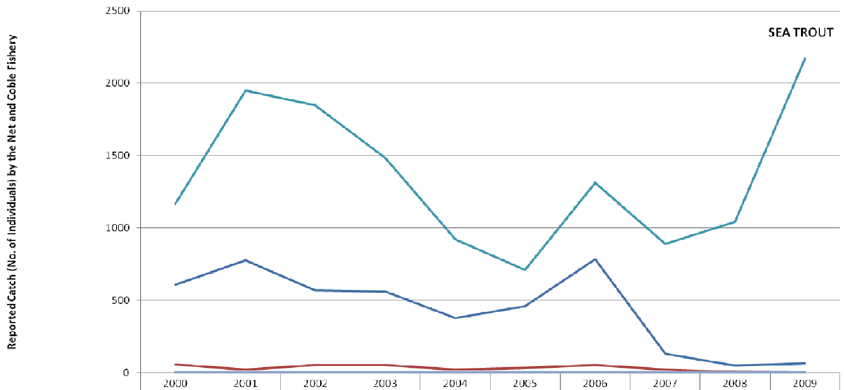
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Ugie	0	0	0	0	27	26	14	14	24	9
Ythan	3	0	6	0	0	2	0	0	0	0
Don	0	0	0	0	0	0	0	0	0	0
Dee (Aberdeenshire)	0	0	0	0	0	0	0	0	0	0
North Esk	722	582	807	952	532	618	745	415	912	1268
Bervie	0	0	0	0	0	0	0	0	0	0
South Esk	0	0	0	0	0	0	0	0	0	0

Year



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Ugie	0	0	0	0	127	54	25	18	38	14
Ythan	1	0	0	1	0	0	0	0	0	0
Don	1	0	0	0	0	0	0	0	0	0
Dee (Aberdeenshire)	0	0	0	0	0	0	0	0	0	0
North Esk	2888	1561	1617	1603	1252	2208	1454	886	1537	1842
Bervie	0	0	0	0	0	0	0	0	0	0
South Esk	0	0	0	0	0	0	0	0	0	0

Year



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Ugie	608	774	569	559	378	460	782	131	50	66
Ythan	56	23	54	52	20	33	53	20	5	0
Don	0	0	0	0	0	0	0	0	0	0
Dee (Aberdeenshire)	0	0	0	0	0	0	0	0	0	0
North Esk	1167	1949	1848	1485	922	710	1310	888	1041	2172
Bervie	0	0	0	0	0	0	0	0	0	0
South Esk	0	0	0	0	0	0	0	0	0	0

Year

Figure 6.13 Annual Variation in Catches by the Net-and-coble Fishery by Species and District

Fixed Engines Seasonality

The principal fixed engine net fishery within North East region takes place in the Esk district, as it was also the case for net-and-coble. The use of fixed engines in the remaining districts appears to be comparatively low, with only the Ythan and the Don recording catches by this method in some numbers.

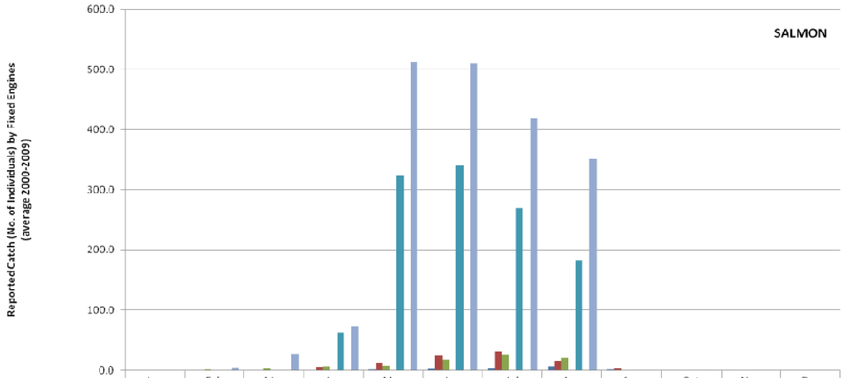
Overall peak catches by this method are recorded from May to August for salmon, July and August for grilse and May and June for sea trout (Figure 6.14).

Fixed Engines Annual Variation

As it is apparent from Figure 6.15, there has been a strong decline in the total catch by fixed engines in the North Esk over the years, more obvious since 2007. This is a result of the buyout of the North Esk's coastal netting stations by the Esk District Salmon Fishery Board.

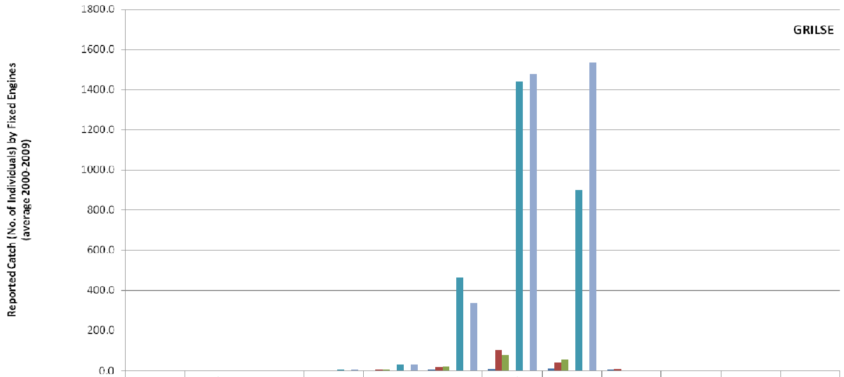
Despite the closure of the commercial coastal fishery in the North Esk, fixed engines are still commercially operational in the South Esk. The salmon catch in the South Esk by fixed engines has fluctuated over the ten year period under consideration, whilst for grilse the overall trend has been one of a decline, especially from 2007. Sea trout catches in the South Esk, have also fluctuated during the ten year period under consideration, with 2003 recording the highest catch (3,143 individuals) within the period.

In the Ythan the annual catch by fixed engines for all the species has been variable, with no clear trend shown from 2000 to 2009, whilst in the Don there is a clear trend towards a decrease in the annual total catch by fixed engines from 2004 onwards, with no fish being caught at all by this method in the last two years (2008 and 2009) (Figure 6.15).



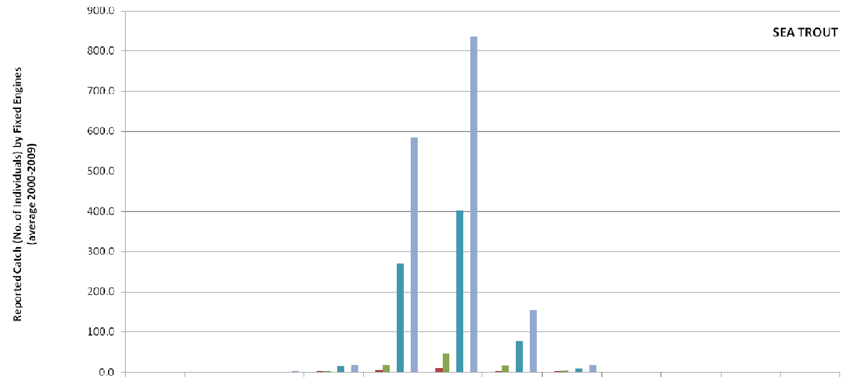
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ugie	0.0	0.0	0.0	0.0	1.1	2.4	3.6	5.6	1.0	0.0	0.0	0.0
Ythan	0.0	0.0	0.0	4.8	13.0	26.0	30.9	15.6	3.2	0.0	0.0	0.0
Don	0.0	1.7	3.2	6.1	7.2	17.1	26.9	20.3	0.0	0.0	0.0	0.0
Dee (Aberdeenshire)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
North Esk	0.0	0.0	0.0	62.2	323.3	340.6	269.5	181.5	0.0	0.0	0.0	0.0
Bervie	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South Esk	0.0	4.4	27.2	73.4	511.5	510.4	417.8	351.2	0.0	0.0	0.0	0.0

Month



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ugie	0.0	0.0	0.0	0.0	0.0	0.2	7.5	12.1	0.5	0.0	0.0	0.0
Ythan	0.0	0.0	0.0	0.0	0.2	16.8	102.4	39.4	6.0	0.0	0.0	0.0
Don	0.0	0.0	0.0	0.0	0.3	22.1	81.1	54.9	0.0	0.0	0.0	0.0
Dee (Aberdeenshire)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
North Esk	0.0	0.0	0.0	0.2	29.8	462.1	1441.2	902.2	0.0	0.0	0.0	0.0
Bervie	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South Esk	0.0	0.0	0.0	0.1	28.4	335.8	1478.1	1535.2	0.0	0.0	0.0	0.0

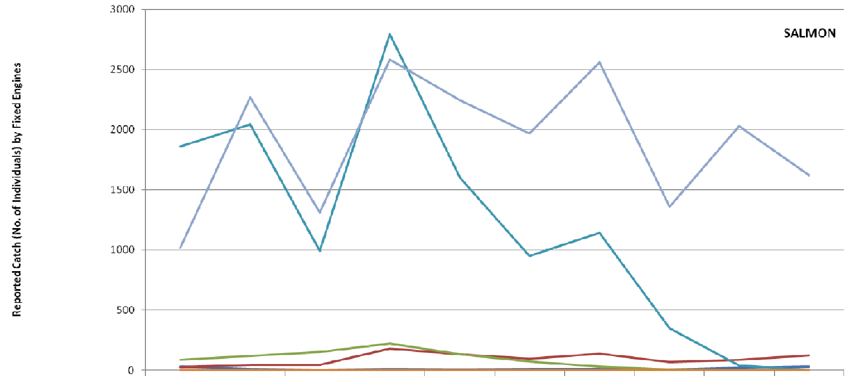
Month



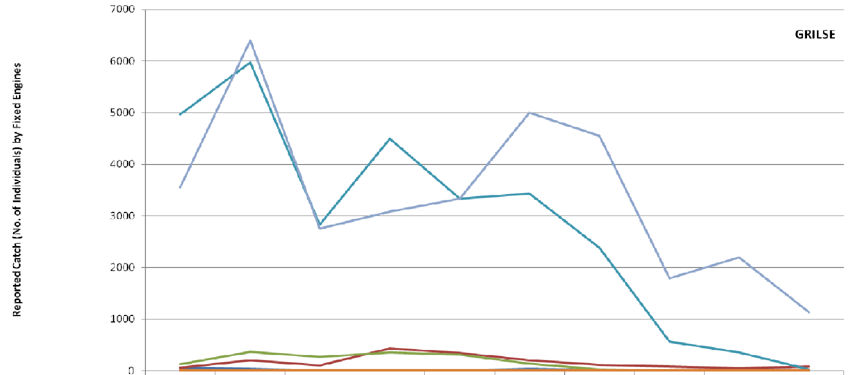
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ugie	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ythan	0.0	0.0	0.0	0.5	4.8	10.4	2.6	0.7	0.0	0.0	0.0	0.0
Don	0.0	0.0	0.0	1.3	18.7	47.6	16.4	3.2	0.0	0.0	0.0	0.0
Dee (Aberdeenshire)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
North Esk	0.0	0.0	0.0	15.2	270.0	403.5	78.1	9.1	0.0	0.0	0.0	0.0
Bervie	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South Esk	0.0	0.0	0.8	17.4	585.2	835.6	155.2	18.5	0.0	0.0	0.0	0.0

Month

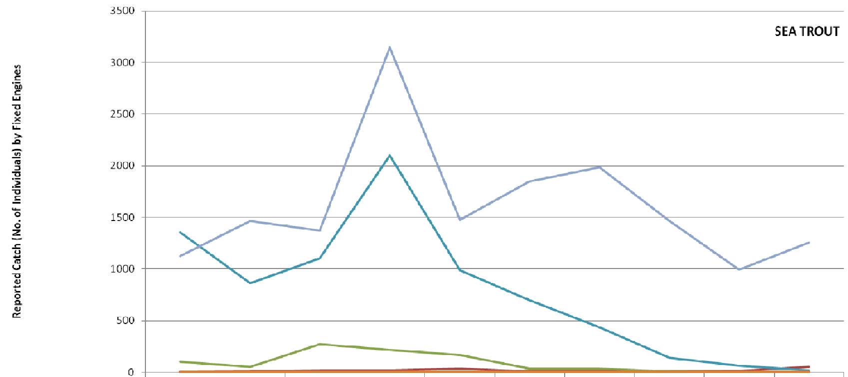
Figure 6.14 Seasonality of the Catch (average 2000-2009) by Fixed Engines



Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Ugie	30	10	4	9	6	10	11	6	19	32
Ythan	27	42	44	181	133	94	140	68	84	122
Don	87	118	150	223	134	73	32	8	0	0
Dee (Aberdeenshire)	0	0	0	0	0	0	0	0	0	0
North Esk	1858	2045	991	2796	1600	948	1142	350	38	4
Bervie	0	0	0	0	0	0	0	0	0	0
South Esk	1015	2269	1313	2582	2243	1970	2558	1357	2030	1622



Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Ugie	55	35	9	9	2	34	17	8	22	12
Ythan	58	200	102	433	344	196	111	79	43	82
Don	128	369	265	350	316	133	23	0	0	0
Dee (Aberdeenshire)	0	0	0	0	0	0	0	0	0	0
North Esk	4964	5973	2830	4497	3338	3427	2380	563	355	28
Bervie	0	0	0	0	0	0	0	0	0	0
South Esk	3548	6397	2751	3086	3335	4997	4548	1787	2194	1133



Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Ugie	0	0	0	0	0	0	0	0	0	0
Ythan	4	6	21	16	36	7	25	10	12	53
Don	103	49	268	213	164	36	34	5	0	0
Dee (Aberdeenshire)	0	0	0	0	0	0	0	0	0	0
North Esk	1354	859	1100	2101	989	700	434	141	65	16
Bervie	0	0	0	0	0	0	0	0	0	0
South Esk	1127	1464	1372	3143	1473	1847	1986	1464	995	1256

Figure 6.15 Annual Variation in Catches by Fixed Engines by Species and District

6.5.3 The Esk District Net Fishery

The annual reported catches of the net fisheries by region in Scotland are illustrated in Figure 6.16 below. The catch in the North East region has been further broken down by individual district. The location of active net fisheries in Scotland in 2009 is also shown on the figure, based on graphical information provided by MSS.

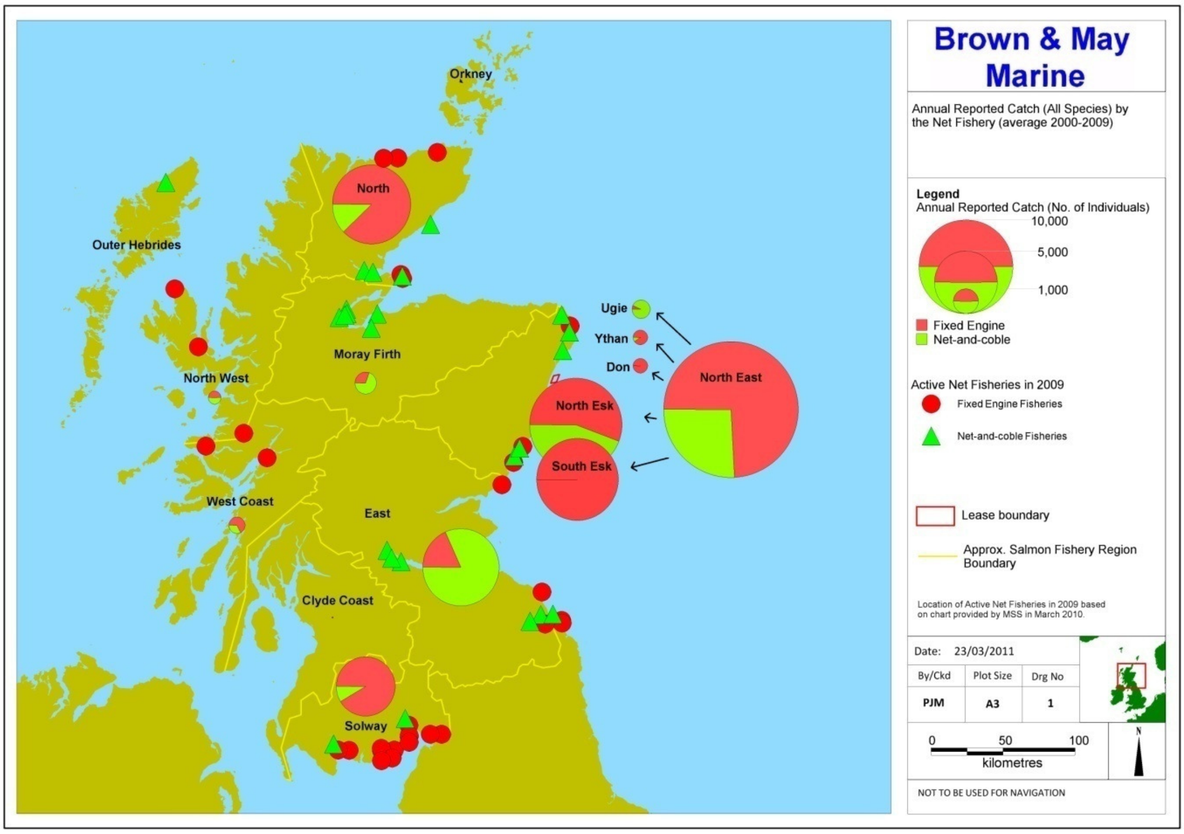


Figure 6.16 Annual (average 2000-2009) Reported Catch of Net Fisheries by Region

As it is apparent from Figure 6.16, the Esk district supports important net fisheries, accounting for the majority of the total net catch recorded in the North East and being of relevance in a national context.

In the South Esk, the principal fixed engine fishery currently active is the Usan Fishery. The Usan's heritable rights stretch between Scurdie Ness lighthouse to the north and Auchmethie Harbour near Arbroath to the south and it operates 8 netting stations. Fish caught by this fishery originate principally from the Tay up to the Dee and the Don (Consultation Meeting, 2011b).

As previously mentioned in Section 6.5.2.2, the fixed engine coastal fishery in the North Esk is currently closed as a result of the buyout of the coastal netting stations by the Esk Salmon Fishery Board. Net-and-coble, however, still takes place in the river. There is a net-and-coble station located at Kinnaber (Consultation Meeting, 2011b).

6.6 Local

6.6.1 Introduction

The following section provides reported catch data for the rod-and-line and the net fishery in the Don, the district located in the immediate vicinity of the proposed EOWDC and incorporates further information gathered through consultation with the Don District Salmon Fishery Board (DDSFB). As previously mentioned, consultation with individual coastal netting right holders will be undertaken once the location of the export cable has been defined.

6.6.2 Fishing Methods in the Don

The distribution of the reported catch (all species combined) in the district by fishing method from 2000 to 2009 is given in Figure 6.17. The majority of the catches in the Don are by rod-and-line, which accounts for 88.9% of the total catch, of which more than a half is by catch and release. The net fishery operates to a lower extent in the district, accounting for only 11.1% of the total reported catch. It should be noted that netting in the Don is only by fixed engines, with no net-and-coble currently taking place, although it existed in the past (Consultation Meeting, 2010c).

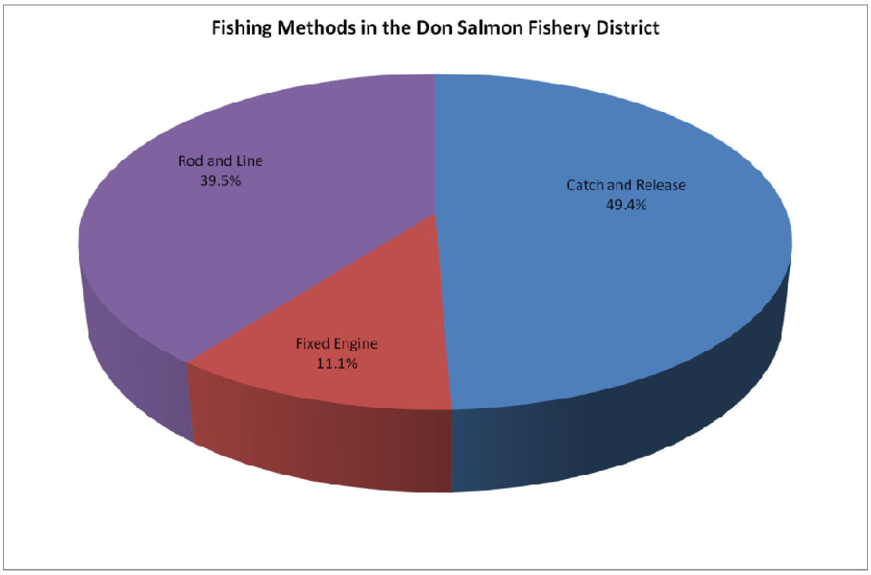


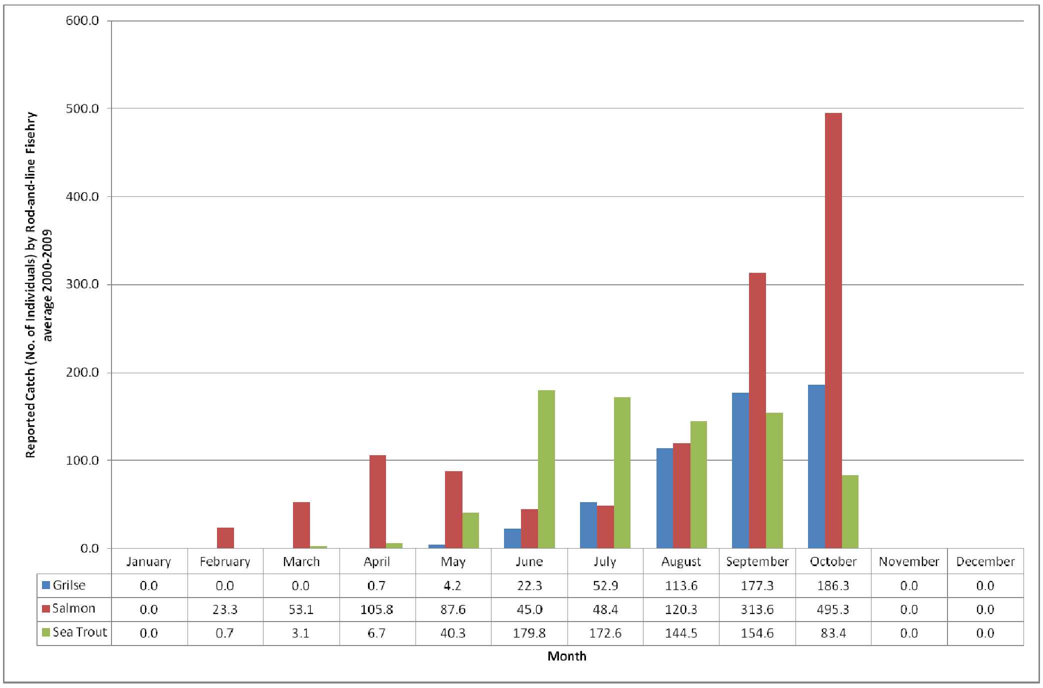
Figure 6.17 Distribution of the Catch by Method in the Don District (2000-2009)

6.6.3 Seasonality of the Fisheries and Main Runs

The netting season in the Don runs from 11th February to 26th August, whilst for rod-and-line the season lasts longer ending on 31st October (Consultation Meeting, 2010c). An indication of the seasonality of the catches by species is shown in Figure 6.18 and Figure 6.19 for the rod-and-line (including catch-and release) and net fishery (fixed engines) respectively, based on average monthly catches for the period 2000-2009.

6.6.3.1 Rod-and-line

The rod-and-line fishery records the highest reported catches from August to October for salmon and grilse, and between June and October for sea trout. It should be noted that earlier fish runs (eg. spring salmon) whilst recording lower catches are also of relative importance to the fishery as they allow for extended fishing seasons (Figure 6.18).

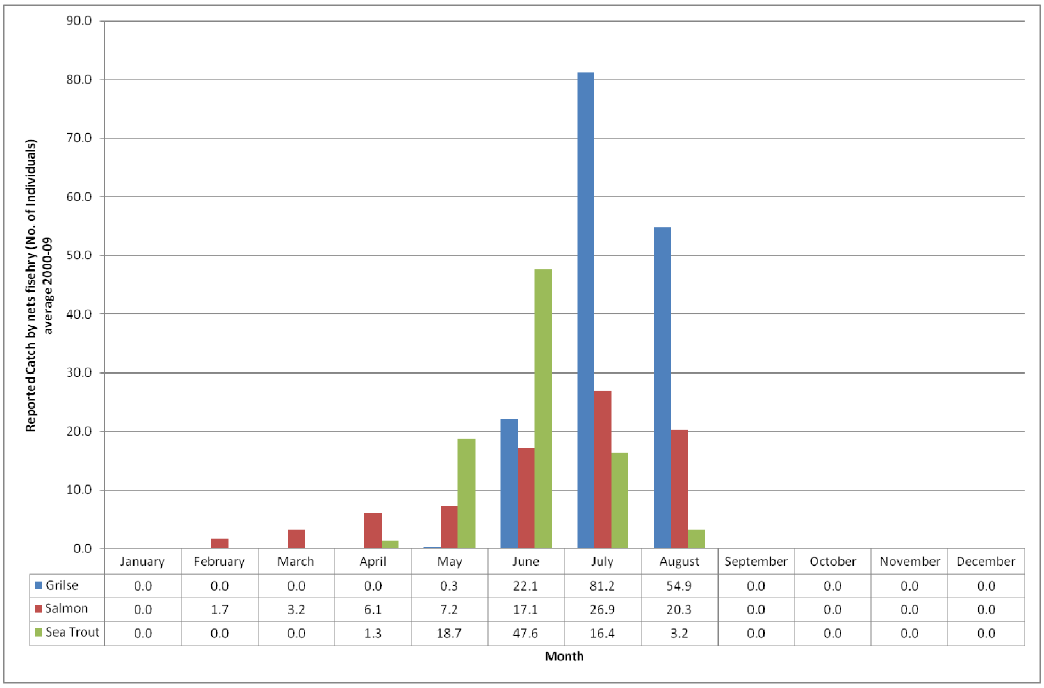


	January	February	March	April	May	June	July	August	September	October	November	December
Grilse	0.0	0.0	0.0	0.7	4.2	22.3	52.9	113.6	177.3	186.3	0.0	0.0
Salmon	0.0	23.3	53.1	105.8	87.6	45.0	48.4	120.3	313.6	495.3	0.0	0.0
Sea Trout	0.0	0.7	3.1	6.7	40.3	179.8	172.6	144.5	154.6	83.4	0.0	0.0

Figure 6.18 Reported Catch by Rod-and-line (including catch and release)

6.6.3.2 Fixed Engines

The seasonality of reported catches in the net fishery is similar to that shown for rod-and-line. The highest catches in fixed engines are however recorded slightly earlier than by rod-and line. The seasonality of the captures by fixed engines reflects to some extent the timing of the coastal migration of adult salmon and sea trout before entering the river to spawn (Figure 6.19).



	January	February	March	April	May	June	July	August	September	October	November	December
Grilse	0.0	0.0	0.0	0.0	0.3	22.1	81.2	54.9	0.0	0.0	0.0	0.0
Salmon	0.0	1.7	3.2	6.1	7.2	17.1	26.9	20.3	0.0	0.0	0.0	0.0
Sea Trout	0.0	0.0	0.0	1.3	18.7	47.6	16.4	3.2	0.0	0.0	0.0	0.0

Figure 6.19 Reported Catch by Fixed Engines

6.6.3.3 Principal Runs

The main runs of salmon and sea trout as specified by the DDSFB (Consultation Meeting, 2010c) in the Don are as follows:

- Spring salmon: mid December to April
- 2SW salmon: May-June
- Grilse: July to Mid October
- Sea trout: June to early August

In addition to the runs detailed above, there are two smolt runs in the Don. The first takes place in May through to early June and the second in September (Consultation Meeting, 2010c).

There has been a change in the timing of the grilse run in recent years. In the past, the bulk of the grilse run used to take place in July, however this now takes place later in the season with the peak run taking place in late August and continuing through until October ((Consultation Meeting, 2010c).

6.6.4 Annual Variation

An indication of the annual changes in the total catch by species from 2000 to 2009 in the Don is given in Figure 6.20 and Figure 6.21 for the rod-and-line fishery (including catch and release) and net fishery (fixed engines), respectively.

6.6.4.1 Rod-and-line

Salmon catches peaked in 2004, with a decline in the following years. 2009 recorded the lowest salmon catch in the district within the ten year period under consideration.

The grilse catch has fluctuated over the years, ranging from a minimum of 419 to a maximum of 887 fish reported per year, peak catches were recorded in 2004. The trend in sea trout catches has been one of a decline, particularly between 2000 and 2003, when a strong decrease in catches for this species was observed (2,253 fish caught in 2000 compared to 445 fish caught in 2003).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Grilse	419	512	430	556	887	526	675	626	450	492
Salmon	1133	1528	1235	761	2453	2025	1483	786	839	681
Sea Trout	2253	1425	807	445	1011	523	659	294	157	283
Total	3805	3465	2472	1762	4351	3074	2817	1706	1446	1456

Year

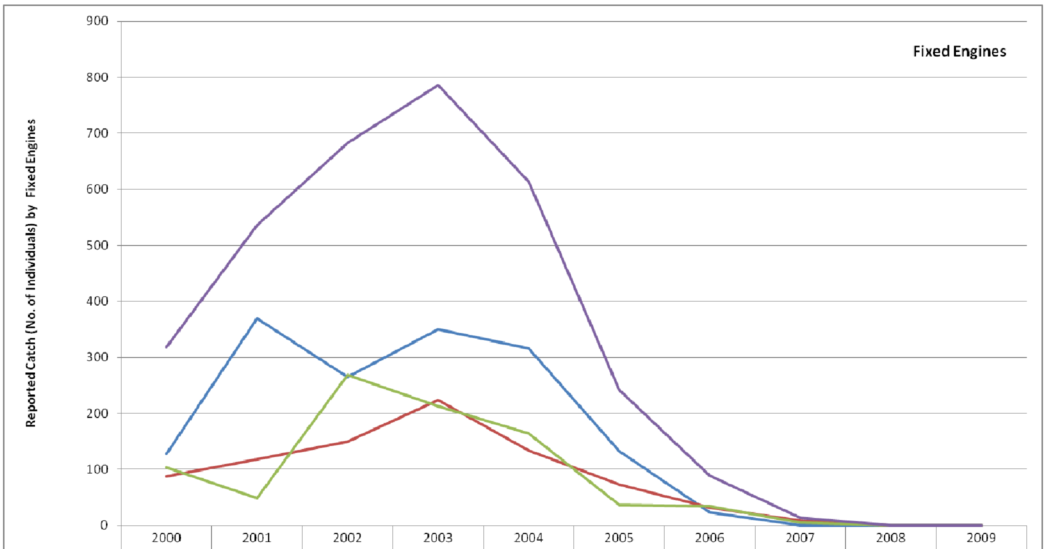
Figure 6.20 Annual Variation of the Rod-and-line Catch by Species in the Don District (2000 -2009)

DDSFB's representatives indicated during consultation that the spring stock salmon fishery in the Don has shown a slight improvement two years running and that similarly, the grilse, autumn salmon and sea trout runs have also improved in the past few years (Consultation Meeting, 2010c).

6.6.4.2 Fixed Engines

As it is apparent from Figure 6.21 below, there has been a marked decrease in catches by fixed engines in the Don for all species in the last few years, especially since 2003-2004. It should be noted that no catches have been reported by this fishery in 2008 and 2009.

In line with this, anecdotal evidence suggests that the remaining netsmen in the local area operate on a part–time or hobby basis, with the closest commercial netting stations located to the south, in the Esk District near Montrose (MS, 2007).



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Grilse	128	369	265	350	316	133	23	0	0	0
Salmon	87	118	150	223	134	73	32	8	0	0
Sea Trout	103	49	268	213	164	36	34	5	0	0
Total	318	536	683	786	614	242	89	13	0	0

Year

Figure 6.21 Annual Variation of Fixed Engines Catch by Species in the Don District (2000 -2009)

6.6.5 Coastal Netting Stations in the Don

There are eight coastal netting stations in the Don district located in the immediate vicinity of the Aberdeen Offshore Wind Farm. Their locations and current owners are shown in Figure 6.22.

Three of the eight stations have been bought up by the DDSFB, the Atlantic Salmon Trust and Trump International and are not currently fished (Consultation Meeting, 2010c). The five remaining stations (shown in dark and light blue in Figure 6.22) are owned by two right holders. No catches have been reported in the last two years from these stations, suggesting that they are not currently fished. It should however be recognised that a degree of under-reporting may have occurred. In addition, netting activities may at any time recommence.

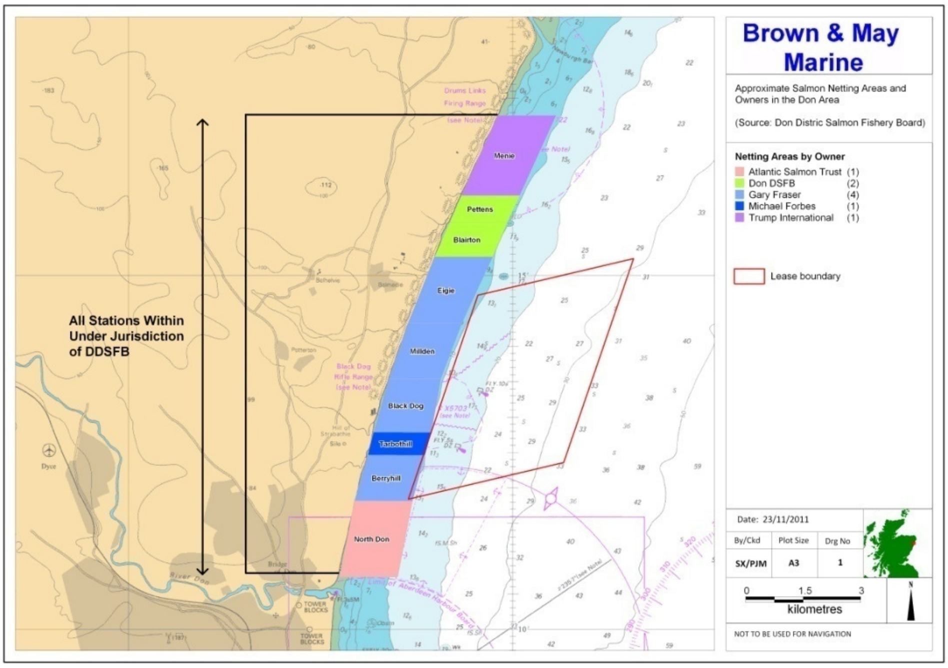


Figure 6.22 Coastal Netting Stations under jurisdiction of the Don District Salmon Fishery Board

6.7 Future Fisheries

As explained in Section 6.3, salmon fisheries are subject to a wide range of regulations and restrictions, from government through to individual districts. All the DSFBs in the North East region are making significant efforts to ensure the future of the industry and specifically the rod-and-line fishery with DSFBs, trusts and conservation groups implementing programmes to maintain and improve upon the number and quality of salmon and sea trout in their rivers. Catch and release policies are also increasingly closely monitored and hatcheries have been developed in some districts.

A priority for the majority of the Boards is the maintenance and development of rod-and-line fishing. It is expected that this trend will continue in the future, in line with the joint aims of the ASFB and other organisations. Parallel to the maintenance and development of the rod-and-line fisheries, a decrease in the costal netting activity in Scotland, either as a result of river and conservation interests buying up coastal stations, as well as increasing restrictions, has been the trend in the last decade. This will likely continue to be the case in the future.

Scotland, together with England, Norway and Northern Ireland has come under increasing international pressure to establish a policy for managing Multi Stock Fisheries (MSFs). This is of particular sensitivity in Scotland, as fishing is prosecuted under heritable property rights, rather than as an activity licensed by Government, as in most salmon producing countries (Crawley, 2010). International advice is that there should be a presumption against operating Multi Stock Fisheries, such as coastal netting, unless they can be shown not to contravene basic conservation policies (ASFB, AST and S&TA, 2009).

It should be noted that there are numerous constraints placed upon the degree to which potential losses and their significance to salmon and sea trout fisheries can be assessed over the operational life of the proposed EOWDC. As is the case with other commercial fishing activities, unpredictable and unrelated influencing variables such as natural fluctuations in stock levels or changes in legislation could significantly alter elements within the baseline.

As discussed in Section 5.6, both salmon and sea trout Scottish populations are currently subject to a number of threats. Whilst conservation measures to protect these species have increased in the last years, it is not possible to be certain of what the outcome of these will be and how this will be affected by natural fluctuations in stock levels during the life time of the proposed EOWDC.

6.8 Main Concerns raised by Fisheries Stakeholders

The main concerns expressed during consultation meetings and in questionnaires by fisheries stakeholders are as follows:

- Potential impact on migratory patterns and disturbance derived from EMFs
- Potential impact on migratory patterns and disturbance derived from underwater noise during construction
- Potential impact of sediment plumes derived from construction activities
- Potential for the proposed EOWDC to alter the path the salmon take to return to home rivers
- Indirect impacts caused by changes in prey availability, principally in relation to sandeels.
- Potential for the turbines to result in a physical barrier to migration

7.0 References

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APPENDIX 01- CONSULTATION

Questionnaires

Completed questionnaires have been received from the following fisheries stakeholders:

- District Salmon Fishery Boards
    - Don
    - Ythan
    - Dee
    - Brora
    - Kyle of Sutherland
    - Tweed
    - Caithness
    - Lossie
    - Cromarty
    - Ness/Beauly
    - Helmsdale

- Netsmen/Net Fisheries
    - Kincurdie Salmon Fishings-Patience Family Trust (Ness)
    - Wilkhaven and Castle Salmon Fishery - Ian N. Paterson (Cromarty)

- Moray Firth Sea Trout Project (MFSTP)

Consultation Meetings

Consultation meetings were carried out with the following District Salmon Fishery Boards and net fisheries:

- Ugie District Salmon Fishery Board (26/10/2010)
- Ythan District Salmon Fishery Board (26/10/2010)
- Don District Salmon Fishery Board (27/10/2010)
- Dee District Salmon Fishery Board (17/01/2011)
- Esk District Salmon Fishery Board (27/10/2010)
- Usan Fisheries (Montrose) (17/02/2011)

European Offshore Wind Deployment Centre
Environmental Statement

Appendix 22.2: Salmon and Sea Trout EIA Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

European Offshore Wind Deployment Centre (EOWDC)

Salmon and Sea Trout Impact Assessment

Undertaken by
Brown & May Marine Ltd

Reference	Date of Issue	Issue Type	Checked	Approved
EOWDC-SSTIA01	09/05/2011	FINAL	SJA/PJM/SX	SJA

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Tables

Figures

1.0 Introduction

The following document details the Salmon and Sea Trout Impact Assessment for the European Offshore Wind Deployment Centre (EOWDC).

The primary focus of this report is the assessment of the potential for salmon and sea trout, especially during migration, to be affected by the EOWDC. Given the socio-economic importance of the salmon and sea trout fishery in Scotland, both in rivers and in coastal waters, the potential for the fishery to be directly or indirectly affected has also been evaluated (Section 3.5).

2.0 Methodology

2.1 Key Guidance Documents

In the absence of guidelines specific to the assessment of impacts on salmon and sea trout and in relation to offshore wind farm developments, the following documents have provided guidance:

- Strategic Environmental Assessment (SEA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Volume 1: Environmental Report. Marine Scotland. 2010
- Habitats Regulations Appraisal Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Appropriate Assessment Information Review. Marine Scotland .2011
- Offshore Wind Farms guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements. Version 2- 2004
- EOWDC Marine Scotland Scoping Response (December 2010 and January 2011 update)

2.2 Information and Data Sources

The principal sources of information used for the undertaking of this assessment are as follows:

- Marine Scotland Review of Migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: Implications for the development of marine renewables (Malcolm *et al*., 2010)
- Scottish Natural Heritage Literature review on the potential effect of electromagnetic fields and subsea noise from marine renewable energy developments on Atlantic salmon, sea trout and European eel (Gill and Barlett, 2010)
- Consultation with District Salmon Fishery Boards and other relevant stakeholders
- Collaborative Offshore Wind Research Into the Environment (COWRIE) Publications
- Monitoring Surveys undertaken in Operational Wind Farms
- Other publically available research literature

2.3 Consultation

Consultation meetings were held with all the salmon fishery boards located within the North East region and with representatives of the netting fishery in the North East.

These were as follows:

- Ugie District Salmon Fishery Board (26/10/2010)
- Ythan District Salmon Fishery Board (26/10/2010)
- Don District Salmon Fishery Board (27/10/2010)
- Dee District Salmon Fishery Board (17/01/2011)
- Esk District Salmon Fishery Board (27/10/2010)
- Usan Fisheries (Montrose) (17/02/2011)

In addition to the above meetings, questionnaires were circulated to all the salmon district fishery boards in Scotland, through the Association of Salmon Fishery Boards (ASFB), and to netsmen, through the Salmon Net Fishing Association of Scotland.

2.4 Data and Information Limitations and Data Gaps

Extensive studies and research concerning the behaviour of salmon, and to a lesser extent sea trout, have been, and are being, undertaken. Despite this, however, the behavioural patterns of the species in the marine environment, particularly on the Scottish east coast, are not fully known and a degree of uncertainty exists regarding salmon and sea trout migratory routes, behaviour in coastal waters, navigation mechanisms and the implication of responses to factors such as noise and EMFs during migration. In light of this, and in order to provide a robust assessment of impacts, a number of assumptions have been made that are further discussed in Section 2.5.7 below.

2.5 Impact Assessment Methodology

The assessment aims to describe the magnitude of effect for each potential impact (i.e. the change created by an activity in terms of its spatial extent, duration and scale) and the sensitivity of each receptor (i.e. the environmental resources that would be affected) based on its importance and recoverability. The effect and sensitivity of the receptor are then used to derive the significance of each potential impact.

2.5.1 Potential Impacts

The potential impacts to be considered are summarised in Table 2.1 below for the construction, operational and decommissioning phases. For the purposes of this assessment and given the uncertainties relating to decommissioning methods at this stage, it has been assumed that the impacts derived from the decommissioning phase will, at worst, be of the same significance as those derived from construction.

Table 2.1 Summary of Key Potential impacts on Salmon and Sea Trout

Development Phase	Source of Impact	Potential Effect
Construction/ Decommissioning	Noise	Direct Impact: Lethal Effects and Hearing Damage
		Disturbance/Delay /Barrier to Migration
		Indirect Impacts: Loss of Key Prey Species
	Increased Sediment Concentrations	Direct Effects
		Disturbance/Delay/Barrier/ to migration
Operation	Noise	Disturbance/Delay /Barrier to Migration
		Indirect Impact: Loss of Key Prey Species
	Physical Presence of Turbines	Disturbance/ Delay/Barrier to Migration
	EMFs	Disturbance /Delay/Barrier to Migration

Given the migratory nature of salmon and sea trout and the potential for the proposed EOWDC to have different impacts on these species depending on the life stage under consideration, for the purposes of this assessment, the receptors have been sub-divided as follows:

- Juvenile salmon (smolts/post-smolts)
- Juvenile sea trout (smolts/post smolts)
- Adult salmon (grilse and Multi-Sea Winter (MSW) salmon)
- Adult sea trout

2.5.2 Assessment Criteria

The criteria used in the assessment are given below:

Spatial Extent of Effect

- A national/international effect
- A regional effect
- A local, site specific effect including within 5km of the site

Duration of Effect

- A long term/permanent effect (more than 10 years)
- A medium effect (existing for 5 to 10 years)
- A short term effect (existing for 1 to 5 years)
- A temporary effect (existing for less than 1 year)

Scale of Effect

- Above accepted standards/guidelines
- Within accepted standards/guidelines
- Where there are no standards/guidelines available, the impact relative to background conditions

Recoverability of the Receptor

- High
- Medium
- Low or None

Importance of the receptor (taking into account international, national and regional legislation, and function within the ecosystem)

- High
- Medium
- Low or None

The impact significance is then given as *MAJOR, MODERATE, MINOR* or *NEGLIGIBLE* guided by the matrix is given in Table 2.2.

Table 2.2 Matrix Used to Guide Significance Ratings of Impacts

		Sensitivity of Receptor			
		VERY HIGH	HIGH	MEDIUM	LOW
Magnitude of Effect (based on spatial, duration and scale)	VERY HIGH	Major	Major	Major	Moderate
	HIGH	Major	Major	Moderate	Minor
	MEDIUM	Major	Moderate	Minor	Minor
	LOW	Moderate	Minor	Minor	Negligible
	NEGLIGIBLE	Minor	Negligible	Negligible	Negligible

2.5.3 Implications of Significance

Where the significance for a potential impact is classified as ***MODERATE to MAJOR*** or ***MAJOR,*** it is considered to be a potentially significant effect. It should be noted however that significant effects may not be unacceptable as their effect may be reversible. A ***NEGLIGIBLE*** significance is assigned to a potential impact if it produces no discernible effect on the environmental resource in question.

2.5.4 Cumulative and In-combination Impact Assessment Methodology

The cumulative and in-combination impact assessments have applied the same methodology and potential impacts outlined above.

In-combination impacts relate to European protected sites that could be affected by the proposed development. These assessments have been addressed within the Habitats Regulations Assessment.

Cumulative impact assessments have been undertaken on those developments and activities which could be reasonably be expected to have an effect.

Other Offshore Wind Farms

The wind farm developments which could contribute to the cumulative impacts are those proposed in the Firth of Forth to the south and the Moray Firth to the north.

Offshore Oil & Gas Developments

Current available information suggests that there is not anticipated to be offshore oil and gas exploration or production activities within the general area of the proposed EOWDC site which could contribute to cumulative effects. This activity has therefore been scoped out of the cumulative assessment process.

Introduction of Marine Protected Areas (MPAs)

The Marine (Scotland) Act has established powers for the development of Marine Protected Areas (MPAs) in the seas around Scotland. These areas, however, have yet to be defined. The introduction of MPA's is not however expected to have any adverse impact on salmon and sea trout and have therefore been scoped out of the cumulative assessment process.

Aggregate Dredging

The Middle Bank licensed dredging area in the Firth of Forth, approximately 150 km from the EOWDC, is the closest licensed dredging area. It should be noted that at present it is not active. This activity has therefore been scoped out of the cumulative assessment process.

Other Offshore Works

Currently there is no information on other offshore works that would contribute to cumulative impacts on salmon and sea trout.

Ocean Laboratory

It is proposed that an Ocean Laboratory may be installed within the site. This will be subject to a separate application and EIA. As such, at this stage, it will only be assessed in terms of its cumulative effect.

2.5.5 Assessment of Impacts against a Changing Baseline

A number of factors unrelated to the proposed EOWDC development may cause changes to salmon and sea trout populations over the life of the project. For instance, increased marine mortality, a trend that has been observed in recent years and thought to be related to environmental factors, could result in a further decline in the numbers of salmon and sea trout in rivers. Furthermore, changes in fishing practices in the coastal and marine environment, and the introduction of further legislation and conservation measures could also impact the state of salmon and sea trout stocks.

2.5.6 Worst Realistic Case

The worst realistic case is assumed to be the installation of 11 turbines, all of which have 8.5 m diameter monopile foundations. The theoretical worst case in terms of cumulative assessment would be the simultaneous construction of the proposed offshore wind developments in the Firth of Forth and in the Moray Firth, coinciding with the proposed EOWDC.

2.5.7 Assumptions

As stated above data gaps exist with respect to the salmon and sea trout baseline and therefore for the purposes of the impact assessment certain assumptions have been made.

Figure 2.1 below shows the location of the EOWDC relative to the principal salmon rivers in the regional area. It can be seen that the Dee, Don and Ythan are closest to the development and the assumption has been made that fish from these rivers are more likely to transit the site. It is also recognised however that fish from other rivers, both within the region (e.g North Esk, South Esk, Ugie) and from other Scottish areas (e.g Moray Firth, North, etc) may on occasions also be present in the vicinity of the development.

Taking a precautionary approach the following assumptions, based on the behavioural patterns of salmon and sea trout, have been made for fish originating in the Dee, Don and Ythan Districts:

- Juvenile salmon and sea trout transit through, or in close proximity to, the site on their seaward migration
- Adult salmon (grilse and MSW) and sea trout transit through, or in close proximity to, the site on their return migration
- Sea trout are present in the vicinity of EOWDC and transit the site as part of their foraging activity

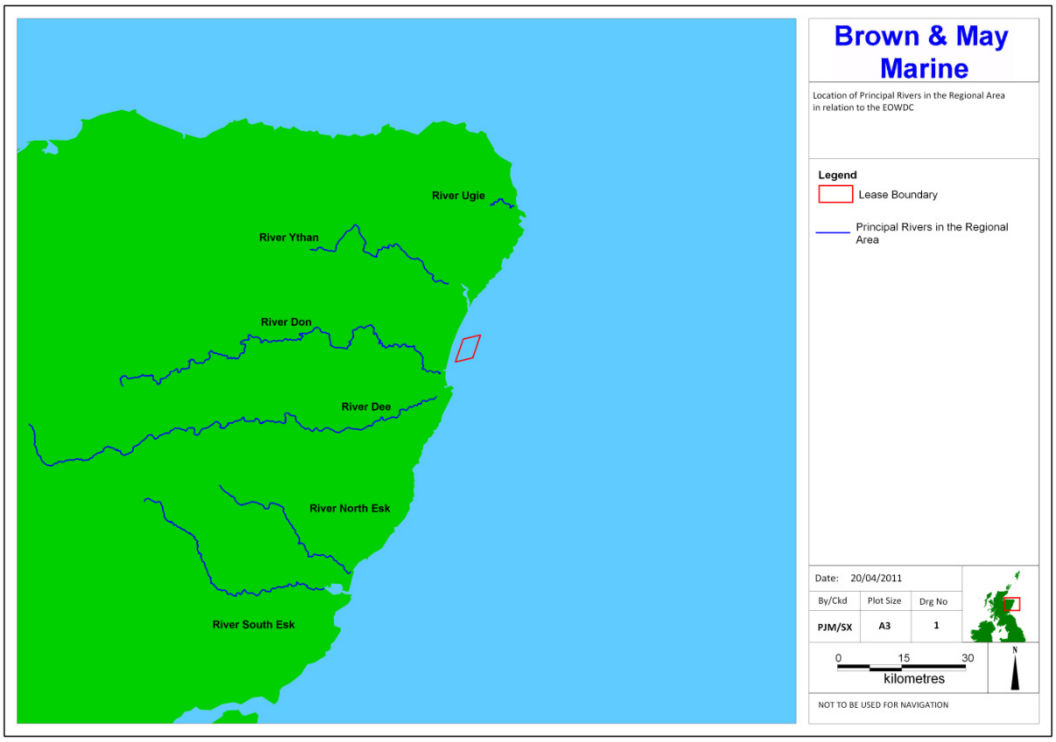

Figure 2.1 Location of the Principal Rivers in the Region in relation to the EOWDC

3.0 Impact Assessment

3.1 Noise and Vibration

3.1.1 Construction and Decommissioning

The principal source of noise during the construction phase will be the possible piling of foundations (monopiles and to a lesser extent jacket structures). Although cable laying and burial, rock placement for scour protection (should it be required) and vessel movements will also result in some levels of noise, these activities will be temporary and localised.

The theoretical maximum number of piling events will be limited to eleven and piling will not be continuous. Under normal conditions, the durations of piling individual foundations for wind farms constructed to date, have typically varied between 20 minutes and thirteen hours. For the purposes of this project, five days is taken as the theoretical maximum duration for the installation of a single foundation within which 24 hours continuous piling is assumed as worst case (further details in Chapter 3, Description of the Proposed Development).

Predicted noise levels from piling activity at the proposed EOWDC were modelled based on piling of 8.5 m diameter piles (worst case) at four different locations (turbines 1, 3, 7 and 11) and taking account of the hearing ability of salmon using the dB_{ht} *(Species)* metric. The model predicts that noise levels which would result in traumatic hearing damage in salmon (130dB_{ht} *(Salmo salar))* could occur at distances of within 20 m of piling (Nedwell *et al.*, 2011). Contour plots of estimated 90dB_{ht} *(Salmo salar)* impact ranges, at which strong behavioural reactions would be expected, were also produced. The results suggest that, at turbine 7 where the 90dB_{ht} impact range was greatest, the average impact range would be 4.2 km (value range 3.6 km- 4.7 km).

An indication of the spatial ranges at which behavioural reactions in salmon may occur for two of the four locations modelled is given in Figure 3.1. This illustrates the estimated 90dB$_{ht}$ *(Salmo salar)* and the 75bB$_{ht}$ *(Salmo salar)* impact ranges contours. It is considered that at 75dB$_{ht}$ levels, 85% of individuals would react to noise although effects will probably be limited due to habituation.

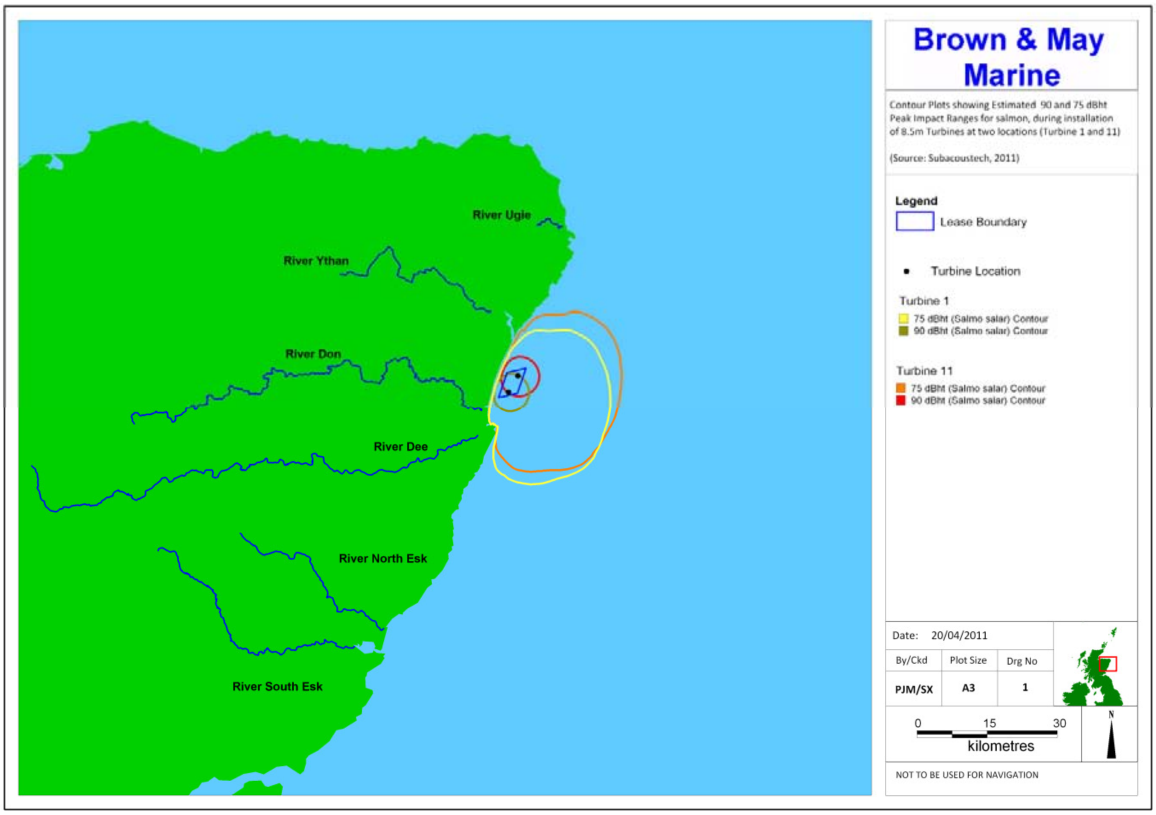

Figure 3.1 Contour Plots showing Estimated 90 and 75dB$_{ht}$ *(Salmo salar)* peak impact ranges during installation of 8.5m diameter Turbines at two locations (Turbine 1 and 11) (Source: Nedwell *et al.*, 2011)

It should be noted that the assessment given below is based on a theoretical worst case scenario, involving piling of 11 monopiles of 8.5 m diameter. As the EOWDC is an experimental development to trial various foundations types, in reality it is expected that less than eleven monopiles will be installed.

Unlike hearing specialists such as herring, salmonids have no direct connection between the swim bladder and the ear and are therefore considered to be hearing generalists.

Salmon have been shown to respond to low frequency sounds (below 380 Hz), with best hearing (threshold 95 dB re 1 μ Pa) at 160 Hz (Hawkins and Johnstone, 1978). The ability of salmonids to respond to sound pressure is regarded as relatively poor with a narrow frequency span, a limited ability to discriminate between sounds, and a low overall sensitivity (Gill and Bartlett, 2010). Based on sound measurements undertaken in the River Dee, Hawkins and Johnstone (1978) concluded that salmon are unlikely to detect sounds originating in air, but may be sensitive to substrate borne sounds.

Research carried out on the effects of piling noise on caged brown trout (*Salmo trutta)* at the Red Funnell's Southampton Terminal (Nedwell *et al*., 2003a) found no behavioural reactions to vibro-piling and no responses to hammer pile operations for fish as close as 50 and 417 m from the source, respectively. Further studies carried out on brown trout (*Salmo trutta*) suggest that the hearing of brown trout is less sensitive than that of salmon. Analysis using the dB_{ht} metric indicated that the noise at the nearest locations during impact piling reached levels at which salmon were expected to react strongly, however, brown trout showed little reaction (Nedwell *et al*., 2006).

For the purposes of this assessment, salmon has been used as a surrogate for sea trout, whilst it is appreciated that the sensitivities of the two species may be different. In addition, it is recognised that juveniles, such as smolts, and small grilse, may also have different sensitivities than adults, being generally considered to be more vulnerable to noise impacts (Hastings and Popper, 2005; MS, 2011). In experimental and river settings they have been found to avoid localised high intensity sounds less than 10 Hz (Sand *et al*., 2001; Knudsen *et al.,* 1992; Knudsen, 1997).

3.1.1.1 Direct Impacts: Lethal Effects and Hearing Damage

Potential Impact

Based on the results of the noise modelling undertaken for salmon (Nedwell *et al.*, 2011), it is expected that lethal noise levels during construction would only occur in the immediate vicinity of areas where piling is being undertaken (< 3 m from the pile).

Similarly the potential for traumatic hearing damage in salmon and sea trout would only take place in localised areas. Using the $130dB_{ht}$ criteria from Nedwell *et al*. (2007), and assuming fish are not deterred from the area, salmon would be expected to suffer traumatic hearing damage within 20-30 m of the piling activity. This distance has been further refined using the fleeing animal model which assumes that animal swim away from the noise source. Using a swim speed of 1 m/s and taking into account the accumulated noise dose near a typical piling operation, the model calculates that fish within 1 m of the piling activity, at the onset of piling, are unlikely to be able to flee before suffering hearing damage.

As lethal/traumatic hearing damage effects are only predicted to occur very close to the pile, and given that soft start piling will deter animals from this area, the magnitude of this impact is considered to be *NEGLIGIBLE*. The receptors, taking the small number of fish potentially present at a given time within the small spatial area where impacts could occur and given their importance as conservation species are considered of *HIGH* sensitivity. The potential direct impacts derived from construction noise on salmon and sea trout are therefore considered of *NEGLIGIBLE* significance.

Mitigation

None other than the use of soft start piling.

Residual Impact

NEGLIGIBLE

Cumulative Impact

None

3.1.1.2 Disturbance/Delay/Barrier to Migration

As illustrated in Figure 3.1 there is potential for behavioural responses to occur in a wider area than just the immediate turbine locations ($95dB_{ht}$ and $75dB_{ht}$ contours). The implications of behavioural responses will depend on the life stage under consideration and the ecology of the species, and on assumptions (Section 2.5.7), rather than definitive research evidence of salmon and sea trout migration routes.

Potential Impact

Salmon and Sea Trout Juveniles (Smolts/Post-smolts)

Information on the behaviour of salmon and sea trout smolts and post-smolts in Scottish waters once they leave the freshwater habitat is limited. Smolts usually leave rivers from April to June and are thought to make limited use of estuarine habitats moving rapidly to the open sea. Research based on salmon suggests post-smolts normally swim in the upper few metres of the water column (1-3m) and do not closely follow nearby shores, having being recorded swimming at distances up to 2-5km from the shore.

Given the close proximity of the Don, Dee and Ythan to the proposed EOWDC, juvenile salmon and sea trout (smolts and post-smolts) originating from these rivers may transit close to or through the proposed EOWDC during their early marine phase. It is also possible that post-smolts originating in other rivers, especially those in the regional study area (Ugie, North Esk and South Esk), may transit close to or through the proposed EOWDC where noise levels could result in strong (90dB_{ht}) or mild (75dB_{ht}) behavioural reactions.

In the case of sea trout, which do not generally venture to distant offshore feeding grounds, there is potential for post-smolts to transit the proposed EOWDC site during their early marine phase as part of their foraging activity.

It is considered that any delay in smolt/post-smolt migration would be extremely short term, given the durations of the worst case piling events (24 hours per pile) and the localised area where strong behavioural reactions are expected to occur (approx. 4 km radius). The magnitude of the impact is therefore considered to be *LOW.* The number of juvenile salmon and sea trout originating from most rivers potentially transiting areas where strong behavioural reactions could occur at any given time is also expected to be low.

The sensitivity of the receptors, particularly those smolts/post-smolts originating in the Dee, Don and Ythan, given the close proximity of the rivers to the proposed EOWDC site is however considered to be *HIGH/VERY HIGH*.

The potential impact of construction noise on juvenile salmon and sea trout (smolts/post-smolts) migration is therefore considered of *MINOR/MODERATE* significance in the case of fish originating in the Dee, Don and Ythan.

Adult Salmon and Sea Trout

On the east coast of Scotland, as far north as the Aberdeenshire coast, the migration of adult salmon in coastal waters is believed to predominantly occur in a northerly direction, potentially starting as far south as the north east coast of England. On this basis, it is likely that adult salmon from the Dee, Don, Ythan and Ugie may migrate through the proposed EOWDC and its vicinity. Fish from other rivers could also transit the site and adjacent areas, principally fish returning to the Esk rivers, and to a lesser extent rivers flowing into the Moray Firth and other Scottish regions, although this would be expected to occur to a lesser extent.

In the case of sea trout, it is expected that adult fish transiting the site both as part of their migration or foraging activity will principally originate from the Dee, Don and Ythan and to a lesser extent other rivers in the regional area (Ugie, North Esk and South Esk). As for salmon, it is possible that sea trout originating in other Scottish regions could also transit the area of EOWDC, as long distance migrations have also been observed.

Adult salmon and sea trout returning to the Dee, Don and Ythan have been reported to remain in estuaries waiting for appropriate conditions to enter the river. Noise levels around the Dee, Don and Ythan estuarine areas are not expected to be above $75dB_{ht}$ *(Salmo salar)* (Figure 3.1), and therefore may, at worst, only cause mild behavioural reactions in salmon and sea trout.

In the absence of specific information on the implications of behavioural responses triggered by noise in pre-spawning adult salmon and sea trout in the marine environment prior to river entry, it is considered that the fish may react in one of the following ways:

- Avoid the area and return to the estuary once construction noise has ceased. Assuming the worst case scenario of 24 hour continuous piling per pile, this would result in a short term delay in upstream migration, similar to that caused by natural factors (e.g waiting for adequate flow conditions).

- Reproductive instinct may overrule behavioural reactions potentially triggered by noise (e.g avoidance reactions) and salmon and sea trout may remain in the estuary and enter the river at the time they would normally do, despite of the noise. For example, research undertaken on herring, a hearing specialist, at a spawning site, concluded that the high priority given to reproductive activities may in some instances overrule avoidance responses (Skaret *et al.,* 2004).

For salmon and sea trout originating in other rivers in the region, if transiting areas where noise levels could cause significant avoidance reactions, it is likely that the implications on their migration will be limited to slight changes in their migratory patterns and potentially, slight delays in river entry.

Taking the worst case scenario, that adult fish migrating into the Dee, Don and Ythan will avoid the area due to noise levels, it is considered that the magnitude of the impact will be *LOW*, on the basis of the relatively short duration of a piling event and the relatively short nature of any delays in migration. Given their importance as species of conservation, especially in the case of salmon in the Dee SAC, and taking account of the relatively small number of fish potentially affected by a piling event, on the basis of the diversity of salmon runs and river entry timing in the case of salmon to take place in some rivers throughout the year, the receptors are considered of *HIGH* sensitivity. The impact due to construction noise on adult salmon and sea trout returning to the Dee, the Don and the Ythan is therefore considered of *MINOR* significance.

Mitigation

Juvenile Salmon and Sea Trout

It is proposed that piling activities be scheduled in consultation with Marine Scotland Science, Scottish Natural Heritage and the Dee, Don and Ythan District Salmon Fishery Boards to ensure minimal disturbance to smolt runs.

The timing of the principal smolt runs in the Ythan, Dee and Don Salmon Fishery Districts as given by the Boards during consultation is given in Table 3.1 below.

Table 3.1 Principal Smolt Runs in the Ythan Dee and Don

District Salmon Fishery Board	Timing of Smolt Runs
Ythan	mid May- end of June
Dee	March-June
Don	May-early June
	September

Adult Salmon and Sea Trout

In light of the different time of river entry in salmon and sea trout originating in different rivers and the diversity and relative importance of salmon and sea trout runs on a river specific basis, the scheduling of piling activities to minimise potential impacts may not be possible for all adult salmon and sea trout migrations. The final piling schedule will however be agreed and defined in consultation with Marine Scotland, Scottish Natural Heritage and the Ythan, Dee and Don District Salmon Fishery Boards.

The timing of the principal salmon and sea trout runs in the rivers located in the proximity of the proposed EOWDC as specified by the Ythan, Don and Dee District Salmon Fishery Boards during consultation are given in Table 3.2 below.

Table 3.2 Principal Salmon and Sea Trout Runs in

District Salmon Fishery Board	Principal Grilse Run	Principal Salmon Run	Principal Sea Trout Runs
Ythan	Autumn	Autumn	May-August
Dee	late May-September	Feb-May (Spring salmon)	May-June
		Summer and Autumn (2SW salmon)	
Don	July-Mid October	mid Dec-April (Spring Salmon)	June- early August
		May-June (2SW salmon)	

Residual Impact

Juvenile Salmon and Sea Trout

Provided that piling operations are scheduled to minimise potential impacts on salmon and sea trout juveniles, it is considered that the residual impact of construction noise on juvenile salmon and sea trout migration will be of *NEGLIGIBLE-MINOR* significance.

Adult Salmon and Sea Trout

The residual impact is expected to be the same as the potential impact (*MINOR)* and possibly *NEGLIGIBLE* depending on final piling schedules, foundation types and installation methods used.

Cumulative Impact

Juvenile Salmon and Sea Trout

The installation of the proposed Ocean Laboratory will involve the piling of a 8.5 m diameter pile, assuming the worst case scenario. This would result in further 24h piling in the area of the EOWDC being undertaken. Given the small area to be affected and the short duration of the noise disturbance, it is not considered that the installation of the proposed Ocean Laboratory will result in a significant cumulative impact in relation to construction noise. In addition, the installation of the Ocean Laboratory, as proposed for the installation of the turbines, would also be scheduled to minimise potential impacts on juvenile salmon and sea trout.

Adult Salmon and Sea Trout

In the case of adult salmon, noise derived from construction activities in the Firth of Forth proposed developments, could result in further impacts on fish migrating towards rivers in the regional area. Taking the worst case scenario, that piling activities in the proposed offshore wind farm developments in the Firth of Forth area are undertaken coinciding with piling operations at the proposed EOWDC, potential direct impacts and avoidance reactions in the Firth of Forth area could result in disturbance to adult salmon migration, further contributing to potential delays in migration/river entry.

Given the limited number of turbines to be installed in the proposed EOWDC in comparison to the offshore wind developments proposed in the Firth of Forth, the contribution of EOWDC to any cumulative impact is likely to be of *NEGLIGIBLE* significance.

3.1.1.3 Key Prey Species

Potential Impact

Noise and vibration during construction could result in a displacement of the food resource if avoidance reactions are triggered in species of importance as prey items to salmon and sea trout. This is relevant in the case of clupeids, such as herring and sprats, as they are hearing specialists and are among the preferred prey species of salmon and sea trout.

Potential impacts derived from prey displacement, if any, are likely to be of greater significance for sea trout than for salmon as they generally remain in coastal areas during their marine phase.

The magnitude of the impact on sea trout through displacement of food resource is considered to be *LOW* on the basis of the spatial scale of the impact and its relatively short duration (theoretical worst case of 11 piling events and 24 hours continuous piling per pile). The sensitivity of the receptor is considered to be *LOW* on the basis of the relatively small number of sea trout potentially feeding in the area from which the food resource could be displaced at a given time, the mobility of sea trout and the availability of other key prey species which are not likely to be disturbed by noise in the wider area (e.g sandeels). The significance of the impact is therefore considered to be *NEGLIGIBLE.*

Mitigation

None required

Residual Impact

Same as the potential impact

Cumulative Impact

There is potential for salmon, in some cases, and more importantly sea trout, to use the Moray Firth and Firth of Forth areas as a feeding ground, principally in relation to the presence of herring and sandeels in these areas.

In view of the limited number of turbines and piling events to be undertaken in the EOWDC in comparison to the developments proposed in the Firth of Forth and the Moray Firth, the contribution by the EOWDC to the any cumulative impact on key prey species due to construction noise would be *NEGLIGIBLE*.

3.1.2 Operation

Noise may arise from a variety of sources during the operational phase of a wind farm, including aerodynamic blade noise, gearbox noise and noise from other machinery (Nedwell *et al.*, 2003b).

Potential Impact

Studies carried out in Denmark on the effect of offshore wind farms on the distribution of fish in areas relevant to the Horns Rev Offshore Wind Farm (Hoffman *et al.,* 2000) found that significant noise levels in the frequency range at which fish typically exhibit a strong response would be expected to be confined to the immediate vicinity of the turbines, within a radius of no more than several hundred of metres. Hoffman *et al.*, 2000 suggested that because of the spatial extent of the low-frequency fields from the turbines, fish would perceive them to be very different compared to the low-frequency fields of other animals. It was therefore concluded that fish species were not expected to be impaired in their ability to detect predators and prey. It was also suggested that the continuous character of the turbine noise was likely to promote habituation in fish species.

In line with this, post-construction monitoring work undertaken in Horns Rev did not find evidence to confirm that fish densities in the general vicinity of the turbines were different from within the ar ray with species such as sandeel, sprat, mackerel and schools of cod recorded in-between the turbines (Hvdt *et al.,* 2006; Hvdt *et al*., 2005). Furthermore, research on species attracted to hard bottom substrates at Horns Rev found that noise and vibration from the turbine generator did not have an impact on the fish communities within the wind farm site (Leonhard *et al*., 2005). Similarly the results of post-construction monitoring fish surveys carried out in the Barrow Offshore Wind Farm and in the North Hoyle Wind Farm did not find significant differences in catch rates during operation in relation to pre-construction catches (BOWind, 2009; RWE npower renewables, 2008), further suggesting that operational noise does not prevent fish from transiting the area of the wind farms.

Walhberg and Westerberg (2005) estimated that Atlantic salmon detect operational turbines at a distance of 0.4 km and 0.5 km at wind speeds of 8 and 13m/s respectively and found that fish are consistently scared away from turbines only at ranges shorter than 4 m, and only at high wind speeds (above 30m/s). The same study concluded that the acoustic impact of wind turbines on fish is restricted to masking communication and orientation signals rather than physiological damage or consistent avoidance reactions.

It should be noted that given the proximity of the proposed EOWDC to major shipping routes into Aberdeen harbour, it is likely that salmon and sea trout transiting the area are habituated to relatively high background noise levels (ANATEC, 2011).

In light of this it is expected that noise generated during operation will not result in a significant impact on the migration of salmon and sea trout juveniles and adult migration neither have an effect on salmon and sea trout feeding and prey availability. The magnitude of the impact and the sensitivity of the receptors are considered to be *LOW*, hence the potential impact of operational noise is considered to be of *NEGLIGIBLE* significance.

Mitigation

None proposed.

Residual Impact

NEGLIGIBLE

Cumulative Impact

None expected.

3.2 Increased Sediment Concentrations

3.2.1 Construction and Decommissioning

Construction activities such as cable laying, piling and rock placement have potential to result in temporary sediment re-suspension increasing turbidity (OSPAR, 2004).

As indicated in the coastal processes section, after installation of the first three turbines, the resulting sediment plume is expected to record a maximum concentration of 35mg/l which extends from Aberdeen harbour to approximately 3 km south of the river Ythan. After installation of 11 foundations, higher concentrations will also remain levelled with Aberdeen Harbour to approximately 3 km of the River Ythan (ABPMER, 2011,). It should be noted that during project specific surveys suspended sediment concentrations found in the area ranged from 0.1 to 43.1 mg/l, with an average value of 20.7 mg/l (ABPMER, 2011a).

Potential Impacts

A wide range of studies have assessed the effect of turbidity levels above natural background on the physiology and behaviour of salmonids. The majority of these are, however, based on freshwater and experimental settings rather than the marine environment. The research indicates that high levels of suspended sediment may be fatal to salmonids while lower levels of suspended sediment and turbidity may cause chronic sub-lethal effects such as loss or reduction of foraging capability, reduced growth, resistance to disease, increased stress and interference with cues necessary for orientation in homing and migration (Bash *et al.,* 2001). Lethal levels of sediment in fish typically range from hundreds to thousands mg/l whilst sub-lethal effects may manifest at significantly lower levels, ranging from tens to hundreds mg/l depending on species specific tolerance (Birtwell, 1999).

A summary of the principal physiological and behavioural effects of turbidity on salmonids is given in Table 3.3.

Table 3.3 Principal Physiological and Behavioural Effect of Turbidity on Salmonids (Bash *et al.,* 2001)

Physiological	Behavioural
Gill trauma	Avoidance
Osmoregulation	Territoriality
Blood Chemistry	Foraging and Predation
Reproduction and Growth	Homing and Migration

Research on the behaviour of juvenile Atlantic salmon has found that initial introduction of sediment (20mg/l) increases foraging activity (Robertson *et al.,* 2007). The same study found a decline in territorial behaviour and avoidance reactions at sediment levels ranging from 60 to 180mg/l. Short term pulses of suspended sediment have also been shown to disrupt feeding behaviour and elicit alarm reactions that may cause fish to relocate downstream to undisturbed areas (Berg and Northcote, 1985)

Whilst physiological and behavioural responses have been observed in a number of studies, salmonids are considered to have the ability to cope with some level of turbidity at certain life stages. Juvenile salmonids are present in turbid estuaries prior migration, as well as in streams with high natural levels of glacial silt, and therefore high turbidity and low visibility (Gregory and Northcote, 1993). In addition salmonids may also encounter naturally turbid conditions during flood events and other natural circumstances (Bash *et al.,* 2001). Measurements undertaken in the River Don (Hillier, 2001), found that concentrations of suspended solids typically ranged from 1 to 10mg/l during base flows, however reached levels up to 150mg/l during high flows.

It should be noted that the potential disturbance through increased sediment concentrations will be short term as once construction works cease, the sediment source for the suspended sediment plume is removed and the tidal regime acts to further reduce the sediment concentrations back to background levels by continual dispersion (ABPMER, 2011).

Based on the relatively short term scale of any potential impact caused by the plume, its relative small spatial extent, and the fact that the expected sediment concentrations within the plume are in line with background levels observed in the area, the magnitude of the impact is considered to be *LOW*. The receptors (adult and juvenile salmon and seat trout), given their tolerance to the expected levels of suspended sediment and their swimming capability, are considered to have a *LOW-MEDIUM* sensitivity in the case of fish originating in the Dee, Don and Ythan, as they are more likely to transit the EOWDC site. The impact of suspended sediments during construction is therefore considered of *NEGLIGIBLE-MINOR* significance.

Mitigation

No mitigation required.

Residual Impact

Same as the potential impact.

Cumulative Impact

In the absence of other offshore activities that could potentially contribute to increased sediment concentrations (e.g. dredging) expected to take place in the vicinity of the proposed EOWDC, no cumulative impacts are expected to take place.

3.3 Electromagnetic Fields (EMFs)

3.3.1 Operation

The magnetic fields anticipated to be produced by the AC cables associated with the proposed EOWDC are small (1.5 µT) in comparison to the Earth's magnetic field (approximately 50 µT). Atlantic salmon are expected to perceive these magnetic fields as new localised additions to the heterogeneous pattern of geomagnetic anomalies already occurring naturally and anthropogenically in the sea (MS, 2011).

Potential Impact

The potential impacts on salmon and sea trout migration derived from the magnetic fields generated by the export and inter array cables could theoretically range from small or large scale disorientation to a barrier to migration.

The Collaborative Offshore Wind Research into the Environment (COWRIE) group has published a number of reviews of current knowledge on the potential impacts of EMFs derived from offshore wind farm developments on electrically and magnetically sensitive species (Gill *et al*., 2009; Gill *et al.,* 2005; CMACS, 2003). The focus of these reports has however been on elasmobranch species, as they are the main group known to be electroreceptive and magnetosensitive (Gill *et al.*, 2009; Gill *et al.*, 2005).

The OSPAR Commission (2008) review of impacts associated with power cables considered that whilst the presence of magnetite in migratory species, including salmonids, suggests that they may use the earth's geomagnetic field for navigation, there is no experimental evidence to determine whether migrating salmon can detect and/or could be affected by anthropogenic magnetic fields of a magnitude comparable to the earth's geomagnetic field. For example, research undertaken on the effect of modified magnetic fields on ocean migration using maturing chum salmon (*Oncorhynchus* *keta*), found no observable effect on the horizontal and vertical movements when the magnetic field was modified (Yano *et al.,* 1997).

In line with the above, Ohman *et al*. (2007) point out that detection of stimuli may not necessarily lead to behavioural responses in fish and that senses that detect magnetic fields are not the only means of spatial orientation, as vision, hearing and olfaction as well as hydrographic and geoelectric information could all be used for spatial orientation. The use of olfaction cues in the final freshwater stage of the homing migration is well documented and it is generally accepted that as salmon approach their natal rivers there is a transition from oceanic orientation mechanisms to mechanisms more appropriate for river migration (Dittman and Quinn, 1996). Ueda *et al.,(*1998) carried out research on the homing mechanisms of sockeye salmon (*Oncorhynchus nerka*) and found that interference of magnetic cues by the attachment of a magnetic ring did not affect the direct return of the fish to the home river and it was concluded that fish returned straight to the vicinity of the natal area using visual cues and finally reach the exact homing point using olfactory cues.

The Environmental report of the Scottish Marine Renewables SEA 2, Environmental Report, 2007 (Section C: Chapter 18- Electromagnetic Fields) states, based on current research and existing cables, that fish species sensitive to magnetic fields such as salmon and eels are not expected to be impacted by the magnetic fields likely to be produced during the operation of device arrays and export cables of tidal and wave energy marine installations proposed in the north coast of Scotland. Similarly, the *Habitats Regulations Appraisal of Draft Plan for Offshore wind Energy in Scottish Territorial Waters: Appropriate Assessment Information Review* (MS, 2011) considers the maximum level of risk in relation to impacts of EMFs on Atlantic salmon to be low.

Gill and Barlett (2010), in a review of the potential impacts of noise and electromagnetic fields from marine renewable installations on salmon, sea trout and European eels, state that there is unclear evidence to assess the overall effect of EMFs from subsea cables on migration and movement behaviour of salmon and sea trout. In addition, it is also stated that whilst physiological responses to EMFs have been demonstrated on laboratory based studies in both salmon and sea trout, there is no evidence on which to determine the effect of a small, local change in magnetic field in the context of their large scale migration or how this may impact their migratory routes.

The magnitude and intensity of the potential movement and behavioural effects on salmonids would be closely linked to the proximity of the fish to the source of the EMF. If there is going to be any effect on their migration, this will be most likely dependent on the depth of water and the proximity of the rivers to the development site (Gill and Barlett, 2010).

The key receptors of potential impacts derived from EMFs would primarily be adult salmon and sea trout returning to the Dee, Don and Ythan, and potentially the Ugie, assuming they transit the site and or the area of the export cable during migration. It should be noted, however, that given the proximity of the EOWDC to the rivers, it is likely that salmon and sea trout may be using olfactory and potentially other types of cues for spatial orientation, in addition to or instead of, magnetic mechanisms, at the time that they will encounter the magnetic fields generated by the EOWDC.

Given the small area of the wind farm and the total cabling involved, a maximum of 13 km for inter array cables and 26 km for the four export cables (1 x 5 km, 1 x 6 km, 1 x 7 km, 1 x 8 km) (further details in Chapter 3, Description of the Proposed Development), the fact that magnetic fields will only be encountered in close proximity to the cables (within tens of metres) and the potential for fish to be using spatial orientation mechanisms other than magnetic navigation, the magnitude of the impact is considered to be *NEGLIGIBLE* to *LOW*. Taking a precautionary approach based on the conservation importance of the species and the lack of definitive evidence in respect of impacts on the migration of salmonids, the receptors, salmon and sea trout originating in rivers within the regional study area, are considered of *HIGH* sensitivity. The impact of EMFs on salmon and sea trout migration is therefore considered to be of *NEGLIGIBLE* to *MINOR* significance.

Mitigation
The cables will be buried. Burial to depth realistically achievable offshore (0.6 m – 3 m) will not make significant difference to the resultant fields or the distance over which they propagate. Cable burial to a depth of at least 1 metre is only likely to provide some mitigation for the possible impacts of the strongest B-fields and induced E-fields that exist within millimetres of the cable (CMACS, 2003).

Residual Impact
Same as the potential impact.

Cumulative Impact
EMF emissions from the proposed offshore wind farm developments in the Firth of Forth and in the Moray Firth could potentially further affect migrating salmon. Assuming the prevalent travelling direction of coastal migration is northerly, there is potential for salmon heading to the rivers in the regional area to be present in the vicinity of the proposed developments in the Firth of Forth at an early stage of their migration. Similarly, there is potential for sea trout to transit both the Moray Firth and the Firth of Forth development areas either during migration or as a result of foraging activity.

Given the relatively small area of the proposed EOWDC and the total cabling used in comparison to the proposed offshore wind developments in the Moray Firth and the Firth of Forth, it is considered that for salmon and sea trout originating in rivers in the regional area the contribution of the EOWDC to any potential cumulative impact would be of *NEGLIGIBLE* significance.

3.4 Physical Presence of the Turbines

3.4.1 Operation

Potential Impact
The physical presence of the turbines could potentially result in disturbance, delays or a barrier to migration. The minimum spacing between turbines assuming installation of 11 turbines would be of 750 m. On the basis of the small total area of the proposed EOWDC, the spacing between turbines, and the ability of salmon and sea trout to overcome obstacles during migration such as dams and other man made obstructions, it is not considered that the physical presence of the turbines will significantly affect salmon and sea trout migration. The impact is considered to be of *LOW* magnitude. The sensitivity of the receptors on the basis of their importance is considered to be *LOW*. The potential impact of the physical presence of the turbine is therefore considered of *NEGLIGIBLE* significance.

Mitigation
None required.

Residual Impact
Same as potential impact.

Cumulative Impact
None expected.

3.5 Impacts on the Salmon and Sea Trout Fisheries

3.5.1 Potential Impacts

The potential impacts that fisheries could theoretically sustain from the EOWDC development are:

- Loss of or restricted access to fishing areas
- Interference to fishing activities
- Loss of or reduction of catch

Loss of or Restricted Access to Fishing Areas

In the case of the local coastal fisheries, given the limited range of netting operations (1300 metres from the shore Low Water), There will be no loss of area or restricted access impacts associated with the construction and operation of the EOWDC and therefore the significance of the impact will be *NEGLIGIBLE.*

Whilst the export cable route has yet to be finalised, taking the worst case scenario that the cable route would pass through a coastal netting station, there could be a small, localised temporary loss of fishing area. As given in the Salmon and Sea Trout Baseline Assessment for the proposed EOWDC, there has been a progressive decline in coastal netting by fixed engines in the local area since 2000 with no reported catches being recorded in the Don District in 2008 and 2009.

Taking the short duration of export cable laying and therefore the short period of exclusion, if the export cable route should pass through a fishing area which was being actively fished, the unmitigated impact is considered to be localised and of *MODERATE* significance.

In the case of rod and line fisheries, due to the distance of both the wind farm site and the export cable route from salmon and sea trout rivers, there will not be any loss of fishing area or restricted access, therefore the impact will be of *NEGLIGIBLE* significance.

Mitigation

Mitigation may well naturally occur whereby the final export cable route will avoid any areas where coastal netting occurs. Similarly, as occurred in 2008 and 2009 in the Don District, fixed engine activity may not occur. The appropriate liaison and consultation will be undertaken with the relevant stakeholders with the objective of minimising potential impacts to *NEGLIGIBLE* significance.

Interference to Fishing Activities

As with loss of, or restricted access to fishing areas, the installation of turbines and intra-field cables will not have any direct impact in terms of interfering with fixed engine, net and coble or rod and line fishing activities. Similarly, apart from a possible temporary loss of access associated with the export cable installation, discussed above, it not expected that any other activity associated with the development will directly affect salmon and sea trout fishing. The impact is therefore predicted to be of *NEGLIGIBLE* significance.

Mitigation

Same as for loss of or restricted access to fishing areas

Loss or Reduction of Catches

The impact of loss or reduction of salmon and sea trout catches, will in effect, be directly related to the effects on the ecology of the two species as assessed above. As given in Table 4.1 below, the significance of the residual impacts is predicted to range from *NEGLIGIBLE* to *MINOR*.

In the case of coastal fisheries, and particularly those which currently appear to not be actively fished, it is expected that the residual impacts will be for the most part *NEGLIGIBLE.* There is however the possibility of *MINOR* impacts, if piling coincides with the migration times of returning adult fish following migration routes along which fishing occurs. An impact would only occur however if construction activities caused the fish to alter their migration routes away from fishing locations as opposed to them only causing a short term delay in migration.

The significance of the impacts on rod and line fisheries, which have a substantially greater overall socio-economic value than the coastal fisheries in the relevant districts, will similarly be dependent upon the short and longer term impacts of the development on salmon and sea trout. As given above, it is considered that the impacts of the construction, operational and decommissioning phases of the EOWDC will range in significance from *NEGLIGIBLE* to *MINOR*. It is however recognised that the scale and magnitude of the potential impacts will vary between districts and will also be related to the relative values of the rod and line fisheries within individual districts and the timing and importance of runs within specific rivers.

With completion of construction activities it is envisaged that the fully operational phase of the development will, with the exception of possible limited EMF related effects, not have any significant effects on salmon and sea trout fisheries. Therefore the potential impacts are, for the most part, considered to be of *NEGLIGIBLE* significance.

3.6 Monitoring

As emphasized above, the assessment of the effects of the construction/decommissioning and operation of EOWDC upon salmonids is constrained by gaps in available baseline information, particularly that describing the behaviour of salmon and sea trout not only in the vicinity of the proposed development but also in the wider marine environment. In addition, there is insufficient direct evidence relating to the potential impacts of offshore wind farms on salmon and sea trout. As a consequence, the precautionary principle has been adopted by taking the 'worst case scenario'.

In practice, however, it is possible that salmon and sea trout may not be adversely affected by the construction and operation of EOWDC, particularly in light of the known obstacles the species overcome during their respective life cycles and the limited number of turbines to be installed. EOWDC will consult with Marine Scotland, Scottish Natural Heritage and the Dee, Don and Ythan Salmon District Fishery Boards in order to identify feasible and relevant monitoring options.

4.0 Summary

The significance level of the impacts derived of the construction, decommissioning and operational phase of the proposed EOWDC, on salmon and sea trout, including cumulative effects, are summarised in Table 4.1 below. A summary of the impacts on salmon and sea trout fisheries is given in Table 4.2.

