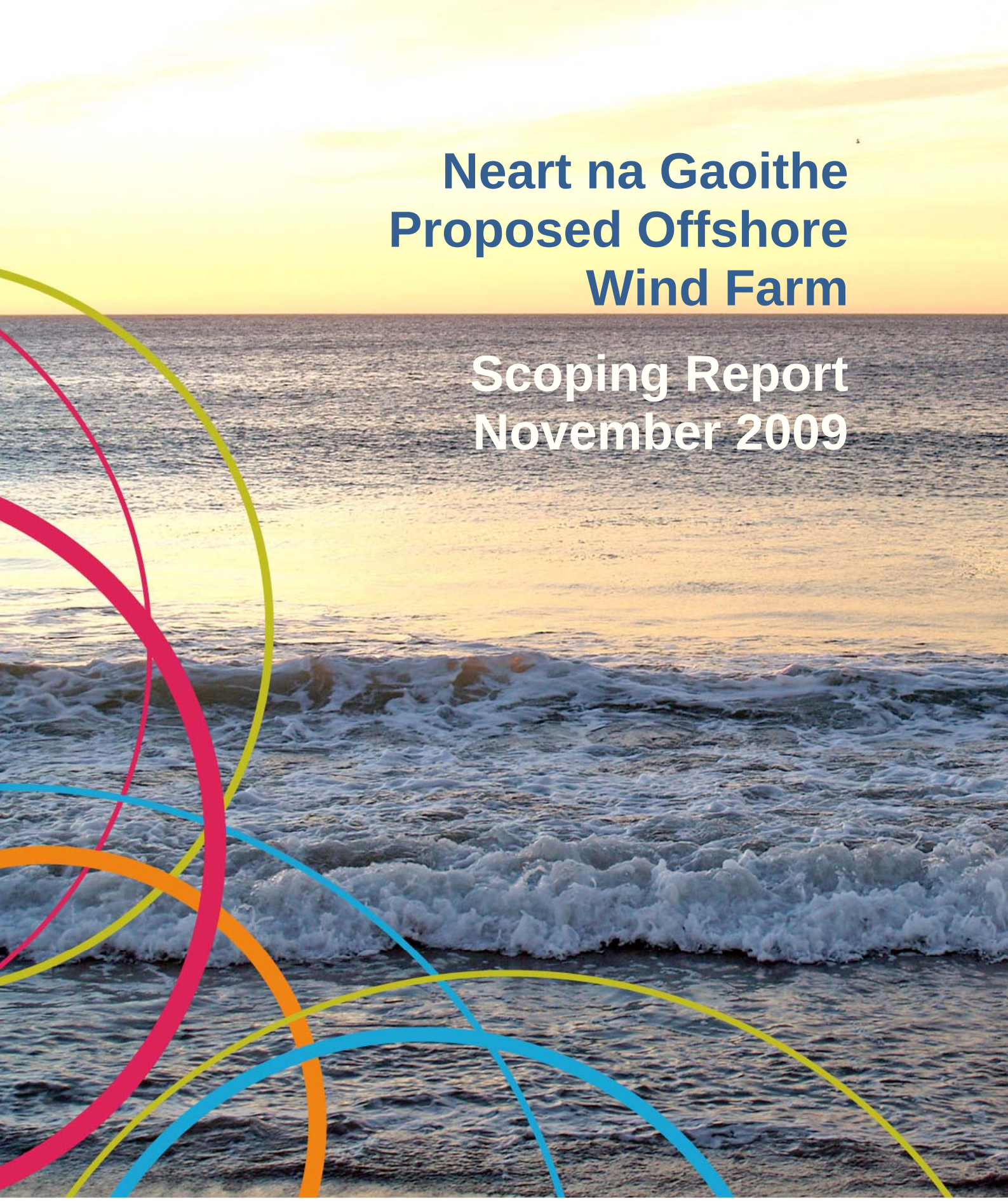
Neart na Gaoithe Proposed Offshore Wind Farm

Scoping Report
November 2009



MAINSTREAM RENEWABLE POWER

Proposed Offshore Wind Farm Scoping Report: Neart na Gaoithe

Document Release and Authorisation Record			
Job No: Report No: Date: Client Name: Client Contact(s):	J/1/06/1419 09/J/1/06/1419/0848 November 2009 Neart na Gaoithe Offshore Wind Ltd Cameron Smith Zoe Crutchfield	Version: 1 Status: Final	
QA	**Name**	**Signature**	**Date**
Project Manager	Bruce Tomlinson		
Report written by	Genevra Harker Rosie Buse		
Report checked by	Steven Freeman		
Report authorised by	Bruce Tomlinson		

Project website: www.neartnagaoithe.com

Table of Contents

Proposed Offshore Wind Farm Scoping Report: Neart na Gaoithe i
Table of Contents i
Table of Figures vii
Table of Tables ix
Acronyms i
Executive Summary 1

1 Introduction 2
1.1 Background Information 2
1.2 Mainstream Renewable Power Ltd and Neart na Gaoithe Offshore Wind Ltd 2
1.3 Emu Limited 2
1.4 Scoping Document 3
1.4.1 Aims of Document 3
1.4.2 Get Involved 3
1.5 Site Selection 4
1.6 Consultation 8

2 Legislative Framework 9
2.1 The Need for Offshore Wind in Scotland 9
2.2 Scottish Offshore Wind Policy 9
2.2.1 Scottish Territorial Wind Farms 10
2.2.2 Strategic Environmental Assessment in Scottish Territorial Waters 11
2.3 Regional Policy 11

3 Project Description 13
3.1 Site Location 13
3.2 Wind Resource 13
3.3 Development Details 14
3.4 Planning and Consent for Neart na Gaoithe 15
3.4.1 Navigation Rights 17
3.5 Engineering Considerations 17
3.6 Grid Connection 18
3.6.1 Offshore Cable Route 18
3.6.2 Onshore Substation 19
3.7 Operation, Maintenance and Monitoring of Performance 20