Table 4.1 Impact Assessment Summary

Salmon and Sea Trout Impact Assessment							
Construction and Decommissioning							
Source of Potential Impact	**Potential Impact**	**Receptor**	**Significance Level**	**Mitigation**	**Residual Significance**	**Cumulative Impact**	**Monitoring**
Noise	Direct Impact	Adult and juvenile salmon and sea trout	Negligible	Soft-start piling	Negligible	None Expected	Appropriate and relevant monitoring will be assessed through discussion with relevant stakeholders and regulators
	Disturbance/ Delay/Barrier to Migration	Salmon and sea trout juveniles	Minor to Moderate	Installation schedule to be discussed with relevant stakeholders and regulators	Negligible to Minor	Negligible	
		Salmon and sea trout adults	Minor	Installation schedule to be discussed with relevant stakeholders and regulators	Negligible to Minor	Negligible	
	Key prey species	Adult sea trout	Negligible	None required	Negligible	None expected	
Increased sediment concentration	Direct effects/ Disturbance/ Delay/Barrier to Migration	Juvenile and adult salmon and sea trout	Negligible to Minor	None required	Negligible to Minor	None expected	None planned
Operational							
Source of Potential Impact	**Potential Impact**	**Receptor**	**Significance Level**	**Mitigation**	**Residual Significance**	**Cumulative Impact**	**Monitoring**
Noise	Disturbance/ Delay/Barrier to Migration	Adult and juvenile salmon and sea trout	Negligible	None required	Negligible	None expected	None planned
	Feeding						
EMFs	Disturbance/Delay/Barrier to Migration	Adult and juvenile salmon and sea trout	Negligible to minor	None other than cable burial	Negligible to minor	Negligible	None planned
Presence of Turbines	Disturbance/ Delay/Barrier to Migration	Adult and juvenile salmon and sea trout	Negligible	None required	Negligible	None expected	None planned

Table 4.2 Salmon and Sea Trout Fishery Impact Assessment

<table>
<tr><th colspan="5">Salmon and Sea Trout Fisheries Impact Assessment</th></tr>
<tr><th colspan="5">Construction and Decommissioning</th></tr>
<tr><th>Potential Impact</th><th>Receptor</th><th>Potential Impact</th><th>Mitigation</th><th>Residual Impact</th></tr>
<tr><td rowspan="3">Loss of or Restricted Access to Fishing Areas</td><td>Coastal netting during cable installation</td><td>Moderate</td><td rowspan="7">Liaison and consultation with relevant stakeholders</td><td rowspan="3">Negligible</td></tr>
<tr><td>Coastal netting during other construction activities</td><td rowspan="2">Negligible</td></tr>
<tr><td>Rod and line fisheries</td></tr>
<tr><td rowspan="3">Interference with fishing activities</td><td>Coastal netting during cable installation</td><td rowspan="3">Negligible</td><td rowspan="3">Negligible</td></tr>
<tr><td>Coastal netting during other construction activities</td></tr>
<tr><td>Rod-and-line fisheries</td></tr>
<tr><td>Loss or reduction of catch</td><td>Netting and rod-and-line fisheries</td><td>Negligible to minor</td><td>Negligible to minor</td></tr>
<tr><th colspan="5">Operation</th></tr>
<tr><th>Potential Impact</th><th>Receptor</th><th>Potential Impact</th><th>Mitigation</th><th>Residual Impact</th></tr>
<tr><td>Loss or reduction of catch</td><td>Netting and rod-and-line fisheries</td><td>Negligible</td><td>Liaison and consultation with relevant stakeholders</td><td>Negligible</td></tr>
</table>

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European Offshore Wind Deployment Centre
Environmental Statement

Appendix 23.1: Socio-economics, Recreation and Tourism Baseline Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

DTZ

Bringing You the Power of One™

Socioeconomic, Recreation and Tourism Assessment of the European Offshore Wind Deployment Centre:

Baseline Report

Aberdeen Offshore Wind Farm Limited

May 2011

Ref: 1112D600

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Contents

1.0 Abbreviations

- ACSEF – Aberdeen City and Shire Economic Future
- AOWFL – Aberdeen Offshore Wind Farm Limited
- EOWDC – European Offshore Wind Deployment Centre
- GVA / Gross Value Added – a measure of the economic value of a job or economic activity
- GW – Gigawatt, a measure of electrical generation capacity, equivalent to 1 billion Watts
- LQ / Location Quotient – a measure of industrial specialisation. Location quotients measure whether a region has a particular specialism in an industry or trade, and are calculated by dividing the proportion of employees in a certain industry in the Inner Study Area by the corresponding proportion of employees in the sector in a benchmark area (e.g. Scotland). A location quotient greater than one, indicates that the Inner Study Area has a specialism within that industry, relative to the benchmark area.
- MW – Megawatt, a measure of electrical generation capacity, equivalent to 1 million Watts
- OWIG – Offshore Wind Industry Group
- SIC – Standard Industrial Classification, a system used by the Office of National Statistics to classify economic activities by industry type
- STW – abbreviation for Scottish Territorial Waters

2.0 Information for the Non-Technical Summary

2.1 Aberdeen Offshore Wind Farm Limited (AOWFL) is proposing to develop an offshore wind farm and deployment centre off the coast of Aberdeen, known as the European Offshore Wind Deployment Centre (EOWDC). DTZ has been commissioned by AOWFL to undertake a socioeconomic, recreation and tourism impact assessment of the proposed EOWDC. The scope of the assessment is the Inner Study Area (Aberdeen and Aberdeenshire), Wider Study Area (Scotland), and the UK.

2.2 There is a significant renewable energy resource in Scotland, coupled with a high level of government commitment to renewable energy generation. The Scottish Government is committed to achieving a headline target of 20% of total Scottish energy use from renewable sources by 2020. Scotland has a quarter of Europe's offshore wind potential. The Crown Estate has granted exclusive development rights for 11 offshore wind zones in Scotland. The project has been successful in gaining EU funding of up to €40m from the European Economic Recovery Plan. This award is in recognition of the project's potential role in supporting development of the European offshore wind industry by proving technologies and techniques.

2.3 At a local level, Aberdeen City and Aberdeenshire recognise the importance of the energy sector to the local economy. The 'Energetica' project has been developed which sets out a vision as to how the Inner Study Area can see energy, tourism, other industries and quality of life factors combine to raise the profile and economic performance of the region.

2.4 The Inner Study Area can be characterised as follows:

- A population of 457,300 people in 2009, which has grown by 4.8% since 2003 (a faster rate than the UK or Scotland)
- High levels of employment in the working age population (79.4% of the working age population are employed, compared to 71.9% in Scotland)
- Low level of unemployment (2.8% in the Inner Study Area compared to 7.1% in Scotland)
- A highly qualified workforce (24% of the workforce is degree qualified, compared to 20.5% in Scotland)
- The Inner Study Area is less dependent on public sector employment than other parts of Scotland. The Inner Study Area has a significant Oil and Gas sector – comprising 25,700 workers, and accounting for over 60% of UK employment in the oil and gas industry. This provides a firm foundation for development of new energy sources such as offshore wind, given the complementarity of skills required.
- The three principle ports within the Inner Study Area are Aberdeen, Peterhead, and Fraserburgh. Aberdeen Port is the major supply base for the North Sea oil industry and employs around 11,000 people; whilst Peterhead landed 149,200 tonnes of fish in 2009 valued at £118 million (27% of the total Scottish market).
- 1.5 million tourist trips were made to Aberdeen and Grampian in 2009, contributing £344 million of expenditure to the local economy. The region attracts a high number of Scottish and UK tourists. A relatively high proportion of tourist trips into the region relate to business tourism – almost three quarters of visitors to Aberdeen City are business-related. The most significant tourism investment in the inner study area is the Trump Corporation's investment at Menie Estate which will increase tourist income in coming years.
- The coastline of the Inner Study Area is used for a variety of recreational activities including sailing (although only to a moderate extent relative to other parts of Scotland), sea angling, surfing, canoeing, kayaking, windsurfing and kite surfing. Fraserburgh is a particularly popular surfing location and regularly holds surf competitions and events such as the UK Surf Tour and Fraserburgh Surf Festival.

2.5 Looking forward, the Inner Study Area is expected to experience a weak recovery from the recession. Forecasts show that the economy is expected to grow by an average of 2.7% per annum in the period 2011-2015 in the Inner Study Area, compared to 2.9% in Scotland, and 3.4% in the UK. Employment in the Inner Study Area is expected to decline by 12,100 jobs from 2008 to 2011; after which it is expected that there will be a gradual recovery, with job numbers increasing by 6,000 in the period 2011 to 2018. Over the period 2008-2018 as a whole, the worst affected industries in terms of job losses are expected to be Manufacturing and Oil and Gas industries.

3.0 Introduction

3.1 Aberdeen Offshore Wind Farm Ltd (AOWFL) is proposing to develop an offshore wind farm and deployment centre off the coast of Aberdeen, known as the European Offshore Wind Deployment Centre (EOWDC).

3.2 The proposed project would combine a small commercially operated wind farm with a test and research centre, allowing manufacturers to test "first of run" wind turbines and innovative foundation solutions along with related operation and maintenance access logistics.

3.3 DTZ has been commissioned by AOWFL to undertake a socioeconomic, recreation and tourism impact assessment of the proposed EOWDC. The structure of the assessment can be summarised as follows:

- **Baseline Technical Report (this document)** – this provides a summary of the policy context with regard to offshore renewables in Scotland; and a baseline of indicators related to socioeconomics, recreation and tourism within Aberdeen City and Aberdeenshire.
- **EIA Technical Report** – an assessment of the impact that the proposed EOWDC will have upon socioeconomics, recreation and tourism in the study areas, as described below.

3.4 The scope of this assessment is to consider the impacts of the development across the following areas:

- **Socioeconomic** – employment and economic impacts associated with the construction, operation and decommissioning of the project, including supply chain and income effects
- **Tourism** – considering the impact on tourism in the local area
- **Recreation** – considering the impact on coastal recreational activities
- **Research and Development** – considering the possible impact of the deployment centre on the UK offshore wind industry as a whole, due to the opportunity for research, development and testing of equipment.

3.5 For the purposes of this assessment, the study area has been defined as follows:

- **Inner study area**: the two local authority areas of Aberdeen City and Aberdeenshire, the development will pose direct impacts to this area
- **Wider study area:** Scotland as a whole
- **UK**: potential national impacts, such as the impact on the offshore wind industry as a whole

Consultation

3.6 DTZ consulted with the following individuals in April 2011 (all by phone) to inform the Baseline Assessment and Impact Assessment:

- Colin Parker, Chief Executive, Aberdeen Harbour

- Matt North, Port Manager for the Port of Dundee, Forth Ports
- Steven Paterson, Chief Financial Officer, Peterhead Port Authority
- Eric May, Marine Renewable Section Leader, Marine Scotland
- Robert Forbes, Aberdeen City Council
- Eric Wells, Aberdeenshire Council
- Roddy Mathieson, Aberdeenshire Council
- Alistair Reid, Aberdeenshire Council
- Paul Reynolds, Offshore Wind Development Manager, RenewableUK
- Sara Budge, Project Director, Energetica
- Dr Graham Russell, RYA Scotland

Key Guidance Documents

3.7 This assessment has been undertaken based on the following guidance on economic assessment:

- HM Treasury (2003) Green Book
- BIS (2010) Impact Assessment Guidance
- English Partnerships (2008) Additionality Guide: Third Edition
- BIS (2009) Guidance for Using Additionality Benchmarks in Appraisal
- Surfers Against Sewage (2009) Guidance on Environmental Impact Assessment of Offshore Renewable Energy Development on Surfing Resources and Recreation

Data Information and Sources

3.8 The following key sources of data have been used to inform the baseline assessment:

- Marine Scotland (2011) Economic Assessment of Short Term Options for Offshore Wind Energy in Scottish Territorial Waters: Costs and Benefits to Other Marine Users and Interests
- Office of National Statistics (2003-2009) Mid Year Population Estimates
- Office of National Statistics (2009) Annual Population Survey
- Office of National Statistics (2009) Claimant Count
- Office of National Statistics (2009) Annual Business Inquiry / Business Register and Employment Survey
- Visit Scotland (2009) Visit Scotland Tourism Statistics
- Scottish Government (2010) Scottish Sea Fisheries Statistics 2009

3.9 A full list of documents referenced in this Baseline Assessment is provided in Section 8 below.

4.0 Policy Context

4.1 The Scottish Government (2009a: 5) is committed to achieving a headline target of 20% of total Scottish energy use from renewable sources by 2020. The European Directive on Renewable Energy (2009) and the Climate Change Act (Scotland) 2009 look to reduce carbon emissions and increase the proportion of energy produced from renewable sources.

4.2 In 2009, the Scottish Government published a Renewables Action Plan, which identifies the collective actions of government and its agencies to meet the renewable energy target. The Renewables Action Plan states that offshore wind development will be the key policy focus in the short to medium term, not only for its generation potential, but also in terms of economic opportunities related to manufacturing and infrastructure.

4.3 The Scottish Government states that Scotland can lead the world in the development of renewable energy technologies. The potential for offshore development in Scotland is large, with an estimated 206 GW of offshore wind, wave and tidal resources in Scottish waters - 39% of the UK total (Offshore Valuation Group, 2010: 31).

4.4 According to Scotland's Offshore Wind Route Map (OWIG, 2010: 5), Scotland has a quarter of Europe's offshore wind potential. Scotland's renewable energy capacity stands at 206 GW, however, Scotland's domestic energy requirement stands at 10.5 GW, therefore there is potential for the country to become a significant net exporter of sustainable energy to the rest of the UK and Europe (Scottish Development International, 2011: 5).

4.5 Scotland is currently a stakeholder in the offshore wind market. It is home to the Beatrice wind demonstrator project in the Moray Firth, the world's first deep water offshore wind turbine deployment, and Robin Rigg, E.ON's fully commissioned 180 MW wind farm in the Solway Firth (OWIG, 2010: 5). In 2009 the Crown Estate issued exclusive rights to nine consortia to develop 6.3 GW of offshore wind power in Scottish Territorial Waters (STW) (or up to 1,300 turbines). With strong wind resources, and experience in offshore activities such as oil and gas, Scotland has a competitive advantage and is well positioned to take a global lead in the offshore wind industry.

4.6 The National Renewables Infrastructure Plan (Scottish Enterprise, 2010a: 3) states that total UK expenditure on offshore wind projects is estimated at £72 billion to £84 billion. In Scottish Territorial Waters alone, capital expenditure on offshore wind projects over the period 2010-2020 has been estimated at £15 - £18 billion.

4.7 In 2010, the Crown Estate announced licenses for nine new offshore wind development zones around the UK (under the 'Round 3' licensing process), which aim to deliver a quarter of the UK's electricity needs by 2020. Delivery of this capacity requires massive investment in onshore and offshore energy infrastructure and supply chains. The two Round 3 projects in Scotland are in the Moray Firth (1.3 GW) and the Firth of Forth (3.5 GW).

4.8 In March 2011 the Scottish Government published 'Blue Seas – Green Energy: A Sectoral Plan for Offshore Wind Energy in Scottish Territorial Waters' (Scottish Government, 2011) which sets out the Scottish Government's plan for offshore wind. Scottish Ministers have decided that six of the nine Scottish sites granted exclusive rights by the Crown Estate should be progressed within the plan. Three of the sites previously granted exclusivity licences by The Crown Estate were omitted from consideration in this document as all three are on the Western coast of Scotland. The plan identifies a further 25 sites that should be considered for development between 2020 and 2030.

4.9 As a result of Crown Estate Round 3, STW leasing rounds, and the UK and Scottish Government Climate Change targets, there is a strong expectation that offshore wind programmes will begin large scale installation by 2014/15.

4.10 According to OWIG (2010: 9), offshore renewables represent the biggest opportunity for sustainable economic growth in Scotland for a generation in terms of manufacturing, supply chain, job creation and training opportunities. If Scotland is successful in developing a strong supply chain in offshore renewables, many of the nation's ports and harbours could be involved in related economic activity

(Scottish Enterprise, 2010a: 3).

4.11 RenewableUK (2010: 7) suggests that skills present in the oil and gas sector in the UK (in particular Scotland) will be crucial for the offshore wind industry and will be highly sought after. The Inner Study Area has a sizeable oil and gas industry and the development of offshore wind will provide further employment opportunities for those within Aberdeen City and Aberdeenshire.

4.12 At a local level, Aberdeen City and Aberdeenshire recognise the importance of the energy sector to the local economy. The Energy Review Report (2009) of the local area estimated that almost 40,000 people are directly employed in Aberdeen City and Aberdeenshire's energy sector, with the majority being residents of the area. In order to further enhance the energy sector in the area, Aberdeen City and Aberdeenshire have developed the 'Energetica' project; this public/private partnership aims to create the world's greatest concentration of energy companies on a 30 mile coastal strip between Peterhead and Aberdeen.

4.13 The project has been successful in gaining EU funding of up to €40m from the European Economic Recovery Plan. This award is in recognition of the project's potential role in supporting development of the European offshore wind industry by proving technologies and techniques.

5.0 Baseline Description

Population

5.1 The population of the Inner Study Area (the two local authority areas of Aberdeen City and Aberdeenshire) stood at 457,300 in 2009. Aberdeenshire is the larger of the two local authorities, accounting for 243,500 persons, with the remaining 213,800 residing in Aberdeen City. The population of Aberdeenshire has grown by 6.5% since 2003 – a faster rate than the UK and Scotland averages or Aberdeen City. Population growth in Aberdeen City has been slower, yet still slightly above the Scottish average as illustrated in Table 4.1 below.

Table 4.1: Population Estimates

Region	2003 Population	2009 Population	Population Growth 2003-2009
Aberdeen City	207,500	213,800	3.0%
Aberdeenshire	228,800	243,500	6.5%
Inner Study Area	436,300	457,300	4.8%
Wider Study Area	5,057,400	5,194,000	2.7%
United Kingdom	59,552,200	61,792,000	3.8%

Source: Mid-Year Population Estimates, Office of National Statistics, Downloaded from www.nomisweb.co.uk on 22nd March 2011

5.2 Population projections (General Register Office for Scotland, 2011) state that the population growth rate in Aberdeenshire will continue to be well above the Scottish average; whilst the population of Aberdeen City will continue to grow but at a slower rate. The population of Aberdeenshire is forecast to be 289,900 by 2030; an increase of 19.0% between 2009 and 2030. The population of Aberdeen City is forecast to be 219,800 in 2030; an increase of 4.0% (below the Scottish average of 6.5% for the same period).

5.3 The higher population growth rate projected for Aberdeenshire is expected to be generated from continued outward migration from Aberdeen City, possibly reflecting quality of life factors and better transport links. A potential lack of housing within Aberdeen City (especially family housing) may be another driver in Aberdeenshire's higher projected population growth.

5.4 A relatively high proportion (69.3%) of Aberdeen City's population is of working age (16 to 64 years of age), higher than the corresponding figures of 64.8% for Aberdeenshire, 65.7% across Scotland, and 65.0% across the UK as a whole.

Employment and Economic Activity

5.5 The Inner Study Area has a higher resident employment rate amongst the resident working age population than the Scottish and UK average. Just under 80% of the working age population is in employment, well above the UK average which is closer to 71% as illustrated in Table 4.2 below.

Table 4.2: Resident Employment by Region 2009

Region	Resident Employment Rate	Working Age Population	Employment
Aberdeen City	78.5%	148,100	116,300
Aberdeenshire	80.3%	157,800	126,700
Inner Study Area	79.4%	305,900	242,900
Wider Study Area	71.9%	3,413,100	2,454,000
United Kingdom	70.6%	40,137,100	28,336,800

Source: Annual Population Survey, Office of National Statistics, Downloaded from www.nomisweb.co.uk on 22nd March 2011

5.6 Resident unemployment and claimant count rates (those claiming unemployment benefits) are lower within the Inner Study Area than national average. In 2009 the resident unemployment rate within the Inner Study Area stood at 2.8% of the working age population, much lower than the Scottish average (7.1%).

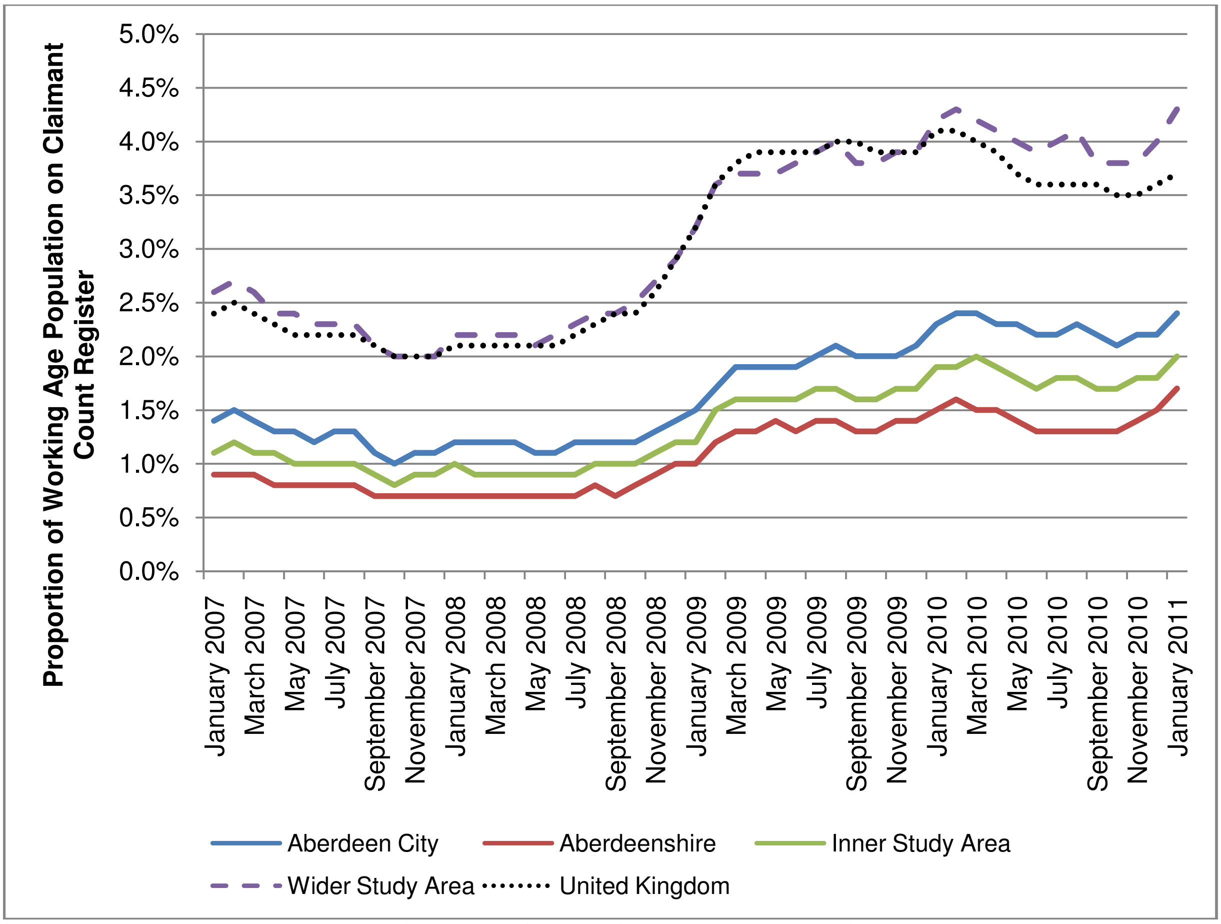
Table 4.3: Resident Unemployment by Region 2009

Region	Resident Unemployment Rate	Working Age Population	Unemployment
Aberdeen City	2.8%	148,100	4,100
Aberdeenshire	2.8%	157,800	4,400
Inner Study Area	2.8%	305,900	8,500
Wider Study Area	7.1%	3,413,100	242,300
United Kingdom	7.8%	40,137,100	3,130,700

Source: Annual Population Survey, Office of National Statistics, Downloaded from www.nomisweb.co.uk on 22nd March 2011

5.7 The claimant count provides much more up to date figures than the unemployment data presented above, and can therefore be used as a proxy for unemployment. As Figure 4.1 illustrates, the claimant count for the Inner Study Area has risen during the recession but remains significantly below the national average. The claimant count in Aberdeen City has been consistently above the Aberdeenshire rate.

Figure 4.1: Claimant Count by Region 2007 to 2011



Source: Jobseeker's Allowance Claimant Count, Office of National Statistics, Downloaded from www.nomisweb.co.uk on 22nd March 2011

5.8 Table 4.4 shows that the economic activity rate in the working age population is higher in the Inner Study Area (81.7%) than Scotland (77.4%) and the United Kingdom (76.5%). A slightly higher proportion of those who are currently economically inactive within the Inner Study Area want a job compared to the national benchmarks.

Table 4.4: Economic Activity by Region 2009

Economic Activity	Aberdeen City	Aberdeenshire	Inner Study Area	Wider Study Area	United Knigdom
Economic Activity	80.8%	82.6%	81.7%	77.4%	76.5%
Economic Inactivity	19.2%	17.4%	18.3%	22.6%	23.5%
Want a job	6.8%	5.5%	6.1%	5.8%	5.5%
Not looking for a job	12.4%	11.9%	12.1%	16.8%	18.0%

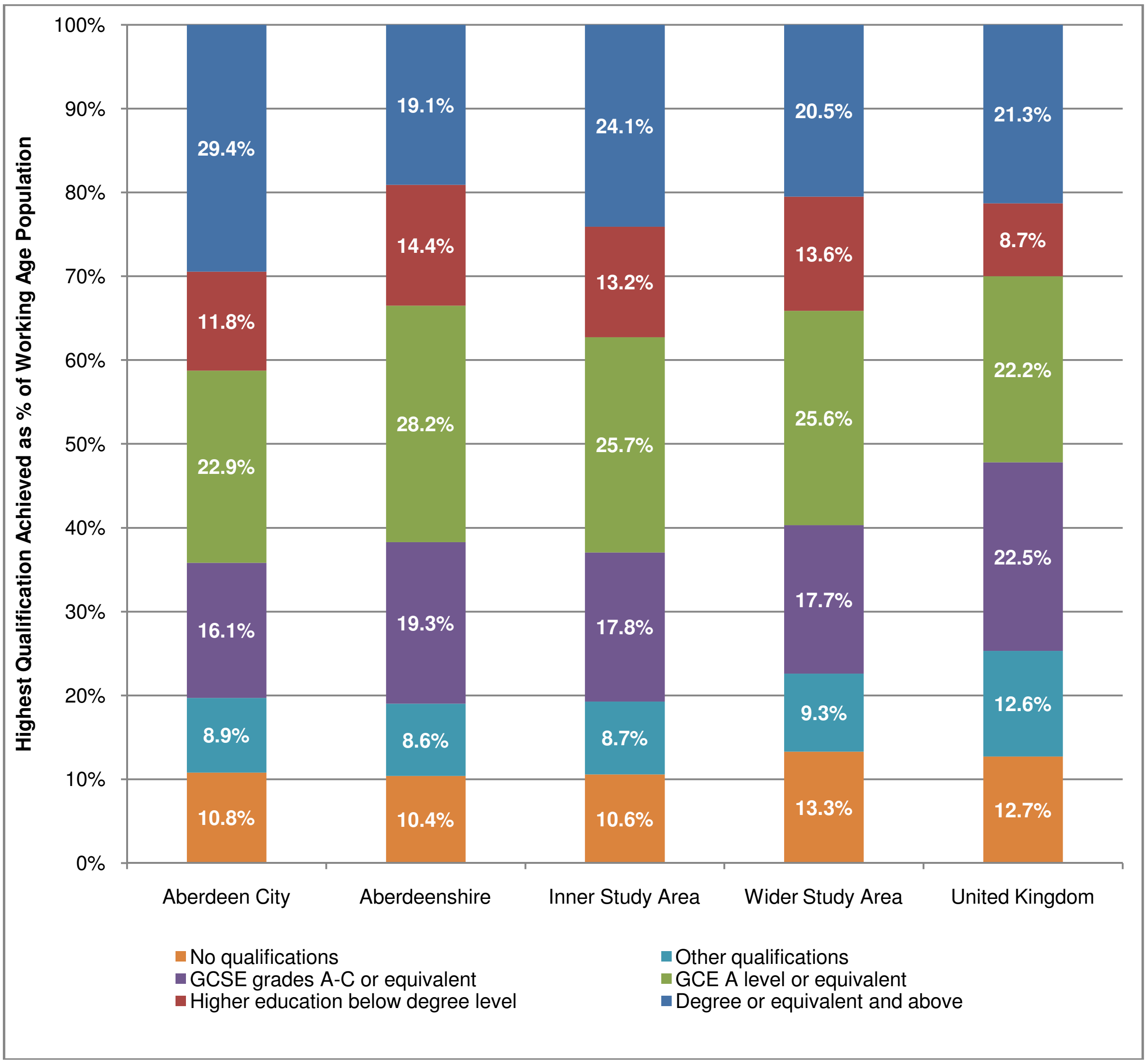
Source: Annual Population Survey, Office of National Statistics, Downloaded from www.nomisweb.co.uk on 22nd March 2011

5.9 Overall, these data show that the Inner Study Area has a relatively tight labour market, with high levels of economic activity and low levels of unemployment.

Qualifications

5.10 The Inner Study Area has a highly skilled working age population: 24.1% of the working age population are educated to degree level or higher, compared to 20.5% in Scotland as a whole. The levels of qualification are particularly high in Aberdeen City, where 29.4% are qualified to degree level, and only 10.8% of people have no qualifications. Aberdeenshire has a qualification profile more like the Scottish average with 19.1% educated to degree level and higher proportions of the working age population holding higher education (but not degree level) and A-Level qualifications than Aberdeen City.

Figure 4.2: Highest Qualification Achieved Profile by Region 2009



Source: Annual Population Survey, Office of National Statistics, Downloaded from www.nomisweb.co.uk on 22nd March 2011

Industrial Structure

5.11 Table 4.5a and Table 4.5b provide employment data from the Annual Business Inquiry/Business Register and Employment Survey, Office of National Statistics. Total employment may be higher than resident employment figures, as the region may support employment for those that live outside of the stated region.

5.12 The Inner Study Area has a higher number of jobs located within the region than the number of residents with jobs; suggesting that the region also provides employment to those commuting in from outside the area. In 2009, there were 263,000 jobs in the Inner Study Area, of which 175,960 were in

Aberdeen City, and 87,080 in Aberdeenshire. Aberdeen City appears to provide employment to many people in Aberdeenshire as well as some outside the region.

5.13 The employment profile of the Inner Study Area is somewhat different to national benchmarks as illustrated in Table 4.5a, as measured by Standard Industrial Classification (SIC). In particular the proportion of those working within Extractive Industries (which includes the oil and gas sector, at 9.8% of total employment, or 25,700 persons) is much higher than the Scottish and Great British average (Annual Business Inquiry/Business Register and Employment Survey does not report UK data, only up to Great Britain level). The vast majority of this employment is related to the extraction of crude petroleum and support activities to the industry. The Energy Review 2009 (ACSEF, 2009: 5) suggests a higher figure of almost 40,000 employees directly related to the energy sector.

5.14 The largest industry within Aberdeen City is human health and social work activities, representing 15.2% of employment in 2009 (26,680 persons), followed by mining and quarrying (21,890 persons; 12.4%, including oil and gas) and professional, scientific and technical activities (23,570 persons; 13.4%), in particular engineering activities and related technical consultancy (15,240 persons).

5.15 The Aberdeenshire employment profile is different to that of Aberdeen City. The oil and gas industry, although proportionally larger than the Scottish and GB average, is smaller than in Aberdeen City. The largest industrial sector within Aberdeenshire is wholesale and retail trade employing 14,420 persons (16.6% of total employment), followed by Manufacturing (10,930 persons; 12.6%) and human health and social work activities (9,860 persons; 11.3%). According to Annual Business Inquiry/Business Register and Employment Survey data at the four digit SIC code level, the largest manufacturing industry in Aberdeenshire is fish processing, employing 1,860 persons.

5.16 Neither Aberdeen City nor Aberdeenshire are overly dependent on the public sector. Although public sector employment (sum of public administration and defence, education and human health and social work activities from Table 4.5a) represents in the region of 25% of employment within the region, this is proportionally lower than the Scottish (31%) and Great British (GB) (28%) averages.

Table 4.5a: Employment Profile by Standard Industrial Classification Section 2009

SIC Sections	Aberdeen City	Aberdeenshire	Inner Study Area	Wider Study Area	Great Britain
Agriculture, forestry and fishing	0.0%	1.2%	0.4%	1.4%	0.8%
Mining and quarrying	12.4%	4.4%	9.8%	1.2%	0.2%
Manufacturing	6.8%	12.6%	8.7%	7.9%	9.0%
Electricity, gas, steam and air conditioning supply	0.1%	0.3%	0.2%	0.7%	0.4%
Water supply; sewerage, waste management	0.2%	0.4%	0.2%	0.7%	0.6%
Construction	3.8%	8.1%	5.2%	5.5%	4.8%
Wholesale and retail trade	11.5%	16.6%	13.2%	14.8%	16.2%
Transportation and storage	4.4%	4.5%	4.4%	4.3%	4.6%
Accommodation and food service activities	6.9%	6.7%	6.8%	7.3%	6.7%
Information and communication	2.0%	1.2%	1.8%	2.4%	3.7%
Financial and insurance activities	1.2%	1.0%	1.2%	3.9%	3.9%
Real estate activities	1.0%	0.7%	0.9%	1.1%	1.5%
Professional, scientific and technical activities	13.4%	9.1%	12.0%	6.3%	7.0%
Administrative and support service activities	7.5%	4.1%	6.4%	7.5%	7.7%
Public administration and defence	4.5%	4.8%	4.6%	6.4%	5.7%
Education	5.8%	8.6%	6.7%	8.2%	9.5%
Human health and social work activities	15.2%	11.3%	13.9%	16.1%	13.1%
Arts, entertainment and recreation	1.8%	2.1%	1.9%	2.6%	2.4%
Other service activities	1.4%	2.3%	1.7%	1.7%	2.1%
Total Employment	**175,960**	**87,080**	**263,000**	**2,382,500**	**26,206,120**

Source: Annual Business Inquiry/Business Register and Employment Survey, Office of National Statistics, Downloaded from www.nomisweb.co.uk on 22nd March 2011

Table 4.5b: Employment Profile by Standard Industrial Classification Section 2009

SIC Sections	Aberdeen City	Aberdeenshire	Inner Study Area	Wider Study Area	Great Britain
Agriculture, forestry and fishing	60	1,070	1,130	33,760	204,020
Mining and quarrying	21,890	3,810	25,700	29,190	55,280
Manufacturing	11,990	10,930	22,920	187,750	2,358,390
Electricity, gas, steam and air conditioning supply	210	290	500	16,470	115,540
Water supply; sewerage, waste management	280	340	610	16,000	150,640
Construction	6,710	7,060	13,770	132,230	1,261,390
Wholesale and retail trade	20,280	14,420	34,700	351,440	4,247,900
Transportation and storage	7,720	3,950	11,660	102,510	1,212,070
Accommodation and food service activities	12,190	5,820	18,010	173,380	1,763,770
Information and communication	3,560	1,050	4,610	57,040	972,510
Financial and insurance activities	2,190	850	3,040	93,540	1,034,570
Real estate activities	1,750	590	2,330	27,290	398,120
Professional, scientific and technical activities	23,570	7,930	31,500	149,010	1,824,610
Administrative and support service activities	13,150	3,580	16,740	177,760	2,021,020
Public administration and defence	7,930	4,170	12,100	153,000	1,484,610
Education	10,250	7,500	17,750	195,900	2,490,790
Human health and social work activities	26,680	9,860	36,530	383,380	3,425,320
Arts, entertainment and recreation	3,150	1,860	5,000	61,700	638,970
Other service activities	2,400	2,000	4,400	41,150	546,600
Total Employment	**175,960**	**87,080**	**263,000**	**2,382,500**	**26,206,120**

Source: Annual Business Inquiry/Business Register and Employment Survey, Office of National Statistics, Downloaded from www.nomisweb.co.uk on 22nd March 2011

5.17 Tables 4.6 and 4.7 identify the location quotient of employment in a number of industrial sectors. Location quotients measure whether a region has a particular specialism in an industry or trade, and are calculated by dividing the proportion of employees in a certain industry in the Inner Study Area by the corresponding proportion of employees in the sector in a benchmark area (e.g. Scotland). A location quotient greater than one, indicates that the Inner Study Area has a specialism within that industry, relative to the benchmark area.

5.18 Oil and Gas support services is a significant specialism within the economy of the Inner Study Area relative to the Scottish and GB benchmarks.

5.19 Annual Business Inquiry/Business Register and Employment Survey data states that employment within the 'Extraction of crude petroleum and natural gas' sector in the Inner Study Area represents 98% of total employment within the industry in Scotland, and 62% of the industry in GB. Similarly, 99% of Scottish and 89% of GB employment in Extractive Industry supporting services is found within the Inner Study Area. Other strong specialisms in the Inner Study Area include: architectural and engineering activities, repair and installation of machinery and equipment, and fishing and aquaculture.

Table 4.6: Location Quotient (LQ), Inner Study Area against Scotland Benchmark 2009

Two-Digit SIC Code	2009 Employment	LQ (Scotland Benchmark)
06 : Extraction of crude petroleum and natural gas	7,020	8.97
09 : Extractive Industry service activities	15,580	8.96
19 : Manufacture of coke and refined petroleum products	N/A	4.69
71 : Architectural and engineering activities	23,320	4.08
33 : Repair and installation of machinery and equipment	2,610	2.45

Source: Annual Business Inquiry/Business Register and Employment Survey, Office of National Statistics, Downloaded from www.nomisweb.co.uk on 22nd March 2011

Table 4.7: Location Quotient, Inner Study Area against Great Britain Benchmark 2009

Two-Digit SIC Code	2009 Employment	LQ (GB Benchmark)
09 : Extractive Industry service activities	15,580	88.4
06 : Extraction of crude petroleum and natural gas	7,020	55.1
03 : Fishing and aquaculture	1,170	17.9
71 : Architectural and engineering activities	23,320	5.6
02 : Forestry and logging	260	2.8

Source: Annual Business Inquiry/Business Register and Employment Survey, Office of National Statistics, Downloaded from www.nomisweb.co.uk on 22nd March 2011

5.20 In 2009, according to Annual Business Inquiry/Business Register and Employment Survey data 1,170 persons were employed within the two digit SIC code '03 : Fishing and aquaculture', representing 27.9% and 18.0% of the Scottish and Great British fishing industry respectively.

5.21 There are three principal ports within the Inner Study Area (Aberdeen, Peterhead, and Fraserburgh), plus a number of smaller ports and harbours used for commercial and fishing activities such as Banff, Buckie, Gourdon, Johnshaven, Macduff, Portsoy, and Stonehaven. Aberdeen is the major supply base for the North Sea oil industry and employs around 11,000 people, a large number of which are oil related (Marine Scotland, 2011: 27). Peterhead is the UK's largest fishing port and is also a major oil industry support base. 140,000 passengers a year travel on Northlink ferries from Aberdeen and Lerwick and Kirkwall, which gives considerable economic and social benefits to both port and harbour operators as well as the surrounding areas (Marine Scotland, 2011: 27).

5.22 Marine Scotland (2011: 10) states that: "Scotland is one of the largest fishing nations in Europe and the Scottish fleet is responsible for landing 66% of the total UK volume of fish. The fishing sector contributed around £144 million gross value added (GVA) to the Scottish economy in 2009, and total of £443 million of fish was landed in Scotland".

5.23 The Inner Study Area is home to the most valuable district in terms of the value of fish landed in Scotland: Peterhead landed 149,200 tonnes of fish in 2009 valued at £118 million (27% of the total Scottish market). Other important ports in the study area for landing fish are Fraserburgh (37,500 tonnes), Aberdeen (3,500 tonnes) and Buckie (1,900 tonnes) (Marine Scotland, 2011: 12-13).

Renewable Energy Sector

5.24 Innovas (2010: 43) valued the UK renewable energy sector at £31.3 billion in 2007/08, of which Scotland accounted for £2.6 billion (8.3%). Scotland's renewable energy sector was the fifth largest in the UK, behind English regions such as London, South East, North West and the West Midlands. UK employment within the sector stood at 265,700 in 2007/08, of which Scottish employment stood at 22,200 (8.4%).

5.25 As of February 2011, Scottish Renewables stated that renewable energy generation capacity in Scotland stood at 4,405 MW, of which wind was the largest contributor with 2,562 MW, followed by hydro (1,395 MW) and biomass heat (225 MW). Offshore wind is relatively new to Scotland as the majority of offshore wind development has so far taken place off English and Welsh coasts. Scotland currently has two operational offshore wind sites, the Beatrice wind demonstrator project with two 5 MW turbines and Robin Rigg with a total capacity of 180 MW. However, Scottish Renewables (2011: 1) estimate that the proposed offshore wind developments in Scotland may create around 28,000 direct jobs by 2020.

5.26 Aberdeen Renewable Energy Group (AREG) was set up by Aberdeen City Council to help develop the region as a centre of excellence in renewable technologies. AREG are developing the Energy Futures Centre in Aberdeen, which aims to lead the way nationally and globally in R&D of renewable technology, bringing together the key players from across the energy sector. Other projects include a new Renewables Research Centre in partnership with the two universities based in the city (University of Aberdeen and Robert Gordon University).

5.27 A number of onshore wind farms are located within the Inner Study Area including Glens of Foundland Wind Farm (26 MW), Dummuies Wind Farm (10MW) and Boyndie Wind Farm Cooperative (14 MW). There are also a number of smaller developments within the Inner Study Area such as three turbines generating 2.5MW of electricity at Mackie's ice cream factory near Inverurie and in 2007 Cults Primary School became the first school in Scotland to use wind generated power (ACSEF, 2009: 20-21). The Inner Study Area is also home to a number of biomass projects including Aboyne Academy, one of the first schools in Scotland to have installed a biomass heating system.

Business Base

5.28 Table 4.8 provides an overview of the size of businesses by employment number bands. Nearly 83% of businesses in the Inner Study Area employ 10 or fewer people. Aberdeenshire has a larger proportion of small businesses, those employing ten or less employees, than Aberdeen City. Aberdeen City has a higher number of larger employers, perhaps reflecting the industrial structure of employment, and the Oil and Gas sector.

Table 4.8: Business by Employment Band 2009

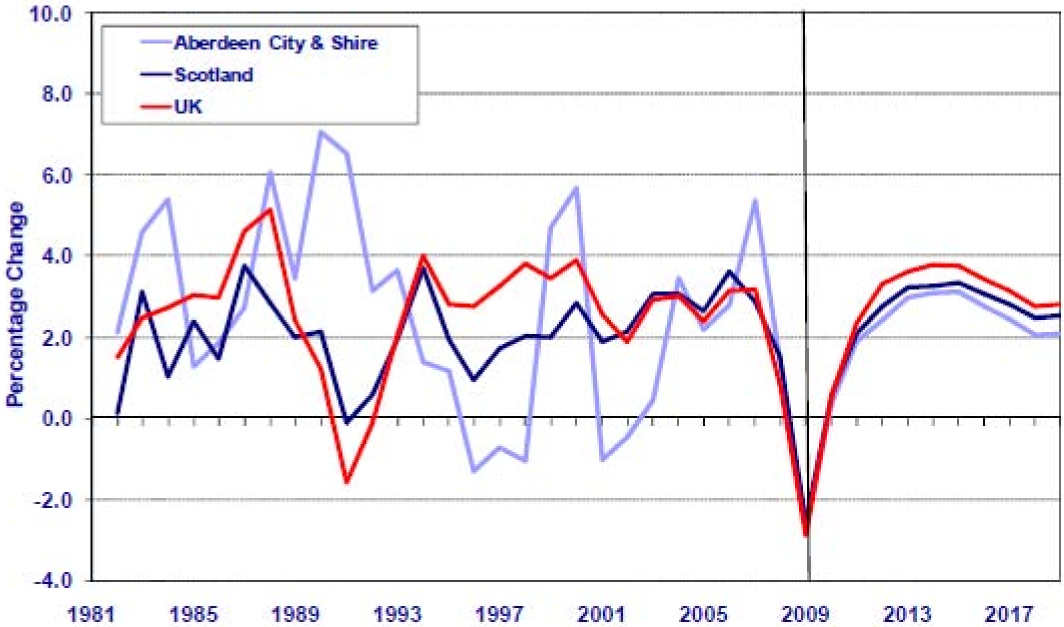
Region	Businesses	1 to 10	11 to 49	50 to 199	200 Plus
Aberdeen City	9,680	77.8%	16.1%	5.0%	1.2%
Aberdeenshire	11,280	87.4%	10.3%	2.0%	0.4%
Inner Study Area	20,960	82.9%	12.9%	3.4%	0.7%
Scotland	181,470	81.4%	14.4%	3.4%	0.8%
Great Britain	2,446,020	85.0%	11.5%	2.8%	0.7%

Source: Annual Business Inquiry/Business Register and Employment Survey, Workplace Analysis, Office of National Statistics, Downloaded from www.nomisweb.co.uk on 22nd March 2011

Future Performance

5.29 Scottish Enterprise (2009) provides an overview of the structure of the region's economy and forecasts for the future direction of the economy. The review suggests that the recovery from the current downturn is likely to be largely service sector led. The Inner Study Area will experience a weaker upturn than most other regions in Scotland and the UK. Average annual gross value added (GVA) growth between 2011 and 2015 is expected to be 2.7% in the Inner Study Area, compared with 2.9% in Scotland and 3.4% in the UK (Scottish Enterprise, 2009: 73).

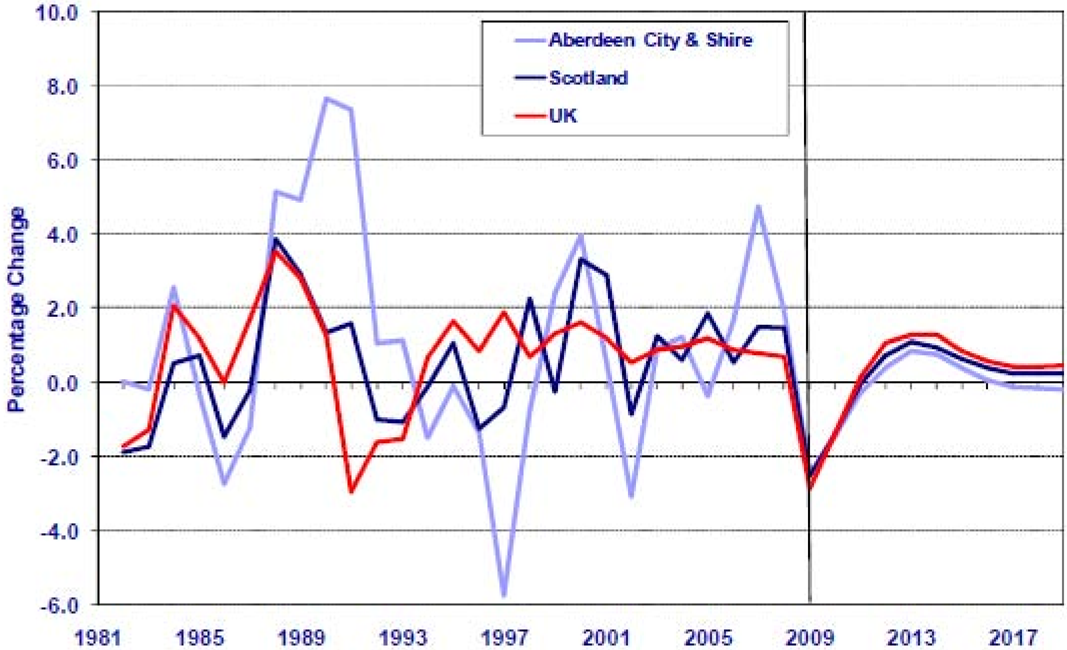
Figure 4.3: GVA Growth 1981 to 2019



Source: Scottish Enterprise Aberdeen City & Shire Economic Review 2009, Oxford Economics

5.30 Scottish Enterprise (2009) suggests that overall employment in the Inner Study Area will contract over the period 2008 to 2018, with a loss of around 6,000 jobs (Scottish Enterprise, 2009: 73). An estimated 12,100 jobs will be lost between 2008 and 2011, with a recovery between 2012 and 2018 creating 6,000 jobs (Scottish Enterprise, 2009:73). It is estimated that 2008 employment levels will not be regained until beyond 2018 as highlighted in Figure 4.4.

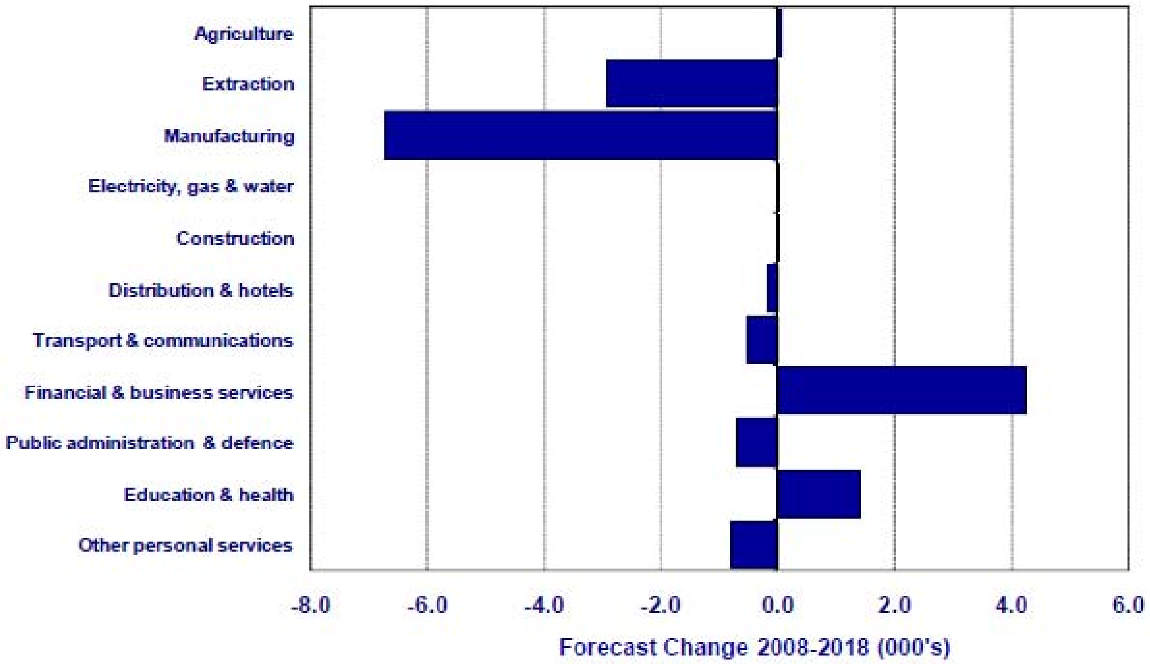
Figure 4.4: Employment Growth Forecast



Source: Scottish Enterprise Aberdeen City & Shire Economic Review 2009, Oxford Economics

5.31 The worst affected sectors will be Manufacturing and Extractive Industries (such as Oil and Gas), with estimated losses of 6,700 and 2,900 jobs by 2018 respectively. The only sectors that are expected to grow between 2008 and 2018 are Education and Health, and Financial Services, as illustrated in Figure 4.5.

Figure 4.5: Employment Change by Sector, 2008 to 2018



Source: Scottish Enterprise Aberdeen City & Shire Economic Review 2009, Oxford Economics

Tourism

5.32 In 2009, around 15 million overnight tourism trips were taken in Scotland, for which expenditure totalled over £4 billion (Visit Scotland, 2010a: 3).

5.33 It is estimated that in 2009, tourists made around 1.5 million trips to Aberdeen & Grampian, staying for 6.1 million nights and spending a total of £344 million as illustrated in Table 4.9 (Visit Scotland, 2010b: 3). On the basis of tourist numbers, therefore, the Aberdeen and Grampian area accounts for around 10% of the total tourism sector in Scotland. Aberdeenshire's tourist industry is growing in importance, with its major natural assets the Cairngorms and coast, supplemented by visitor attractions based on Aberdeenshire's heritage.

Table 4.9: Visit Scotland Tourism Statistics 2009

Tourist Metric	Aberdeen & Grampian		Scotland	
	UK visitors	Overseas Visitors	UK visitors	Overseas Visitors
Trips[a]	1.25 million	0.24 million	12.5 million	2.6 million
Nights[b]	4.38 million	1.67 million	46.1 million	21.9 million
Spend[c]	£246 million	£98 million	£1,249 million	£1,259 million

Source: Visit Scotland, Scotland – The Key Facts on Tourism in 2009; Visit Scotland, Tourism in Northern Scotland 2009

a: Stay of one or more nights away from home for holidays, visits to friends, business and conference or any other purpose other than boarding education of semi-permanent employment.

b: Nights spent away from home using any type of accommodation or in transit on a tourist trip.

c: Spending incurred while away from home on a tourist trip and advance payments for such items as fares and accommodation. For overseas visitor statistics, the cost of travel to the destination is excluded.

5.34 Of the 1.5 million trips made by tourists to Aberdeen and Grampian, 50% were made by Scottish visitors - much higher than the Scottish average of 39%. Overseas visitors represented 240,000 trips to the region in 2009, staying for 1.67 million nights and spending around £98 million. Germany and the USA were the largest markets for the region, making up a quarter of all international visits and spend between them (Visit Scotland, 2010b: 3).

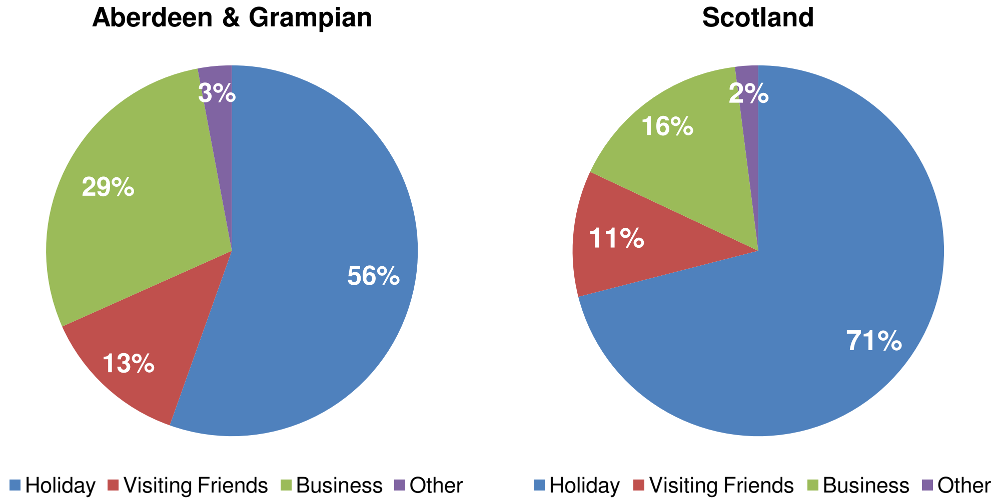
Table 4.10: Tourist Numbers by Country of Residence 2009

Toursit Residence	Aberdeen & Grampian		Scotland	
England	450,000	30.2%	5,980,800	39.9%
Scotland	750,000	50.3%	5,856,200	39.0%
Northern Ireland	25,000	1.7%	373,800	2.5%
Wales	25,000	1.7%	249,200	1.7%
Outside UK	240,000	16.1%	2,540,000	16.9%

Source: Visit Scotland, Scotland – The Key Facts on Tourism in 2009; Visit Scotland, Tourism in Northern Scotland 2009

5.35 Figure 4.3 provides an overview of UK visitor type to both the Aberdeen & Grampian region and Scotland. The Inner Study Area is more reliant upon business tourism than the Scottish average (29% of tourist trips versus the Scottish average of 16%), whilst tourist trips are of relative less importance in Aberdeen and Grampian (56%) than Scotland as a whole (70%). The proportion of business tourism in Aberdeen is close to that of Glasgow (27%) (Visit Scotland, 2010c: 1), but above that of Edinburgh (22%) (Visit Scotland, 2010d: 1).

Figure 4.3: Tourist Trip by UK Visitor Type 2009



Source: Visit Scotland, Scotland – The Key Facts on Tourism in 2009; Visit Scotland, Tourism in Northern Scotland 2009

5.36 Aberdeen City and Shire is recognised as an area of outstanding natural beauty and unique attractiveness. Scottish Enterprise (2010b: 4) states that the region is an attractive region for hotel operators and developers. The report identifies two concerns, especially for those targeting the business tourism market which is important to the Inner Study Area: current demand from the business market is not always met by the current stock especially if there is need for larger capacity bookings; the leisure tourist offering requires to be developed further in order to more strongly position the Inner Study Area as a competent visitor destination (Scottish Enterprise, 2010b: 6).

5.37 Scottish Enterprise (2010b: 12) estimate that business tourism accounts for a higher proportion of visitor trips and spend than the Visit Scotland figures (Visit Scotland, 2010b: 3). Scottish Enterprise estimates that over half of visitors to Aberdeenshire, and almost three quarters of visitors to Aberdeen City were business related. Business tourism is estimated to be worth £137 million per year to the local economy (Scottish Enterprise, 2010b: 12).

5.38 Scottish Enterprise (2010b) identified a number of key tourism developments within the Inner Study Area which are described in Table 4.11. In addition, the Menie Estate development by the Trump organisation is the most significant tourism investment ever to take place in Aberdeenshire and will see several hundred million pounds of investment into the local economy.

Table 4.11: Key Developments in Tourism and Infrastructure- Aberdeen City & Shire

Attraction	Development
Royal Deeside & Cairngorms	SE's Destination Plan estimated to increase tourism income by £30 million. Identifying sites for resort and accommodation development.
Banffshire Coast	A number of initiatives underway to boost tourist income by £5 million a year, mainly through art and boat festivals.
Golf Tourism	The Inner Study Area is one of the main beneficiaries from £177 million Scottish golf market. A number of championship links golf courses are in the pipeline which will significantly impact the local economy.
Food Tourism	Current key attraction such as Deans of Huntly Visitor Centre and distillery projects will continue to grow. A number of events showcasing local produce will also attract tourists in the future.
Business Tourism	Despite the economic downturn, business tourism will continue to be of importance to the region. Major industry conferences such as Society of Petroleum Engineers (SPE) Offshore Europe Oil & Gas Conference & Exhibition are significant to the local economy.
City Centre Retail	The £275 million Union Square retail and leisure development opened in October 2009. The 700,000 sq ft centre includes a cinema, shops and restaurants and is integrated with the city's bus and rail stations.

Source: Scottish Enterprise, Aberdeen City & Shire Hotel Accommodation Report Feb 2010

5.39 Table 4.12 lists the top five visitor attractions in Aberdeen & Grampian. None of the Aberdeen-based visitor attractions feature in the Scottish top ten list, with David Welch Winter Gardens (313,217 visitors) below the tenth placed Scottish visitor attraction: National War Museum, Edinburgh (494,213). The top ten list is dominated by attractions in Glasgow and Edinburgh.

Table 4.12: Top Visitor Attractions, 2009

Aberdeen & Grampian			Scotland		
Rank	Visitor Attraction	Visitor Numbers	Rank	Visitor Attraction	Visitor Numbers
1	David Welch Winter Gardens (Aberdeen)	313,217	1	Kelvingrove Art Gallery & Museum, Glasgow	1,368,096
2	Johnston's Cashmere Visitor Centre (Elgin)	202,200	2	Edinburgh Castle	1,196,481
3	Aberdeen Art Gallery	178,344	3	The National Gallery Complex, Edinburgh	890,361
4	Aberdeen Maritime Museum	76,558	4	World Famous Old Blacksmiths Shop, Gretna Green	706,663
5	Provost Skene's House (Aberdeen)	61,071	5	St Giles Cathedral, Edinburgh	653,864
			6	Edinburgh Zoo	636,867
			7	National Museum of Scotland, Edinburgh	589,621
			8	Gallery of Modern Art, Glasgow	536,916
			9	Edinburgh Bus Tours	531,352
			10	National War Museum, Edinburgh	494,213

Source: Visit Scotland, Scotland – The Key Facts on Tourism in 2009; Visit Scotland, Tourism in Northern Scotland 2009

Recreation

5.40 The Scottish coast, in particular the West coast, is identified as one of the World's best destinations for sailing. According to the Royal Yachting Association (RYA), recreational boating and sailing tourism contributes about £300 million to the Scottish economy (Marine Scotland, 2011: 38). Sailing off the east coast of Scotland is concentrated in the Firth of Tay and Firth of Forth and further south. Recreational use is moderate along the coastline of the Inner Study Area. The inner Moray Firth is an important area for recreational sailing. The value of sailing area from Helmsdale to Peterhead stood at £10.1 million in 2010, and the corresponding figure for the coastline of Peterhead to Berwick is £7.9 million (Marine Scotland, 2011: 40).

5.41 Sea angling takes place along most of the Scottish Coast. The Scottish Government estimates that 125,200 adults and 23,450 children went sea angling in Scotland in 2008, with a total expenditure of £141 million (Marine Scotland, 2011: 42). Sea angling supported 3,148 FTE Scottish jobs in 2008 (Scottish Government, 2009b: 8).

5.42 There are a number of other widespread water-borne recreational activities of importance. British Marine Federation (BMF, 2009: 31) estimates that across Scotland, 52,869 adults participate in surfing, 23,952 in windsurfing and 37,416 in canoeing. Fraserburgh, located within the Inner Study Area, is a particularly popular surfing location and regularly holds surf competitions and events such as the UK Surf Tour and Fraserburgh Surf Festival. There are a number of popular surfing and windsurfing sites along the coast of the Inner Study Area including: Lossiemouth, Spey Bay, Sandend Bay, Cullen, Banff, Pennan, Aberdeen Beach, Aberdeen Harbour, Stonehaven and St Combs.

6.0 Summary

6.1 AOWFL is proposing to develop an offshore wind farm and deployment centre off the coast of Aberdeen, known as the European Offshore Wind Deployment Centre (EOWDC). DTZ has been commissioned by AOWFL to undertake a socioeconomic, recreation and tourism impact assessment of the proposed EOWDC.

6.2 There is a significant renewable energy resource in Scotland, coupled with a high level of government commitment to renewable energy generation. The Scottish Government is committed to achieving a headline target of 20% of total Scottish energy use from renewable sources by 2020. Scotland has a quarter of Europe's offshore wind potential. The Crown Estate has granted exclusive development rights for 11 offshore wind zones in Scotland.

6.3 At a local level, Aberdeen City and Aberdeenshire recognise the importance of the energy sector to the local economy. The 'Energetica' project has been developed which sets out a vision as to how the Inner Study Area can see energy, tourism, other industries and quality of life factors combine to raise the profile and economic performance of the region.

6.4 The Inner Study Area can be characterised as follows:

- A population of 457,300 people in 2009, which has grown by 4.8% since 2003 (a faster rate than the UK or Scotland)
- High levels of employment in the working age population (79.4% of the working age population are employed, compared to 71.9% in Scotland)
- Low level of unemployment (2.8% in the Inner Study Area compared to 7.1% in Scotland)
- A highly qualified workforce (24% of the workforce is degree qualified, compared to 20.5% in Scotland)
- The Inner Study Area is less dependent on public sector employment than other parts of Scotland. The Inner Study Area has a significant Oil and Gas sector – comprising 25,700 workers, and accounting for over 60% of UK employment in the oil and gas industry. This

provides a firm foundation for development of new energy sources such as offshore wind, given the complementarity of skills required.

- The three principle ports within the Inner Study Area are Aberdeen, Peterhead, and Fraserburgh. Aberdeen Port is the major supply base for the North Sea oil industry and employs around 11,000 people; whilst Peterhead landed 149,200 tonnes of fish in 2009 valued at £118 million (27% of the total Scottish market).
- 1.5 million tourist trips were made to Aberdeen and Grampian in 2009, contributing £344 million of expenditure to the local economy. The region attracts a high number of Scottish and UK tourists. A relatively high proportion of tourist trips into the region relate to business tourism – almost three quarters of visitors to Aberdeen City are business-related. The most significant tourism investment in the inner study area is the Trump Corporation's investment at Menie Estate which will increase tourist income in coming years.
- The coastline of the Inner Study Area is used for a variety of recreational activities including sailing (although only to a moderate extent relative to other parts of Scotland), sea angling, surfing, canoeing, kayaking, windsurfing and kitesurfing. Fraserburgh is a particularly popular surfing location and regularly holds surf competitions and events such as the UK Surf Tour and Fraserburgh Surf Festival.

6.5 Looking forward, the Inner Study Area is expected to experience a weak recovery from the recession. Forecasts show that the economy is expected to grow by an average of 2.7% per annum in the period 2011-2015 in the Inner Study Area, compared to 2.9% in Scotland, and 3.4% in the UK. Employment in the Inner Study Area is expected to decline by 12,100 jobs from 2008 to 2011; after which it is expected that there will be a gradual recovery, with job numbers increasing by 6,000 in the period 2011 to 2018. Over the period 2008-2018 as a whole, the worst affected industries in terms of job losses are expected to be Manufacturing and Oil and Gas industries.

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European Offshore Wind Deployment Centre

Environmental Statement

Appendix 23.2: Socioeconomics, Recreation and Tourism EIA Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

DTZ

Bringing You the Power of One™

Socioeconomic, Tourism & Recreation Assessment of the European Offshore Wind Deployment Centre:

EIA Technical Report

Aberdeen Offshore Wind Farm Limited

May 2011

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Contents

1.0 Information for the Non-Technical Summary

1.1 Aberdeen Offshore Wind Farm Limited (AOWFL) is proposing to develop an offshore wind farm and deployment centre off the coast of Aberdeen, known as the European Offshore Wind Deployment Centre (EOWDC). DTZ has been commissioned by AOWFL to undertake a socioeconomic, recreation and tourism impact assessment of the proposed EOWDC. The scope of the assessment is the Inner Study Area (Aberdeen and Aberdeenshire), Wider Study Area (Scotland), and the UK.

1.2 The project has been successful in gaining EU funding of up to €40m from the European Economic Recovery Plan. This award is in recognition of the project's potential role in supporting development of the European offshore wind industry by proving technologies and techniques. It also has an excellent strategic fit with local and national policy, as described in the Baseline Report. The Scottish Government is committed to achieving a headline target of 20% of total Scottish energy use from renewable sources by 2020, and Scotland has a quarter of Europe's offshore wind potential. At a local level, Aberdeen City and Aberdeenshire recognise the importance of the energy sector to the local economy. The 'Energetica' project has been developed which sets out a vision as to how the Inner Study Area can see energy, tourism, other industries and quality of life factors combine to raise the profile and economic performance of the region.

1.3 The impacts considered in this assessment are the direct and supply chain impacts of construction, operation and decommissioning activities; impacts on tourism; impacts on recreational activities; and impacts on the offshore wind energy sector. A range of assumptions have been developed in consultation with AOWFL in order to assess the socioeconomic impact of the development, and are set out in the report. For the purposes of this assessment, it has been assumed that the capacity of the EOWDC will be 84 MW across 11 turbines.

1.4 Total capital expenditure during the two-year **Construction Phase** has been estimated at £260.4 million. As shown in the summary table, it has been estimated that this will support 738 job-years worth of employment, and £40m of Gross Value Added (GVA) in Scotland; of which 296 job-years and £16 million of GVA will be in the Inner Study Area (Aberdeen and Aberdeenshire). The impact related to the Inner Study Area will relate mainly to the construction and assembly of turbines and foundations, whilst the additional impact in the rest of Scotland will relate to the manufacture of project components such as foundations and potentially also wind turbines.

Table 1.1: Summary of Impact: Construction Phase (2 years)

Total Employment (job-years)	Direct & Indirect	Induced	Total
Inner Study Area	248	48	296
Wider Study Area (Scotland)	531	207	738
UK	955	n/a	n/a
Gross Value Added (£ million, discounted)	**Direct & Indirect**	**Induced**	**Total**
Inner Study Area	£13.8	£2.3	£16.1
Wider Study Area (Scotland)	£29.5	£10.0	£39.6
UK	£53.1	n/a	n/a

The Crown Estate lease has a limit of 22 years within which construction and decommissioning must also take place. In terms of the Operational Phase of the project – this is anticipated to be up to 22 years in duration, and therefore a 'Long-term' effect. Once fully deployed, it is anticipated that the EOWDC will require a local team of around 25 jobs for operational and maintenance activities. Over the up to 22 year operational life of the development, this will support 768 job-years worth of employment and £23m of GVA at the Scotland level as summarised below.

Table 1.2: Summary of Operational Impacts over lifetime of project (22 years)

Total Employment (job-years)	Direct & Indirect	Induced	Total
Inner Study Area	553	108	661
Wider Study Area (Scotland)	553	216	768
UK	693	n/a	n/a
Gross Value Added (£ million, discounted)	Direct & Indirect	Induced	Total
Inner Study Area	£17.4	£3.0	£20.4
Wider Study Area (Scotland)	£17.4	£5.9	£23.4
UK	£21.9	n/a	n/a

1.5 The **Decommissioning Phase** is expected to be temporary, lasting for up to 5 months. It has been estimated that the total expenditure on decommissioning will be £33.3m, and this will support 248 job-years of employment and £7.7m of GVA at the Scotland level.

Table 1.3: Summary of Impacts from Decommissioning Phase (up to 5 months)

Total Employment (job-years)	Direct & Indirect	Induced	Total
Inner Study Area	178	35	213
Wider Study Area (Scotland)	178	69	248
UK	178	n/a	n/a
NPV of GVA	**Direct & Indirect**	**Induced**	**Total**
Inner Study Area	£5.8	£1.0	£6.8
Wider Study Area (Scotland)	£5.8	£2.0	£7.7
UK	£5.8	n/a	n/a

1.6 The impact of other offshore wind farm projects in the vicinity of the proposed development is likely to be very significant. Around 7.5GW of offshore wind capacity is planned for the East coast of Scotland, which will require capital investment in the order of £23 billion[1] up to 2020 supporting 28,000 jobs and having a major impact on ports such as Leith, Dundee, Nigg, Aberdeen, Peterhead, and Fife Energy Park. Consultees felt that this project would have a significant role in supporting the development of the industry as there is an identified need for more proving sites for turbines (RenewableUK).

1.7 The impact of the proposed development on **Tourism** is considered to be of **negligible significance.**

1.8 The impact of the proposed development on **Recreational** activities is considered to be of **negligible significance.**

1.9 The impact of the proposed development on **Research and Development and the Offshore Wind industry** has also been considered at both a local and national level. The view of consultations was that the proposed deployment centre would have a **positive impact** on the offshore wind sector. The following quotations highlight the significance of that impact:

- *'The development of offshore wind still faces many challenges to commercial deployment. The operation of the EOWDC will make a strong contribution to knowledge sharing for new components, designs and access methodologies for construction, operations and maintenance to be executed in the marine environment.'* **Chris Bronsdon, Chief Executive, Scottish European Green Energy Centre (SEGEC)**
- *'The European Offshore Wind Deployment Centre will provide invaluable opportunities for R&D, helping the industry to grow with real confidence. Innovative projects such as this will*

[1] i.e. 7,460MW of capacity multiplied by a CAPEX figure of £3.1 million per MW

help the UK to maintain its position as the world leader in offshore wind. This will in turn encourage more investors to come forward, creating thousands of jobs in the rapidly-expanding offshore wind sector.' **Maria McCaffery, Chief Executive of RenewableUK**

- *'This is potentially a great opportunity for Scotland's research community to actively engage in the development of an important means to generate low carbon electricity. Particularly important will be the deployment of the Ocean Laboratory, a wide range of turbines and support structures as possible and access to these for independent evaluation in order to aid future developments.'* **Professor Paul Mitchell of the University of Aberdeen's School of Engineering**

- *'The EOWDC is a major component of ACSEF's flagship project, Energetica. As a pioneering offshore wind project, it will be at the cutting edge of the development of new technologies and presents significant opportunities for Aberdeen City and Shire to build a viable, robust supply chain around offshore wind, particularly in the areas of development, operation and maintenance'* **Sara Budge, project manager for Energetica, Aberdeen City and Shire Economic Future (ACSEF)**

- *'This is a real opportunity for Aberdeen and the North-east [of Scotland] to place itself at the forefront of this aspect of the renewables industry. There is fierce completion not just in Scotland but across the rest of Europe to gain recognition as a leader in the field and this project will provide an extremely valuable testing site for manufacturers to demonstrate their products and to gather vital data on performance.'* **Bob Collier, Chief Executive of Aberdeen & Grampian Chamber of Commerce**

1.10 Overall, the assessment demonstrates that the project will have a significant positive impact on the economy of the Inner Study Area and the remainder of Scotland. **Including construction, operation and decommissioning, it is estimated that the project will support over 1,750 job-years worth of employment in Scotland, and over £70 million of Gross Value Added**. It will also provide benefits to the wider offshore wind energy sector by providing opportunities for testing, research and development, and training. This will accelerate the deployment of offshore wind projects progressing through The Crown Estate's 'Round 3' and Scottish Territorial Waters licensing processes by providing the opportunity to demonstrate new equipment in the marine environment.

2.0 Introduction

2.1 AOWFL is proposing to develop an offshore wind farm and deployment centre off the coast of Aberdeen, known as the European Offshore Wind Deployment Centre (EOWDC).

2.2 The proposed project would combine a small commercially operated wind farm with a test and research centre, allowing manufacturers to test "first of run" wind turbines and innovative foundation solutions along with related operation and maintenance access logistics.

2.3 The project has been successful in gaining EU funding of up to €40m from the European Economic Recovery Plan. This award is in recognition of the project's potential role in supporting development of the offshore European wind industry by proving technologies and techniques.

2.4 DTZ has been commissioned by AOWFL to undertake a socio-economic, recreation and tourism impact assessment of the proposed EOWDC. The structure of the assessment can be summarised as follows:

- **Baseline Technical Report** – this provides a summary of the policy context with regard to offshore renewables in Scotland; and a baseline of indicators related to socio-economics, recreation and tourism within Aberdeen City and Aberdeenshire.

- **EIA Technical Report (this document)** – an assessment of the impact that the proposed EOWDC will have upon socio-economics, recreation and tourism in the study areas, as described below.

2.5 The scope of this assessment is to consider the impacts of the development across the areas listed below. The scope of the assessment has been informed through a benchmarking exercise (see Section 6) which identified the key socio-economic impacts which have been considered in previous Environmental Impact Assessments of comparable offshore wind schemes.

- **Socioeconomic** – employment and economic impacts associated with the construction, operation and decommissioning of the project, including supply chain and income effects
- **Tourism** – considering the impact on tourism in the local area
- **Recreation** – considering the impact on coastal recreational activities
- **Research and Development** – considering the possible impact of the deployment centre on the UK offshore wind industry as a whole, due to the opportunity for research, development and testing of equipment.

2.6 For the purposes of this assessment, the study area has been defined as follows:

- **Inner study area**: the two local authority areas of Aberdeen City and Aberdeenshire, the development will pose direct impacts to this area
- **Wider study area:** Scotland as a whole
- **UK**: potential national impacts, such as the impact on the offshore wind industry as a whole

Consultation

2.7 DTZ consulted with the following individuals in April 2011 (all by phone) to inform the Baseline Assessment and Impact Assessment:

- Colin Parker, Chief Executive, Aberdeen Harbour
- Matt North, Port Manager for the Port of Dundee, Forth Ports
- Steven Paterson, Chief Financial Officer, Peterhead Port Authority
- Eric May, Marine Renewable Section Leader, Marine Scotland
- Robert Forbes, Aberdeen City Council
- Eric Wells, Aberdeenshire Council
- Roddy Mathieson, Aberdeenshire Council
- Alistair Reid, Aberdeenshire Council
- Paul Reynolds, Offshore Wind Development Manager, RenewableUK
- Sara Budge, Project Director, Energetica
- Dr Graham Russell, RYA Scotland

Key Guidance Documents

2.8 This assessment has been undertaken based on the following guidance on economic assessment:

- HM Treasury (2003) Green Book
- BIS (2010) Impact Assessment Guidance
- English Partnerships (2008) Additionality Guide: Third Edition
- BIS (2009) Guidance for Using Additionality Benchmarks in Appraisal

- Surfers Against Sewage (2009) Guidance on Environmental Impact Assessment of Offshore Renewable Energy Development on Surfing Resources and Recreation

Data Information and Sources

2.9 The main sources of information for this assessment (aside from consultations) are the following:

- BWEA (2009) UK Offshore Wind: Charting the Right Course
- Ernst & Young (2009) Cost of and financial support for offshore wind
- Marine Scotland (2011) Economic Assessment of Short Term Options for Offshore Wind Energy in Scottish Territorial Waters: Costs and Benefits to Other Marine Users and Interests
- Scottish Enterprise (2010) National Renewables Infrastructure Plan
- Scottish Renewables (2010) Scottish Offshore Wind: Creating an Industry
- Technip (2011) Rochdale Envelope Requirements for the European Offshore Wind Development Centre
- The Crown Estate / BVG Associates (2010) Guide to an Offshore Wind Farm

Impact Methodology

2.10 The overall impact methodology is primarily based on a quantitative assessment of the economic impacts in terms of job and Gross Value Added (GVA), in line with HM Treasury (2003) Green Book guidance.

2.11 The level of significance is assessed as follows:

Table 2.1: Impact Methodology

Magnitude of the Effect (based on spatial extent, duration, and scale)		
Spatial Extent of Effect, assessed at the level of • Inner Study Area (Aberdeen & Aberdeenshire) • Wider Study Area (Scotland) • UK	**Duration of Effect** • Long-term/ permanent (more than 10 years) • Medium-term (existing for 5 to 10 years) • Short-term (existing for 1 to 5 years) • Temporary effect (existing for less than a year)	**Scale of Effect:** As there are no specific standards or guidelines, the impacts have been assessed relative to baseline conditions, or a 'No Development' scenario
Sensitivity of the Receptor		
The sensitivity of the receptor is typically assessed in terms of the recoverability of the receptor and importance of the receptor. However this method of assessment does not perform well in terms of socio-economic impacts (particularly beneficial impacts), where the receptor is assumed to be the economy, population, businesses and workforce in the study area. In the case of job creation (or job losses), the sensitivity has been judged in terms of the level of unemployment in the area.		

2.12 Impacts are assigned a rating of major, moderate, minor or negligible, based on the magnitude of the effect and sensitivity of the receptor, as follows:

Table 2.2: Matrix for Significance of Impact

Magnitude of Effect based on spatial, duration and scale of effect	Sensitivity of Receptor Very High	High	Medium	Low
Very High	Major	Major	Major	Moderate
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Moderate	Minor
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

Cumulative and In-combination Impact Assessment Methodology

2.13 The core development under consideration within this assessment is the offshore works associated with the European Offshore Wind Deployment Centre (EOWDC). Other cumulative developments which need to be considered are: the onshore works associated with the project, the Ocean Laboratory element of the project, and any other potential offshore wind energy projects in the area.

2.14 The onshore works will be subject to a separate Environmental Impact Assessment, however they have been considered briefly within this assessment as a cumulative development.

2.15 The cumulative impact assessment has also considered the interaction with other offshore wind developments on the East coast of Scotland. There are two clusters of offshore wind farm developments planned for the East coast of Scotland totalling around 7.5GW of capacity, as follows:

- **Moray Firth** – Beatrice project (920MW) and Moray Firth Round 3 project (1,300 MW)
- **Firth of Forth** – Inch Cape (905MW), Neart na Gaoithe (420MW), Forth Array (415MW), and Firth of Forth Round 3 project (3,500MW)

Worst Realistic Case

2.16 In conducting this assessment, consideration has been given to the possible range of impact scenarios, based around the following key aspects of the project:

- **Scale** (capacity deployed) and timing of the project - the larger scale the project and the sooner it takes place, the greater the beneficial economic impacts
- **Sourcing of components** – higher levels of local sourcing will increase beneficial impacts in the Inner and Wider study areas.
- **Usage of local ports for construction and operational activities** – using a local port such as Peterhead or Aberdeen will increase beneficial impacts in the inner study area.

2.17 For the purposes of this assessment, a central scenario has been developed reflecting the most likely outcome; although it is recognised that there is some uncertainty around the key project parameters above, and that the actual impact may be higher or lower.

Scale and timing of the project

2.18 The level of capacity deployed within the EOWDC is one of the key variables for the socioeconomic assessment; as this determines the scale of capital and operational expenditure and the resulting socioeconomic impact. The development will comprise 11 turbines of between 4MW and 10MW each (although The Crown Estate Lease limits the overall capacity to 100 MW). However, following further consultation with the developer, it appears that the most likely outcome is towards the midpoint of this range rather than the extremes, as the development is likely to involve a mix of different turbine designs and sizes. For the purposes of this assessment, DTZ has used an indicative total capacity figure of **84MW**, based on the following assumptions:

- 4 x 6 MW turbines installed in 2013
- 4 x 7.5 MW turbines plus 3 x 10 MW turbines installed in 2014

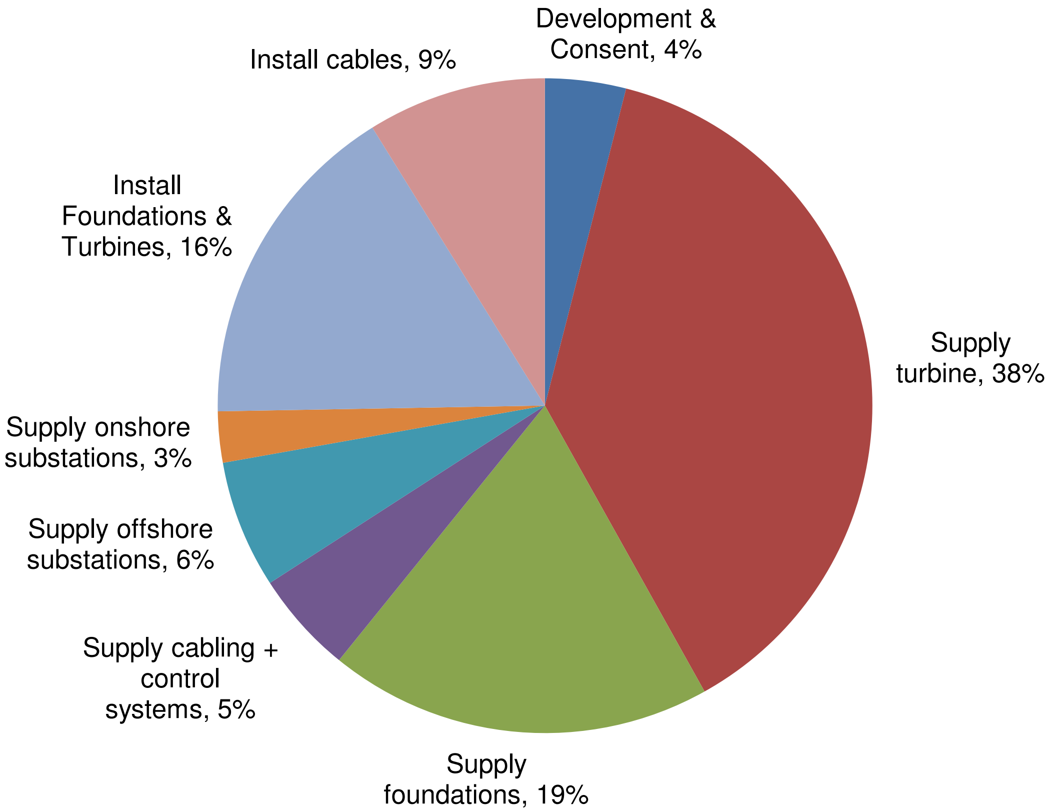
2.19 It is anticipated that the project will be constructed over a two year period, and will be operational for up to 22 years.

Sourcing of Project Components

2.20 Another key aspect in determining the socioeconomic impact during the construction phase is the extent to which project-related capital expenditure is captured by businesses within the study area. This can be assessed by breaking the total CAPEX into its constituent elements; and then making assumptions as to the likelihood of each element of expenditure remaining within the study area.

2.21 A report produced by BVG Associates for The Crown Estate (2010) provides a breakdown of the CAPEX for a typical offshore wind farm, based on industry benchmarks, which DTZ has analysed as shown in Figure 2.3. As can be seen, the largest single element is the cost associated with the supply of the wind turbine generator (38%), followed by the supply of foundations (19%), and the installation of foundations and turbines (16%). Installation activities account for 25% of the total CAPEX, whilst supply of project components comprises 71% of the total CAPEX (the remaining 4% relates to Development and Consenting).

Figure 2.3: Breakdown of Capital Cost for a Typical Offshore Wind Farm (Source: Crown Estate / BVG Associates, 2010)



2.22 DTZ has considered where the main project elements are likely to be sourced from, in consultation with AOWFL and wider consultees, and bearing in mind the actual locations of potential suppliers for each element. The assumptions are shown in Table 2.4:

Table 2.4: Assumptions on Sourcing of Components

Project Element (% of CAPEX)	Assumption	Comments
Turbines (38% of CAPEX)	Assume: 25% Wider Study Area 25% Rest of UK 50% Non-UK	The key manufacturers of offshore wind turbines are currently located in Continental Europe and Asia. A number of manufacturers (e.g. Siemens, GE, Clipper Windpower, Mitsubishi, Vestas, Gamesa, Doosan) are considering the development of manufacturing bases for offshore turbines in the UK. Of these, Doosan and Gamesa are considering investing in Scotland, but not in the Inner Study Area.[2] Given that the project proposes to use a mix of turbines, it is likely that they will be sourced from a number of distinct companies and locations.
Foundations (19% of CAPEX)	Assume: 50% Wider Study Area 50% Rest of UK	There are a number of suppliers of foundations for offshore wind projects in the UK, including some within the Wider Study Area (but not Inner Study Area) such as BiFab. Given the physical size of foundations it is preferable to source locally if possible. Given that there will be a mix of foundations used within the development, it is possible that they will be sourced from a range of different locations
Cabling & control systems (11%)	Assume: 50% Rest of UK 50% Non-UK	The probable source for this element is the UK or Scandinavia. No offshore substation is proposed so this element is included within cabling.
Development & Consenting (4%)	Assume: 33% Inner Study Area 33% Wider Study Area 33% Rest of UK	Includes project development work, which in this case will be split between Technip, AOWFL and any associated contractors/advisors. Also includes survey work which is likely to be carried out locally.
Onshore Substation (3%)	Note: this element falls outside the scope of this assessment, as the assessment only covers offshore works. The impact of this element is considered in the section on Cumulative Impacts below.	

Usage of Local Ports

2.23 Another main factor which will influence the scale of socioeconomic impacts is the choice of port used during the construction and operational phases – and whether this is within the Inner Study Area, Wider Study Area, or further afield – as this is a key factor in the location of impact.

2.24 The final decision on which port(s) are to be used has not yet been made, although current intentions are as follows:

- Potential utilisation of Aberdeen Port for small vessels during the construction phase, and for operational activities
- Potential utilisation of Peterhead Port as a construction port

2.25 DTZ has conducted an independent high-level review of a number of major ports in close proximity to the proposed development site (see Section 6), including Aberdeen and Peterhead, in order to assess their suitability for construction and operational activities. This review found that Aberdeen and Peterhead ports are likely to be sufficient for construction activities in relation to the EOWDC, although noting that these ports may not be suitable for the construction of larger offshore wind projects in their current state, due to space constraints.

[2] Doosan in Renfrew, near Glasgow, and Gamesa in Dundee

2.26 The review also found that Aberdeen and Peterhead have sufficient infrastructure in order to be used during the operational phase, and offer good facilities and may be chosen due to the requirement for an operational port in close proximity to the development site.

2.27 Overall, the conclusions of DTZ's review of ports are consistent with the preferences of the project, as indicated above. For the purposes of this assessment, it has therefore been assumed that the both the construction port and operational port will be located within the Inner Study Area (i.e. Peterhead and Aberdeen).

3.0 Impact Assessment

Direct and Supply Chain Impacts

Construction Phase

Potential Impacts

3.1 The construction of an offshore wind farm can potentially generate socioeconomic benefits related to the direct employment of staff in manufacturing and construction activities, and indirect knock-on impacts on the supply chain for the construction project.

3.2 As identified in Section 2 above, the **duration** of the construction phase will be for two years (2013-2014), and is therefore viewed to be a **short-term effect**.

3.3 In assessing the **scale** of the impact it is important to first consider the level of capital expenditure (CAPEX) related to the project. As detailed costings have not yet been finalised for the project, DTZ has estimated the total capital cost based on the likely capacity and industry benchmarks for the level of CAPEX per Mega Watt (MW).

3.4 BWEA (2009) identifies that the capital cost offshore wind projects currently stands at £3.1 million per MW. This ratio has increased markedly in recent years, due to changes in commodity prices, foreign exchange rates, and supply constraints. BWEA (2009) provides a range of forecasts for CAPEX, concluding that there is some uncertainty as to whether CAPEX will increase or decrease in the short to medium term. On this basis, DTZ has used the current figure of £3.1 million per MW in order to model the likely CAPEX associated with the EOWDC.

3.5 Based on a total capacity of 84 MW, this results in an estimated capital cost of **£260.4 million**, as shown in Table 3.1.

Table 3.1: Capital Cost estimates for the EOWDC

	2013	2014	Total
Capacity Deployed in year	24	60	84
CAPEX per MW (£m)	3.1	3.1	
Total CAPEX	74.4	186.0	260.4

3.6 Based on the assumptions on sourcing of project components (as set out in Figure 2.4) and excluding the onshore elements, the proportion of CAPEX retained within the study area is estimated to be as follows:

Table 3.2: Assumptions of CAPEX retained in study area

Project component	% of CAPEX	Inner Study Area	Wider Study Area (inc Inner Study Area)	UK (Inc Wider Study Area)
Development & Consent	4.0%	1.3%	2.7%	4.0%
Supply turbine	38.0%		9.5%	19.0%
Supply foundations	19.0%		9.5%	19.0%
Supply cabling & control systems	11.4%			5.7%
Install Foundations & Turbines	16.5%	16.5%	16.5%	16.5%
Install cables	8.9%			4.4%
Total CAPEX retained (% of total)		17.8%	38.1%	68.56%
Total CAPEX retained (£m)		£46.3	£99.2	£178.5

3.7 As shown in Table 3.2, it has been assumed that 38% of CAPEX will be retained in the Wider Study Area (Scotland), of which 18% will be retained in the Inner Study Area. This translates into £99m of expenditure captured in the Wider Study Area, of which £46m will be captured in the Inner Study Area.

3.8 The next steps in calculating the impact are described as follows, and summarised in Table 3.3:

- The number of job-years supported directly or indirectly by project expenditure can be calculated by dividing the total expenditure by the average turnover per worker in a relevant industrial sector – which in this case would be the 'Construction of Civil Engineering Projects'[3] sector, with a turnover per head of £187,000 (Source: Annual Business Inquiry 2008, Office for National Statistics). As shown in Table 3.3, the project is estimated to support 531 job-years worth of employment in the Wider Study Area, of which 248 job-years worth of employment will be in the Inner Study Area.

- The Gross Value Added (GVA) supported by the expenditure can be estimated by multiplying the number of job-years by the average GVA per worker in the sector - £59,000 (Source: Annual Business Inquiry 2008, Office for National Statistics; Construction of Civil Engineering Projects sector). HM Treasury (2003) Green Book guidance recommends that where possible, economic impacts which occur over differing timescales are expressed in Net Present Values (NPV) terms using an appropriate discount rate (the guidance suggests 3.5%). As shown in Table 3.5, the GVA supported (directly or indirectly) by the proposed development in the Wider Study Area is estimated to be £29.5m, of which £13.8m will be in the Inner Study Area.

- The direct and indirect employment supported will increase household incomes and expenditure in the local area, which will support additional jobs. This is known as an induced or income multiplier effect. At a Scotland level, estimates have been made for the scale of the income multiplier effect in the Scottish Input-Output tables (the latest set of data relates to 2007). For the construction sector the induced multiplier is 0.39 for employment, or 0.34 for GVA. In the absence of any corresponding estimates of multiplier effects for the Inner Study Area, we have assumed that the multiplier effects on the local economy will be half as great as for Scotland as a whole (i.e. 0.195 for employment, and 0.17 for GVA).

[3] As defined in the Office for National Statistics Standard Industrial Classification (SIC) system

Table 3.3: Summary of Impact: Construction Phase

Total Employment (job-years)	Direct & Indirect	Induced	Total	Magnitude of Impact
Inner Study Area	248	48	296	Medium
Wider Study Area (Scotland)	531	207	738	High
UK	955	n/a	n/a	Very High
NPV of GVA (£m)	**Direct & Indirect**	**Induced**	**Total**	
Inner Study Area	£13.8	£2.3	£16.1	Medium
Wider Study Area (Scotland)	£29.5	£10.0	£39.6	High
UK	£53.1	n/a	n/a	Very High

3.9 The receptors of the above economic impacts have been assumed to be the economy, population, businesses, and workforce of the Inner Study Area and Wider Study Area. One way of assessing the sensitivity of the receptors is in terms of the relative level of unemployment – as the creation of jobs associated with the proposed project will be of benefit in reducing unemployment in the area, and partially offsetting the anticipated contraction in employment in other sectors such as oil and gas and manufacturing (see Baseline Report, Figure 4.5). As described in the baseline report, the current level of unemployment is 2.8% in the Inner Study Area, and 7.1% in the Wider Study Area (compared to a UK benchmark of 7.8%).

3.10 Another factor in assessing the sensitivity of the receptors is in terms of the wider catalytic impact the development could have in supporting the development of renewable energy sector. This is particularly true of the Inner Study Area, where the project will have a strong linkage with other local initiatives such as the Energetica project described in the Baseline Report. **Overall, the sensitivity of the receptors has been assessed as 'Medium' in both the Inner Study Area and the Wider Study Area.**

3.11 The impact on the Inner Study Area has been assessed of Medium (positive) magnitude, Medium sensitivity and therefore of **Moderate (positive) significance**. In the Wider Study Area, the potential impact has been assessed of High (positive) significance, Medium sensitivity, and therefore of **Moderate (positive) significance.**

Mitigation

3.12 The impacts of the development in terms of direct employment and supply chain impacts have been assessed to be of Moderate positive significance. Therefore no mitigation of negative impacts is required.

3.13 The consultations with stakeholders including Aberdeen City and Shire Councils and Scottish Enterprise, including the Energetica Project, highlighted the anticipated positive impacts of the project on the economy in both the Inner Study Area and Wider Study Area.

3.14 However, it is acknowledged that there is some uncertainty as to the scale of impact, as set out in Section 2. Actions which should be taken in order to maximise the beneficial impacts of the development include the following:

- Work with the major ports within the Inner Study Area to ensure that they can be utilised during the construction, operational, and decommissioning phases; identifying any necessary infrastructure upgrades at the earliest possible opportunity.
- Identify suitable local businesses which could provide components of the project. Engage with these companies and make them aware of the opportunities available where possible. Actively encourage these businesses to bid for contracts related to the project. Scottish Enterprise has been engaged in activities of this kind.

Residual Impacts

3.15 Not applicable – no mitigation measures

Cumulative Impacts

3.16 This assessment covers the offshore works for the proposed project only: onshore works will be considered separately in the assessment as part of the application for the onshore works. In terms of socioeconomic impact, the onshore works such as a substation are viewed to be of negligible significance on their own. The rationale for this is that the total capital expenditure on this element will be relatively modest (3% of total CAPEX), and that components are likely to be sourced from outside the Inner Study Area or Wider Study Area. However, consultees have highlighted the benefits of locating onshore works at the Science and Energy Park in order to support a cluster of offshore wind related businesses. If this can be achieved, the cumulative beneficial impacts will be greater.

3.17 The impact of other offshore wind farm projects in the vicinity of the proposed development is likely to be very significant. As described in Section 2, there is around 7.5GW of offshore wind capacity planned for the East coast of Scotland, which will require capital investment in the order of £23 billion[4] and will be constructed on a phased basis between now and around 2020. A study by Scottish Renewables (2010) showed that the offshore wind sector in Scotland could directly support 28,000 full time equivalent jobs by 2020. Offshore wind projects on the East coast of Scotland will have a major impact on ports in the area - a report by Scottish Enterprise & HIE (2010a) concluded that the most likely ports/locations to be used for offshore wind manufacturing and construction in the area are Leith, Dundee, Nigg, Aberdeen, Peterhead, and Fife Energy Park. Consultees felt that this project would have a significant role in supporting the development of the industry as there is an identified need for more proving sites for turbines (RenewableUK).

Operational Phase

3.18 The operation of an offshore wind farm can potentially generate socioeconomic benefits related to the direct and indirect employment of staff in operations and maintenance (O&M) activities.

3.19 The **duration** of the operational phase is 22 years, and is therefore judged to have a **long-term** effect.

3.20 In order to assess the **scale** of the effect, it is necessary to consider the total level of Operational Expenditure (OPEX); the proportion of this which will be retained locally; and the employment which this will support. The following assumptions have been used, with the results shown below:

- Total OPEX can be estimated based on the total installed capacity (i.e. 84MW by end of 2014) multiplied by a ratio of £79,000 per MW per annum (Source: Ernst & Young, 2009). This means that once all capacity has been installed in 2014, the total OPEX will be around £6.6 million per annum.
- The proportion of total OPEX which will be retained locally has been estimated in a number of studies. A report by Scottish Renewables (2010) estimated that of total OPEX related to offshore wind projects in Scottish Territorial Waters, 45% would be retained in Scotland, and 56% in the UK. The local impact will relate to the operations and maintenance team, which will typically be located in a port proximate to the wind farm site to minimise transfer times. DTZ's review of port infrastructure (see Section 6) concluded that there are two ports in the Inner Study Area (Aberdeen and Peterhead) which would be suitable for use as an Operations and Maintenance base. The project has confirmed the utilisation of Aberdeen Port during this phase of development. On this basis, it can be assumed that the 45% of OPEX which falls within the Wider Study Area would relate to the Inner Study Area and not the remainder of Scotland.

[4] i.e. 7,460MW of capacity multiplied by a CAPEX figure of £3.1 million per MW

- Direct and Indirect GVA impacts can be estimated using a ratio of OPEX to GVA of 2.27 to 1 (Source: Scottish Renewables, 2010).
- The level of direct and indirect employment can be estimated from GVA using a suitable ratio for the total cost per operations and maintenance job, which Scottish Renewables (2010) estimated at £52,000.
- As with the construction phase above, the induced multiplier effect has been calculated through reference to the Scottish Input Output tables. At Scotland level, the induced multiplier for the construction sector is 0.39 for employment, or 0.34 for GVA. It has been assumed that the corresponding multiplier effects for the Inner Study Area are 0.195 for employment, and 0.17 for GVA.

Table 3.4: Operational Impacts (per annum, once all capacity deployed)

	OPEX (£m p.a.)	Jobs supported directly & indirectly	GVA (£m p.a.)
Inner Study Area	3.0	25	1.3
Wider Study Area (Scotland)	3.0	25	1.3
UK	3.7	31	1.6

Table 3.5: Total Operational Impacts over lifetime of project (22 years)

Total Employment (job-years)	Direct & Indirect	Induced	Total	Magnitude of Impact
Inner Study Area	553	108	661	High
Wider Study Area (Scotland)	553	216	768	High
UK	693	n/a	n/a	High
NPV of GVA	**Direct & Indirect**	**Induced**	**Total**	**Magnitude of Impact**
Inner Study Area	£17.4	£3.0	£20.4	High
Wider Study Area (Scotland)	£17.4	£5.9	£23.4	High
UK	£21.9	n/a	n/a	High

3.21 As shown in Table 3.4, O&M activities will (directly and indirectly) support 25 jobs and £1.3 million of GVA per annum in the Inner Study Area. Over the 22 year operational phase of the project, the project will directly or indirectly support £17.4 million of GVA in the Inner Study Area, or £20.4 million once induced effects have been taken into account. The impact is viewed to be of High significance at both the level of the Inner Study Area and Wider Study Area.

3.22 The sensitivity of receptors is as described above in relation to the Construction phase– i.e. 'Medium' in both the Inner Study Area and Wider Study Area.

3.23 In the Inner Study Area, the potential impact has been assessed of High (positive) magnitude, Medium sensitivity and therefore of **Moderate (positive) significance**. In the Wider Study Area, the potential impact has been assessed of High (positive) significance, Medium sensitivity, and therefore of **Moderate (positive) significance**.

Mitigation

3.24 The above section demonstrates that the impact of the development during the operational phase is of Moderate positive significance. Therefore no mitigation of negative impacts is required.

Residual Impacts

3.25 No change from pre-mitigation position.

Cumulative Impacts

3.26 This assessment covers the offshore works for the proposed project only: onshore works will be considered separately. In terms of socio-economic impact, the onshore works such as substations are viewed to be of negligible significance, as OPEX related to these elements will be minimal. However, as already identified, the siting of these elements on the Energy Park north of Aberdeen could, in the opinion of consultees, support a cluster of offshore wind related companies and be used as part of the demonstration and training aspects of the project. This would have knock-on beneficial impacts for the local economy.

3.27 The impact of other offshore wind farm projects in the vicinity of the proposed development during the operational phase is likely to be very significant. As described in Section 2, there is around 7.5GW of offshore wind capacity planned for the East coast of Scotland, which will require operational expenditure of nearly £600 million per annum[5] for the lifetime of these projects. This will support a large number of permanent jobs in operations and maintenance, which are likely to be located in operations and maintenance ports on the East Coast of Scotland.

Decommissioning Phase

3.28 The decommissioning of an offshore wind farm can potentially generate socioeconomic benefits related to the removal, disassembly, and disposal of wind farm components. It is anticipated that foundations and turbines will be cut/lifted and removed by a self-elevating crane vessel. Cables will be left in situ where possible, with exposed ends cut and/or buried.

3.29 The **duration** of the decommissioning phase is estimated to be up to 5 months, and is therefore judged to be a **temporary** effect.

3.30 In order to assess the **scale** of the effect, it is necessary to consider the total level of expenditure on decommissioning; the location of this expenditure; and the employment which this will support. The following assumptions have been used:

- Ernst and Young (2009) recommend that the costings for offshore wind projects build in a contingency equivalent to £18,000 per MW per annum for decommissioning; which for a project with a lifetime of 22 years equates to a total figure of £396,000 per MW of capacity.
- This figure has been multiplied by the total capacity (84 MW) to give a total decommissioning cost of **£33.3 million**.
- It has been assumed that the decommissioning phase takes place in 2036/7, assuming a 22 year lifetime of the project.
- It has been assumed that the construction port would be used for decommissioning activity – which as described above, has been assumed to be in the Inner Study Area. The economic activity associated with decommissioning activity will be associated with the decommissioning port.
- The number of job-years directly or indirectly supported by expenditure on decommissioning can be calculated by dividing the total expenditure by the average turnover per worker in a relevant industrial sector – which in this case would be the 'Construction of Civil Engineering Projects'[6] sector, with a turnover per head of £187,000 (Source: Annual Business Inquiry 2008, Office for National Statistics).
- The Gross Value Added (GVA) supported by the expenditure on decommissioning activity can be estimated by multiplying the number of job-years by the average GVA per worker in the sector of £59,000 (Source: Annual Business Inquiry 2008, Office for National Statistics;

[5] i.e. 7,460 MW multiplied by £79,000 per MW per annum
[6] As defined in the Office for National Statistics Standard Industrial Classification (SIC) system

Construction of Civil Engineering Projects sector).

- HM Treasury (2003) Green Book guidance recommends that where possible, economic impacts which occur over differing timescales are expressed in Net Present Values (NPV) terms using an appropriate discount rate (the guidance suggests 3.5%).
- As with the construction phase above, the induced multiplier effect has been calculated through reference to the Scottish Input Output tables. At Scotland level, the induced multiplier for the construction sector is 0.39 for employment, or 0.34 for GVA. It has been assumed that the corresponding multiplier effects for the Inner Study Area are 0.195 for employment, and 0.17 for GVA.

3.31 Overall, the analysis shows that the total expenditure on decommissioning will be £33.3 million. This will directly or indirectly support 178 job-years of employment within the Inner Study Area, generating £5.8 million of GVA. Once induced effects have been taken into consideration, this will support £6.8 million worth of GVA in the Inner Study Area.

Table 3.6: Summary of Impacts from Decommissioning Phase

Total Employment (job-years)	Direct & Indirect	Induced	Total	Magnitude of Impact
Inner Study Area	178	35	213	Medium
Wider Study Area (Scotland)	178	69	248	Medium
UK	178	n/a	n/a	Medium
NPV of GVA	**Direct & Indirect**	**Induced**	**Total**	**Magnitude of Impact**
Inner Study Area	£5.8	£1.0	£6.8	Medium
Wider Study Area (Scotland)	£5.8	£2.0	£7.7	Medium
UK	£5.8	n/a	n/a	Medium

3.32 As with the impacts associated with construction and operation, the **sensitivity of the receptors** has been assessed as 'Medium' in the Inner Study Area and Wider Study Area.

3.33 In the Inner Study Area, the impact has been assessed to be of Medium magnitude, Medium sensitivity, and therefore of **Moderate (positive) significance.** In the Wider Study Area, the impact has been assessed of Medium magnitude, Medium sensitivity and therefore of **Moderate (positive) significance**.

Mitigation

3.34 The above section demonstrates that the impact of the development during the decommissioning phase is of Moderate positive significance. Therefore no mitigation of negative impacts is required.

Residual Impacts

3.35 No change from pre-mitigation position.

Cumulative Impacts

3.36 This assessment covers the offshore works for the proposed project only: onshore works will be considered separately.

3.37 The impact of other offshore wind farm projects in the vicinity of the proposed development during the decommissioning phase is likely to be very significant. As described in Section 2, there is around 7.5GW of offshore wind capacity planned for the East coast of Scotland. The expenditure on decommissioning on these projects could total nearly £3 billion[7], and is likely to take place around 25 years from commissioning (which on the East coast projects is likely to occur between now and

[7] i.e. 7,460 MW of capacity multiplied by around £400,000 per MW (assuming a 22 year project lifetime)

2020). This will create a large number of temporary jobs for the duration of the decommissioning phase. The £7m of GVA associated with this project will be a very small part of the wider cumulative impacts.

Impact on Tourism

3.38 Marine Scotland (2011) highlight that offshore wind projects can have a range of potential impacts on tourism, including positive and negative impacts:

- Visual effects on the landscape and seascape deterring visitors to an area or deterring tourism investment;
- Disturbance or injury to coastal or marine wildlife interests (e.g. for wildlife watching) during construction or operation of the wind farm;
- Disruption to site access for tourism operations; and
- Visual effects on landscape and seascape during operation creating tourism opportunities, providing add-on benefits to existing wildlife excursions and attracting visitors to an area.

3.39 The Marine Scotland assessment cites a survey by Riddington et al (2008), which estimates the impacts of *onshore* wind farm development on tourism expenditure in Scotland (Note: there is no corresponding survey looking at the impact of offshore wind projects on tourism, but this is taken to be a reasonable proxy). The survey found that the vast majority of visitors (93-99%) who had seen a wind farm suggested that the experience would not have any effect on their decision to return to the area; in fact there were some tourists for whom the experience increased the likelihood of a return visit rather than decreasing it.

3.40 The assessment by Marine Scotland suggests that the seascapes in the East and North East of Scotland (i.e. the area around the proposed development site) are less sensitive than the West coast of Scotland (citing Scott et al, 2005); and that the effects of offshore wind development on general tourism in these regions has therefore been considered to be negligible.

3.41 Commercial wildlife boat trips such as whale watching trips have the potential to be impacted directly by the physical presence of the wind farms by making access difficult to routes often used by the boats or by interrupting lines of sight while scanning for wildlife with scopes or binoculars. However the report by Marine Scotland (2011) found these effects to be negligible.

3.42 Overall, the assessment by Marine Scotland (2011) suggests that the impact of offshore wind farms on tourism is of negligible significance. This view is supported in a study by Glasgow Caledonian University for the Scottish Government (2008), which concluded that 'even using a worst case scenario, the impact of current [wind farm] applications [on tourism] would be very small.'

3.43 The views of consultees supported this view, though the close proximity of the Trump Development at Menie Estate has been noted. Construction of new golf courses is well underway at Menie and the EOWDC lies to the south east of the estate. Consultees also highlighted the high levels of business tourism. The baseline report highlighted Visit Scotland and Scottish Enterprise statistics showing that nearly three quarters of tourist trips to Aberdeen are for business. The EOWDC will clearly support and potentially grow this important market segment, which is estimated by Scottish Enterprise to be worth £137 million per annum.

3.44 The assessment by Marine Scotland (2011) suggests that offshore wind farms can have positive impacts on tourism – particularly where the wind farm has an associated visitor centre. For example, a report by BWEA (2006) reviewed numerous studies and surveys assessing the impacts of wind farms on tourism in the UK, including two operational offshore wind farms in England and Wales. The report stated that E.ON UK's Scroby Sands Information Centre welcomed 30,000 people in the first six months (from May 2004), and in 2009, 42,000 people visited the centre (Marine Scotland, 2011). .

3.45 Furthermore, there may be positive effects on the local tourism economy associated with temporary workers during the construction phase. It is often the case on offshore wind construction projects, that workers are employed on a shift pattern system – for example one week of work on an offshore vessel, followed by one week of shore leave. Workers on shore leave are likely to have a (modest) impact on the local tourist economy, through expenditure on accommodation and subsistence. The extent of this impact varies from development to development, and has not been quantified in this case.

3.46 Overall, the potential impact on tourism has been assessed to be of **negligible significance**. The EOWDC may have a minor beneficial effect on business tourism.

Impact on Recreation

3.47 The assessment of Offshore Wind projects in Scotland by Marine Scotland (2011) highlights that in general, offshore wind projects may have impacts on recreational boating; and surfing, windsurfing and kayaking.

3.48 The EOWDC is seen by consultees to be too far offshore to prevent surfing or bathing. In terms of the potential impact on recreational boating, a number of potential impacts have been considered such as: safety, changes to recreational boating behaviour or activity levels, and increased steaming distances to avoid offshore wind farms. There are known to be jet skiers in the area.

3.49 However, the assessment by Marine Scotland concludes that the presence of an offshore wind farm will not have any significant negative impacts in terms of changes to recreational boating behaviour or activity levels, or collision risk/navigation. A position statement by the European Boating Association (EBA) states that “there is no danger to a vessel under 24 metres in length navigating through the farm taking reasonable care” – a position which is supported by the RYA Scotland (Marine Scotland, 2011, pg 73). The report also suggests that (with the exception of one offshore wind development in the West of Scotland) there would not be any impacts in relation to the loss of essential routes to anchorage points. Consultation with RYA further reveals that normal sailing routes for large craft are several miles offshore at that point in order to avoid Aberdeen Harbour traffic. Any small craft (e.g. dingy sailing) would, on the other hand, sail around and in between the turbines quite safely.

3.50 The only impact quantified in the assessment by Marine Scotland relates to the negative impact (increased cost) associated with increased steaming distances to avoid wind farms, for which a number of scenarios are identified (High, Medium, and Low Impact). However even in the High Impact scenario, the overall impact associated with increased steaming is £33,000 per annum for the 10 offshore wind farms in Scottish Territorial Waters combined. Given the relatively small area affected by the proposed development (26 sq km) compared to the projects considered in the Marine Scotland report (1,233 sq km combined), the impact associated with the proposed development is likely to be of **negligible significance**.

3.51 In terms of the potential impact on surfing, windsurfing and kayaking, the assessment by Marine Scotland (2011) identifies that the main impact of offshore wind developments is related to the deterioration of surf wave quality due to the presence of foundations. However, the assessment concludes, based on evidence from existing wind farm developments, that there have been no significant changes in wave quality at the shoreline as a result of other offshore wind projects. On this basis, it has been assumed that the proposed development will not have a significant impact on surfing, windsurfing or kayaking activity.

3.52 Overall, the potential impact on recreation has been assessed of **negligible significance**.

Impact on the Offshore Wind sector / R&D impacts

3.53 The EOWDC has the potential to create benefits for the offshore wind energy sector at a local and national level, through its role as a deployment and research and development centre. Key features of the EOWDC in this regard are that it will involve the deployment of different foundation and turbine designs; and the inclusion of the Ocean Laboratory within the overall development, which will provide both training and environmental monitoring opportunities.

3.54 Deployment centres are needed to allow manufacturers to test turbines, foundation designs and other components in the offshore environment. Given the large number of manufacturers expressing an interest in UK manufacture of offshore turbines, a large number of turbine test locations will be required.

3.55 The EOWDC will be the second largest of four current deployment centres in the UK. The others are at Blyth (National Renewable Energy Centre) with up to 99 MW of capacity (20 turbines) in development; and two smaller deployment centres each comprising two turbines (Gunfleet sands, Kent and 2B Energy at Methil, Fife). The four current centres will collectively provide the opportunity to test 35 turbines, of which 11 (or 30%) would be at the EOWDC. RenewableUK identifies a further two sites as being required to support industry development in the current round of licensing plus more sites in future rounds.

3.56 The deployment centres will allow manufacturers to improve reliability and reduce costs through testing. Extensive data will be generated that will be of benefit to all of the industry. RenewableUK has identified a need for 10 new UK factories to produce the 23 GW required by 2020. Sites such as the EOWDC will be critical in the UK securing this new manufacturing base and the associated jobs. Its location off Aberdeen will allow the lessons of the oil and gas industry to be transferred to offshore wind reinforcing the region's position in energy. Turbine manufacturers from China, France, Korea, USA and Japan have already shown keen interest in the EOWDC as a possible route into supplying Round 3 projects.

3.57 Stakeholders have expressed their strong support for the scheme, and the significant impact it will have in supporting the development of the offshore wind energy sector at a national level through the R&D opportunities it provides:

- 'The development of offshore wind still faces many challenges to commercial deployment. The operation of the EOWDC will make a strong contribution to knowledge sharing for new components, designs and access methodologies for construction, operations and maintenance to be executed in the marine environment.' **Chris Bronsdon, Chief Executive, Scottish European Green Energy Centre (SEGEC)**
- 'The European Offshore Wind Deployment Centre will provide invaluable opportunities for R&D, helping the industry to grow with real confidence. Innovative projects such as this will help the UK to maintain its position as the world leader in offshore wind. This will in turn encourage more investors to come forward, creating thousands of jobs in the rapidly-expanding offshore wind sector.' **Maria McCaffery, Chief Executive of RenewableUK**
- 'This is potentially a great opportunity for Scotland's research community to actively engage in the development of an important means to generate low carbon electricity. Particularly important will be the deployment of the Ocean Laboratory, a wide range of turbines and support structures as possible and access to these for independent evaluation in order to aid future developments.' **Professor Paul Mitchell of the University of Aberdeen's School of Engineering**

3.58 Consultees in the Inner Study Area saw the EOWDC as a key part of the Energetica project (discussed in the Baseline Report), underlining the capability of the area in energy and renewables and helping to attract inward investment. For example, if the onshore elements could be co-located with the Energy Park (Bridge of Don) it would help to create a cluster of energy and engineering companies in one location. Sara Budge, project manager for Energetica, Aberdeen City and Shire Economic Future (ACSEF), commented:

"The EOWDC is a major component of ACSEF's flagship project, Energetica. As a pioneering offshore wind project, it will be at the cutting edge of the development of new technologies and presents significant opportunities for Aberdeen City and Shire to build a viable, robust supply chain around offshore wind, particularly in the areas of development, operation and maintenance

"Energetica is a highly ambitious, dynamic proposal at the heart of our efforts to promote Aberdeen City and Shire as a global energy hub. In addition to the EOWDC, the hydrogen corridor, airport development zone and Peterhead's decommissioning and emerging marine renewable sector along with links to the region's two universities and research base are also key to Energetica's success.

"Energetica may have the potential for a Smart Grid system to transport and deliver electricity, a pump storage facility to store any excess electricity produced through wind generation, test and research facilities for other forms of renewable energy and high quality, low carbon commercial and industrial accommodation."

3.59 Bob Collier, Chief Executive of Aberdeen & Grampian Chamber of Commerce commented:

"This is a real opportunity for Aberdeen and the North-east [of Scotland] to place itself at the forefront of this aspect of the renewables industry. There is fierce completion not just in Scotland but across the rest of Europe to gain recognition as a leader in the field and this project will provide an extremely valuable testing site for manufacturers to demonstrate their products and to gather vital data on performance."

3.60 Overall, the consultees and stakeholders have expressed a high level of support for the project. They identified that the proposed project will be an important contributor to the offshore wind industry as a whole, in particular benefitting the rollout of Round 3 projects, and benefitting the local area / Inner Study Area.

3.61 Whilst it is not possible to precisely quantify the scale, magnitude or duration of this effect, **DTZ's view is that this effect is of Moderate/Major (positive) significance to the Inner Study Area, and of Moderate (positive) significance to the Wider Study Area and the UK.**

4.0 Summary of Impact Assessment

4.1 The following tables provide a summary of the Impact Assessment at the level of the Inner Study Area and Wider Study Area.

Table 4.1: Impact Assessment: Inner Study Area

Potential Impact / Activity	Sensitivity of Receptor	Scale	Duration	Spatial Extent	Magnitude of Effect	Significance	Significance after Mitigation
Direct & Supply Chain impacts							
Construction	Medium	Medium (positive)	Short-term	Local	Medium (positive)	Moderate (positive)	Moderate (positive)
Operation	Medium	High (positive)	Long-term	Local	High (positive)	Moderate (positive)	Moderate (positive)
Decommissioning	Medium	Medium	Temporary	Local	Medium (positive)	Moderate (positive)	Moderate (positive)
Tourism	Medium	Low (positive)	Long-term	Local	Negligible	Negligible	Negligible
Recreation	Low	Low (positive)	Long-term	Local	Negligible	Negligible	Negligible
R&D	High	Medium (positive)	Long-term	Local / National / International	High (positive)	Moderate / Major (positive)	Moderate / Major (positive)

Table 4.2: Impact Assessment: Wider Study Area

Potential Impact / Activity	Sensitivity of Receptor	Scale	Duration	Spatial Extent	Magnitude of Effect	Significance	Significance after Mitigation
Direct & Supply Chain impacts							
Construction	Medium	High (positive)	Short-term	Regional	High (positive)	Moderate (positive)	Moderate (positive)
Operation	Medium	High (positive)	Long-term	Regional	High (positive)	Moderate (positive)	Moderate (positive)
Decommissioning	Medium	Medium (positive)	Temporary	Regional	Medium (positive)	Moderate (positive)	Moderate (positive)
Tourism	Low	Negligible	Long term	Regional	Negligible	Negligible	Negligible
Recreation	Low	Negligible	Long term	Regional	Negligible	Negligible	Negligible
R&D	High	Medium (positive)	Long term	Local / National / International	Medium (positive)	Moderate (positive)	Moderate (positive)

5.0 Appendix 1: Port Assessment

5.1 The construction, operation and decommissioning of the European Offshore Wind Deployment Centre will require the use of port facilities. The extent to which ports will be required will vary depending on various factors such as the technical specification of the wind farm, the location of the development site and the level of ongoing maintenance required. This appendix briefly explores the port specifications needed to deliver each phase of the proposed wind farm development, and seeks to identify at high level which ports in the local area could be suitable.

5.2 The following ports have been assessed. These ports were chosen on the basis that they are the nearest major ports to the development site and are of sufficient size to support at least part of the construction and / or operational phases.

- Aberdeen
- Peterhead
- Cromarty Firth (including Nigg and Invergordon)
- Dundee

5.3 Aberdeen and Peterhead are located within the Inner Study Area, whilst Cromarty Firth and Dundee are outside of the Inner study area but within the Wider Study Area.

Port Requirements

Construction and Decommissioning Activity

5.4 The National Renewable Infrastructure Plan (NRIP) produced by Scottish Enterprise and Highlands and Islands Enterprise (2010a) sets out the priorities for investment in infrastructure to ensure that the Scottish economy benefits from the growth potential of the renewable energy sector. The report identifies sites suitable for offshore wind construction, ranking them according to their potential.

5.5 The NRIP draws upon research carried out by BVG Associates for DECC (2009), which identified that the typical requirements for a construction port with the capacity to deploy 100 turbines a year is:

- At least 80,000 sq m (8 hectares) suitable for laydown and pre-assembly
- 200-300 m of quayside length with high load baring capacity and adjacent access
- Water access to accommodate vessels up to 140 m in length, 45 m beam and 6 m draft with no tidal or other access restrictions
- Overhead clearance of 100 m minimum to allow for the vertical transportation of towers
- Sites with weather restrictions could require additional lay down space, up to 300,000 sq m (30 hectares)

5.6 Whilst the DECC (2009) report identifies the infrastructure required to deploy 100 turbines per year, the proposed project is much smaller at only 11 turbines. On this basis, it is possible that some of the infrastructure requirements such as the extent of lay-down space could be scaled back given the need to handle fewer turbines at any one point in time (depending on the exact method of construction). The Project has indicated that approximately 20,000 sq m (2 hectares) of laydown space will be required at the construction port.

5.7 However, the requirements for harbour access, draft, quayside length and vessel dimensions are likely to be as per the DECC (2009) assessment, since it is anticipated that the proposed project will utilise standard jackup crane vessels (as per the DECC, 2009 assessment).

Operational Phase

5.8 The DECC (2009) report describes the need for ports to act as bases for operations and maintenance activities. The main factors in choosing an operations and maintenance port are proximity to the offshore wind farm (in order to minimise transfer times), uninterrupted access, and adequate berthing for maintenance vessels.

5.9 As a result of the oil and gas industry there is already a wide range of locations which are able to service the operations and maintenance of wind farm operations, particularly along the east coast of Scotland.

Port specifications

Aberdeen

5.10 The Port of Aberdeen is the closest major port to the proposed development site. It is the principal commercial port in Northern Scotland dealing with general cargo, roll-on/roll-off and container traffic. There a total of six deep water berthing areas in Aberdeen Harbour. Consultations with Aberdeen Harbour have identified Telford Dock as being the most suitable for construction and / or assembly of wind farm components. Telford dock has 520 m of berthing space available, a heavy lifting area and two transit sheds. The two sheds have a total space of 4,700 sq m (0.47 ha). This could make them suitable for storing parts such as turbine blades. It is possible that the construction phase could take place at Aberdeen, although there are some constraints in terms of the amount of space available.

5.11 Aberdeen has expressed an interest in becoming the operations port for the EOWDC development. The port has over 40 years experience in delivering similar support services for the oil and gas industry. It also benefits from being the closest location to the wind farm site, reducing the time taken to transfer between the wind farm and the port. The port has confirmed that it would be possible for operations activities to take place alongside existing port activities.

5.12 The NRIP Stage 2 document (Scottish Enterprise, 2010b) states that Aberdeen has the 'potential [to be used] for distributed manufacturing and service and maintenance [of offshore wind farms], and expertise in offshore industries which could be diversified.'

5.13 Aberdeen Harbour recently made the following statement in support of the proposed development:

> *"We welcome today's announcement and subsequent planning application; both crucial steps in driving forward the European Offshore Wind Deployment Centre (EOWDC).*
>
> *"Renewable energy, and in particular the offshore wind industry, has the potential to generate significant levels of traffic for Aberdeen Harbour in the future, while offering considerable economic opportunities that will benefit the whole region. Vessels involved in surveying and drilling bore holes for offshore wind farms are, for example, already utilising the port's facilities.*
>
> *"The EOWDC is a facility that has the potential to substantially develop the north east's burgeoning renewables sector. The harbour's future role as an operations and maintenance base for the Scottish renewables industry is something we will embrace as we build on the excellent reputation we have already established within the existing oil and gas industry."*

Peterhead

5.14 Peterhead port is located to the north of the proposed wind farm site. Based upon consultations with representatives of the Peterhead Port Authority, Smith Embankment is the facility which is most likely to be able to service any wind farm related construction activity. This newly developed facility has a 200 m berthing area, with 10 m draft, heavy lifting equipment and no tidal restrictions. Attached to the Smith Embankment is 16,000 sq m (1.6 ha) of working area which is specified as being suitable for offshore and onshore renewable developments. There is the potential to reclaim a further 50,000 sq m (5 ha) from the harbour if the phase 2 development goes ahead.

5.15 Peterhead has experience in delivering ongoing support to the oil and gas industry and would be a suitable base for the operations base for the proposed wind farm. It is possible that part of the ASCO facility to the south of the port area could be redeployed to support the offshore renewable industry.

Cromarty Firth

5.16 Cromarty Firth is a trust port. The Cromarty Firth Port Authority (CFPA) has authority over the shipping and navigation across the whole of the Firth up to a limit of two miles offshore. The CFPA own several facilities within the Firth such as the Invergordon Service Base, whilst some other assets such as those at Nigg are owned by other parties.

5.17 Nigg is a 96 hectare facility majority owned by KBR Ltd. Its facilities include a dry dock, large fabrication / warehouse buildings, 725 m of quayside with load-out areas up to 1,000 tonnes. It is accessible in all states of wind and tide, with extensive deep water and sheltered anchorage. Existing buildings on site include fabrication units of 17,000 sq m, assembly of 17,000 sq m and warehousing of 22,000 sq m. The NRIP Stage 2 report (Scottish Enterprise, 2010b) identifies that the site is suitable for large scale integrated manufacturing of offshore wind components, construction, and operations activities, particularly in conjunction with the site at Invergordon. The turbines used for the Beatrice offshore wind demonstrator project were assembled at Nigg. Nigg has the potential to be used for construction activities relating to the Aberdeen Offshore Project.

5.18 The Invergordon Service Base (ISB) has around 450 m of quayside space with water depth varying between 5.5 and 12 m. The ISB has many years experience supporting the oil and gas sector and has developed a strong supply chain. Therefore, ISB would have many of the necessary skills and expertise to be involved as an operations facility for the Aberdeen Offshore Wind project, once in place. The main downside is that the distance between Cromarty Firth and the proposed development site is significant, meaning that there may be other closer ports to the development site which are more suitable overall.

Dundee

5.19 The port of Dundee currently offers around 27 hectares of development land available for the renewable sector, all of which is in the ownership of Forth Ports. Other sites have been identified within the City of Dundee for renewable energy activities which do not require waterside access. The port itself offers about 1,800m of quayside in a sheltered location with access to the North Sea unrestricted by either air draft or vessel width. The water depth along the quay is up to 9.5m. Facilities include heavy lift equipment and required space to accept jack-up rigs. Potential exists for a rail freight terminal within the port estate.

5.20 The NRIP Stage 2 report (Scottish Enterprise, 2010b) identifies that there ‘is potential for a major turbine manufacturing facility and a tower manufacturing facility to co-locate on the site.’ Further capacity could exist for supply chain operations within the existing site.

5.21 In theory Dundee would have the required facilities and experience to act as either a construction or operations port for the Aberdeen Wind Farm development. However, as with Cromarty Firth, the distance between the port and the development site may prove to be a significant drawback in terms of operations activities.

Summary of Port Suitability

5.22 Table 5,1 below summarises the capability of the four chosen ports for construction activity, based upon the high-level assessment we have conducted.

Table 5.1: Summary of Port Suitability – Construction Activities

	Suitability as a construction port	Suitability as an operational port	Comments
Aberdeen	✔	✔	Some constraints in space available, but potentially sufficient for the EOWDC project. Proximate to the development site.
Peterhead	✔	✔	Some constraints in space available, but plans to expand capacity in the future. Proximate to the development site.
Cromarty Firth (Nigg)	✔	x	Highly ranked by the NRIP as a site to support the development of offshore wind in Scotland. Distance from site means it is less likely to be chosen for operational activity.
Dundee	✔	x	Large amounts of development space available. Highly ranked by the NRIP as a site to support the development of offshore wind in Scotland. Distance from site means it is less likely to be chosen for operational activity.

5.23 On the basis of this assessment, it appears that both of the ports in the Inner Study Area (Aberdeen and Peterhead) could be utilised in the construction phase of the proposed project; particularly given the relatively small scale of the EOWDC development relative to other commercial wind farm projects.

5.24 In terms of operations and maintenance activities, the most likely scenario is that one of the major ports in the Inner Study Area (Aberdeen or Peterhead) would be utilised. The rationale for this is that whilst other ports meet the requirements in terms of port infrastructure, the ports in the Inner Study Area benefit from proximity to the development site (which is a particular advantage for operational activities).

6.0 Appendix 2: Benchmarking of Offshore Wind Projects

6.1 The purpose of this section is to highlight the range of socio-economic impacts which have been considered in previous Environmental Impact Assessment studies for other comparable offshore wind projects around the UK, to inform the scope of the Impact Assessment. This assessment has been made through reference to completed Environment Impact Assessments of the following offshore wind projects, as summarised in Table 6.1:

- North Hoyle
- Beatrice
- Gwynt Y Mor
- Kentish Flats

6.2 In summary, the main socio-economic impacts identified across all of the case studies are:

- Direct employment during the Construction, and Operations and Maintenance phases
- Value of the construction project
- Supply chain effects

- Impact on tourism and recreation
- Impact on other marine activities such as fishing and shipping

Table 6.1: Summary of Socio-Economic Impacts of Benchmark Offshore Wind Projects

Details of the development:	North Hoyle	Gwynt Y Mor	Kentish Flats	Beatrice Demonstrator
Location	North Wales	North Wales	Thames Estuary	Moray Firth
Capacity / number of turbines	60 MW 30 turbines	576MW 160 turbines	129MW 30 turbines	10MW 2 turbines
Timescale	Constructed in 2002	Installation 2011-2014	Constructed 2004	Constructed 2006
Scope of assessment:				
Direct employment during the Construction, and Operations and Maintenance phases	✔	✔	✔	✔ #
Value of construction project	✔	✔	✔	✔ #
Supply chain effects	✔	✔	✔	✔ #
Impact on tourism and recreation	✔	✔	✔	✔
Impact on other marine activities such as fishing and shipping	✔	✔	✔	✔
Impact on offshore wind industry	✔		✔	
Community benefits		✔		
Sources of Information:	[8]	[9]	[10]	[11], [12]
# - not considered in the EIA report itself, but within a separate report by Highlands and Islands Enterprise / Snedden Economics (2005)				

7.0 References

- BIS (2009) Guidance for Using Additionality Benchmarks in Appraisal
- BIS (2010) Impact Assessment Guidance

- [8] Source: NWP Offshore Ltd (2002) North Hoyle Offshore Wind Farm Environmental Statement
- [9] Source: Gwynt Y Mor Offshore Wind Farm Limited (2005) Environmental Statement – Non Technical Summary
- [10] Source: Global Renewable Energy Partners (2002) Kentish Flats Offshore Windfarm: Non-technical Summary
- [11] Source: Talisman Energy (2004) Beatrice Wind Farm Demonstrator Project: Environmental Statement

[12] Snedden Economics Ltd (2005) Economic Impact of Proposed Talisman Offshore Wind Farm in the Beatrice Oilfield

- BWEA (2006) The impact of wind farms on the tourist industry in the UK
- BWEA (2009) UK Offshore Wind: Charting the Right Course
- BWEA (2010) Building an Industry
- DECC (2009) UK Ports for the Offshore Wind Industry: Time to Act
- English Partnerships (2008) Additionality Guide: Third Edition
- Ernst & Young (2009) Cost of and financial support for offshore wind
- Glasgow Caledonian University (2008) The economic impacts of wind farms on Scottish tourism
- Global Renewable Energy Partners (2002) Kentish Flats Offshore Windfarm: Non-technical Summary
- Gwynt Y Mor Offshore Wind Farm Limited (2005) Environmental Statement − Non Technical Summary
- HM Treasury (2003) Green Book
- Marine Scotland (2011) Economic Assessment of Short Term Options for Offshore Wind Energy in Scottish Territorial Waters: Costs and Benefits to Other Marine Users and Interests
- NWP Offshore Ltd (2002) North Hoyle Offshore Wind Farm Environmental Statement
- RenewableUK (2010) UK Offshore Wind: Building an Industry
- Scottish Enterprise and Highlands and Islands Enterprise (2010a) National Renewables Infrastructure Plan Stage 1 Report
- Scottish Enterprise and Highlands and Islands Enterprise (2010b) National Renewables Infrastructure Plan Stage 2 Report
- Scottish Government (2009) Technical Report: Economic Impact of Recreational Sea Angling in Scotland
- Scottish Renewables (2010) Scottish Offshore Wind: Creating an Industry
- Snedden Economics Ltd (2005) Economic Impact of Proposed Talisman Offshore Wind Farm in the Beatrice Oilfield
- Surfers Against Sewage (2009) Guidance on environmental impact assessment of offshore renewable energy development on surfing resources and recreation
- Talisman Energy (2004) Beatrice Wind Farm Demonstrator Project: Environmental Statement
- Technip (2011) Rochdale Envelope Requirements for the European Offshore Wind Development Centre
- The Crown Estate / BVG Associates (2010) Guide to an Offshore Wind Farm

8.0 Glossary

- GVA / Gross Value Added – a measure of the economic value of a job or economic activity
- GW – Gigawatt, a measure of electrical generation capacity, equivalent to 1 billion Watts

- Ha – hectare (10,000 square metres)
- MW – Megawatt, a measure of electrical generation capacity, equivalent to 1 million Watts
- STW – abbreviation for Scottish Territorial Waters

European Offshore Wind Deployment Centre
Environmental Statement

Appendix 24.1: In Air Noise Baseline Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

1 IN – AIR NOISE BASELINE TECHNICAL REPORT

1 This baseline technical report describes the measurement of the background noise and derivation of noise limits at various locations along the shoreline near the proposed European Offshore Wind Deployment Centre (EOWDC) to the north of Aberdeen.

1.1 Information for the Non-Technical Summary

2 A baseline noise survey has been carried out in order to establish the existing background noise at the four closest residential properties to the proposed offshore wind farm and at a further two locations representative of properties further inland where the influence of noise from the sea will be lower. The measurement locations were agreed with the Environmental Health Departments at Aberdeen City and Aberdeenshire Council. This document summarises the findings.

3 The measured background noise levels are influenced by sea noise and by traffic noise, especially that from the A90. Noise levels also show a correlation with increasing wind speed.

4 The results are used to derive the noise limits for the proposed EOWDC according to the UK Department of Trade & Industry's ETSU-R-97, *The Assessment and Rating of Noise from Wind Farms* (DTI, 1996).

1.2 Introduction

5 An assessment has been carried out of the existing noise environment at locations along the shoreline closest to the proposed development to the north of Aberdeen.

6 The baseline survey has been carried out to derive noise limits for the proposed development according to guidance normally used for onshore wind farms. This guidance has been used as there is currently a lack of Planning Policy Guidance for offshore wind farms with respect to noise impact on onshore residential properties.

7 This approach has been agreed with the Environmental Health Officers from Aberdeen City and Aberdeenshire Councils.

1.2.1 Methodology Consultation

8 Aberdeen Offshore Wind Farm Limited (AOWFL) submitted a Request for an Environmental Impact Assessment (EIA) Scoping Opinion in August 2010. Chapter 6.9 deals with in-air noise assessment. None of the responses received identified specific requirements for in-air noise assessment for residential properties onshore.

9 The Environmental Health Officers of Aberdeen City Council and Aberdeenshire Council have been consulted regarding the assessment methodology and the choice of measurement locations for the baseline noise survey:

- Andrew Gilchrist, Aberdeen City Council (110106)
- John Dawson, Aberdeenshire Council (110106)

1.2.2 Key Guidance Documents

10 The following key documents have been used in the assessment:

- Scottish Executive (2011). Planning Advice Note PAN 1/2011: Planning and Noise
- Scottish Executive (2010). Web based 'renewables advice'
- DTI Working Group on Noise from Wind Turbines (1996). The Assessment and Rating of Noise from Wind Farms ETSU-R-97
- Aberdeenshire Council (2005). Use of Wind Energy in Aberdeenshire: Guidance for Developers – Supplementary Planning Guidance Part 1
- Bowdler et al (2009). Institute of Acoustics (IOA) Bulletin Vol 34 no 2, March/April 2009 Prediction and Assessment of Wind Turbine Noise

11 The documents listed above have all been written for the purpose of assessing onshore wind farm developments but have been adopted for this project as providing suitable guidance on assessing background noise and deriving noise limits for the onshore residential properties.

1.2.3 Data Information and Sources

12 Background noise data was measured at 6 locations for three weeks. Wind speed was simultaneously measured with a SoDAR (Sound Detection and Ranging) remote sensing device on a field at Easter Hatton. This onshore wind data has been translated to the offshore wind farm location as described in (Oldbaum 2011).

- Oldbaum Services Limited (2011a). Wind speed data spatial translation – Method Statement for Aberdeen Offshore Windfarm Limited (Appendix 3).
- Hayes McKenzie Partnership Ltd. (2011). Measurement of background noise data and rainfall.
- Oldbaum Services Limited (2011b). Wind speed data spatial translation – Wind data analysis for Aberdeen Offshore Windfarm Limited (Appendix 4).

1.3 Baseline Description

1.3.1 Legislative and Planning Context

Planning Advice Note PAN1/2011, Planning and Noise

PAN1/2011 indentifies two sources of noise from wind turbines; mechanical noise and aerodynamic noise. It states that '*Good acoustical design and siting of turbines is essential to minimise the potential to generate noise*'. It refers to the '*web based planning advice*' on renewables technologies for onshore wind turbines.

Scottish Executive Web Based Planning Advice, Onshore Wind Turbines

13 The web based Planning Advice, Onshore Wind Turbines refers to ETSU-R-97, *Assessment and Rating of Noise from Wind Farms* (DTI, 1996a), as the document that *'should be followed by applicants and consultees and used by planning authorities to assess and rate noise from wind energy developments*'. There is no equivalent guidance for offshore wind farms, but there is no reason why the ETSU-R-97 guidance should not apply. ETSU-R-97 contains noise limits designed to protect external amenity during the day and sleep disturbance at night. These limits are derived from baseline noise measurements carried out at potentially affected properties around the proposed development site.

ETSU-R-97, The Assessment and Rating of Noise from Wind Farms

14 ETSU-R-97, *The Assessment and Rating of Noise from Wind Farms* (DTI 1996a), presents the recommendations of the Working Group on Noise from Wind Turbines, set up in 1993 by the DTI as a result of difficulties experienced in applying the noise guidelines existing at the time to wind farm noise assessments. The group comprised independent experts on wind turbine noise, wind farm developers, DTI personnel and local authority Environmental Health Officers. In September 1996 the Working Group published its findings by way of report ETSU-R-97. This document describes a framework for the measurement of wind farm noise and contains suggested noise limits, which were derived with reference to existing standards and guidance relating to noise emission from various sources.

15 The form of the noise limits proposed in ETSU-R-97 is that noise should be limited to X dB L_{A90} or 5 dB above the ‘prevailing background noise level’, whichever is the greater.

16 For night-time (2300-0700) the value of ‘X’ is given as 43, to protect against sleep disturbance indoors with a window open. The prevailing background noise is that acquired during the same night-time hours.

17 For day-time hours (evenings and week-ends) ‘X’ is given as 35-40 with the actual value in the range dependant on:

- The number of dwellings in the neighbourhood of the wind farm.
- The effect of noise limits on the number of kWh generated.
- The duration and level of exposure.

The prevailing background noise is that acquired during the quiet day-time hours, as defined in ETSU-R-97.

18 A simplified limit of 35 dB L_{A90} for 10 m height wind speeds up to 10 m/s is specified for smaller or more remote schemes obviating the need for background noise measurements in such cases. This also provides a useful tool for determining the extent of baseline monitoring required for any proposal.

19 It is stated that the $L_{A90,10min}$ noise descriptor should be adopted for both background and wind farm noise levels and that, for the wind farm noise, this is likely to be between 1.5 and 2.5 dB less than the L_{Aeq} measured over the same period. The $L_{Aeq,t}$ is the equivalent continuous 'A' weighted sound pressure level occurring over the measurement period t. It is often used as a description of the average noise level. Use of the L_{A90} descriptor for wind farm

noise allows reliable measurements to be made without corruption from relatively loud, transitory noise events from other sources.

20 ETSU-R-97 also specifies that a penalty should be added to the predicted noise levels, where any tonal component is present. The level of this penalty is described and is related to the level by which any tonal components exceed audibility.

Lord Hunt's Response to Environmental Protection UK

21 In October 2009, The Rt Hon Lord Hunt of Kings Heath OBE (Minister of State, DECC) wrote to Environmental Protection UK in response to their claim that a review of ETSU was due. He states:

'You're quite right that modern turbines are generally larger than those on which the ETSU-R-97 guidance was based. Noise outputs from these larger turbines have also, however, reduced in that time. Since the ETSU-R-97 derived noise limits are a function of background noise, there is currently no evidence to suggest that the larger turbines are any more likely to cause a noise impact than earlier and smaller designs. Similarly, there is currently no evidence to suggest that the small incidence of Amplitude Modulation (AM) that is reported to occur at a few sites is as a result of turbine size'.
'In essence, therefore, we continue to support the approach set out in Planning Policy Statement (PPS) 22 - Renewable Energy, including the use of ETSU-R-97 to "ensure that renewable energy developments have been located and designed in such a way to minimise increases in ambient noise levels".

Use of Wind Energy in Aberdeenshire: Supplementary Planning Guidance Part 1

22 A variation to the lower fixed noise limits described by ETSU-R-97, (see above). Aberdeenshire Council specify lower noise limits at 38 dB $L_{A90,10min}$ during night-time and 35 dB $L_{A90,10min}$ during day-time for very quiet locations. Theses lower fixed noise limits are valid for measurements carried out externally and have been applied to this study.

Institute of Acoustics Bulletin Article, Prediction and Assessment of Wind Turbine Noise, March/April 2009

23 Institute of Acoustics Bulletin Vol 34 no. 2 (Bowdler et al., 2009) contains an agreement, jointly authored by a number of consultants working in the wind turbine sector for both developers, local authorities and third parties, on an agreed methodology for addressing issues not covered by ETSU-R-97. This includes a methodology for dealing with vertical wind shear (which is the difference of the wind speed at different heights).

24 It should be noted that this article is written in the context of onshore wind farms, but the recommendation for dealing with wind shear is also applicable for offshore wind farms.

1.3.2 Baseline Conditions

Measurement Positions

25 Noise measurements were agreed to be carried out at six measurement locations, representing the four closest dwellings to the proposed

development site and two locations further inland, as indicated on Figure 1, Appendix 1 and as described below.

Four Winds (E395191, N814956)

26 Four Winds is a property to the west of the proposed development roughly 1,530 m from the shore and 470 m to the west of the A90. The equipment was located in the eastern corner of the garden, closest to the proposed wind farm site and near to the amenity area, as shown in Photographs 1. The principal source of noise at this location was road traffic during installation, and road traffic and wind in the trees during collection of the equipment.

Photographs 1 Four Winds Baseline Noise Measurement Position

16 Chapelwell Wynd, Balmedie (E396968, N817138)

27 16 Chapelwell Wynd is a property to the west of the proposed development roughly 575 m from the shore and 645 m to the east of the A90. The equipment was located in the rear garden, by a pond so that the house was shielded from sea noise and in the amenity area, as shown in Photographs 2. The principal sources of noise at this location were road traffic, the sea, helicopters and the trickling of the pond (which was being drained by the owner to prevent future noise) during installation, and the sea, helicopters and wind in the trees during collection of the equipment.

Photographs 2 16 Chapelwell Wynd Baseline Noise Measurement Position

Easter Hatton (E396245, N816102)

28 Easter Hatton is a property to the west of the proposed development roughly 915 m from the shore and 65 m to the east of the A90. The equipment was located in the side garden, in the middle of the lawn amenity area, as shown in Photographs 3. The principal sources of noise at this location were road traffic and the sea during installation, and road traffic, the distant sea, aeroplanes and wind in the trees during collection of the equipment.

Photographs 3 Easter Hatton Baseline Noise Measurement Position

Hareburn House (E396294, N813979)

29 Hareburn House is a property to the west of the proposed development roughly 180 m from the shore and 780 m to the east of the A90. The equipment was located in the rear garden, between the house and the bushes in the amenity area, as shown in Photographs 4. The principal sources of noise at this location were the sea and distant road traffic during installation, and the sea, helicopters and wind in the bushes during collection of the equipment.

Photographs 4 Hareburn House Baseline Noise Measurement Position

3 Tarbothill Farm Cottages (E395696, N813430)

30 3 Tarbothill Farm Cottages is a property to the west of the proposed development roughly 680 m from the shore and 330 m to the east of the A90. The equipment was located in the side garden, in the amenity area, as shown in Photographs 5. The principal sources of noise at this location were the sea and distant road traffic during installation, and road traffic, the distant sea, distant farm machinery and wind in the bushes during collection of the equipment.

Photographs 5 3 Tarbothill Farm Cottages Baseline Noise Measurement Position

16 Dubford Gardens, Bridge of Don (E393913, N812140)

31 16 Dubford Gardens is a property to the west of the proposed development roughly 2,070 m from the shore and 720 m to the west of the A90. The equipment was located in the middle of the rear garden, in the amenity area, as shown in Photographs 6. The principal sources of noise at this location were road traffic and rain noise during installation, and road traffic and wind in the trees during collection of the equipment.

Photographs 6 16 Dubford Gardens Baseline Noise Measurement Position

Measurement Procedure

Instrumentation

32 The baseline noise measurements were made with four Larson Davis model LD-820 Precision Integrating Sound Level Meters fitted with 1/2" microphones, one Larson Davis model LD-831 and one Larson Davis model LD-824, which comply with the type 1 standard in IEC 651-1:1979. The microphones were fitted with 45 mm radius foam ball windshields surrounded by secondary windshields of 40 mm thickness, in line with recommendations in ETSU W/13/00386/REP, Noise Measurements in Windy Conditions (DTI, 1996b), and were mounted on tripods at a height of 1.2 m. Pre-calibration was carried out using a Bruel & Kjaer model 4231 acoustic calibrator (s/n 2218188). The calibration of each meter was checked at the end of the monitoring period using the same acoustic calibrator.

33 Noise monitoring equipment was left at the measurement positions for a period of 21 days from 15th February to 8th March 2011. The meters were programmed to measure a number of statistical noise indices, including the L_{A90}, together with the maximum and minimum levels and the L_{Aeq} (the Equivalent Continuous A-Weighted Sound Pressure Level) over consecutive 10-minute periods. Results were automatically stored at 10-minute intervals, synchronised to wind speed measurements from the on-site SoDAR to allow for later correlation between the two.

34 Calibration of the noise measurement equipment was carried out before the monitoring period commenced and was checked at the end. A drift of no more than 1.2 dB was noted at any location.

35 Wind speed and direction measurements were made with the AQ500 SoDAR unit installed at East Hatton, Balmedie (NGR E396714, N815608) at various heights up to 200 m agl (above ground level) during the course of the noise measurement. This data has been translated to the proposed EOWDC location as described in (Oldbaum 2011a and 2011b).

36 Rain data for the site has been obtained from the Met Office Central Climate Unit for the background noise survey. Periods with recorded rainfall from the Met Office data have been excluded from any further assessment.

Wind Shear

37 It is now well established that wind speed experienced by a wind turbine cannot be correctly predicted from 10 m height wind speed measurements and ground roughness conditions alone. Hub height wind speed, and hence the wind speed experienced by the wind turbine, may be under-predicted under these conditions and hence the output noise level may be under-predicted. To correctly account for this in the assessment methodology, background noise is referenced to hub height wind speed, as described in the agreement published in the Institute of Acoustics Bulletin (Bowdler et al., 2009).

38 Wind speed and direction was measured with an AQ500 SoDAR remote sensing device at Easter Hatton, Balmedie, an onshore location near the coastline. The data was recorded in 5 m steps from 50 m to 200 m. This data has been translated to the location of the offshore wind farm as described in (Oldbaum 2011b). For the assessment, the measured data correlating to hub height wind speed is used.

39 This translated hub height wind speed has then been corrected to 'standardised' 10 m height wind speed, as required by the method described in the IoA Bulletin using the same methodology as is used by the manufacturers to produce noise data for 'standardised' 10 m height wind speed, i.e.:

$$V_{10} = V_h \cdot \frac{\ln\left(\frac{h_{10}}{z_0}\right)}{\ln\left(\frac{h_h}{z_0}\right)}$$

40 Where V_{10} and V_h are the 'standardised' 10 m height (h_{10}) and hub height (h_h) wind speeds respectively, and z_0 is the standardised ground roughness length (= 0.05 m).

41 This standardisation is not intended to reflect actual 10 m height wind speed conditions and does not affect the relationship between turbine noise, background noise, and the derived noise limits.

Results of Noise Measurements

42 Raw data results of the noise measurements are not included in this chapter due to the relatively large amount of information gathered. Figures are, however, available on request which show the $L_{A90,10min}$ and $L_{Aeq,10min}$ in periods of 24 hours from midday to midday, at the measurement location, together with wind speed.

43 The noise limits are derived in accordance with ETSU-R-97 and the Aberdeenshire Supplementary Planning Guidance, as agreed with Aberdeen City Council and Aberdeenshire Council Environmental Health Officers.

44 Due to a technical error, the sound level meter at Hareburn House only recorded data for 3 days. During that period background noise levels were between 40 and 58 dB L_{A90} at 3 m/s and 52 and 59 dB L_{A90} at higher wind speeds during amenity hours and 42 and 55 dB L_{A90} at 3 m/s and 52 and 55 dB L_{A90} at higher wind speeds during night hours. Comparing the measured noise level of Hareburn House with the noise levels obtained at 3 Tarbothill Farm and 16 Chapelwell Wynd leads to the conclusion that background noise levels are generally higher at Hareburn House due to the proximity of the sea. The approach taken to use the noise limits derived from the measurement at Chapelwell Wynd as a substitute for Hareburn House is considered conservative as lower noise levels were recorded at this property compared to Tarbothill Farm. It is also assumed that using those noise limits is more representative for the houses in Blackdog which are further back from the shoreline as Hareburn House and would therefore receive less sea noise than Hareburn House.

45 Although the measured background noise data show a strong influence from the sea and the traffic noise of the A90 at all locations except Dubford Gardens, it also shows a correlation with increasing wind speed.

Noise Limits

46 Plots have been produced of the measured L_{A90} background noise levels against wind speed at six locations representing the four closest residential properties to the wind farm site and two more distant properties representative of properties further inland where the influence of noise from

the sea will be lower. The derived noise limits are based on the lower ETSU-R-97 day time limit and the night time limit of 38 dB L_{A90} or background noise level plus 5 dB, whichever is the greater. The plots for these locations also show the upper ETSU-R-97 day time limit for completeness.

47 The measured background noise correlated with equivalent offshore wind speed and subsequently derived noise limits according to ETSU-R-97 are shown in Chart X.1 to X.10 in Appendix 2 for the night hours and quiet day-time hours periods for the representative residential locations.

Other Residential Properties

48 The assessments carried out for the background noise measurement locations are generally representative of the properties most likely to be affected in each area. This has been determined by considering distance from the sea, distance from the A90, and the type of residential area.

49 Generally all other properties in the area being represented receive a lower predicted noise level and, assuming background noise is similar, will receive a lower impact than the assessed location.

50 The only area to which this doesn't apply is 16 Dubford Gardens. This is due to the measurement being chosen for being both further from the A90, and on the edge of the Aberdeen suburb of Bridge of Don. Although there are properties closer to the wind farm site, which will therefore have a higher predicted noise level from the wind farm, these properties will equally have a higher background noise than that of 16 Dubford Gardens, due to their proximity to the A90, sea and being in a more built-up region. 16 Dubford Gardens was therefore chosen to represent this area due to its location balancing these factors.

1.4 Summary

51 An assessment of the existing background noise at properties near the proposed EOWDC has been performed. The guidance contained within ETSU-R-97 has been used to derive noise limits at these properties.

52 Background noise measurements were made at six locations representative of those likely to be most affected by noise from the proposed development. These locations were agreed with the Environmental Health Officers for the Local Planning Authorities from the Aberdeen City and Aberdeenshire Councils.

53 Analysis of the measured data has been performed in accordance with ETSU-R-97 to determine the existing background noise environment at these six locations.

1.5 Appendices

- Appendix 1: Map showing measurement locations
- Appendix 2: Assessment charts from background noise survey
- Appendix 3: Oldbaum Services Limited (2011a). Wind speed data spatial translation – Method Statement for Aberdeen Offshore Windfarm Limited
- Appendix 4: Oldbaum Services Limited (2011b). Wind speed data spatial translation – Wind data analysis for Aberdeen Offshore Windfarm Limited.

1.6 References

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Appendix 1

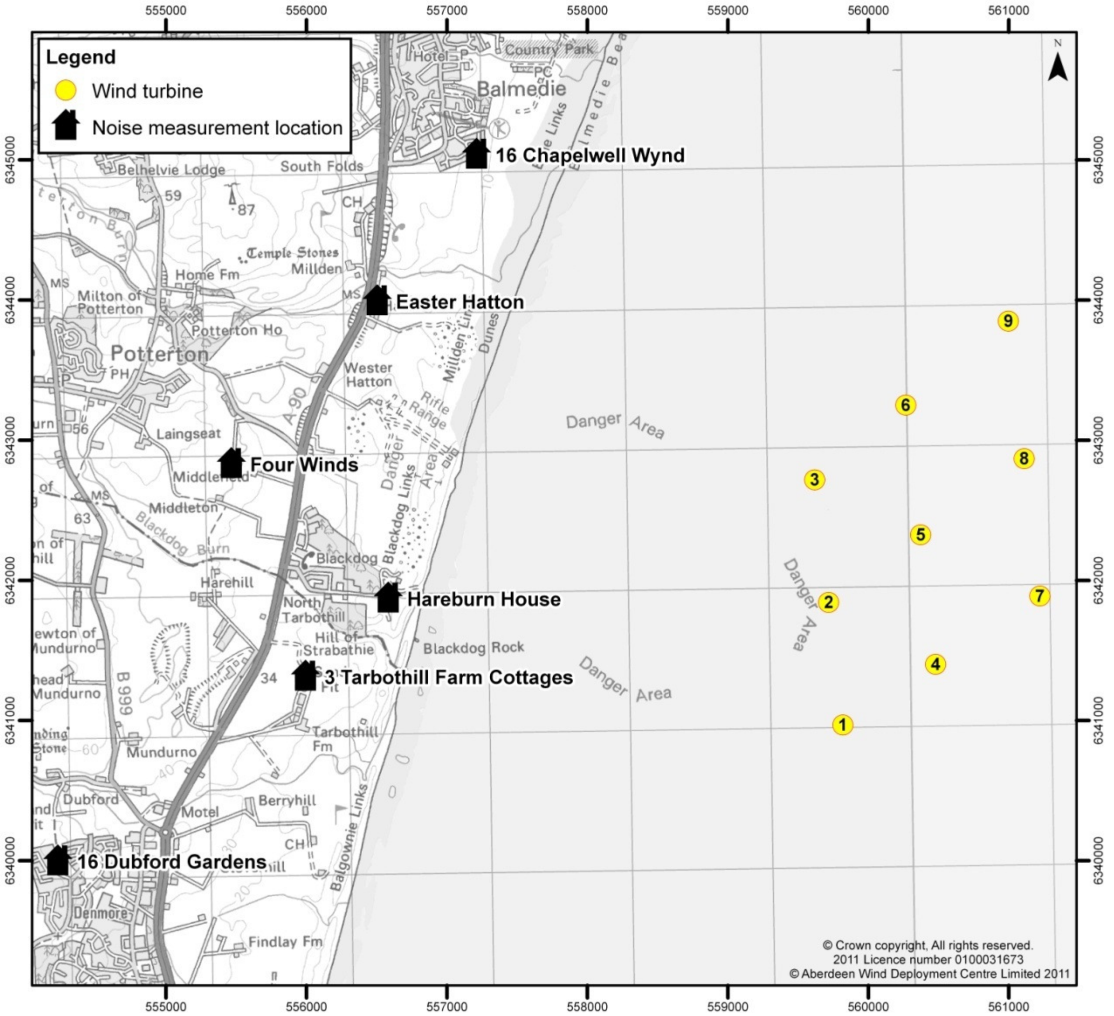


Figure 1 - Noise measurement locations

Appendix 2

Four Winds

Chart 1

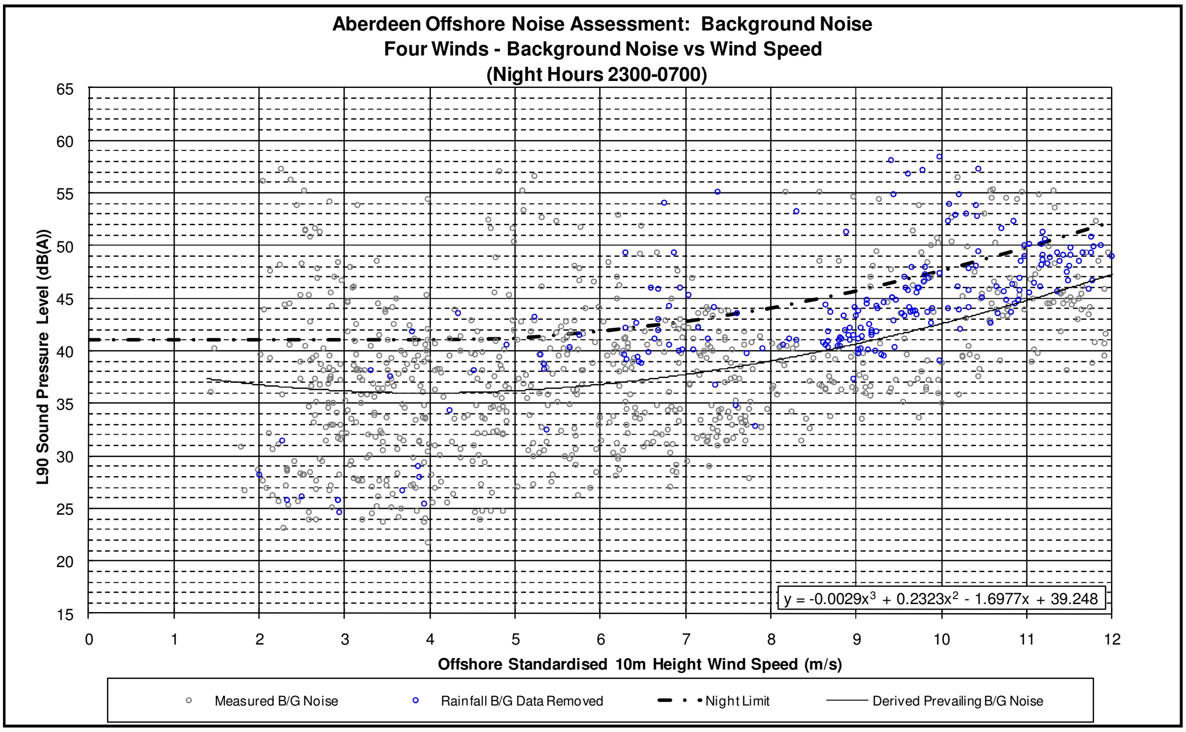
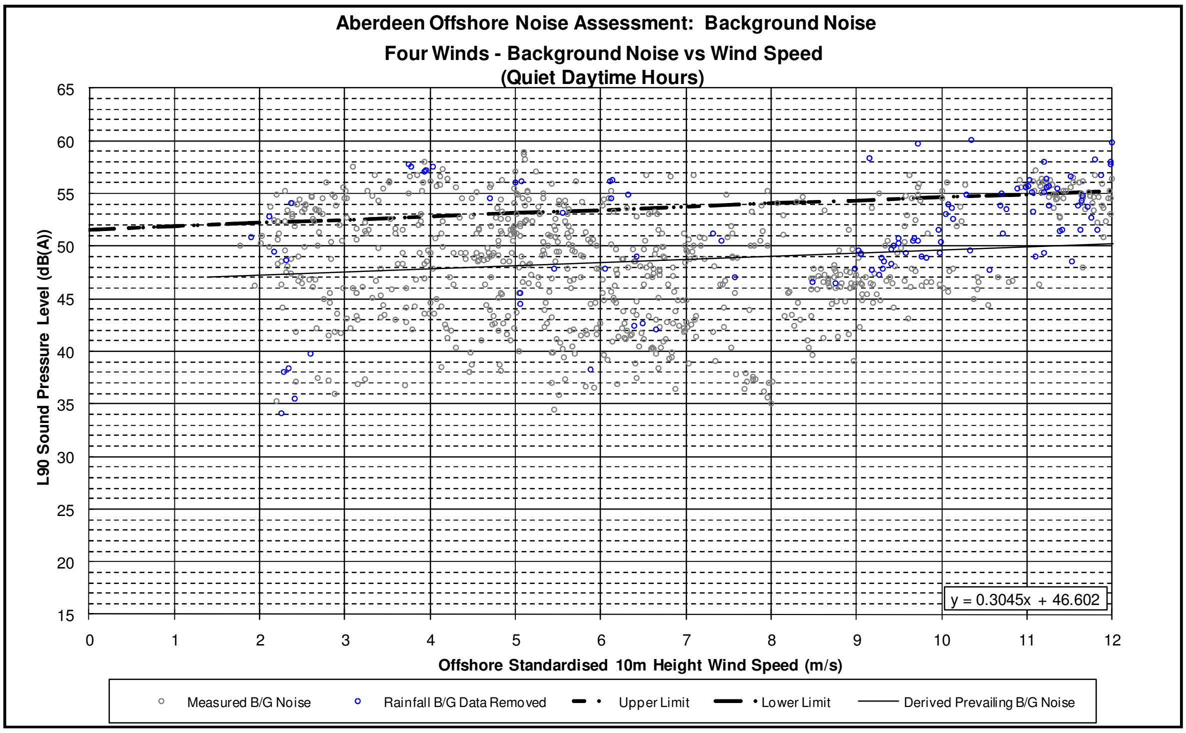


Chart 2



16 Chapelwell Wynd

Chart 3

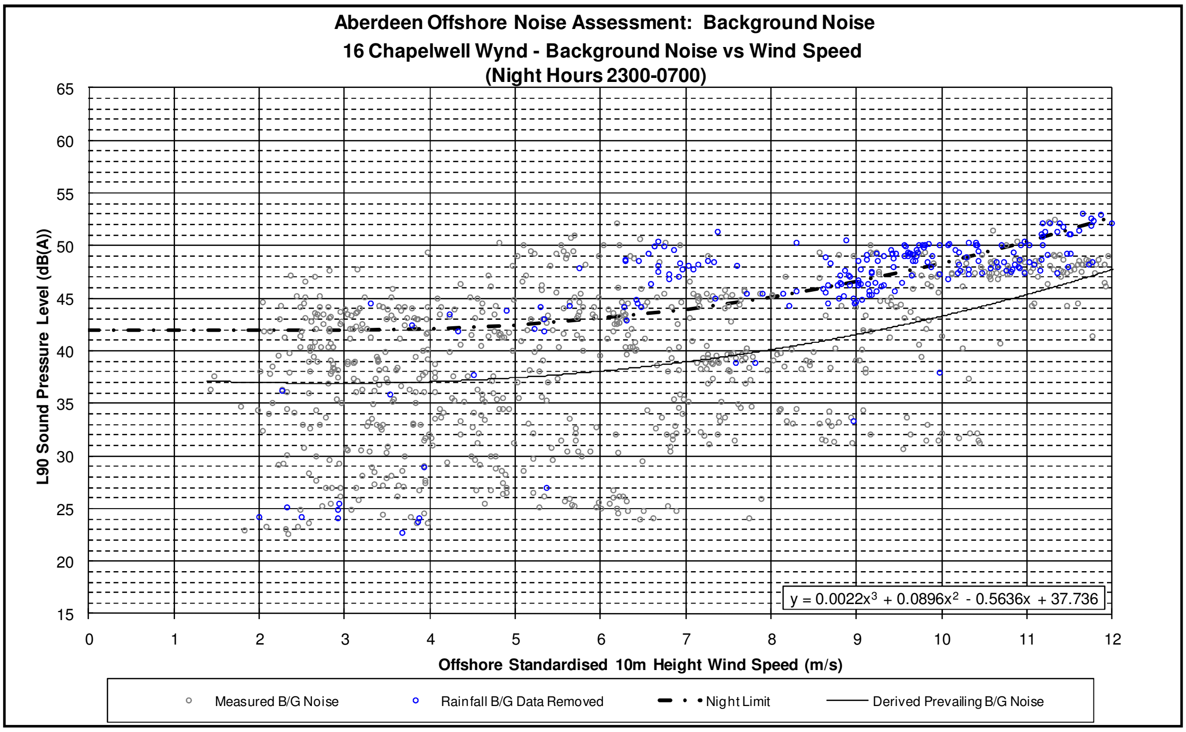
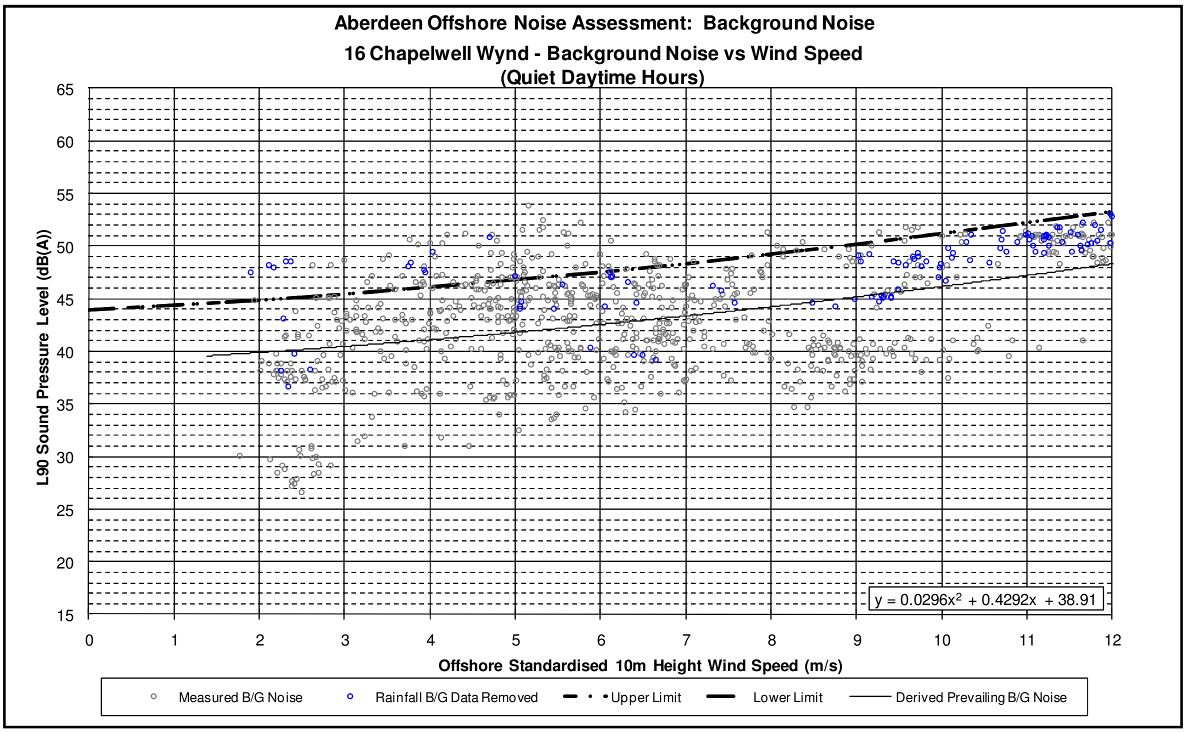


Chart 4



Easter Hatton

Chart 5

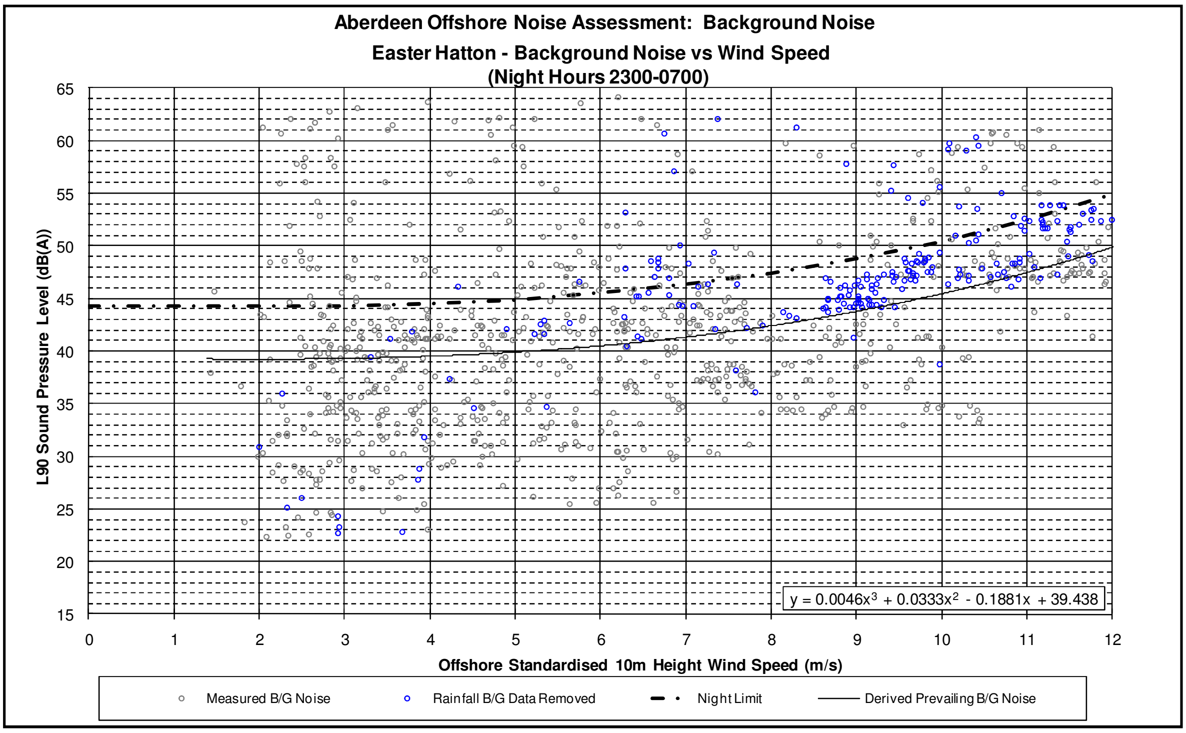
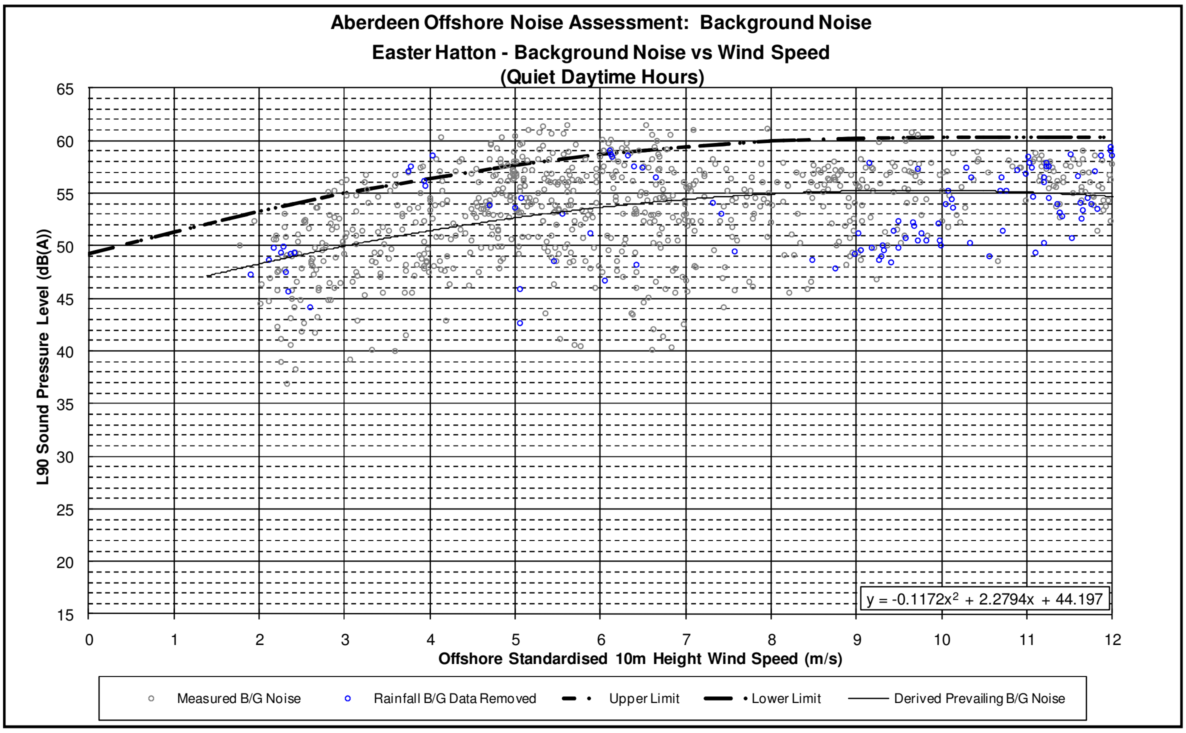


Chart 6



3 Tarbothill Farm Cottages

Chart 7

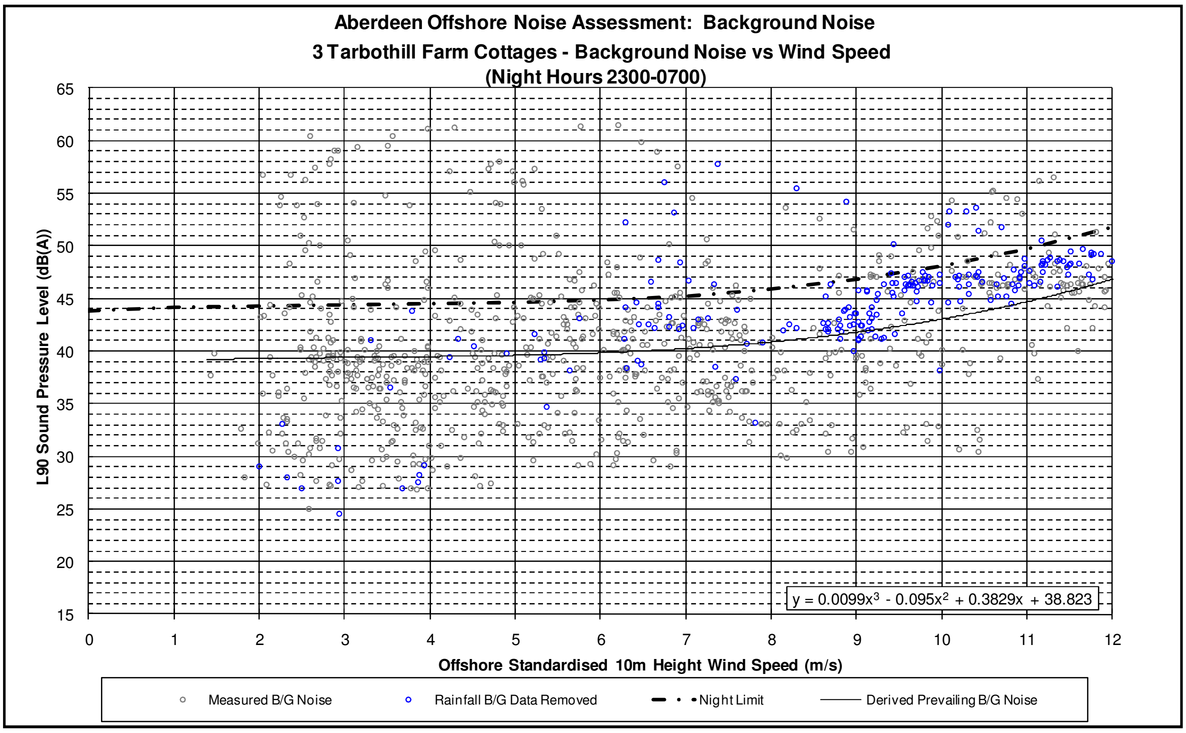
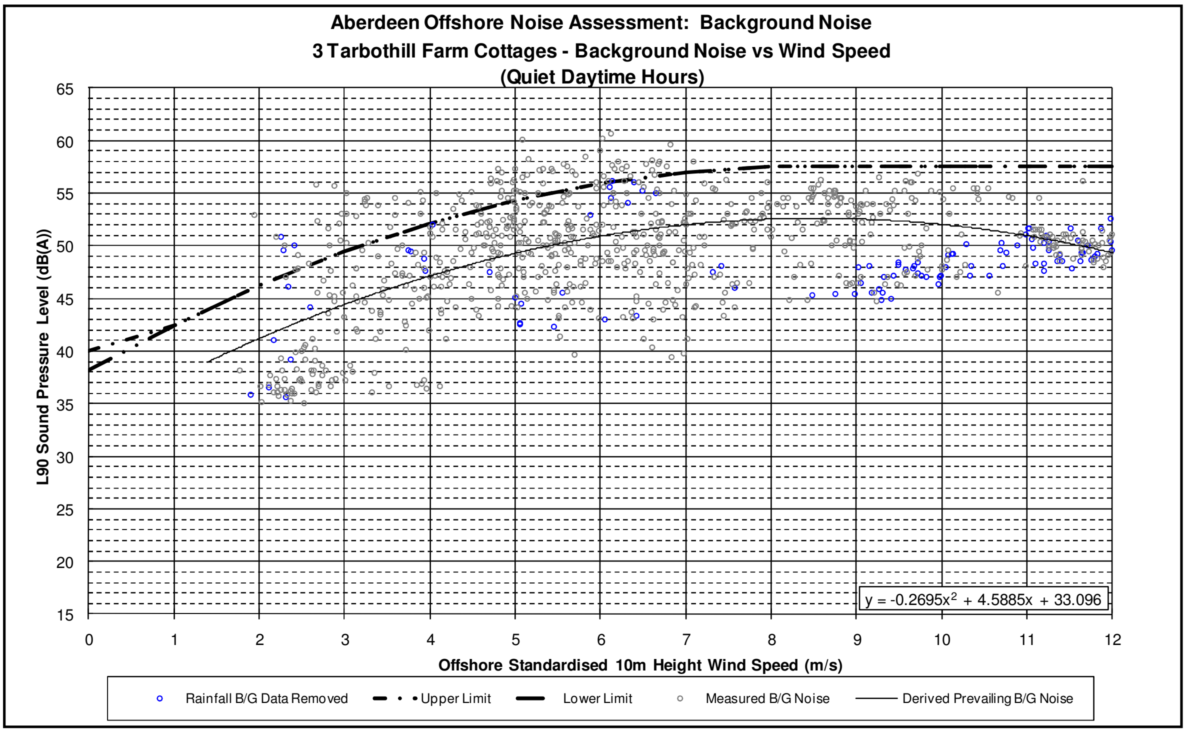


Chart 8



16 Dubford Gardens

Chart 9

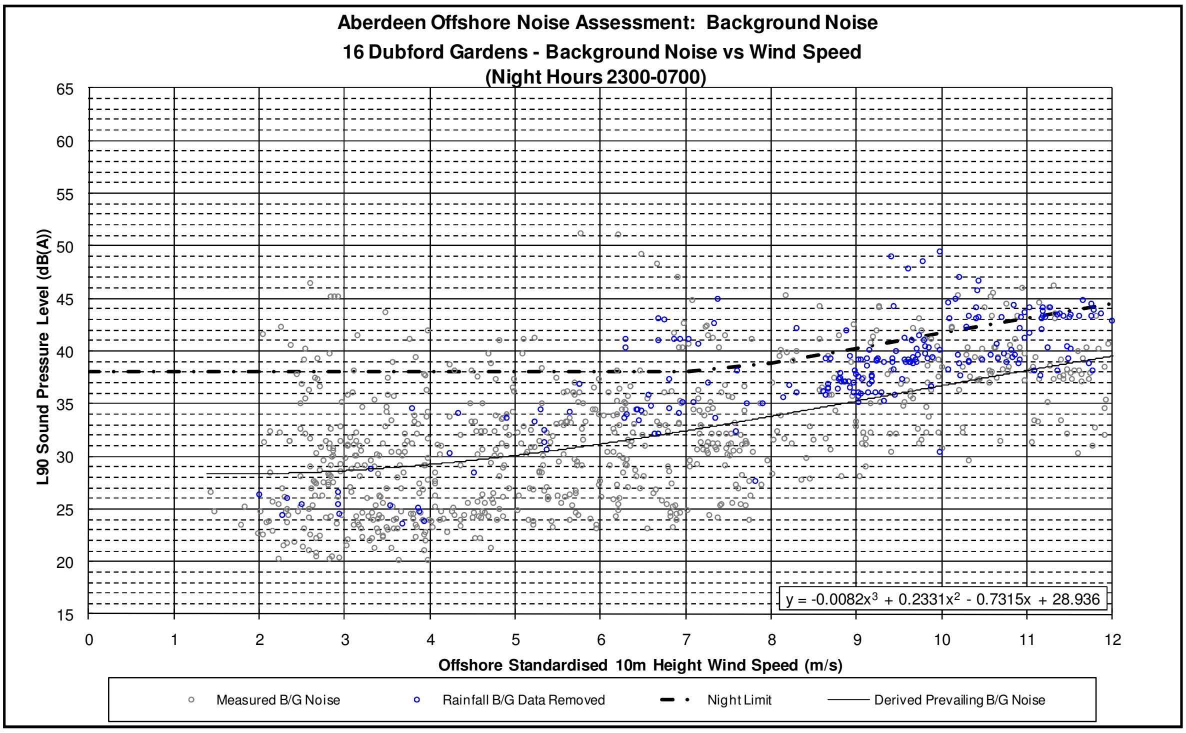
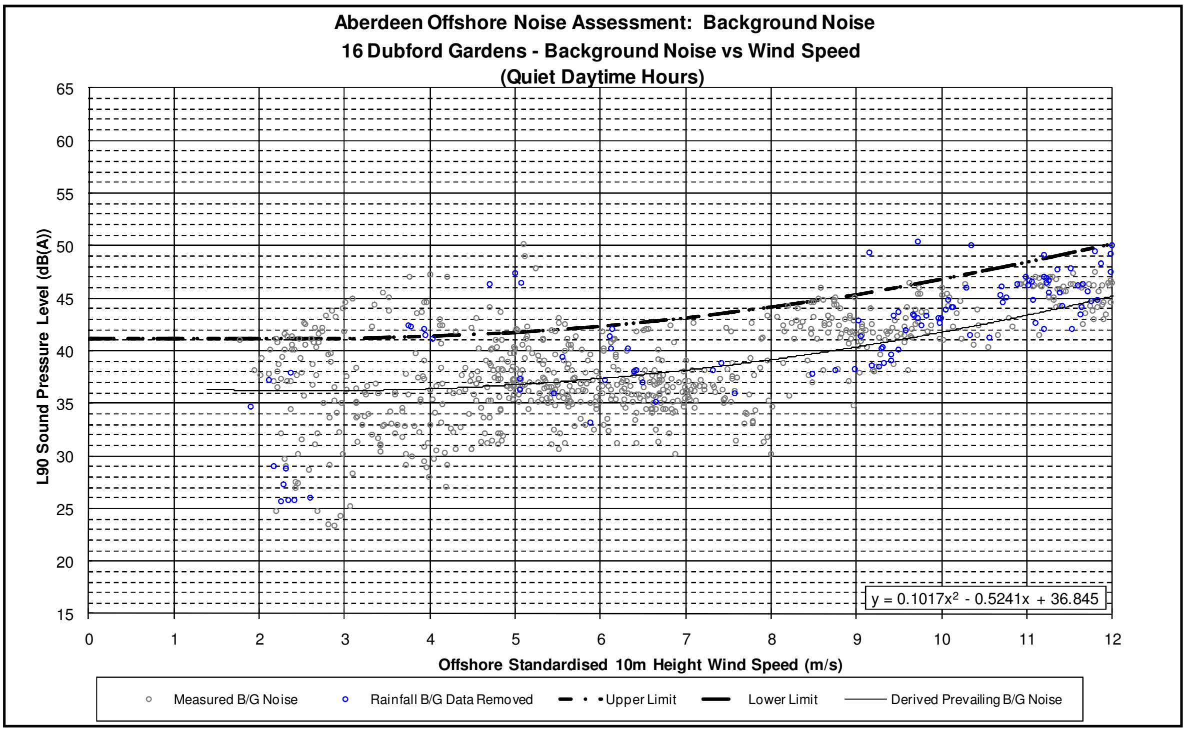


Chart 10



OLDBAUM SERVICES LIMITED

Wind speed data spatial translation – Method Statement

Aberdeen Offshore Windfarm limited

Andy Oldroyd

2/27/2011

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Overview:

Method statement for the translation of wind speed data for noise assessment from onshore to offshore.