4 Physical Environment 21
4.1 Metocean 21
4.1.1 General Description 21
4.1.2 Available Data 21
4.1.3 Method of Assessment 23
4.1.4 Further Requirements 23
4.1.5 Potential Mitigation and Monitoring 23
4.1.6 Cumulative Impacts 23
4.2 Bathymetry 24
4.2.1 General Description 24
4.2.2 Available Data 24
4.2.3 Method of Assessment 24
4.2.4 Further Requirements 27
4.2.5 Potential Mitigation and Monitoring 27
4.2.6 Cumulative Impacts 27
4.3 Geology 27
4.3.1 General Description 27
4.3.2 Available Data 28
4.3.3 Method of Assessment 28
4.3.4 Further Requirements 28
4.3.5 Potential Mitigation and Monitoring 28
4.3.6 Cumulative Impacts 28
4.4 Seabed Sediments and Bedforms 29
4.4.1 General Description 29
4.4.2 Available Data 29
4.4.3 Method of Assessment 29
4.4.4 Further Requirements 30
4.4.5 Potential Mitigation and Monitoring 30
4.4.6 Cumulative Impacts 30
4.5 Sediment Transport 30
4.5.1 General Description 30
4.5.2 Available Data 30
4.5.3 Method of Assessment 31
4.5.4 Further Requirements 31
4.5.5 Potential Mitigation and Monitoring 31
4.5.6 Cumulative Impacts 32

5 Biological Environment 33
5.1 Marine Ecology 33
5.1.1 General Description 33
5.1.2 Available Data 35
5.1.3 Method of Assessment 36
5.1.4 Further Requirements 37
5.1.5 Cumulative Impacts 37
5.2 Fish and Shellfish Ecology 37
5.2.1 General Description 37
5.2.2 Available Data 40
5.2.3 Method of Assessment 42
5.2.4 Further Requirements 42
5.2.5 Potential Mitigation and Monitoring 43
5.2.6 Cumulative Impacts 43
5.3 Marine Mammals 43
5.3.1 General Description 43
5.3.2 Available Data 45
5.3.3 Method of Assessment 46
5.3.4 Further Requirements 46
5.3.5 Potential Mitigation and Monitoring 47
5.3.6 Cumulative Impacts 47
5.4 Noise 47
5.4.1 General Description 47
5.4.2 Available Data 47
5.4.3 Method of Assessment 48
5.4.4 Further Requirements 49
5.4.5 Potential Mitigation and Monitoring 49
5.4.6 Cumulative Impacts 49
5.5 Ornithology 50
5.5.1 General Description 50
5.5.2 Available Data 54
5.5.3 Method of Assessment 54
5.5.4 Further Requirements 55
5.5.5 Potential Mitigation and Monitoring 55
5.5.6 Cumulative Impacts 55

5.6 Terrestrial Ecology 56
5.6.1 General Description 56
5.6.2 Available Data 58
5.6.3 Method of Assessment 59
5.6.4 Further Requirements 63
5.6.5 Potential Mitigation and Monitoring 64
5.6.6 Cumulative Impacts 64
5.7 Nature Designations 64
5.7.1 General Description 64
5.7.2 Available Data 66
5.7.3 Method of Assessment 68
5.7.4 Further Requirements 68
5.7.5 Potential Mitigation and Monitoring 69
5.7.6 Cumulative Impacts 69

6 Human Environment 70
6.1 Landscape, Seascape and Visual Assessment 70
6.1.1 General Description 70
6.1.2 Available Data 71
6.1.3 Method of Assessment 72
6.1.4 Further Requirements 74
6.1.5 Potential Mitigation and Monitoring 74
6.1.6 Cumulative Effects 75
6.2 Archaeology and Cultural Heritage 75
6.2.1 General Description 75
6.2.2 Available Data 77
6.2.3 Method of Assessment 78
6.2.4 Potential Mitigation and Monitoring 79
6.2.5 Cumulative Impacts 80
6.3 Navigation 80
6.3.1 General Description 80
6.3.2 Available Data 80
6.3.3 Method of Assessment 81
6.3.4 Further Requirements 83
6.3.5 Potential Mitigation and Monitoring 83
6.3.6 Cumulative Impacts 83

6.4 Commercial Fishing 83
6.4.1 General Description 83
6.4.2 Available Data 85
6.4.3 Method of Assessment 86
6.4.4 Further Requirements 87
6.4.5 Potential Mitigation and Monitoring 87
6.4.6 Cumulative Impacts 87
6.5 Military and Aviation 87
6.5.1 General Description 87
6.5.2 Available Data 89
6.5.3 Method of Assessment 89
6.5.4 Further Requirements 90
6.5.5 Potential Mitigation and Monitoring 90
6.5.6 Cumulative Impacts 91
6.6 Socio-economics 91
6.6.1 General Description 91
6.6.2 Available Data 91
6.6.3 Method of Assessment 92
6.6.4 Further Requirements 93
6.6.5 Potential Mitigation and Monitoring 93
6.6.6 Cumulative Impacts 93
6.7 Other Human Activities 93
6.7.1 General Description 93
6.7.2 Available Data 95
6.7.3 Method of Assessment 96
6.7.4 Further Requirements 96
6.7.5 Potential Mitigation and Monitoring 96
6.7.6 Cumulative Impacts 96

7 Conclusions and Recommendations 97
References 98

Table of Figures

Figure 1-1 Overview of the Three Zones within Scottish Territorial Waters 4

Figure 1-2 Shipping Density Data and Potential Sites 5

Figure 2-1 NnGOWL site (9) in relation to Bell Rock (8), Inch Cape (7) and Forth Array (10) sites 11

Figure 3-1 Proposed Layout & Design 13

Figure 3-3 Proposed Cable Routes for the Neart na Gaoithe Offshore Wind Farm 19

Figure 4-1 Waverider Location in Outer Firth of Forth 22

Figure 4-2 Tidal Diamond Information for the Outer Firth of Forth 24

Figure 4-3 Bathymetry of the Surrounding Area 25

Figure 4-4 2 m Interval Depth Contours for Neart na Gaoithe 26

Figure 4-5 Bedrock Geology 27

Figure 4-6 Seabed Sediments 29

Figure 5-1 Fish Spawning and Nursery Areas 39

Figure 5-2 The Distribution of *Nephrops*. Source: SOAEFD (in Robson, C.F. 1997) 40

Figure 5-3 Marine Mammal sightings in Firth of Forth (Key Species) 44

Figure 5-4 Left Hand Side - 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). Right Hand Side – Harbour seal distribution in the northwestern 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 (Pollock *et al*. 2000). Source: Hammond *et al.,* 2004 45

Figure 5-5 Bird sensitivity in the region of Neart na Gaoithe 51

Figure 5-6 Potentially sensitive species occurring within the Forth in Nationally important numbers 52

Figure 5-7 Potentially sensitive species occurring within the Forth (1) 52

Figure 5-8 Potentially sensitive species occurring within the Forth (2) 53

Figure 5-9 Potentially sensitive species occurring within the Forth (3) 53

Figure 5-10 Nature Conservation Designations Association with the Neart na Gaoithe Cable Routes 57

Figure 5-11 Nature Conservation Designations Onshore from Neart na Gaoithe 65

Figure 6-1 Site Location in Relation to the Fife and East Lothian Coasts 71

Figure 6-2 Protected Wrecks and Charted Wrecks within the Study Area 76

Figure 6-3 Shipping Density 80

Figure 6-4 Creel Area and Fish Landings and Surveillance Data 84

Figure 6-5 Military Practice Areas and RAF Leuchars 88

Figure 6-6 Other Marine Users and Activities 94

Table of Tables

Table 1-1	Site Selection Constraints	7
Table 1-2	Stakeholder Consultation List	8
Table 2-1	Wind Farms in Scottish Territorial Waters	10
Table 3-1	Coordinates of Neart na Gaoithe (WGS84 Decimal Degrees)	14
Table 3-2	Met Mast Location	15
Table 5-1	Summary of the characteristic habitats, biotopes and associated species	35
Table 5-2	Spawning Periods for Species in the Firth of Forth	38
Table 5-3	An Approach for Assessing the Value or Sensitivity of Ecological Receptors in Scotland	62
Table 5-4	Criteria for Describing Impact Magnitude	62
Table 5-5	Matrix for Determining Significance of Ecological Impacts	63
Table 6-1	Onshore Wind Farms in the region	95

Acronyms

AD	Air Defence
ADS	Archaeology Data Service
AGDS	Acoustic Ground Discrimination System
AIL	Abnormal Indivisible Loads
AIS	Automatic Identification System
AML	Additional Military Layers
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
BAE	BAE Systems Insyte
BAP	Biodiversity Action Plan
BERR	Department for Business, Enterprise and Regulatory Reform
BGS	British Geological Survey
BODC	British Oceanographic Data Centre
BWEA	British Wind Energy Association
CA	Cruising Association
CAA	Civil Aviation Authority
CAP	Civil Aviation Authority Publication
CD	Chart Datum
CEC	Crown Estate Commission
CEFAS	Centre for Environment, Fish and Aquaculture Science
CEO	Chief Executive Officer
CERT	Carbon Emissions Reduction Target
CMACS	Centre for Marine and Coastal Studies
COWRIE	Collaborative Offshore Wind Research in to the Environment
CPA	Coastal Protection Act
CREEM	Centre for Research into Ecological and Environmental Modelling
DASSH	Data Archive for Seabed Species and Habitats
DECC	Department for Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DFT	Department for Transport
DTi	Department of Trade and Industry
EC	European Commission
ECU	Energy Consents Unit
EcIA	Ecological Impact Assessment
EIA	Environmental Impact Assessment
Emu	Emu Limited
EO	Earth Observation
ERMC	Environmental Risk Management Capability
ES	Environmental Statement
ESRC	Economic and Social Research Centre
EST	Energy Savings Trust
EU	European Union
FEPA	Food and Environmental Protection Act
FREDS	Forum for Renewable Energy Development in Scotland
FRPB	Forth River Purification Board
FRS	Fisheries Research Services
GH	Garrad Hassan
GIS	Geographical Information Systems
GLOSS	Global Sea Level Observing System
GOOSAG	Global Ocean Observing System Action Group
HER	Historic Environment Records
HS	Historic Scotland
IBA	Important Bird Area
ICES	International Council for the Exploration of the Sea
ICOMOS	International Council on Monuments and Sites
IEEM	Institute of Ecological and Environmental Management
IFA	Institute for Archaeologists
IHO	International Hydrographic Organisation
ILS	Instrumented Landing Systems

IODE	International Oceanographic Data and Information Exchange
IWC	Integrated Water Column
JNAPC	Joint Nautical Archaeology Policy Committee
JNCC	Joint Nature Conservation Committee
LBAP	Local Biodiversity Action Plan
MAGIC	Multi-Agency Geographic Information for the Countryside
MCA	Maritime and Coastguard Agency
MEDIN	Marine Environmental Data and Information Network
MESH	Mapping European Seabed Habitats
MOD	Ministry of Defence
MTZ	Mandatory Transponder Zones
NAS	National Archive of Scotland
NATS	National Air Traffic Service
NBN	National Biodiversity Network
NERC EODC	Natural Environment Research Centre Earth Observation Data Centre
NERL	NATS En Route Plc
NFFO	National Federation Fishermen's Organisation
NGET	National Grid Electricity Transmission
NnGOWL	Neart na Gaoithe Offshore Wind Limited
NRL	Natural Research Ltd
NVC	National Vegetation Classification
OBS	Optical Backscatter Sensor
ode	ode Limited
OFGEM	Office of Gas and Electricity Markets
OFTO	Offshore Transmission Owner
OREI	Offshore Renewable Energy Installations
OSPAR	The Convention for the Protection of the marine Environment of the North-East Atlantic
OWE	Offshore Wind Energy Europe
PAR	Precision Approach Radar
PSR	Primary Surveillance Radar
PTS	Permanent Threshold Shift
RAMSAR	The RAMSAR Convention on Wetlands
RCS	Radar Cross Section
RO	Renewables Obligation
ROW	Receiver of Wreck
RSL	Relative Sea Level
RSPB	Royal Society for the Protection of Birds
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SEL	Sound Exposure Level
SEPA	Scottish Environment Protection Agency
SFF	Scottish Fishermen's Federation
SKM	Sinclair Knight Merz Group
SMRU	Sea Mammal Research Unit (Ltd)
SNH	Scottish Natural Heritage
SPA	Special Protection Area
SPP	Scottish Planning Policy
SRA	Synthetic Radar Aperture
SSR	Secondary Surveillance Radar
TCP	Town and Country Planning Act
TTS	Temporary Threshold Shift
UKHO	United Kingdom Hydrographic Office
UNESCO	United Nations Educational, Scientific and Cultural Organization
UXO	Unexploded Ordnance
VMS	Vessel Monitoring System
VTS	Vessel Traffic Services
WWII	World War 2
ZTV	Zone of Theoretical Visibility

Executive Summary

Neart na Gaoithe is a Scottish Gaelic phrase meaning "might of the wind".