Report No.:	RAOWFL001
Document type:	Method Statement
Site:	Aberdeen Offshore Windfarm
Analysis Period:	-
Client:	Aberdeen Offshore Windfarm Limited - -
Client Contact	Anthony Hunt & Gavin Scarf
Contractor:	Oldbaum Services Limited Unit 13a; The Alpha centre Stirling University Innovation park Stirling; Scotland FK9 4NF
Order No.:	-
Order date:	-
Document date:	27th February 2011
Author:	A Oldroyd (andy@oldbaumservices.co.uk)
Verified by:	M Griesbaum (monica@oldbaumservices.co.uk)
Revision Status	Final (Revision 2)

A Oldroyd M Griesbaum

The report consists of 14 pages including all annexes

Contents

1.0 Scope

The following method statement details the process to be undertaken to translate data from the AQ500 SoDAR deployment at Easter Hatton to the position of the proposed Aberdeen Offshore Windfarm.

The installation at Easter Hatton is detailed in the following reports, which are available upon request:

Method Statement: MSVFALL002-151210

Risk Assessment: RAVFALL002-261110

Install Report: IFVFLL002-120111

The coastal location represents a good compromise to onsite data acquisition for offshore wind farms.

Given the flat terrain nature of the installation, the SoDAR (Sound Detecting And Ranging) location should experience similar flow conditions to that of the offshore wind farm.

From the primary wind direction, the wind will approach the wind farm and SoDAR location from onshore (South West – Westerly being the predominant direction). As the wind translates from onshore to offshore, a new internal boundary layer will form, and develop until new free stream flow conditions are developed. Typically this can be in the order of 15km – 20km from the coastline, depending on local conditions. Therefore it can be expected that the offshore wind farm location will feel the effect of the onshore constraints.

From offshore, easterly winds, the flow can be thought of as open sea conditions. Again a coastal location is a good compromise for these conditions, as the close proximity of the installations to the coast line means that local roughness effects have had very little time and space to modify the flow such that the SoDAR will experience significantly different conditions from that seen offshore.

Section 2 introduces the AQ500 SoDAR system in general terms, with typical validation results, acquired in Scottish conditions, shown in Annex 1.

Section 3 states the methodology used to translate the data series spatially from the install location to the proposed wind farm installation. The technique shown can be thought of as standard industry practice, minimising any increase in uncertainty in wind speed.

2.0 Instrumentation

The following section introduces the technology used to capture wind speed data. The AQ500 SoDAR system is a well respected reliable unit which has been in use since 2002 in the wind industry. There are now over 200 units in operation, providing accurate wind speed data for a variety of roles within the wind industry sector.

2.1 AQ500 SoDAR system

Figure 2.1 shows the AQ500 system on site in Sweden, housed within its own trailer unit.

The system is designed to be primarily powered by PV input, but has the energy security of a small generator back-up system which is intelligently controlled to help maintain the voltage level in the 600Ah of battery storage.

The system is flexible, relatively easy to deploy, and has a good track record in the wind industry. As a first look system the AQ500 has an unprecedented track record in terms of data quality, system reliability, and customer base within the wind industry.

Figure 2.1: In deployment in Sweden with Thnadners attachment

Table 2.1 summarises the specification of the SoDAR system. Figure 2.2 shows the actual AQ500 antenna housed within the trailer unit. The whole setup is designed to minimise side-lobe sound propagation, i.e noise pollution, and to minimise broadband loud noise interference with the return signal.

Item	Specification	Range
1	Height Range	20-200m
2	Height Resolution	5m
3	Accuracy Wind Speed	0.1m/s
4	Antenna Arrangement	3-beam
5	Antenna Height	1.2m
6	Antenna Width	1m
7	Antenna Weight	70kg
8	Data Transfer	GSM
9	Data Format	ASCII via SODWIN Software

10	Operating Frequency	3144Hz
11	Temperature Range	-40 ^{o}C to +60 ^{o}C
12	Humidity Range	10 to 100% RH

Table 2.1: AQ500 system specification

The AQ500 is unique on the market in that it is a three beam arrangement rather than the more common phased array type approach. The main benefit of this technique is that the system has generally better data availability statistics throughout the height range (typically greater than 95% at 90m), is less prone to background noise issues, and is less prone to error in rain conditions. Rain intensifies the scatter of the output sound signal, meaning the return signal is generally at a lower level. As the AQ500 is capable of emitting 300W peak pulses, the system is capable of returning values even in rain periods. Annex 1 gives some indicative values of an AQ500 in comparison with a Met mast station.

Figure 2.2: AQ500 antenna in standalone setup – most systems now deployed in trailer unit

2.1.1 Power Supply

Power supply integrity is the achilles' heel of most remote sensing systems, specifically when looking to operate in cold climate conditions. The AQ500 has a robust well trialled system which provides an intelligent, always-on, stability to the system. Over 200 systems currently operate within the UK and Europe with little or no system failures due to power system failure. The main mode of non-system availability is in prolonged no solar period with fuel running out. This is generally due to running the system in a low fuel configuration for quick and easy re-deployment depending on measurement campaign.

Table 2.2 specifies the AQ500 trailer and power supply solution.

Item	Specification	Range
1	Solar Input	480W
2	Generator	5kW
3	Battery Storage	600Ah
4	SMS notification	Via GSM
5	Trailer Height	2m
6	Trailer Width	1.4m
7	Trailer weight (incl. SoDAR)	1100kg
8	Fuel Tank Size	200 l
9	Power Consumption	30-50W
10	Pulse Power (max)	300W (user set or adaptive according to SNR)
11	Acoustic Power	17W (Max)
12	Electrical heating	240V AC user defined thermostat

Table 2.2 Power Supply specification

2.1.2 Health and Safety and System Security

The AQ500 is a self contained unit with little or no user intervention required in the setup of the system.

Prior to every installation a full risk assessment is carried out by Oldbaum Services to ensure that all risks have been identified and mitigated. This is done in conjunction with the client to ensure the clients HSE policy is adhered to.

The system is fully self contained with no potential for environmental impact. All systems can be fully isolated with a central kill on/off switch available. All systems are provided with fire extinguishers as required.

Security is handled by an integrated GPS vehicle tracking system, high grade hitch lock, wheel lock, and if required all wheels can be removed allowing the system to be fully supported on the four corner levelling legs.

3.0 Methodology

In order to translate the data form onshore to offshore conditions, numerical modelling techniques will be employed which are standard within the wind industry.

For this project, the most appropriate software is the WAsP (Wind Atlas analysis and application Programme) software developed by the Danish Technical University at RISOE, Roskilde. WAsP 10.0 will be used for this analysis, which has been specifically updated to help with coastal boundaries in the numerical domain, and the transition from onshore to offshore conditions.

To provide the noise study with the required data, the change in flow characteristics will be obtained and reported as a series of speed ups, or coefficients generated within WAsP to be applied to wind speed values to show the effect of moving the data acquisition point from onshore to offshore.

It should be noted that it is not possible to translate the full resolution time series as the change in wind speed will be reported and summarised by a directional sector bin. Typically this is a bin of 30 degrees width, and therefore 12 sectors are reported. The reporting of data in directional sector bins is standard practice in the wind industry.

Therefore a speedup value will be calculated for each sector bin, and this will be applied to each wind speed value within the bin. This will have no negative impact on the wind shear profile derived from this process.

The procedural methodology for the Aberdeen Offshore Windfarm is:

1. AQ500 data received and quality checked using Oldbaum standard practice for SoDAR data;
2. Data analysed and summarised to show mean wind speed, profile by sector, turbulence by sector and both wind speed and wind direction distributions;
3. Data summarised and collated into 30 degree sector bins;
4. Definition of numerical run within WAsP, including importing of local terrain maps;
5. Import of data series and summary of data acquisition point within WAsP;
6. Plausibility check of WAsP values with initial analysis values reported in 2;
7. Data summary of wind speed coefficients at the Aberdeen Offshore Wind development area;
8. Modification of SoDAR time series using WAsP calculated coefficients.

The output will be a wind speed timeseries consistent with industry best practice and suitable for use within the noise measurement campaign.

5.0 About Oldbaum

Oldbaum Services is a wind energy consultancy, with roots tracing back to 2003. In 2003 Technical Director Andy Oldroyd won a Green Energy Award whilst working for Chillwind for introducing a new measurement technique (Sound Detecting and Ranging or SoDAR) to the wind industry sector.

Andy, and his fellow Director Monica Griesbaum have continued to bring innovation and rigour to the wind industry, pioneering quality control and wind sensor use with such novel techniques as LiDAR and SoDAR.

Our company and experience has continued through involvement in innovative high profile projects such as the Beatrice offshore wind demonstrator, and has been recognised by Oldbaum Services winning an EC FP7 bid for the NORSEWInD Programme, with Andy Oldroyd as Coordinator.

NORSEWInD is a 7 million Euro project designed to deliver offshore wind atlases for the Baltic, Irish and North Sea areas based on physical data. The data is acquired from Met masts, LiDAR's located offshore and satellite based datasets. The result is a highly innovative project reducing uncertainty in offshore development by easing access to data for offshore developers.

Oldbaum are recognised experts in remote sensing and in particular data acquisition in offshore wind developments. This knowledge and understanding of the wind energy sector will prove invaluable in terms of understanding fully the nature of the challenges ahead, delivering the outputs defined in the feasibility study, and ultimately delivering a useable, innovative and necessary marine energy development tool.

Oldbaum Services are part of the Leosphere Wind Experts programme, and have been working with all forms of LiDAR since 2005. Oldbaum have designed acceptance tests and measurement campaigns for all forms of LiDAR (Continuous wave or pulse) and have therefore a unique perspective and experience in the unique challenges posed by each system type.

Annex 1.0: AQ500 validation results

The following is an extract of a test undertaken at Myers Hill in Scotland. The data IS FORM a well instrumented 80m met mast as reference, with the AQ500 being located 300m to the South West of the system. No filters have been applied apart form directional filters to exclude the influence of the 1MW NEG MICON WTG's located to the North East and South East of the met mast.

Full test results can be downloaded here: http://www.aqs.se/wordpress/wp-content/uploads/2009/12/AQSMH001_221209.pdf (large file)

Annex 1.0: Data Availability

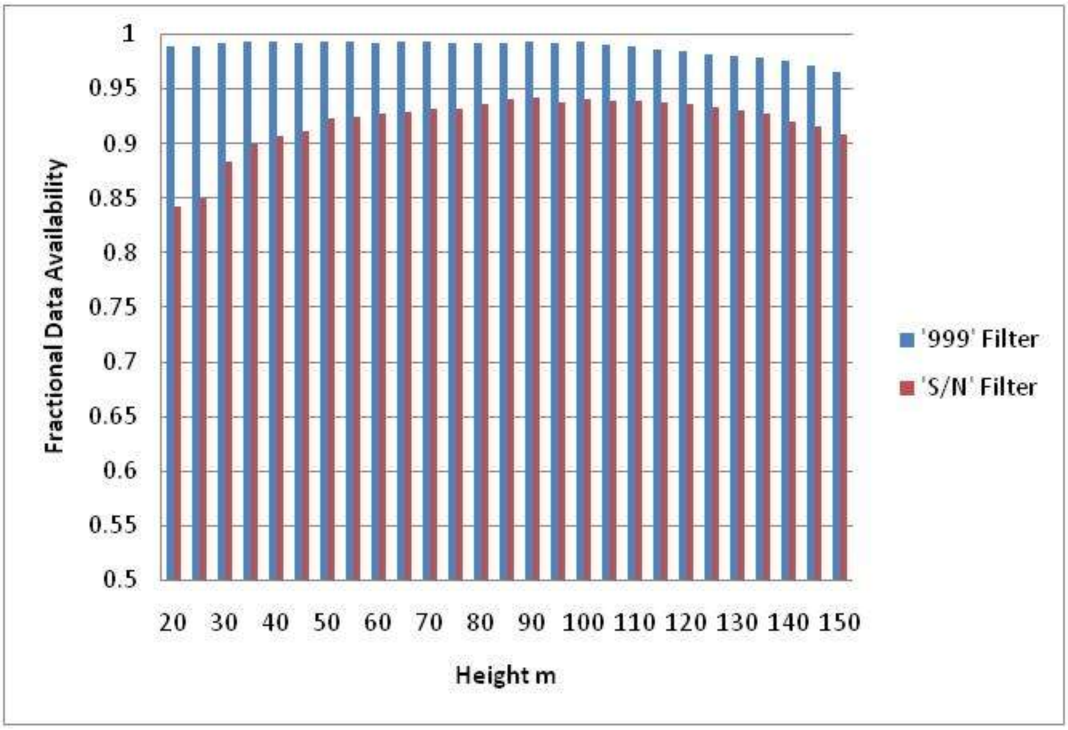

Figure A1.1: Data Availability of AQ500 System

Annex 1.0: Correlation Results

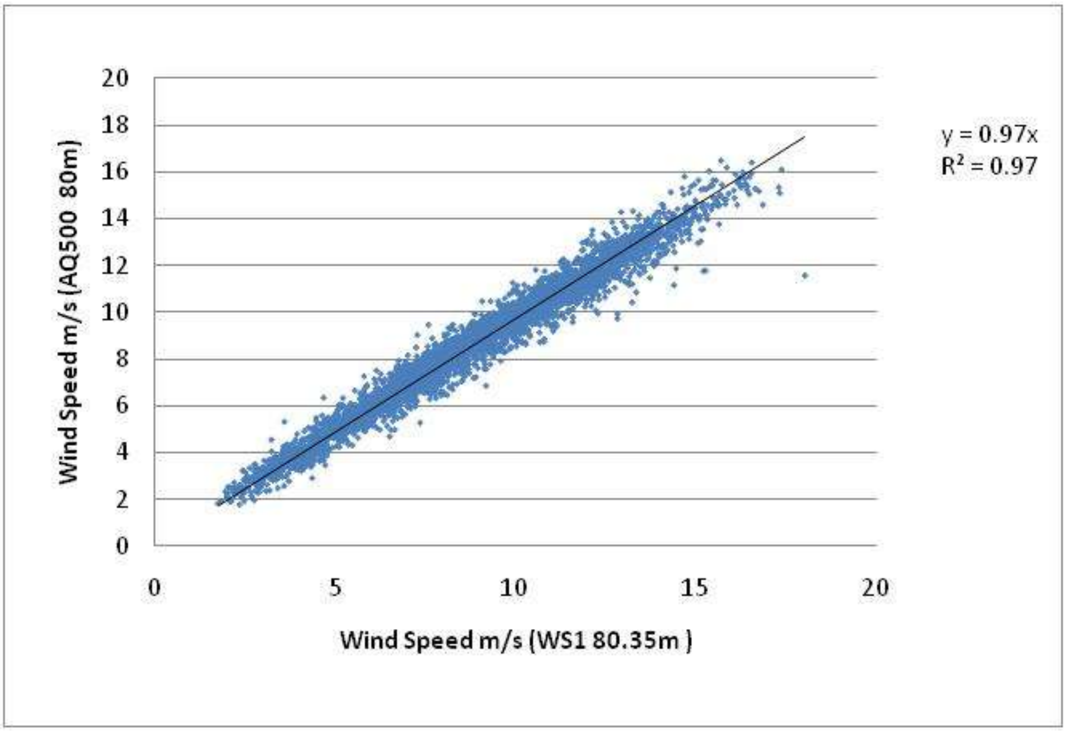

Figure A1.2: Overall correlation with 80m mast @ 80m, 300m Separation. Direction filter applied

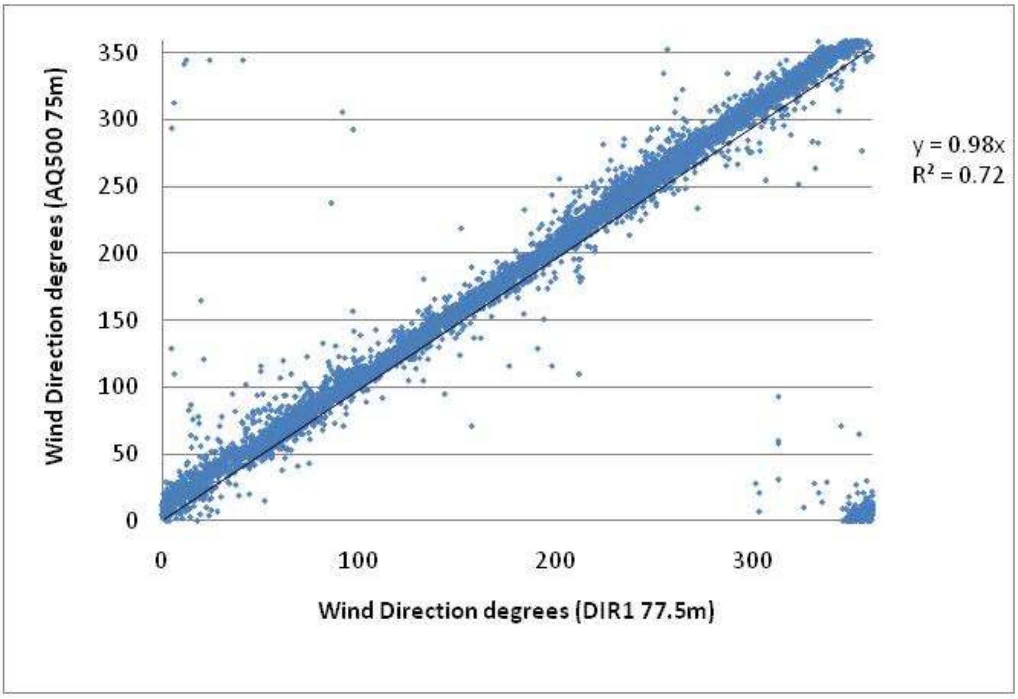

Figure A1.3: Direction Correlation – No applied filter

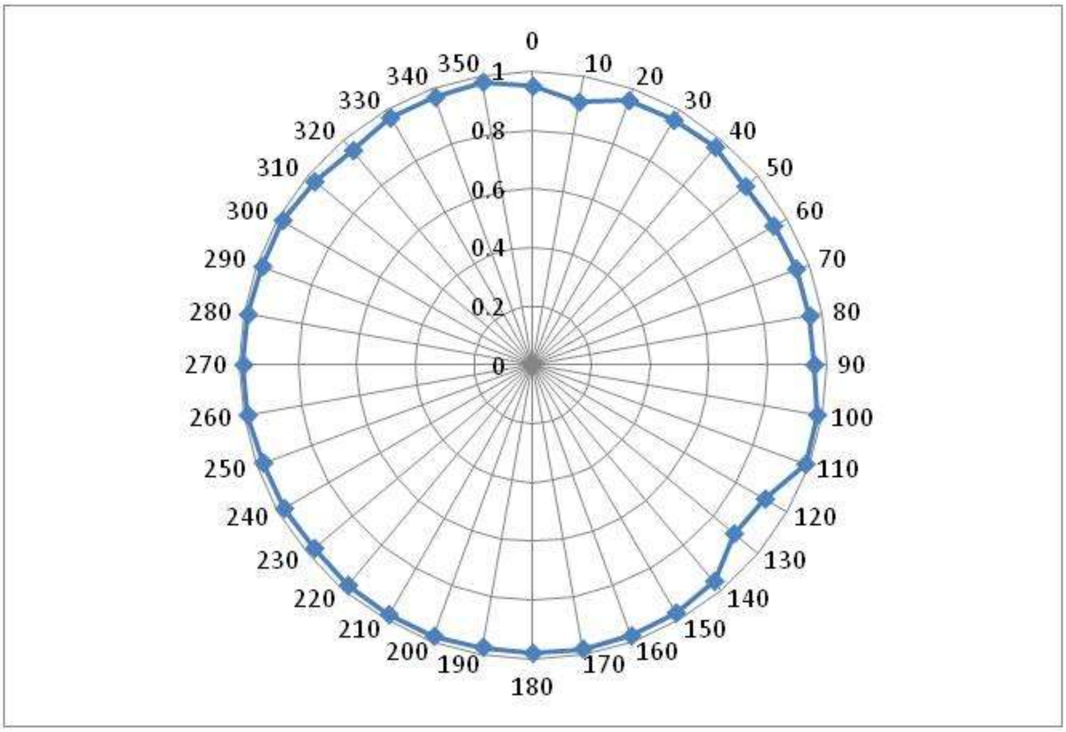

Figure A1.4: Correlation by Direction. Kinks show location of NEG Micon systems

Annex 1.0: Shear Profile Results

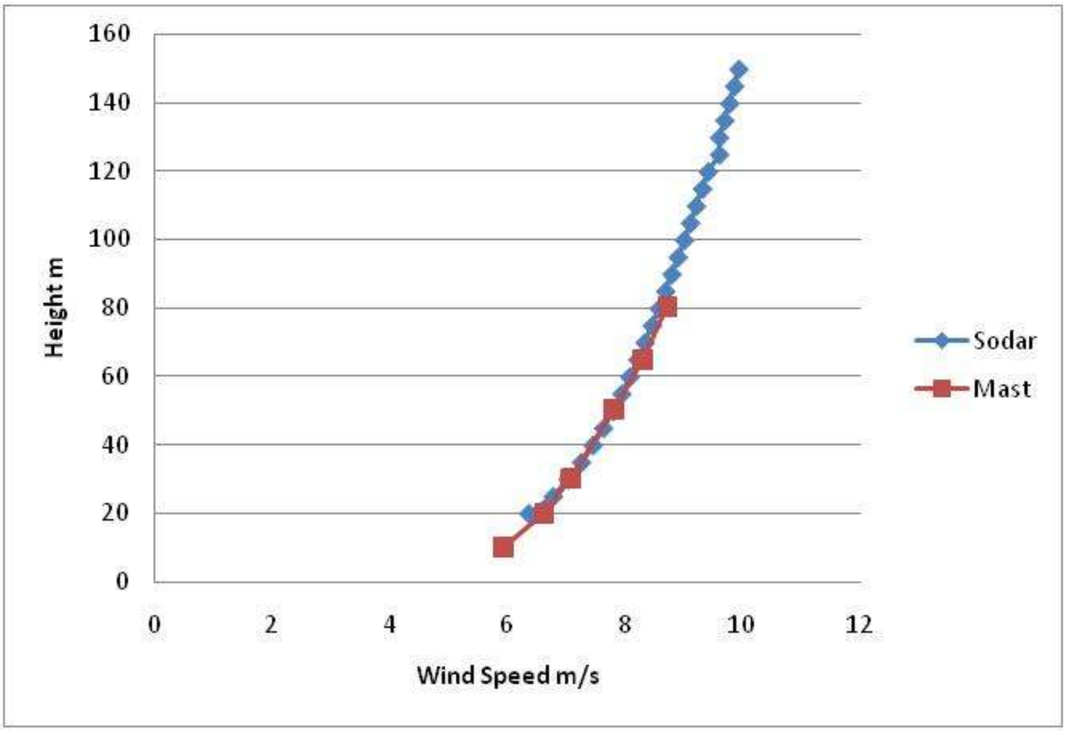

Figure A1.5: Shear profile Direction filter applied

	Mast	Sodar
c	0.0017	0.0026
b	4.9921	4.8059
α	0.2003	0.2081
R^2	0.9944	0.9979

Table A1.1: Regression analysis output equation of form cx^b .

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All RS systems have issue with turbulence through spatial and temporal averaging, or in some cases systematic filtering of the turbulence spectrum. IN this case we advocate the use of bin averaged values. Time series turbulence should be treated with caution, however Bin averaging shows the ability of the system for site classification.

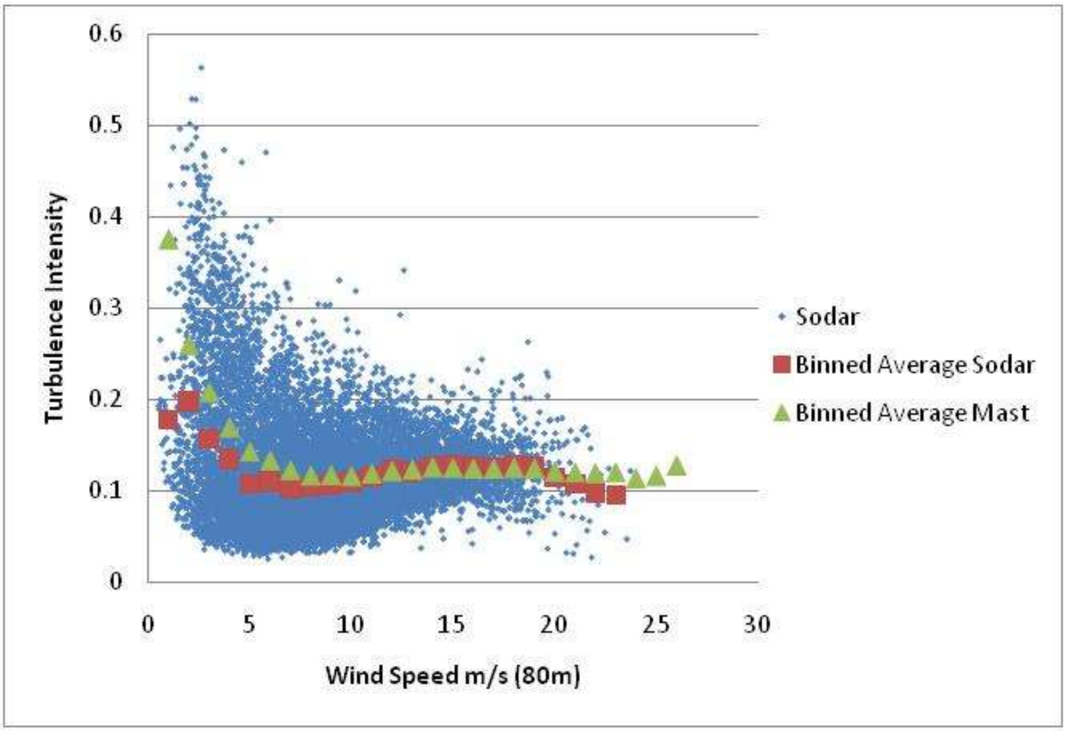

Figure A1.6: Turbulence Bin averaged values

Annex 1.0: Rain performance

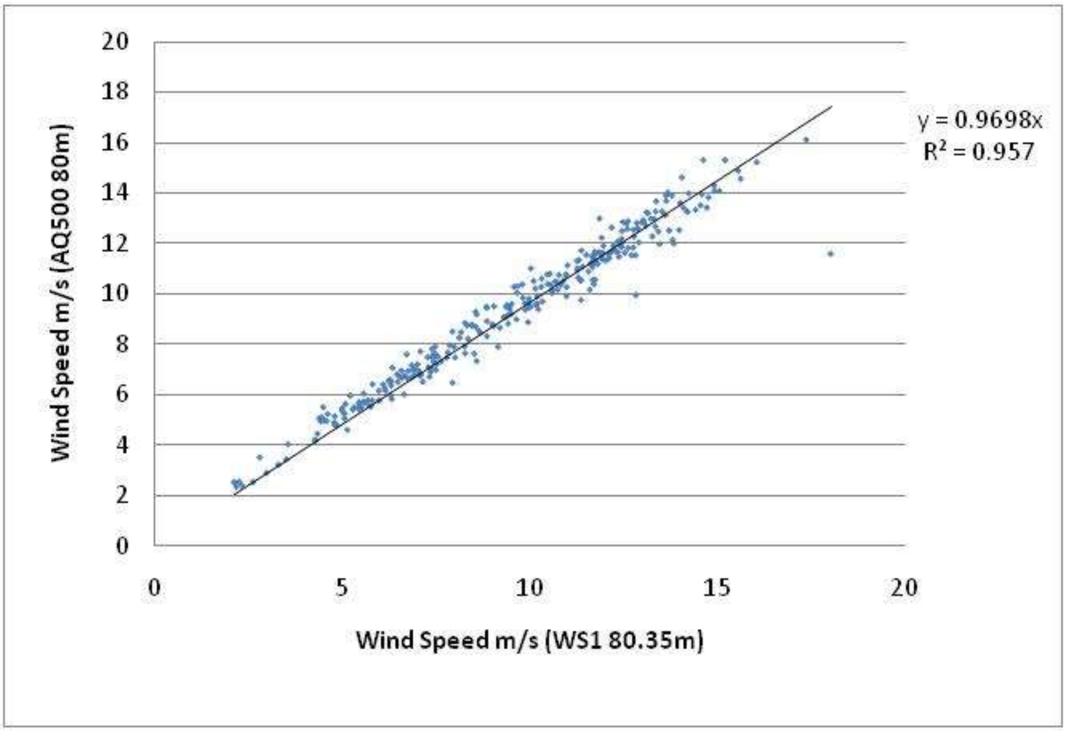

Figure A1.7: Rain period data

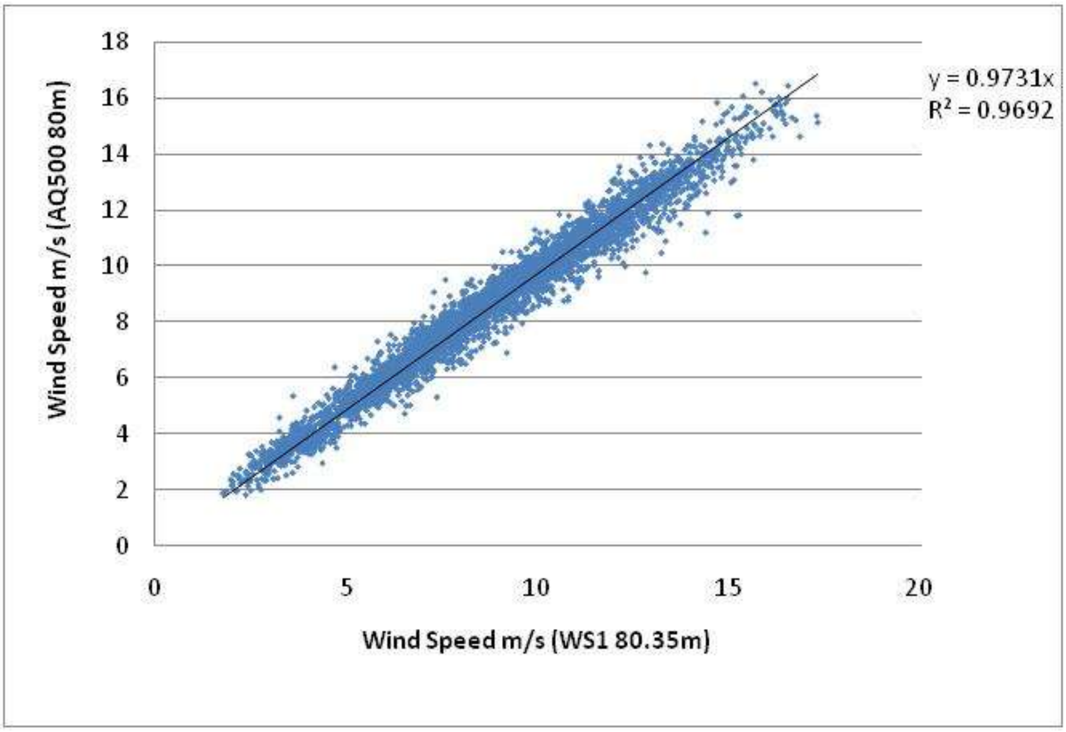

Figure A1.8: Non rain affected,

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Wind speed data spatial translation

Aberdeen Offshore Windfarm Limited

Andy Oldroyd

3/18/2011

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Overview:

Wind data analysis for Aberdeen offshore wind farm limited

Report No.:	RAOWFL002 - 180310
Document type:	Report
Site:	Easter Hatton
Analysis Period:	-
Client:	Aberdeen Offshore Windfarm Limited - -
Client Contact	Anthony Hunt; Gavin Scarf
Contractor:	Oldbaum Services Limited Unit 13a; The Alpha centre Stirling University Innovation park Stirling; Scotland FK9 4NF
Order No.:	-
Order date:	-
Document date:	18th March 201
Author:	A Oldroyd (andy@oldbaumservices.co.uk) P Maji (p.maji@oldbaumservices.co.uk)
Verified by:	M Griesbaum (monica@oldbaumservices.co.uk)
Revision Status	Final

A Oldroyd

M Griesbaum

The report consists of 23 pages including all annexes

Contents

1.0 Scope

The following report details the process undertaken to translate data from the AQ500 SoDAR deployment Easter Hatton to the position of the proposed Aberdeen Offshore Windfarm.

The installation at Easter Hatton is detailed in the following reports, which are available upon request:

Method Statement: MSVFALL002-151210

Risk Assessment: RAVFALL002-261110

Install Report: IFVFLL002-120111

The coastal location represents a good compromise to onsite data acquisition for offshore wind farms.

The location to be used as the wind farm site is: **400533, 814777.**

Given the flat terrain nature of the installation, the SoDAR (Sound Detecting And Ranging) the assumption is that the wind farm location should experience similar flow conditions to that of the offshore wind farm.

From the primary wind direction, the wind will approach the wind farm and SoDAR location from onshore (South West – Westerly being the predominant direction). As the wind translates from onshore to offshore, a new internal boundary layer will form, and develop until new free stream flow conditions are developed. Typically this can be in the order of 15km – 20km from the coastline, depending on local conditions. Therefore it can be expected that the offshore wind farm location will feel the effect of the onshore roughness.

From offshore, easterly winds, the flow can be thought of as open sea conditions. Again a coastal location is a good compromise for these conditions, as the close proximity of the installations to the coast line means that local roughness effects have had very little time and space to modify the flow such that the SoDAR will experience significantly different conditions from that seen offshore.

Section 2 introduces the AQ500 SoDAR system in general terms, with typical validation results, acquired in Scottish conditions, shown in Annex 1.

Section 3 states the methodology used to translate the data series spatially from the install location to the proposed wind farm installation. The technique shown can be thought of as standard industry practice, minimising any increase in uncertainty in wind speed.

Section 4 summarises the results of the analysis.

.0 Instrumentation

The following section introduces the technology used to capture wind speed data. The AQ500 SoDAR system is a well respected reliable unit which has been in use since 2002 in the wind industry. There are now over 200 units in operation, providing accurate wind speed data for a variety of roles within the wind industry sector.

2.1 AQ500 SoDAR system

Figure 2.1 shows the AQ500 system on site in Sweden, housed within its own trailer unit.

The system is designed to be primarily powered by PV input, but has the energy security of a small generator back-up system which is intelligently controlled to help maintain the voltage level in the 600Ah of battery storage.

The system is flexible, relatively easy to deploy, and has a good track record in the wind industry. As a first look system the AQ500 has an unprecedented track record in terms of data quality, system reliability, and customer base within the wind industry.

Figure 2.1: In deployment at Easter Hatton with Thnadners attachment

Table 2.1 summarises the specification of the SoDAR system. Figure 2.2 shows the actual AQ500 antenna housed within the trailer unit. The whole setup is designed to minimise side-lobe sound propagation, i.e noise pollution, and to minimise broadband loud noise interference with the return signal.

Item	Specification	Range
1	Height Range	20-200m
2	Height Resolution	5m
3	Accuracy Wind Speed	0.1m/s
4	Antenna Arrangement	3-beam
5	Antenna Height	1.2m
6	Antenna Width	1m
7	Antenna Weight	70kg
8	Data Transfer	GSM
9	Data Format	ASCII via SODWIN Software
10	Operating Frequency	3144Hz
11	Temperature Range	-40 ^{o}C to +60 ^{o}C
12	Humidity Range	10 to 100% RH

Table 2.1: AQ500 system specification

The AQ500 is unique on the market in that it is a three beam arrangement rather than the more common phased array type approach. The main benefit of this technique is that the system has generally better data availability statistics throughout the height range (typically greater than 95% at 90m), is less prone to background noise issues, and is less prone to error in rain conditions. Rain intensifies the scatter of the output sound signal, meaning the return signal is generally at a lower level. As the AQ500 is capable of emitting 300W peak pulses, the system is capable of returning values even in rain periods. Annex 1 gives some indicative values of an AQ500 in comparison with a Met mast station.

Figure 2.2: AQ500 antenna in standalone setup – most systems now deployed in trailer unit

2.1.1 Power Supply

Power supply integrity is the Achilles' heel of most remote sensing systems, specifically when looking to operate in cold climate conditions. The AQ500 has a robust well trialled system which provides an intelligent, always-on, stability to the system. Over 200 systems currently operate within the UK and Europe with little or no system failures due to power system failure. The main mode of non-system availability is in prolonged no solar period with fuel running out. This is generally due to running the system in a low fuel configuration for quick and easy re-deployment depending on measurement campaign.

Table 2.2 specifies the AQ500 trailer and power supply solution.

Item	Specification	Range
1	Solar Input	480W
2	Generator	5kW
3	Battery Storage	600Ah
4	SMS notification	Via GSM
5	Trailer Height	2m
6	Trailer Width	1.4m
7	Trailer weight (incl. SoDAR)	1100kg
8	Fuel Tank Size	200 l

9	Power Consumption	30-50W
10	Pulse Power (max)	300W (user set or adaptive according to SNR)
11	Acoustic Power	17W (Max)
12	Electrical heating	240V AC user defined thermostat

Table 2.2 Power Supply specification

2.1.2 Health and Safety and System Security

The AQ500 is a self contained unit with little or no user intervention required in the setup of the system.

Prior to every installation a full risk assessment is carried out by Oldbaum Services to ensure that all risks have been identified and mitigated. This is done in conjunction with the client to ensure the clients HSE policy is adhered to.

The system is fully self-contained with no potential for environmental impact. All systems can be fully isolated with a central kill on/off switch available. All systems are provided with fire extinguishers as required.

Security is handled by an integrated GPS vehicle tracking system, high grade hitch lock, wheel lock, and if required all wheels can be removed allowing the system to be fully supported on the four corner levelling legs.

3.0 Methodology

In order to translate the data from onshore to offshore conditions, numerical modelling techniques will be employed which are standard within the wind industry.

For this project, the most appropriate software is the WAsP (Wind Atlas analysis and application Programme) software developed by the Danish Technical University at RISOE, Roskilde. WAsP 10.0 will be used for this analysis, which has been specifically updated to help with coastal boundaries in the numerical domain, and the transition from onshore to offshore conditions.

To provide the noise study with the required data, the change in flow characteristics will be obtained and reported as a series of speed ups, or coefficients generated within WAsP to be applied to wind speed values to show the effect of moving the data acquisition point from onshore to offshore.

It should be noted that it is not possible to translate the full resolution time series as the change in wind speed will be reported and summarised by a directional sector bin. Typically this is a bin of 30 degrees width, and therefore 12 sectors are reported. The reporting of data in directional sector bins is standard practice in the wind industry.

Therefore a speedup value will be calculated for each sector bin, and this will be applied to each wind speed value within the bin. This will have no negative impact on the wind shear profile derived from this process.

The procedural methodology for the Aberdeen Offshore Windfarm is:

1. AQ500 data received and quality checked using Oldbaum standard practice for SoDAR data;
2. Data analysed and summarised to show mean wind speed, profile by sector, turbulence by sector and both wind speed and wind direction distributions;
3. Data summarised and collated into 30 degree sector bins;
4. Definition of numerical run within WAsP, including importing of local terrain maps;
5. Import of data series and summary of data acquisition point within WAsP;
6. Plausibility check of WAsP values with initial analysis values reported in 2;
7. Data summary of wind speed coefficients at the Aberdeen Offshore Wind development area;
8. Modification of SoDAR time series using WAsP calculated coefficients.

4.0 Analysis results

Section 4 summarises the data analysis as used to generate the final output time series. The terrain file used to generate the wind analysis in WAsP is shown in Figure 4.1:

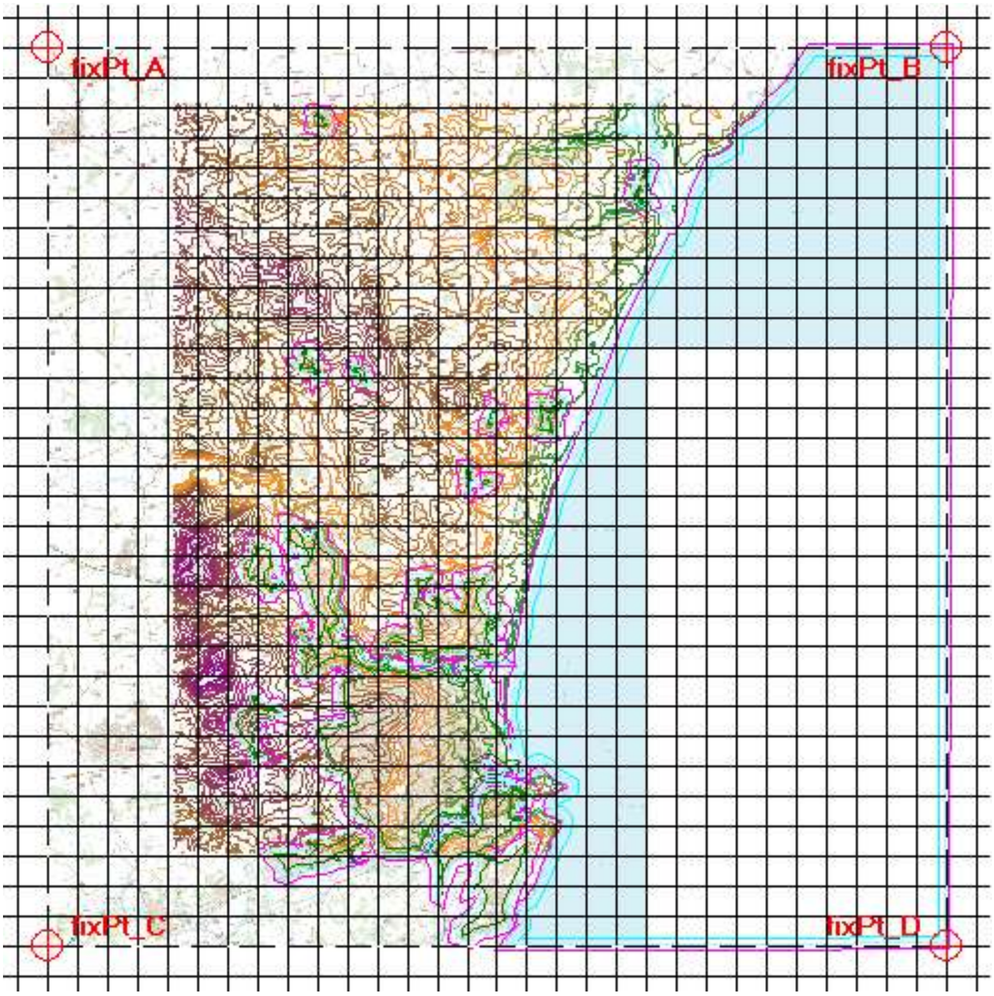


Figure 4.1: Contour map showing 10m height contours with roughness used for calculation.

4.1 Data filtering

SoDAR data can be prone to some errors in measurement which can be eliminated through careful filtering. These errors can include:

- Fixed echo;
- Low signal to noise ratio;
- Data loss through high background noise levels.

In this case the following data filters were used to clean the dataset prior to analysis:

- Data screened for null values (e.g. “9999”)

Wind speed data spatial translation

- Data with low signal to noise ratio (S:N < 50) removed.

The data period covered is from the 17th December 2010 (00:00) till 10th March 2011 (23:50).

4.2 Easter Hatton Summary

Figure 4.2 shows the wind speed data analysis output from WAsP.

A reference height of 120m was chosen by the client as being the hub height reference for this project, and is therefore used to summarise the data analysis.

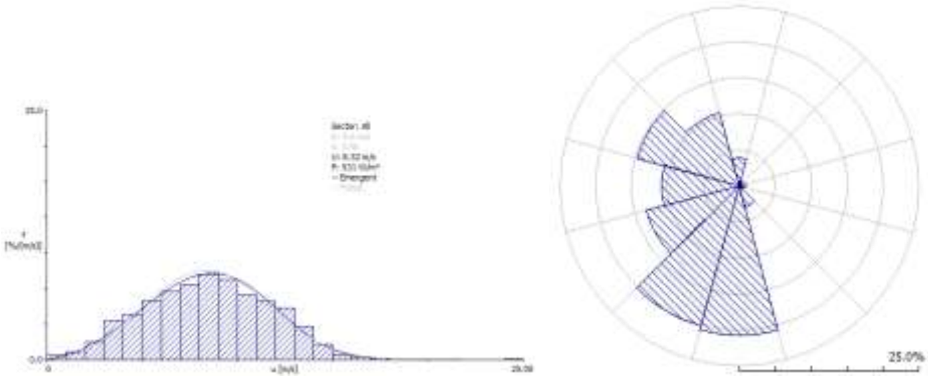


Figure 4.2: WAsP summary of SoDAR output at 120m (A=9.6, k=3.06, U=8.57m/s)

Figure 4.2 clearly shows the wind speed within the analysis period rarely came from easterly sectors, with the predominant direction being southerly during this period.

Figure 4.3 shows the site characteristic turbulence as a function of wind speed

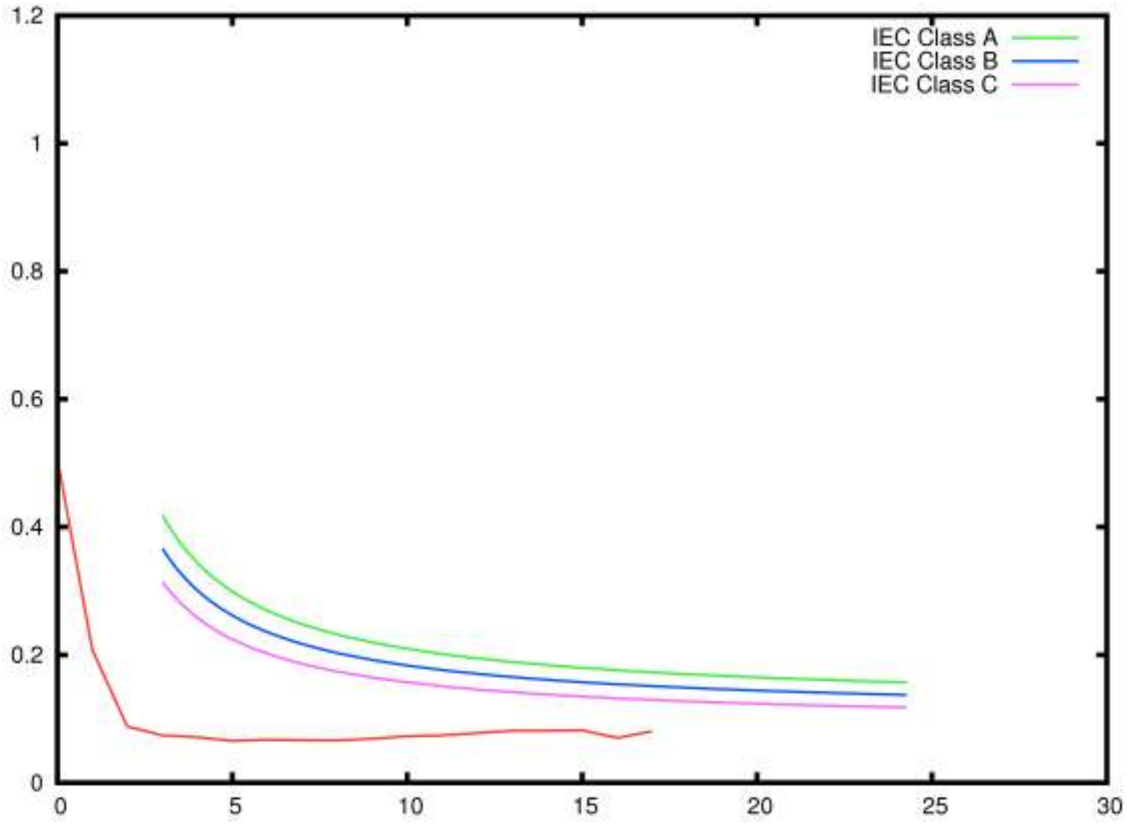


Figure 4.3: Site characteristic wind speed on data submitted.

Figure 4.4 shows the turbulence by sector with Table 4.1 showing the shear profile by sector.

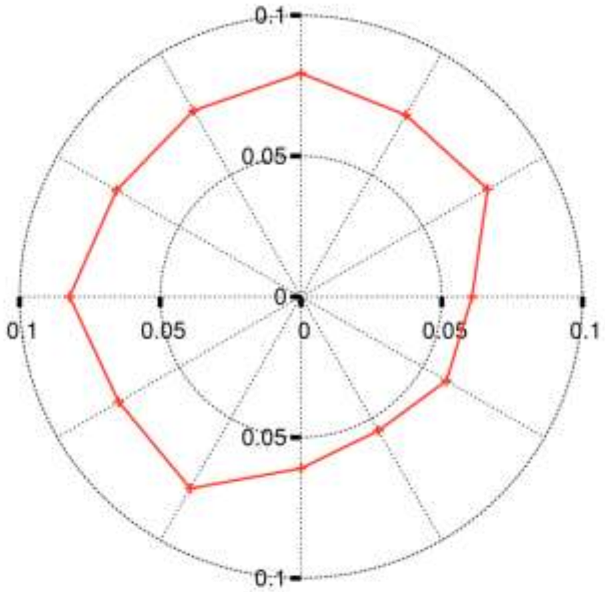


Figure 4.4: Turbulence intensity Rose

	Direction Sector	Mean Exponent
1	345-15	0.438
2	15-45	0.753
3	45-75	--
4	75-105	--
5	105-135	--
6	135-165	--
7	165-195	0.140
8	195-225	0.295
9	225-255	0.248
10	255-285	0.282
11	285-315	0.337
12	315-345	0.295

Table 4.1: Shear mean exponent by sector

The Turbulence rose shows a consistent level of turbulence by sector, supporting the little effect of local features on the SoDAR site. There is however high shear from Sector 2, which is most likely, a function of very few data points in these sectors as opposed to being physical.

The mean shear profile is 0.205, with a reported turbulence intensity of 8.02% at 15m/s. This is a typical value for offshore supporting the suitability of the location for providing data for the offshore project.

4.4 Wind Farm data Summary

Figure 4.5 shows the WAsP wind speed predicted output at the Wind Farm location.

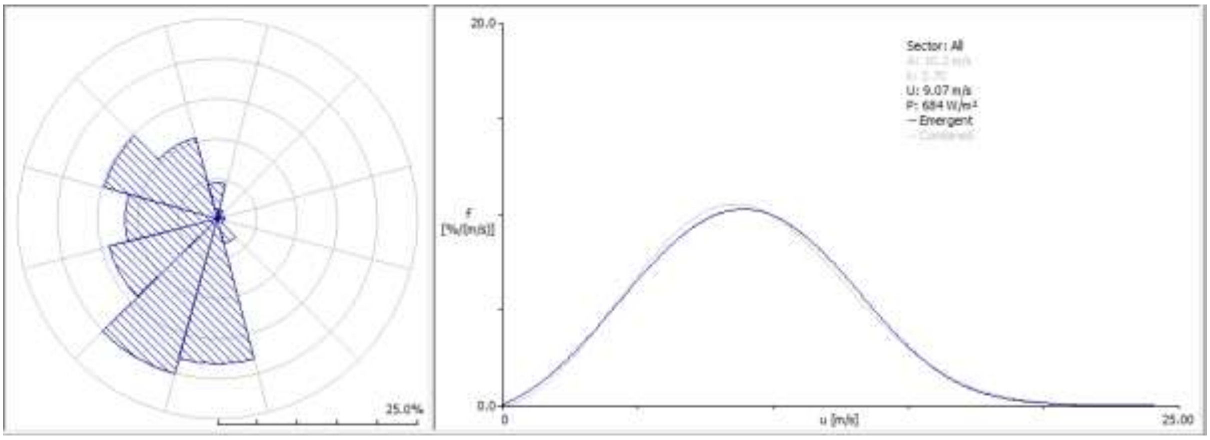


Figure 4.5: WAsP output at 120m (A=10.2m/s, k=2.7; U=9.07m/s)

Figure s 4.6 and 4.7 shows the shear output for the onshore SoDAR and offshore location respectively where the shear has reduced as the flow has migrated from onshore to offshore. This is to be expected, and supports the method used.

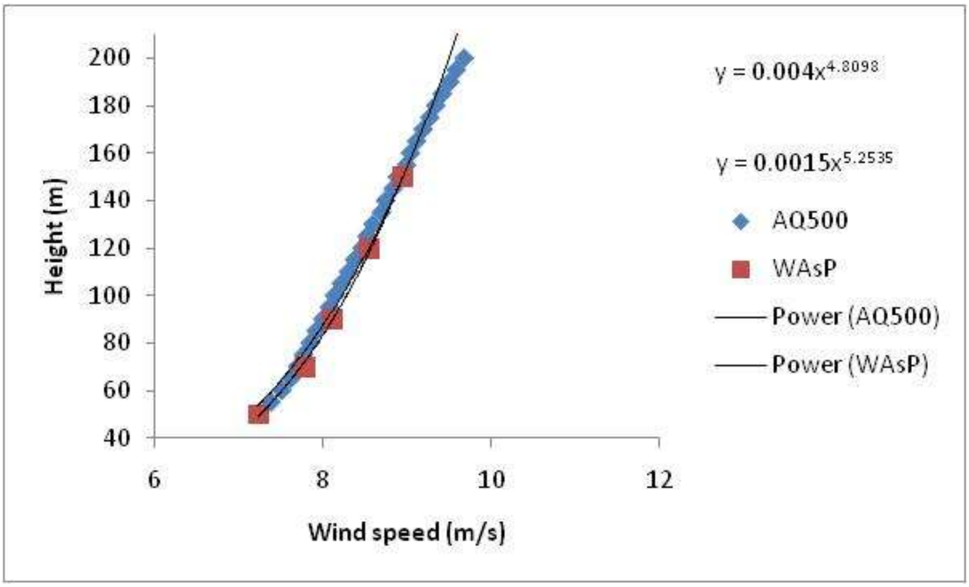


Figure 4.6: SoDAR and WAsP derived Shear Profile for Easter Hatton

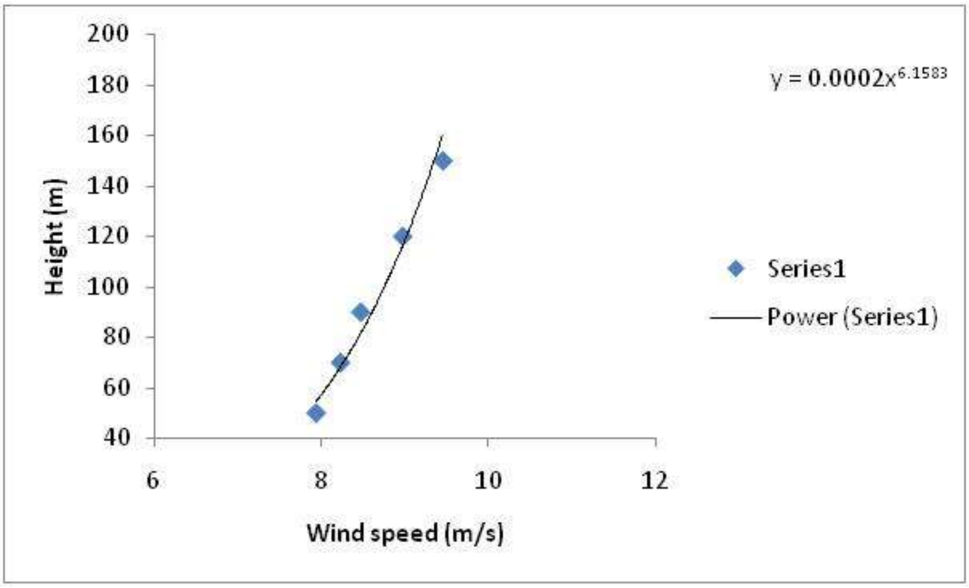


Figure 4.7: WAsP Predicted hear profile (0.16)

The wind speed predicted has increased slightly from 8.57m/s to 9.07m/s at 120m

The predicted WAsP climate was calculated at 5 heights (50m, 70m, 90m, 120m, and 150m), and the resultant wind speed ratio between the WAsP predicted output and the actual SoDAR recorded value was used to calculate a coefficient.

The WAsP values are also used to generate the predicted shear profile, which in turn is used to give a flow modification coefficient for each height level recorded by the SoDAR.

Table 4.3 summarises the 5 calculated coefficients, and table 4.4 the coefficients used to modify the time series.

Height	OWC wind speed from WAsP	Wind climate at reference site from WAsP	Scaling factor
50	7.23	7.95	1.099585
70	7.78	8.33	1.070694
90	8.11	8.6	1.060419
120	8.55	9.07	1.060819
150	8.94	9.51	1.063758

Table 4.3: Scaling Factors from WAsP onshore and Predicted

Mean Speed M/s	Height (m)
7.86806	50
7.990778	55
8.104483	60
8.210508	65
8.309909	70
8.40353	75
8.492062	80
8.576074	85
8.656043	90
8.732374	95
8.805411	100
8.875451	105
8.94275	110
9.007534	115
9.07	120
9.130323	125
9.188657	130
9.245141	135
9.2999	140
9.353044	145
9.404675	150
9.454883	155
9.503753	160
9.55136	165
9.597774	170
9.643058	175
9.68727	180
9.730466	185
9.772695	190
9.814003	195
9.854433	200

Table 4.4: Modified SoDAR shear profile for all heights

The coefficients are then used to modify the SoDAR time series at all heights and the resultant time series generated is the output of this report.

Figure 4.8 shows the final shear profile generated from the modified SoDAR time series.

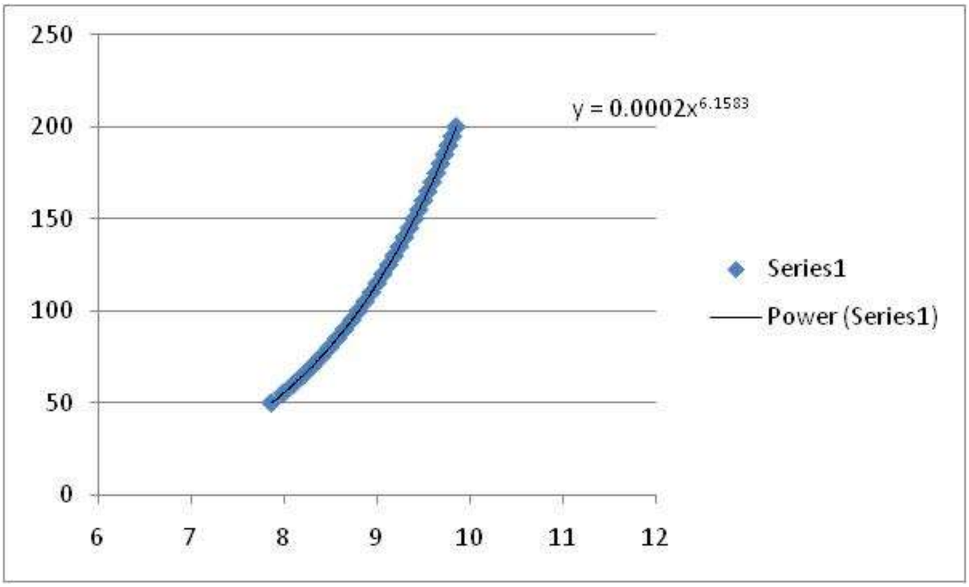


Figure 4.8: modified SoDAR data now representing the offshore wind farm climate (Shear =0.16)

5.0 Summary

An analysis has been performed to translate locally acquired onshore SoDAR data form an AQ500 system to a location offshore.

The onshore dataset has been characterised into a climate file suitable for WAsP and used to generate a predicted wind speed value at the wind farm location. This was done for 5 heights.

The resultant predicted wind shear and speed up effect was then used to calculate the speed up coefficients for all heights, ranging from 50m – 200m in 5m increments.

The output is a modified time series which is sent in accompaniment to this report.

The reference height was 120m, and the resultant wind speed increased from 8.57m/s to 9.07m/s.

6.0 About Oldbaum

Oldbaum Services is a wind energy consultancy, with roots tracing back to 2003. In 2003 Technical Director Andy Oldroyd won a Green Energy Award whilst working for Chillwind for introducing a new measurement technique (Sound Detecting and Ranging or SoDAR) to the wind industry sector.

Andy and his fellow Director Monica Griesbaum have continued to bring innovation and rigour to the wind industry, pioneering quality control and wind sensor use with such novel techniques as LiDAR and SoDAR.

Our company and experience has continued through involvement in innovative high profile projects such as the Beatrice offshore wind demonstrator, and has been recognised by Oldbaum Services winning an EC FP7 bid for the NORSEWInD Programme, with Andy Oldroyd as Coordinator.

NORSEWInD is a 7 million Euro project designed to deliver offshore wind atlases for the Baltic, Irish and North Sea areas based on physical data. The data is acquired from Met masts, LiDAR's located offshore and satellite based datasets. The result is a highly innovative project reducing uncertainty in offshore development by easing access to data for offshore developers.

Oldbaum are recognised experts in remote sensing and in particular data acquisition in offshore wind developments. This knowledge and understanding of the wind energy sector will prove invaluable in terms of understanding fully the nature of the challenges ahead, delivering the outputs defined in the feasibility study, and ultimately delivering a useable, innovative and necessary marine energy development tool.

Oldbaum Services are part of the Leosphere Wind Experts programme, and have been working with all forms of LiDAR since 2005. Oldbaum have designed acceptance tests and measurement campaigns for all forms of LiDAR (Continuous wave or pulse) and have therefore a unique perspective and experience in the unique challenges posed by each system type.

Annex 1.0: AQ500 validation results

The following is an extract of a test undertaken at Myers Hill in Scotland. The data IS FORM a well instrumented 80m met mast as reference, with the AQ500 being located 300m to the South West of the system. No filters have been applied apart from directional filters to exclude the influence of the 1MW NEG MICON WTG's located to the North East and South East of the met mast.

Full test results can be downloaded here: http://www.aqs.se/wordpress/wp-content/uploads/2009/12/AQSMH001_221209.pdf (large file)

Annex 1.0: Data Availability

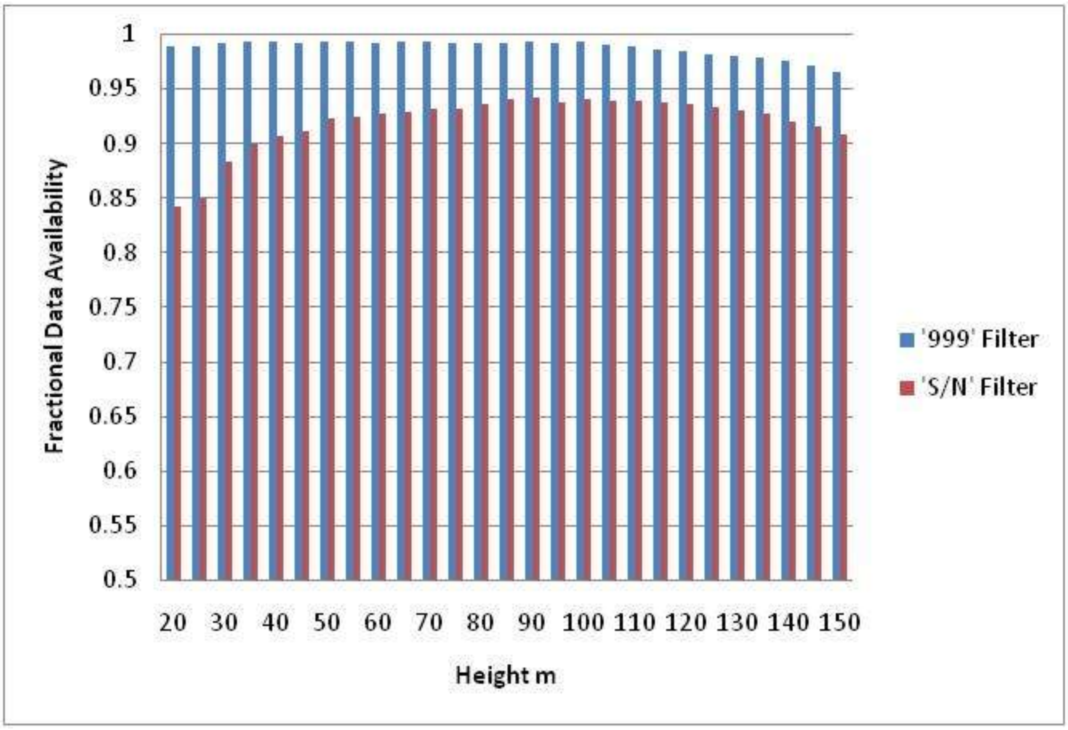


Figure A1.1: Data Availability of AQ500 System

Annex 1.0: Correlation Results

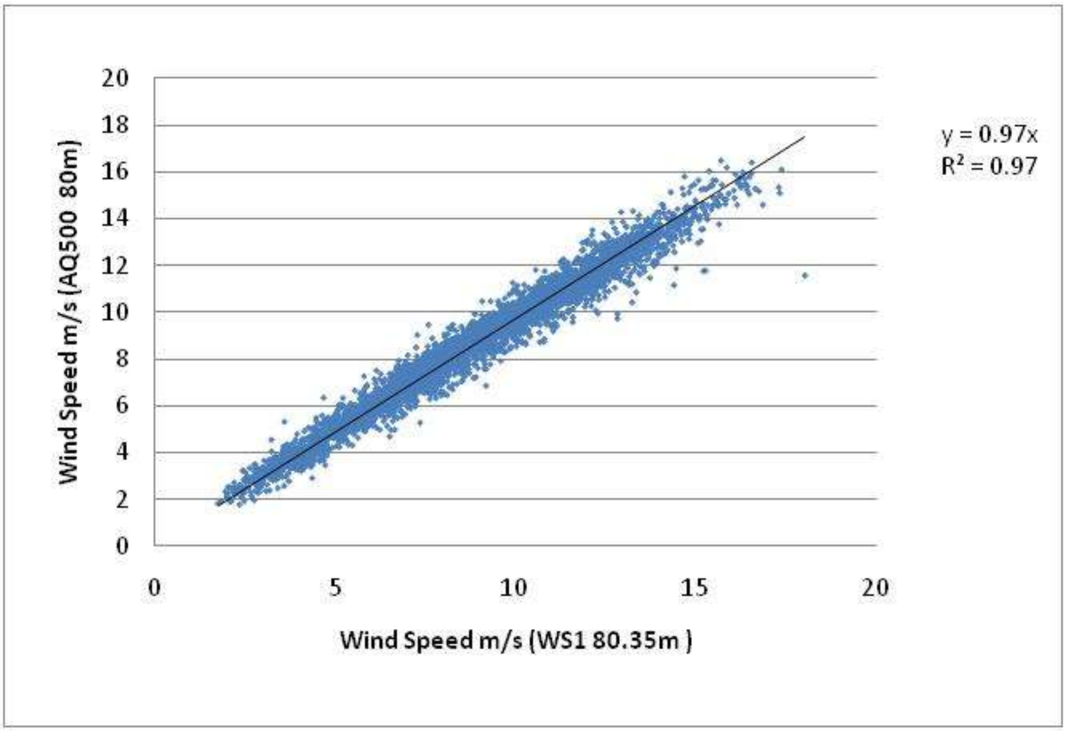


Figure A1.2: Overall correlation with 80m mast @ 80m, 300m Separation. Direction filter applied

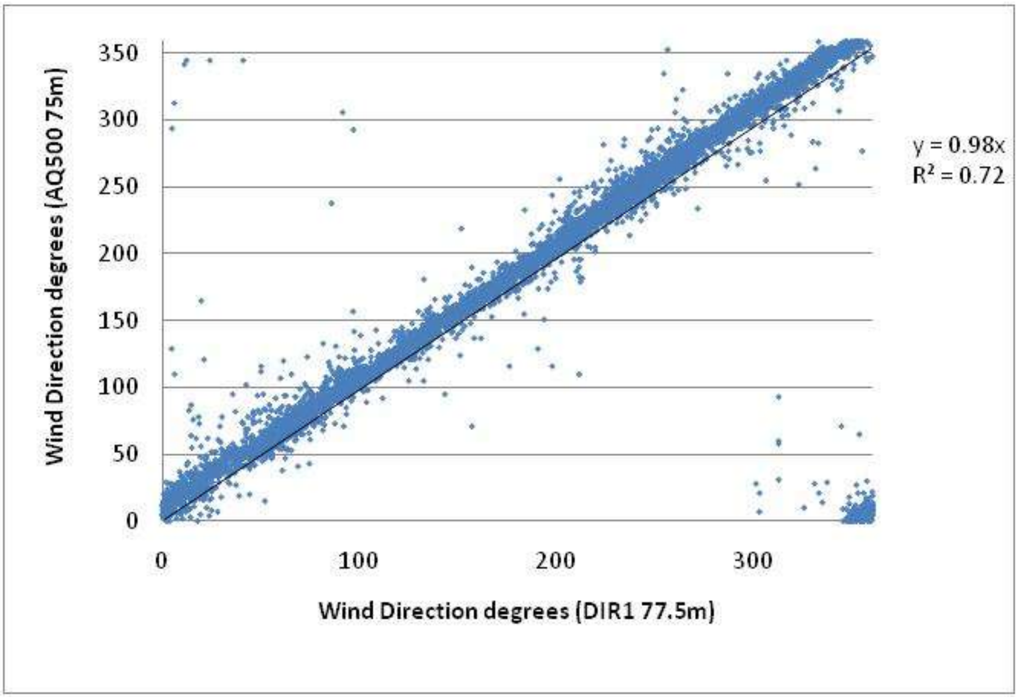
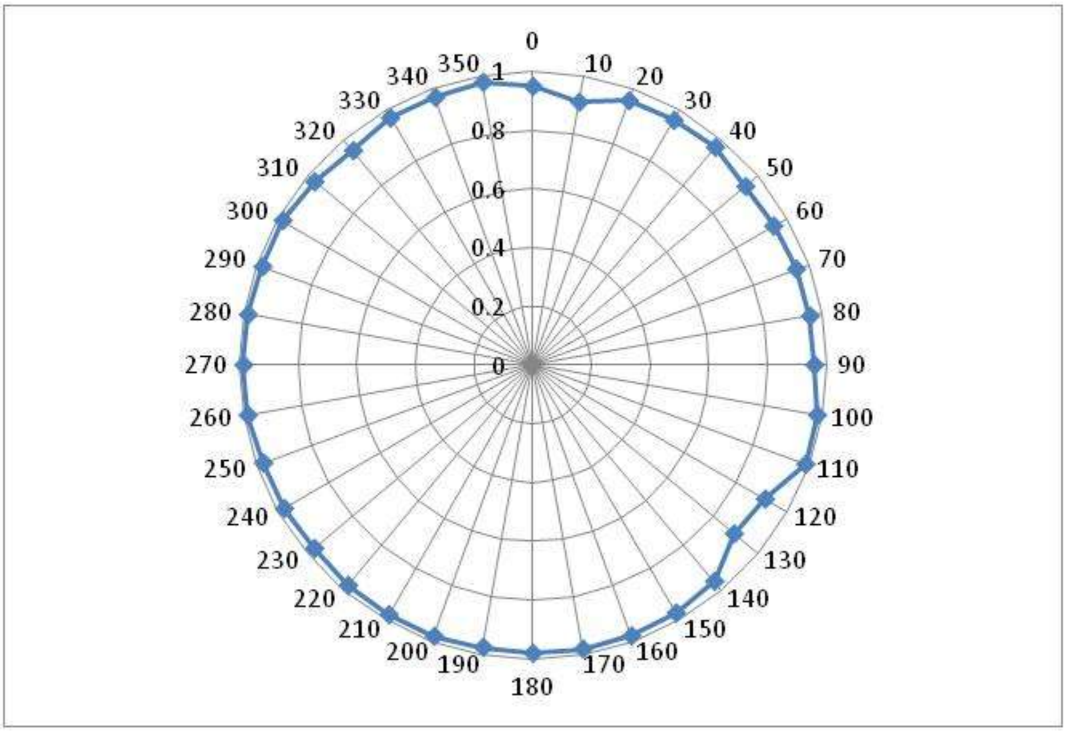


Figure A1.3: Direction Correlation – No applied filter

Wind speed data spatial translation



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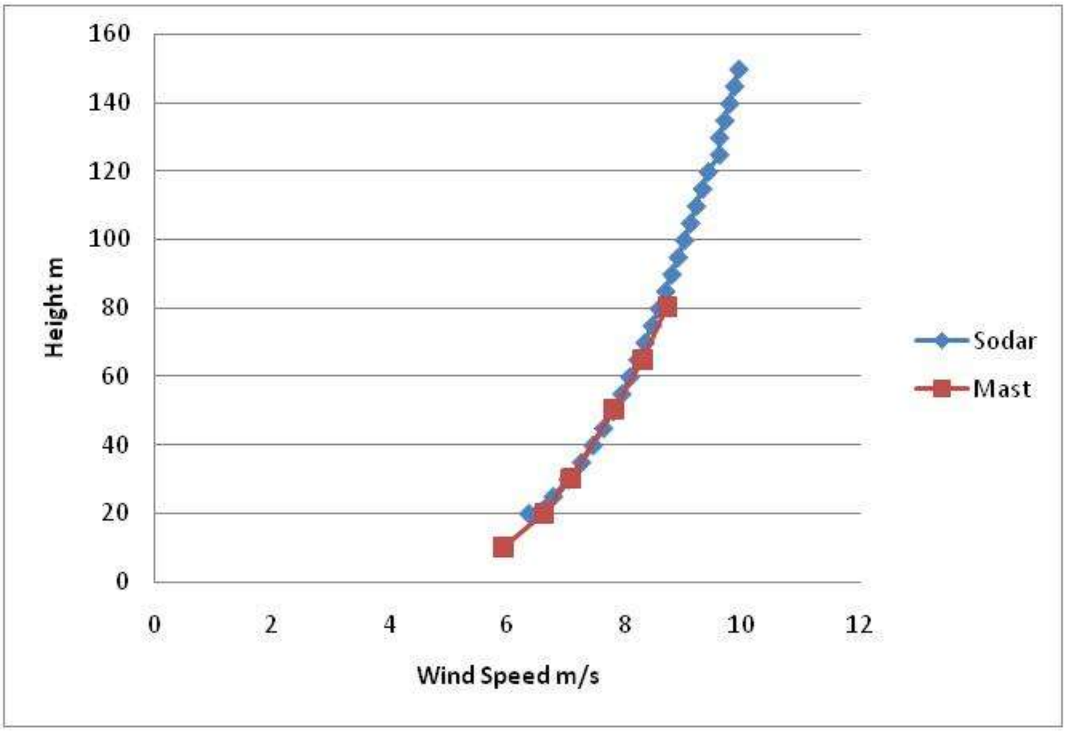
Annex 1.0: Shear Profile Results



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All RS systems have issue with turbulence through spatial and temporal averaging, or in some cases systematic filtering of the turbulence spectrum. IN this case we advocate the use of bin averaged values. Time series turbulence should be treated with caution; however Bin averaging shows the ability of the system for site classification.

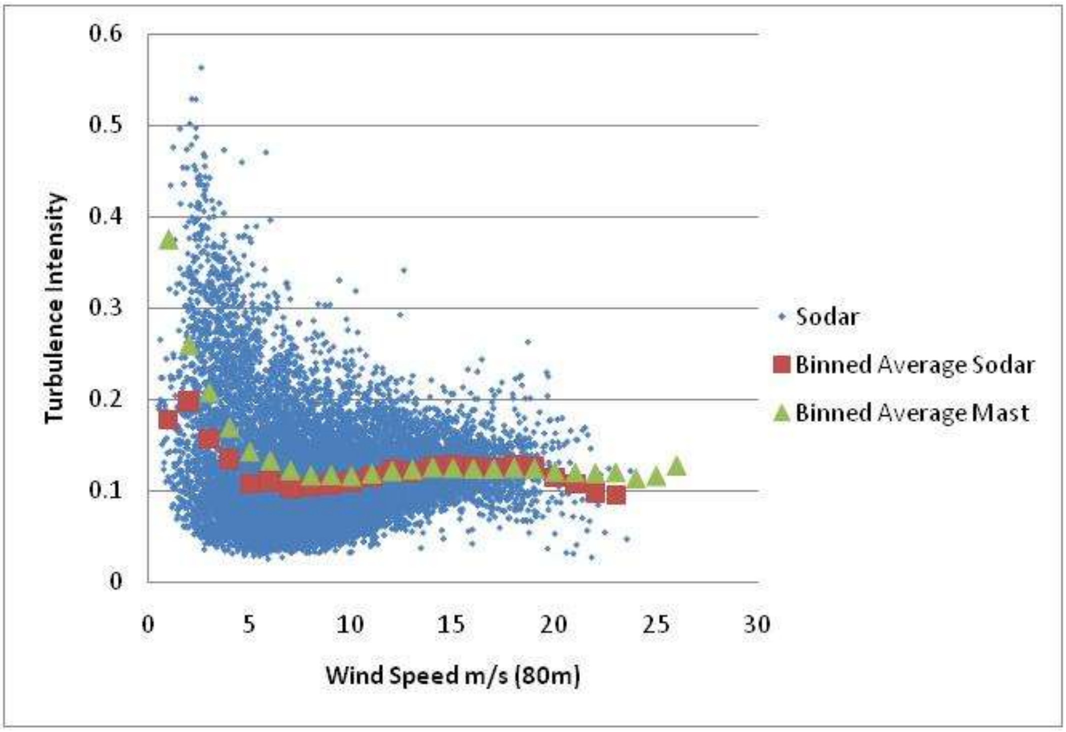

Figure A1.6: Turbulence Bin averaged values

Annex 1.0: Rain performance

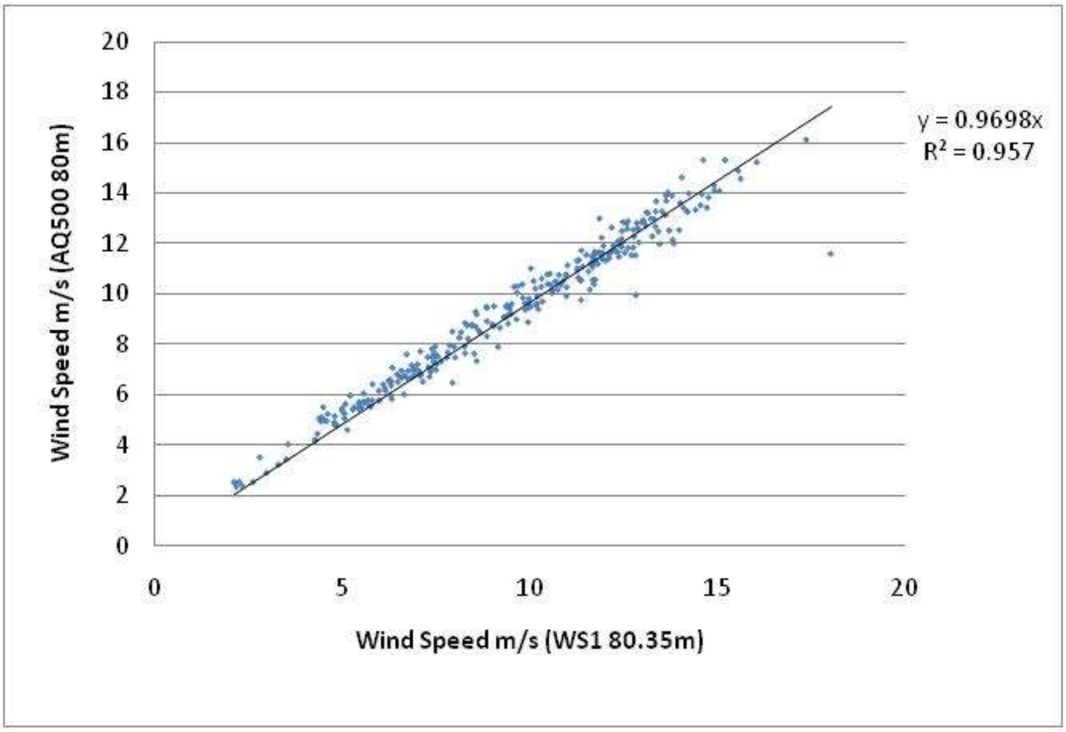

Figure A1.7: Rain period data

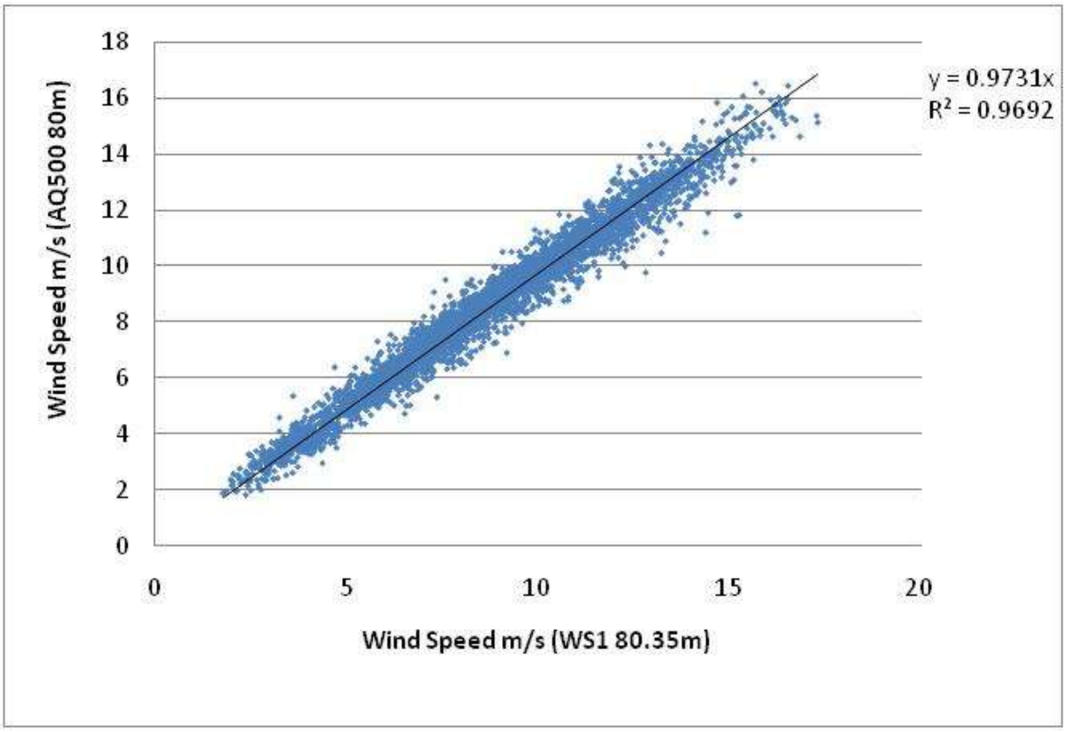

Figure A1.8: Non rain affected,

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European Offshore Wind Deployment Centre
Environmental Statement

Appendix 24.2: In Air Noise EIA Technical Report

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

1 IN - AIR NOISE IMPACT ASSESSMENT

1 This chapter describes the effects of noise at onshore locations along the shoreline north of Aberdeen from the proposed European Offshore Wind Deployment Centre (EOWDC) due to the construction and operation of the wind turbines.

2 Noise emissions associated with the construction and operation of the wind turbines will also be radiated into the water. The effects upon the marine environment due to noise being transmitted from the wind turbine support structure or pile into the water are dealt with within the underwater noise chapter.

1.1 Information for the Non-Technical Summary

3 The noise impact due to the operation of the proposed European Offshore Wind Deployment Centre on residential properties on land is assessed.

4 The operational noise assessment has been carried out according to ETSU-R-97, *Assessment and Rating of Noise from Wind Farms*, as specified in Scottish Government web based planning advice on onshore wind turbines referred to in PAN 1/2011, *Planning and Noise*, as there is no equivalent guidance for offshore wind farms affecting properties on land. The more stringent Aberdeenshire Council noise limits have also been taken into account.

5 Predictions of the typical noise levels likely to result from the operation of the wind farm were carried out based on generic noise data for a wind turbine with a rated power of up to 10 MW and a hub height of 100 m.

6 The assessment shows that predicted operational noise levels would meet the ETSU-R-97/Aberdeenshire Council night-time noise limits and lower day-time noise limits under all conditions.

7 It is assumed that piling with a hydraulic hammer causes the highest noise levels of all foundation types. The prediction of the construction noise has therefore been carried out for pile driving with assumed sound power level based on piling noise measurements elsewhere.

8 The noise limits for the construction noise have been derived from measurements of existing noise level in accordance with BS5228-1:2009 *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*. The predictions show exceedance of the night-time noise limits for piling activities. It is proposed that piling activities should be restricted to daytime hours from 07:00 to 19:00 hours only, unless otherwise agreed with Aberdeen City and Aberdeenshire Council or if significant levels of mitigation can be applied during night time hours.

9 A cumulative noise assessment of the operational wind farm noise and the diesel generator located on the potential ocean laboratory platform has been carried out. The additional noise from the diesel generator results in no increase of the predicted operational wind farm noise.

1.2 Introduction

10 An assessment has been carried out that takes into account the predicted noise immissions from the proposed EOWDC wind turbines using a generic worst case sound power level and the existing noise environment at locations along the shoreline north of Aberdeen.

11 The generic wind turbine assumed for the noise predictions has a hub height of 100 m and a maximum sound power level (SWL) of 112 dB(A) at 9 m/s at standardised 10 m height wind speed. The anticipated hub height for the EOWDC is between 100 m and 120 m. Noise predictions have been carried out for a wind turbine with a 100 m hub height as this represents the worst case in terms of source height.

12 As part of the proposed EOWDC development it is possible that an Ocean Laboratory may also be developed which could include a diesel generator for power supply, this development would be subject to a separate consent application. A prediction of the cumulative noise levels due to the combined operation of the generator and the wind turbines has been carried out.

13 An assessment has been performed of the construction noise associated with piling operations for the wind turbine foundations when using a monopile construction.

1.2.1 Methodology Consultation

14 Aberdeen Offshore Wind Farm Limited (AOWFL) submitted a Request for an Environmental Impact Assessment (EIA) Scoping Opinion in August 2010. Chapter 6.9 deals with airborne noise assessment. None of the responses received identified specific requirements for airborne noise assessment for residential properties onshore.

15 The Environmental Health Officers of Aberdeen City Council and Aberdeenshire Council have been consulted regarding the operational noise assessment methodology and the choice of measurement locations for the baseline noise survey:

- Andrew Gilchrist, Aberdeen City Council (110106)
- John Dawson, Aberdeenshire Council (110106)

1.2.2 Key Guidance Documents

16 The following documents have been used in the assessment:

- Scottish Executive (2011). Planning Advice Note PAN 1/2011: Planning and Noise
- Scottish Executive (2010). Web based ‘renewables advice’
- Department of Trade and Industry (1996). The Assessment and Rating of Noise from Wind Farms ETSU-R-97
- Aberdeenshire Council (2005). Use of Wind Energy in Aberdeenshire: Guidance for Developers – Supplementary Planning Guidance Part 1
- Institute of Acoustics Bulletin Vol 34 No 2, March/April 2009 Prediction and Assessment of Wind Turbine Noise

- British Standards Institution (BSI) (2009). BS 5228:2009 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise
- The Scottish Government (2011). Technical Advice Note – Assessment of Noise

17 The documents listed above have all been written for the purpose of assessing onshore developments but have been adopted for this project as providing suitable guidance on assessing background noise and deriving noise limits for the onshore residential properties.

18 Advice on long-range sound propagation over sea has been taken from:

- Mathieu Boué (2007). Report for Swedish Energy Agency: Long-range sound propagation over the sea with application to wind turbine noise.

1.2.3 Data Information and Sources

19 Background noise monitoring was carried out at 6 locations for three weeks. The results of this survey and the derivation of the noise limits is described in the baseline technical report *Measurement of background noise data and rainfall (Hayes McKenzie Partnership Ltd (HMPL), 2011)*.

20 Wind speed was simultaneously measured with a SoDAR (Sound Detection and Ranging) remote sensing device on a field at Easter Hatton, Balmedie, an onshore location near the coastline. This onshore wind data has been translated to the offshore wind farm location as described in (Oldbaum 2011).

- Oldbaum Services Limited (2011a). Wind speed data spatial translation – Method Statement for Aberdeen Offshore Windfarm Limited
- Hayes McKenzie Partnership Ltd. (2011). Measurement of background noise data and rainfall.
- Hayes McKenzie Partnership Ltd. (2011). Baseline Technical Report for European Offshore Wind Deployment Centre.
- Oldbaum Services Limited (2011b). Wind speed data spatial translation – Wind data analysis for Aberdeen Offshore Windfarm Limited

1.2.4 Impact Assessment Methodology

21 Planning Policy Guidance associated with the development of wind farms currently only deals with onshore developments regarding airborne noise. In the absence of detailed Planning Guidance on the development of Offshore Wind Farms and noise immissions, the best current practice for onshore developments as been referred to.

22 When wind speeds are high any noise is masked by wind induced noise effects, particularly that of the trees being blown. Noise from the sea and the traffic noise from the A90 will also contribute to the masking of noise from the proposed EOWDC wind turbines but this will be more significant at lower wind speeds when wind induced background noise may be low. Wind turbine noise increases with wind speed up to rated power with very low levels of noise being generated at lower wind speeds.

23 Noise levels are normally expressed in decibels. Noise in the environment is measured using the dB(A) scale which includes a correction for the response of the human ear to noises with different frequency content. Planning Advice Note PAN 1/2011, *Planning and Noise* (Scottish Executive, 2011) states that:

'For noise of a similar character, a change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving and doubling the loudness of a sound'.

24 It also provides examples of noise levels from certain activities as shown in Table 1 (below).

Table 1: Examples of Indicative Noise Levels*

Source/Activity	Indicative noise level dB (A)
Unsilenced pneumatic drill (at 7 m distance)	95
Heavy diesel lorry (40km/h at 7 m distance)	83
Modern twin-engine jet (at take-off at 152 m distance)	81
Passenger car (60 km/h at 7m distance)	70
Office environment	60
Ordinary conversation	50
Quiet bedroom	35

* Based on information in PAN 1/2011, Planning and Noise

1.2.4.1 Legislative and Planning Context

***Planning Advice Note PAN1/2011, Planning and Noise* (Scottish Executive, 2011)**

25 PAN1/2011 replaces PAN56 *Planning and Noise*. It identifies two sources of noise from wind turbines; mechanical noise and aerodynamic noise. It states that '*Good acoustical design and siting of turbines is essential to minimise the potential to generate noise*'. It refers to the '*web based planning advice*' on renewable technologies for onshore wind turbines.

26 PAN1/2011 states that the Control of Pollution Act 1974 and the Pollution and Prevention Control Act 1999 are suitable to limit noise from temporary construction sites.

***Scottish Executive Web Based Planning Advice, Onshore Wind Turbines* (Scottish Executive, 2010)**

27 The web based Planning Advice, Onshore Wind Turbines refers to ETSU-R-97, *Assessment and Rating of Noise from Wind Farms* (DTI, 1996a), as the document that *'should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments*'. There is no equivalent guidance for offshore wind farms, but there is no reason why the ETSU-R-97 guidance should not apply. ETSU-R-97 contains noise limits designed to protect external amenity during the day and sleep disturbance at night. These limits are derived from baseline noise measurements carried out at potentially affected properties around the proposed development site.

***ETSU-R-97, The Assessment and Rating of Noise from Wind Farms* (DTI, 1996a)**

28 ETSU-R-97, *The Assessment and Rating of Noise from Wind Farms*, presents the recommendations of the Working Group on Noise from Wind Turbines, set up in 1993 by the Department of Trade and Industry (DTI) as a result of difficulties experienced in applying the noise guidelines existing at the time to wind farm noise assessments. The group comprised independent experts on wind turbine noise, wind farm developers, DTI personnel and local authority EHOs. In September 1996 the Working Group published its findings by way of report ETSU-R-97. This document describes a framework for the measurement of wind farm noise and contains suggested noise limits, which were derived with reference to existing standards and guidance relating to noise emission from various sources.

29 It is recommended that noise limits should be applied to external locations used for relaxation or where a quiet environment is highly desirable. These limits should be set relative to background noise and should reflect the variation in both wind turbine source noise and background noise with wind speed. It is not, however, necessary to use a margin above background in particularly quiet areas as such low limits are not necessary to offer a reasonable degree of protection to wind farm neighbours.

30 Separate noise limits should apply for day-time and for night-time as during the night the protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance.

31 The form of the noise limits proposed in ETSU-R-97 is that noise should be limited to X dB L_{A90} or 5 dB above the ‘prevailing background noise level’, whichever is the greater.

32 The $L_{A90,T}$ is the A-weighted sound pressure level exceeded for 90% of a given time period T. Background noise is commonly measured using this index. The $L_{Aeq,T}$ is the equivalent continuous A-weighted sound pressure level determined as an energetic average during a certain time interval T. The A-weighting curve is based on the inverted 40 phon equal loudness curve and is designed to mimic the human hearing over a certain frequency range.

33 For night-time (2300-0700) the value of ‘X’ is given as 43, to protect against sleep disturbance indoors with a window open. The 43 dB(A) lower limit is based on a sleep disturbance criteria of 35 dB(A) with an allowance of 10 dB for attenuation through an open window and 2 dB subtracted to account for the use of L_{A90} rather the L_{Aeq}. The prevailing background noise is that acquired during the same night-time hours.

34 For day-time hours (evenings and week-ends) ‘X’ is given as 35-40 with the actual value in the range dependant on:

- The number of dwellings in the neighbourhood of the wind farm
- The effect of noise limits on the number of kWh generated
- The duration and level of exposure

The prevailing background noise is that acquired during the quiet day-time hours, as defined in ETSU-R-97.

35 The prevailing background noise level is set by calculation of a best fit curve through values of background noise plotted against wind speed as measured during the appropriate time period with background noise measured in terms of L_{A90}. The L_{A90} is the noise level which is exceeded for 90% of the measurement period ‘t’. It is recommended that at least 1 week’s worth of measurements is required.

36 It is stated that the $L_{A90,10min}$ noise descriptor should be adopted for both background and wind farm noise levels and that, for the wind farm noise, this is likely to be between 1.5 and 2.5 dB less than the L_{Aeq} measured over the same period. The $L_{Aeq,t}$ is the equivalent continuous 'A' weighted sound pressure level occurring over the measurement period t. It is often used as a description of the average noise level. Use of the L_{A90} descriptor for wind farm noise allows reliable measurements to be made without corruption from relatively loud, transitory noise events from other sources.

37 ETSU-R-97 also specifies that a penalty should be added to the predicted noise levels, where any tonal component is present. The level of this penalty is described and is related to the level by which any tonal components exceed audibility.

***Use of Wind Energy in Aberdeenshire: Supplementary Planning Guidance Part 1* (Aberdeenshire Council, 2005)**

38 As a variation to the lower fixed noise limits described by ETSU-R-97, (see above), Aberdeenshire Council specifies the lower noise limits at 38 dB $L_{A90,10min}$ during night-time and 35 dB $L_{A90,10min}$ during day-time for very quiet locations. These lower fixed noise limits are valid for measurements carried out externally.

Institute of Acoustics Bulletin Article, Prediction and Assessment of Wind Turbine Noise, March/April (IoA Bulletin 34, 2009

39 Institute of Acoustics (IoA) Bulletin Vol 34 no. 2 contains an agreement, jointly authored by a number of consultants working in the wind turbine sector for both developers, local authorities and third parties, on an agreed methodology for addressing issues not covered by ETSU-R-97. This includes a methodology for dealing with wind shear.

40 It should be noted that this article is written in the context of onshore wind farms, but the recommendation for dealing with wind shear is also applicable for offshore wind farms.

Blade Swish (Aerodynamic Modulation)

41 The noise limits prescribed in ETSU-R-97 take into account the fact that all wind turbines exhibit the character of noise described as blade swish, to a certain extent. *The Measurement of Low Frequency Noise at Three UK Wind Farms* (DTI, 2006), concluded that *'the common cause of complaints associated with noise at all three wind farms is not associated with low frequency noise, but is the audible modulation of the aerodynamic noise, especially at night'*. It suggests that *'it may be appropriate to re-visit the issue of aerodynamic modulation (AM) and the means by which it should be assessed'*.

42 As a result, Salford University carried out a study, jointly commissioned by the Department for Food, Environment and Rural Affairs (Defra), Department for Business, Enterprise and Regulatory Reform (BERR, formerly the DTI) and the Department for Communities and Local Government (DCLG), to investigate AM of wind turbine noise. The results were published by way of report NANR233 *Research into Aerodynamic Modulation of Wind Turbine Noise*, which concluded that AM was only considered to be a definite factor at four, and a possible factor at eight, out of the 133 sites (all the sites in the UK operational at the time of the study) considered. At the four sites, it was considered that conditions associated with AM might occur between about 7% and 15% of the time.

43 In a statement accompanying the published report, BERR states that it *'continues to support the approach set out in Planning Policy Statement (PPS) 22 – Renewable Energy. This approach for local planning authorities to ensure that renewable energy*

developments have been located and designed in such a way to minimise increases in ambient noise levels, through the use of the 1996 report by ETSU to assess and rate noise from wind energy developments.' PPS 22 is the relevant English planning advice covering onshore wind turbines, equivalent to the Scottish PAN 45.

44 Renewable UK, the trade body representing the wind and marine energy industry, has recently commissioned a research project involving two university departments specialising in noise issues, two independent UK consultancy practices and a well respected researcher in the field of source localisation on wind turbine blades to carry out further research into this issue.

45 The above effects are described for onshore wind farms. It has yet to be determined whether these affects arise for offshore wind farms.

Infrasound

46 Infrasound is defined as noise occurring at frequencies below that at which sound is normally audible, i.e. at less than 20 Hz, due to the significantly reduced sensitivity of the ear at such frequencies. In this frequency range, for sound to be perceptible, it has to be at a very high amplitude and it is generally considered that when such sounds are perceptible then they can cause considerable annoyance.

47 Wind turbines have been cited as significant producers of infrasound. This has, however, been due to the high levels of such noise, as well as audible low frequency thumping noise, occurring on older 'downwind' wind turbines of which many were installed in the USA prior to the large scale take up of wind power production in the UK. Downwind wind turbines are configured with the blades downwind of the tower such that the blades pass through the wake left in the wind stream by the tower resulting in a regular audible thump, with infrasonic components, each time a blade passes the tower. Virtually all wind turbines which have been installed in the UK, however, have been of the upwind design; that is with the blades up wind of the tower, such that this effect is eliminated.

48 The DTI (2006) report concluded that '*Infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range. Even assuming that the most sensitive members of the population have a hearing threshold which is 12 dB lower than the median hearing threshold, measured infrasound levels are well below this criterion'*. It goes on to state that, based on information from the World Health Organisation that '*there is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects'* it may be concluded that *'infrasound associated with modern wind turbines is not a source which may be injurious to the health of a wind farm neighbour'*.

Low Frequency Noise

49 Noise from modern wind turbines is essentially broad band in nature in that it contains similar amounts of noise energy in all frequency bands from low to high frequency. As distance from a wind farm site increases the noise level decreases as a result of the spreading out of the sound energy but also due to air absorption which increases with increasing frequency. This means that although the energy across the whole frequency range is reduced, higher frequencies are reduced more than lower frequencies with the effect that as distance from the site increases the ratio of low to high frequencies also increases. This effect may be observed with road traffic noise or natural sources such as the sea where higher frequency components are diminished relative to lower frequency components at long distances. The DTI study showed that low frequency noise could be measurable on occasion but was below

the low frequency noise criterion published in DEFRA Project Report NANR45, Proposed Criteria for the Assessment of Low Frequency Noise Disturbance.

1.2.4.2 Construction Site Noise Planning Policy Guidance

***BS 5228, Code of Practice for Noise and Vibration Control on Construction and Open Sites* (British Standards Institution, 2009)**

50 British Standard BS5228 was re-issued in 2009 as BS5228: 2009, *Code of Practice for Noise and Vibration Control on Construction and Open Sites*.

51 The Control of Pollution Act 1974 provides a legal framework for the control of construction noise. Example criteria for the assessment of construction noise effects and a method for prediction of noise levels from construction activities are given in BS5228. Two example methods are provided for assessing the impact of construction activities.

52 The first is based on the use of criteria defined in Department of the Environment (DoE) Advisory Leaflet (AL) 72, *Noise Control On Building Sites* (DoE, 1976) which sets a fixed limit of 70 dB(A) in rural suburban and urban areas away from main roads and traffic and 75 dB(A) in urban areas near main roads in heavy industrial areas. Noise levels are generally taken as façade L_{Aeq} values with free-field levels taken to be 3 dB lower giving an equivalent noise criterion of 67 dB L_{Aeq} and 72 dB(A) respectively.

53 The second is based on noise change but applies minimum criteria of:

- 45 dB L_{Aeq}: night-time (2300-0700)
- 55 dB L_{Aeq}: evening and weekends (1900-2300 weekdays, 1300-2300 Saturdays and 0700-2300 Sundays)
- 65 dB L_{Aeq}: daytime (0700-1900) including Saturdays (0700-1300)

These criteria are applicable when existing noise levels are low, and subject to a construction period of one month or more. The threshold values are based on measured background data and give limits in three categories A, B and C, depending on the magnitude of the background noise levels. It should be noted that the time period to which each limit applies also defines the time averaging period for the calculated L_{Aeq}.

1.2.4.3 Sleep Disturbance Criteria

54 International Guidance concerning the effects of noise upon sleep are covered in a number of documents discussed within ETSU-R-97. In general, if internal noise levels are limited to a range of no more than 30 - 35 dB L_{Aeq}, then sleep disturbance and any adverse effects of noise upon sleep will be minimised. Since the issue of ETSU-R-97 further guidance has been issued by the World Health Organisation (WHO): *Guidelines for Community Noise* in March 2000 and *Night Noise Guidelines for Europe* in 2009.

55 The Guidance within BS 8233: 1999 *Sound Insulation and Noise Reductions for Buildings – Code of Practice* (BSI, 1999) follows the advice contained within the WHO (2000) Report on Community Noise which states that unoccupied indoor ambient noise levels within bedrooms are a “good “ design when in the range of

around 30 dB L_{Aeq} and “reasonable” when around 35 dB L_{Aeq}. Individual noise events should also be limited to no more than 45 dB L_{Amax}. This internal noise level criterion is not relevant for operational wind turbine noise as it refers to individual, discrete noise events, but is applicable for driving piles into the seabed for wind turbine foundations.

56 The WHO World Health Organisation (WHO) *Night Noise Guidelines for Europe* advises as to what is an acceptable external noise level to a bedroom and gives a value of $L_{night,outside}$ = 40 dB below which no effect harmful to health has been observed and this level is therefore recommended as night noise guideline. It should be noted that this is an average noise level over a period of 8 hours per night over a whole year. Due to the nature of the averaging, events with higher and lower short-term noise level can occur during this period.

1.2.4.4 Prediction of Wind Turbine Noise Levels

57 Noise predictions were carried out using International Standard ISO 9613, Acoustics – Attenuation of Sound During Propagation Outdoors (International Organization for Standardization, 1996) but with an adjustment added to allow for long distance propagation over the sea surface. The propagation model described in Part 2 of this standard provides for the prediction of sound pressure levels based on either short-term downwind (i.e. worst case) conditions or long term overall averages up to 1000 m. Only the downwind condition has been considered in this assessment, that is for wind blowing from the proposed development site towards the nearby houses. When the wind is blowing in the opposite direction noise levels will be significantly lower, especially if there is any shielding between the site and the houses. Therefore, the results of the assessment should be considered as the ‘worst case’ in that they any impacts identified will only be present for a limited duration when winds are blowing onshore.

58 The ISO propagation model calculates the predicted sound pressure level by taking the source sound power level for each wind turbine in separate octave bands and subtracting a number of attenuation factors according to the following:

Predicted Octave Band Noise Level = $L_w + D – A_{geo} - A_{atm} – A_{gr} - A_{bar} - A_{misc}$

59 The predicted octave band levels from each of the wind turbines are summed together to give the overall ‘A’ weighted predicted sound level from all the wind turbines acting together. These factors are discussed in detail below.

L_W - Source Sound Power Level

60 The sound power level of a noise source is normally expressed in dB re: 1pW (10^{-12} Watt). Noise predictions have been based on source sound power levels of a typical 3 MW class offshore wind turbine with a 4 dB margin added to represent a generic 10 MW wind turbine. This approach has been adopted so that predictions are higher than the sound power level of currently operational offshore wind turbines and therefore assumed to be worst case. The noise levels for different wind speeds are shown in Table 2.

Table 2: Wind Turbine Source Sound Power Levels for a Generic 10 MW Wind Turbine with 100 m Hub Height

Standardised Wind Speed at 10 m height (m/s)	Sound Power Level (dB L_{Aeq} re 1 pW)
4	99.5
5	109.6
6	111.5
7	112.0
8	112.0
9	112.0
10	112.0

61 The noise spectrum used is shown in Table 3. This data is based on typical octave band spectra of a 3 MW class wind turbine for 8 m/s (referenced to 10 m height) and has then been normalised to the overall sound power level at each integer wind speed.

Table 3: Normalised Noise Spectrum for Maximum Sound Power Level for a Generic 10 MW Wind Turbine with Hub Height 100 m

Octave Band Centre Frequency (Hz)	Normalised Octave Band Sound Power Level (dB L_{Aeq} re 1 pW)
63	91.6
125	100.9
250	105.9
500	107.0
1k	106.6
2k	99.9
4k	89.7
8k	76.8

D – Directivity Factor

62 The directivity factor allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In this case the sound power level is measured in a down wind direction, corresponding to the worst case propagation conditions considered here and needs no further adjustment.

A_{geo} – Geometrical Divergence

63 The geometrical divergence accounts for spherical spreading in the free-field from a point sound source resulting in attenuation depending on distance. It has been found

in various publications (e.g. Boué, 2007 and Søndergaard, 2005) that for sound propagation at sea, spherical spreading is only applicable up to a certain distance. Measurements of piling activities carried out by Hayes McKenzie Partnership Ltd have found that the prediction correlates well with a distance of 800 m for the spherical spreading term:

$A_{geo} = 20 \cdot \log(800) + 11$

64 At distances beyond 800 m the propagation is modelled with cylindrical spreading:

$A_{geo} = 10 \cdot \log(d/800)$

where d = distance from the wind turbine.

65 Each of the wind turbines may be considered as a point source beyond distances corresponding to one rotor diameter.

***A_{atm}* - Atmospheric Absorption**

66 Sound propagation through the atmosphere is attenuated by the conversion of the sound energy into heat. This attenuation is dependent on the temperature and relative humidity of the air through which the sound is travelling and is frequency dependent with increasing attenuation towards higher frequencies. The attenuation depends on distance according to:

$A_{atm} = d \cdot \alpha$

where d = distance from the wind turbine
α = atmospheric absorption coefficient in dB/m.

67 Published values of 'α' from ISO 9613 Part 1 (International Organization for Standardization, 1992), corresponding to a temperature of 10ºC and a relative humidity of 70% have been used for these predictions. These are the values specified in the Acoustics Bulletin article *Prediction and Assessment of Wind Turbine Noise* (IoA, 2009), which give relatively low levels of atmospheric attenuation, and subsequently worst case noise predictions as shown in Table 4.

Table 4: **Frequency dependent Atmospherical Absorption Coefficients (10°C and 70% Humidity)**

Octave Band Centre Frequency (Hz)	Atmospheric Absorption Coefficient (dB/m)
63	0.00012
125	0.00041
250	0.00104
500	0.00193
1k	0.00366
2k	0.00966
4k	0.0328
8k	0.117

A_{gr} - Ground Effect

68 Ground effect is the interference of sound reflected by the ground interfering with the sound propagating directly from source to receiver. The prediction of ground effects is inherently complex and depends on the source height, receiver height, propagation height between the source and receiver and the ground conditions. The ground conditions are described according to a variable G, which varies between 0 for 'hard' ground (includes paving, water, ice, concrete and any sites with low porosity) and 1 for 'soft' ground (includes ground covered by grass, trees or other vegetation). The predictions have been carried out using a source height corresponding to the proposed height of the wind turbine nacelle, a receiver height of 4 m and an assumed ground factor G = 0 for the water surface.

A_{bar} - Barrier Attenuation

69 The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise. The barrier attenuations predicted by the ISO 9613 model have, however, been shown to be significantly greater than that measured in practice under down wind conditions. The results of a study of propagation of noise from wind farm sites carried out for ETSU (DTI, 2000) concludes that an attenuation of just 2 dB should be allowed where the direct line of site between the source and receiver is just interrupted and that 10 dB should be allowed where a barrier lies within 5 m of a receiver and provides a significant interruption to the line of site. It should be noted that no barrier attenuation has been used in any of the noise predictions carried out here.

A_{misc} – Miscellaneous Other Effects

70 ISO 9613 includes effects of propagation through foliage, industrial plants and housing as additional attenuation effects. These have not been included here and any such effects are unlikely to significantly reduce noise levels below those predicted.

Tonality

71 No allowance has been made for the character of the noise emitted by the wind turbines. In general, wind turbines exhibit little tonality within the radiated noise. However, an appropriate method to control such a character is through the imposition of a Planning Condition which limits the level of tonality that a site may emit. ETSU-R-97 defines a method by which tonality may be assessed and proposes a penalty system for any tonality which might be measured.

Wind Shear

72 It is now well established that wind speed experienced by a wind turbine cannot be correctly predicted from 10 m height wind speed measurements and ground roughness conditions alone. Hub height wind speed, and hence the wind speed experienced by the wind turbine, may be under-predicted under these conditions and hence the output noise level may be under-predicted. To correctly account for this in the assessment methodology, background noise is referenced to hub height wind speed, as described in the agreement published in the IoA Bulletin (IoA, 2009).

73 Wind speed and direction was measured with an AQ500 SoDAR remote sensing device at Easter Hatton, Balmedie, an onshore location near the coastline. The data was recorded in 5 m steps from 50 m to 200 m. This data has been translated to the location of the proposed EOWDC as described in (Oldbaum 2011b). For the assessment, the measured data correlating to hub height wind speed is used.

74 This translated hub height wind speed has then been corrected to 'standardised' 10 m height wind speed, as required by the method described in (IoA, 2009) using the same methodology as is used by the manufacturers to produce noise data for 'standardised' 10 m height wind speed, i.e.:

$$V_{10} = V_h \cdot \frac{\ln\left(\frac{h_{10}}{z_0}\right)}{\ln\left(\frac{h_h}{z_0}\right)}$$

75 Where V_{10} and V_h are the 'standardised' 10 m height (h_{10}) and hub height (h_h) wind speeds respectively, and z_0 is the standardised ground roughness length (= 0.05 m).

76 This standardisation is not intended to reflect actual 10 m height wind speed conditions and does not affect the relationship between wind turbine noise, background noise, and the derived noise limits.

1.2.4.5 Prediction of Construction Noise Associated with Wind Turbine Erection

77 Noise associated with the construction of the wind turbines will be caused by the following sources:

- Noise associated with the insertion of the wind turbine tower foundation
- Noise associated with the erection of the wind turbine tower and nacelle/rotor assembly
- Noise associated with boat movements to and from shore
- Noise associated with onsite activities such as cable laying at the point the cable comes ashore.

78 The potentially noisiest activity associated with these potential sources is related to the installation of the wind turbine foundation. The method of foundation construction that will generate the greatest level of noise is associated with a monopile foundation system.

79 Drilling of the monopile would minimise the noise emissions from this construction operation, however, it may be necessary to drive the pile into the seabed. If this is the case, then there is the potential for impulsive piling noise to occur.

80 Specifically, if the monopile is driven into the sea bed, levels associated with this method of pile insertion can generate measured sound pressure levels as high as 105 dB L_{Amax} and 93 dB $L_{Aeq,1\ minute}$ measured at a distance of 55 metres from the pile. This is equivalent to a source noise level of L_{WAmax}=151 dB re: 1 pW and L_{WA}=139 dB re: 1 pW respectively.

1.2.4.6 Spatial Extent of Effect

81 The construction of the proposed EOWDC will have a regional effect. The piling noise levels will be greater than 65 dB $L_{Aeq,1minute}$ for up to 1.6 km distance from the piling location. The piling will still be audible at a greater distance further inland especially when background noise is low and the influence of the surf and the A90 traffic noise decrease.

82 The operational noise will have a local effect on the nearest properties along the shore in the vicinity of the proposed EOWDC.

1.2.4.7 Duration of Effect

83 The highest construction noise due to the piling process is expected to last 24 hours per location at a maximum, i.e. 11x 24 hours. It is expected that there are breaks inbetween, when the vessel is relocated and the next monopile lifted in position. Therefore this will have a temporary effect on the residents.

84 The Crown Estate lease for the proposed EOWDC is 22 years, the project will therefore have a long-term effect. It is assumed that the wind farm will be decommissioned after its operational span of life has been reached so that the effect is not considered permanent.

1.2.4.8 Scale of Effect

85 Table 5 is taken from the Technical Advice Note (TAN Noise) on the Assessment of Noise issued by The Scottish Government in association with PAN 01/2011.

Table 5: Classification of Magnitude on Noise Impacts according to TAN *Assessment of Noise* (Table 2.2)

Descriptor for Magnitude of Impact	Generic Criteria of Descriptor
Major adverse	Loss of resource and/or quality of resource; severe damage to key characteristics, features or elements
Moderate adverse	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements
Minor adverse	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements
Negligible adverse	Very minor loss or detrimental alteration to one or more characteristics, features or elements
No change	No loss or alteration of characteristics, features or elements; no observable impact

1.2.4.9 Recoverability of the Receptor

86 Due to the limited time of 11 days with high noise levels from the piling noise, it is expected that the receptor, i.e. the residents in the affected area, will fully recover from any effects.

1.2.4.10 Importance of the Receptor

87 The receptor, i.e. the affected residents near the shore, is considered of high importance.

1.2.5 Implications of Significance

88 The receptors closest to the shore and the A90 are considered of medium sensitivity as background noise is relatively high. Further inland with fewer other noise sources, the sensitivity increases.

89 Schools, hospitals/residential care homes, residential properties with low background noise, conference facilities and quiet outdoor areas used for recreation are considered to have a high sensitivity to noise.

1.2.6 Cumulative Impact Assessment Methodology

90 Cumulative impact assessments have been undertaken on all existing and any reasonably foreseeable project/development activities. The possible development of an Ocean Laboratory has been considered as having the potential to contribute to cumulative impacts and has been assessed.

1.2.7 Worst Case

91 At this stage of the project, no decision has been made on which wind turbine foundation type will be adopted. The noise associated with a hydraulic hammer driving monopiles into the seabed is assumed to be the loudest of all foundation types. It is also the loudest activity of the construction process itself. The prediction of construction noise from piling 8.5 m diameter monopiles is therefore considered worst case.

92 There is no information available about the sound power level of potential candidate wind turbines. Some of the wind turbine types in the offshore market are still in the development stage and the manufacturer can therefore not yet issue information about the sound power level. Generic sound power level data has been assumed based on source sound power levels of a typical 3 MW class offshore wind turbine with an added margin of 4 dB which is considered worst case for currently available offshore wind turbine models. The anticipated hub height for the EOWDC is between 100 m and 120 m. Noise predictions have been carried out for a wind turbine with a 100 m hub height as this represents the worst case in terms of source height.

93 A worst case cumulative noise assessment that considers a possible ocean laboratory has been carried out for the construction and operational phases of the proposed EOWDC. This includes the possible installation of an additional 8.5 m diameter monopile and a diesel generator during the operational phase. It is possible that if the ocean laboratory is developed a diesel generator may not be required.

1.3 Impact Assessment

1.3.1 Deployment of 11 Wind Turbines

1.3.1.1 Construction Phase

Potential Impacts

94 The noise limits for the construction period are based on Table E.1 in BS5228 – Part 1 (BSI, 2009), derived from the average measured LAeq from the background noise survey as displayed Table 6. Sound pressure levels measured at wind speeds >5m/s have been removed from further assessment. This is in accordance with BS4142:1997 Method for Rating industrial noise affecting mixed residential and industrial areas and BS7445 Description and measurement of environmental noise (BSI, 1991).

95 For the purpose of assessing the noise generated by the construction of the proposed EOWDC, hours are defined as follows:

- daytime: 07:00-19:00 weekdays
07:00-13:00 Saturdays
- evenings and weekends: 19:00-23:00 weekdays
13:00-23:00 Saturdays
07:00-23:00 Sundays
- night-time: 23:00-07:00

Table 6: Arithmetic averaged measured Sound Pressure Level at Measurement Locations

Location	Easting	Northing	Average Measured Day L_{Aeq}, dB	Average Measured Evenings and Weekends L_{Aeq}, dB	Average Measured Night L_{Aeq}, dB
Four Winds	395191	814956	54	53	44
16 Chapelwell Wynd	396968	817138	49	45	40
Easter Hatton	396245	816102	61	57	52
Hareburn House*	396294	813979	57	55	53
3 Tarbothill Farm Cottages	395696	813430	56	51	48
16 Dubford Gardens	393913	812139	49	41	32

*data only available for 3 days

96 Table 7 shows the suggested noise limits for the construction activities based on the average measured background at each property. BS5228 (BSI, 2009) gives threshold values for a whole period, e.g. an $L_{Aeq,day}$ for a period of 12 hours.

Table 7: Noise Limits derived from Table E.2 in BS 5228 – Part 1 at the Measurement Locations.

Location	Easting	Northing	Noise Limit Day L_{Aeq}, dB	Noise Limit Evenings and Weekends L_{Aeq}, dB	Noise Limit Night L_{Aeq}, dB
Four Winds	395191	814956	65	60	45
16 Chapelwell Wynd	396968	817138	65	55	45
Easter Hatton	396245	816102	65	60	55
Hareburn House*	396294	813979	65	60	55
3 Tarbothill Farm Cottages	395696	813430	65	55	55
16 Dubford Gardens	393913	812139	65	55	45

*data only available for 3 days

97 Predictions of the incident noise levels at the shore-line have been performed using the same method as for noise from an operational wind farm. The noise spectrum was taken from a measurement during piling activity carried out by HMPL. The highest equivalent sound pressure level measured at a distance of 55 metres from the pile was 93 dB $L_{Aeq,1minute}$. This is equivalent to a source noise level of L_{WA}=139 dB re: 1 pW. The predicted noise levels for the same six locations as for the operational wind farm assessment are detailed in Table 8 below.

Table 8: Predicted Noise Levels $L_{Aeq,1minute}$ associated with driven Monopile Activity at Wind Turbine Locations and potential Ocean Laboratory

Location	WT location											
	1	2	3	4	5	6	7	8	9	10	11	Ocean Lab
Four Winds	63	64	64	62	63	63	62	62	62	61	61	63
16 Chapelwell Wynd	63	64	66	63	64	65	63	64	65	63	63	63
Easter Hatton	64	65	66	63	64	65	63	63	64	62	62	64
Hareburn House	66	66	66	65	65	65	63	63	63	62	62	66
3 Tarbothill Farm Cottages	65	65	65	64	64	63	62	62	62	61	61	65
16 Dubford Gardens	62	62	61	61	62	60	60	60	59	59	58	62

98 As it is proposed that pile insertion for the tower support structures may occur during any period of the day or night, it is appropriate to consider the worst-case noise impact that may occur, i.e. the potential for sleep disturbance of residents within dwellings facing the site. Therefore, the potential for construction noise is evaluated against the criterion of 45 dB $L_{Amax,inside}$ for night time operations. Assuming an attenuation of 10 dB, the outside level above which sleep of the residents is likely to be disturbed is 55 dB L_{Amax}.

99 Table 9 shows the predicted $L_{Amax,outside}$ based on the maximum sound power level determined during a measurement of a 30 minute piling operation carried out by HMPL.

100 The maximum sound pressure level measured at a distance of 55 metres from the pile was 105 dB L_{Amax}. This is equivalent to a source noise level of L_{WAmax}=151 dB re: 1 pW.

Table 9: Predicted Noise Levels $L_{Amax,outside}$ associated with Driven Monopile Activity at Wind Turbine Locations and potential Ocean Laboratory

Location	WT location											
	1	2	3	4	5	6	7	8	9	10	11	Ocean Lab
Four Winds	75	76	76	74	75	75	74	74	74	73	73	76
16 Chapelwell Wynd	75	76	78	75	76	77	75	76	77	75	75	75
Easter Hatton	76	77	78	75	76	77	75	75	76	74	71	76
Hareburn House	78	78	78	77	77	77	75	75	75	74	74	78
3 Tarbothill Farm Cottages	77	77	77	76	76	75	74	74	74	73	73	77
16 Dubford Gardens	74	74	73	73	73	72	72	72	71	71	70	74

101 As there is only limited information available about the foundation type(s) that could be used for the proposed EOWDC it has not yet been decided which equipment will be used for the construction period, the relevant sound power level has had to be assumed for this assessment. The predicted piling noise is based on measurements previously carried out by HMPL for an offshore piling noise assessment.

102 The predicted $L_{Aeq,1minute}$ in Table 8 exceeds the suggested daytime noise limits in Table 7 by 1 dB at the three closest locations to the development. At Chapelwell Wynd and Easter Hatton this would only be the case for the piling at location 3. At Hareburn House this would be the case for turbine location 1-3 and at the potential ocean laboratory location.

103 The predicted $L_{Aeq,1minute}$ would, however, comply with the noise criterion of proposed noise limit of 67 dB L_{Aeq} for rural and suburban areas as suggested in the Environment Advisory Leaflet 72, *Noise Control On Building Sites* (DoE, 1976).

104 Comparing the predicted noise levels in Table 8 with the evening and weekend noise limits in Table 7 shows that the noise limits are exceeded at all locations by a minimum margin of 4 dB at Four Winds and a maximum margin of 11 dB at 16 Chapelwell Wynd.

105 The night-time noise limits in Table 7 are exceeded at all locations by a minimum margin of 10 dB at 3 Tarbothill Farm Cottages and by a maximum margin of 21 dB at 16 Chapewell Wynd.

106 Table 10 shows the highest predicted $L_{Aeq,1minute}$ for each property and a comparison with the adopted criterion.

Table 10: Comparison of highest Predicted Noise Level $L_{Aeq,1minute}$ at each Property with adopted Noise Limits, yes / no indicate if value is within the noise limit, values in brackets indicate exceedance above the noise limit.

Location	Highest predicted $L_{Aeq,1minute}$, dB	DoE AL 72 Noise Limit (67 dB L_{Aeq})	BS 5228 – Part 1 Noise Limits (see Table 7)		
			Day L_{Aeq}, dB	Evenings/ Weekends L_{Aeq}, dB	Night L_{Aeq}, dB
Four Winds	64	Yes	Yes	No (+4 dB)	No (+19 dB)
16 Chapelwell Wynd	66	Yes	No (+1 dB)	No (+11 dB)	No (+21 dB)
Easter Hatton	66	Yes	No (+1 dB)	No (+6 dB)	No (+11 dB)
Hareburn House*	66	Yes	No (+1 dB)	No (+6 dB)	No (+11 dB)
3 Tarbothill Farm Cottages	65	Yes	Yes	No (+10 dB)	No (+10 dB)
16 Dubford Gardens	62	Yes	Yes	No (+7 dB)	No (+17 dB)

107 It should be noted that the noise levels measured by HMPL decreased during the piling operation by 8 dB within half an hour due to the immersion of the hydraulic hammer into the water.

108 The maximum sound pressure levels are considerably higher due to the impulsive nature of the piling operation with a hammer. Comparing the highest predicted maximum sound pressure level of 78 dB L_{Amax} in Table 9 with the WHO noise level for sleep disturbance of 55 dB L_{Amax} for outside the bedroom window shows that the sleep disturbance criterion is exceeded by up to 23 dB at the closest locations.

109 With regard to the impact from piling noise during the daytime it is expected that the noise from driving a pile into the seabed has a minor adverse impact on the residents during the daytime at those properties where background noise is already high due to the noise from the surf and the A90. It is assumed that due to the repetitive nature of the piling noise and slight exceedance of the daytime noise limits, the noise will be noticeable (mildly intrusive) and may cause small changes in behaviour such as closing the windows or turning up the volume of the TV/radio (see Table 5 above and Table 2.5 in (TAN Noise)). At properties further away from the A90 and the coast and therefore with lower background noise, effects may increase and have a minor to moderate adverse impact for a limited time as the piling noise will be more noticeable and may be perceived as disruptive.

110 Due to the limited period of time it is expected that the residents will fully recover from any disturbance during the day-time. The recovery period after disturbed sleep for up to 12 nights would, in all likelihood, be longer. A full recovery is expected once the construction phase is completed. The impact on the closest neighbours of the proposed EOWDC due to piling noise during evenings/weekends is expected to be between minor and major adverse depending on the prevailing background noise and the distance to the development. The repetitive nature and the magnitude may be perceived as mildly intrusive up to very disruptive if the noise impact requires a significant change in behaviour such as keeping windows closed at all times, or not being able to use the garden in the evenings.

111 The impact from piling noise during the night-time, the impact is expected to be between minor and major adverse for the L_{Aeq}, depending on the location, i.e. distance to the development, and the prevailing background noise. For the closest properties it may result in loss of regular sleep and increased stress due to the magnitude of the noise levels and the nature of the noise (repetitive). It is considered to be major adverse impact for these properties. Depending on prevailing background noise and increasing distance to the piling activity, the impact will be reduced.

112 The impact on undisturbed sleep will be major adverse for the closest properties but would also affect a wider area when assessing the maximum sound pressure level against the adopted sleep disturbance criteria due to the magnitude of the noise levels. The generated noise levels will be well above the recommended criterion for undisturbed sleep and therefore prevent regular sleep.

113 The predicted piling noise will have a major and thus significant impact on the residents during evenings/weekends and during the night through temporary loss of amenity and likelihood of disturbed sleep during the driving of the monopiles.

114 Due to the limited period of the piling operation to 12 days, the effect on the surrounding properties during the day is regarded to be less significant than for the evening/weekend or night-time. BS 5228-1:2009 (BSI, 2009) states in Appendix E.3.2 that '*if the total noise level exceeds the appropriate category value* (i.e. noise limit), *then a significant effect is deemed to occur*.' The exceedance of the noise limits occurs only during a very limited period at the beginning of the piling process and a limited number of properties on a limited number of days (i.e. when piling the closest locations). This is a potential significant effect but is considered reversible and only of limited duration. Therefore the effect is expected to be acceptable.

Mitigation

115 It is impossible to calculate the reduction of noise levels due to proposed noise mitigation measures as very little data is available for airborne noise reduction of offshore piling operation and currently it is uncertain which machinery will be used.

116 Suggestions for the noise reduction of onshore building construction sites is available but it should be noted that those piles are much smaller in diameter and therefore much less energy is needed to drive them and thus a lower noise emission is produced. It is possible that suggested measures might not be practically feasible at sea.

117 Potential mitigation measures at the source could include enclosing the hammer head and the top of the pile in an acoustic screening or using a resilient pad between hammer head and pile to prolong the impulse/contact time and thus reduce the peak sound power level. If hammer driver monopiles are to be installed, consideration will be given to the selection of the hammer and potential dampening techniques to abate in-air emissions.

118 Using vibration pile driving reduces the sound power level compared to impulse pile driving, especially the peak level. This technique, however, is normally only used for small piles and is limited to a certain type of soil. It therefore may not be suitable for the proposed EOWDC.

119 The duration of high noise levels can be reduced when pile driving is limited to the necessary amount to achieve necessary penetration depth and mechanical boring is used when applicable.

120 It is recommended that a stringent noise management policy is designed to ensure the noise levels at nearby dwellings are kept to a minimum at all times. It is recommended that regular meetings are held with one or more elected resident's representatives to ensure noise levels do not become excessive. A 24hr contact telephone number should be made available and publicised for surrounding receptors in case noise levels become excessive.

121 To reduce annoyance and hostility, potentially affected residential areas should be notified well before the piling operations start and be informed about the expected impacts and the duration of the construction phase. A neighbourhood comment and complaint system should be developed to record and deal with complaints.

122 In order to mitigate the effects on sleep disturbance during the night and periods used for relaxation at the weekends, it is proposed to restrict the pile driving operation to the following periods:

- Mondays – Fridays 07:00 until 19:00
- Saturdays 07:00 until 13:00
- Sundays and bank holidays no noisy equipment should operate

Residual Impacts

123 If piling is not carried out during the night there will be no noise impact on the residents during this time and the impact will be negligible.

124 By introducing a noise management policy that includes regular meetings with local resident representatives and facilitates the dissemination of information on the expected timing and duration of piling it is expected that the impact during daytime hours will be minor. As the construction period associated with high noise levels is only for a limited time and as methods to screen the sound at source could potentially be employed this impact could be reduced even further.

125 By following the same mitigation as is proposed for daytime hours above it is felt that the impacts during evenings and weekends will also be moderate adverse.

Cumulative Impacts

126 The installation of the potential Ocean Laboratory has been assessed as a cumulative impact. Table 9 highlights that the worst case predicted noise levels associated with installing the potential Ocean Laboratory will be similar to those associated with installing the worst case wind turbine on the site. Additional time spent installing the structure would increase the time local residents could be exposed to noise. However, as the additional time that noise will be generated will only be of a short, temporary duration the cumulative impact is assessed as being of minor significance.

Monitoring

127 It is vital to monitor the construction noise at least at the beginning of the pile driving phase. This is essential to establish the real sound power level of the pile driving activity, verify the propagation calculation and check the efficiency of the mitigation measures.

128 It is suggested to measure the sound pressure level as close to the piling operation as possible to calculate the sound power level of this noise source.

129 Further monitoring should be carried out at the locations where the background noise monitoring has been done. It might be advisable to choose one location at a greater distance inland (2-3 km) to establish how far inland the noise could cause complaints, especially in areas where there is not much road traffic and surf noise.

130 During the monitoring noise mitigation measures could also be tested and it could be established whether sufficient mitigation is in place to allow for night-time piling as well.

1.3.1.2 Operational Phase

131 To determine the potential impact of the proposed development when operating, wind turbine noise has been assessed in accordance with the guidance contained within ETSU-R-97.

132 Following discussions with the relevant EHOs noise predictions were carried out for the four locations representing the closest residential properties to the proposed EOWDC and two locations further inland. The predictions assume down wind propagation from all sources simultaneously, which cannot occur in practice. The predicted noise levels are summarised in Table 11 below.

Table 11: Highest predicted Wind Farm Noise Level at the assessed Properties

Location	**Highest predicted wind farm noise level L_{A90}, dB**
Four Winds	39.5
16 Chapelwell Wynd	40.9
Easter Hatton	40.7
Hareburn House	41.3
3 Tarbothill Farm Cottages	40.2
16 Dubford Gardens	37.2

Potential Impacts

133 Plots have been produced of the measured L_{A90} background noise levels against wind speed at six locations representing the closest residential properties to the proposed EOWDC site. The derived noise limits are based on the lower ETSU-R-97 daytime limit and the Aberdeenshire night-time limit of 38 dB L_{A90} or background noise level plus 5 dB, whichever is the greater. The plots for these locations also show the upper ETSU-R-97 day time limit for completeness.

134 All the data points corresponding with recorded incidences of rainfall were removed.

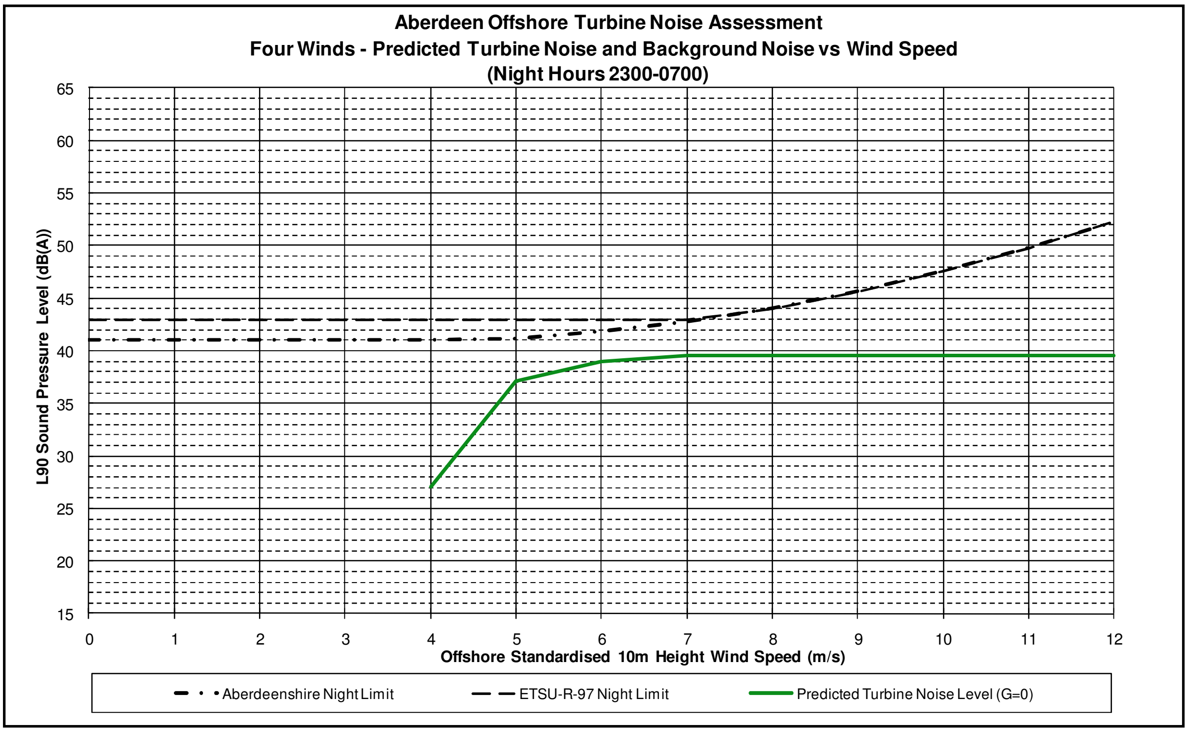
135 The assessment plots are shown in Chart 1 to 12 for the night hours and daytime hours for the representative residential locations.

136 Due to a technical error, the sound level meter at Hareburn House only recorded data for 3 days. During that period background noise levels were between 40 and 58 dB L_{A90} at 3 m/s and 52 and 59 dB L_{A90} at higher wind speeds during amenity hours and 42 and 55 dB L_{A90} at 3 m/s and 52 and 55 dB L_{A90} at higher wind speeds during night hours. Comparing the measured noise level of Hareburn House with the noise levels obtained at 3 Tarbothill Farm and 16 Chapelwell Wynd leads to the conclusion that background noise levels are generally higher at Hareburn House due to the proximity of the sea. The approach taken to use the noise limits derived from the measurement at Chapelwell Wynd as a substitute for Hareburn House is considered conservative as lower noise levels were recorded at this property compared to Tarbothill Farm. It is also assumed that using those noise limits is more representative for the houses in Blackdog which are further back from the shoreline as Hareburn House and would therefore receive less sea noise than Hareburn House.

137 The ETSU-R-97 noise limits assume that the wind turbine noise contains no audible tones. Where tones are present, a correction should be added to the measured or predicted noise level before comparison with the recommended limits. The audibility of any tones can be assessed by comparing the narrow band level of such tones with the masking level contained in a band of frequencies around the tone called the critical band. The ETSU-R-97 recommendations suggest a tone correction, which depends on the amount by which the tone exceeds the audibility threshold. A warranty will be sought from the manufacturer of the wind turbines for this site, once the model has been chosen, that the noise output will not require a correction under the ETSU-R-97 scheme.

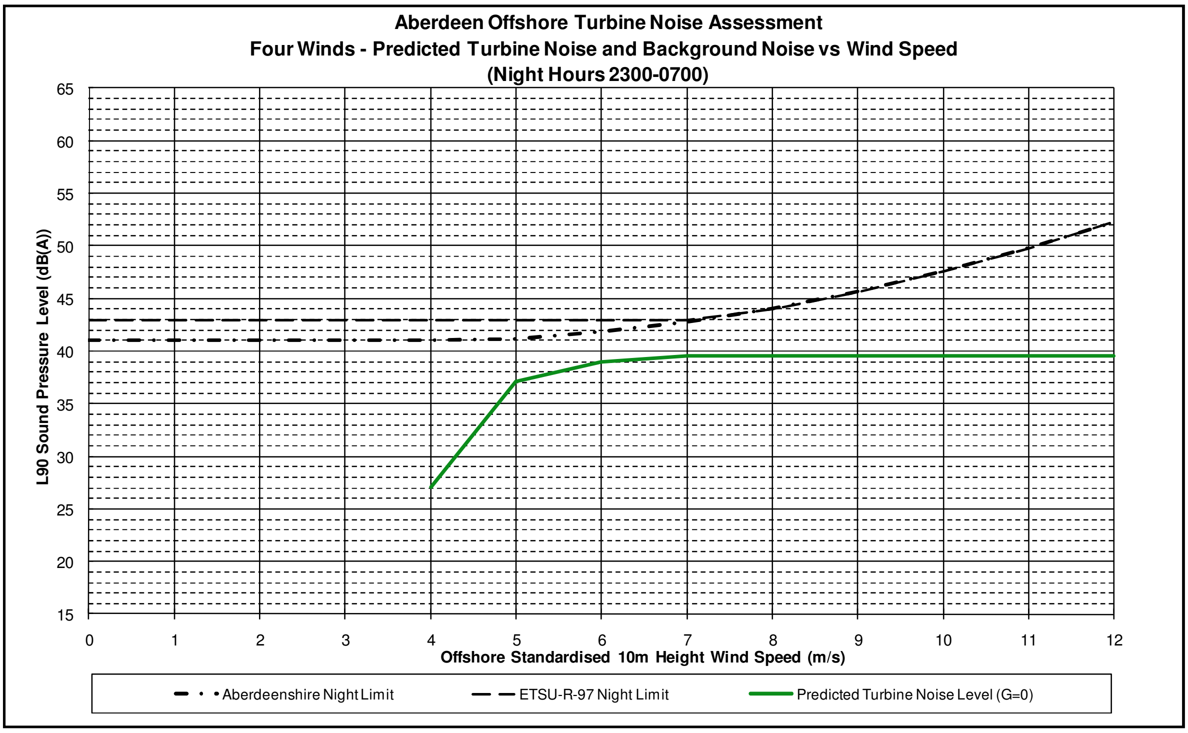
Four Winds

Chart. 1



138 Chart 1 shows that at Four Winds, the typical predicted wind turbine noise level meets the night noise limit by a minimum margin of 2.8 dB. The typical predicted wind farm noise level is below the prevailing background noise for wind speeds above 8.5 m/s.

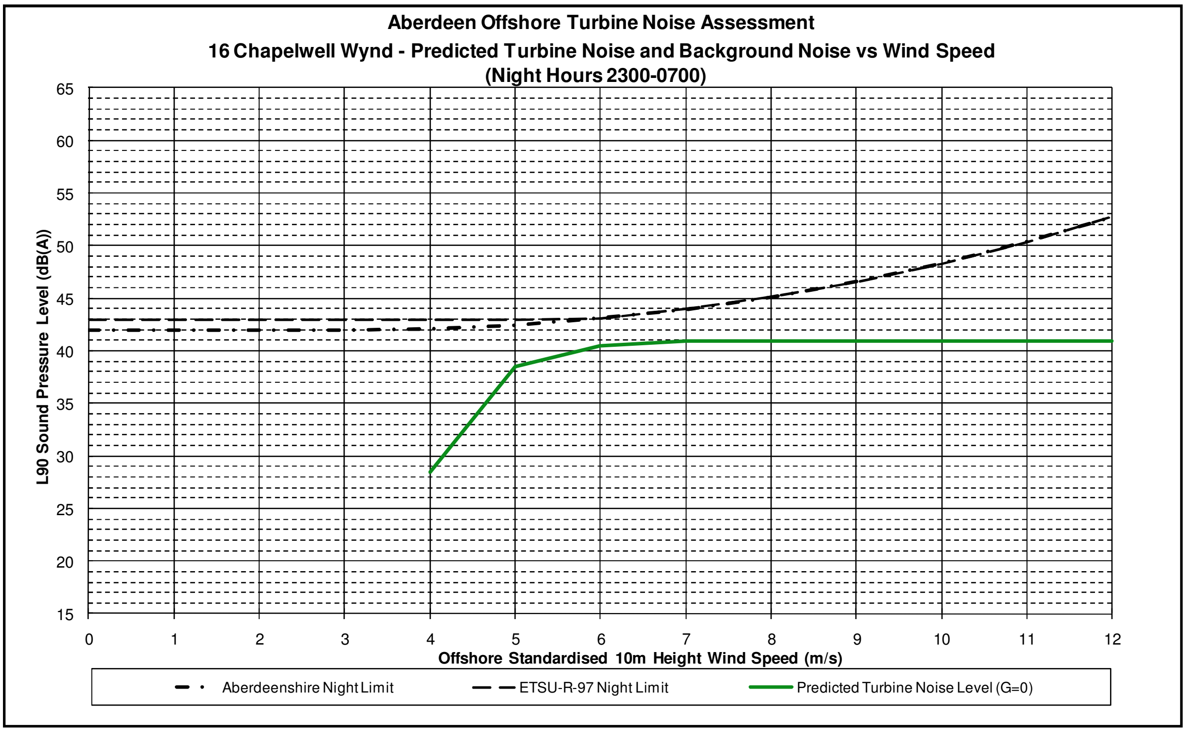
Chart. 2



139 Chart 2 shows that at Four Winds, the typical predicted wind turbine noise level meets the ETSU-R-97 day-time noise limit by a minimum margin of 14.2 dB. The typical predicted wind farm noise is below the prevailing background noise for all wind speeds.

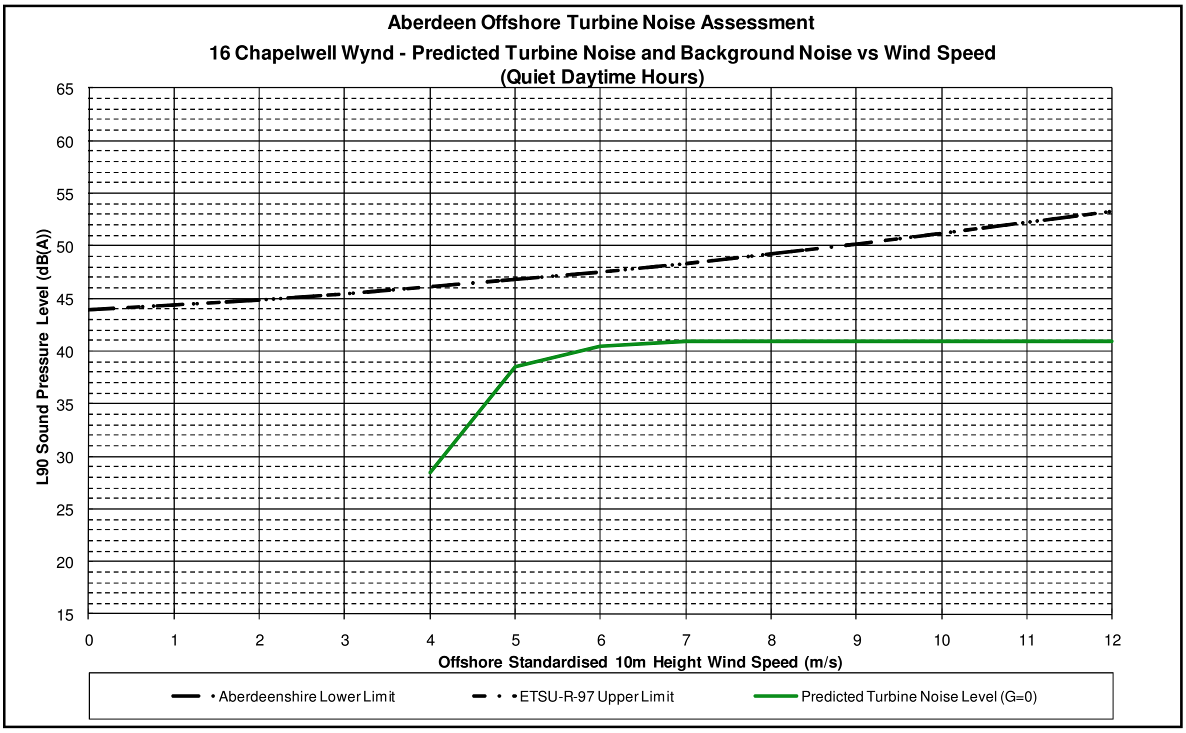
16 Chapelwell Wynd

Chart. 3



140 Chart 3 shows that at 16 Chapelwell Wynd, the typical predicted wind turbine noise level meets the night noise limit by a minimum margin of 2.7 dB. The typical predicted wind farm noise level is below the prevailing background noise for all wind speeds above 8.5 m/s.

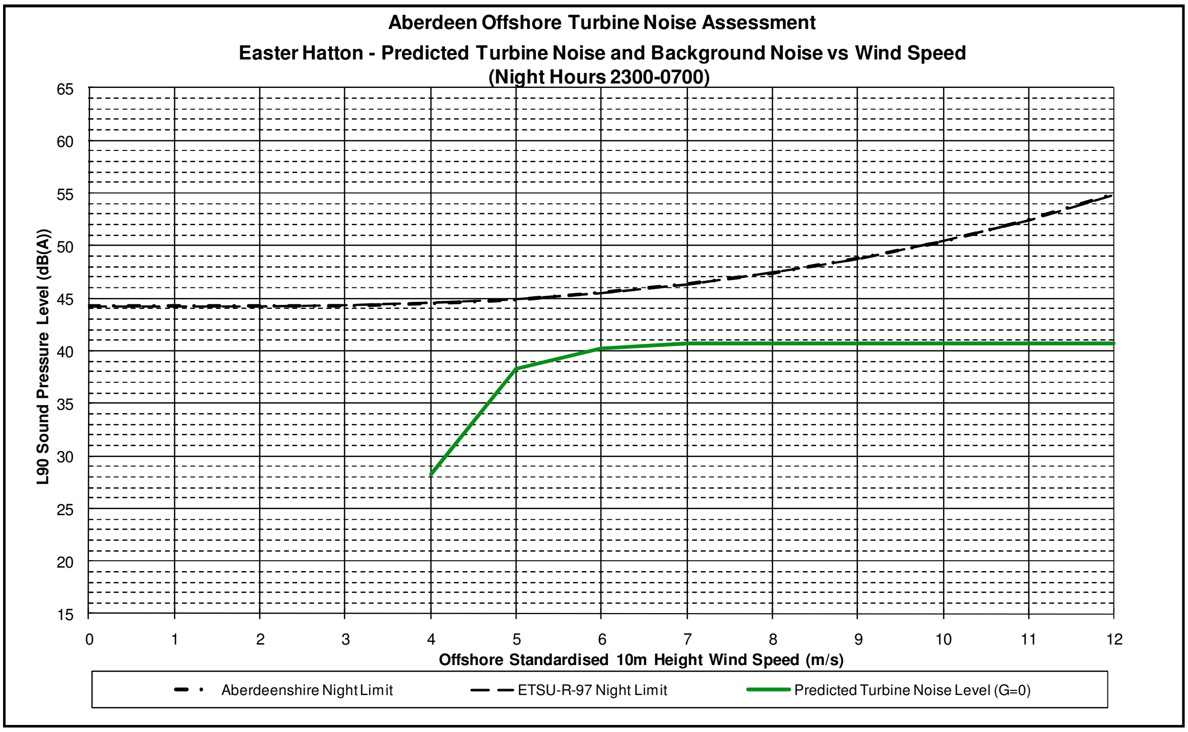
Chart. 4



141 Chart 4 shows that at 16 Chapelwell Wynd, the typical predicted wind turbine noise level meets the ETSU-R-97 day-time noise limit by a minimum margin of 7.1 dB. The typical predicted wind farm noise is below the prevailing background noise for all wind speeds.

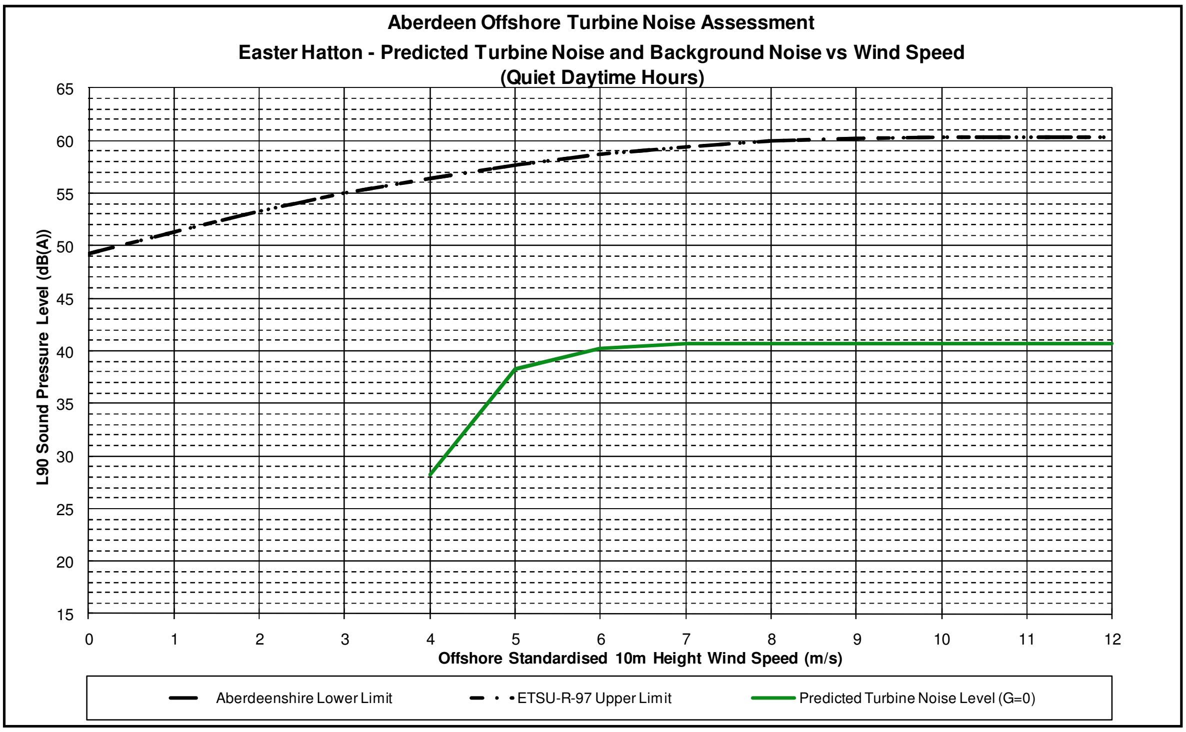
Easter Hatton

Chart. 5



142 Chart 5 shows that at Easter Hatton, the typical predicted wind turbine noise level meets the night noise limit by a minimum margin of 5.3 dB. The typical predicted wind farm noise level is below the prevailing background noise for all wind speeds.

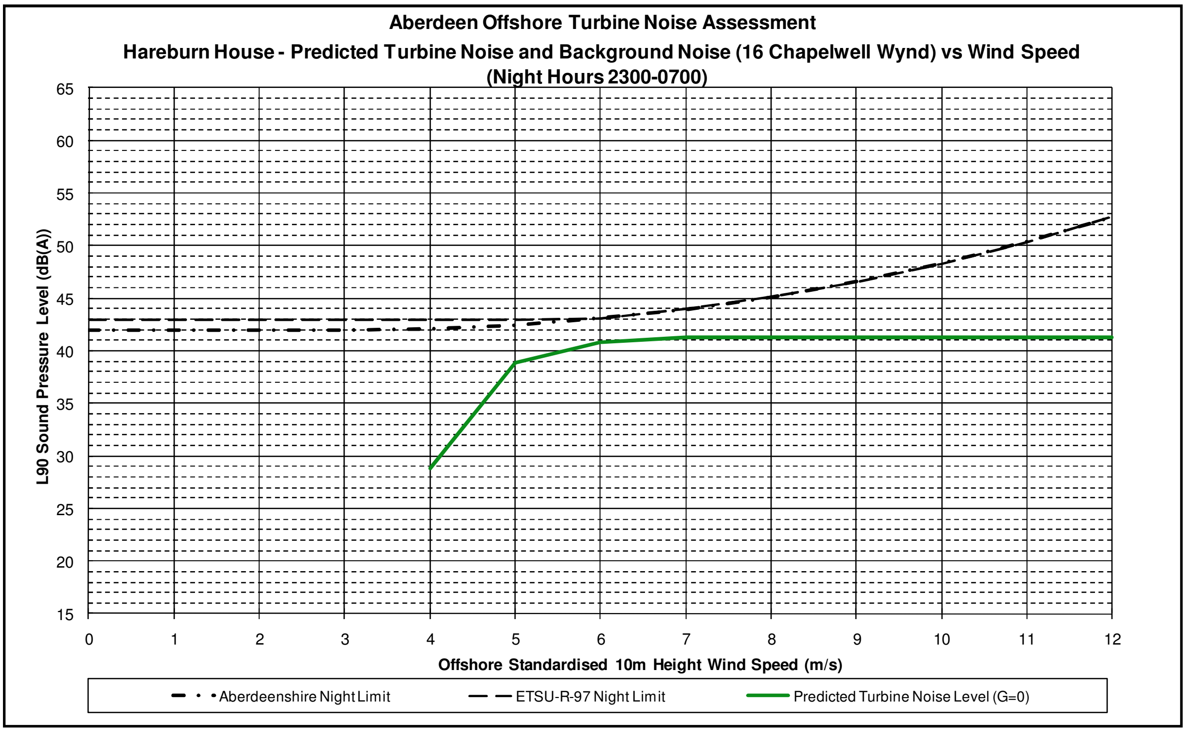
Chart. 6



143 Chart 6 shows that at Easter Hatton, the typical predicted wind turbine noise level meets the ETSU-R-97 day-time noise limit by a minimum margin of 18.5 dB. The typical predicted wind farm noise is below the prevailing background noise for all wind speeds.

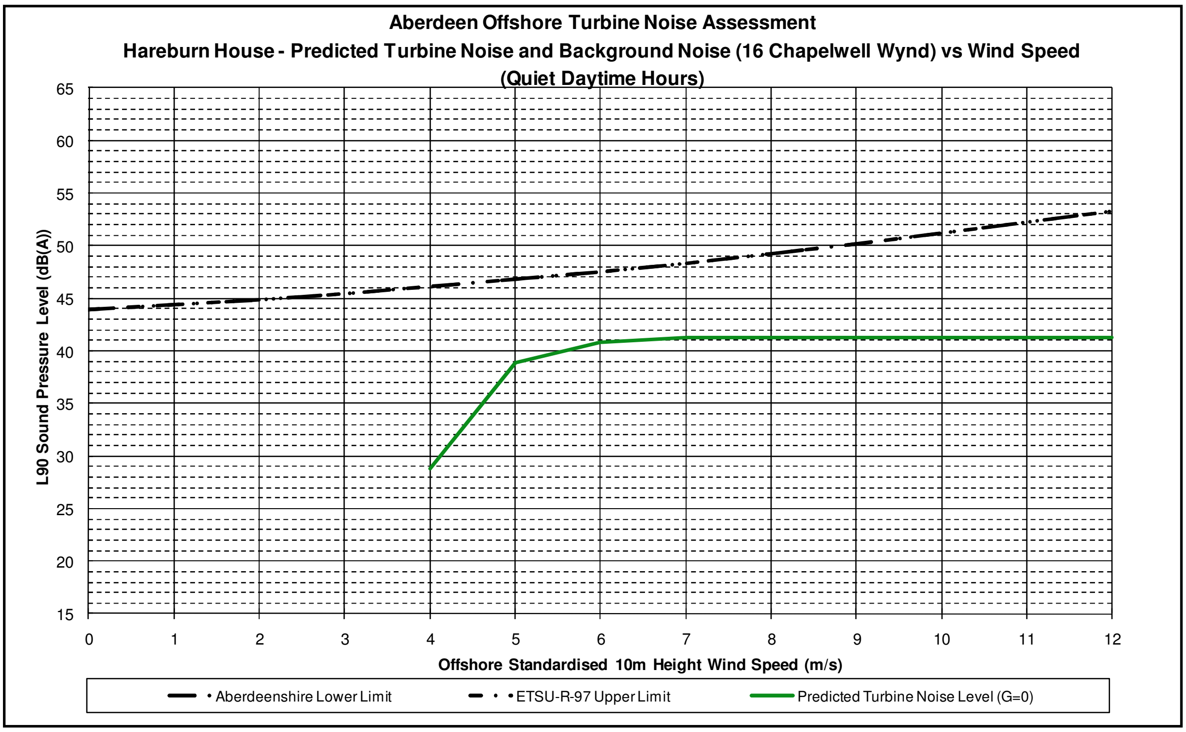
Hareburn House

Chart. 7



144 Chart 7 shows that at Hareburn House, the typical predicted wind turbine noise level meets the night noise limit, based on the background noise measurements at 16 Chapelwell Wynd, by a minimum margin of 2.3 dB.

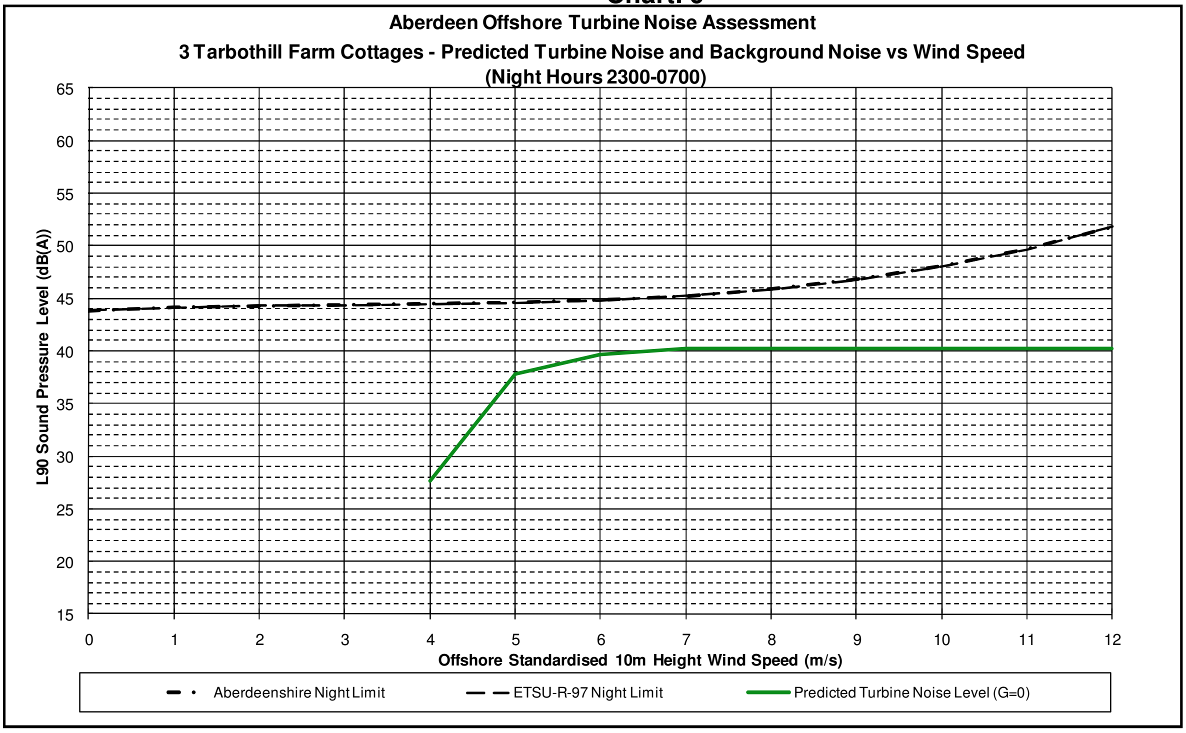
Chart. 8



145 Chart 8 shows that at Hareburn House, the typical predicted wind turbine noise level meets the ETSU-R-97 day-time noise limit assigned from 16 Chapelwell Wynd by a minimum margin of 6.7 dB.

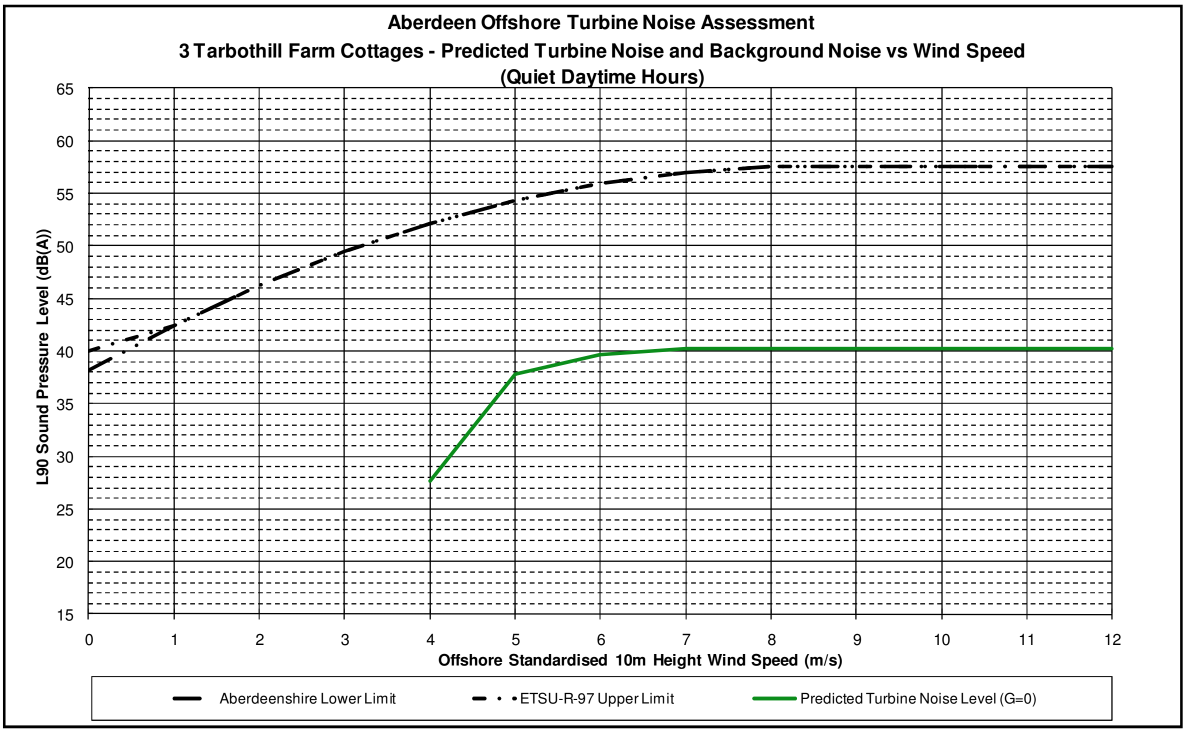
3 Tarbothill Farm Cottages

Chart. 9



146 Chart 9 shows that at 3 Tarbothill Farm Cottages, the typical predicted wind turbine noise level meets the night noise limit by a minimum margin of 5 dB. The typical predicted wind farm noise level is below the prevailing background noise for all wind speeds.

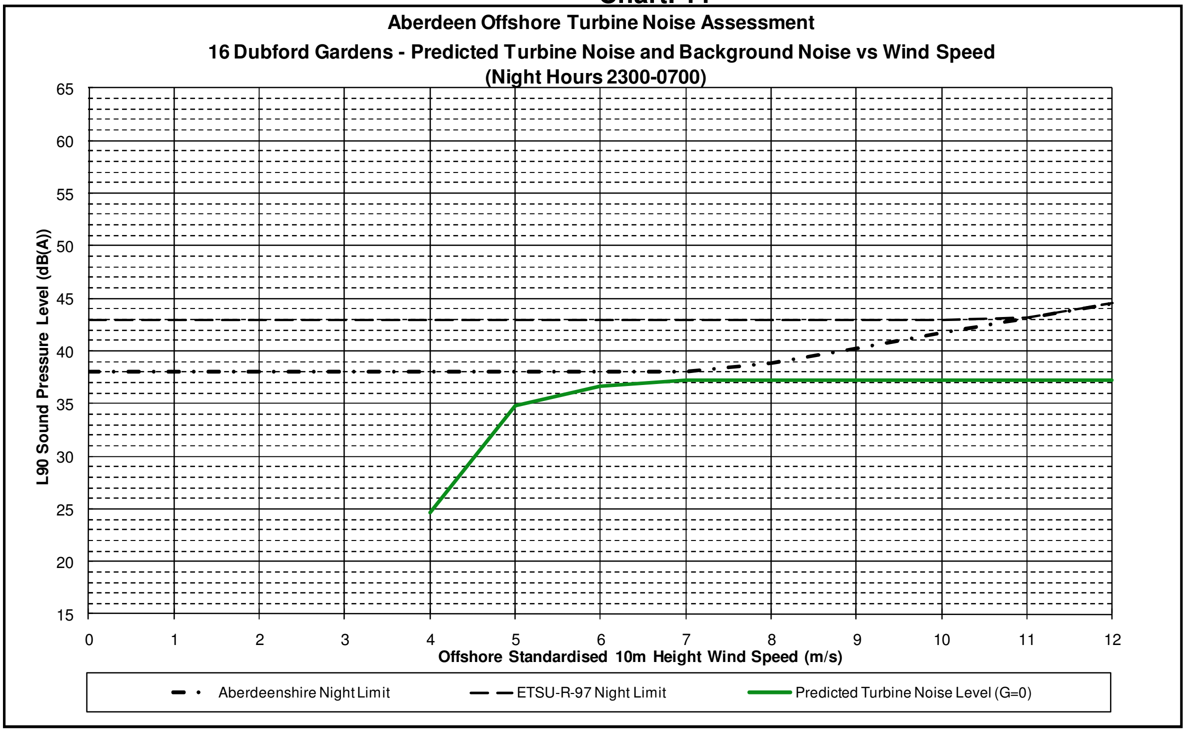
Chart. 10



147 Chart 10 shows that at 3 Tarbothill Farm Cottages, the typical predicted wind turbine noise level meets the ETSU-R-97 day-time noise limit by a minimum margin of 16.2 dB. The typical predicted wind farm noise is below the prevailing background noise for all wind speeds.

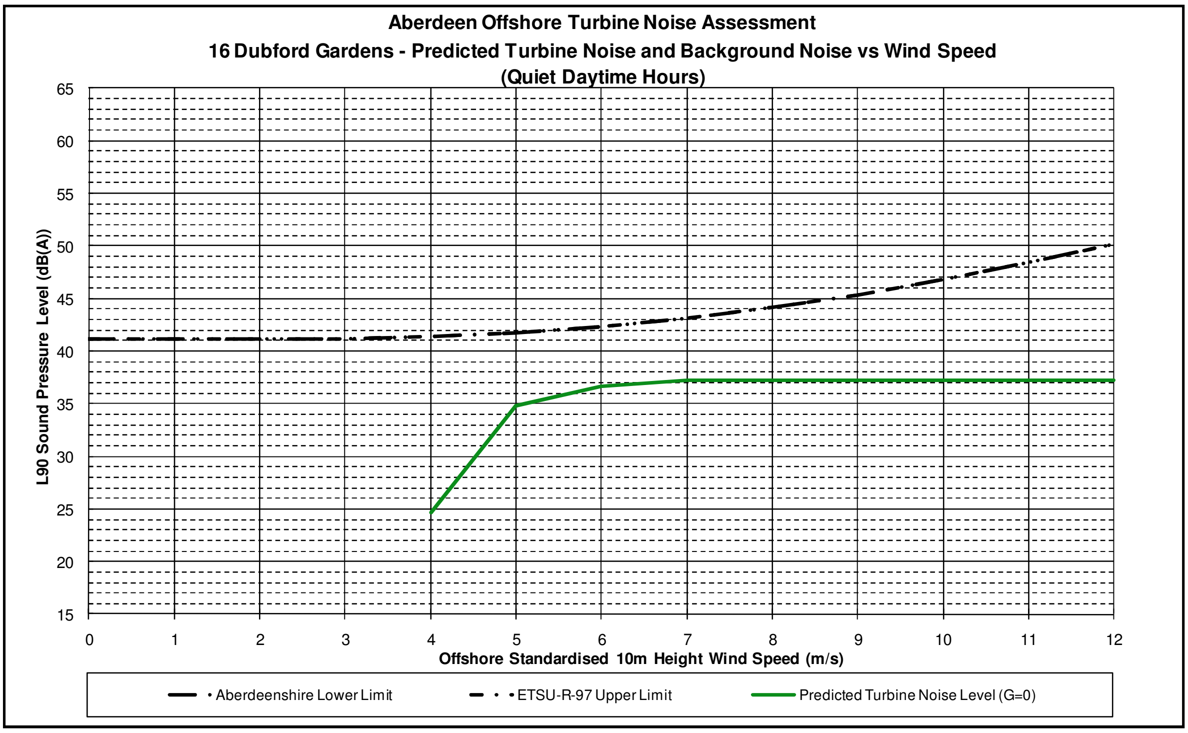
16 Dubford Gardens

Chart. 11



148 Chart 11 shows that at 16 Dubford Gardens, the typical predicted wind turbine noise level meets the night noise limit by a minimum margin of 0.8 dB. The typical predicted wind farm noise level is below the prevailing background noise for wind speeds above 10.5 m/s.

Chart. 12



149 Chart 12 shows that at 16 Dubford Gardens, the typical predicted wind turbine noise level meets the ETSU-R-97 lower day-time noise limit by a minimum margin of 5.7 dB. The typical predicted wind farm noise is below the prevailing background noise for all wind speeds.

1.3.1.3 Other Residential Properties

150 The assessments carried out for the background noise measurement locations are generally representative of the most affected properties in each area. This has been determined by considering distance from the sea, distance from the A90, and the type of residential area. Generally all other properties in the area being represented receive a lower predicted noise level and, assuming background noise is similar, will receive a lower impact than the assessed location.

151 The only area to which this doesn't apply is 16 Dubford Gardens. This is due to the measurement being chosen being both further from the A90, and on the edge of the Aberdeen suburb of Bridge of Don. Although there are properties closer to the proposed EOWDC site, which will therefore have a higher predicted noise level from the wind farm, these properties will equally have a higher background noise than that of 16 Dubford Gardens, due to their proximity to the A90, sea and being in a more built-up region. 16 Dubford Gardens was therefore chosen to represent this area due to its location balancing these factors.

152 The operational wind farm is predicted to be within the noise limits set by ETSU-R-97, the accepted guideline for onshore wind farm noise which has been adopted in this assessment and is therefore considered to have a negligible impact in terms of ETSU-R-97 noise limits.

Mitigation

153 None required

Residual Impacts

154 As no mitigation is required the residual impact will be negligible.

Cumulative Impacts

155 The proposed EOWDC may be supplemented by the installation of a diesel generator on the potential Ocean Laboratory Platform for electricity generation for the laboratory. The operational wind farm noise has been assessed together with the operation of the diesel generator of the potential ocean laboratory as a cumulative impact.

156 The height of the ocean laboratory is proposed to be 18 – 20 m above sea level. This has been assumed as source height. The source noise level of 90 dB(A) at 1 m distance for the diesel generator has been given in chapter 3, Description of the Proposed Development. Table 12 shows the assumed octave band sound power level based on octave band information from BS5228:2009 Appendix C, Table C.4 normalised to 90 dB(A).

Table 12: Normalised Noise Spectrum for a Diesel Generator at 1 m

Octave Band Centre Frequency (Hz)	Normalised Octave Band Sound Power Level (dB L_{Aeq})
63	88.8
125	81.8
250	76.8
500	72.8
1k	69.8
2k	65.8
4k	66.8
8k	59.8

157 The results of the cumulative assessment showed no change in predicted noise levels at all. The operation of the diesel generator has no effect on the predicted noise levels of the operational EOWDC, the cumulative impact has therefore been assessed as negligible.

Monitoring

158 Due to the magnitude of the prevailing background noise compared to the predicted EOWDC noise especially during the daytime, it might be difficult or impossible to distinguish between the two during a measurement especially if the wind turbines cannot be stopped for an additional background noise measurement during the survey.

159 If the Planning Permission requires a compliance test nevertheless, it is proposed to carry out the measurement at the same locations as previously, according to the methodology proposed in ETSU-R-97, measuring the $L_{A90,10minute}$ of the total noise and background noise with the wind turbines stopped if possible, and compare the measured sound pressure level with the noise limits proposed in this EIA chapter.