Neart na Gaoithe Offshore Wind Ltd (NnGOWL), a subsidiary company of Mainstream Renewable Power Ltd, is proposing to develop an offshore wind farm 15.5 km east of Fife Ness. The proposed offshore wind farm is called Neart na Gaoithe. The development is part of The Crown Estate's invitation to developers to bid for potential offshore wind farm sites within Scottish territorial waters. Following the bid, the Crown Estate offered exclusivity agreements for ten sites around Scotland, with the potential to generate over 6 GW of offshore wind power. These agreements are subject to the Scottish Government's Strategic Environmental Assessment (SEA) for offshore wind within Scottish territorial waters. The SEA is due to be completed in 2010, subject to its findings, The Crown Estate will award agreements for lease for suitable sites. Leases which enable the developers to progress with construction works will only be granted by The Crown Estate once the developer has obtained statutory consents and permissions from the Scottish Government.

As part of NnGOWLs development ethos, this scoping report has been prepared to ease the process and provide as much information up front as possible. The report therefore contains more detailed information at this stage than usually expected. NnGOWL are committed to this development and by undertaking detailed studies and consultation early in the process, NnGOWL aim to achieve consent of the best possible project in a timely manner.

The aim of this scoping report is to inform stakeholders about the proposed offshore wind farm development, give an overview of the existing environment, and propose methods for assessing the potential impacts. It gives stakeholders the opportunity to comment on, and make suggestions for improving, the environmental assessment. As such, this document identifies the key constraints to development, the available data sources, outlines the proposed methods of assessment, describes further requirements and considers potential mitigation and monitoring requirements as well as identifying any cumulative impacts for each issue.

Key issues that have been identified through this scoping phase, include:

Radar – Neart na Gaoithe is likely to affect the Primary Surveillance Radar (PSR) at RAF Leuchars. Potential solutions will need to be discussed with RAF Leuchars to determine suitable mitigation.

Birds – The proposed site is relatively close to several SPAs on the coast and Firth of Forth Islands, and is adjacent to a potential feeding ground at Wee Bankie. In particular, the colonies on the Isle of May and Bass Rock will be considered. The species most likely to occur in the area are gannet, kittiwake, puffin, fulmar, guillemot and razorbill.

Marine Mammals – Several species of marine mammal are known to occur in the Outer Firth of Forth, including minke whale, harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin, killer whale, Risso dolphin and bottlenose dolphin. The bottlenose dolphins may be individuals from the Moray Firth SAC. The Firth of Tay and Eden Estuary SAC is important for common seal, while the Isle of May supports a breeding colony of grey seals. The potential impacts on these species will need robust study and may require an Appropriate Assessment.

Other Sea Users – NnGOWL recognise that the proposed wind farm operation has the potential to impact upon existing users the area and are committed to working with stakeholders to minimise and mitigate all potential conflicts.

Suitable methods for assessment will be discussed with the relevant stakeholders through this scoping process, and appropriate mitigation and monitoring developed where required.

1 Introduction

1.1 Background Information

The world is facing new challenges, which have significant social, environmental and economic consequences; in particular, climate change and energy security. Consequently, governments are implementing radical policy changes and setting targets to reduce carbon dioxide emissions. European Union leaders have agreed on a binding target of 20% of EU energy consumption to be provided by renewable sources by 2020. By the same year, they have also agreed to cut carbon dioxide emissions by 20% from 1990 levels. Although energy security is an important issue, this scoping report is focussed on the environmental concerns, rather than the social and economic.

To help achieve these targets, in May 2008 The Crown Estate invited developers to bid for potential offshore wind farm sites within Scottish territorial waters. Following the bid, the Crown Estate offered exclusivity agreements for ten sites around Scotland, with the potential to generate over 6 GW of offshore wind power.

Neart na Gaoithe Offshore Wind Ltd (NnGOWL), a subsidiary company of Mainstream Renewable Power Ltd, was awarded one of these exclusivity agreements. The proposed offshore wind farm project is called Neart na Gaoithe and is located to the north-east of the Firth of Forth, 15.5 km directly east of Fife Ness. The proposed wind farm would cover an area of approximately 105 km^2; comprise around 75 turbines and have a target capacity of up to 450 MW.

1.2 Mainstream Renewable Power Ltd and Neart na Gaoithe Offshore Wind Ltd

Mainstream Renewable Power Ltd (referred to as Mainstream throughout the document) was founded in 2008 by Dr. Eddie O'Connor and Fintan Whelan, the former CEO and Corporate Finance Manager of Airtricity. Since February 2008 Mainstream has:

- Set up offices in Berlin, Chicago, Dublin, London, Santiago, Sydney and Toronto;
- Identified and recruited some of the most talented and experienced teams in the industry;
- Established its board to include chairman, Fintan Drury, Sir Roy Gardner, former head of Centrica, Brendan Halligan of Sustainable Energy Ireland and Mark Brown of Barclays Capital;
- Raised €72 million in equity including €20 million from Barclays Capital in return for a 14.6% stake in the company; and
- Identified potential partners in key markets.

Mainstream, and its subsidiary company NnGOWL, is committed to undertaking all necessary work to deliver a consented wind farm that will be responsibly designed and capable of being constructed and operated in a timely fashion, efficiently and safely.

1.3 Emu Limited

This Scoping document has been produced by Emu Limited in close collaboration with staff at Mainstream. Emu Ltd specialises in consultancy, research and survey in the marine sector. The company undertakes full life-cycle marine development projects. In particular, Emu assists developers and regulators in data collection, analysis and interpretation ranging from site selection, feasibility and consent to monitoring and mitigation.