160 Should complaints arise due to the operational noise of the EOWDC, it is suggested that monitoring should be carried out at the affected properties with the results compared to the limits derived for the nearest relevant property where background noise monitoring was carried out.

1.3.1.4 Decommissioning Phase

Potential Impacts

161 The decommissioning phase is not expected to cause any significant effect as noise levels from shipping and taking down the wind turbine parts will be significantly lower than the piling noise from the construction phase.

1.3.2 **Additional Potential Noise Generating Activities**

1.3.2.1 Construction Phase

Potential Impacts

162 Noise from shipping activities is not considered significant and has not been assessed here.

163 The main noise source of the cable laying process is assumed to be from the activity of ploughing, trenching or jetting. Neither the machinery nor the exact cable route is known at this stage and therefore no accurate assessment could be carried out. It is expected that the effect, if at all, would be where the cable route comes to shore but due to the duration of the activity and the machinery potentially under water for most of the works, a negligible impact on the closest residential properties is expected. No further assessment has been carried out here.

164 To ensure compliance with the noise limits adopted from BS5228-1:2009 it is suggested to carry out measurements during the period, when the cable lying activity is closest to the nearest properties. For any other times, noise levels would be lower and thus comply with the noise limits.

Mitigation

165 None required.

Residual Impact

166 As no mitigation is required the residual impact will be negligible.

1.3.2.2 Operational Phase

Potential Impacts

Additional noise generated from ongoing operation and maintenance (for example vessel movements) is not considered significant and has not been assessed here.

Mitigation

167 None required.

Residual Impact

168 None.

1.3.3 EOWDC Future Research and Monitoring Opportunities

1.3.3.1 Offshore Piling

169 As only limited noise data is available for the offshore piling activity it is suggested to carry out sound measurements at the source and simultaneously at two receiver locations, one near the shore and one further inland. The sound source measurements would provide sound power level for future offshore projects which involve piling and would also be useful to verify the data that has been used for this assessment.

170 The noise measurements onshore in combination with the simultaneous sound source measurements can be used to verify the propagation model for long-range propagation at sea and also to verify the noise reduction measures for local residents during the construction phase. Those measurements are also essential to show compliance with the construction noise limits.

171 Furthermore, the measurements can also be used to refine the sound propagation model especially to investigate the influence of ground absorption for locations further inland.

1.3.3.2 Offshore Wind Turbines

172 Many new offshore wind turbine types have been developed in the last few years but there is still not much noise data available, partly because some of the wind turbine types are still in the development state. Sound source measurements at the offshore wind turbines can fill this gap and provide essential information for a correct sound propagation calculation.

173 Simultaneous noise measurements at the same receptors for which background noise measurements have been carried out can be used to verify the propagation model and also show compliance with the derived noise limits.

174 Long-term noise measurement onshore could be used to investigate the effects certain weather conditions on the propagation and audibility of offshore wind farm noise at onshore receptor locations. This could result in a study where measured noise level are compared with the perception of local residents to get a better understanding of the effects of offshore wind farm noise on residents living near the coast and further inland where the masking noise of the sea noise will be less.

1.4 Summary

175 An assessment of the potential noise impact from the European Offshore Wind Deployment Centre has been performed. The guidance contained within ETSU-R-97 has been used to assess the potential noise impact of the proposed development, as specified in Scottish Government web based planning advice on onshore wind turbines as referred to in PAN 1/2011 (Scottish Executive, 2011), *Planning and Noise*.

176 Background noise measurements were taken at six locations neighbouring the proposed EOWDC. These locations were agreed with the Environmental Health Officers (EHO) for the Local Planning Authorities of Aberdeen City and Aberdeenshire Council.

177 Analysis of the measured data has been performed in accordance with ETSU-R-97 to determine the pre-existing background noise environment at these six locations.

178 Predictions of wind turbine noise have been made, based upon a generic sound power level typical for a 10 MW generating capacity wind turbine. The calculation procedure adopted is considered to be worst-case.

179 A warranty will be sought from the manufacturer of the wind turbine for this site such that any tonal noise output from the wind turbines will not require a correction under the ETSU-R-97 scheme.

180 The predicted levels and measured background noise levels indicate that for all dwellings located onshore, wind turbine noise will meet the amenity and night-time noise criteria proposed within ETSU-R-97.

181 Predictions of noise associated with the possible diesel generator, associated with the potential ocean laboratory indicate that this noise source will result in no audible noise at onshore receptor locations and the sleep disturbance due to this noise source will not occur.

182 Cumulative assessment of the operational EOWDC noise and the possible diesel generator resulted in no change of the operational EOWDC noise.

183 Prediction of the pile driving noise during the construction phase shows exceedance of the night-time noise limits adopted from BS5228:2009 Part 1 (BSI, 2009) at all properties. It has therefore been proposed that construction times should be limited to daytime hours unless suitable noise mitigation can be found and verified by measurements.

184 Prediction of the pile driving noise during daytime shows exceedance of the L_{Aeq} daytime noise limits adopted from BS5228:2009 Part 1 (BSI, 2009) at three assessed properties by 1 dB. With a suitable noise management policy it is expected that the impact during daytime hours will be minor adverse. As the construction period with high noise levels is only for a limited time and as methods to screen the sound at source could potentially be employed this impact could be reduced even further.

185 A summary of the impacts is provided in Table 13.

Table 13: Impact Assessment Summary Table

Potential Impact	Significance Level	Mitigation	Residual Significance	Monitoring
Sleep disturbance during piling night	Major	No piling during night	Negligible	No
Stress, annoyance during piling daytime	Minor to Moderate	Screens and good information policy	Minor	Yes, to determine real sound levels and check efficiency of potential mitigation measures.
Exceedance of noise limits during operation day	Negligible	Not required	Negligible	No
Exceedance noise limits operation night,	Negligible	Not required	Negligible	No
Construction noise from other machinery	Negligible	Not required	Negligible	No
Operational noise from diesel generator	Negligible	Not required	Negligible	No

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European Offshore Wind Deployment Centre

Environmental Statement

Appendix 28.1: Draft EMP

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

1 INTRODUCTION

1 This document provides the Environmental Management Plan (EMP) for Aberdeen Offshore Wind Farm Limited's (AOWFL) proposed European Offshore Wind Deployment Centre (EOWDC) for the three phases of offshore construction, operational and decommissioning.

2 Due to the nature of the proposed project (a test centre) and the stage at which this document has been produced it has not been possible to fully address every element. For the purposes of this document a list of likely outline method statements has been produced and an example outline provided. As further information is made available so these documents will be updated.

1.1 Aim of the Environmental Management Plan (EMP)

3 The aim of the EMP is to ensure that all aspects of environmental management are carried out in accordance with relevant legislation and best practice guidelines.

4 This is to be achieved by taking a fully integrated approach to project management through the complete cycle of preparation, planning, action, monitoring, checking and review.

5 The EMP will be implemented prior to construction and in consultation with statutory authorities, with a suite of complementary management plans corresponding to different aspects of the construction activity. The documents will be tailored specifically to ensure compliance with the consent conditions for the project and current environmental best practice. The following documents would be incorporated into a final EMP:

- Monitoring Protocol (as per statutory consents)
- Incident Reporting and Non Conformance Procedure
- Emergency Response Plan
- Collision Risk Management Plan
- Marine Pollution Contingency Plan
- Dropped Objects and Materials Recovery Plan
- Archaeology Plan
- Noise, Dust and Vibration Management Plan
- Waste Management Plan

6 The final EMP would be in place well before construction begins to take full account of all pre-construction monitoring requirements.

1.2 Structure of this Document

7 This EMP is divided in to three sections:

a. **Part 1** provides background and supporting information for the EMP.

b. **Part 2** details in a series of summary briefing notes, the environmental impacts identified to date and the associated commitments made with regard to environmental management, impact mitigation measures and consent conditions, all of which AOWFL is obliged to carry out. These commitments derive from the EOWDC Environmental Statement.

c. **Part 3** provides an introduction to outline construction method statements.

8 It should be noted that further commitments could be contained in any consent granted to the project. At such time these commitments would be fully incorporated in to the EMP.

PART 1

2 POLICY

9 Suitable and effective safety, health and environmental management would be in place for the duration of the project.

10 A health and safety plan would be prepared covering all aspects relating to health and safety.

11 A manager would be appointed responsible for the overall safety, health and environmental policy. It would be the joint responsibility of all employees to ensure this policy is implemented via collective and individual responsibilities set out within the policy document.

3 PLANNING REQUIREMENTS

3.1 Environmental Aspects

12 An environmental aspect is any element of an activity that could interact with the environment and that may have the potential to have an environmental impact.

13 The following documents were used to formulate the draft EMP and contain information on potential environmental impacts and environmental aspects of the EOWDC proposal:

- European Offshore Wind Development Centre Environmental Statement of which this document forms Appendix of Chapter 28
- aspects identified in good practice
- Marine Scotland Guidance

14 This draft EMP focuses upon the key offshore environmental aspects with detail provided in outline briefing notes.

15 This information may be supplemented as additional studies may be undertaken throughout the phases of the development and would be taken into account as appropriate.

3.2 Legal and Other Requirements

16 It is important that all elements and activities associated with the development in all its phases comply with all relevant environmental legislation.

17 Lead responsibility for delivering compliance with relevant environmental obligations and legal statues is set out below.

- before issue of construction contracts: The applicant development team
- construction: Construction Contractor
- operation: Operations Contractor
- decommissioning: Decommissioning Contractor

18 Responsibility to identify and adhere to specific and current environmental legal requirements will lie with the main contractor.

3.3 Objectives, Targets and Programme

19 At the heart of the EOWDC project is the interaction between a research and potential test and training centre with a small, highly innovative, commercially operated and highly instrumented and monitored offshore wind farm. The site will offer potential opportunities for commercial R&D, testing and dissemination including long-term environmental monitoring and improvement. This future monitoring should play a key role in the development of the EMP.

20 Long-term improvement goals would be identified for the project. These would be compatible with the policy for the development and consider the relevant environmental impacts.

21 The applicant is committed to the following environmental objectives:

- exemplary performance in all aspects of environmental management
- a proactive attitude to environmental protection
- no prosecutions
- monitoring
- collision risk for key species less than predicted
- a target of no reportable environmental incidents at any stage in the project
- minimum ornithological and ecological disturbance commensurate with building an operational wind farm
- regular reporting and communication on environmental performance with statutory bodies and the local community

22 To support the long-term goals, a series of environmental targets, focusing upon the short-term actions would be developed. These would be supported by a programme that sets out how the targets are to be achieved (eg resources, specific actions and timescales). Action may take the form of the following:

- development of improvement strategies in particular areas, one-off actions, such as establishment of an environmental component to the website, introduction of technological solutions to resolve/improve environmental issues
- on-going actions that could be tracked over time, eg tonnage of waste disposed (or recycled)

23 The long-term objectives, the short-term targets and progress against these would be reviewed on a regular basis. This would form part of the management review and meetings with the independent Environmental Management Committee.

24 The review would continue through all phases of the development with the objectives, targets and management programme reflecting the key issues for the activities being undertaken and the lead responsibilities.

4 IMPLEMENTATION

4.1 Resources, Roles, Responsibility and Authority

25 The overall project management team would have the responsibility of delivering the EMP. In this way environmental management would be fully integrated into the running of the project. This team's roles would include:

- review of all method statements and review against all management plans and checking that work is carried out accordingly
- ensuring monitoring in accordance with all management plans is carried out and reviewed; and
- reporting as required by the management plans

26 In order to implement the management plans identified above and to ensure the monitoring procedures outlined in the briefing notes are implemented, the project management team would employ a number of skilled experts during the construction, operation and decommissioning periods. This could include:

- ornithologist
- marine mammal observer
- marine ecologist
- fisheries expert
- archaeologist

4.1.1 Incorporation of EMP into Contracts

27 The EMP would be incorporated into all contracts. Incentives and/ or penalties would be introduced where appropriate to ensure that the EMP is adhered to throughout the development process.

4.1.2 Day to Day Responsibility

28 During construction, operation and decommissioning, a client representative would be on-site or on-call and able to respond to any incident. They would have the authority to halt or modify work in response to environmental concerns and the responsibility to ensure that all monitoring and checks are carried out in accordance to the relevant schedules. They would also have the necessary training and authority to direct the emergency response team to deal with environmental incidents.

4.2 Competence, Training and Awareness

4.2.1 Evaluation of Contractors and Subcontractors

29 When contractors are assessed consideration would be given to organisational environmental management systems and ability to implement the EMP.

4.2.2 Training

30 Suitably trained staff would be employed to manage this EMP and fulfil the roles identified in this document. Any contractors working on studies would be selected taking into account their environmental awareness and where appropriate their experience in the implementation of EMPs.

31 For construction, all senior project management staff would undergo environmental awareness training, such as the IOSH five day course. Specific members of the team would have appropriate professional environmental training as would consultants and advisors.

32 The emergency response team would be trained to carry out their work (in the unlikely event of an incident happening) with high environmental awareness to minimise the impact of any response.

4.2.3 Site Induction

33 Environmental awareness would feature prominently in the induction for all workers and site visitors.

4.3 Communication

4.3.1 Contractors and Subcontractors

34 During pre-construction surveys and then during construction, operation and decommissioning, there would be regular project meetings, including a review of environmental issues and current sensitivities.

35 Part of the review of all method statements would include an environmental audit.

4.3.2 Workforce

36 Information would also be provided to the workforce via Construction Design and Management Pre-Construction Information, the workforce would also be informed of specific areas of sensitivity and generally reminded of the sensitivity of the site through toolbox talks, posters and in method statements. They would be encouraged to report any concerns on environmental issues immediately to the project management team. All issues and actions taken would be reviewed by the project management team as a minimum on a weekly basis.

4.3.3 Meetings Programme

37 Health, safety and environment would be on the agenda of every regular project meeting.

4.4 Documentation

38 During construction, thedocumentation would include up to date records of the site and all environmental issues so that the project management team has current information available.

39 The 'documents' available could include:

- GIS Constraints Register
- design risk register
- all method statements
- all briefing notes
- all risk assessments
- commitments register

40 All records would be kept and maintained during the operation phase so that management plans could be adapted in response to changing circumstances and so that they are available for decommissioning.

4.5 Control of Documents

41 A document management system would be in place prior to construction. All method statements, risk assessments, audits, monitoring records, reviews and meeting minutes would be recorded in this system.

4.6 Operational Control

42 Before construction, records would be maintained of all activities and assessments (risk assessments, pre-construction surveys). It would be ensured that they are properly controlled and the results are passed on to the construction and operation teams later.

43 Day to day control of the project during construction would involve:

- constraints register
- working time
- time of year working
- working areas
- project planning
- preparation and monitoring of overall plan – six months, one year, total project
- preparation of detailed plan – one month ahead
- checks against constraints register
- method statements
- risk assessments
- commitments register

5 CHECKING

5.1 Monitoring and Measurement

5.1.1 Pre-construction

44 All surveys would be monitored for compliance with EOWDC specifications and appropriate management plans.

5.1.2 During Construction

45 The following monitoring checks are examples of checks that could be carried out during construction:

- water quality
- pollution control measures
- noise (in air/ sub-acoustic)
- traffic (vessels)
- scour protection

5.1.3 During Operation

46 The following monitoring checks are examples of checks that could be carried out during operation:

- water quality
- pollution control measures
- noise (in air/ sub-acoustic)
- traffic (vessels)
- scour protection

5.1.4 Monitoring Plan Timetable

47 Monitoring plans will be agreed within a specific timetable as agreed with all relevant parties.

5.2 Evaluation of Compliance

48 Full records of all measurements, shipments and transfers would be kept to demonstrate compliance with licenses and permits. The recording systems would be prepared in advance and regularly audited and reviewed.

5.3 Non-conformity, Corrective Actions and Preventative Action

49 All non-conformity would be investigated and reported to the project management team if necessary. All corrective actions would be recorded with dates for action. An overall register would be kept and regularly reviewed by the project management team and shared with other parent

projects for trend spotting. It is possible that incidents would also be required by law to be reported to industry.

5.4 Control of Records

50 Records would be controlled through the document management system and the project management team would have responsibility to ensure this is done.

5.5 Internal Audit

51 Regular internal audits would be carried out in accordance with a schedule agreed with the management team.

6 MANAGEMENT REVIEW

6.1 Project Team Review

6.1.1 Regular Review of EMP

52 This document would be reviewed regularly.

6.1.2 Preparation of Reports

53 The relevant project management team would be responsible for the preparation and presentation of reports to the relevant stakeholders.

PART 2

7 OUTLINE BRIEFING NOTES

54 This section of the draft EMP contains outline briefing notes which are relevant to all phases of the EOWDC (ie construction, operation, maintenance and decommissioning). The purpose of the briefing notes is to provide information about the environmental aspects and set out the measures necessary to reduce the environmental impact of the development during the construction stage. Outline briefing notes have been prepared for the following areas:

- Outline Briefing Note 1: General Obligations
- Outline Briefing Note 2: Ornithology
- Outline Briefing Note 3: Marine Mammals
- Outline Briefing Note 4: Marine Ecology
- Outline Briefing Note 5: In-Air Noise
- Outline Briefing Note 6: Offshore Archaeology
- Outline Briefing Note 7: Coastal Processes
- Outline Briefing Note 8: Commercial Fisheries
- Outline Briefing Note 9: Salmon and Sea Trout
- Outline Briefing Note 10: Commercial Shipping and Navigation

55 These outline briefing notes are intended for use upon consenting of the proposed EOWDC. During the initial post consent period they would be refined and finalised. During the pre-construction phase they outline the pre-construction monitoring and surveys required, and during the construction phase they outline procedures to be followed.

56 Compliance with the measures outlined in the resultant briefing notes and the method statements supporting them is mandatory via contractual obligation.

57 The outline briefing notes are intended for use by project team members and contractors responsible for construction.

58 In order to ensure compliance with many of the measures set out in these briefing notes, a series of outline construction method statements will be prepared to support this draft EMP once further information is available. For the purposes of this document an introduction to outline method statements is provided.

OUTLINE BRIEFING NOTE 1: GENERAL OBLIGATIONS

Contents:

1. Background and Context
2. Mandatory Actions
3. Monitoring Survey Requirements
4. Further Information

1. Background and Context

Any general obligations stated within a Section 36 consent (under the Electricity Act 1989 (as amended)) or Marine Licence (under the Marine (Scotland) Act 2010) that are not applicable to other briefing notes will be captured within this briefing note.

2. Mandatory Actions

Obligations listed within the European Offshore Wind Deployment Centre Environmental Statement 2011 are listed below

Table 1.1 Obligations out lined in the proposed EOWDC ES

Phase	Document	Chapter	Potential Impact	Obligation
Construction	Project Description	Chapter 3	Health and Safety/ Navigation	The wind farm would be designed and constructed to satisfy the requirements of the Civil Aviation Authority (CAA) and the Northern Lighthouse Board (NLB).
Construction	Project Description	Chapter 3	Health and Safety/ Navigation	The construction area will be depicted on Admiralty Charts by the UK Hydrographic Office. Information pertaining to construction will be disseminated through the Notice to Mariners procedure together with regular communication with local and regional stakeholders.

Construction	Project Description	Chapter 3		The construction area and incomplete structures would be lit and marked in accordance with the protocol recommended by Trinity House Lighthouse Service.
Construction	Project Description	Chapter 3	General obligation	Cables would be buried in the seabed to a sufficient depth, which will be determined by a burial protection study but would be to at least 0.6 m.
Construction	Project Description	Chapter 3	Safety	Advisory or applied for exclusion zones would be in place.
Operation	Project Description	Chapter 3	Visual Impact	Colour scheme of the wind turbine tower, nacelle and blades is likely to be light grey RAL 7035, white RAL 9010 or equivalent.
Operation	Project Description	Chapter 3	Health and Safety	All turbines would be designed to allow for the following safety features: a) yawing of the wind turbines shall be possible via the remote control b) remotely park the wind turbines in an oriented stop, to allow for heli-hoist operation

Any obligations outlined in the Section 36 Consent and Marine Licence would be listed below.

Table 1.2 Obligations outlined in Section 36 Consent and/ or Marine Licence

Phase	Document	Chapter	Potential Impact	Obligation

3. Monitoring / Survey Requirements

None at the time of writing.

4. Further Information

None at the time of writing.

OUTLINE BRIEFING NOTE 2: ORNITHOLOGY

Contents:

1. Background and Context

A total of 63 species of birds were recorded during ornithological surveys. Thirty seven of these species were either a qualifying species for a Special Protection Area or were recorded in numbers that could be of concern should there be an impact from the proposed EOWDC development.

For the majority of species the impact from the proposed EOWDC is deemed to be negligible. However, for some species the impact is deemed to be minor or moderate (on a scale of negligible, minor, moderate and major).

2. Mandatory Actions

Obligations listed within the European Offshore Wind Deployment Centre Environmental Statement 2010 are listed below.

Table 2.1 Obligations out lined in the proposed EOWDC ES

Phase	Document	Chapter	Potential Impact	Obligation
All Phases	Ornithology Baseline and EIA	Chapter 10	Numerous	Required mitigation and monitoring to be agreed.

Any obligations outlined in the Section 36 Consent and Marine Licence would be listed below.

Table 2.2 Obligations outlined in Section 36 Consent and/ or Marine Licence

Phase	Document	Chapter	Potential Impact	Obligation

3. Monitoring / Survey Requirements

A detailed monitoring programme aimed at specific issues or concerns would be developed with the Regulator and advisors should consent be granted.

4. Further Information

None at the time of writing.

OUTLINE BRIEFING NOTE 3: MARINE MAMMALS

Contents:

1. Background and Context

A number of marine mammals make use of Aberdeen Bay throughout the year; the more commonly sighted species are the harbour porpoise, bottlenose dolphin and grey and common seal. Potential impacts have been assessed as being of negligible to minor significance. However, in some instances behavioural disturbance and displacement during possible construction activities is considered to be of moderate to potentially major significance.

A number of mitigation strategies have been suggested in order to minimize any impacts upon marine mammals.

2. Mandatory Actions

Obligations listed within the European Offshore Wind Deployment Centre Environmental Statement 2010 are listed below.

Table 3.1 Obligations out lined in proposed EOWDC ES

Phase	Document	Chapter	Potential Impact	Obligation
All	Marine Mammals EIA	Chapter 12	Underwater noise causing physiological damage/ behavioural disturbance/ interference of sound produced by marine mammals	A Marine Mammal Protection Plan (MMPP) would be developed.

Any obligations outlined in the Section 36 Consent, Marine Licence or European Protected Species Licence would be listed below.

Table 3.2 Obligations outlined in Section 36 Consent and/ or Marine Licence

Phase	Document	Chapter	Potential Impact	Obligation

3. Monitoring / Survey Requirements

A detailed monitoring programme aimed at specific issues or concerns would be developed as part of the Marine Mammal Protection Plan.

4. Further Information

None at the time of writing.

OUTLINE BRIEFING NOTE 4: MARINE ECOLOGY

Contents:

1. Background and Context

An impact assessment has been undertaken for the European Offshore Wind Development Centre looking at the development's potential effects on the marine ecology within which the proposed EOWDC is located.

The majority of the site is covered by fine well sorted sands and fine muddy sands. The most common species at the site are worms and shellfish. On the sea bed brittle stars, brown shrimp and swimming crabs are common whilst fish species in the area are predominantly made up of plaice, dab, hooknose and whiting.

Impacts to marine ecology have been assessed as being negligible to minor with the exception of the worst case impact from construction noise upon fish which is considered to be of minor to possibly moderate significance.

2. Mandatory Actions

Obligations from the European Offshore Wind Deployment Centre Environmental Statement 2010 are listed below.

Table 4.1 Obligations out lined in ES

Phase	Document	Chapter	Potential Impact	Obligation
Construction	Marine Ecology EIA	Chapter 9	Habitat Loss	Good construction practices would be discussed with contractors and could include backfilling trenches (natural backfilling of the subsea trenches may take place) to just below the adjacent beach surface level to allow natural accretion to fill the upper surface.
Construction	Marine Ecology EIA	Chapter 9	Underwater Noise and Vibration on Fish and Shellfish	Soft-start procedure.

Operation	Marine Ecology EIA	Chapter 9	Impacts to fish and benthos resulting from Electromagnetic Fields.	Industry standards and best practice arising out of ongoing research work would be adopted for the EOWDC development where practicable.

Any obligations outlined in the Section 36 Consent and Marine Licence would be listed below.

Table 4.2 Obligations outlined in Section 36 Consent and/ or Marine Licence

Phase	**Document**	**Chapter**	**Potential Impact**	**Obligation**

3. Monitoring / Survey Requirements

Monitoring will be agreed with the relevant statutory authorities.

4. Further Information

None at the time of writing.

OUTLINE BRIEFING NOTE 5: IN-AIR NOISE

Contents:

1. Background and Context

Background noise measurements and wind speeds were measured on site over a period of 3 weeks. Consultation was carried out with the local authorities and key guidance documents were also used for the assessment.

The noise impact from the construction, operation and decommissioning of the proposed EOWDC on residential properties was assessed using suggested national limits (ETSU guidelines) as well as more stringent local noise limits.

The operational noise was assessed as being of negligible significance. For the noise associated with the construction of the proposed EOWDC it is anticipated that the impact during the day will be of minor significance. For night time hours mitigation suggests that certain construction activities are not carried out during this time, this resulting in a negligible significance.

2. Mandatory Actions

Obligations from the European Offshore Wind Deployment Centre Environmental Statement 2010 are listed below.

Table 5.1 Obligations out lined in proposed EOWDC ES

Phase	Document	Chapter	Potential Impact	Obligation
All	In-Air Noise EIA	Chapter 24	Noise impacts to local residents	Adherence to noise levels set by ETSU.
Construction	In-Air Noise EIA	Chapter 24	Sleep disturbance during piling night	No monopiles of 8.5 m diameter to be installed at night.
Construction	In-Air Noise EIA	Chapter 24	Stress, annoyance during piling daytime	Screens and good information policy.

Any obligations outlined in the Section 36 Consent and Marine Licence would be listed below.

Table 5.2 Obligations outlined in Section 36 Consent and/ or Marine Licence

Phase	Document	Chapter	Potential Impact	Obligation

3. Monitoring / Survey Requirements

Monitoring will be required to determine real sound levels and check efficiency of potential mitigation measures.

4. Further Information

None at the time of writing.

OUTLINE BRIEFING NOTE 6: OFFSHORE ARCHAEOLOGY

Contents:

1. Background and Context

The archaeological geophysical review identified several anomalies which may be man-made or natural features. Of these a potential impact has been predicted for one unidentified wreck which lies in close proximity to Wind Turbine 8.

2. Mandatory Actions

Obligations from the European Offshore Wind Deployment Centre Environmental Statement 2010 are listed below.

Table 6.1 Obligations out lined in proposed EOWDC ES

Phase	Document	Chapter	Potential Impact	Obligation
Construction	Offshore Archaeology EIA	Chapter 18	Damage to post-glacial submerged landscape features/ Known wreck sites	Avoidance, Reporting protocol.
Construction/ Operation/ Decommissioning	Offshore Archaeology EIA	Chapter 18	Damage to known wreck sites	Avoidance, Research, Reporting protocol.
Construction	Offshore Archaeology EIA	Chapter 18	Damage to prehistoric sites and finds	Reporting protocol.
Construction	Offshore Archaeology EIA	Chapter 18	Damage to unknown wreck sites	Reporting protocol.
Construction	Offshore Archaeology EIA	Chapter 18	Damage to unknown aircraft crash sites	Reporting protocol.

Any obligations outlined in the Section 36 Consent and Marine Licence would be listed below.

Table 6.2 Obligations outlined in Section 36 Consent and/ or Marine Licence

Phase	Document	Chapter	Potential Impact	Obligation

3. Monitoring / Survey Requirements

Monitoring could include:

Geophysical survey/ Remotely Operated Underwater Vehicle/ Finds Reporting Protocol

4. Further Information

None at the time of writing.

OUTLINE BRIEFING NOTE 7: COASTAL PROCESSES

Contents:

1. Background and Context

The coastal processes assessment included consideration of the potential changes to geology, waves, currents, sediment, seabed features and water quality.

It is shown that the majority of potential impacts can be considered of negligible significance. The exception is that of scour which, in the absence of scour protection measures, can be considered as minor significance.

2. Mandatory Actions

Obligations from the European Offshore Wind Deployment Centre Environmental Statement 2010 are listed below.

Table 7.1 Obligations out lined in proposed EOWDC ES

Phase	Document	Chapter	Potential Impact	Obligation
Operational	Coastal Processes EIA	Chapter 8	Scour around foundation base (and resulting habitat loss)	As a matter of good practice, the project's detailed design would consider whether scour protection can reasonably be provided to further reduce this impact.

Any obligations outlined in the Section 36 Consent and Marine Licence would be listed below.

Table 7.2 Obligations outlined in Section 36 Consent and/ or Marine Licence

Phase	Document	Chapter	Potential Impact	Obligation

3. Monitoring / Survey Requirements

It is not considered essential to include scour monitoring as an integral aspect of post-construction monitoring although it could be considered as an additional aspect.

Appropriate research studies will be implemented if novel techniques are used for cable installation where there is an absence of any previous research.

4. Further Information

None at the time of writing.

OUTLINE BRIEFING NOTE 8: COMMERCIAL FISHERIES

Contents:

1. Background and Context

Commercial fishing activities in the area surrounding the proposed EOWDC are considered to be at relatively low levels. Potting for crab and lobsters; trawling for whitefish; and dredging for scallops account for the majority of the activity.

Given the limited number of turbines proposed, the small area of the site and the low level of fishing activity within it, the overall impacts on commercial fishing are expected to be negligible, although for a small number of local vessels, the potential impacts may be of minor significance.

2. Mandatory Actions

Obligations from the European Offshore Wind Deployment Centre Environmental Statement 2010 are listed below.

Table 8.1 Obligations out lined in proposed EOWDC ES

Phase	Document	Chapter	Potential Impact	Obligation
Construction and decommissioning	Commercial Fisheries EIA	Chapter 21	Adverse impacts on commercially exploited species	Use of appropriate engineering techniques, eg soft start.
Construction and decommissioning	Commercial Fisheries EIA	Chapter 21	Complete loss of, or restricted access to traditional fishing grounds	Effective, on-going liaison.
Construction, operational and, decommissioning	Commercial Fisheries EIA	Chapter 21	Safety issues for fishing vessels	Implementation and adherence to standard offshore safety procedures. Involvement of the SFF for liaison and information distribution.
Construction, operational and decommissioning	Commercial Fisheries EIA	Chapter 21	Interference to fishing activities	Construction/ maintenance vessels using existing shipping routes. On-going liaison informing skippers of construction/

				maintenance vessels schedules and routes.
Construction and decommissioning	Commercial Fisheries EIA	Chapter 21	Increased steaming times to fishing grounds	Transitory, short term exclusion areas around construction activities within the site. Limited numbers of potentially impacted vessels.
Construction and decommissioning	Commercial Fisheries EIA	Chapter 21	Presence of seabed obstacles and obstructions	Contractors are required by contract to report and recover any accidentally dropped objects. Seabed obstructions and spoils identified during post-construction monitoring, which might represent a hazard to fishing, would be rectified. Any scour protection rock placement would be adjacent to wind turbine bases.
Operational	Commercial Fisheries EIA	Chapter 21	Damage to fishing gear/vessels from exposed cables	Cable burial to at least 0.6 m depth.
Operational	Commercial Fisheries EIA	Chapter 21	Damage to fishing gear/vessels from exposed cables	Implementation and adherence to standard offshore safety procedures.
Operational	Commercial Fisheries EIA	Chapter 21	Damage to fishing gear/vessels from exposed cables	Cable route surveys.
Operational	Commercial Fisheries EIA	Chapter 21	Damage to fishing gear/vessels from exposed cables	Temporary exclusion zones until issues are rectified.

Any obligations outlined in the Section 36 Consent and Marine Licence would be listed below.

Table 8.2 Obligations outlined in Section 36 Consent and/ or Marine Licence

Phase	Document	Chapter	Potential Impact	Obligation

3. Monitoring / Survey Requirements

None at the time of writing.

4. Further Information

None at the time of writing.

OUTLINE BRIEFING NOTE 9: SALMON AND SEA TROUT

Contents:

1. Background and Context

Scottish salmon populations are recognised as being of national and international importance. In addition to their ecological value, salmon and sea trout are species of importance from a socioeconomic perspective.

The majority of impacts have been assessed as having negligible impact although it is possible that construction activities could have a negligible to minor impact following mitigation. Mitigation is likely to include specific scheduling of construction periods so that peak times of salmon entering or exiting local rivers are not affected. Further consultation will be held with statutory consultees and salmon fisheries boards when construction methods and timing are considered further.

2. Mandatory Actions

Obligations from the European Offshore Wind Deployment Centre Environmental Statement 2010 are listed below.

Table 9.1 Obligations out lined in proposed EOWDC ES

Phase	Document	Chapter	Potential Impact	Obligation
Construction	Salmon and Sea Trout EIA	Chapter 22	Noise, Direct Impact	Soft-start piling.
Construction	Salmon and Sea Trout EIA	Chapter 22	Noise, Disturbance/ Delay/Barrier to Migration	Mitigation to be agreed if required.

Any obligations outlined in the Section 36 Consent and Marine Licence would be listed below.

Table 9.2 Obligations outlined in Section 36 Consent and/ or Marine Licence

Phase	Document	Chapter	Potential Impact	Obligation

3. Monitoring / Survey Requirements

Appropriate and relevant monitoring will be assessed through discussion with relevant stakeholders and regulators.

4. Further Information

None at the time of writing.

OUTLINE BRIEFING NOTE 10: COMMERCIAL SHIPPING AND NAVIGATION

Contents:

1. Background and Context

A Navigational Risk Assessment (NRA) has been carried out for the proposed EOWDC. A number of potential impacts were identified, the majority of these are considered to be negligible or to cause no impact. Compared to the marine accident risk levels in the UK, the increase in risk to both people and the environment caused by the proposed EOWDC is low.

Extensive consultation with Aberdeen Harbour Board (AHB) and key consultees has resulted in a number of changes being made to the site layout. Recent consultation has indicated that the current site is acceptable and all hazards are identified to be low.

2. Mandatory Actions

Obligations from the European Offshore Wind Deployment Centre Environmental Statement 2010 are listed below. Table 12.1 below summarises the main risk mitigation measures identified within the NRA, it should be noted that discussions on other measures will continue both pre- and post-construction and during the life of the project with the MCA, Aberdeen Harbour Board and other relevant stakeholders.

Table 10.1 Obligations out lined in proposed EOWDC ES

Phase	Document	Chapter	Potential Impact	Obligation
Construction	Project Description	Chapter 3	Health and Safety/ Navigation	The EOWDC would be designed and constructed to satisfy the requirements of the Civil Aviation Authority (CAA) and the Northern Lighthouse Board (NLB).
Construction	Project Description	Chapter 3	Safety and Navigation	The construction area will be depicted on Admiralty Charts by the UK Hydrographic Office. Information pertaining to construction would be disseminated through the Notice to Mariners procedure together with regular communication with local and regional stakeholders.

Construction	Project Description	Chapter 3		The construction area and incomplete structures would be lit and marked in accordance with the protocol recommended by THLS.
All	Navigational Risk Assessment	Appendix 15.1	Safety and Navigation	Marked on Admiralty Charts: The EOWDC would be charted by the UK Hydrographic Office using the magenta wind turbine tower chart symbol found in publication “NP 5011 - Symbols and Abbreviations used in Admiralty Charts”. Submarine cables associated with the project will also be charted on the appropriate scale charts.
All	Navigational Risk Assessment	Appendix 15.1		Information Circulation: Appropriate liaison to ensure information on the wind farm and special activitiesis circulated in Notices to Mariners, Navigation Information Broadcasts and other appropriate media.
All	Navigational Risk Assessment	Appendix 15.1		Marking and Lighting: Structures to be marked and lit in-line with NLB and IALA guidance.
All	Navigational Risk Assessment	Appendix 15.1		Wind Turbine Air Draught: Lowest point of rotor sweep at least 22 m above Mean High Water Springs as per RYA and MCA recommendations.
All	Navigational Risk Assessment	Appendix 15.1		Cable Protection: Cables to be buried to suitable depth based on cable protection study taking into account fishing and anchoring practices in Aberdeen Bay(but to at least 0.6 m). Periodic inspection of the cable to ensure it remains buried. Positions of cable routes notified to Kingfisher Information Services (KIS) for inclusion in cable awareness charts and plotters for the fishing industry.
All	Navigational Risk Assessment	Appendix 15.1		Compliance with MCA’s Marine Guidance Notice (MGN) 371 including Annex 5: Annex 5 specifies “Standards and procedures for generator shutdown and other operational requirements in the event of a

				search and rescue, counter pollution or salvage incident in or around an Offshore Renewable Energy Installation.”
All	Navigational Risk Assessment	Appendix 15.1		Formulation of an Emergency Response Cooperation Plan (ERCoP) as per MCA Template: AOWFL will use the draft template created by the MCA to formulate an emergency response plan and site Safety Management Systems, in consultation with the MCA.

Any obligations outlined in the Section 36 Consent and Marine Licence would be listed below.

Table 10.2 Obligations outlined in Section 36 Consent and/ or Marine Licence

Phase	Document	Chapter	Potential Impact	Obligation

3. Monitoring / Survey Requirements

The Navigational Risk Assessment will be reviewed as required. The health and safety plan will include an incident/accident reporting system which will allow incidents and near misses to be recorded and reviewed to monitor the effectiveness of the risk control measures in place at the site. In addition to this any information gleaned from near misses/accidents at other offshore wind farm sites will be considered with respect to the control measures applied at the proposed EOWDC.

Whilst no radar monitoring of vessel movements has been proposed for the site, Automatic Identification System monitoring is being considered which can be used to monitor and record the movements of vessels around the proposed EOWDC site and associated export cables to shore, as well as company vessels working at the site.

4. Further Information

None at the time of writing.

PART 3

8 OUTLINE CONSTRUCTION METHOD STATEMENTS

8.1 What are Construction Method Statements

Construction method statements are considered an important part of engineering best practice by making sure that safety, timetable, environmental conditions and commitments for mitigation are integrated into the construction process. Information on construction method statement procedures normally forms part of the tender process and often acts to distinguish competitive bids (that is, demonstration of an understanding of the environmental objectives becomes a criterion in tender evaluation). In this regard, it is normal practice for the environmental practitioner to set the objectives, but for the design and construction engineers/contractors to meet those objectives in the most efficient and cost-effective manner.

It is considered impracticable and contrary to the objectives of continuous improvement to produce detailed construction method statements prior to consent approval.

8.2 Outline Construction Method Statements

Outline construction method statements would be included in the tender package to inform construction contractors and their engineers as to the requirements of the tender, and to enable them to develop the construction method statements.

Accordingly, the method statements do not provide:

- detailed final design
- detailed site specific construction methodologies

The method statements will be produced to recognise that the different construction activities would require different construction methods, all of which may vary due to the relative site sensitivities. Examples of likely outline construction method statements are as follows:

- OCMS – Introduction
- OCMS 01 - Temporary Compound
- OCMS 02 - Cable Installation
- OCMS 03 - Waste Management
- OCMS 04 - Wind Turbine Construction
- OCMS 05 – Traffic (Vessel) Management
- OCMS 06 – Scour Protection
- OCMS 07 – Foundation Installation
- OCMS 08 – Commissioning
- OCMS 09 – Connection
- OCMS 10 – Pre-Installation Survey

- OCMS 11 – Post-Installation Survey
- OCMS 12 – Landfall Construction

8.3 Other Outline Method Statements

Other outline method statements would include:

- Decommissioning

It is unlikely that operations and maintenance would have specific method statements. An Operations and Maintenance Plan would be in place to ensure adherence to environmental, health and safety policies and legislation.

European Offshore Wind Deployment Centre

Environmental Statement

Appendix 29.1: Information to Inform a Habitats Regulation Appraisal

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

GENESIS

European Offshore Wind Deployment Centre

Information to Inform a Habitats Regulations Appraisal

June 11

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Contents

1 INTRODUCTION

The purpose of this document is to provide a summary of the information required to inform any possible Habitats Regulations Appraisal that may be required to be undertaken by the competent authority with respect to the proposed European Offshore Wind Deployment Centre (EOWDC) as required under the EU Habitats and Birds Directives.

The document aims to identify all qualifying species or habitats that, based on data collected at the proposed development site, have the potential to be impacted. A high level assessment on the risk of a possible adverse effect has been undertaken and a conclusion made on the level of risk to a qualifying species or habitat.

This assessment is based on site specific data collected from the surveys undertaken so far and, where appropriate, relevant data from other offshore wind farms. The aim of this assessment is to identify the species or habitats that may be required to be assessed by the competent authority as part of a Habitats Regulations Appraisal and potential future Appropriate Assessments and also consider the risk of a potential adverse effect occurring to the sites' qualifying species of habitats

This assessment takes into consideration comments received in response to the EOWDC Scoping Opinion request from SNH to Marine Scotland dated 29 September 2010 (SNH 2010) and further response from Marine Scotland to the *Assessment against the Habitats Regulations and cumulative impacts screening* (Genesis 2011; Marine Scotland 2011).

It is recognised that further bird and marine mammal data currently being collected may also be used to inform a future HRA. When the data become available it will be reviewed and used, if required, to update this document.

2 QUALIFYING SITES

Under Article 6 of the Habitats Directive and Regulation 45 of the Conservation (Natural Habitats etc) Regulations 1994 (as amended) the competent authority is required to assess whether or not a plan or programme will adversely affect the integrity of a Special Protection Area (SPA) or Special Area of Conservation (SAC).

There are a number of SPAs and SACs that have the potential to be impacted by the proposed offshore wind farm. The scope of this assessment is based on the Natura 2000 sites identified within the scoping document for which there is some evidence that the qualifying species could be present in the area of the proposed EOWDC and subsequent advice from SNH and Marine Scotland (SNH 2010; Marine Scotland 2011).

Special Protection Areas

Eleven SPAs have been identified as having qualifying species that have the potential to be impacted by the proposed offshore wind farm and an assessment has been made for each of the species cited against the site's Conservation Objectives (Appendix A). The assessment is based on whether the species is at risk of:

Collision – The risk of collision depends on a number of variables, in particular species specific near and far field avoidance rates, flight heights, speed of flight, frequency of movements in or near to the turbines as well as the size and location of the turbines themselves. Additional factors such as weather and species' behaviour can also affect the risk of collision.

Displacement – Evidence from existing offshore wind farms have identified that some species of seabird may avoid entering wind farms and therefore be displaced from areas that they would otherwise utilise. The level of displacement is very species specific and the duration of displacement may vary across species, with some species avoiding wind farms immediately post-construction and returning to the area after a period of time and other species showing little or no evidence of returning to the wind farm area post construction. Displacement from an area may cause reduced foraging areas, increasing inter and intra specific competition and consequently lowering survival rates. Secondary impacts such as reducing prey availability, i.e. less fish in an area during construction, may also cause displacement as birds forage elsewhere for food.

Barrier effects – In order to avoid flying through wind farms many species have been recorded flying around or over them and consequently may have to fly further than prior to the construction of the wind farm. This increase in flying distance may cause an increase in energy expenditure, which could have a detrimental effect on the fitness of the individual and reduce survival or fecundity rates. This is of particular concern should there be regular, daily, movements around a wind farm, i.e. to and from foraging or roosting areas.

In-combination impacts – in-combination impacts are assessed under the Conservation (Natural Habitats & c.) Regulations 1994 (as amended). Impacts include those arising from existing and reasonably foreseeable activities including:

- Shipping
- Fishing
- Aggregates
- Dredging
- Oil and gas installations
- Renewables

In-combination impacts relates specifically to those from other plans or projects on European Sites.

Special Areas of Conservation

Eight SACs have been identified that have qualifying species or habitats that may have the potential to be impacted by the proposed development. This assessment has considered each of the species or habitats cited for each site and their Conservation Objectives. The assessment is based on potential risks arising from:

Habitat disturbance – The qualifying habitats may be sensitive to physical impacts arising from the proposed offshore wind farm, in particular direct physical impacts caused by construction or less direct impacts caused by reduced or increased sediment loads.

Displacement – Species listed within the relevant SACs may be impacted by noise or other activities that may cause an increase in mortality, temporary injury, or displacement away from the area.

The following assessment attempts to assess the potential impacts arising from the proposed EOWDC against the qualifying species and habitats. For species or habitats where no potential for a likely significant effect has been identified no further assessment has been undertaken.

3 PROJECT DESCRIPTION

A detailed description of the proposed EOWDC project is presented in Chapter 3 of the Environmental Statement.

The proposed development is approximately 2 km from the coastline at its closest point in Aberdeen Bay (Figure 3-1). The total area of the turbine layout is 4.3 km^2 within the lease boundary area of 20 km^2. Water depth ranges from between 20 m and 30 m Lowest Astronomical Tide (LAT). The key project characteristic are presented in Table 3-1.

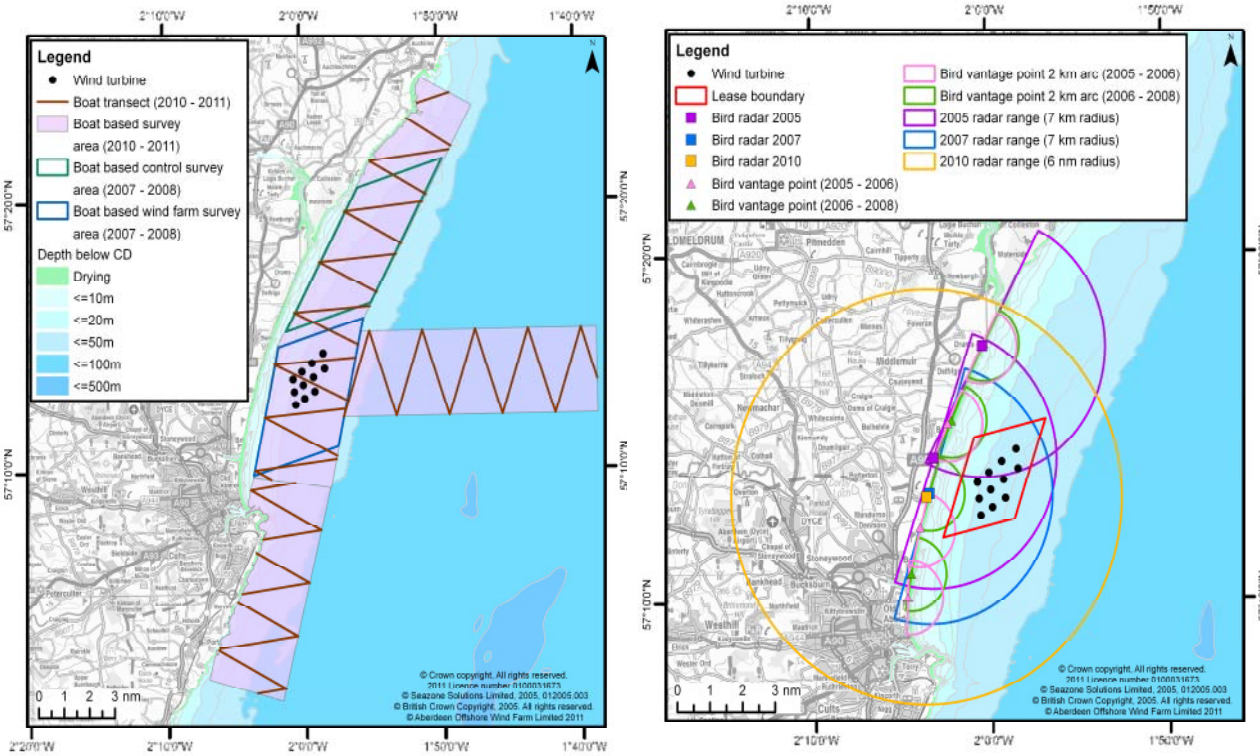

Figure 3-1: Location of proposed EOWDC and bird and marine mammal surveys undertaken

It is proposed that the project may be constructed in two phases. The actual deployment of wind turbines is at this stage not known and the numbers deployed in 2013 and 2014 are variable but for the purposes of the EOWDC assessment, the following has been assumed for the phasing

2013 - 4 wind turbines installed
2014 - 7 wind turbines installed

Table 3-1: key project characteristics

Key Project Characteristics	
Maximum Capacity	100 MW
Maximum Number of Wind Turbines	11
Lease Boundary Area	20 km^2
Distance to Shore	2 km
Water Depth Across Wind Turbine Locations	20 – 30 m
Individual Wind Turbine Capacity	4 to 10 MW
Maximum Rotor Diameter above LAT	150 m
Maximum Hub Height above LAT	120 m
Maximum Tip Height above LAT	195 m
Minimum Clearance Above Sea Level	22 m
Indicative Spacing between Wind Turbines	Between 790 m and 1,050 m
Foundation Types	Potential foundations include monopiles, jackets, tripods, gravity base structure, suction caisson/ buckets
Inter-array Cables	Maximum number of 12. Total length of 13 km.
Export Cables	Maximum number of 4 will run from the wind turbine array back to Mean High Water Spring (MHWS) Total length of 26 km

4 SCOPE OF ASSESSMENT

Likely species present

Which species of bird are known to occur or are likely to occur in the area of the proposed development?

In order to undertake this initial step a review has been undertaken of the site specific data collected at the proposed EOWDC location in Aberdeen Bay from both land and boat based surveys since 2005 and aerial surveys undertaken by the JNCC in 2005 and 2006.

Boat based survey data were used from surveys undertaken between January 2007 and July 2008 and reported in a number of reports:

- Monthly survey reports for February 2007 – April 2008
- 6-month interim report for February 2007 – July 2007
- 1st year survey report for February 2007 – January 2008
- Bird boat survey raw data for February 2007 – July 2008

Land based surveys from four vantage points across Aberdeen Bay were undertaken between April 2006 and March 2008. The surveys provided good coverage for the near-shore waters particularly areas inaccessible by boat due to shallow water depth. A number of reports presenting the results of the Vantage Point (VP) surveys have been produced:

- Monthly survey reports for April 2007 – March 2008.
- Six-month reports completed for
  - April –September 2006
  - October 2006 – March 2007
  - April – September 2007
  - October 2007 – March 2008
- VP data for March 2005 – October 2005.
- VP data for April 2006 – March 2008.

Radar Surveys have been undertaken on three occasions from two sites within Aberdeen Bay between 2005 and 2010. A total of ten days of radar surveys were undertaken in 2005 and fifteen in 2007 and further five days in 2010.

In April 2005 a study using both s-band and x-band radar was undertaken at two locations within Aberdeen Bay: Drums and East Hatton. A further fifteen day study in April 2007 was undertaken at Blackdog, just south of Drums. In 2010 a further survey was undertaken during April aimed to focus efforts on recording pink-footed goose migration. The study also recorded all other species observed during the study.

In addition to surveys undertaken specifically to obtain information relevant to the proposed project other ornithological surveys have been undertaken in Aberdeen Bay, the results from which have been used in this report. In particular, the results of three aerial bird surveys undertaken by the JNCC between December 2005 and May 2006. It is recognised that there are other potential sources of data including local bird reports or Wetland Bird Survey (WeBS) counts (Calbrade *et al.* 2010; NESBR). For the purposes of this assessment these data sources have been used for reference purposes. Species recorded in Aberdeen Bay from site specific surveys are presented in (Table 4-1).

For further detailed information on the species recorded within Aberdeen Bay the Ornithological Baseline and Impact Assessment should be referred to (Appendix 10.1 to the Environmental Statement).

Potential sensitivity to offshore wind farms

There are a number of publications presenting the likely sensitivity of bird species to offshore wind farms (e.g. Zucco *et al.* 2006; RSPB 2010) and there is general agreement between the various publications as to the main potential risks to birds and individual species sensitivities from wind farms. For the purposes of this assessment the report published by the RSPB in 2010 has been used to provide the relevant information on species' sensitivities. For species that were not included in the RSPB publication a score has been given based on existing data from offshore wind farms, e.g. Pettersson (2005); Petersen *et al*. (2006).

The potential sensitivities to wind farm developments based on the review by Langston (2010) and other offshore wind farm developments are presented in Table 4-1 for the species recorded in Aberdeen Bay from site specific surveys,.

Table 4-1: Species recorded in Aberdeen Bay from site specific surveys and their potential vulnerability

Vulnerability to wind farm development					Feature of SPA with potential for interaction with site? (Y/N)	Use of site (breeding, wintering, passage)
	Collision.	Displacement	Barrier	Habitat/Prey		
Whooper swan	***	*	*	-	Y	P
Mute swan	High	Low	Low	-	N	B/W/P
Pink-footed goose	**	**	*	-	Y	P
Greylag goose	**	**	*	-	Y	P
Barnacle goose	**	**	*	-	Y	P
Brent goose	**	**	*	-	N	P
Shelduck	Mod	Low	Low	-	Y	P
Eurasian Wigeon	Mod	Low	Low	-	Y	P
Eurasian Teal	Mod	Low	Low	-	Y	P
Mallard	Mod	Low	Low	-	Y	B/W/P
Tufted duck	Mod	Low	Low	-	N	B/W/P
Common eider	*	*	**	**	Y	B/W
Long-tailed duck	*	**	**	**	N	W
Common scoter	*	**	**	**	N	W/P
Velvet scoter	*	**	**	**	N	W/P
Common goldeneye	*	*	**	**	N	W/P
Red-breasted merganser	*	*	**	**	N	W/P
Red-throated diver	*	***	**	**	N	W/P
Black-throated diver	*	***	**	**	N	W/P
Great northern diver	*	***	**	**	N	W/P
Northern Fulmar	*	*	*	**	Y	B/W
Manx shearwater	*	*		**	N	P

Vulnerability to wind farm development	Collision.	Displacement	Barrier	Habitat/Prey	Feature of SPA with potential for interaction with site? (Y/N)	Use of site (breeding, wintering, passage)
Sooty shearwater	*	*		**	N	P
European storm petrel	*	*	-	**	N	P
Gannet	**	*	*	*	Y	B/W/P
Cormorant	**	*	**	**	Y	B/W
European Shag	*	**	**	**	Y	B/W
Grey heron	High	Low	Low	-	N	B/W/P
Oystercatcher	Mod	Low	Low	-	Y	B/W/P
Ringed plover	Mod	Low	Low	-	N	B/W/P
Golden plover	Mod	Low	Low	-	N	P
Lapwing	Mod	Low	Low	-	Y	B/W/P
Knot	Mod	Low	Low	-	N	P
Sanderling	Mod	Low	Low	-	N	W/P
Dunlin	Mod	Low	Low	-	N	P
Black-tailed godwit	Mod	Low	Low	-	N	P
Bar-tailed godwit	Mod	Low	Low	-	N	W/P
Redshank	Mod	Low	Low	-	Y	B/W/P
Whimbrel	Mod	Low	Low	-	N	P
Curlew	Mod	Low	Low	-	N	B/W/P
Turnstone	Mod	Low	Low	-	N	W/P
Pomarine skua	**	*	*	*	N	P
Arctic skua	**	*	*	*	N	P
Long-tailed skua	**	*	*	*	N	P
Great skua	**	*	*	*	N	P
Glaucous gull	Mod	Low	Low	Low	N	W
Little gull	*	*	*	*	N	P

Vulnerability to wind farm development	Collision.	Displacement	Barrier	Habitat/Prey	Feature of SPA with potential for interaction with site? (Y/N)	Use of site (breeding, wintering, passage)
Black-headed gull	*	*	*	*	N	B/W/P
Sabine's gull					N	P
Common gull	*	*	*	*	N	B/W/P
Lesser black-backed gull	**	*	*	*	Y	B
Herring gull	**	*	*	*	Y	B/W/P
Great black-backed gull	**	*	*	*	N	B/W
Kittiwake	**	*	*	*	Y	B/W
Little tern	**	*	*	*	Y	B
Sandwich tern	**	*	*	**	Y	B
Common tern	**	*	*	**	Y	B
Arctic tern	**	*	*	**	Y	B
Guillemot	*	**	**	**	Y	B/W
Razorbill	*	**	**	**	Y	B/W
Black guillemot	*	**	**	**	N	B/W
Puffin	*	**	**	**	Y	B
Little auk	*	**	**	**	N	W/P

Note – *** = high sensitivity, ** = moderate sensitivity, * = low sensitivity (Langston 2010).

High/mod/low designations have been made based on published data from offshore wind farms either for that particular species or similar 'sister' species.

5 SPAS

There is no clear guidance on how to define the extent and scope of a seabird population that could potentially be impacted by a proposed offshore wind farm. King *et al*. (2009) suggests that regional populations should be the Round 2 strategic areas (Renewable Energy Zones) or the Round 3 zones. However, as the proposed EOWDC is not in such an area there is no clear guidance as to how to identify the regional population for this assessment.

The scope of the review undertaken for this document was based on all coastal SPAs between Troup, Pennan and Lions Heads SPA, on the Moray Firth and the Forth Islands SPA to the south; covering approximately 300 km of coastline. This covers a greater length shoreline than any of the Round 2 Renewable Energy Zones and a significant proportion of eastern Scotland's coastline. Consequently, it covers an area greater than suggested as guidance within the COWRIE report (King *et al*. 2009); therefore ensuring that a representative area is covered.

All coastal or near coastal SPAs were identified using information from the SNH and JNCC websites (JNCC 2011, SNH 2011). A total of 11 SPAs have been identified as having qualifying species that are at potential risk of an adverse effect from the proposed project (Figure 5-1).

:

- Buchan Ness to Collieston SPA
- Fair Isle SPA
- Firth of Forth SPA
- Firth of Tay & Eden Estuary SPA
- Forth Islands SPA
- Fowlsheugh SPA
- Loch of Skene SPA
- Loch of Strathbeg SPA
- Montrose Basin SPA
- Troup, Pennan and Lion's Heads SPA
- Ythan Estuary, Sands of Forvie and Miekle Loch SPA

Further details on each of the SPAs including their qualifying species and Conservation Objectives are presented in Appendix A. Not all those species listed within the site designations have been recorded within the area of the proposed EOWDC and consequently not all qualifying species are at risk of a potential impact.

Table 5-1 links the species that have been recorded within the proposed EOWDC area (Table 4-1) with the relevant SPAs (Appendix A). In addition, the table presents the distance each SPA is from the proposed EOWDC and the population of each species at the time of designation and when available, more recent populations.

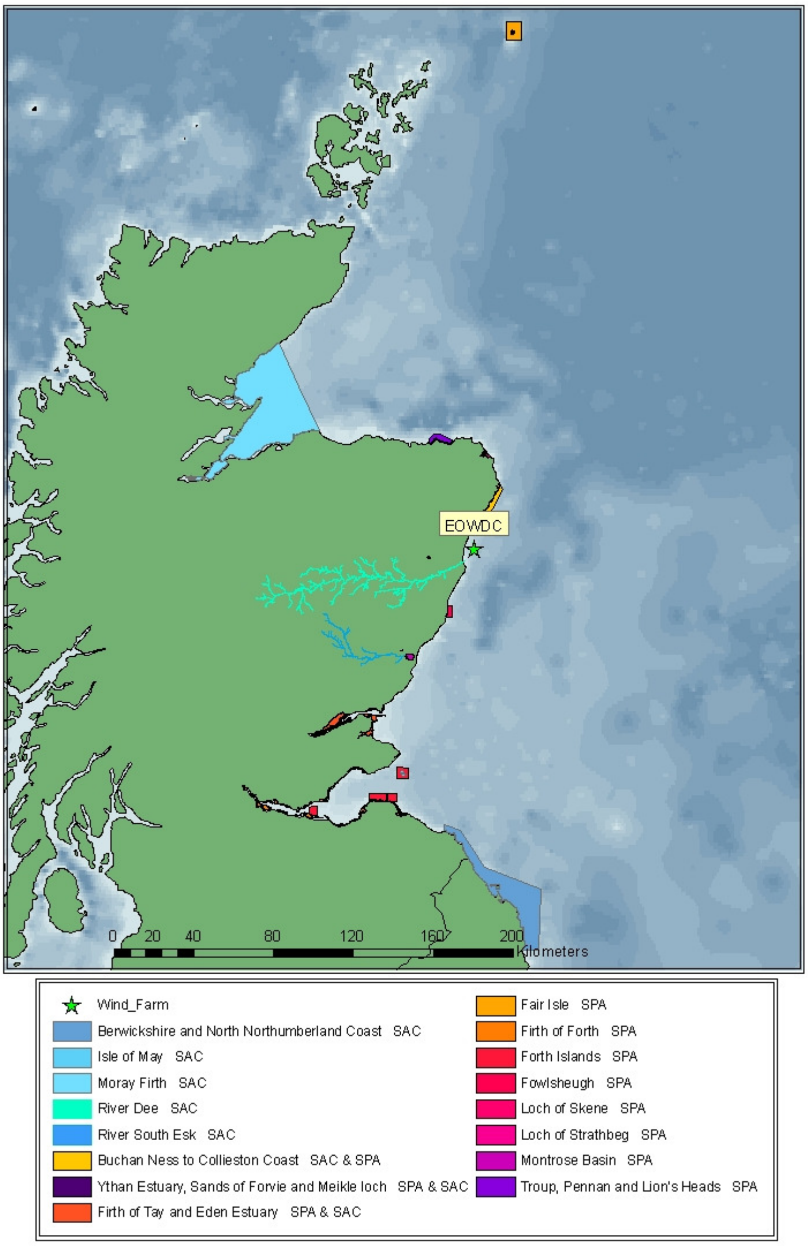

Figure 5-1: Designated sites scoped in to the HRA

Source JNCC 2011. http://jncc.defra.gov.uk/page-4

Table 5-1: Qualifying species recorded from surveys and potential linkage with Special Protection Area

Species	Site name	Distance from site (km)	Qualifying feature	Pop^{n} of SPA	
				Designation or SPA review	Most recent
Whooper swan	Loch of Strathbeg	47.6	3.3% of GB wintering pop^{n}	183	333 (1)
Pink footed goose	Ythan Estuary	7.2	7.7% of GB Wintering pop^{n}	17,213	16,300 (1)
	Firth of Forth	134	5.5% of GB wintering pop^{n}	12,400	4,463 (1)
	Firth of Tay & Eden	96	1.7% of GB wintering pop^{n}	3,769	2,704 (1)
	Loch of Strathbeg	47.6	17.7% of GB Wintering pop^{n}	39,924	53,454 (1)
	Montrose Basin	61	14.1% of GB Wintering pop^{n}.	31,622	38,911 (4)
Greylag goose	Loch of Skene	21	Migratory species	10,840	790 (3)
	Loch of Strathbeg	47.6	3.3% of GB Wintering pop^{n}	3,325	580 (3)
	Montrose Basin	61	1.1% GB Wintering pop^{n}	1,080	275 (4)
	Firth of Tay & Eden Estuary	96	1.0% of GB Wintering pop^{n}	1,200	2,640 (3)
Barnacle goose	Loch of Strathbeg	47.6	1.9% of GB wintering pop^{n}	226	726 (1)
Shelduck	Montrose Basin	61	Waterfowl assemblage	-	988 (4)
	Firth of Forth	134	1.2% of NW European pop^{n}	3,586	3,166 (1)
	Forth of Tay & Eden	96	Waterfowl assemblage	-	1,114 (1)
Teal	Loch of Strathbeg	47.6	Waterfowl assemblage	-	504 (3)
Wigeon	Montrose Basin	61	Waterfowl assemblage	-	3,944 (1)
	Firth of Forth	134	Waterfowl assemblage	2,139	2,139 (1)

Species	Site name	Distance from site (km)	Qualifying feature	Pop^{n} of SPA	
				Designation or SPA review	Most recent
Mallard	Firth of Forth	134	Waterfowl assemblage	-	2546 (5)
Common eider	Ythan Estuary	7.2	Waterfowl assemblage	-	3,688 (1)
	Montrose Basin	61	Waterfowl assemblage	-	1,983 (4)
	Firth of Tay & Eden	96	Waterfowl assemblage	-	4,378 (1)
	Firth of Forth	134	Waterfowl assemblage	9,400	5,188 (1)
Long tailed duck	Firth of Forth	134	Waterfowl assemblage	1,045	215 (1)
	Firth Tay and Eden	96	Waterfowl assemblage	-	204 (1)
Common scoter	Firth of Forth	134	Waterfowl assemblage	-	635
	Firth of Tay & Eden	96	Waterfowl assemblage	-	-
Velvet scoter	Firth of Forth	134	Waterfowl assemblage	2,880	731 (1)
	Firth of Tay & Eden	96	Waterfowl assemblage	-	326 (1)
Common Goldeneye	Firth of Forth	134	Waterfowl assemblage	-	581 (1)
	Firth of Tay & Eden Estuary	96	Waterfowl assemblage		255 (1)
Red-breasted merganser	Firth of Forth	134	Waterfowl assemblage	670	410 (1)
Red throated diver	Firth of Forth	134	1.8% of GB pop^{n}	88	317 (1)
Fulmar	Buchan Ness – Collieston	9.5	Waterfowl assemblage	1,765 prs	1,370 (3)
	Fowlsheugh	31.1	Waterfowl assemblage	1,170 prs	246 (3)
	Forth Islands	124.4	Waterfowl assemblage	1,600 prs	402 (3)

Species	Site name	Distance from site (km)	Qualifying feature	Popⁿ of SPA	
				Designation or SPA review	Most recent
	Troup, Pennan and Lion's Head	74.3	Waterfowl assemblage	4,400 prs	636 (3)
Gannet	Forth Islands	124.4	13.1% of N. Atlantic breeding popⁿ	34,400 prs	48,065 prs (2)
	Fair Isle	260	0.6% of GB popⁿ	1,166 prs	3,582 AoN (2)
Cormorant	Forth Islands	124.4	Waterfowl assemblage	200 prs	198 prs (2)
	Forth Islands	124.4	Wintering assemblage	682	-
	Firth of Tay & Eden Estuary	96	Wintering assemblage	230	-
European shag	Buchan Ness – Collieston	9.5	Waterfowl assemblage	1,045 prs	331 prs (3)
	Forth Islands	124.4	2.3% of biogeographical popⁿ	2,887 prs	480 prs
Great crested grebe	Firth of Forth	134	7% of GB wintering popⁿ	720	-
Curlew	Firth of Forth	134	2% of GB popⁿ	1,928	3,939 (1)
Oystercatcher	Montrose Basin	61	Waterfowl assemblages	-	1,385 (4)
	Firth of Tay & Eden Estuary	96	Waterfowl assemblage	-	-
	Firth of Forth	134	Waterfowl assemblage	2,368	7,638 (1)
Golden plover	Firth of Forth	134	Waterfowl assemblage	2,970	-
Lapwing	Ythan Estuary	7.2	Waterfowl assemblage	-	6,269 (3)
	Firth of Forth	134	Waterfowl assemblages	4,184	-
Sanderling	Firth Tay & Eden	96	Waterfowl assemblages	-	277 (1)
Ringed plover	Firth of Forth	134	Waterfowl assemblage	328	471 (1)

Species	Site name	Distance from site (km)	Qualifying feature	Pop^{n} of SPA	
				Designation or SPA review	Most recent
Turnstone	Firth of Forth	134	1% of western Palearctic pop^{n}	1,286	853 (1)
Redshank	Ythan Estuary	7.2	Waterfowl assemblage		2,471 (1)
	Firth of Forth	134	Waterfowl assemblage	3,700	5,111 (1)
	Firth of Tay & Eden Estuary	96	2.5% of wintering pop^{n}	1,800	1,162 (1)
	Montrose Basin	61	1.5% of wintering pop^{n}	2,259	1,951 (4)
Lesser black backed gull	Forth Islands	124.4	2.4% of west European pop^{n}.	2,920 prs	2,779 (2)
Herring gull	Buchan Ness – Collieston	9.5	Waterfowl assemblage	4,292 prs	3,079 (3)
	Fowlsheugh	31.1	Waterfowl assemblage	3,190 prs	122 (2)
	Forth Islands	124.4	Waterfowl assemblage	6,600 prs	2,968
	Troup, Pennan and Lion's Head	74.3	Waterfowl assemblage	4,200 prs	1,597 (3)
Kittiwake	Buchan Ness – Collieston	9.5	Waterfowl assemblage	30,452 prs	12,542 (2)
	Fowlsheugh	31.1	1.1% of East Atlantic Breeding pop^{n}	34,870 prs	11,140 (2)
	Forth Islands	124.4	Waterfowl assemblage	8,400 prs	2,316 (2)
	Troup, Pennan and Lion's Head	74.3	Waterfowl assemblage	-	14,896 (3)
Little tern	Ythan Estuary	7.2	1.7% of GB Breeding pop^{n}.	41 prs	36 prs -(3)
	Firth of Tay and Eden Estuary	96	1% of GB Breeding pop^{n}	25 prs	0 prs -(3)
Sandwich tern	Ythan Estuary	7.2	4.3% of GB Breeding pop^{n}	600 prs	645 AoN
	Loch of Strathbeg	47.6	3.8% of GB Breeding pop^{n}	530 prs	1-2 AoN

Species	Site name	Distance from site (km)	Qualifying feature	Pop^{n} of SPA	
				Designation or SPA review	Most recent
	Firth of Forth	134	3.8% of GB passage	1,617	-
	Forth Islands	124.4	0.2% of GB Breeding pop^{n}	22 prs	0
Common tern	Ythan Estuary	7.2	2.2% of GB Breeding pop^{n}	265 prs	6 prs
	Forth Islands	124.4	6.5% of GB Breeding pop^{n}	800 prs	378 prs [2]
Arctic tern	Forth Islands	124.4	1.2% of GB Breeding pop^{n}	540 prs	908 prs [–2]
Guillemot	Buchan Ness – Collieston	9.5	Waterfowl assemblage	8,640 prs	19,296
	Fowlsheugh	31.1	1.8% of East Atlantic Breeding pop^{n}.	40,140 prs	50,566
	Troup, Pennan and Lion's Head	74.3	1.3% of East Atlantic Breeding pop^{n}.	29,902 prs	16,325
	Forth Islands	124.4	Waterfowl assemblage	16,000 prs	2,550
Razorbill	Buchan Ness to Collieston	9.5	Waterfowl assemblage		4,179
	Fowlsheugh	31.1	Waterfowl assemblage	5,800	4,632
	Forth Islands	124.4	Waterfowl assemblage	1,400 prs	3,464
	Troup, Pennan and Lion's Head	74.3	Waterfowl assemblage	-	-
Puffin	Forth Islands	124.4	2.3% of breeding pop^{n}.	21,000 prs	58,867 AoN

1 = Calbrade, *et al.* 2010, 2 = BTO 2011, 3 = JNCC 2011, 4 = Montrose Basin 2011, 5 = SNH 2011

Potential for in-combination impacts

The consideration of potential in-combination impacts is of key importance when undertaking a Habitats Regulations Appraisal.

Having identified the species of seabird occurring within the proposed EOWDC area and the relevant SPAs for which the species may be a qualifying feature the next step is identify the potential for in-combination impacts.

EC Guidance (EC 2000) advises that '*when determining likely significant effects, the combination of other plans or projects should also be considered to take account of cumulative impacts. It would seem appropriate to restrict the combination provision to other plans or projects, which have been actually proposed*.

Guidance produced by COWRIE (King, *et al*. 2009) proposes that assessments should include:

- Projects that have been consented but which are yet to be constructed.
- Projects for which an application has been made,
- Projects that are reasonably foreseeable – i.e. those for which an application has yet to be made but where such application is known to be imminent.

Activities identified that may cause a potential in-combination impact include:

- Shipping
- Fishing
- Aggregates
- Dredging
- Oil and Gas
- Renewable Energy

Shipping and Fishing

Impacts from exisiting shipping and fishing activities are 'unregulated' activities, in that they do not require a specific permit before being undertaken. They are ongoing and impacts arising from them are reflected in the baseline environmental data. Currently, approximately 16,000 vessel movements take place in and out of Aberdeen harbour each year and there are no known planned increases in either shipping of fishing in the area. EC Guidance indicates that completed plans and projects are excluded from assessment requirements of Article 6(3) unless the continuing effects on the site point to a pattern of progressive loss of site integrity, which is not the case in the area of the proposed development with regards to either shipping or fishing activities. Consequently, they have not been considered as part of any in-combination impact assessment (EC 2000).

Aggregates

There are no aggregate activities in the vicinty of the proposed EOWDC.

Dredging

There are no dredging deposit sites within Aberdeen Bay. Dredging associated with Aberdeen Harbour can occasionally occur, although it is infrequent. There are currently plans to undertake dredging in Aberdeen Harbour during 2012. This will be completed prior to any proposed construction activites associated with the proposed EOWDC. Consequenlty, there will no in-combiantion impacts associated with dredging.

Oil and Gas

Aside from shipping activites associated with the oil and gas industry there are are no oil and gas acitivities in the wider Aberdeen Bay area.

Renewable Energy Projects

There are currently five proposed offshore wind farms in the Firth of Forth and Moray Firth. The Beatrice and Moray Firth Offshore Wind Farms are in the Moray Firth; approximately 150 km away and Neart na Gaiothe and Inch Cape and Firth of Forth are in the Firth of Forth, approximately 70 km to the south of the proposed EOWDC (Table 5-2 Figure 3-1). There is currenlty one operational demonstrator project in the Moary Firth, the Beatrice Demonstrator.

Table 5-2: Proposed offshore wind energy projects that may have potential in-combination impacts

Name of development	Developer	MW	Possible / Actual number of Turbines	Project timeframe construction
The Beatrice Demonstrator	Joint Venture Talisman and Scottish and Southern Energy	10	2	Installed operational
The Moray Firth Eastern Development	Moray Offshore Renewables Ltd	1,300	67	Construction starts 2015
The Moray Firth Western Development			Not yet known	Unknown >2015 (EIA commences 2013)
Beatrice	Sea Energy Renewables Ltd & Scottish and Southern Energy	920	184	2014
Firth of Forth: Phase 1	SeaGreen	1,075	215	2015
Firth of Forth: Phase 2		1,435	287	Unknown >2015
Firth of Forth: Phase 3		955	191	Unknown >2015
Neart na Gaoithe	Mainstream Renewable Power	420	130	2014
Inch Cape	SeaEnergy	905	181	2015

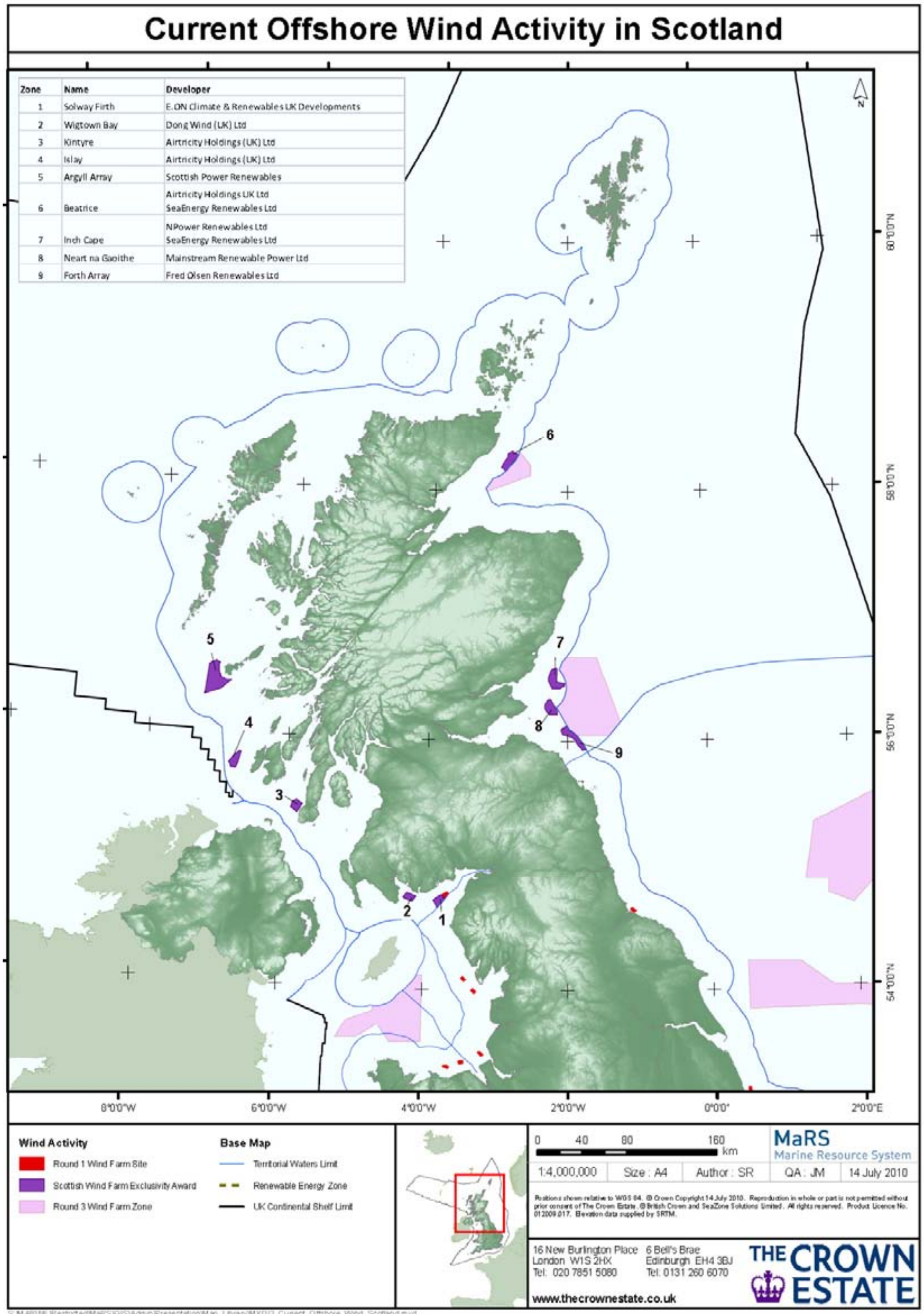

Figure 5-2: Map showing the nine initial proposed offshore wind farms in Scottish Territorial Waters

Based on the known foraging ranges of breeding seabirds occuring in the proposed EOWDC (Roos 2010, Thaxter *et al.* 2010) it has been identifed that there is the potential for an in-combination impact on the following plans or projects (Table 5-2):

- Beatrice Demonstrator Project (operational),
- The Beatrice Offshore Wind Farm (proposed),
- The Moray Firth Offshore Wind Farm (proposed),
- Inch Cape Offshore Wind farm (proposed),
- Firth of Forth Offshore Wind Farm (proposed),
- Neart na Gaoithe Offshore Wind Farm (proposed).

In order to undertake an in-combination impact assessment it is necessary to know details of the proposed plans. Currently, apart from an approximate number of turbines there is little information for any of the proposed developments and no data are available on the location or type of turbines planned to be installed nor, importantly, are there any survey data available to identify which species of bird may be present at each of the sites and in what numbers. Consequently, it is not possible to undertake a detailed in-combination impact assessment that includes the proposed renewable energy developments.

Identifying potential for interaction

Having identified the relevant SPAs and qualifying species an assessment has been undertaken to identify which species have the potential to interact with the proposed EOWDC either alone or in-combination with other plans or projects (Table 5-3). For breeding species the assessment is based on the maximum reported foraging ranges for each species and where more than one distance is available the greatest distance has been selected (Roos 2010, Thaxter *et al*. 2010). For non-breeding birds that are listed as qualifying species for an SPA they are all considered to be at potential risk but the level of significance is based on the number of birds recorded within the proposed development area and their behaviour.

Table 5-3: Breeding seabirds associated with a relevant SPA for which potential impacts could occur either alone or in-combination

Breeding bird species known to frequent area of development	Known foraging range from breeding colony (km)		Potential overlap with SPA colony	Distance from proposed EOWDC (km)	Potential overlap with proposed EOWDC (based on max foraging distance)	Potential overlap with other offshore wind farms and proposed EOWDC
	Max	Mean Max [-1]				
Common eider	100	38.33	Ythan Estuary	7.2	Y	No
			Montrose Basin	61	Y	Firth of Forth, Neart na Gaoithe, Inch Cape
			Firth of Tay & Eden Estuary	96	Y	Firth of Forth, Neart na Gaoithe, Inch Cape
			Firth of Forth SPA	134	N	No
Fulmar	664	311	Buchan Ness – Collieston,	9.5	Y	Moray Firth, Firth of Forth, Beatrice, Neart na Gaoithe, Inch Cape
			Fowlsheugh	31.1	Y	Moray Firth, Firth of Forth, Beatrice, Neart na Gaoithe, Inch Cape
			Forth Islands	124.4	Y	Moray Firth, Firth of Forth, Beatrice, Neart na Gaoithe, Inch Cape
			Troup, Pennan and Lions Head	74.3	Y	Moray Firth, Firth of Forth, Beatrice, Neart na Gaoithe, Inch Cape
			Orkney, Shetland, West coast of Scotland, North Sea	>260	Y	All UK offshore wind farms
Gannet	640	308	Forth Islands	124.4	Y	Moray Firth, Firth of Forth, Beatrice, Neart na Gaoithe, Inch Cape. All North Sea offshore wind farms

Breeding bird species known to frequent area of development	Known foraging range from breeding colony (km)		Potential overlap with SPA colony	Distance from proposed EOWDC (km)	Potential overlap with proposed EOWDC (based on max foraging distance)	Potential overlap with other offshore wind farms and proposed EOWDC
	Max	Mean Max [-1]				
			Fair Isle	260	Y	Moray Firth, Firth of Forth, Beatrice, Neart na Gaoithe, Inch Cape. All North Sea offshore wind farms North of the Wash
Cormorant	35	25	Forth Islands	124.4	N	No
European Shag	17	16	Buchan Ness to Collieston	9.5	Y	No
			Forth Islands	124.4	N	No
Lesser black-backed gull	180	132	Forth Islands	124.4	Y	Firth of Forth, Neart na Gaoithe, Inch Cape
Herring gull	92	61	Buchan Ness to Collieston	9.5	Y	No
			Fowlsheugh	31.1	Y	Firth of Forth, Neart na Gaoithe, Inch Cape
			Forth Islands	124.4	N	No
Kittiwake	83	66	Buchan Ness to Collieston	9.5	Y	No
			Fowlsheugh	31.1	Y	Firth of Forth
			Forth Islands	124.4	N	No
			Troup, Pennan and Lions Head	74.3	Y	Moray Firth, Beatrice

Breeding bird species known to frequent area of development	Known foraging range from breeding colony (km)		Potential overlap with SPA colony	Distance from proposed EOWDC (km)	Potential overlap with proposed EOWDC (based on max foraging distance)	Potential overlap with other offshore wind farms and proposed EOWDC
	Max	Mean Max [-1]				
Little tern	11	6	Ythan	7.2	Y	No
			Firth of Tay and Eden Estuary	96	N	No
Sandwich tern	70	42	Ythan	7.2	Y	No
			Loch of Strathbeg	47.6	Y	No
Common tern	37	34	Ythan	7.2	Y	No
			Forth Islands	124.4	N	No
Arctic tern	25	12	Forth Islands	124.4	N	No
Guillemot	135	71	Buchan Ness – Collieston	9.5	Y	Firth of Forth, Neart na Gaoithe, Inch Cape
			Forth Islands	124.4	Y	Firth of Forth, Neart na Gaoithe, Inch Cape
			Fowlsheugh	31.1	Y	Firth of Forth, Neart na Gaoithe, Inch Cape
			Troup, Pennan and Lions Head	74.3	Y	Moray Firth, Beatrice
Razorbill	150	31	Buchan Ness – Collieston	9.5	Y	Firth of Forth, Neart na Gaoithe, Inch Cape
			Fowlsheugh	31.1	Y	Firth of Forth, Neart na Gaoithe, Inch Cape

Breeding bird species known to frequent area of development	Known foraging range from breeding colony (km) Max	Mean Max [1]	Potential overlap with SPA colony	Distance from proposed EOWDC (km)	Potential overlap with proposed EOWDC (based on max foraging distance)	Potential overlap with other offshore wind farms and proposed EOWDC
			Forth Islands	124.4	Y	Firth of Forth, Neart na Gaoithe, Inch Cape
			Troup, Pennan and Lions Head	74.3	Y	Moray Firth, Beatrice
Puffin	200	86	Forth Islands	124.4	Y	Firth of Forth, Neart na Gaoithe, Inch Cape

[1] - Mean Max is the mean foraging distance based on the maximum foraging distances reported from various studies

Based on the above screening assessment, species identified as having a likely potential for an interaction with the proposed EOWDC are further considered in the high level screen assessment in Section **Error! Reference source not found.**. The information presented is a summary of that presented for each species in the Ornithological Baseline and Impact Assessment (Appendix 10.1 of the Environmental Statement) and this should be used in conjunction with the summarised information presented here to further inform any possible future Habitats Regulations Appraisal.

6 SCREENING ASSESSMENT

Whooper swan		Loch of Strathbeg
Population	SPA	203 individuals representing up to 3.7% of the wintering population in Great Britain (5 year peak mean 1991/2 - 1995/6)
	Recent population	333 individuals
Data	Aerial surveys	None
	Boat based (WF)	No sightings
	VP Surveys (Abdn Bay)	No sightings
	Radar	Five at Drums 28 October 2005.
Impact	Collision risk	One sighting of five birds below 20 m. Whooper swans are known to fly at turbine height.
	Displacement	No
	Barrier effect	Unknown
Evidence base	Site specific	Very few whooper swans recorded at proposed EOWDC
	Generic	Good data on flight height and direction from tagging studies (e.g. Griffen, Rees & Hughes 2010)
Evidence of potential impact	No	No evidence from existing wind farms of impacts but there is recognised to be potential risk of collisions.
Potential to assess	Yes	
Risk	Low	Very few recorded sightings at proposed location.
Further assessment	**No**	

Pink-footed goose		Ythan Estuary, Sands of Forvie and Meikle Loch	Montrose Basin	Loch of Strathbeg	Firth of Forth	Forth of Tay & Eden
Population	SPA	17,213 ind	31,622 ind	39,924 ind	12,400 ind	3,769
	Recent population	16,300 (07/08)	*c.*38,911 (08/09)	53,454 (08/09)	3,220 (08/09)	2,704 (08/09)
Data	Aerial surveys	No data				
	Boat based (WF)	No definite sightings				
	VP Surveys (Abdn Bay)	5.8 (birds per hour Oct – Mar 2006). A total of 646 were recorded from all sites Oct – Mar 08.				
	Radar	858 at Drums. Four sightings of 102 birds between 11 & 26th April 2007; 90 in April 2010.				
Impact	Collision risk	Flight height – of the 858 recorded at Drums, all were flying between 44 m and 60 m in October 2008. 90 birds in April 2007 were below 30 m.				
	Displacement	No				
	Barrier effect	Geese fly over or around wind farms.				
Evidence base	Site specific	Little evidence of significant usage of the site. Radar data has not recorded significant geese movements in April or October. Between half and 100% were recorded flying above 25 m.				
	Generic	Flight height data from R1 & R2 wind farms. Collision Risk Modelling, PVA by SNH and DECC				
Evidence of potential impact	No	No evidence of any impact on Geese species from either onshore or offshore wind farms. Barrow Offshore Wind Farm recorded avoidance behaviour (Petterson 2005; Petersen *et al.* 2006; Jensen 2006; BOW 2007)				
Potential to assess	Yes					
Risk	Low	Site specific data is limited but indicated high proportion at turbine height. Published data from other constructed wind farms indicating a very high avoidance rate and no impacts recorded.				
Further assessment	**Yes**					

Greylag goose		Loch of Skene	Montrose Basin	Firth of Tay & Eden Estuary	Loch of Strathbeg
Population	SPA	10,840 (5 year peak mean 1991/2 - 1995/6)	1,080	1,200	3,325
	Recent population	790 (2010). 5 year peak mean of 2,555 (03 – 08)	2,519 (Jan 2011)	2,640 08/09	580 (2007)
Data	Aerial surveys	No data			
	Boat based (WF)	No sightings			
	VP Surveys (Abdn Bay)	Peak average of 0.5 birds per hour (Oct 06 – Mar 07)			
	Radar	None reported			
Impact	Collision risk	Geese are very good at avoiding wind farms.			
	Displacement	No			
	Barrier effect	Geese fly either around or over wind farms. Minor barrier effect.			
Evidence base	Site specific	Few records with none from radar or boat based surveys.			
	Generic	Evidence that geese, including greylag geese, avoid wind turbines (e.g. Petterson 2005; Petersen *et al.* 2006; Jensen 2006; BOW 2007).			
Evidence of potential impact	No	No offshore wind farms have been shown to impact on geese.			
Potential to assess	Yes				
Risk	Low	Very few recorded sightings of greylag goose during either onshore or offshore surveys.			
Further assessment	**No**				

Barnacle goose		Loch of Strathbeg
Population	SPA	Article 4.2 - Waterfowl assemblage of at least 20,000 - Recorded as for all species as 95,000 individuals
	Recent population	121 (2008); 5 year peak mean 733 (03 – 08)
Data	Aerial surveys	No data
	Boat based (WF)	No sightings
	VP Surveys (Abdn Bay)	46 passed Balmedie (Oct 07 – Mar 08). 1,820 between April & September 2006
	Radar	281 observed at Easter Hatton. Mean flock size of 56.
Impact	Collision risk	All 281 observed barnacle geese were below 30 m in height.
	Displacement	No
	Barrier effect	Geese are known to fly around or over or between turbines.
Evidence base	Site specific	Evidence of passage occurring. Some data on flight heights.
	Generic	Data from Kalmar Sound and other offshore wind farms indicated high avoidance rates (e.g. Petterson 2005; Petersen *et al*. 2006; Jensen 2006; BOW 2007).
Evidence of potential impact	No	Geese have a very high avoidance rate. Relatively low numbers recorded at proposed EOWDC location.
Potential to assess	Yes	
Risk	Low	Published data from other constructed wind farms indicating a very high avoidance rate and no impacts recorded.
Further assessment	**No**	

Shelduck		**Montrose Basin**	**Firth of Forth**	**Firth of Tay & Eden estuary**
Population	SPA	Article 4.2 - Waterfowl assemblage of at least 20,000	3,586	Article 4.2 - Waterfowl assemblage of at least 20,000
	Recent population	988 (08/09)	3,166 (08/09)	1,114
Data	Aerial surveys	No data		
	Boat based (WF)	No Records		
	VP Surveys (Abdn Bay)	1 – 2 May 2007, Jan and March 2008,		
	Radar	No records		
Impact	Collision risk	Very low		
	Displacement	No		
	Barrier effect	No		
Evidence base	Site specific	Very few sightings		
	Generic	Wildfowl tend to fly around wind farms (Petterson 2005; Petersen *et al*. 2006).		
Evidence of potential impact	No	No evidence from existing wind farms of any impact on shelduck		
Potential to assess	Yes			
Risk	Low	Very low numbers recorded in proposed EWODC area. No evidence from other offshore wind farms of any impacts on shelduck.		
Further assessment	**No**			

Teal		Loch of Strathbeg
Population	SPA	Article 4.2 - Waterfowl assemblage of at least 20,000
	Recent population	504 (2007)
Data	Aerial surveys	No data
	Boat based (WF)	Two individuals
	VP Surveys (Abdn Bay)	27 pass Blackdog (Oct 07 – Mar 08)
	Radar	No records
Impact	Collision risk	One of the two teal recorded was between 25 – 200 metres
	Displacement	No
	Barrier effect	No
Evidence base	Site specific	Very few sightings
	Generic	Wildfowl tend to fly around wind farms (e.g. Petterson 2005; Petersen *et al*. 2006).
Evidence of potential impact	No	No evidence from existing wind farms of any impact on teal.
Potential to assess	Yes	
Risk	Low	Very low numbers recorded at proposed EOWDC area. No evidence from other offshore wind farms of any impacts on teal.
Further assessment	**No**	

Wigeon		Montrose Basin	Firth of Forth
Population	SPA	Article 4.2 - Waterfowl assemblage of at least 20,000	2,139
	Recent population	3,944 (08/09)	-
Data	Aerial surveys	No data	
	Boat based (WF)	1 April 2008	
	VP Surveys (Abdn Bay)	13 in March 2008	
	Radar	No data	
Impact	Collision risk	Very low	
	Displacement	No	
	Barrier effect	No	
Evidence base	Site specific	Very few sightings	
	Generic	Wildfowl tend to fly around wind farms (e.g. Petterson 2005; Petersen *et al.* 2006).	
Evidence of potential impact	No	No evidence from existing wind farms of any impact on wigeon.	
Potential to assess	Yes		
Risk	Low	Very low numbers recorded at proposed development area. No evidence from other offshore wind farms of any impacts on wigeon.	
Further assessment	**No**		

Common eider		Ythan Estuary, Sands of Forvie and Meikle Loch	Montrose Basin	Firth of Forth	Firth of Tay and Eden
Population	SPA	Article 4.2.	Article 4.2.	9,400	Article 4.2
	Recent population	3,688	1,983 (July 2010)	5,188	4,378
Data	Aerial surveys	JNCC data for Winter surveys in 2003, Dec 2005, Jan 2006 & May 2006 & summer surveys in 2006 both showed that extensive near-shore usage in waters <20 m. Peak count of 283 in May 2006.			
	Boat based (WF)	A total of 14 eider were recorded in the wind farm area from Feb 2007 – Mar 2008. With a max of 5 in April 2007. In the control area a total of 68 were recorded with a maximum of 26 in October 2007. Maximum counts of between 400 – 500 birds in August and September			
	VP Surveys (Abdn Bay)	877 recorded during VP surveys Oct 2007 to Mar 2008. An average of 8.1 per hour			
	Radar	Peak count of 680 common eider recorded October 2005, 0 – 4,000 m from shore.			
Impact	Collision risk	October 2005 – maximum flight height of 10 m from 680 sightings. All 835 in April 2007 were below 30 m. 98% of VP sightings were below 30 m.			
	Displacement	May be temporary displacement during construction but wind farm predominantly in waters > 20 m. Tuno Knob identified initial displacement followed by birds entering the wind farm.			
	Barrier effect	Evidence from Denmark and Sweden clearly indicate that common eider fly over or around wind turbines (e.g. Petterson 2005; Petersen *et al.* 2006).			
Evidence base	Site specific	The majority of common eider are within 500 m of the shore (>500 out 835 April 2007).			
	Generic	Flight height data from Denmark and Sweden shows common eiders fly predominantly below turbine height with very low collision risk. Evidence of barrier effect as common eider fly around turbines.			
Evidence of potential impact	Yes	Possible evidence of short-term displacement. No evidence of collision risk. Potential barrier effect.			
Potential to assess	Yes				
Risk	Low	Relatively few common eider recorded within proposed EOWDC area and evidence of very low collision risk. Possible displacement may occur.			
Further assessment	**Yes**	Due to significant numbers in wider area.			

Fulmar		**Buchan Ness to Collieston Coast**	**Fowlsheugh**	**Forth Islands**	**Troup Pennan and Lion Head**
Population	SPA	Article 4.2 - Waterfowl assemblage of at least 20,000	Article 4.2 - Waterfowl assemblage of at least 20,000.	Article 4.2 - Waterfowl assemblage of at least 20,000.	Article 4.2 - Waterfowl assemblage of at least 20,000.
	Recent population	1,370	246	Isle of May – 358 (2009 Bass Rock – 44 (2009)	636 (2007)
Data	Aerial surveys	No data			
	Boat based (WF)	In the wind farm peak count of 16 (Feb 2007). In the control area up to 45 peak count Dec 07.			
	VP Surveys (Aberdeen Bay)	Peak average of 9.5 birds per hour (Apr – Sep 2006).			
	Radar	Not reported.			
Impact	Collision risk	All 84 recorded sightings were below 15 m.			
	Displacement	No evidence of displacement.			
	Barrier effect	No data.			
Evidence base	Site specific	Eighteen months of boat data some flight height data available.			
	Generic	Few sightings from SNS wind farms showing no evidence of an effect.			
Evidence of potential impact	No	Relatively few records of fulmar at constructed offshore wind farms.			
Potential to assess	Yes				
Risk	Low	Low risk of collision due to low flight heights and relatively low numbers in the wind farm area.			
Further assessment	**No**				

Gannet		Forth Islands	Fair Isle
Population	SPA	34,400 pairs representing at least 13.1% of the breeding North Atlantic population (Count, as at 1994	1,166 nests
	Recent population	51,647 prs	3,582 (2009) nests
Data	Aerial surveys	No data	
	Boat based (WF)	In wind farm peak count 47 (August); 67 In the control area peak count was in August.	
	VP Surveys (Abdn Bay)	Peak of 120 birds per hour (July 2007).	
	Radar	110 recorded by radar in spring 2005. Peak numbers 3.0 km and 5 km from shore. 633 gannets were recorded in autumn 2007, most between 1.5 and 3.0 km from shore.	
Impact	Collision risk	17% of 347 recorded flights were between 25 m and 200 m; Up to 73% were >25 m at Drums (Oct 07 – Mar 08). Maximum height recorded using radar is 30 m.	
	Displacement	No	
	Barrier effect	Birds may fly around the wind farm.	
Evidence base	Site specific	Some boat based survey data.	
	Generic	Evidence of displacement from Horns Rev Offshore Wind Farm.	
Evidence of potential impact	Yes	Possible collision risk.	
Potential to assess	Yes	Based on flight height data and distribution.	
Risk	Medium	Frequently recorded and at rotor height.	
Further assessment	**Yes**		

Cormorant		Forth Islands
Population	SPA	200 prs - Article 4.2 - Waterfowl assemblage of at least 20,000
	Recent population	198 pairs
Data	Aerial surveys	No data
	Boat based (WF)	Peak of 17 in the wind farm area during October 2007; 20 in the control area during September 2007.
	VP Surveys (Abdn Bay)	Peak average of 4.2 birds per hour (Apr 06 – Sept 06)
	Radar	96 recorded during October 2005
Impact	Collision risk	All sightings from boat based surveys were below 25 m. 89 % of all flights at Nysted Offshore Wind Farm were below turbine height.
	Displacement	None reported
	Barrier effect	None reported
Evidence base	Site specific	Boat based data demonstrating birds are in water depths of <20 m.
	Generic	Evidence indicates very low collision risk and no displacement (Zucco *et al.* 2006).
Evidence of potential impact	No	None reported from offshore wind farms.
Potential to assess	Yes	
Risk	Low	Birds outwith wind farm area and low collision risk.
Further assessment	**No**	

European shag		Buchan Ness to Collieston Coast	Forth Islands
Population	SPA	Article 4.2 - Waterfowl assemblage of at least 20,000	2,887 pairs
	Recent population	331 (2007)	Isle of May – 465 (2009) Bass Rock – 15 (2009)
Data	Aerial surveys	No	
	Boat based (WF)	A total of 14 birds in total. *c* 5 within wind farm area	
	VP Surveys (Abdn Bay)	Peak of 3 birds per hour during April 2007 and an average peak of 0.9 birds per hour (Oct 06 – Mar 07).	
	Radar	14 records of 10 observations (spring 2007).	
Impact	Collision risk	No recorded flights above 25 m.	
	Displacement	Birds have been recorded near or in wind farms.	
	Barrier effect	Possible, due to regular flight movements. Not known if there is a barrier effect.	
Evidence base	Site specific	Few sightings, all near shore.	
	Generic	Uncommon at offshore wind farms. Little evidence available.	
Evidence of potential impact	No	Possible displacement or barrier.	
Potential to assess	Yes		
Risk	Low	Very low risk of collision and little or no evidence of displacement or barrier effects.	
Further assessment	**No**	Few sightings, nearshore low flying and no evidence of displacement.	

Oystercatcher		Montrose Basin
Population	SPA	Article 4.2 - Waterfowl assemblage of at least 20,000
	Recent population	1,766 (Feb 2010)
Data	Aerial surveys	No data
	Boat based (WF)	None recorded
	VP Surveys (Abdn Bay)	Up to 190 birds recorded during summer 2007. Peak movements along the coast of 3.1 birds/hr at the Don Mouth during the winter of 2006 & 2007.
	Radar	None
Impact	Collision risk	Few data available on flight heights. No evidence of concentrations or commuting routes across wind farm.
	Displacement	No
	Barrier effect	Waders have been recorded flying around wind farms.
Evidence base	Site specific	Little evidence of any usage of the site.
	Generic	Few nearshore wind farms have recorded oystercatcher behaviour and flight heights.
Evidence of potential impact	No	
Potential to assess	Yes	
Risk	Low	No evidence of any usage of the site or evidence of any regular passage.
Further assessment	**No**	

Lapwing		Ythan Estuary, Sands of Forvie and Meikle Loch
Population	SPA	Article 4.2 - Waterfowl assemblage of at least 20,000 - Recorded as a total of all species as 51,265
	Recent population	Peak numbers in Ythan in August with maximum of 6,269 in August 2006.
Data	Aerial surveys	No data
	Boat based (WF)	None recorded
	VP Surveys (Abdn Bay)	None recorded offshore.
	Radar	680 lapwing recorded October 2005. 835 birds in April 2007, 0 – 4.0 km from shore
Impact	Collision risk	Possible risk of collision. No evidence of any significant usage of the site.
	Displacement	No
	Barrier effect	May have barrier effect.
Evidence base	Site specific	Little evidence of any impacts to lapwing from offshore wind farms. Few records from Kalmar sound.
	Generic	Flight height data from Denmark and Sweden. Evidence of barrier effect.
Evidence of potential impact	No	Possible evidence of short-term displacement. No evidence of collision risk. Potential barrier effect. Few records from other offshore wind farms show majority fly below turbine height.
Potential to assess	Yes	
Risk	Low	Due to low numbers present offshore and those recorded from onshore being at Drums to the north of the proposed development and therefore at no risk of collision to and from the Ythan Estuary SPA.
Further assessment	**No**	

Redshank		Ythan Estuary, Sands of Forvie and Meikle Loch	Montrose Basin	Firth of Forth	Firth of Tay & Eden Estuary
Population	SPA	Article 4.2 - Waterfowl assemblage of at least 20,000 - Recorded as for all species as 51,265 individuals	Article 4.2 - Waterfowl assemblage of at least 20,000 ind.	Waterfowl assemblage	Waterfowl assemblage
	Recent population	1,497 in 2008; 5 year peak mean of 2,216 between 03 - 08	1,951 (Nov 2010)	5,111	1,162
Data	Aerial surveys	No data			
	Boat based (WF)	None recorded			
	VP Surveys (AbdnBay)	A total of 11 birds at the Donmouth (Oct 2007 – Mar 2008). Peak of 7 in Nov 2007.			
	Radar	None			
Impact	Collision risk	Few data available on flight heights. No evidence of concentrations or commuting routes across wind farm.			
	Displacement	No			
	Barrier effect	Waders have been recorded flying around wind farms.			
Evidence base	Site specific	Little evidence of any usage of the site.			
	Generic	Few nearshore wind farms have recorded redshank behaviour and flight heights.			
Evidence of potential impact	No				
Potential to assess	Yes				
Risk	Low	No evidence of any usage of the site or evidence of any regular passage. Very small numbers recorded.			
Further assessment	**No**				

Lesser black-backed gull		**Forth Islands**
Population	SPA	2,920 pairs representing at least 2.4% of the breeding Western Europe/Mediterranean/Western Africa population (Count, as at 1994)
	Recent population	2,779 apparently occupied nests
Data	Aerial surveys	No
	Boat based (WF)	Only two sightings in the wind farm area during June.
	VP Surveys (Abdn Bay)	Peak average of 2 birds per hour (Apr 06 – Sept 06).
	Radar	None reported.
Impact	Collision risk	Birds regularly fly at turbine height. Extensive data from other offshore wind farms.
	Displacement	No
	Barrier effect	No
Evidence base	Site specific	Small number of sightings.
	Generic	Data from other offshore wind farms.
Evidence of potential impact	Yes	Collision risk.
Potential to assess	Yes	
Risk	Low	Small numbers of gulls recorded in the area.
Further assessment	**No**	

Herring gull		Buchan Ness to Collieston Coast	Fowlsheugh	Forth Islands
Population	SPA	Article 4.2 - Waterfowl assemblage of at least 20,000	Article 4.2 - Waterfowl assemblage of at least 20,000	Article 4.2 - Waterfowl assemblage of at least 20,000
	Recent population	3,079 AoN (2007)	122 AoN (2008)	Isle of May 2,962 (2008) Bass Rock 169 (2004)
Data	Aerial surveys	No data		
	Boat based (WF)	Up to 456 July 2007; 417 June 2007 within wind farm survey area. Considerably fewer during other months.		
	VP Surveys (Aberdeen Bay)	7,737 herring gulls recorded between Oct 07 and Mar 08 with a peak average of 54 birds per hour (Oct 06 -Mar 07).		
	Radar	Gull sp only recorded. >10,000 recordings but no distance or height measurements		
Impact	Collision risk	>30% between 25m and 200m from boat based studies. >60% were between 30 & 150 metre flight height from VP studies.		
	Displacement	No evidence for displacement may be an attraction.		
	Barrier effect	No evidence of a barrier effect.		
Evidence base	Site specific	Eighteen months of boat based survey data.		
	Generic	Herring gulls frequently fly at rotor height but evidence indicates they have relatively high avoidance rates.		
Evidence of potential impact	Yes	Collision risk.		
Potential to assess	Yes	A common species at many offshore wind farms. Good flight height data.		
Risk	Medium	Frequently recorded within wind farm area at rotor height.		
Further assessment	**Yes**			

Kittiwake		Buchan Ness to Collieston Coast	Fowlsheugh	Forth Islands	Troup Pennan & Lion's Heads
Population	SPA	Article 4.2 - Waterfowl assemblage of at least 20,000	Article 4.2 - Waterfowl assemblage of at least 20,000	Article 4.2 - Waterfowl assemblage of at least 20,000	Article 4.2 - Waterfowl assemblage of at least 20,000
	Recent population	12,542 AoN [1] (2007)	11,140 prs in 2006	3,354 on Isle of May in 2008	14,896 AoN
Data	Aerial surveys	No data			
	Boat based (WF)	Maximum of 1,676 in July 2007 in WF and 663 in control area in July 2007.			
	VP Surveys (Abdn Bay)	Average of up 70 birds per hour Summer 2006. 1 per hour from October to March 2007.			
	Radar	None reported			
Impact	Collision risk	40% above 25 m.			
	Displacement	No			
	Barrier effect	No - Gulls tend not to avoid flying through wind farms.			
Evidence base	Site specific	Extensive usage of Aberdeen Bay but low usage of the site. Flight heights recorded.			
	Generic	Some evidence available from other sites.			
Evidence of impact	No	Possible collision risk.			
Potential to assess	Yes				
Risk	Low	Site regularly used. Potential risk of collision. Possible displacement.			
Further assessment	**Yes**				

[1] AoN = Apparently Occupied Nests

Little tern		**Ythan Estuary, Sands of Forvie and Meikle Loch**	**Firth of Tay and Eden Estuary**
Population	SPA	41 pairs	25 pairs
	Recent population	21 (2008) 36 (2009)	0 pairs
Data	Aerial surveys	None	
	Boat based (WF)	0	
	VP Surveys (Abdn Bay)	0.1 (birds per hour)	
Impact source	Collision risk	Flight height – 3 - 8 m at Scroby Sands Offshore Wind Farm.	
	Displacement	There is no evidence of displacement of little terns.	
Evidence base	Site specific	No little terns recorded within wind farm location.	
	Generic	Scroby Sands Offshore Wind Farm monitoring report (ECON 2006; ECON 2008).	
Evidence of potential impact	No	Possible collision risk but none reported from Scroby Sands Offshore Wind Farm (e.g. ECON 2006)	
Potential to assess	Yes		
Risk	Low	None recorded within wind farm location. Evidence from other sites show low flight height and low likelihood of foraging offshore. Although possible evidence of prey displacement (ECON 2006; ECON 2008)	
Further assessment	**Yes**		

Sandwich tern		**Ythan Estuary, Sands of Forvie and Meikle Loch**	**Loch of Strathbeg**	**Forth Islands**	**Firth of Forth**
Population	SPA	600 pairs	530 pairs	22 pairs	1,617 ind (passage)
	Recent population	0 (1993 & 1994) peak of 1,802 pairs in 1987; mean 517pairs over 20 years. 645 AoN 2009	0 – No breeding since 2000. 1 pr in 2010	0 in 2007	-
Data	Aerial surveys	No data			
	Boat based (WF)	43 birds between May & July 2007			
	VP Surveys (Abdn Bay)	Up to 300 birds per hour in August 2007			
Impact	Collision risk	Flight height –all recorded flights below 25 m, 16 were between 15 & 25 m.			
	Displacement	Little evidence that Sandwich terns avoid flying through wind farms (e.g. Evaraert & Stienen 2006).			
Evidence base	Site specific	Boat based data indicates low usage of the site compared to elsewhere. 4% of flights at rotor height from boat based surveys. Vantage Point surveys recorded 44% of flight heights at rotor height Nearly all sightings in waters of *c* 10 m and less than 20 m.			
	Generic	Flight height data available from Humber, Kentish Flats, Sheringham Shoal, London Array, Docking Shoal, Race Bank Offshore Wind Farms. Collision risk data from Zeebrugge Offshore Wind Farm. Overall 12% recorded at rotor height			
Evidence of potential impact	Yes	Although site specific data indicates predominantly low flight heights below probable turbine height, data from other wind farms identify potential collision risk.			
Potential to assess	Yes				
Risk	Medium	Based on site specific data the risk is low but data from elsewhere identify probable collision risk.			
Further assessment	**Yes**				

Common tern		**Ythan Estuary, Sands of Forvie and Meikle Loch**	**Forth Islands**
Population	SPA population	265 prs	800 prs
	Recent data	6 (2004), 0 (2005), 6 (2006),	378 AoN
Data	Aerial surveys	None	
	Boat based (WF)	55 peak monthly count (July 2007).	
	VP Surveys (Abdn Bay)	16.7 (birds per hr)	
	Radar surveys	14 common terns at Blackdog in April 2007.	
Impact source	Collision risk	Flight height – 14% above 25 m. Up to 23 % between 15 m and 25 m. Other wind farms reported 11% at rotor height.	
	Displacement	Common terns are not known to be displaced	
Evidence base	Site specific	All sightings within the wind farm footprint are in waters of <20 m. To the north they occur further offshore. 21 common terns were recorded 'on the sea' in the wind farm area during July 2007.	
	Generic	Flight heights available at Humber, Kentish Flats, Sheringham Shoal, London Array Offshore Wind Farms.	
Evidence of potential impact	Yes	Collision risk data from Zeebrugge indicates potential collision risk (e.g. Evaraert & Stienen 2006).	
Potential to assess	Yes		
Risk	Medium	Relatively high numbers recorded in wider wind farm area. However evidence shows that majority fly below turbine heights.	
Further assessment	**Yes**		

Arctic tern		Forth Islands
Population	SPA population	540 prs
	Recent data	908 prs
Data	Aerial surveys	None
	Boat based (WF)	3 Arctic terns in July 2007
	VP Surveys (Abdn Bay)	Peak of 150 birds per hour at Drums July 2008, In 2007 a peak of 10 birds per hour
	Radar surveys	None recorded
Impact source	Collision risk	Flight height – none above 25 m. Elsewhere 24% recorded at rotor height
	Displacement	Arctic terns are not known to be displaced
Evidence base	Site specific	Few sightings within proposed EOWDC area. The majority of sightings to the north.
	Generic	Flight heights available at Humber, Kentish Flats, Sheringham Shoal, London Array Offshore Wind Farms. 24% reported as being at rotor height.
Evidence of potential impact	Yes	Collision risk data from Zeebrugge indicates potential collision risk for Terns (e.g. Evaraert & Stienen 2006).
Potential to assess	Yes	
Risk	Low	Low numbers recorded and relevant SPA 124 km away
Further assessment	No	

Guillemot		Buchan Ness to Collieston Coast	Fowlsheugh	Troup, Pennan and Lion's head	Forth Islands
Population	SPA	Article 4.2	Article 4.2	Article 4.2	Article 4.
	Recent population	19,296 ind. in 2007	50,566 ind. in 2009	16,325 ind. in 2007	2,550 individuals in 2009
Data	Aerial surveys	No			
	Boat based (WF)	Maximum of 1,165 in July 2007 in EOWDC and 2,419 in control area (July 2007). Widespread.			
	VP Surveys (Abdn Bay)	Up to 250 birds per hour in March 2007; Average of 59 birds per hour (Apr 2006 – Sept 2006). Ave of 24 per hour (Oct 2006 – Mar 2007).			
	Radar	259 sightings in 2005. Peak numbers between 4 km & 4.5 km during the spring and 2.0 – 2.5 km during autumn.			
Impact	Collision risk	One out of 243 recorded flights was above 25 m. VP surveys – 98 % below 30 m (Oct – Mar 08).			
	Displacement	Possible. No significant effect reported from North Hoyle Offshore Wind Farm or Kentish Flats (Gill *et al.* 2008). Reported increase in avoidance at Horns Rev Offshore Wind Farm.			
	Barrier effect	Some evidence that guillemots detour.			
Evidence base	Site specific	Extensive usage of the site. No specific concentrations recorded in the site.			
	Generic	Evidence from Horns Rev and North Hoyle Offshore Wind Farm.			
Evidence of potential impact	Yes	Low risk of collision. Possible displacement.			
Potential to assess	Yes				
Risk	Low	Extensive usage of the site, possible evidence of displacement.			
Further assessment	**Yes**				

Razorbill		**Buchan Ness to Collieston Coast**	**Fowlsheugh**	**Troup, Pennan & Lion's Heads**	**Forth Islands**
Population	SPA	Article 4.2 - Waterfowl assemblage of at least 20,000	Article 4.2 - Waterfowl assemblage of at least 20,000	Article 4.2 - Waterfowl assemblage of at least 20,000	Article 4.2 - Waterfowl assemblage of at least 20,000
	Recent population	4,179 individuals in 2007	4,632 individuals in 2009	3,216 Ind	3,464 individuals in 2008
Data	Aerial surveys	No			
	Boat based (WF)	Peak count in wind farm area of 273 in August 2007; 112 in Nov 2007. Up to 378 in control area (August 2007)			
	VP Surveys (Abdn Bay)	Peak average of 1.5 birds per hour (Oct 06 – Mar 07); Peak of seven birds per hour in March 2006			
	Radar	Yes but data combined with guillemot.			
Impact	Collision risk	132 recorded flights all below 25 m.			
	Displacement	Possible			
	Barrier effect	Possible depending on flight line.			
Evidence base	Site specific	Boat based and VP data			
	Generic	Limited data from other offshore wind farms.			
Evidence of potential impact	Yes	No evidence of collision risk but possible displacement effect.			
Potential to assess	Yes				
Risk	Low	Relatively small numbers of birds widely distributed.			
Further assessment	**Yes**				

Puffin		Forth Islands
Population	SPA	21,000 pairs representing at least 2.3% of the breeding population (Count, as at 1992).
Data	Recent population	56,867 apparently occupied nests in 2009.
	Aerial surveys	None
Data	Boat based (WF)	In the wind farm area a peak count of 221 during August 2007 and 285 in the control area during September 2007. Most sightings were in water depths of greater than 20 metres.
	VP Surveys (Abdn Bay)	Peak average of 0.3 birds per hour (Apr 06 – Sept 06).
	Radar	One recorded in October 2005
Impact	Collision risk	Low
	Displacement	Possible – most sightings were in water depths of greater than 20 m.
	Barrier effect	Low
Evidence base	Site specific	One year of boat based data.
	Generic	None
Evidence of potential impact	No	Puffins have not been a species regularly recorded at offshore wind farms.
Potential to assess	Yes	
Risk	Low	Nearest SPA 124 km away. Relatively low numbers recorded and potential small area of displacement
Further assessment	No	

7 SPECIES ASSESSMENTS

Pink-footed goose

Pink-footed goose is a qualifying species for the Ythan Estuary, Sands of Forvie & Miekle Loch SPA, Loch of Strathbeg SPA and the Montrose Basin SPA. Further to the south it is also a qualifying species for Firth of Forth and Firth of Tay & Eden SPAs.

The Conservation Objectives for the SPAs are:

To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and

To ensure for the qualifying species that the following are maintained in the long term:

- *Population of the species as a viable component of the site.*
- *Distribution of the species within site.*
- *Distribution and extent of habitats supporting the species.*
- *Structure, function and supporting processes of habitats supporting the species.*
- *No significant disturbance of the species.*

Birds arrive from their breeding grounds in Iceland to North-east Scotland during September and October and the Loch of Strathbeg and the Miekle Loch are important roosting sites for the species. Pink-footed geese exhibit a high degree of site loyalty with up to 76 % of geese returning to the same roost between winters (Mitchell & Hearn 2004), although they can move in variable numbers to other wintering sites, e.g. in 2010 arriving autumn geese moved onwards to the Montrose Basin SPA where record numbers of approximately 65,000 were recorded. Following their arrival the majority of pink-footed geese continue south-west to Lancashire and then overland to Norfolk wintering in all three areas. Spring migration is more prolonged with peak numbers during the spring occurring during April.

The UK population of pink-footed geese has increased considerably since the 1950's with a UK wintering population of 302,774 in 2006 (WWT 2007). Peak numbers of pink-footed geese in North-east Scotland occur in October with a five year mean peak between 2003 and 2008 at the Loch of Strathbeg of 55,153 and a similar mean count of 15,515 on Meikle Loch (Holt *et al.* 2009).

7.1.1 Evidence of site usage

There have been no definite sightings of pink-footed geese within the proposed EOWDC area from boat based surveys, although a flock of 180 geese sp. were recorded from boat surveys in November 2007 may have been this species. Vantage Point (VP) surveys have recorded a total of 646 pink-footed geese and from radar studies a total of 858 individuals. Over half the geese were reported to be flying at rotor height, i.e. >25 m.

The coastal waters of Aberdeen Bay are therefore regularly used by pink-footed geese but in relatively lower numbers compared to onshore sites.

7.1.2 Evidence of potential impact

Evidence from data obtained for other offshore wind farms indicate that pink-footed geese regularly fly at rotor height. Observations from Walney Bird Observatory during 2005 and 2007 recorded between 33% and 58% of all sightings above 25 m. Further observations off

Lincolnshire recorded between 37% and 74% of pink-footed geese flying at rotor height. Consequently, pink footed geese could be at risk of collision.

Although studies undertaken in Sweden and Denmark do show Geese flying around wind turbines, there is no evidence that there will be any significant displacement or barrier effects (Petterson 2005).

7.1.3 Evidence of collision risk

Collision risk modelling has been undertaken based on a number of highly precautionary assumptions.

1. The total number of pink-footed geese passing through North-east Scotland each autumn is 340,000. This is based on the entire UK wintering population occurring in North-east Scotland, which is not thought to be the case, as some but an unknown number of geese will arrive directly into the north-west England from their breeding grounds in Iceland (WWT 2007).
2. All pink-footed geese migrate south across a front of up to 5 km offshore and 5 km inland and therefore over a 10 km wide front. The maximum width of the proposed development is 3.6 km and therefore intercepts 36% of the potential flight path. This is precautionary as site specific data indicates that the majority of geese fly within 1 km from shore and therefore do not interact with potential development. Furthermore ringing results indicate that a significant proportion of pink-footed geese fly south-west to north-west England which would lead them overland away from the proposed EOWDC. However, for the purposes of the collision risk modelling it assumed that 36% of the UK wintering population of pink-footed geese cross the proposed development area, i.e. 122,400 birds and that they pass through the site each autumn and spring, i.e. a total passage of 244,800 birds per year.
3. Those that do fly across the development area, 46% do so at turbine height and that there is no far field avoidance.
4. The same rate of passage occurs during the spring as it does during the autumn is also very precautionary as the numbers of pink-footed geese in the spring are always significantly lower than those in the autumn indicating that many pink-footed geese do not pass through the region during the spring migration.

Collision Risk Modelling has been undertaken on these precautionary assumptions using a range of avoidance rates: 98%, 99% and 99.5%.

Table 7-1: Number of pink-footed geese collisions at a range of avoidance rates

Collision probability	Avoidance rate (%)		
	98	99	99.5
8.4%	56	28	14

Based on the various very precautionary scenarios and using a precautionary avoidance rate of 99% as recommended by SNH, it is predicted that up to a 28 collisions per year may occur (Table 7-1).

The annual mortality rate for pink-footed goose is 13.7% (BTO 2011). Consequently, out of a population of 340,000 an annual mortality of 45,560 pink-footed geese may be predicted. Therefore, 1% of the baseline mortality is 4,556 birds per year.

Based on the results from the precautionary Collision Risk Modelling undertaken the number of pink-footed geese that may collide is lower than that which may cause concern of a potentially significant impact on pink-footed geese.

To assess whether there is the potential for an adverse effect on pink-footed geese as a qualifying species for the relevant regional SPAs the assessment is based on the 5 year peak mean counts as opposed to numbers published at the time of SPA citation as the populations of pink-footed geese have increased significantly since the SPA citations were originally made. It is also assumed that each SPA population is separate from each other and any collision impacts relate to birds only associated with that SPA.

This is unrealistic as the number of birds for which collision risk modelling has been undertaken is significantly greater than the numbers cited within site specific qualifying interests.

As the counts relate only to the autumn passage of geese the modelling is based on a similar rate of passage across each site in the spring.

Table 7-2: Predicted natural mortality rates of pink-footed geese at relevant SPAs

Site SPA	Population	Natural Mortality	1% of Natural Mortality
Ythan Estuary, Sands of Forvie and Meikle Loch	16,300	2,233	22
Loch of Strathbeg	53,454	7,323	73
Firth of Forth	3,220	441	4
Firth of Tay and Eden Estuary	2,704	370	4
Montrose Basin	38,911	5,330	53

Based on the above the results and the precautionary guidance threshold of a 1% increase in baseline mortality the results from the Collision Risk Modelling indicate that there is the potential for an adverse effect to occur should all potential collisions relate to geese associated with three of the SPAs.

Results from monitoring undertaken at constructed offshore wind farms indicate a very high level of avoidance of wind farms by Geese, including pink-footed geese. Monitoring undertaken at Barrow Offshore Wind Farm has demonstrated that the pink-footed geese flying at rotor height adjust their flight height and fly over the wind turbines. Less than 2 % remained at turbine height and those that did adjusted the flight lines to fly between the turbines. No collisions were observed (BOW 2007).

None of the 100,000 geese (brent, white-fronted and barnacle geese) recorded at Kalmar sound in Sweden collided with the Utrunden or Yttre Stengrund Wind Farms (Petterson 2005).

In total over 120,000 geese of eight species have been recorded from five constructed wind farms over a period of 12 years, during which time only one collision has been observed. The collision involved a brent goose recorded at Rønland Offshore Wind Farm in Denmark.

There is therefore strong evidence to suggest that geese, including pink-footed geese, have a very low collision risk. Furthermore the collision risk modelling is highly precautionary and the numbers predicted to collide are still relatively small compared to the population as a whole.

Further evidence to support the conclusions that the potential impacts from collision risk are minor come from Population Viability Analysis (PVA) undertaken on pink-footed geese which indicate that the pink-footed goose population may be able to withstand an increase in mortality (from whichever source) of 5,000 birds per year (Trinder *et al.* 2005). Further PVA commissioned by DECC to model the possible effects of additional mortality on the pink-footed goose population over a 25 year period indicated that there was a 2% chance of the pink-footed goose population decreasing to below 150,000 if, due to collisions, wind farms increase the annual mortality by more than 1,000 birds over and above current impacts, e.g. hunting. (Trinder 2008). Consequently, the possible additional increase in mortality of up to 28 birds per year will not cause an adverse effect..

Risk of an adverse collision effect - Low

7.1.4 Evidence of displacement

There is no evidence of any displacement effects on pink-footed geese from offshore wind farms.

Risk of an adverse displacement effect - Low

7.1.5 Evidence of barrier effect

Monitoring undertaken at Barrow Offshore Wind Farm identified pink-footed geese altering flight height to avoid the wind farm or flying between the turbines. Consequently, although pink-footed geese demonstrated avoidance behaviour there was no evidence of a significant barrier effect.

Risk of an adverse barrier effect – Low

7.1.6 Evidence of in-combination impact

There is the potential for an in-combination impact of pink-footed goose from other offshore developments that have previously been recognised as having a potential impact on pink-footed geese, particularly with respect to collision risk.

In-combination collision risk totals based on collision risk modelling are presented in Table 7-3. The collision risk modelling undertaken at the time was based on avoidance rates of 95, 99 and 99.5%. Based on an avoidance rate of 99%, a total of up to 167 pink-footed geese are predicted to be impacted from all the currently consented offshore wind farms.

Based on the total UK population of approximately 340,000 pink-footed geese and a 1% baseline mortality rate of 4,556 individuals per year the potential in-combination impacts are considered not to be adverse.

Further projects in the Firth of Forth and Moray Firth have the potential to cause an incremental increase in mortality rates. There are no data available on the likely numbers of pink-footed geese present within the proposed developments presented in Table 5-2. However, evidence from ringing indicate that the majority of pink-footed geese move south-west and are therefore unlikely to be recorded within the Firth of forth area in large numbers. However, the numbers likely to cross the Moray Firth are unknown. However, all evidence indicates that pink-footed geese avoid wind turbines and therefore it is believed that there is unlikely to be an adverse affect arising from collision risk.

Table 7-3: Predicted potential collision mortality for pink-footed geese.

Site	Avoidance rate		
	95%	**99 %**	**99.5 %**
Ormonde	77	15	8
Walney	6	1	<1
West of Duddon Sands	5	1	<1
Barrow	15	15	8
Docking Shoal		15	8
Humber Gateway		48	24
Lincs	171 - 262	34 – 52	17 – 26
Lynn & Inner Dowsing	100 - 165	20 – 33	10 – 17
Total	**374 - 530**	**149 – 167**	**69 – 85**

Risk of an adverse in-combination effect - Low

7.1.7 Conclusion

Taking into account data obtained from the proposed EOWDC and supported by published data from other sites it is concluded that the proposed EOWDC either alone or in-combination will not cause an adverse effect on the integrity of the relevant SPAs with regard to pink-footed goose.

Common eider

Common eider ducks are part of the qualifying assemblage under Article 4.2 of the Directive 2009/147/EC (codified 79/409/EEC) by regularly supporting at least 51,265 individual waterfowl (5 year peak mean 1991/2 - 1995/6) for the Ythan Estuary, Sands of Forvie and Meikle Loch SPA, Montrose Basin SPA, Firth of Tay & Eden Estuary SPA, Firth of Forth SPA.

The Conservation Objectives for the SPAs are:

To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and

To ensure for the qualifying species that the following are maintained in the long term:

- *Population of the species as a viable component of the site.*
- *Distribution of the species within site.*
- *Distribution and extent of habitats supporting the species.*
- *Structure, function and supporting processes of habitats supporting the species.*
- *No significant disturbance of the species.*

Common eiders occur in the area throughout the year but most adults winter in the Firth of Forth and Tay estuary. First winter birds remain near the estuary (Baillie & Milne 1988). Peak numbers occur in the Ythan during May with maximum counts of up to 4,212 in 2004 and a five year peak mean of 3,333 individuals. Within Aberdeen Bay, peak counts of common eider occur in late summer when up to 6,003 were recorded in 2005 and the peak mean between 2003 and 2008 in Aberdeen Bay was 4,833. In the Montrose Basin peak counts of common eider occur during July with 1,983 in July 2010.

7.1.8 Evidence of site usage

Aberdeen Bay has the fourth largest population of common eider in the UK (Holt *et al*. 2009).

Site specific boat based surveys undertaken between February 2007 and January 2008 recorded a total of 68 individuals across both the control area and the proposed development area with a maximum of five within the wind farm area in April 2007. All but one of the sightings occurred in waters of less than 20 m. In contrast to the boat based surveys, common eider were frequently recorded from the four land based vantage point survey locations with a total of 877 recorded in flight between October 2007 and March 2008 and an overall average of 8.1 birds per hour flying past each point. Thus, indicating extensive near-shore coastal usage.

Figure 7-1 presents the eider distribution from boat based data collected between September and May. Few sightings were obtained from boat based surveys between June and September. The results indicate that eider occur infrequently within the proposed development area.

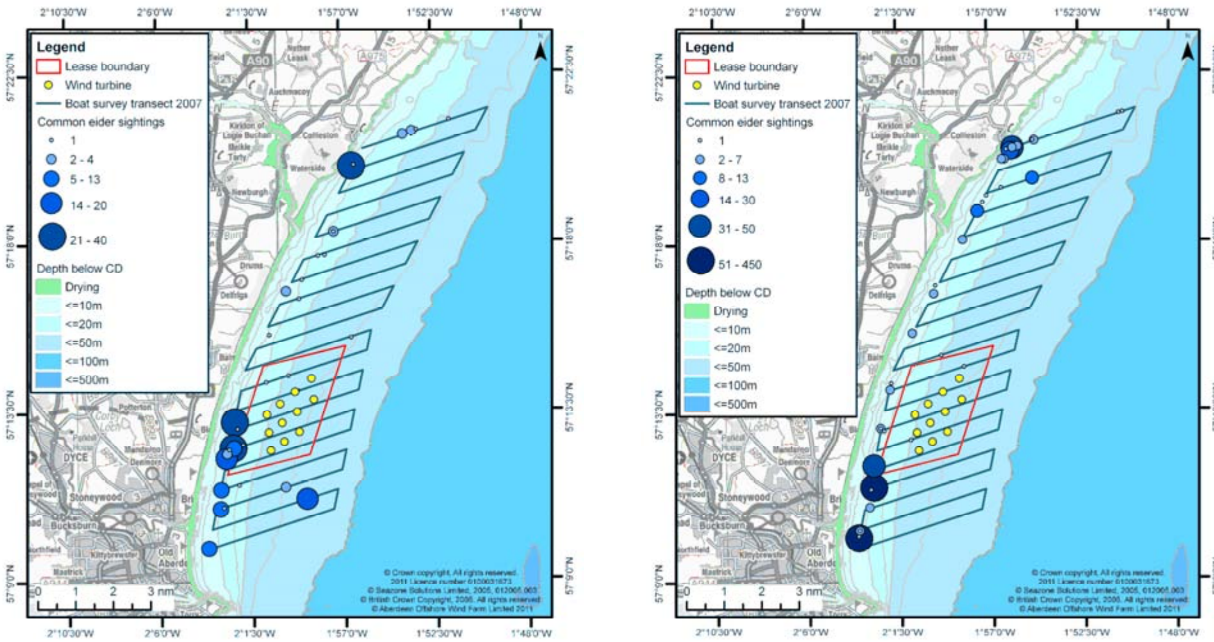

Figure 7-1: Common eider distribution in Aberdeen Bay September to May (all sightings).

Data from Denmark supports the evidence obtained from within Aberdeen Bay that common eider occur very infrequently in water depths of >20 m with less than 1 % of 36,700 records in the relatively deeper waters.

7.1.9 Evidence of collision risk

Evidence from data obtained for other offshore wind farms indicate that common eider fly predominantly below rotor height. Observations from Denmark indicate that more than 80 % of all common eider flights occur below 30 m (Kahlert *et al* 2000). Further evidence from Denmark and Sweden have demonstrated that Common eider duck have a very high avoidance rate with no collisions detected at Horns rev offshore wind farm that has an annual autumn passage of between 40,000 to 60,000 common eider per year (Petersen *et al* 2006). Similar avoidance rates were found at Kalmar Sound Offshore Wind Farm (Pettersson 2005). There is no evidence of a potential collision risk impact.

Risk of a significant effect - Low

7.1.10 Evidence of a displacement

Based on the results from the monitoring data, the worst-case scenario is that should displacement occur, that no eider will be within the proposed development area and there will be 80% displacement out to a distance of 1 km and a further 50% decrease in abundance out to 2 km from the wind farm.

Based on the peak density obtained from boat based surveys of 10.9 birds/km^2 during the winter period, should there be a total displacement of eider from within the proposed EOWDC area then it is predicted that up to 47 eider may be displaced during periods of peak density. Based on an 80% displacement out to 1 km (a total surface area of 12.3 km^2)

from the proposed development area then it is predicted that a total of 154 eider may be displaced with a further 44 out to 2 km should there be 20% displacement. Therefore, the maximum number of eider potentially displaced is up to 198 birds based on the highest densities recorded from any survey within Aberdeen Bay and at least some displacement out to 2 km.

Based on the estimated total of 198 potentially displaced eider out of a peak reported count of 3,500 eider at Blackdog, it is predicted that up to 6% of the eider within Aberdeen Bay may be displaced. However, the distribution of eider within Aberdeen Bay is clustered with peak numbers occurring at various sites across the bay during different seasons (Sohle *et al.* 2006). The area off Blackdog regularly records the peak counts of eider in Aberdeen Bay (NESBR) and should displacement occur a greater proportion of eider might be affected than is estimated using densities obtained from boat based surveys.

The Tuno Knob Offshore Wind Farm in Denmark is a relatively small wind farm of ten turbines in an area that holds up to 5,800 eider. Post-construction monitoring at Tuno Knob has indicated that the distribution of eider is closely related to their prey and although there may be some displacement immediately post-construction there is unlikely to be any significant displacement of eider from the proposed development area as long as their prey remain available (Guillemette *et al.* 1999). Evidence from studies undertaken at Nysted offshore wind farm have indicated that although there was an avoidance of the area during construction there was a subsequent increase of 48% within the wind farm area post-construction but a decrease in numbers out to 2 and 4 km (Zucco *et al.* 2006).

These two studies demonstrate that eiders do not avoid wind farms post-construction and their distribution is closely aligned to the availability of prey. The main prey items for eider are mussels (*mytilus edulus*). Evidence from constructed wind farms indicate that there is likely to be an increase in mussels around the base of turbines and that no significant impacts have been detected on mussels from the construction of wind farms. Consequently, there is unlikely to be a negative impact on prey availability for eiders within Aberdeen Bay.

Table 7-4: Calculations used to calculate potential displacement of eider

Calculations used for displacement	
Area	*Peak density of eider – 10.9 birds/km^2*
Area of EOWDC – 4.3 km^2	4.3 * 10.9 = 47
Area of EOWDC 1 km buffer – 12.3 km^2 @ 80%	(12.3 * 10.9)*0.8 = 107
Area of EOWDC 2 km buffer – 20.3 km^2 @ 20%	(20.3 * 10.9)*0.2 = 44
Total predicted displacement	47+107 + 44 = 198

7.1.11 Disturbance

Eiders may be disturbed by vessels both during the construction phase and during operations from maintenance vessels. Studies have indicated that there may be displacement from large vessels out to 1,000 m (Larsen & Laubek 2005).

During construction there may be a number of vessels operating within the area but they will likely be focussed around a single point where the turbine is being installed. Consequently, eider may be displaced from within 1 km radius of the installation; an area of 3 km^2. Based on the highest recorded density of 10.9 birds/km^2, it is therefore predicted that up to 33 eider may be displaced from the vicinity during construction. This equates to approximately 1% of the peak eider population within Aberdeen Bay based on the peak estimated figure of 3,500 individuals. The construction period will be of short duration and the impacts from construction vessels temporary. Displacement by service boats may diminish the re-population potential of the EOWDC. It is not known how many service vessels may be required but based on the scale of the proposed development there is unlikely to be frequently more than one vessel on any one occasion. The presence of the proposed development in the vicinity of the intensively used Aberdeen Harbour means that the potential increase of one vessel movement on a regular basis will not have any noticeable difference to the number of vessels already using Aberdeen Bay. Any specific displacement caused by the service or construction boats will be temporary as eiders will be able to move into the area once the vessels leave.

Risk of an adverse effect from displacement or disturbance - Low

7.1.12 Evidence of barrier effect

Evidence from Denmark and Sweden suggest that common eider fly around, rather than through, wind farms. Consequently, there will be an increase in energy expenditure. Research at the substantially larger Nysted Offshore Wind Farm comprising of 72 turbines calculated an increase of flight distance of 500 m caused by flying around the wind farm. The conclusions of the study were that such a flight would not have any adverse effect on migrating common eider.

There is no evidence of regular daily movements of eider within Aberdeen Bay to and from feeding or roosting areas. Should it occur with eider making daily movements from the Ythan Estuary to Aberdeen Bay to the south of the proposed development and the birds select to fly around the turbines up to 1 km away then they may incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.0 – 2.5% (Caldrow, Stillman & West 2007; Speakman, Gray & Furness 2009). This is a relatively small increase in daily energy expenditure and is unlikely to have an adverse effect on eiders in Aberdeen Bay.

The peak numbers of eider in Aberdeen Bay occur during July and August when the adult eider undergo a complete wing moult over a period of four weeks, during which time they become flightless. The daily energetic costs during this period increase but the birds remain within certain areas where they can forage and cannot undergo daily flight movements (Guillemette *et al.* 2007) Consequently, there is no incremental increase in daily energy expenditure due to the barrier effect during this period of higher energy expenditure.

Data obtained from two years of Vantage Point surveys did not detect any evidence to suggest that there are regular daily flights by eider across the proposed development area and so a regular barrier effect that may cause a long-term increase in daily energetic costs is not predicted. There is the potential for a relatively small *ad hoc* increase as birds move around the bay but as most movements are within 1 km of the coast regular barrier effects are unlikely.

Risk of a an adverse effect from barriers – Low

7.1.13 Evidence of in-combination impact

There is the potential for an in-combination effect with other shipping activities within Aberdeen Bay and the vessels associated with the proposed development. Currently there are up to 16,000 vessels per year using Aberdeen harbour and the incremental increase in vessel usage associated with the development, operation and decommissioning of the proposed EOWDC will be relatively small, particularly during the period of operation. Vessels associated with the proposed development will be no closer than 2 km from shore, the distance of the nearest turbine, and therefore unlikely to have an impact on the nearshore eider. There is no evidence of any potential in-combination effect from the proposed development and other offshore activities for common, particularly with respect to displacement/disturbance risk.

Risk of an adverse in-combination effect – Low

7.1.14 Conclusion

Taking into account data obtained from the proposed EOWDC and supported by published data from other sites it is concluded that the proposed development either alone or in-combination will not cause an adverse effect on the integrity of the relevant SPAs with regard to common eider.

Gannet

Gannets occur as a qualifying species for the Forth Islands SPA with a breeding population of 44,000 pairs (Mitchell *et al.,* 2004).

The Bass Rock is approximately 130 km from the proposed EOWDC location. Data from tagged gannets at Bass Rock have recorded breeding gannets foraging up to 540 km from the colony with a mean distance of 230 km and consequently could occur within the proposed EOWDC area.

Elsewhere the nearest SPA with gannet as a qualifying species is Fair Isle which is located 260 km to the north of the proposed development. The foraging ranges from gannets from their breeding colonies means that Fair Isle and all the other SPA colonies are within range of the proposed development.

Troup Head is the closest gannetry to the proposed development located approximately 73 km to the north. This gannetry has increased in size over the last twenty years and now contains 1,810 nests (NESBR 2009). Being considerably closer than other existing colonies the Troup Head colony is likely to be the main source of gannets in Aberdeen Bay during the breeding season but gannet is not a qualifying species for the SPA and therefore not considered as part of this assessment.

7.1.15 Evidence of site usage

Gannets were recorded throughout Aberdeen Bay from boat based surveys with no areas identified as being of particular importance but with the majority of sightings in water depths of between 20 m and 50 m. Numbers of gannets recorded were lowest between November and March and highest during the breeding season from April to August when gannets were widespread throughout the area.

Boat based survey data recorded a peak count of 47 birds in the original wind farm survey area and 67 in the control area. Vantage Point surveys recorded up to 43 birds per hour between April and September 2006. The majority of sightings were greater than 1.5 km from shore with peak numbers between 3.0 and 3.5 km from the coast.

There is no evidence to suggest that the gannets recorded in Aberdeen Bay are those from either the Bass Rock or Fair Isle SPAs. However, the area is within the known foraging range of the species and it is likely that at least some of the gannets recorded are associated with the Bass Rock and other SPAs elsewhere.

7.1.16 Evidence of collision risk

Data obtained from both boat and land based observations indicate that between 18 % and 73 % of gannets fly greater than 25 m above the sea surface. Data from other UK offshore wind farm indicate a lower percentage at rotor height with between 6 % and 14 % of gannets flying greater than 20 m above sea surface. There have been relatively few constructed wind farms where gannets have been regularly recorded. Data from Horns Rev Offshore Wind Farm suggest that gannets do not fly through wind farms and therefore avoid the area. Consequently, the risk of collision is low. Out of a total of 1,144 gannets recorded at Horns Rev, no collisions were observed. Gannets have been reported as occurring within North Hoyle Offshore Wind Farm and no collisions have been reported.

Collision risk modelling undertaken for the proposed development based on a range of potential avoidance rates from 98%, 99% and 99.5% indicate that between 0.41 and 1.6 gannets per year may collide with the proposed development.

Based on the various scenarios and using a precautionary avoidance rate of 98% it is predicted that a total of 1.6 collisions per year may occur. The current SPA population in the region is 51,647 pairs.

The annual mortality rate for gannet is 8.1 % (BTO 2011). Consequently, out of a population of 51,647 pairs (103,294 adults) an annual mortality of 8,367 gannets may be predicted. Therefore, 1% of the baseline mortality is 84 birds per year, i.e. an increase in mortality rate of more than 84 birds per year caused by collisions may be considered significant.

For the two individual SPAs the increase in mortality that could cause an adverse effect is lower:

- Fair Isle SPA has a current population of 3,582 AoN (5,164 adults); therefore an annual mortality rate of 418 adults. 1% of baseline mortality is therefore 4 individuals.
- Forth Islands SPA has a current population of 51,647 AoN (103,294); therefore an annual mortality rate of 8,367 adults. 1% of baseline mortality is therefore 84 individuals.

The results from the collision risk modelling indicate that between 1 and 2 gannets per year may collide with the proposed development. This is lower than either of the baseline mortality rates used to indicate whether the potential impact is will have an adverse effect.

There is no evidence that gannets from Fair Isle occur within the region during the breeding season. Foraging activity will likely remain within the waters around Shetland and therefore it is not predicted that there will be any impact on gannets associated with the Fair Isle SPA during the breeding season.

Tagging data of birds from the Bass Rock colony indicates that they forage widely and are potentially at collision risk with the proposed development (Hamer *et al.* 2000). Based on the collision risk modelling undertaken, should all the potential collisions be of birds arising from the Bass Rock colony in the Forth SPA, 124 km away, then there will be a very small increase in the baseline mortality rate and below the level that may be of concern.

Evidence from existing offshore wind farms indicates that gannets avoid flying through wind farms and may have a significant far field avoidance rate; this behaviour will further reduce the risk of potential collision.

Consequently, based on the evidence available it is unlikely that there will be an adverse effect on gannets from either of the SPAs due to collision mortality.

Risk of an adverse effect from collision - Low

7.1.17 Evidence of displacement

Evidence from Horns Rev Offshore Wind Farm indicates that gannets will avoid entering the wind farm. Data from boat based surveys and Vantage Point surveys indicate that there are no areas of Aberdeen Bay that are preferentially used by gannets and consequently any gannets displaced from the footprint of the wind farm will be able to forage elsewhere and there is no evidence to suggest that the displacement will cause an adverse effect on gannets using the area. Should avoidance occur, there will be a corresponding reduction in potential risk of collision.

There is the potential for displacement of prey species from the area during construction, should pile driving be undertaken. During this period it may be that gannets may be displaced from a wider area until such time their prey returns. Pile driving, should it occur, will be undertaken over a relatively short period of time and consequently the duration of potential displacement impact will also likely be relatively short and the area potentially impacted relatively small compared to the wider foraging ranges of Sandwich terns. Adult gannets are known to exhibit a great degree of flexibility in selection of prey, foraging locations and distances travelled. Consequently, they are adaptable to forage outwith the area during the period of potential impact (Hamer *et al.* 2007).

Risk of adverse effect from displacement – Low

7.1.18 Evidence of barrier effects

It is possible that the displacement of gannets from the proposed EOWDC area may cause a barrier effect. Evidence from Horns Rev Offshore Wind Farm indicates that gannets will fly around the wind farm area thus cause a potential increase in energetic costs. The predicted increase in distance travelled due to the presence of the wind farm is less than 500 m and consequently any additional increase in energetic expenditure will be negligible compared to the distance travelled to and from the breeding colonies.

Risk of an adverse effect from barrier – Low

7.1.19 Evidence of in-combination impact

The theoretical very large foraging range that gannets can fly suggest that any individual gannet may interact with a number of the proposed offshore wind farms in Scottish waters. Published data elsewhere indicates that gannets from colonies in Shetland or eastern England are unlikely to occur in Aberdeen Bay during the breeding season (Langston 2011), although they may occur during periods of passage.

Consequently, there is low potential for in-combination effects with respect to gannets from Fair Isle SPA or Bempton Cliffs SPA. However, there is evidence to suggest that the gannets from the Forth Island SPA may occur within the Aberdeen Bay area. Populations from this SPA may also interact with potential offshore wind farm developments currently proposed the Firth of Forth area, namely: Neart na Gaoithe, Inch Cape and Firth of Forth offshore wind farms. There is currently very limited information on the proposed developments as decisions on the location, scale and numbers of turbines are still to be decided. Based on the scoping reports it is currently predicted that there may be an additional 526 turbines within the Firth of Forth area (Table 7-5). Information on the use of these areas by gannets is limited with no published information currently available from on-going studies being undertaken for the proposed wind farms. It is therefore not possible to undertake an in-combination collision risk assessment based on collision risk modelling or an assessment on possible in-combination impacts arising from displacement or barrier effects.

Table 7-5: Predicted wind farms that may have an in-combination impact on gannets in the Firth of Forth

Project	Estimated no. of turbines	Area (km^2)	Predicted Application date
Inch Cape	181	151	2012
Neart Na Gaoithe	130	105	2012
Firth of Forth (phase I)	215	597	2013

There is a significant difference in scale between the proposed development and those planned elsewhere and it is a significantly greater distance from the Forth Islands SPA. Any potential incremental increase in mortality of between one and two birds per year arising from the proposed development will likely be very minor.

Collision Risk Modelling undertaken for Beatrice Offshore Wind Farm predicted a total of five gannets per year may collide with the Beatrice demonstrator project development based on a 98% avoidance rate (Talisman 2005). The additional mortality from the proposed development may increase this by one or two birds per year. There are two planned offshore wind farms within the Moray Firth that could potentially have an in-combination impact on the gannets at Troup head (Table 7-6). There is little information on the number or scale of turbines and there is no published information currently available from on-going studies being undertaken for the proposed wind farms. It is therefore not possible to undertake an in-combination collision risk assessment based on collision risk modelling or an assessment on possible in-combination effects from displacement or barrier impacts. The scale of the proposed development is significantly smaller than those proposed in the Moray Firth and consequently based on the current information on gannet distribution the scale of potential impact proportionally smaller.

Table 7-6: Predicted wind farms that may have an in-combination impact on gannets in the Moray Firth

Project	Estimated no. of turbines	Area (km^2)	Predicted Application date
Moray Firth (phase 1)	200	296	2012
Beatrice	184	131	2012

Risk of an adverse in-combination effect – Low

7.1.20 Conclusion

Taking into account data obtained from the proposed EOWDC and supported by published data from other sites it is concluded that the proposed development either alone or in-combination will not cause an adverse effect on the integrity of the relevant SPAs with regard to gannet.

Herring gull

Herring gull are a qualifying species for the Buchan Ness to Collieston Coast SPA, Fowlsheugh SPA and Forth Islands SPA (Mitchell *et al.* 2004). The UK breeding population has undergone a significant decline in recent years although the exact reasons for this decline are unknown.

During the breeding season herring gulls remain largely coastal with maximum foraging ranges from the breeding colony of 54 km.

7.1.21 Evidence of site usage

The known foraging range of breeding herring gulls indicates that herring gulls from the Forth Islands SPA will not occur in Aberdeen Bay during the breeding season. Birds from Buchan Ness to Collieston SPA and Fowlsheugh SPA may use the area.

Data from boat based surveys indicate significant seasonal variability in the usage of the site. Greatest numbers occurred in the wind farm study area during June and July with a peak count of 456 birds in July 2007. Most sightings were in the south-west of the study area with relatively few within the proposed development area. Further data from vantage point counts recorded a mean peak count of 54 birds per hour passing the observation points and no significant difference in the number of birds was detected across all four vantage point sites suggesting a relatively uniform usage of the coastline across Aberdeen Bay. Herring gulls were the most frequently recorded species from vantage point surveys from between October 2006 and March 2007.

7.1.22 Evidence of potential collision risk

Herring gulls are one of the most frequently recorded species in Aberdeen Bay. The species regularly flies at the height of the turbines and shows no avoidance of wind farms, nor any displacement.

Evidence from site specific monitoring using boat based and land-based surveys and other data sources indicate that herring gulls are widespread and frequent within Aberdeen Bay and with a distinct seasonal peak during the summer months.

Results from collision risk modelling assessed the potential impact across a range of avoidance rates of between 98 and 99.5%. The results indicate that between 1.8 and 7.2 herring gulls may collide with the proposed EOWDC each year.

Based on the regional SPA population of herring gulls of 19,562 individuals, the annual mortality rate will be 2,347 individuals and therefore the 1% baseline mortality rate will be 235 birds per year. The results from the Collision Risk Modelling predict a total of up to seven herring gulls per year may collide with the turbines.

The Buchan Ness to Collieston Coast SPA lies approximately 9.5 km away from the proposed development and holds approximately 6,158 breeding herring gulls (Based on counts undertaken in 2007). The colony will therefore have an annual mortality of 739 birds. It is likely that many of herring gulls recorded within Aberdeen Bay during the breeding period are associated with this colony. The results from the collision risk modelling predict an annual mortality of 7 herring gulls per year indicating that there will not likely be an adverse effect on the population of herring gulls associated with the SPA based on the precautionary assumption that an increase of 1% above baseline mortality could be adverse, i.e. more than 8 herring gulls a year collide with the turbines. However, the predicted mortality of 7 birds per year is close but it is based on a series of precautionary figures that assume the peak numbers recorded within the development area are constant throughout the year. It is therefore predicted that the number estimated to collide each year is precautionary as are the avoidance rates, which have been reported as being greater than 99% (Everaert & Kuijken 2007).

The Fowlsheugh SPA lies 31 km away from the proposed development and holds 122 breeding pairs of herring gull based on latest counts. Therefore, the annual mortality rate from this colony is 14 birds per year. Based on the results from the collision risk modelling it is concluded that if all the herring gulls at risk of collision are from Fowlsheugh then there is the potential for an adverse effect on the SPA population

The Forth Islands SPA is approximately 124 km away and holds 13,200 herring gulls. However, the SPA is too far away for breeding herring gulls from the SPA to occur regularly, if at all, within the proposed development area during the breeding season. Therefore, there will not be an adverse effect on the population of the Forth Islands SPA due to collision.

The collision risk modelling is based on the peak number of herring gulls recorded from any of the surveys. Whereas the number of birds present in the actual wind farm development area was lower. Consequently, the numbers used for the collision risk modelling are precautionary.

Risk of an adverse effect from collision – Low

7.1.23 Evidence of displacement

Evidence from existing offshore wind farms indicate that herring gulls may enter the wind farm. No evidence of any displacement has been recorded.

Risk of an adverse effect from displacement – Low

7.1.24 Evidence of barrier effects

There is no evidence of any barrier effect to herring gulls from offshore wind farms.

Risk of an adverse effect from barrier effects – Low

7.1.25 In-combination effects

There is a potential for an in-combination effect with herring gulls originating from the Fowlsheugh SPA with proposed plans for offshore wind farms in the Firth of Forth. There is limited information on the proposed projects and no information on the number of herring gulls present in the area. However, given the location of the proposed developments and the close proximity to coastlines that herring gulls frequent during the breeding season it is predicted that there will be relatively few herring gulls within the proposed Firth of Forth wind farm areas. Consequently, the risk of an adverse in-combination impact is predicted to be low.

7.1.26 Conclusion

Taking into account data obtained from the proposed EOWDC and supported by published data from other sites it is concluded that the proposed development either alone or in-combination will not cause an adverse effect on the integrity of the relevant SPAs with regard to herring gull.

Kittiwake

Kittiwake is a qualifying species for Buchan Ness to Collieston Coast SPA, Fowlsheugh SPA Forth Islands SPA and Troup Pennan and Lion's Heads SPA as part of the waterbird assemblages under Article 4.2 of the Directive. Populations of kittiwakes at these colonies have decreased over recent years. The colony at Fowlsheugh was the largest and held 35,000 breeding pairs in 1992 but has decreased to below 12,000 pairs in 2006. The largest colony is now at Troup Pennan and Lion's Heads SPA where 14,896 pairs nest, followed by Buchan Ness to Collieston SPA that has 12,542 apparently occupied nests, i.e. 25,000 individuals.

The foraging ranges of kittiwakes from breeding colonies have been studied at the Isle of May and have indicated a maximum foraging range of 83 km. Consequently, birds from the Forth Islands will be unlikely to be foraging within the proposed development area during the breeding season. Kittiwakes from Collieston, Fowlsheugh and Troup, Pennan & Lions Heads SPA may occur within the proposed development area.

7.1.27 Evidence of site usage

Kittiwakes were recorded throughout Aberdeen Bay in highly seasonally variable numbers. During the winter periods very few kittiwakes were recorded. However during the breeding season kittiwakes were frequently recorded with estimated populations within the control area during this period of 1,676 birds and 663 birds in the proposed EOWDC development area. Peak densities of 33 birds/km^2 were recorded to the north of the proposed development during the summer months. Land-based observations also recorded peak numbers during the summer months with a peak in July. Of those for which flight height was recorded, 22% were greater than 25 m above the sea surface. The majority of sightings were between 1 – 3 km of the coast.

7.1.28 Evidence of collision risk

Collision risk modelling undertaken for the proposed EOWDC over a range of avoidance rates between 98 and 99.5% indicated that between 0.9 and 3.6 kittiwakes per year may collide.

Based on the regional SPA population of kittiwakes of 83,156 individuals, the annual mortality rate will be 4,989 individuals and therefore the 1% baseline mortality rate is 50 birds per year. The results from the collision risk modelling predict a total of four kittiwakes per year may collide with the wind turbines and therefore the proposed development will not have an adverse effect on the regional SPA population of kittwakes

The Buchan Ness to Collieston Coast SPA lies approximately 9.5 km away from the proposed development and holds approximately 25,000 breeding kittiwakes, based on the latest available counts in 2007. The colony will therefore have an annual mortality of 1,505 birds. It is likely that many of kittiwakes recorded within Aberdeen Bay during the breeding period are associated with this colony. The results from the collision risk modelling, which predict a mortality of four kittiwakes per year, indicates that there will not be an adverse effect on the population of kittiwakes associated with the SPA. This is based on the precautionary assumption that an increase of 1% above baseline mortality could be adverse, i.e. more than 15 kittiwakes a year collide with the turbines.

The Fowlsheugh SPA lies 31 km away from the proposed development and holds 11,140 breeding pairs of kittiwake based on latest counts. Therefore, the annual mortality rate from this colony is 1,337 birds per year. Based on the results from the collision risk modelling it is concluded that if all the kittiwakes at risk of collision are from Fowlsheugh then there is unlikely to be an adverse effect on the SPA population.

The Troup Pennan & Lion's Head SPA lies 74.3 km to the north of the proposed development and holds 29,792 breeding kittiwakes. The annual mortality is estimated to be 1,787 birds per year and consequently, based on a 1% of annual mortality threshold, an adverse effect on kittiwakes from this colony is not predicted.

The Forth Islands SPA is approximately 124 km to the south and holds 4,632 breeding kittiwakes. However, the maximum foraging range for kittiwakes reported is 83 km (Roos 2010) and therefore the SPA is outwith the maximum foraging range for breeding kittiwakes and therefore there will not be an adverse effect on the population due to collision.

Based on the results of the Collision Risk Modelling and the current regional and SPA populations, it is predicted that that the potential population affect caused by collision impacts with the proposed development on kittiwakes is negligible.

Risk of an adverse effect from collision – Low

7.1.29 Evidence of barrier effects

There is no evidence of any barrier effect to kittiwake from offshore wind farms.

Risk of an adverse effect from barrier impacts – Low

7.1.30 Evidence of displacement

There is no evidence of any displacement effect of kittiwakes from other constructed offshore wind farms.

Risk of an adverse effect from displacement – Low

7.1.31 In-combination effects

There is a potential for an in-combination effect with kittiwakes originating from the Fowlsheugh SPA with proposed plans for offshore wind farms in the Firth of Forth and those from Troup, Pennan and Lions Heads with proposed plans in the Moray Firth. There is limited information on the proposed projects and no information on the number of kittiwakes present in the area. However, as the potential incremental increase in mortality from the proposed development is less than four birds per year it is predicted that this will not have add significantly to the potential in-combination effect on the population. Consequently, the risk of an adverse in-combination impact arising from this development is predicted to be low.

Risk of an adverse effect from in-combination effects – Low

7.1.32 Conclusion

Taking into account data obtained from the proposed EOWDC and supported by published data from other sites it is concluded that the proposed development either alone or in-combination will not cause an adverse effect on the integrity of the relevant SPAs with regard to kittiwake.

Little tern

Little tern is a qualifying species for the Ythan Estuary, Sands of Forvie and Meikle Loch SPA and held 36 breeding pairs in 2009 and Firth of Tay and Eden Estuary SPA.

Little terns no longer nest at the Firth of Tay and Eden Estuary SPA and therefore the site is not considered further in the assessment

They arrive from their West African wintering grounds from April onwards and depart in August and September. They feed on small fish, foraging in close in-shore waters.

The numbers nesting at Sands of Forvie varies considerably across years with many years having only a few pairs and others occasionally over 70 pairs nesting. The number of young fledged also varies considerably with most years producing only a few young due to predation and weather. During years where nests fail early on birds may leave the region by the end of June and early July but in years where nesting has been successful birds may remain in the area through to August or early September.

7.1.33 Evidence of site usage

Very few little terns were recorded from either the boat based or land-based surveys and none were recorded within the footprint of the proposed development area.

All sightings were within 2 km of the coast. Flight heights for those recorded were all below 30 m and typically little terns forage between 3 and 8 m above the sea surface.

7.1.34 Evidence of collision risk

No little terns were recorded within the proposed development area and flight heights of little terns are typically well below the turbine height (ECON 2006). Therefore, as little terns have not been recorded in the area and they fly predominantly below rotor height there is very little risk of collision

Risk of an adverse effect – Low

7.1.35 Evidence of displacement

Evidence from studies undertaken in Belgium and the UK has not shown any evidence of a displacement effect with some evidence of an increase in usage of a site following construction (ECON 2008). Consequently, it is predicted that there will be no displacement effects on little terns due to potential development.

Risk of an adverse effect – Low

7.1.36 Evidence Disturbance

Little terns forage on small fish often, young clupeids. Monitoring undertaken at Scroby Sands recorded a reduction in the availability of young herring following the construction of a wind farm by pile-driving and a subsequent breeding failure of little terns (ECON 2008). The little terns were able to compensate for the reduction in available prey by foraging further afield and changing prey items and there has not been any evidence of an overall population decline in the number of little terns in the area but the locations where the terns foraged and the sizes of colonies have varied.

The significance of any potential effect depends on the scale of displacement and its duration. It also depends on whether other suitable foraging areas can be located. Although these are difficult to predict any potential impacts upon prey are expected to be relatively short-term as they should affect only one or two breeding seasons depending on whether significant pile-driving takes place and whether construction is undertaken over one or two years. Following cessation of construction, it is predicted that new juvenile fish will be available the following season.

The numbers of little terns at the Sands of Forvie each year is highly variable as is their breeding success, with many years where they fail to produce many, if any, young consequently the integrity of the colony is unlikely to be effected by any reduction in breeding over a couple of years should it occur. Based on the available evidence, particularly the highly variable inter-annual breeding success and breeding population it is predicted that should pile-driving occur that there will not be any adverse effect on the integrity of the site with respect to breeding little terns.

Risk of adverse disturbance effect - Low

7.1.37 Evidence of barrier effects

As little terns forage predominantly within 2 km of the coast there will not be a barrier effect.

Risk of an adverse barrier effect – Low

7.1.38 In-combination effects

There are no other offshore developments that have the potential for an in-combination effect on little terns originating from the Ythan Estuary, Sands of Forvie and Miekle Loch SPA.

Risk of an adverse effect from in-combination effects – Low

7.1.39 Conclusion

Taking into account data obtained from the proposed EOWDC and supported by published data from other sites it is concluded that the proposed development either alone or in-combination will not cause an adverse effect on the integrity of the relevant SPAs with regard to little tern.

Sandwich tern

Sandwich tern is a qualifying species for the Ythan Estuary, Sands of Forvie and Meikle Loch SPA, Loch of Strathbeg SPA and Forth Islands SPA and Firth of Forth SPA.

The Ythan Estaury, Sands of Forvie and Meikle Loch SPA holds Scotland's largest breeding colony of Sandwich tern with a peak of 1,802 pairs in 1987 and an average of 517 pairs over the last 20 years. Recent counts of breeding birds at Sands of Forvie have been of 900 pairs in 2007, 670 in 2008 and 645 in 2009, indicating an ongoing and steady decline in the use of this site.

Sandwich terns have not bred at the Loch of Strathbeg SPA in recent years until 2010 when 1 pair nested.

The Firth of Forth SPA has a passage of Sandwich terns with up to 1,617 birds. It is not known which colonies these Sandwich terns originate from but are likely to be from a number of different colonies.

Birds return to their breeding grounds during April and remain in the area until the autumn. The number of terns breeding is highly variable and their success depends on the availability of suitable prey, predation and weather. Sandwich terns forage offshore for small fish species, particularly sandeels and clupeids. The distance that they forage varies depending on prey availability with distances of up to 67 km reported.

7.1.40 Evidence of site usage

The known foraging ranges of breeding Sandwich terns indicates that terns present within the wind farm study area may be associated with the Ythan Estuary, Sands of Forvie and Meikle Loch SPA.

Data from boat based surveys indicate very low usage of the wind farm study area with only five Sandwich terns recorded during May 2007. Elsewhere in Aberdeen Bay higher numbers were recorded particularly to the north, nearer to the Sands of Forvie breeding colony. Vantage point counts recorded relatively high numbers of Sandwich terns between April and September 2006 with an average of 25 birds per hour across all four vantage point sites. Evidence from boat based and vantage point surveys suggests that although there is extensive near shore usage of Aberdeen Bay there is relatively low usage of the proposed EOWDC location by Sandwich terns.

7.1.41 Evidence of collision risk

Collision risk modelling undertaken for Sandwich tern over a range of avoidance rates indicate a potential collision risk of between 0.1 and 0.4 birds per year.

Based on the regional SPA population of Sandwich tern of 645 breeding pairs the annual mortality rate will be 142 individuals and therefore the 1% baseline mortality rate is 1.4 birds per year. The results from the Collision Risk Modelling indicate less than 1 Sandwich tern will collide per year with the wind turbines.

Evidence from site specific monitoring using boat based and land-based surveys and other data sources indicate that relatively few Sandwich terns occur in area of the proposed development with nearly all sightings within 2 km of the coast and the majority within 1 km.

Data from existing offshore wind farms have reported relatively high number of collisions of sandwich tern with wind turbines (e.g. Everaert & Stienen 2006). However, they have also demonstrated high avoidance rates of greater than 99%. The number of collisions recorded has been largely due to the high number of transits made by the Sandwich terns at the sites. Site specific data indicates a low usage of the proposed development area and low numbers of transits across the site consequently a low risk of collision.

Based on the small numbers of sandwich terns recorded within the proposed development area and the relatively high avoidance rates reported for Sandwich terns, it is predicted that the risk of collision is low.

Risk of an adverse effect from collision – Low

7.1.42 Evidence of displacement

There is no evidence from offshore wind farms of any displacement effects on Sandwich terns.

Risk of an adverse effect from displacement - Low

7.1.43 Disturbance

Sandwich terns are not predicted to be impacted directly by disturbance from construction or operating vessels.

Sandwich terns feed predominantly on sandeels and clupeids (young herring) and should these prey species be impacted by construction activities in the vicinity of the proposed development then Sandwich terns may have to either forage more widely or find alternative prey. It is not possible to determine whether either possible impacts are potentially likely but Sandwich terns do forage widely in the coastal waters of Aberdeen Bay and appear not to occur in the EOWDC area so those that are effected may be able to relocate should there be a localised effect.

There is no evidence of an indirect impact on breeding Sandwich terns from other constructed offshore wind farms but there is the potential for a temporary effect on Sandwich terns should the construction of the proposed development cause a significant decline in the prey of Sandwich during the breeding season. If this effect occurs it is predicted that it would last no longer than the period of construction before fish numbers returns back to the population levels prior to construction.

Sandwich terns breeding success is highly variable across years with the population withstanding years with very low breeding success without having a significant effect on the colony size. Consequently should Sandwich terns be unsuccessful in breeding due to the potential displacement of prey then it is predicted that the effects will last no longer than the construction seasons and not have an adverse effect on the integrity of the site.

Risk of an adverse effect from disturbance impacts – Low

7.1.44 Evidence of barrier effects

There is no evidence of any barrier effect to Sandwich terns from offshore wind farms,

Risk of an adverse effect from barrier impacts – Low

7.1.45 In-combination effects

There are no other offshore developments that have the potential for an in-combination effect on Sandwich terns originating from the Ythan Estuary, Sands of Forvie and Miekle Loch SPA. Consequently, the risk of an adverse in-combination impact arising from the proposed EOWDC is predicted to be low.

Risk of an adverse effect from in-combination effects – Low

7.1.46 Conclusion

Taking into account data obtained from the proposed EOWDC and supported by published data from other sites it is concluded that the proposed development either alone or in-combination will not cause an adverse effect on the integrity of the relevant SPAs with regard to Sandwich tern.

Common tern

Common tern is a qualifying species for the Ythan Estuary, Sands of Forvie and Meikle Loch SPA. At the time of designation the SPA held 2.2 % of the UK breeding population with 265 pairs. Since then the population has decreased with no more than 6 pairs since 2006. They are also a qualifying species for the Forth Islands SPA where up to 378 pairs nest

Birds return to their breeding grounds during April and remain in the area until the autumn. The number of terns breeding is highly variable and their success depends on the availability of suitable prey, predation and weather. Common terns forage offshore for small fish species, particularly sandeels and clupeids. The distance that they forage varies depending on prey availability with distances of up to 34 km reported.

7.1.47 Evidence of site usage

The known foraging range of breeding common tern indicates that terns present within the wind farm study area may be associated with the Ythan Estuary, Sands of Forvie and Meikle Loch SPA but not the Forth Islands SPA.

Data from boat based surveys indicate regular usage of the wind farm study area during the breeding season with up to 55 birds recorded during a boat based survey undertaken in July 2007. Vantage point counts recorded an average of 16.7 birds per hour across all four vantage point sites.

7.1.48 Evidence of collision risk

Boat based surveys recorded 14% of flights at rotor height

Collision risk modelling based on a range of avoidance rates of 98% 99% and 99.5% predicted between 0.8 and 3.5 common terns per year may be at risk of collision.

Based on the regional SPA population of 768 breeding adults, the annual mortality rate will be 77 individuals and therefore the 1% baseline mortality rate is less than one bird per year. The results from the Collision Risk Modelling predict a total of 3.5 common terns per year may collide with the wind turbines.

Six pairs of common tern nest on the Sands of Forvie and consequently any increase in adult mortality could have an adverse effect. The Sands of Forvie lies approximately 7.2 km away from the proposed development and therefore may be within the potential foraging range of breeding common terns, which although have been estimated to forage less than 25 km away from their nests are more likely to be within 4 – 6 km (Roos 2010).

A total of 378 pairs of common tern nest at the Firth of Forth, which lies approximately 124 km away and therefore outwith the maximum foraging range recorded for common terns.

The data used in the collision risk model is based on the peak counts recorded from anywhere within Aberdeen Bay from boat based surveys which were significantly greater than those within the wind farm area itself. Consequently, the number of birds predicted to be at risk of collision is precautionary. As is the avoidance rate used of 98%.

Data obtained from Zeebrugge, where common terns frequently pass across an array of turbines, have reported relatively high collision mortalities although very low collision probabilities of 0.1% for birds flying at rotor height and 0.007% for birds at all altitudes (Everaert & Stienen 2006). Consequently, the use of a 99% avoidance rate may be more appropriate. Based on this, the number of potential collisions by common terns may be between one to two birds per year. Should one or more of the six breeding pairs from the Ythan Estuary, Forvie Sands and Meikle Loch SPA collide with the proposed EOWDC then the effect on the SPA population will be adverse. However, the relatively low usage of the site and the high avoidance rates makes this event unlikely and therefore the proposed development is not likely to have an adverse effect on the integrity of the site.

Risk of an adverse collision effect – Low

7.1.49 Evidence of displacement

Evidence from studies undertaken in Denmark where common terns were seen to enter operating wind farms indicates that there may be little or no displacement. Should displacement occur, site specific data indicates that common terns may forage elsewhere, particularly to the north where then numbers of common terns present were higher.

Risk of an adverse displacement effect – Low

7.1.50 Disturbance

Should the construction of the proposed development cause a reduction in the availability of prey to breeding terns then this may cause an adverse effect.

The location of nearest tern colonies and that more common terns were recorded to the north of the development area indicate that should there be a reduction of suitable prey in the vicinity of the proposed development than there are other areas where common terns may forage, e.g. in the Ythan Estuary. Any potential impact will likely last for no more than the one or two seasons as juvenile fish will be available as prey the following year.

The significance of any potential effect depends on the type of installation technique used the subsequent scale of disturbance and its duration. It also depends on whether other suitable foraging areas are available. Post construction monitoring undertaken at Kentish Flats did not record any reduction in the number of terns using the area and noted an increase in overall numbers (Gill *et al*. 2008).

Based on the results from site specific surveys indicating common terns can forage widely and evidence from studies undertaken at other constructed wind farms indicating that foraging with recently constructed wind farms can occur, it is predicted that there is unlikely to be an adverse effect from construction activities.

Risk of an adverse effect from disturbance - Low

7.1.51 Evidence of barrier effects

There is no evidence of any barrier effect to common terns from offshore wind farms.

Risk of an adverse barrier effect – Low

7.1.52 In-combination effects

There are no other offshore developments that have the potential for an in-combination effect on common terns originating from the Ythan Estuary, Sands of Forvie and Miekle Loch SPA. Consequently, the risk of an adverse in-combination impact arising from the proposed EOWDC is predicted to be low.

Risk of an adverse effect from in-combination impacts – Low

7.1.53 Conclusion

Taking into account data obtained from the proposed EOWDC and supported by published data from other sites it is concluded that the proposed development either alone or in-combination will not cause an adverse effect on the integrity of the relevant SPAs with regard to common tern.

Guillemot

There are three guillemot colonies as part of SPA assemblages along the coast of North-east Scotland. Colonies of nearly 20,000 birds to the north of the wind farm area in the Buchan Ness to Collieston Coast SPA and 16,000 at Troup, Pennan and Lion's Heads SPA and a further 51,000 guillemots to the south of the proposed development at the Fowlsheugh SPA. Further south the Forth Islands SPA holds 16,000 birds.

7.1.54 Evidence of site usage

Guillemots were recorded widely across Aberdeen Bay from all surveys. Data from boat based surveys indicate that peak counts in the bay occur during the post-breeding period, particularly in July with more birds recorded within the control site than within the proposed EOWDC development area. Relatively high numbers remain within the area until November after which numbers of guillemots in the area decrease. Land based observations recorded peak numbers during April. Data from boat based surveys recorded guillemots widely across the surveyed areas and land-based observations recorded most guillemots from between 1.5 km and 4.5 km from the coast.

7.1.55 Evidence of collision risk

Collision risk modelling has been undertaken using a range of potential avoidance rates of 98%, 99% and 99.5%. The results from the modelling based on the highest densities recorded from any of the boat based surveys indicates that between 0.01 and 0.04 birds per year may collide with the proposed development.

Out of a peak regional population of 5,447 individuals an annual mortality of 294 guillemot, may be predicted. Therefore, 1% of the baseline mortality is 3 birds per year.

Based on the results from collision risk modelling, which predicts a total of 0.04 collision per year at a 98% avoidance rate, there will not be an adverse effect on the guillemot due to collisions.

The assessment against the relevant SPA populations indicates a very low risk of an adverse effect arising from collisions.

Based on the results from the collision risk modelling it is concluded that the potential effect from collision risk is negligible.

Risk of an adverse collision effect – Low

7.1.56 Barrier effect

Studies undertaken in Sweden and Denmark indicate that there is some potential for a barrier effect to occur with a reduced number of birds crossing the constructed wind farms.

During the breeding season it is predicted that there may be regular flights to and from colonies some of which will intersect the proposed development area. Should a barrier effect occur with guillemots from either Fowlsheugh or Buchan Ness to Collieston Coast SPAs making daily movements from one location to another around the proposed development area then they may incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.0 – 2.5% (Speakman, Gray & Furness 2009). Multiple flights will increase this expenditure.

The location and size of the proposed development is such that it will only occupy a relatively small zone through which birds may avoid flying. Regular daily movements by individual birds that could cause an incremental increase in distance of foraging flights on a daily basis is not predicted to occur, i.e. birds from colonies will forage over a wider area and will not need to detour around the proposed development on a regular daily basis.

Based on the above it is concluded that the potential incremental increases in foraging distances are unlikely to cause an adverse effect on guillemots.

Risk of an adverse barrier effect – Low

7.1.57 Evidence of displacement effect

The maximum number of guillemot potentially displaced has been calculated to be up to 1,355 birds based on the highest densities recorded from any survey within Aberdeen Bay and displacement out to 2 km. Based on the regional SPA population estimate of 88,737 guillemots then approximately 1.5% of the regional SPA population may be displaced.

Should there be a displacement effect there is no evidence to suggest that the loss of the area of the proposed development will be significant and that individuals displaced will not be able to find suitable foraging areas elsewhere. Therefore, there is no evidence to suggest that any displacement will have a negative impact on guillemots.

Post-construction monitoring undertaken at Horns Rev offshore wind farm has indicated that displacement of guillemots can occur. However, results from other operating wind farms have not shown a total displacement of guillemots. Guillemots have been recorded at the constructed Kentish Flats Offshore Wind Farm but in reduced numbers (Gill *et al.* 2008).

Based on the evidence from existing offshore wind farms it is predicted that the potential impact from displacement may be moderate but unlikely to have an adverse effect on the integrity of the relevant SPAs as displaced birds will not all die and will be able to relocate to other suitable sites.

Risk of an adverse displacement effect – Low

7.1.58 In-combination effects

Birds from the relevant SPAs may also occur in either proposed developments in the Moray Firth or the Firth of Forth.

The only data available is that from the Beatrice Demonstrator Project which recorded 19 guillemots over a period of 12 months pre-construction surveys indicating a relative low usage of the site by guillemots (Talisman 2005). The size, scale and exact locations of the Round 3 and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of guillemots that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be an in-combination impact arising from the proposed plans. However, although the developments are within the potential foraging ranges of guillemots from a number of SPAs the, relatively far, distance the proposed development is from the other planned offshore wind farms and its relatively small scale reduces the risk of a potentially significant in-combination effects. Furthermore, the effects from displacement are such that it is predicted that displaced guillemots will not die and therefore, although there may be a proportion of birds displaced it is predicted that the potential impacts will not be adverse.

Risk of an adverse effect from in-combination impacts – Low

7.1.59 Conclusion

Taking into account data obtained from the proposed EOWDC and supported by published data from other sites it is concluded that the proposed development either alone or in-combination will not cause an adverse effect on the integrity of the relevant SPAs with regard to guillemot.

Razorbill

There are four razorbill colonies as part of SPA assemblages that have the potential to be impacted by the proposed development. Buchan Ness to Collieston Coast SPA has 4,179 individuals, Fowlsheugh has 4,632 individuals, Forth Islands has 3,464 individuals and Troup, penan and Lion's Head has 3,216 razorbills.

7.1.60 Evidence of site usage

Razorbills were widely recorded across Aberdeen Bay from all surveys. Low numbers were present at the beginning of the year but increased from April onwards. Data from boat based surveys indicate peak counts in the bay between July and September but also a high count in October. Birds were recorded in relatively equal numbers across both the control site and the proposed EOWDC survey area. Land based observations recorded peak numbers during April and September.

Data from boat based surveys recorded razorbills widely across the surveyed areas and land based observations recorded most birds from between 2.0 km and 4.0 km from the coast.

All those recorded in flight were seen to be flying below 25 m.

7.1.61 Evidence of collision risk

No razorbills have been reported as flying at rotor height within Aberdeen Bay or from other wind farms and no reports of collisions by razorbills have been found. Consequently, it is concluded that the risk of a collision with a turbine is very small and that collision mortality will not cause an adverse effect to razorbills.

Risk of an adverse collision effect – Low

7.1.62 Barrier effect

During the breeding season it is predicted that there may be regular flights to and from colonies some of which will intersect the proposed development area. The distance razorbills forage varies depending upon the availability of suitable prey and at what stage during the breeding season they are. Should a barrier effect occur with razorbills from either Fowlsheugh or Buchan Ness to Collieston Coast SPAs making daily movements from one location to another around the proposed development area then they may incur an additional flight distance of up 3.2 km each way, or a total of 6.4 km. This may increase the daily energy expenditure to between 2.0 – 2.5% (Speakman, Gray & Furness 2009). More regular flights will increase energetic costs

The location and size of the proposed development is such that it will only occupy a relatively small zone through which birds may avoid flying. No significant concentrations of razorbills were recorded in the vicinity of the proposed development and therefore it is not considered to be a particularly favourable area for foraging. Regular daily movements by individual birds that could cause an incremental increase in distance of foraging flights on a daily basis is not predicted to occur, i.e. birds from colonies will forage over a wider area and will not need to detour around the proposed development on a regular daily basis.