The team comprising Emu Ltd has been operating since 1988 and currently operates with 110 staff undertaking multidisciplinary marine related projects across the globe. Significant experience has been gained in marine renewables (wind, wave and tide), marine aggregates (sand and gravel) and oil and gas. Recently Emu Ltd has been heavily involved in Regional Environmental Assessments (REA) which focus heavily on cumulative and in-combination impacts, stakeholder engagement and exploring opportunities for streamlining the consenting process.

1.4 Scoping Document

1.4.1 Aims of Document

NnGOWL regards effective planning and the robust scoping of the environmental impact assessment (EIA) as a critical step to securing consent with the support of stakeholders. As part of the feasibility work to define the site during the bid phase, initial consultation was undertaken with various stakeholders. These included the Maritime and Coastguard Agency (MCA), Fisheries Research Services (FRS), Scottish Natural Heritage (SNH), Scottish Environment Protection Agency (SEPA), Royal Society for the Protection of Birds (RSPB) Scotland, Chamber of Shipping, Scottish Fishermen's Federation (SFF), and the Ministry of Defence (MOD). The knowledge and advice gained from this process have been incorporated into this scoping document and initial wind farm proposals.

This Scoping Document is part of the consent process. It is the initial document which describes the proposed Neart na Gaoithe development, and surrounding environment. It then describes potential impacts identified at this stage, what data are available, and how the full assessment will be undertaken. This information is the basis for the EIA, which will be submitted in support of the planning application as an ES.

NnGOWL value the feedback received during the scoping process and particularly welcome advice from stakeholders on:

- Additional data sets or impact assessment tools that may be beneficial to the EIA process.
- How to better understand the potential impacts to local communities and industries and mitigation options available.
- Suggestions and advice on how to best engage all stakeholders in the EIA process.

1.4.2 Get Involved

There are a number of ways in which you can get involved in the scoping process and be kept informed of developments:

Website www.neartnagaoithe.com

Register at the website www.neartnagaoithe.com to:

- Download our Scoping document and other documentation as it becomes available.
- Receive alerts via email on project updates and upcoming events.
- Email us your queries and feedback.
- We will be organising consultation events throughout the development process and will be posting details on this website. We can inform you of events by email once you have registered.

Email

- Contact us at info@neartnagaoithe.com

Write to us:

Offshore Environment Manager
Neart na Gaoithe Offshore Wind Ltd
Abbey Business Centre
The Beacon
176 St. Vincent Street
Glasgow
G2 5SG.

1.5 Site Selection

The first stage of site selection was to identify areas of seabed less than 60 m in depth, around the Scottish coast. This was refined to areas located within an economic distance of major grid connection points and ports, but that avoided areas of excessive wave heights, that were remote (such as areas in the far west and north of Scotland) or had known major ecological constraints. This process led to the identification of three large areas for further inspection: the Firth of Clyde, the outer Solway Firth, and the area to the east of the Firths of Forth and Tay (Figure 1-1).

All three regions were found to have environmental constraints. However, overall, the east coast region was deemed the most feasible as the west coast zones had significant bird, shipping and MOD issues, as well as possible limitations with the geology and grid connection opportunities. Consequently, various studies were then commissioned to assess the east coast region in more detail to select a possible candidate site.

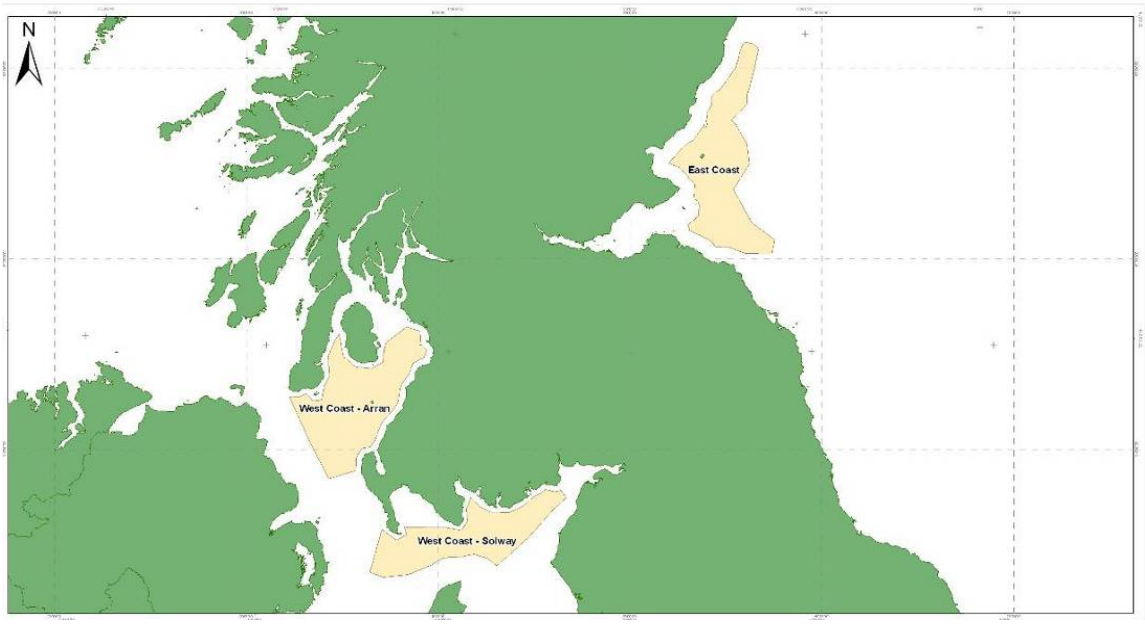


Figure 1-1 Overview of the Three Zones within Scottish Territorial Waters

Early results indicated that both bird and marine mammal issues are key factors across the east coast region. However, given the mobile and wide-ranging nature of these factors alternative constraints were initially used to define potential sites. Therfore, the first dataset used to divide the region into potential 'areas for development' was shipping density. The initial data were provided in June 2008 (Anatec, 2008a); these were then further refined in August (Anatec, 2008b), prior to the bid, and have subsequently been updated in December (Anatec, 2008c).

Figure 1-2 below shows the original sites considered (which were based on the June 2008 data) superimposed on the updated shipping density data from December 2008. The cells are presented with the following rankings:

- Rank 1: < 10 ships per year;
- Rank 2: 10 to 25 ships per year;
- Rank 3: 25 to 60 ships per year;
- Rank 4: 60 to 150 ships per year; and
- Rank 5: > 150 ships per year.

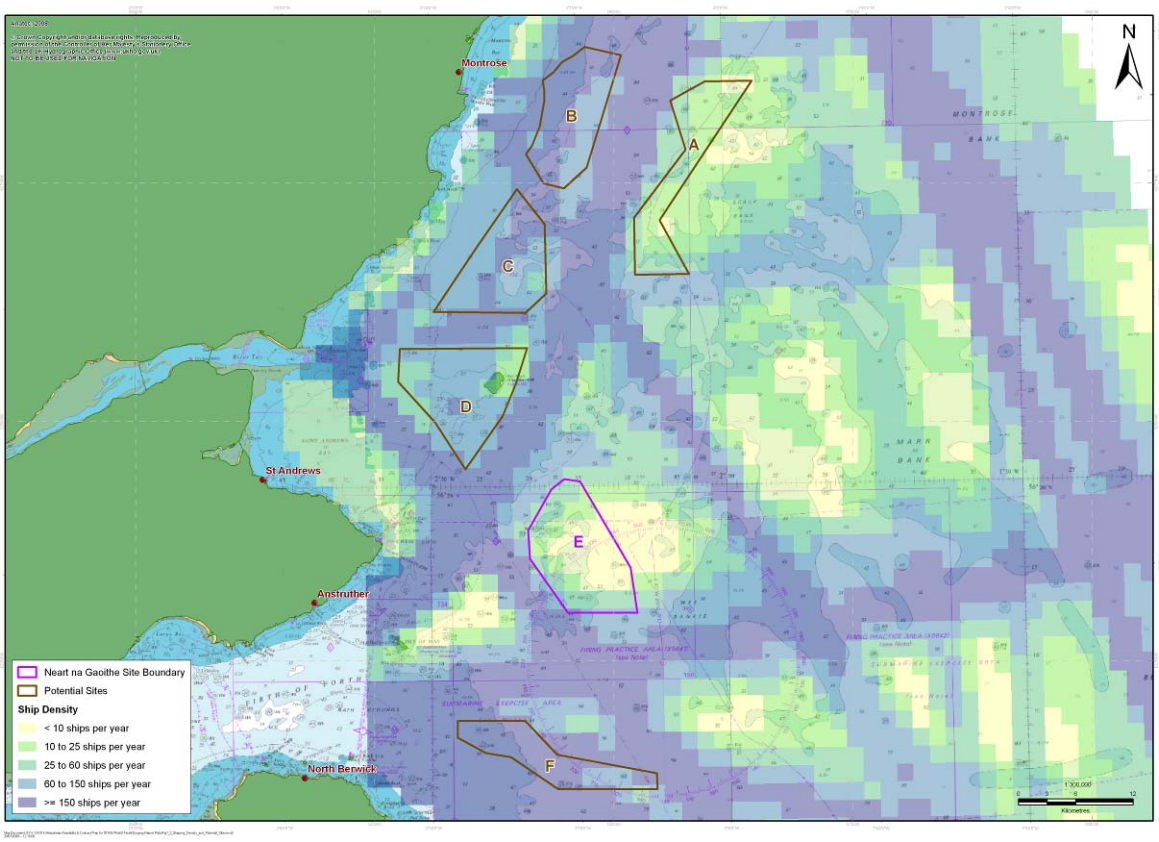


Figure 1-2 Shipping Density Data and Potential Sites

The figure shows that there are some relatively high density routes within the region. The data also show areas where there is little or no shipping activity throughout the year. The Neart na Gaoithe site clearly fits in an area of very low shipping densities. It should also be noted that other areas that were initially based on areas with low shipping densities have subsequently been shown to affect areas of higher relative density as more information has been collated (e.g. Sites B and F), which contributed to the choice of the preferred site (E).

Having assessed the birds, marine mammals and navigation datasets, NnGOWL commissioned technical appraisals of all six east coast sites in order to assess, refine and ultimately rank the candidate sites from the following organisations:

- Garrad Hassan (GH) (wind resource and energy yield);
- Emu Ltd. (overall environmental);
- SKM (grid); and
- ode Ltd (geotechnical and foundation design).

The environmental report contained further specialist reports from:

- Cork Ecology (ornithology and marine mammals);
- Natural Research Ltd (ornithology); and
- LUC (landscape/seascape and visual).

In addition to the above, consultations were undertaken with the Scottish Government, MCA, Chamber of Shipping, RSPB, SNH, FRS, SEPA, SFF, Montrose Port, MOD, Visit Scotland, and Fife Council.

The assessment of the wind resource carried out by GH showed that Site E had the highest long-term mean wind speed amongst the sites that were considered.

The conclusions from the environmental, engineering and energy yield assessments were then combined to identify the most feasible site within the region. This was determined to be Site E, as shown in Table 1-1.

The colour coding scheme for Table 1-1 is illustrated below:

Technical	
Red	Major Technical Issue
Orange	Significant Adverse Financial Impact on Project Viability
Yellow	Some remaining manageable technical risk
Green	Technical aspect which is significantly beneficial

Consent / Environmental	
Red	Major Issue - Significant Consent Risk
Orange	Moderate Issue
Yellow	Minor issue
Green	No Issues