Risk of an adverse barrier effect – Low

7.1.63 Evidence of displacement effect

Therefore, the maximum number of razorbill potentially displaced is up to 241 birds based on the highest densities recorded from any survey within Aberdeen Bay and displacement out to 2 km.

Based on the regional SPA population of 12,175 razorbills then approximately 1.9% of the regional population may be displaced.

Should there be a displacement effect there is no evidence to suggest that the loss of the area of the proposed development will be significant and that individuals displaced will not be able to find suitable foraging areas elsewhere.

Densities of razorbills within the area were not higher than elsewhere and consequently it is not thought that the proposed location is of particular importance, particularly as densities of razorbills tended to be higher to the north. There is no evidence to suggest that any displaced razorbills will not be able to relocate and no reason to suggest that those displaced will die. Consequently, it is predicted that there will not be an adverse effect on razorbills from displacement.

Risk of an adverse displacement effect – Low

7.1.64 In-combination effects

Birds from the relevant SPAs may also occur in either proposed developments in the Moray Firth or the Firth of Forth. There are no other additional activities within Aberdeen Bay that may cause in-combination impacts on razorbills.

The only data available is that from the Beatrice Demonstrator Project which recorded 1 razorbill over a period of 12 months pre-construction surveys (Talisman 2005). The size, scale and exact locations of the Round 3 and those in Scottish Territorial Waters are currently not known and there are no data available to determine the number of razorbills that may be present in the planned development areas. Consequently, it is not possible to determine whether there will be an in-combination impact arising from the proposed plans. However, although the developments are within the potential foraging ranges of razorbills from a number of SPAs the relatively far distance the proposed development is from the other planned offshore wind farms and it's relatively small scale reduces the risk of a potential in-combination effect.

Risk of an adverse effect from in-combination impacts – Low

7.1.65 Conclusion

Taking into account data obtained from the proposed EOWDC and supported by published data from other sites it is concluded that the proposed development either alone or in-combination will not cause an adverse effect on the integrity of the relevant SPAs with regard to razorbill.

8 SAC'S

The scope of the review undertaken for this document was based on all coastal SACs in the wider region and advice received from SNH.

All coastal or near coastal SACs were identified using information from the SNH and JNCC websites (JNCC 2011, SNH 2011). A total of eight SACs have been identified as having qualifying species or habitats that are at potential risk of an adverse effect from the proposed project:

- Berwickshire and North Northumberland Coast SAC
- Buchan Ness to Collieston SAC
- Firth of Tay & Eden Estuary SAC
- Isle of May SAC
- Moray Firth SAC
- River Dee SAC
- River South Esk SAC
- Sands of Forvie SAC

Further details on each of the SACs including their qualifying species and Conservation Objectives are presented in Appendix B.

Annex I habitats – Embryonic shifting sand dunes - *Ammophila arenaria, Empetrum nigrum*		**Sands of Forvie SAC**
SAC		Embryonic shifting dunes, shifting dunes along the shoreline with *Ammophila arenaria*, decalcified fixed dunes with *Empetrum nigrum*, humid dune slacks
Data	Site surveys	None
Impact	Physical impact	None
Evidence base	Site specific	There will be no direct or indirect impacts from the construction or presence of the wind farm on the site.
	Generic	There is no published evidence to indicate either a direct or indirect impact on sand dune habitats from offshore wind farms.
Evidence of potential impact	None	
Potential to assess	Yes	Sediment modelling would confirm lack of any potential impact.
Risk	Low	Proposed offshore wind farm too far to impact on coastal processes at Sands of Forvie SAC.
Further assessment	No	

Large shallow inlets and bays, mudflats and sandflats reefs and submerged or partially submerged caves Annex II species – grey seal		**Berwickshire and North Northumberland Coast SAC**
SAC		Large shallow inlets and bays Mudflats and sandflats not covered by seawater at low tide Reefs Submerged or partially submerged sea caves Grey seal
Data	Site surveys	Boat based survey
Impact	Physical impact	None on qualifying habitats. Potential for noise impacts on grey seals
Evidence base	Site specific	There will be no direct or indirect impacts from the construction or presence of the wind farm on the site's qualifying habitats. Grey seals were present throughout the survey area during all the boat based survey months.
	Generic	There is published evidence to indicate that there is potential for an impact on grey seals arising from noise generated during piling operations.
Evidence of potential impact	Yes	Seals may avoid areas with high levels of sound
Potential to assess	Yes	Noise modelling and site specific data.
Risk	Low	
Further assessment	**Yes**	For grey seal only

Vegetated sea cliffs of the Atlantic and Baltic Coasts		Buchan Ness to Collieston SAC
SAC		The vegetated cliff slopes support a wide range of coastal vegetation types with an abundance of such local species as Scots lovage (*Ligusticum scoticum*) and roseroot (*Sedum rosea*). Maritime heath, acid peatland and brackish flushes also occur.
Data	Site surveys	None
Impact	Physical impact	None
Evidence base	Site specific	There will be no direct or indirect impacts from the construction or presence of the wind farm on the site.
	Generic	There is no published evidence to indicate either a direct or indirect impact on vegetated cliff slopes from offshore wind farms.
Evidence of potential impact	None	
Potential to assess	Yes	
Risk	Low	
Further assessment	No	No evidence to indicate any impact.

Estuaries, Sandbanks, Mudflats and Sandflats Annex II species – Common seal		Forth of Tay & Eden Estuary SAC
SAC		Mudflats and Sandflats not covered by seawater at low tide. Sandbanks which are slightly covered by seawater all the time Estuaries Common seal
Data	Site surveys	Boat based surveys
Impact	Physical impact	None on qualifying habitats Potential for noise impact on common seal
Evidence base	Site specific	There will be no direct or indirect impacts from the construction or presence of the wind farm on the qualifying habitats: mudflats, sandflats, sandbanks and estuaries. No common (harbour) seals were observed during the boat based surveys carried out during 2007-2008. In the four months of boat based surveys carried out during 2010-2011 there were 27 harbour seals observed.
	Generic	There is published evidence to indicate that there is potential for an impact on common seal arising from noise generated during piling operations.
Evidence of potential impact	Yes	Seals may avoid areas with high levels of sound
Potential to assess	Yes	Noise modelling and site specific data.
Risk	Low	
Further assessment	**Yes**	For common seal only

Bottlenose dolphin		Moray Firth SAC	
SAC			
Data	Species	Bottlenose dolphin	Sandbank
	Recent population	193 – 237 individuals	Sandbanks are at least 105 km away
		Bottlenose dolphin – Marine mammal surveys have indicated that bottlenose dolphins occur within the proposed EOWDC area. Previous studies have concluded that they occur off Aberdeen throughout the year with a slight increase in occurrence between November and May. Aberdeen harbour has been identified as an important feeding area for bottlenose dolphins, especially during the winter and spring when dolphins are most abundant. Their presence at this site has been linked to salmon migration up the river.	
Impact	Physical impact	Dolphins present within close proximity to the turbines during pile driving may be physically impacted. No physical impacts on Sandbank habitats *c*105 km away	
	Displacement effect	Dolphins may be displaced away from the area during the construction phase.	
Evidence base	Generic	Bottlenose dolphins from the Moray Firth SAC are known to occur in the area of the proposed EOWDC and as far south as St Andrews Bay. Impacts from noise from pile driving on porpoises have indicated that there is some temporary displacement as far as 21 km away and studies from seismic surveys indicate avoidance behaviour for a range of dolphin species.	
Evidence of potential impact	Yes	Possible displacement or disturbance effect from noise during construction activities.	
Potential to assess	Yes	Noise modelling.	
Risk	Moderate		
Further assessment	**Yes**		

Presence of Annex II species, Freshwater Pearl Mussel, Atlantic Salmon, Otter		River Dee SAC		
SAC				
Data		Freshwater Pearl Mussel	Atlantic Salmon	Otter
	Recent population	1.5 million	-	The population of otter in the Dee catchment is estimated at 40-50 adults.
Impact	Physical	Freshwater Pearl mussel - there will be no direct impacts on fresh water pearl mussel. Potential secondary impact if significant impact on salmon occurs. Atlantic salmon – Possible displacement effect during construction period. Otter – possible disturbance effect on otters from construction noise.		
	Noise			
Evidence base	Site specific	none		
	Generic	Freshwater Pearl Mussel – use Atlantic salmon as a host species for a winter before maturing. No evidence of any impacts on freshwater pearl mussels from offshore wind farms or other offshore activities. Atlantic Salmon – No evidence of displacement effects on Atlantic salmon from noise impacts. Otter – No evidence of any impact from pile driving from offshore wind farms. Mouth of the River Dee is Aberdeen Harbour and Aberdeen City therefore very low usage of the site. Any displacement, should it occur, will only be for the duration of pile driving. No likely significant effect.		
Evidence of potential impact	Yes	Possible displacement of Atlantic salmon effect during construction.		
Potential to assess	Yes			
Risk	Low	Duration of activities will be of a relatively short duration.		
Further assessment	**Yes**			

Presence of Annex II species, Freshwater Pearl Mussel, Atlantic Salmon		River South Esk SAC	
SAC			
Data	Species	Freshwater Pearl Mussel	Atlantic Salmon
	Recent population	Abundant in the River South Esk. The pearl mussel population is most abundant in the middle reaches of the river where they attain densities > 20 m^2	The South Esk supports a large, high-quality salmon *Salmo salar* population in a river draining a moderate-sized catchment on the east coast of Scotland.
Impact	Physical impact	Freshwater Pearl mussel - there will be no direct impacts on fresh water pearl mussel. Potential secondary impact if significant impact on salmon occurs. Atlantic salmon – Possible displacement effect during construction period.	
	Displacement effect		
Evidence base	Generic	Freshwater Pearl Mussel – use Atlantic salmon as a host species for a winter before maturing. No evidence of any impacts on freshwater pearl mussels from offshore wind farms or other offshore activities. Atlantic Salmon – No evidence of displacement effects on Atlantic salmon from noise impacts. Impacts from noise on other fish species (including Salmonids) have indicated that any displacement, should it occur, will be temporary and only for the duration of the pile driving. Fish return to the area. Recovery from temporary threshold shift should it occur may be within 48 hrs. Salmon may avoid the area during the construction period.	
Evidence of potential impact	Yes	Possible displacement effect during construction	
Potential to assess	Yes		
Risk	Low	Duration of activities will be of a relatively short duration.	
Further assessment	**Yes**		

Reefs Annex II species – Common seal		**Isle of May SAC**
SAC		Reefs Grey seal
Data	Site surveys	Boat based survey
Impact	Physical impact	None on qualifying habitat. Potential for noise impacts on grey seals
Evidence base	Site specific	There will be no direct or indirect impacts from the construction or presence of the wind farm on the site's qualifying habitats. Grey seals were present throughout the survey area during all the boat based survey months.
	Generic	There is published evidence to indicate that there is potential for an impact on grey seals arising from noise generated during piling operations.
Evidence of potential impact	Yes	Seals may avoid areas with high levels of sound
Potential to assess	Yes	Noise modelling and site specific data.
Risk	Low	
Further assessment	**Yes**	For grey seal only

Bottlenose dolphin

Further information on the distribution of bottlenose dolphins is presented within the is presented within the *Marine Mammal Impact Environmental Baseline* and *EIA technical report on Marine Mammals* prepared for the proposed EWODC Environmental Statement (Appendices 12.1 and 12.2 of the Environmental Statement). Bottlenose dolphins are known to occur regularly in the Aberdeen Bay area. Observations indicate they are present in the area throughout the year, with a peak occurrence during the winter and spring months (November-May), when they can be observed almost daily feeding at Aberdeen Harbour (Canning 2007; Stockin *et al*. 2006).

Analysis of cetacean distribution and habitat use along the Aberdeenshire coast, indicate that the entrance to the River Dee (Aberdeen Harbour) is an important feeding area for bottlenose dolphins, especially during the winter and spring when dolphins are most abundant (Canning 2007). The majority of sightings away from Aberdeen were of groups travelling while those sighted at Aberdeen generally exhibited foraging behaviours (Canning, 2007).

There were 200 bottlenose dolphins recorded during 62 observations both on and off effort during the boat based surveys carried out 2007-2008 (Figure 8-1). There were 10 observations of 58 bottlenose dolphins collected on effort that would have been available for distance analysis (if statistically feasible). The mean group size of all sightings both on and off effort was 5.2 individuals. The majority of sightings occurred during the spring months with sightings occurring throughout the year. A higher number of individuals were observed in the wind farm survey area in comparison to the control site.

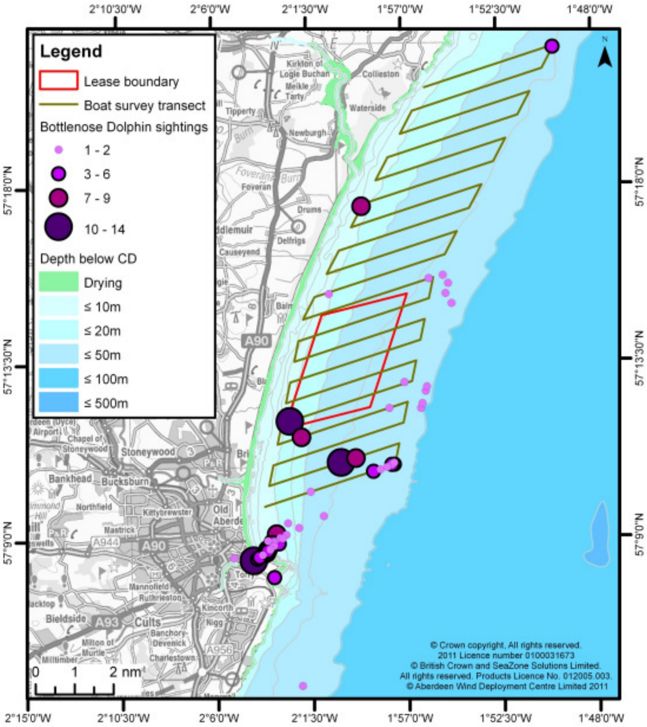

Figure 8-1: Bottlenose dolphins observed on and off effort during the 2007-2008 EOWDC boat surveys

8.1.1 Risk of physical impacts

Further detailed information on the potential impacts arising from the proposed development on bottlenose dolphins are presented in the EIA technical report on marine mammals (Appendix 12.2 of the Environmental Statement).

There is a risk of physical impacts on bottlenose dolphin from the proposed development, particularly during the construction phase when wind turbines may be pile driven into the seabed. Noise generated from pile driving has the potential to cause a range of effects ranging from mortality to permanent physical damage, temporary physical damage and disturbance or displacement.

Underwater sound modelling using the INSPIRE sound propagation model has been used to determine the potential range of underwater noise generated by installing a single 8.5 m diameter monopile. This is based on the worst-case scenario with respect to generation of underwater noise. The INSPIRE model uses a combination of loss caused by the spreading of the energy of the sound field (geometric loss) and loss caused by energy in the water column being absorbed in the underlying sea bed (absorption losses). This is used to estimate the likely transmission losses as the sound propagates away from the source; in this case impact piling. The model is therefore capable of estimating the effect of rapidly varying water depths that are commonly found in UK coastal waters.

For the assessment of physical injury to marine mammals the assessment applies a number of different impact criteria including those proposed by Parvin *et al*. (2007), and also the audiological impact criteria that have been developed by Southall *et al*. (2007).

Sound levels used in the assessment of physical impacts to determine potential adverse effect on Bottlenose dolphin are:

- lethal effect may occur in bottlenose dolphin where peak to peak levels exceed 240 dB re.1µPa
- physical injury may occur in bottlenose dolphin where peak to peak levels exceed 220 dB re.1µPa

The results from the underwater noise modelling undertaken at four wind turbines and the results from Turbine 11, the worst-case based on the piling of an 8.5 m diameter turbine are presented in Figure 8-2. The results from the modelling indicate that the lethal effect level (240 dB peak-peak) and the physical effect level (220 dB peak-peak) will be exceeded at 3 m and 60 m, respectively. As the environmental conditions are comparable for all the wind turbines; the modelling suggests that for physical impacts the anticipated ranges at which lethal effects and physical effects will be the same for all the wind turbine positions.

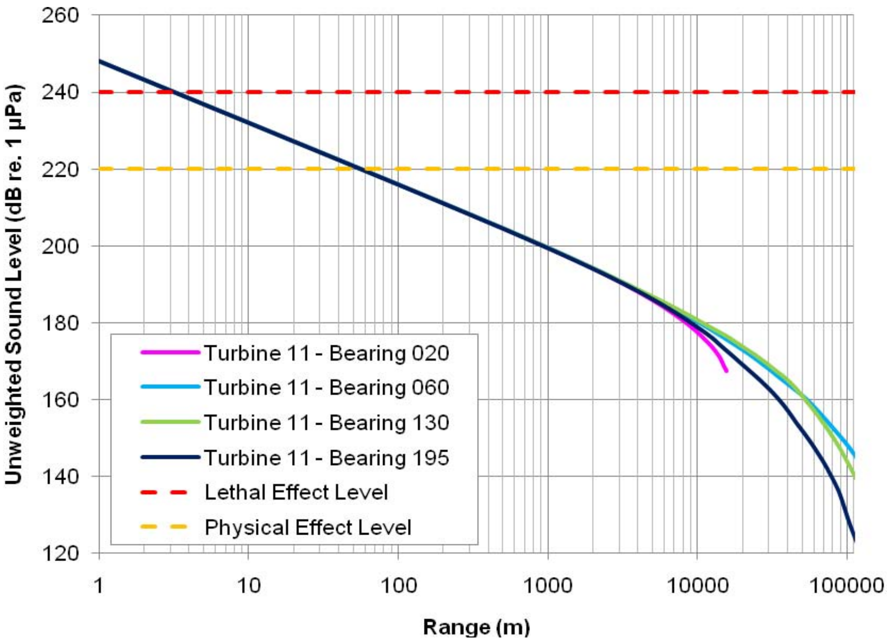

Figure 8-2: Graph showing the unweighted peak to peak noise level with range for the four transects extending from wind turbine 11

Although bottlenose dolphins frequently occur in Aberdeen Bay it is predicted that it is unlikely for a bottlenose dolphin to be within 3 m of the wind turbine during installation and therefore not at risk of mortality.

Hearing impairment in the form of a Temporary Threshold shift (TTS) in hearing may occur where a bottlenose dolphin is exposed to a levels of 130 dB_{ht} and Permanent Threshold Shift (PTS) may occur with repetitive exposure. M-weighted Sound Exposure Levels (dB re. 1 $\mu Pa^2 s$ (M)) have also been used and TTS is predicted to occur at sound levels of 198 dB re 1 $\mu Pa^2/s$ (M_{hf}) (Table 8-1).

Table 8-1: Proposed auditory exposure criteria for bottlenose dolphin frequency specific hearing

Marine mammal group	Sound type	
	Single pulses	Multiple Pulses
Mid Frequency Cetaceans (i.e. bottlenose dolphin)		
Sound Pressure Level	230 dB re 1 µPa (peak)	230 dB re 1 µPa (peak)
Sound Exposure Level	198 dB re 1 $\mu Pa^2/s$ (M_{hf})	198 dB re 1 $\mu Pa^2/s$ (M_{hf})

The 130 dB_{ht} perceived level is used to indicate traumatic hearing damage over a very short exposure time of only a few pile strikes at most (Nedwell *et al*. 2007). Based on this measure it is predicted that there is the potential for traumatic hearing damage out to 290 m from sound source. However, when applying the criteria used by Southall it is predicted that there is the potential for a permanent threshold shift out to 5 m from source or 7 m when based on the single pulse Sound Exposure Level (SEL) criteria which have taken consideration of the hearing capabilities of marine mammal function hearing groups (Southall *et al*. 2007).

Based on the above range of modelling results it is predicted that there is a potential for auditory injury, i.e. permanent threshold shift of between 5 m and 290 m from the sound source, depending on the criteria selected. For the purposes of this assessment the precautionary worst-case figure of 290 m has been used.

It is unlikely that bottlenose dolphin will be present in the vicinity of the proposed development during the period of construction at a range that could cause auditory injury.

As part of any potential future construction operations there will be a Marine Mammal Protection Plan developed in order to ensure that there is a minimal risk of potential impact on bottlenose dolphins arising from construction. As part of the Plan and likely industry standard Licence conditions there will be qualified and experienced marine mammal observers present during construction and the relevant JNCC guidelines will be followed. This will further minimise the potential risk of a bottlenose dolphin being present in the area during construction. Consequently, it is predicted that there will not be an adverse effect with respect to auditory injury on bottlenose dolphins arising from construction.

8.1.2 Risk of disturbance impacts

Similar modelling has been undertaken to assess the potential risk of disturbance to bottlenose dolphins from construction operations. Table 8-2 presents a comparison between the mean predicted dB_{ht} behavioural avoidance impact ranges and the mean M-weighted SEL behavioural avoidance impact ranges for bottlenose dolphin.

The impact ranges for dB_{ht} differ substantially from those predicted using the M-weighted SEL criteria. The ranges using the M-weighted SEL criteria are thought to be highly optimistic, and are in conflict with the limited amount of published information currently available. For instance, harbour porpoise have been found to avoid an area around similar pile driving operations out to a distance of 15 km (Tougaard *et al*. 2006). The most precautionary estimates for the extent of potential disturbance are that there is the potential for avoidance behaviour out to 8.5 km from the possible pile-driving operations.

The accumulated exposure to sound for marine mammals has also been assessed using the auditory injury criteria proposed by Southall *et al*. (2007). This has been done by calculating a standoff range for each marine mammal group, whereby it would safely be able to escape the affected area without receiving a damaging exposure to the sound. The results indicate that a bottlenose dolphin between 120 m and 820 m from the sound source may be impacted from a multiple sound source, i.e. repeated hammering of piles.

Table 8-2: Summary of impact ranges comparing the single pulse behavioural avoidance ranges predicted using the dB_{ht} criteria (Nedwell *et al.* 2007) and the M-weighted SEL approach (Southall *et al.* 2007)

dB_{ht} (Nedwell *et al*, 2007)		M-weighted SELs (Southall *et al*, 2007)	
Species	**Mean behavioural avoidance range (90 dB_{ht})**	**Equivalent M-weighting group**	**Mean behavioural avoidance range**
Bottlenose Dolphin	8.5 km	Mid Frequency Cetacean	120 m

The range at which potential adverse behavioural responses is up to 8.5 km for bottlenose dolphin. However, the behavioural effects are only expected to occur during the piling activities and as such are limited to a maximum time period of 24 hours per pile, although it is expected to take considerably less time than this. The piling of jacket structures is expected to require piles with smaller diameters and will take less time to install, although there will be a greater number of piles per platform. Any behavioural effects that occur to the bottlenose dolphin are expected to be reversible, in that their behaviour will no longer be changed when the piling activity has ceased. Furthermore, as bottlenose dolphins are present along the east coast of Scotland, it is predicted that the temporary displacement of animals from the Aberdeen Bay area will be mitigated by animals moving into other areas within their natural range albeit for a short period of time. Consequently, it is predicted that any potential behavioural responses will be of short duration and not significant.

Risk of an adverse effect– Low

8.1.3 In-combination effects

Bottlenose dolphins from the Moray Firth SAC also occur in the Tay and Firth of Forth area. And therefore there is a potential for an in-combination impact with developments in the Moray Firth and Firth of Forth.

Currently there are no known planned construction activities being undertaken at any of the Round 3 or Scottish Territorial Waters proposed offshore wind farms in 2013; the first year of potential construction planned for the EOWDC. However, there is potential for some construction to be undertaken in 2014 and this may overlap with construction of two other proposed developments in the Moray Firth and Firth of Forth (Table 5-2).

Should this occur then there may be a relatively short period of overlapping construction in 2014 during which time seven turbines may be installed at the proposed EOWDC. It is predicted that the installation of seven turbines will take place over a period of approximately seven days. Consequently, there will be a relatively short period when activities that could impact on bottlenose dolphins overlap. However, the two projects that have the potential to be constructing during the same period of seven days are both in excess of 100 km away and therefore the impacts arising from them, i.e. noise will not spatially overlap. There may be some displacement of bottlenose dolphins away from an area during the short period of time it will take to install up to seven turbines but this potential displacement is not considered to be significant either alone or in-combination with the possible two other projects 100 km away.

Risk of an adverse effect from in-combination impacts – Low

8.1.4 Conclusion

Taking into account data obtained from the proposed EOWDC area and supported by published data from other sites, along with industry standard mitigation measures, it is concluded that the proposed development either alone or in-combination will not cause an adverse effect on the integrity of the relevant SAC with regard to bottlenose dolphin.

The use of a soft start and marine mammal observers complying with the relevant JNCC guidance will reduce the risk of bottlenose dolphins being present within close proximity of the construction activities.

Grey and Common (harbour) seals

Further information on the distribution of both grey and common seals is presented within the *Marine Mammal Impact Environmental Baseline* and *EIA Technical Report on Marine Mammals* assessments prepared for the proposed EOWDC Environmental Statement (Appendices 12.1 and 12.2 of the Environmental Statement).

A total of 114 individual seals, of which a total of 44 were grey seals, 27 harbour seals and 37 were unidentified seals were observed during boat based surveys undertaken within Aberdeen Bay (Figure 8-3 and Figure 8-4).

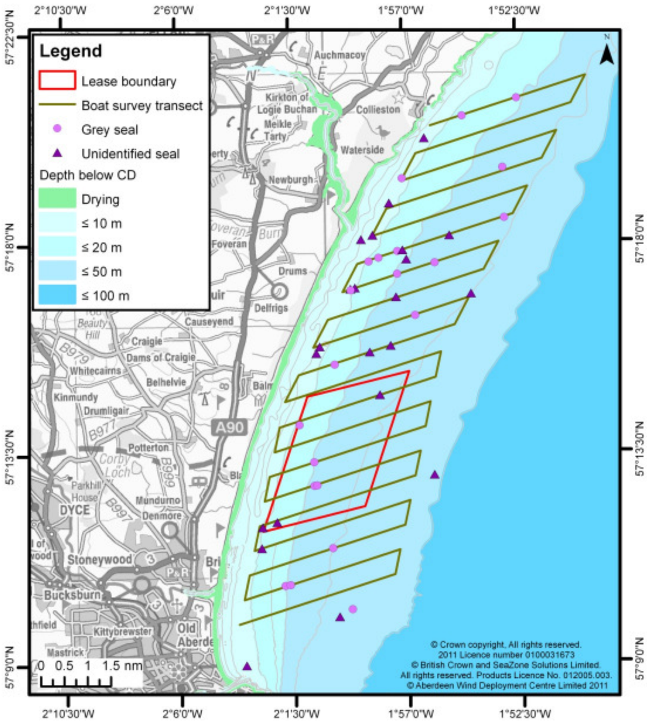

Figure 8-3: Grey and unidentified seals observed during the EOWDC boat based surveys during 2007-2008 (collected on and off-effort)

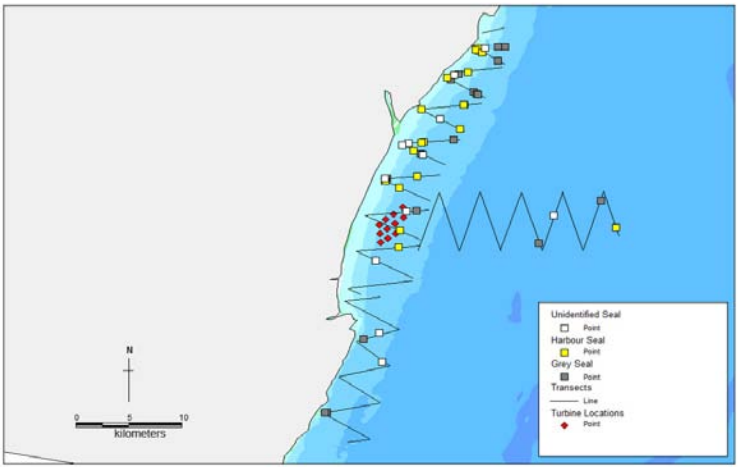

Figure 8-4: On-effort observations of seals along boat-based transects during August, September and November 2010, and January 2011.

Adult grey seals routinely move large distances. Grey seal movements have been studied in the North Sea using satellite-linked telemetry. In a study of animals at the Farne Islands and Abertay Sands, McConnell *et al.* (1999) found that movements were on two geographical scales: long and distant travel (up to 2,100 km away) to known haul-out sites; and local, repeated trips from haul-out sites to discrete offshore areas. Long-distance travel included visits to Orkney, Shetland, the Faroes, and far offshore into the Eastern Atlantic and the North Sea (Hammond *et al*. 2004). Recent telemetry studies have found that seals tagged as far south as the Farne Islands, Isle of May and Moray Firth have been found to enter the Pentland Firth area (SMRU 2011).

In 88% of trips to sea, individual grey seals returned to the same haul-out site from which they departed. The durations of these return trips were short (typically 2-3 days) and their destinations at sea were often localized areas characterized by a seabed of gravel/sand. This is the preferred burrowing habitat of sandeels, an important component of grey seal diet. The limited distance from a haul-out site of return trips (about 40 km) indicates that the seals were foraging within the coastal zone, rather than further offshore (Hammond *et al*., 2004).

The analysis of the seal telemetry data has shown that grey seals tagged in both the Isle of May SAC and Berwickshire and North Northumberland coast SAC appear to routinely travel past Aberdeen through the proposed location on the way to the Pentland Firth.

The radio-tracking of adult female common seals in the inner Moray Firth (1988, 1989, 1992) during the breeding season indicated that seals foraged up to 45 km from the haul-out site, but females with pups restricted their range markedly during the early part of the lactation period (Thompson *et al*. 1994).

Generally it has been thought that common seals forage relatively close inshore within a range of 60 km from their haul-out sites (Thompson *et al.* 1996). However, recent information on foraging movements and the distribution at sea of common seals has highlighted greater travel distances, ranging from 10 km to 120 km, with a mean of 46 km (Hammond *et al*. 2004).

Data from satellite relay data loggers (SRDLs) have highlighted different foraging behaviour of common seals off south-east Scotland and around Orkney and Shetland. Off south-east Scotland, animals were found to be very faithful in their use of haul-out sites on land, and moderately site-faithful in the areas individuals used to forage. Duration of trips ranged from less than one day to 23 days, with a mean of 4.5 days. Foraging in the Moray Firth was mostly closer to the shore. Around Orkney and Shetland there are indications that seals tend to move between haul-outs sites within a 40 km radius of where they were captured with one animal hauling out as far as 200 km from where it was initially tagged. Foraging behaviour is also much more variable both in distance travelled and in the duration of trips. Most foraging trips are within 40 km of haul-outs but there are also longer distance trips to areas more than 200 km from haul-out sites (Hammond *et al*. 2004).

8.1.5 Risk of physical impacts

Further detailed information on the potential impacts arising from the proposed development on grey and common seals are presented in the EIA technical report on marine mammals (Appendix 12.2 of the Environmental Statement).

There is a risk of physical impacts on grey and common seals from the proposed development, particularly during the construction phase when wind turbines may be pile driven into the seabed. Noise generated from pile driving has the potential to cause a range of effects ranging from mortality to permanent physical damage, temporary physical damage and disturbance or displacement.

Underwater sound modelling based on the installation of an 8.5 m diameter monopile

For the assessment of physical injury to marine mammals a number of different impact criteria including those proposed by Parvin *et al*. (2007), and also the audiological impact criteria that have been developed by Southall *et al*. (2007) have been used.

Sound levels used in the assessment of physical impacts to determine potential adverse effect on grey and common seal are:

- lethal effect may occur in seals where peak to peak levels exceed 240 dB re.1µPa
- physical injury may occur in seals where peak to peak levels exceed 220 dB re.1µPa

The results from the underwater noise modelling undertaken based on the worst-case scenario from piling an 8.5 m diameter turbine indicate that the lethal effect level (240 dB peak-peak) and the physical effect level (220 dB peak-peak) will be exceeded at 3 m and 60 m, respectively.

Although both grey and common seals frequently occur in Aberdeen Bay it is predicted that it is unlikely that they will be within 3 m of the wind turbine during installation and therefore not at risk of mortality. However, it is recognised that seals may be curious and therefore may approach the proposed construction activities closer than other marine mammals. The use of a soft start and marine mammal observers complying with the relevant JNCC guidance will reduce the risk of a seal being present within close proximity of the construction activities.

The nearest SAC for grey seal is the Isle of May SAC which is approximately 119 km to the south and the Berwick and Northumberland Coast SAC which is approximately 150 km from the proposed development. The nearest SAC for which common seal is a qualifying species is the Forth of Tay & Eden Estuary SAC which lies 96 Km to the south. Although there may be some passage of seals between this SAC and others in the Pentland Firth the number of either grey or common seals present in Aberdeen Bay from these sites during the relatively short period of construction is predicted to be low, particularly noting that grey seals return from foraging trips to the same haul out site on 88% of occasions and that common seals are not known to undertake regular foraging trips of greater than 60 km and are therefore unlikely to be regularly present in Aberdeen Bay.

Based on the modelling results it is predicted that there is a potential for auditory injury, i.e. permanent threshold shift of between 5 m and 130 m from the sound source, depending on the criteria selected. For the purposes of this assessment the precautionary worst-case figure of 130 m has been used.

The accumulated exposure to sound for marine mammals has been assessed using the auditory injury criteria proposed by Southall *et al*. (2007). This has been done by calculating a standoff range for each marine mammal group, whereby it would safely be able to escape the affected area without receiving a damaging exposure to the sound. The results indicate that a seal between 190 m and 3,600 m from the sound source may be impacted from a multiple sound source, i.e. repeated piling hammers.

It is expected that the perceived loudness of the piling activity will cause the marine mammal to exhibit an aversive behavioural reaction, with the animal moving from the area before the onset of any auditory injury can occur.

There is a risk to individual marine mammals that are exposed to high sound levels in the immediate vicinity of the piling operation, given that marine mammals may be subject to sound levels that are capable of causing physical impacts, including both auditory and non-auditory impacts. Animals would have to be present within the immediate area of the pile driver to be at risk of physical effects and it is considered the risk of marine mammals receiving sound levels capable of causing their death is remote.

8.1.6 Risk of disturbance impacts

Similar modelling has been undertaken to assess the potential risk of disturbance to grey and common seals from construction operations. Table 8-2 presents a comparison between the mean predicted dB_{ht} behavioural avoidance impact ranges and the mean M-weighted SEL behavioural avoidance impact ranges for bottlenose dolphin.

The impact ranges for dB_{ht} differ substantially from those predicted using the M-weighted SEL criteria. The ranges using the M-weighted SEL criteria are thought to be highly optimistic, and are in conflict with the limited amount of published information currently available. For instance, harbour porpoise have been found to avoid an area around similar pile driving operations out to a distance of 15 km (Tougaard *et al*. 2006). The most precautionary estimates for the extent of potential disturbance are that there is the potential for avoidance behaviour out to 8.5 km from the possible pile-driving operations.

The accumulated exposure to sound for marine mammals has also been assessed using the auditory injury criteria proposed by Southall *et al*. (2007). This has been done by calculating a standoff range for each marine mammal group, whereby it would safely be able to escape the affected area without receiving a damaging exposure to the sound. The results indicate that a bottlenose dolphin between 120 m and 820 m from the sound source may be impacted from a multiple sound source, i.e. repeated hammering of piles.

Table 8-3: Summary of impact ranges for common seals comparing the single pulse behavioural avoidance ranges predicted using the dB_{ht} criteria (Nedwell *et al*. 2007) and the M-weighted SEL approach (Southall *et al*. 2007)

dB_{ht} (Nedwell *et al*, 2007)		M-weighted SELs (Southall *et al*, 2007)	
Species	**Mean behavioural avoidance range (90 dB_{ht})**	**Equivalent M-weighting group**	**Mean behavioural avoidance range**
Common seal	9.6 km	Pinnipeds in water	1.6 km

The range at which potential adverse behavioural responses to common seals is up to 9.6 km and it is predicted that it will be the very similar for grey seals. The behavioural effects are only expected to occur during the piling activities and as such are limited to a maximum time period of 24 hours per pile; although it is expected to take considerably less time than this. Any behavioural effects that occur to the Seals are expected to be reversible, in that their behaviour will no longer be changed when the piling activity has ceased. Furthermore, as the seals that may be present are from SACs to the south of the proposed development area and any individuals present in Aberdeen Bay from the qualify sites are likely to be in transit and not resident, the potential displacement away from Aberdeen Bay will be temporary. It is therefore predicted that individuals in transit will not remain in the area of potential disturbance. Consequently, it is predicted that any potential behavioural responses will be of short duration and not significant.

Risk of an adverse effect– Low

8.1.7 In-combination effects

Grey seals from the Isle of May SAC and the Berwick and Northumberland SAC are likely to occur in areas of other potential offshore renewable projects, particularly in the Firth of Forth where there are currently three proposed offshore wind farms. Therefore, there is a potential for an in-combination impact with developments in the Moray Firth.

Based on results from tagging studies, common seals from the Firth of Tay and Eden Estuary are not predicted to occur regularly in the vicinity of the proposed EOWDC and therefore not at risk of an adverse in-combination effect in relation to the proposed development.

Currently there are no known planned construction activities being undertaken at any of the Round 3 or Scottish Territorial Waters proposed offshore wind farms in 2013; the first year of potential construction planned for the EOWDC. However, there is potential for some construction to be undertaken in 2014 and this may overlap with construction of one of the Firth of Forth development, Neart na Gaoithe (Table 5-2).

Should this occur then there may be a relatively short period of overlapping construction in 2014 during which time seven turbines may be installed over a period of approximately seven days at the proposed EOWDC. Consequently, there will be a relatively short period when activities that could impact on seals overlap. However, the proposed Neart Na Gaoithe development is in excess of 100 km from the proposed EOWDC site and therefore the impacts arising from them, i.e. noise will not spatially overlap. There may be some displacement of grey and common seals away from the area during the short period of time it will take to install up to seven turbines but this potential displacement is not considered to be significant either alone or in-combination with a possible other project 100 km away.

Risk of an adverse effect from in-combination impacts – Low

8.1.8 Conclusion

Taking into account data obtained from the proposed EOWDC and supported by published data from other sites along with industry standard mitigation measures it is concluded that the proposed development either alone or in-combination will not cause an adverse effect on the integrity of the relevant SACs with regard to grey seal or common seal.

Atlantic Salmon

The Atlantic salmon is a qualifying species for the River Dee SAC and River South Esk SAC.

Further information on the Atlantic salmon is presented within the *Salmon and Sea Trout Ecology and Fisheries Baseline Assessment* and the *Salmon and Sea trout Impact Assessment* sections of the EIA (Appendices 22.1 and 22.2 of the Environmental Statement).

Atlantic salmon have complex lifecycles during which they spend a proportion of their lives in both freshwater and saltwater.

Young salmon remain in the rivers where they hatched for up to four or five years, although in Scottish rivers two or three years is more usual. Approximately 75% of smolt (young salmon) caught in the River Dee are 2 years old with the rest being mainly 3 years old. They migrate down river to the sea between April and June where they remain for at least one year but usually two or three, before returning back up river, usually in the spring, to spawn, after which the majority of adult salmon die.

When salmon leave the rivers they do so together in shoals leaving the rivers rapidly. The exact migration routes of Salmon from Scottish rivers are not precisely known but they are known to occur in the north-west Atlantic and around West Greenland and the Faroes. The fish swim rapidly at a rate of between 7 – 30 km per day near to the sea surface and can rapidly travel over long distances.

Although salmon may return to the rivers throughout the year with no specific migration period, Multi Sea Winter (MSW) salmon start returning to the rivers in late winter and early spring and continue through to end of May or early June. All the salmon caught in the River Dee during this period are MSW salmon. Summer salmon occur from May onwards and have spent two winters at sea. They, along with grilse (one year old salmon), occur in highest numbers from between July and October. Returning salmon do not delay entry into the rivers and move into them as long as the river conditions are suitable. It is thought that returning salmon migrate along the coasts before entering their rivers.

A review paper by Malcolm *et al.* (2010), suggests a range of potential migratory routes for salmon in Scottish coastal waters, primarily using the results of adult fish tagging studies and the spatial distribution of tag returns from adult fish tagged as smolts as they left Scottish rivers.

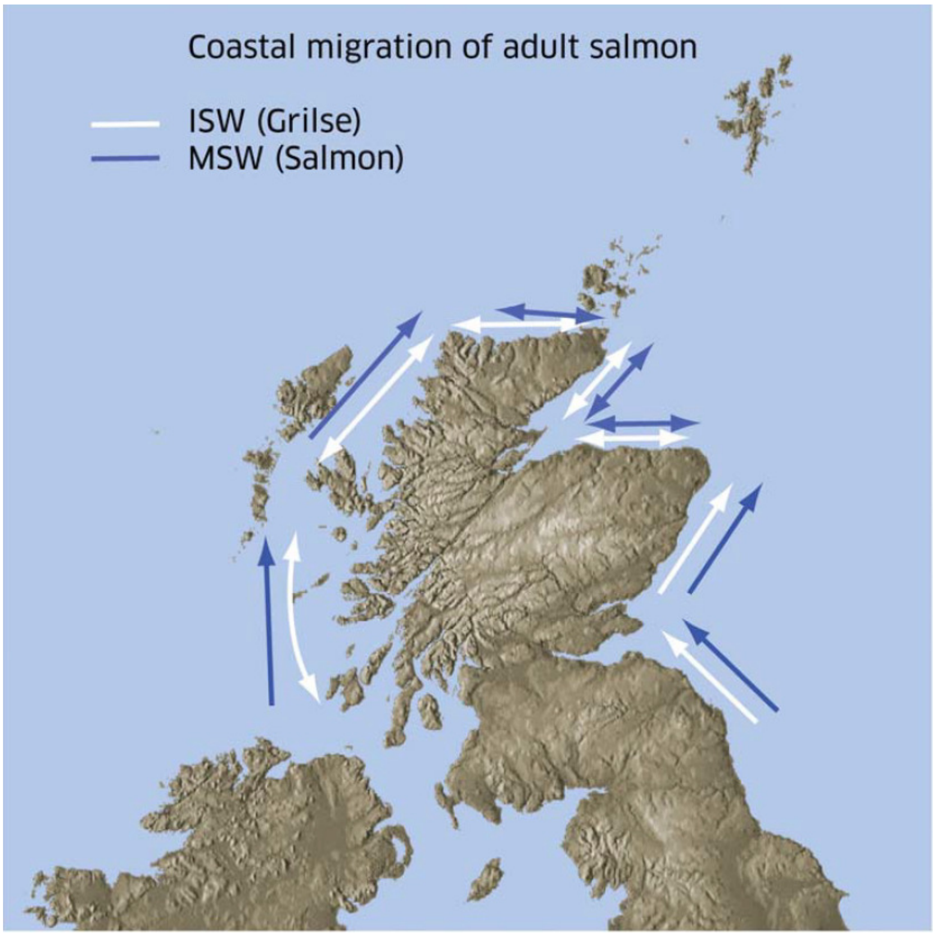

Figure 8-5: Predicted routes of Scottish Atlantic salmon (Malcolm *et al.* 2010)

Salmon entering the River South Esk SAC and River Dee SAC do so from a southerly direction and leave the rivers moving north.

8.1.9 Risk of physical impacts from noise

Potential adverse effects could arise from noise generated during the construction, operation and decommissioning phases of the proposed development. In particular, during the construction period where, should piling occur, the highest noise levels will arise.

Noise modelling undertaken for the proposed EOWDC predict that should piling of 8.5 m diameter piles take place, there is the potential for traumatic hearing damage to Atlantic salmon (based on 130 dB_{ht}) at distances of 20 m or less from the piling operations.

The results from noise modelling undertaken indicate that lethal effects on Atlantic salmon from pile driving associated with the proposed development will only occur out to 3 m from the source. Physical hearing damage may occur out to 20 m or less. Based on the very close range at which salmon are predicted to be required to be in order for there to be a risk of a physical impact and the low numbers of salmon that would occur within the small spatial area along with the relatively short duration possible pile-driving may occur, it is predicted that there will not be any adverse effect on the Atlantic salmon associated with either the River Dee SAC or River South Esk SAC.

8.1.10 Risk of behavioural impacts from noise

Modelling undertaken based on the piling of 8.5 m diameter piles indicates that there is the potential for a strong behavioural reaction out to between 3.6 km and 4.7 km from the construction activities based on a threshold of 90 dB_{ht} and that at levels of 75 dBht up to 85% of salmon may react to noise. The results from the noise modelling undertaken are presented in Figure 8-6.

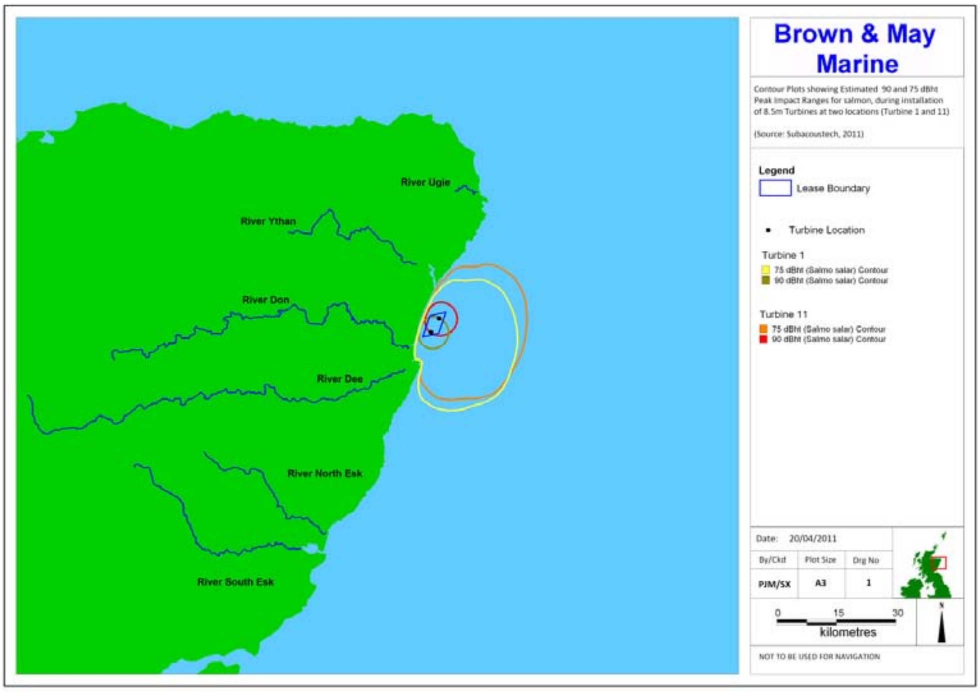

Figure 8-6: Contour Plots showing Estimated 90 and 75dB_{ht} *(Salmo salar)* peak impact ranges during installation of 8.5 m diameter wind turbines at two locations (Turbine 1 and 11)

Salmon are considered to be poor at detecting sounds within the water column although they may be able to detect substrate borne sounds (Gill and Bartlett, 2010).

Salmon smolts and post smolts leaving the SACs do so rapidly, leaving the rivers between April and June and most likely move northwards towards north-west Atlantic, Greenland and the Faroes and unlike returning adults do not necessarily follow the coastlines. Therefore, there is the potential for salmon leaving the relevant SACs to occur within the vicinity of the proposed development. However, the number of salmon smolts and post smolts likely to be in the area of potential impact at any one time is predicted to be low as they depart the rivers over a period of months. The consequences to those that could be affected may mean that either they delay their departure from the rivers for the relatively short period of time during construction, or they may detour around the sound source during the period of migration. The scale of any detour is very small compared to the distances travelled during migration. It is therefore predicted that any behavioural responses arising from construction of the proposed development will not have an adverse effect.

Adult salmon returning to the River South Esk will be unlikely to be impacted by construction activities associated with the proposed development as they return to the river from the south and therefore outwith any zone of potential effect. Salmon returning to the River Dee SAC may be impacted as there is a potential overlap with sound sources that could cause behavioural responses and the River Dee SAC. There are predicted to be potentially two behavioural responses that may occur. Returning Atlantic salmon may delay their entry into the river during piling activities or they may ignore the sound source and enter the river without delay. Should they delay their entry into the River Dee SAC then it will for the duration of piling operations which are predicted to last no longer than 24 hrs per wind turbine and therefore of relatively short duration. Atlantic salmon are known to naturally delay entry into rivers until suitable conditions occur so a delay would not likely have an impact on the salmon.

There is no evidence from other offshore wind farms that operational noise has any adverse effect on fish species, with no decreases in the numbers of fish present within turbine arrays during the operational period of a wind farm. Studies undertaken on Atlantic salmon indicate that although salmon can detect operational turbines at a distance of 0.4 km and 0.5 km behavioural responses only occurred 4 m and then only at high wind speeds (above 30 m/s) (Walhberg & Westerberg 2005).

Based on the above it is predicted that the potential noise impacts arising from the proposed project will not have an adverse effect on the Atlantic salmon associated with the River Dee SAC or River South Esk SAC

Risk of an adverse effect– Low

8.1.11 Risk of impacts from increased sediments

Construction activities such as cable laying, piling and rock placement have potential to result in temporary sediment re-suspension increasing turbidity.

Suspended sediment concentrations within Aberdeen Bay range from 0.1 to 43.1 mg/l with an average of 20.7 mg/l. Sediment modelling has indicated that following construction there is the potential for a sediment plume to occur with a maximum concentration of 35mg/l extending from Aberdeen Harbour to approximately 3 km south of the River Ythan.

Salmon can be affected by high sediment loads, which if high enough can be lethal or at lower levels cause behavioural changes. Lethal sediment loads typically range from between hundreds and thousands mg/l, whilst sub-lethal effects may occur at lower levels, ranging from tens to hundreds mg/l depending on species specific tolerance. Salmon are considered tolerant of relatively high sediment loads with behavioural changes occurring at between 60 to 180 mg/l and therefore unlikely to be affected by the potentially increased loads arising during construction period. The duration of any impact will be short and, should it occur, only arise during the period of construction, which is predicted to be less than 24 hours per turbine. It is therefore predicted that there is unlikely to be an adverse effect arising from the proposed development on Atlantic salmon due to possible short-term increased in turbidity.

8.1.12 Risk of impacts from Electromagnetic Fields

The magnetic fields anticipated to be produced by the AC cables associated with the proposed EOWDC are small (1.5 µT) in comparison to the Earth's magnetic field (approximately 50 µT). Atlantic salmon are expected to perceive these magnetic fields as new localised additions to the heterogeneous pattern of geomagnetic anomalies already occurring naturally and anthropogenically in the sea (MS 2011).

The location of the proposed development, to the north of the River Dee SAC and River South Esk SAC means that returning salmon from the south will not be impacted by any potential EMF arising from the proposed development.

Salmon leaving the SACs may pass across the cables and therefore detect an electromagnetic field. However, studies undertaken on chum salmon and other fish species have not been able to detect any effects from magnetic fields on them (OSPAR 2008). Consequently, it is predicted that there will not be an adverse effect on Atlantic salmon from electromagnetic fields.

Risk of an adverse effect– Low

8.1.13 In-combination effects

Atlantic salmon from the relevant SACs may also occur in either the proposed developments in the Moray Firth or the Firth of Forth.

Currently, there are no known planned construction activities being undertaken at any of the Round 3 or Scottish Territorial Waters proposed offshore wind farms in 2013, the first year of potential construction planned for the proposed EOWDC. There is potential for some construction to be undertaken in 2014 and this may overlap with construction of two other proposed developments (Table 5-2).

Should this occur then there may be a relatively short period of overlapping construction in 2014 during which seven turbines may be installed at the proposed EOWDC. The relatively short duration of any overlapping activities and that the projects are both in excess of 100 km away, it is predicted that should there be any in-combination effects they will not cause an adverse effect on the Atlantic salmon associated with the River Dee and River South Esk SACs.

Risk of an adverse effect from in-combination impacts – Low

8.1.14 Conclusion

Taking into account data obtained from the proposed EOWDC area and supported by published data from other sites it is concluded that the proposed development either alone or in-combination will not cause an adverse effect on the integrity of the relevant SACs with regard to Atlantic Salmon. Consultation with the Regulator, statutory advisors and relevant stakeholders will take place once detailed construction information is available to identify any practical, robust and appropriate mitigation measures that may further reduce any risk.

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Freshwater Pearl Mussel

The Freshwater Pearl Mussel is a qualifying species for the River Dee SAC and the River South Esk SAC.

The freshwater pearl mussel is dependent on salmonid fish during the larval stage of their life cycle, during which time they attach themselves onto the gills of salmon or sea trout until the following summer when they drop off onto the river bed. There is therefore a theoretical possibility that, should there be any significant displacement of salmon or sea trout from their spawning rivers, there could be an adverse effect on the freshwater pearl mussel. As indicated above, it is concluded that any potential effect, either alone or in-combination on Atlantic salmon would, should one occur, be localised, of short duration and only likely to affect a small number of individuals. The same conclusions are made with respect to sea trout.

It is therefore predicted that there will not be any adverse effects on the host species from the proposed development. Consequently, it is anticipated that there will not be any impact on the freshwater pearl mussel.

Risk of an adverse effect – Low

9 CONCLUSIONS

Based on data obtained from the proposed EOWDC area and supported by published data from other sites, it is considered that sufficient information is available to enable a Habitats Regulations Appraisal to be undertaken should it be required. It is concluded that the proposed EOWDC will not cause, on its own or in-combination, an adverse effect on the integrity of the relevant European Sites. Agreed mitigation measures will further reduce the risk of any potential impact. An agreed monitoring programme to be prepared in consultation with the Regulator and advisors will further ensure that the conclusions made are valid.

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11 APPENDIX A

Site	**Buchan Ness to Collieston Coast (including marine extension) SPA**
Area	Area: 5,400.94 ha
Site description	Buchan Ness to Collieston Coast SPA is a stretch of south-east facing cliff in Aberdeenshire, Scotland. The 15 km stretch of cliffs, formed of granite, quartzite and other rocks, runs south of Peterhead, broken only by the sandy beach of Cruden Bay. The varied coastal vegetation on the ledges and the cliff tops includes maritime heath, grassland and brackish flushes. The boundary of the SPA follows the boundaries of Bullers of Buchan Coast SSSI and Collieston to Whinnyfold Coast SSSI, and the seaward extension extends approximately 2 km into the marine environment to include the seabed, water column and surface.
Qualifying Interest	Article 4.2 by regularly supporting in excess of 20,000 individual seabirds. It regularly supports 95,000 seabirds including nationally important populations of the following species: Black-legged kittiwake *Rissa tridactyla* (30,452 pairs, 6.2% of the GB population), Common guillemot *Uria aalge* (8,640 pairs, 1.2% of GB population), Herring gull *Larus argentatus* (4,292 pairs, 2.7% of the GB population), European shag *Phalacrocorax aristotelis* (1,045 pairs, 2.7% of the GB population) Northern fulmar *Fulmarus glacialis* (1,765 pairs, 0.3% of the GB population).
Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species as a viable component of the site. • Distribution of the species within site. • Distribution and extent of habitats supporting the species. • Structure, function and supporting processes of habitats supporting the species. • No significant disturbance of the species. Qualifying Species: Fulmar (*Fulmarus glacialis*) Guillemot (*Uria aalge*) Herring gull (*Larus argentatus*) Kittiwake (*Rissa tridactyla*) Shag (*Phalacrocorax aristotelis*)* Seabird assemblage

Site	Fair Isle SPA
Area	6,824.40 ha
Site description	Fair Isle is an Old Red Sandstone island, the most southerly of the Shetland group, lying halfway between Mainland and Orkney. It has a rocky, cliff coastline with adjacent coastal waters, heather moorland, acidic grassland, maritime grassland and crofting in-bye. The boundary of Fair Isle SPA is coincident with Fair Isle SSSI. The seaward extension extends approximately 2 km into the marine environment to include the seabed, water column and surface.
Qualifying Interest	Fair Isle SPA qualifies under Article 4.1 by regularly supporting populations of European importance of the Annex 1 species: Fair Isle wren *Troglodytes troglodytes fridariensis* (33 territorial males, 100% of the GB population) Arctic tern *Sterna paradisaea* (1100 pairs, 1% of the GB population). Fair Isle SPA further qualifies under Article 4.2 by regularly supporting populations of European importance of the migratory species: Common guillemot *Uria aalge* (32,300 individuals, 1.4% of the north Atlantic biogeographic population). Fair Isle SPA also qualifies under Article 4.2 by regularly supporting in excess of 20,000 individual seabirds. It regularly supports 180,000 seabirds including nationally important populations of the following species: Atlantic puffin *Fratercula arctica* (23,000 individuals, 2% of the GB population) Razorbill *Alca torda* (3,400 individuals, 2% of the GB population), Black-legged kittiwake *Rissa tridactyla* (18,160 pairs, 4% of the GB population), Great skua *Stercorarius skua* (110 pairs, 1% of the GB population), Arctic skua *Stercorarius parasiticus* (110 pairs, 3% of the GB population) European shag *Phalocrocorax aristotelis* (1,100 pairs, 3% of the GB population) Northern gannet *Morus bassanus* (1,166 pairs, 0.6% of the GB population), Northern fulmar *Fulmaris glacialis* (35,210 pairs, 7% of the GB population) Common guillemot *Uria aalge* (32,300 individuals, 3% of the GB population) Arctic tern *Sterna paradisaea* (1,100 pairs).
Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species as a viable component of the site. • Distribution of the species within site. • Distribution and extent of habitats supporting the species. • Structure, function and supporting processes of habitats supporting the species. • No significant disturbance of the species. Qualifying Species:

	Arctic skua (*Stercorarius parasiticus)* Arctic tern (*Sterna paradisaea)* Fair Isle wren (*Troglodytes troglodytes fridariensis)* Fulmar (*Fulmarus glacialis)* Gannet (*Morus bassanus*) Great skua (*Stercorarius skua*) Guillemot (*Uria aalge)* Kittiwake (*Rissa tridactyla)* Puffin (*Fratercula arctica)* Razorbill (*Alca torda)* Shag (*Phalocrocorax aristotelis)** Seabird assemblage
Note – Relevant qualifying interests are for gannet only as advised by SNH (SNH 2010).	

Site	Firth of Forth SPA and Ramsar
Area	6,313.72 ha
Site description	The Firth of Forth SPA is a complex of estuarine and coastal habitats in south-east Scotland stretching east from Alloa to the coasts of Fife and East Lothian. The site includes extensive invertebrate-rich intertidal flats and rocky shores, areas of saltmarsh, lagoons and sand dune. The site is underpinned by the Firth of Forth SSSI.
Qualifying Interest	The Firth of Forth SPA qualifies under Article 4.1 by regularly supporting wintering populations (1993/94-97/98 winter peak means) of European importance of the Annex 1 species: Red-throated diver *Gavia stellata* (90 individuals; 2% of GB) Slavonian grebe *Podiceps auritus* (84; 2% of NW Europe, 21% of GB) Golden plover *Pluvialis apricaria* (2,949; 1% of GB) Bar-tailed godwit *Limosa lapponica* (1,974; 2% of Western Europe, 4% of GB). The site further qualifies under Article 4.1 by regularly supporting a post-breeding (passage) population of European importance of the Annex 1 species: Sandwich tern *Sterna sandvicensis* (1,617, 6% of GB, 1% of East Atlantic). The Firth of Forth SPA qualifies under Article 4.2 by regularly supporting wintering populations (1993/94-97/98 winter peak means) of both European and international importance of the migratory species: Pink-footed goose *Anser brachyrhynchus* (10,852; 6% of Icelandic/Greenlandic), Shelduck *Tadorna tadorna* (moulting flock of 4,509; 2% of NW European), Knot *Calidris canutus* (9,258; 3% of western European/Canadian), Redshank *Tringa totanus* (4,341; 3% of European/West African) Turnstone *Arenaria interpres* (860 individuals; 1% of European). The Firth of Forth SPA further qualifies under Article 4.2 by regularly supporting a wintering waterfowl assemblage of European importance: a 1992/93-96/97 winter peak mean of 95,000 waterfowl, comprising 45,000 wildfowl and 50,000 waders. This assemblage includes nationally important numbers of 15 migratory species: Great crested grebe *Podiceps cristatus* (720; 7% of GB), Cormorant *Phalacrocorax carbo* (682; 5% of GB), Scaup *Aythya marila* (437; 4% of GB), Eider *Somateria mollissima* (9,400; 13% of GB), Long-tailed duck *Clangula hyemalis* (1,045; 4% of GB), Common scoter *Melanitta nigra* (2,880; 8% of GB), Velvet scoter *M. fusca* (635; 21% of GB), Goldeneye *Bucephala clangula* (3,004; 18% of GB population), Red-breasted merganser *Mergus serrator* (670; 7% of GB), Oystercatcher *Haematopus ostralegus* (7,846; 2% of GB), Ringed plover *Charadrius hiaticula* (328; 1% of GB), Grey plover *Pluvialis squatarola* (724; 2% of GB), Dunlin *Calidris 122enelo* (9,514; 2% of GB), Curlew *Numenius arquata* (1,928; 2% of GB). The assemblage also includes large numbers of the following species:

	Wigeon *Anas penelope* (2,139 [1991/2-95/96]), Mallard *A. platyrhnchos* (2,564 [1991/2-95/96]) Lapwing *Vanellus vanellus* (4,148 [1991/2-95/96]).
Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species as a viable component of the site. • Distribution of the species within site. • Distribution and extent of habitats supporting the species. • Structure, function and supporting processes of habitats supporting the species. • No significant disturbance of the species. Qualifying Species: Bar-tailed godwit (*Limosa lapponica)* Common scoter *(Melanitta nigra)* Cormorant (*Phalacrocorax carbo)* Curlew (*Numenius arquata)** Dunlin (*Calidris alpina alpina)* Eider (*Somateria mollissima)* Golden plover (*Pluvialis apricaria)* Goldeneye (*Bucephala clangula)* Great crested grebe (*Podiceps cristatus)* Grey plover (*Pluvialis squatarola*) Knot (*Calidris canutus)* Lapwing (*Vanellus vanellus)* Long-tailed duck (*Clangula hyemalis)* Mallard (*Anas platyrhnchos)* Oystercatcher (*Haematopus ostralegus)* Pink-footed goose (*Anser brachyrhynchus)* Red-breasted merganser (*Mergus serrator)* Redshank (*Tringa totanus)* Red-throated diver (*Gavia stellata)* Ringed plover (*Charadrius hiaticula)* Sandwich tern (*Sterna sandvicensis)* Scaup (*Aythya marila)* Shelduck (*Tadorna tadorna)* Slavonian grebe (*Podiceps auritus)* Turnstone (*Arenaria interpres)* Velvet scoter (*Melanitta fusca)* Wigeon (*Anas penelope)** Waterfowl assemblage

Site	Firth of Tay & Eden Estuary SPA & Ramsar
Area	6,923.29 ha
Site description	The Firth of Tay & Eden Estuary SPA is a complex of estuarine and coastal habitats in eastern Scotland stretching from the mouth of the River Earn in the inner Firth of Tay east to Barry Sands on the Angus coast and St Andrews on the Fife Coast. The site includes extensive invertebrate-rich intertidal flats and areas of reedbed, saltmarsh and sand dune. The SPA is contained within the following SSSIs: Inner Tay Estuary, Monifieth Bay, Barry Links, Tayport-Tentsmuir Coast and Eden Estuary
Qualifying Interest	The Firth of Tay & Eden Estuary SPA qualifies under Article 4.1 of the Birds Directive by regularly supporting nationally important breeding populations of the Annex I species: Marsh harrier *Circus aeruginosus* (average of 4 females in 1992-96, 3% of British population) Little tern *Sterna albifrons* (average of 25 pairs between 1993 and 1997, 1% of British) Bar-tailed godwit *Limosa lapponica* (2,400, 5% of GB and 2% of Western European). The SPA qualifies under Article 4.2 by regularly supporting an internationally important wintering population of redshank *Tringa totanus* (1,800 individuals; 2% of GB and 1% of northwest European populations). The SPA qualifies under Article 4.2 by regularly supporting in winter over 20,000 waterfowl with a 1990/91-94/95 winter peak mean of 48,000 waterfowl, comprising 28,000 wildfowl and 20,000 waders. This assemblage includes internationally important wintering populations (1990/91-94/95 winter peak means) of: Pink-footed goose *Anser brachyrhynchus* (2,800; 1% of GB and Icelandic/Greenlandic populations) Greylag goose *A. anser* (1,200; 1% of GB and Icelandic populations) Nationally important wintering populations of: Cormorant *Phalacrocorax carbo* (230, 2% of GB) Shelduck *Tadorna tadorna* (1,200, 2% of GB) Eider *Somateria mollissima* (13,800, 18% of GB) Long-tailed duck *Clangula hyemalis* (560, 2% of GB) Common scoter *Melanitta nigra* (3,100; 9% of GB) Velvet scoter *Melanitta fusca* (730, 24% of GB), Goldeneye *Bucephala clangula* (230, 1% of GB) Red-breasted merganser *Mergus serrator* (470, 5% of GB) Goosander *Mergus merganser* (220, 2% of GB), Oystercatcher *Haematopus ostralegus* (5,100, 1% of GB), Grey plover *Pluvialis squatarola* (920, 2% of GB), Sanderling *Calidris alba* (220, 1% of GB), Dunlin *Calidris alpina* (5,200, 1% of GB) Black-tailed godwit *Limosa limosa* (150, 2% of GB)
Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term:

	Population of the species as a viable component of the site. Distribution of the species within site. Distribution and extent of habitats supporting the species. Structure, function and supporting processes of habitats supporting the species. No significant disturbance of the species. Qualifying Species: Bar-tailed godwit (*Limosa lapponica*) Black-tailed godwit (*Limosa limosa islandica)* Common scoter (*Melanitta nigra*) Cormorant (*Phalacrocorax carbo*) Dunlin (*Calidris alpina alpina)* Eider *(Somateria mollissima)* Goldeneye (*Bucephala clangula)* Goosander (*Mergus merganser*) Grey plover (*Pluvialis squatarola*) Greylag goose (*Anser anser*) Little tern (*Sterna albifrons*) Long-tailed duck (*Clangula hyemalis*) Marsh harrier (*Circus aeruginosus*) Oystercatcher (*Haematopus ostralegus*) Pink-footed goose (*Anser brachyrhynchus*) Red-breasted merganser (*Mergus serrator*) Redshank (*Tringa totanus*) Sanderling (*Calidris alba*) Shelduck (*Tadorna tadorna*) Velvet scoter (*Melanitta fusca*) Waterfowl assemblage

Site	Forth Islands SPA
Area	9,796.98 ha
Site description	Forth Islands SPA consists of a series of islands supporting the main seabird colonies in the Firth of Forth. The islands of Inchmickery, Isle of May, Fidra, The Lamb, Craigleith and Bass Rock were classified on 25 April 1990. The extension to the site, classified on the 13th February 2004 consists of the island of Long Craig, which supports the largest colony of roseate tern in Scotland. It is the most northerly of only six regular British colonies. The boundary of the Special Protection Area overlaps with the boundaries of the following SSSIs: Long Craig, Inchmickery, Forth Islands, Bass Rock and the Isle of May, and the seaward extension extends approximately 2 km into the marine environment to include the seabed, water column and surface
Qualifying Interest	Forth Islands SPA qualifies under Article 4.1 by regularly supporting populations of European importance of the Annex 1 species: Arctic tern *Sterna paradisaea* (mean between 1992 and 1996 of 540 pairs, 1.2% of the GB population), Roseate tern *Sterna dougallii* (an average of 8 pairs, 1997 - 2001; 13% of GB population), Common tern *Sterna hirundo* (an average of 334 pairs, 1997-2001; 3% of GB population) Sandwich tern *Sterna sandvicensis* (an average of 440 pairs, 3% of GB). Forth Islands SPA further qualifies under Article 4.2 by regularly supporting populations of European importance of the migratory species; Northern gannet *Morus bassanus* (21,600 pairs, 8.2% of world biogeographic population), European shag *Phalacrocorax aristotelis* (2,400 pairs, 1.9% of N Europe biogeographic population), Lesser black-backed gull *Larus fuscus* (1,500 pairs, 1.2% of total *L.f. graellsii* biogeographic population) Atlantic puffin *Fratercula arctica* (14,000 pairs, 1.5% of total *F.a.grabae* biogeographic population). Forth Islands SPA also qualifies under Article 4.2 by regularly supporting in excess of 20,000 individual seabirds. The site regularly supports 90,000 seabirds (three year mean, 1986 – 1988) including nationally important populations of the following species: Razorbill *Alca torda* (1,400 pairs, 1.4% of GB population) Common guillemot *Uria aalge* (16,000 pairs, 2.2% of GB population), Black-legged kittiwake *Rissa tridactyla* (8,400 pairs, 1.7% of GB population), Herring gull *Larus argentatus* (6,600 pairs, 4.1% of GB population), Great cormorant *Phalacrocorax carbo* (200 pairs, 2.8% of GB population), Northern gannet (21,600 pairs), Lesser black-backed gull (1,500 pairs), European shag (2,400 pairs), Atlantic puffin (14,000 pairs), Northern fulmar (798 pairs), Arctic tern (540 pairs), Common tern (334 pairs),

	Roseate tern (8 pairs) Sandwich tern (440 pairs)
Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species as a viable component of the site. • Distribution of the species within site. • Distribution and extent of habitats supporting the species. • Structure, function and supporting processes of habitats supporting the species. • No significant disturbance of the species. Qualifying Species: Arctic tern (Sterna paradisaea) Common tern (Sterna hirundo) Cormorant (Phalacrocorax carbo) Fulmar (Fulmarus glacialis) Gannet (Morus bassanus) Guillemot (Uria aalge) Herring gull (Larus argentatus) Kittiwake (Rissa tridactyla) Lesser black-backed gull (Larus fuscus) Puffin (Fratercula arctica) Razorbill (Alca torda) Roseate tern (Sterna dougallii) Sandwich tern (Sterna sandvicensis) Shag (Phalacrocorax aristotelis) Seabird assemblage

Site	Fowlsheugh (including marine extension) SPA
Area	Area: 1,303.54 Ha National Grid References: NO 879836 to NO 869782
Site description	Fowlsheugh SPA, located 4 km south of Stonehaven on the east coast of Aberdeenshire in north-east Scotland, is a 10.15 ha stretch of sheer cliffs, between 30 m and 60 m high, cut mostly from basalt and conglomerate rocks of Old Red Sandstone age. The boundary of the SPA overlaps with the boundaries of Fowlsheugh SSSI. The seaward extension extends 2 km into the marine environment and includes the seabed, water column and surface.
Qualifying Interest	Fowlsheugh SPA qualifies under Article 4.2 by regularly supporting in excess of 20,000 individual seabirds. The colony regularly supports 145,000 seabirds. The colony further qualifies under Article 4.2 by regularly supporting populations of European importance of the migratory species: Common guillemot *Uria aalge* (56,450 individuals, 5% of GB population, 1.7% of Western European population), Black-legged kittiwake *Rissa tridactyla* (36,650 pairs, 7.5% of the GB population, 1.2 % of World population). The colony also regularly supports nationally important populations of: Razorbill *Alca torda* (5,800 individuals, 3.9% of the GB population). Northern fulmar *Fulmarus glacialis* (1,170 pairs, 0.2% of the GB population), Herring gull *Larus argentatus* (3,190 pairs, 2% of the GB population).
Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species as a viable component of the site • Distribution of the species within site • Distribution and extent of habitats supporting the species □ • Structure, function and supporting processes of habitats supporting the species □ • No significant disturbance of the species Qualifying Species: Fulmar (*Fulmarus glacialis*) Guillemot (*Uria aalge)* Herring gull (*Larus argentatus*) Kittiwake (*Rissa tridactyla)* Razorbill (*Alca torda*) Seabird assemblage

Site	Loch of Skene SPA & Ramsar
Area	120.89 ha
Site description	Loch of Skene is located about 15 km west of Aberdeen in Scotland. It is a shallow (<2 m deep) eutrophic lowland loch surrounded by fringing reedbeds and birch-willow carr. The loch supports an internationally important roost of: • Icelandic Greylag Goose *Anser anser*, • Icelandic Whooper Swan *Cygnus cygnus*. Both swans and geese feed away from the SPA on surrounding agricultural land during the day.
Qualifying Interest	This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive: Over winter: Whooper Swan *Cygnus cygnus,* 203 individuals representing up to 3.7% of the wintering population in Great Britain (5 year peak mean 1991/2 - 1995/6). This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species: Over winter: Greylag Goose *Anser anser*, 10,840 individuals representing up to 10.8% of the wintering Iceland/UK/Ireland population (5 year peak mean 1991/2 - 1995/6).
Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species as a viable component of the site. • Distribution of the species within site. • Distribution and extent of habitats supporting the species. • Structure, function and supporting processes of habitats supporting the species. • No significant disturbance of the species. Qualifying Species: Greylag goose (*Anser anser*)

Site	Loch of Strathbeg SPA & Ramsar
Area	615.94 ha
Site description	The Loch of Strathbeg is located in north-eastern Scotland, in Aberdeenshire, inland from Rattray Head. It is a shallow, naturally eutrophic loch with adjoining reedbeds, freshwater marshes, and Alder *Alnus glutinosa* and willow *Salix* spp. carr. The calcareous dunes and dune slacks within the site are relatively undisturbed and contain a rich flora. The loch constitutes the largest dune slack pool in the UK (200 ha) and the largest waterbody in the north-east Scottish lowlands. It is separated from the sea by a 0.5-1 km wide dune system. The SPA provides wintering habitat for a number of important wetland bird species, particularly wildfowl (swans, geese and ducks), and is also an important staging area for migratory wildfowl from Scandinavia and Iceland/Greenland. In summer, coastal parts of the site are an important breeding area for Sandwich Tern *Sterna sandvicensis*, which feed outside the SPA in adjacent marine areas.
Qualifying Interest	This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive: During the breeding season: Sandwich Tern *Sterna sandvicensis*, 530 pairs representing up to 3.8% of the breeding population in Great Britain (5 year mean, 1993-1997). Over winter: Barnacle Goose *Branta leucopsis*, 226 individuals representing up to 1.9% of the wintering population in Great Britain (5 year peak mean 1991/2 - 1995/6). Whooper Swan *Cygnus cygnus,* 183 individuals representing up to 3.3% of the wintering population in Great Britain (5 year peak mean 1991/2 - 1995/6). This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species: Over winter: Greylag Goose *Anser anser*, 3,325 individuals representing up to 3.3% of the wintering Iceland/UK/Ireland population (winter peak means). Pink-footed Goose *Anser brachyrhynchus*, 39,924 individuals representing up to 17.7% of the wintering Eastern Greenland/Iceland/UK population (5 year peak mean 1991/2 - 1995/6). Assemblage qualification: A wetland of international importance. The area qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl. Over winter: the area regularly supports 49,452 individual waterfowl (5 year peak mean 1991/2 - 1995/6) including: Teal *Anas crecca*, Greylag Goose *Anser anser,* Pink-footed Goose *Anser brachyrhynchus*, Barnacle Goose *Branta leucopsis,* Whooper Swan *Cygnus cygnus*.
Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species as a viable component of the site. • Distribution of the species within site. • Distribution and extent of habitats supporting the species. • Structure, function and supporting processes of habitats supporting the species. • No significant disturbance of the species. Qualifying Species: Barnacle goose (*Branta leucopsis*)

	Greylag goose (*Anser anser)* Pink-footed goose (*Anser brachyrhynchus*) Sandwich tern (*Sterna sandvicensis)* Teal (*Anas crecca)* Whooper swan (*Cygnus cygnus)* Waterfowl assemblage

Site	**Montrose Basin SPA & Ramsar**
Area	984.61 ha
Site description	The Montrose Basin is located on the east coast of Scotland in Angus. It is an enclosed tidal basin fed by the River South Esk and contains areas of mud-flat, marsh and agricultural land, and Dun's Dish, a small eutrophic loch. It is a good natural example of an estuary, relatively unaffected by development, with high species diversity in the intertidal zone and supporting a large population of wintering waterbirds. The site is important for wintering populations of Iceland/Greenland Pink-footed Goose *Anser brachyrhynchus* and Icelandic Greylag Goose *Anser anser,* along with ducks and waders. The geese feed away from the SPA on surrounding agricultural land during the day.
Qualifying Interest	This site qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species: Over winter: Greylag Goose *Anser anser,* 1,080 individuals representing at least 1.1% of the wintering Iceland/UK/Ireland population (5 year peak mean, 1987/8-1991/2). Knot *Calidris canutus*, 4,500 individuals representing at least 1.3% of the wintering Northeastern Canada/Greenland/Iceland/Northwestern Europe population (5 year peak mean 1991/2 - 1995/6). Pink-footed Goose *Anser brachyrhynchus*, 31,622 individuals representing at least 14.1% of the wintering Eastern Greenland/Iceland/UK population (5 year peak mean 1991/2 - 1995/6). Redshank *Tringa totanus*, 2,259 individuals representing at least 1.5% of the wintering Eastern Atlantic - wintering population (5 year peak mean 1991/2 - 1995/6) The area qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl: Over winter, the area regularly supports 54,917 individual waterfowl (5 year peak mean 1991/2 - 1995/6) including: Dunlin *Calidris alpina alpina*, Oystercatcher *Haematopus ostralegus*, Eider *Somateria mollissima*, Wigeon *Anas penelope*, Shelduck *Tadorna tadorna*, Redshank *Tringa totanus*, Knot *Calidris canutus*, Greylag Goose *Anser anser,* Pink-footed Goose *Anser brachyrhynchus*.
Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species as a viable component of the site. • Distribution of the species within site. • Distribution and extent of habitats supporting the species. • Structure, function and supporting processes of habitats supporting the species.

	• No significant disturbance of the species. Qualifying species: Dunlin (*Calidris alpina alpina*) Eider (*Somateria mollissima*) Greylag goose (*Anser anser*) Knot (*Calidris canutus*) Oystercatcher (*Haematopus ostralegus*) Pink-footed goose (*Anser brachyrhynchus*) Redshank (*Tringa totanus*) Shelduck (*Tadorna tadorna*) Wigeon (*Anas penelope*) Waterfowl assemblage

Site	**Troup, Pennan and Lion's Heads SPA**
Area	3,367 ha
Site description	The Troup, Pennan and Lion's Heads Special Protection Area is a 9 km stretch of sea cliffs along the Aberdeenshire coast. The cliffs support large colonies of breeding seabirds. The boundary of the Special Protection Area overlaps with the boundary of Gamrie and Pennan coast SSSI and the seaward extension extends approximately 2 km into the marine environment to include the seabed, water column and surface.
Qualifying Interest	The site qualifies under Article 4.2 by regularly supporting over 20,000 individual breeding seabirds. In 1995 the site supported about 150,000 individual seabirds of 9 species. The site qualifies further under Article 4.2 by regularly supporting internationally important breeding populations of the migratory species: Black-legged kittiwake *Rissa tridactyla* (31,600 pairs in 1995; 6% of the British population and 1% of the total population of the sub-species *R. t. tridactyla*). Common guillemot *Uria aalge* (44,600 individuals in 1995; 4% of the British and 1% of total population of the sub-species *U. a. aalge* and *U. a. albionis*). In addition to the species mentioned above, the assemblage of breeding seabirds includes the regularly occurring migratory species Northern fulmar *Fulmarus glacialis* (4,400 pairs), Herring gull *Larus argentatus* (4,200 pairs; 2% of the British breeding population). Razorbill *Alca torda* (4,800 individuals). All figures in brackets are estimates for 1995.
Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species as a viable component of the site. • Distribution of the species within site. • Distribution and extent of habitats supporting the species. • Structure, function and supporting processes of habitats supporting the species. • No significant disturbance of the species. Qualifying Species: Fulmar (*Fulmarus glacialis)* Guillemot (*Uria aalge*) Herring gull (*Larus argentatus)* Kittiwake (*Rissa tridactyla*) Razorbill (*Alca torda)** Seabird assemblage

<table>
<tr><th>Site</th><th>Ythan Estuary, Sands of Forvie and Meikle Loch SPA & Ramsar</th></tr>
<tr><td>Area</td><td>1016.24 ha</td></tr>
<tr><td>Site description</td><td>Ythan Estuary, Sands of Forvie and Meikle Loch are located north of Aberdeen on the east coast of Scotland. The site comprises the long, narrow estuary of the River Ythan and Meikle Loch. At its mouth, the river splits an extensive area of sand dunes with the Forveran Links on the west bank and the Sands of Forvie dune system on the east bank. Extensive mud-flats in the upper reaches of the estuary are replaced by coarser gravels with Mussel Mytilus edulis beds closer to the sea. The margins of the estuary are varied, with areas of saltmarsh, reedbed and poor fen. Meikle Loch is an important roost site for geese, which feed away from the SPA on surrounding farmland in winter. It is a eutrophic loch supporting limited aquatic vegetation. In summer the coastal habitats of the dunes and estuary provide an important breeding site for three species of tern, whilst in winter the estuary holds large numbers of waders, ducks and geese.</td></tr>
<tr><td>Qualifying Interest</td><td>This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive:
During the breeding season:
Common Tern Sterna hirundo, 265 pairs representing up to 2.2% of the breeding population in Great Britain (Count, as at early 1990s).
Little Tern Sterna albifrons, 41 pairs representing up to 1.7% of the breeding population in Great Britain (Count, as at early 1990s).
Sandwich Tern Sterna sandvicensis, 600 pairs representing up to 4.3% of the breeding population in Great Britain (Seabird Census Register).
This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species:
Over winter;
Pink-footed Goose Anser brachyrhynchus, 17,213 individuals representing up to 7.7% of the wintering Eastern Greenland/Iceland/UK population (winter peak means).
The area qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl.
Over winter, the area regularly supports 51,265 individual waterfowl (5 year peak mean 1991/2 – 1995/6) including:
Redshank Tringa totanus,
Lapwing Vanellus vanellus,
Eider Somateria mollissima,
Pink-footed Goose Anser brachyrhynchus.</td></tr>
<tr><td>Conservation Objectives</td><td>To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
To ensure for the qualifying species that the following are maintained in the long term:
• Population of the species as a viable component of the site.
• Distribution of the species within site.
• Distribution and extent of habitats supporting the species.
• Structure, function and supporting processes of habitats supporting the species.
• No significant disturbance of the species.
Qualifying Species:</td></tr>
</table>

	Common tern (*Sterna hirundo*) Eider (*Somateria mollissima*) Lapwing (*Vanellus vanellus*) Little tern (*Sterna albifrons*) Pink-footed goose (*Anser brachyrhynchus*) Redshank (*Tringa totanus*) Sandwich tern (*Sterna sandvicensis*) Waterfowl assemblage

12 APPENDIX B

Site	Berwickshire and North Northumberland Coast SAC
Area	60545.5 ha
Qualifying Interest	Grey seal Large shallow inlets and bays Mudflats and sandflats not covered by seawater at low tide Reefs Submerged or partially submerged sea caves
Conservation Objectives	To avoid deterioration of the qualifying habitats (listed below) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying habitat that the following are maintained in the long term: • Extent of the habitat on site • Distribution of the habitat within site • Structure and function of the habitat • Processes supporting the habitat • Distribution of typical species of the habitat • Viability of typical species as components of the habitat • No significant disturbance of typical species of the habitat Qualifying Habitats Large shallow inlets and bays Mudflats and sandflats not covered by seawater at low tide Reefs Submerged or partially submerged sea caves. To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are maintained in the long term: Population of the species as a viable component of the site Distribution of the species within site Distribution and extent of habitats supporting the species Structure, function and supporting processes of habitats supporting the species No significant disturbance of the species Qualifying Species: • Grey seal

Site	Buchan Ness to Collieston SAC
Area	207.52 ha
Qualifying Interest	Vegetated sea cliffs of the Atlantic and Baltic coasts Vegetated sea cliffs
Conservation Objectives	To avoid deterioration of the qualifying habitat (listed below) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying habitat that the following are maintained in the long term: • Extent of the habitat on site • Distribution of the habitat within site • Structure and function of the habitat • Processes supporting the habitat • Distribution of typical species of the habitat • Viability of typical species as components of the habitat • No significant disturbance of typical species of the habitat Qualifying Habitat Vegetated Sea Cliffs

<table>
<tr><th>Site</th><th>Firth of Tay and Eden Estuary SAC</th></tr>
<tr><td>Area</td><td>15,412.13 ha</td></tr>
<tr><td>Qualifying Interest</td><td>Estuaries, Sandbanks, Mudflats and Sandflats
Annex II species – Common seal</td></tr>
<tr><td>Conservation Objectives</td><td>To avoid deterioration of the qualifying habitats (listed below) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and
To ensure for the qualifying habitats that the following are maintained in the long term:
Extent of the habitat on site
Distribution of the habitat within site
Structure and function of the habitat
Processes supporting the habitat
Distribution of typical species of the habitat
Viability of typical species as components of the habitat
No significant disturbance of typical species of the habitat
Qualifying Habitats:
• Estuaries
• Intertidal mudflats and sandflats
• Subtidal sandbanks

To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and
To ensure for the qualifying species that the following are maintained in the long term:
Population of the species as a viable component of the site
Distribution of the species within site
Distribution and extent of habitats supporting the species
Structure, function and supporting processes of habitats supporting the species
No significant disturbance of the species

Qualifying Species:
• Common seal</td></tr>
</table>

Site	Isle of May SAC
Area	357.75 ha
Qualifying Interest	Grey seal Reefs
Conservation Objectives	To avoid deterioration of the qualifying habitats (listed below) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying habitats that the following are maintained in the long term: Extent of the habitat on site Distribution of the habitat within site Structure and function of the habitat Processes supporting the habitat Distribution of typical species of the habitat Viability of typical species as components of the habitat No significant disturbance of typical species of the habitat Qualifying Habitats: • Reefs To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are maintained in the long term: Population of the species as a viable component of the site Distribution of the species within site Distribution and extent of habitats supporting the species Structure, function and supporting processes of habitats supporting the species No significant disturbance of the species Qualifying Species: • Grey seal

Site	**Moray Firth SAC**
Area	151,347 ha
Site description	
Qualifying Interest	Sandbanks which are slightly covered by sea water all the time: Subtidal sandbanks Bottlenose dolphin *Tursiops truncatus*
Conservation Objectives	To avoid deterioration of the qualifying habitat (listed below) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying habitat that the following are maintained in the long term: • Extent of the habitat on site • Distribution of the habitat within site • Structure and function of the habitat • Processes supporting the habitat • Distribution of typical species of the habitat • Viability of typical species as components of the habitat • No significant disturbance of typical species of the habitat Qualifying Habitat Subtidal sandbanks To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are established then maintained in the long term: • Population of the species as a viable component of the site • Distribution of the species within site • Distribution and extent of habitats supporting the species • Structure, function and supporting processes of habitats supporting the species • No significant disturbance of the species Qualifying Species Bottlenose dolphin

Site	River Dee SAC
Area	
Site description	2,446.82 ha
Qualifying Interest	Otter *Lutra lutra* Freshwater pearl mussel *Margaritifera margaritifera* Atlantic salmon *Salmo salar*
Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species, including range of genetic types for salmon, as a viable component of the site • Distribution of the species within site Distribution and extent of habitats supporting the species • Structure, function and supporting processes of habitats supporting the species No significant disturbance of the species • Distribution and viability of freshwater pearl mussel host species • Structure, function and supporting processes of habitats supporting • freshwater pearl mussel host species Qualifying species Atlantic salmon • Freshwater pearl mussel Otter

Site	River South Esk SAC
Area	478.62 ha
Qualifying Interest	Freshwater pearl mussel *Margaritifera margaritifera* Atlantic salmon *Salmo salar*
Conservation Objectives	Conservation Objectives for River South Esk Special Area of Conservation To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are maintained in the long term: Population of the species, including range of genetic types for salmon, as a viable component of the site • Distribution of the species within site • Distribution and extent of habitats supporting the species • Structure, function and supporting processes of habitats • supporting the species • No significant disturbance of the species • Distribution and viability of freshwater pearl mussel host species • Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species Qualifying Habitats: Atlantic salmon Freshwater pearl mussel

Site	Sands of Forvie SAC
Area	734 ha
Site description	
Qualifying Interest	Decalcified fixed dunes with Empetrum nigrum* Lime-deficient dune heathland with crowberry Embryonic shifting dunes Shifting dunes Humid dune slacks Humid dune slacks Shifting dunes along the shoreline with Ammophila arenaria ("white dunes") Shifting dunes with marram
Conservation Objectives	Conservation Objectives for Sands of Forvie Special Area of Conservation To avoid deterioration of the qualifying habitats (listed below) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying habitats that the following are maintained in the long term: • Extent of the habitat on site • Distribution of the habitat within site • Structure and function of the habitat • Processes supporting the habitat • Distribution of typical species of the habitat • Viability of typical species as components of the habitat No significant disturbance of typical species of the habitat. Qualifying Habitats: • Humid dune slacks Lime-deficient dune heathland with crowberry* Shifting dunes Shifting dunes with marram