Item		Environmental Criteria					Technical Criteria			
Rank	Site	Site Specific Ecology and Wildlife	Visual Impact	Aviation and Radar	Shipping	Fishing	Energy Yield (estimated wind speed in ms^{-1})	Foundation Type	Physical Conditions	Grid Connection
1	E	Ornithology (high sensitivity: proximity to Isle of May, Wee-Bankie foraging area/sandeel fishery)	Low - Outside 13 km medium zone	Potential RAF Leuchars PSR	Minimal impact, flexibility to adjust alignment	Minimal local impact	High yield- Good wind speed of 9.0/9.1 ms^{-1}, clear of shore	Jacket and Tripod	South: firm bearing, North: more sedimentary	Possible connection to Torness, Cockenzie or Kintore Tealing
2	C	Ornithology (medium sensitivity); possible salmon issues with Tay estuary; close proximity to seal colony	Moderate/Major-poor alignment 8 km from sensitive shore	Potential RAF Leuchars PSR	Possible mitigation required for Montrose Port	Possible impact on nephrops fishing	Low yield- Wind speed of 8.5/7.9 ms^{-1} on margin of viability	Jacket, tripod and some piling	10-30 m sedimentary deposits over bedrock.	Possible connection to Kintore Tealing - Significant landfall issue
3	B	Ornithology (overlap high sensitivity area: proximity to Montrose Bay SPA) possible salmon issues	Moderate -poor alignment along coast, 8 km from Shore	RAF Buchan. Potential PAR at Leuchars	Possible mitigation for Montrose Port, limited alignment flexibility	Possible impact on Nephrops fishing	Low yield – Wind speed of 8.5/7.5 ms^{-1} below viability	Jacket, tripod and some piling	10-30 m sedimentary deposits over bedrock.	Possible connection to Kintore Tealing - Significant landfall issue
4	A	Ornithology (proximity to Wee-Bankie foraging)	Low - Outside 13 km medium zone	RAF Buchan & Perwinnes radar	Minimal Impact, flexibility to adjust alignment	Possible impact on Nephrops fishing	High yield- Good wind speed of 9.1 ms^{-1}, clear of shore	Jacket and Tripod	Weak deposit - unsuitable for foundations	Added 10 km offshore compounds issues with Montrose inshore sites
5	F	Ornithology (high sensitivity area: proximity to Isle of May & coastal SPAs)	Major Impact on sensitive landscapes N.Berwick -Eyemouth	Minimal Impact	Site located by high-density, major shipping lane significant CoS concern	Significant trawling impact, also potting & many small fishing boats.	Low yield- Wind speed of 8.5/7.5 ms^{-1} below viability	Jacket and Tripod	St Andrews Bay formation with some bedrock issues	Possible connection to Torness.
6	D	Ornithology (considered extreme impact area, proximity to coastal SPA due for expansion); Bell Rock submerged reef; seal colony; Tay salmon	Major Impact on sensitive landscapes including major tourist centre St Andrews	Major impact on RAF Leuchars - within 15nm of SSR, in PAR line of sight	Potential impact on shipping identified in August 08 Anatec data	Limited impact on local fishing fleet, possible impact on cod nursery	Low yield- Wind speed of 8.5/7.5 ms^{-1} below viability	Jacket, tripod and some piling	Quaternary deposits with a small area of Tertiary - sheer issue will need addressed	Possible connection to Kintore Tealing - Routing complex
Data Source		*2008 - Emu Report, Natural Research Report 2008, Cork Ecology Report 2008, Consultation with RSPB, SNH , FRS, Scottish Government Seabird groups*	*2008 LUC Report, 2006 Dti SEA study, Fife Council guidance, 2006 ASH report*	*2008 Pager Power Report, MOD consultation*	*2008 Anatec Report, Consultation with Chamber of Shipping, MCA, Montrose Port*	*ICES landing data, Consultation with FRS, Scottish Fisheries Federation, Montrose Port*	*GH Report, Mainstream specialist knowledge*	*ode Report*	*ode Report, Emu Geology Study*	*SKM Report, Mainstream experience*

Table 1-1 Site Selection Constraints

1.6 Consultation

NnGOWL recognise that consultation is an important aspect of the consenting process, both to inform others and to gain more information about the location and appropriate methodologies for assessment. During bid preparation, consultation was undertaken with key stakeholders, given in Table 1-2 with updates of meetings since.

STAKEHOLDER	CONSULTATION	DATE OF MEETING
Chamber of Shipping	Meeting plus correspondence	31-Jul-08
Fife Council	Meetings plus correspondence	13-Mar-09, 20-May-09
Fisheries Research Services (FRS)	Meeting plus correspondence	26-Aug-08, 11-Mar-09
Historic Scotland	Correspondence	
Joint Nature Conservation Committee (JNCC)	Correspondence	
Maritime Coastguard Agency (MCA)	Meeting	02-Sep-08
MOD CNS Heritage	Correspondence	
MOD Safeguarding	Correspondence and formal pro-forma	
Montrose Harbour Master	Meeting plus correspondence	22-Aug-08
Royal Commission on the Ancient and Historic Monuments in Scotland (RCAHMS)	Correspondence	
Royal Society for the Protection of Birds (RSPB)	Meetings plus correspondence	22 -Jul and 28-Aug-08
Scottish Environment Protection Agency (SEPA)	Correspondence	
Scottish Fisheries Federation (SFF)	Meeting plus correspondence	26-Aug-08
Scottish Fisheries Protection Agency (SFPA)	Correspondence	
Scottish Government	Meeting	10-Mar-09
Scottish Natural Heritage	Informal scoping meeting	18-Jun-09
Scottish Natural Heritage (SNH)	Meeting plus correspondence	28-Aug-08
The Crown Estate	Meeting	ongoing
UK Hydrographic Office (UKHO)	Correspondence	

Table 1-2 Stakeholder Consultation List

As part of scoping, and continuing throughout the EIA process, further consultation will be undertaken, particularly with local communities, industries such as shipping and fishing as well as statutory agencies, The Crown Estate and the Scottish Government. See 1.4.2 for details on how to get involved in the scoping process.

2 Legislative Framework

2.1 The Need for Offshore Wind in Scotland

The Scottish Government's Climate Change Bill, passed by the Scottish Parliament in June 2009, 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. In addition to this, Scottish Ministers want 50% of the demand for Scottish electricity to be supplied from renewable sources by 2020, with an interim milestone of 31% by 2011 (Scottish Executive, 2008).

The Scottish Ministers support the full range of renewable generation technologies, including offshore wind, to enable Scotland to realise its renewable energy potential (Global Energy Network Institute, 2007). Currently, the largest potential resource available to help achieve this target is offshore wind.

The main environmental benefits of offshore wind farms are:

- Very low carbon dioxide emissions per unit of electricity generated;
- The improvement of air quality;
- A large resource;
- Increased diversity and security of electricity supply;
- Elimination of cost uncertainties associated with fuel supply fluctuations; and
- Increased levels of sustainability in energy resource use.

2.2 Scottish Offshore Wind Policy

Since the introduction of supportive planning policies for renewables in Scotland in 2001, the Scottish Executive targets for renewable electricity set in 2003, and the start of the Renewables Obligation in 2003 and growing commitments by the UK to help tackle climate change, strong signals have been delivered to the renewable electricity sector to start developing.

Since March 2007, the renewable planning framework has been set out in Scottish Planning Policy 6 (SPP6), which helps ensure the delivery of renewable energy targets as well as supporting the development of a viable renewables industry in Scotland. Through SPP6 the Scottish Government encourages renewable generation from many sources including offshore wind, wave, tidal and solar facilities, and greater use of fuel from wood and other energy crops. The market for renewables is being further encouraged by the RO (Scotland), which requires electricity companies to buy renewable energy or face a penalty.

SPP6 requires that local planning authorities provide positively for renewable energy developments where this can be achieved in an environmentally acceptable manner. However, SPP6 does not set regional production targets.

Scottish Natural Heritage (SNH) as a government agency provides advice on how energy policy, development plan policies, and individual renewable energy development proposals will affect natural heritage interests. SNH's policy on offshore renewables is set out in SNH Policy Statement No. 01/02 "SNH's Policy on Renewable Energy" (Scottish Natural Heritage, 2000). In general, SNH supports the use of renewables to counter the effects of climate change and promote the development of measures, including energy efficiency measures, to reduce the emission of CO_2, in line with government policy.

The Environmental Advisory Forum for Renewable Energy (EAFRE) is a Scottish body appointed to oversee the production of new planning policies for renewables in Scotland. Members of the forum include RSPB Scotland and Scottish Environmental Protection Agency.

2.2.1 Scottish Territorial Wind Farms

Since The Crown Estate initially invited developers to consider offshore wind farms within Scottish territorial waters there has been a positive reaction from the industry. In February 2009, The Crown Estate offered exclusivity agreements to nine companies and consortia for ten sites within Scottish territorial waters. The details are presented below in Table 2-1.

Plan ID	Site Name	Company / Consortia	Size (MW)	Area (km^2)
1	Solway Firth	E.ON Climate & Renewables UK Developments	300	61.5
2	Wigtown Bay	Dong Wind (UK) Ltd	280	51.1
3	Kintyre	Airtricity Holdings (UK) Ltd	378	69.4
4	Islay	Airtricity Holdings (UK) Ltd	680	94.6
5	Argyll Array	Scottish Power Renewables	1,500	361
6	Beatrice	Airtricity Holdings UK Ltd SeaEnergy Renewables Ltd	920	121.3
7	Inch Cape	NPower Renewables Ltd SeaEnergy Renewables Ltd	905	149.9
8	Bell Rock	Airtricity Holdings UK Ltd Fluor Ltd	700	92.8
9	Neart na Gaoithe	Mainstream Renewable Power Ltd	360	105.1
10	Forth Array	Fred Olsen Renewables Ltd	415	128.4

Table 2-1 Wind Farms in Scottish Territorial Waters

The ten exclusivity agreements are designed to allow developers to begin initial surveys and consultation for their sites. Figure 2-1 shows the NnGOWL site in relation to Bell Rock, Inch Cape and Forth Array sites. Under the terms of The Crown Estate exclusivity agreement, developers are obliged to cooperate with each other and this is managed by The Crown Estate through the Forth and Tay Developer Offshore Wind Group. This group is already collaborating on issues such as cumulative impacts, survey methodologies and undertaking regional studies.

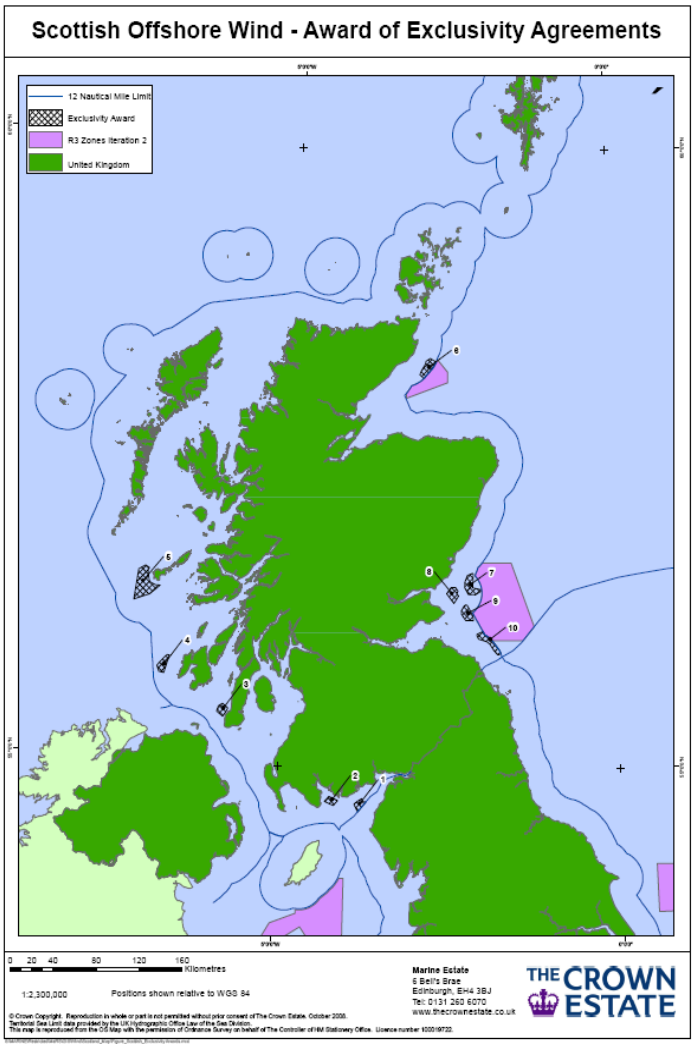


Figure 2-1 **NnGOWL site (9) in relation to Bell Rock (8), Inch Cape (7) and Forth Array (10) sites**

2.2.2 Strategic Environmental Assessment in Scottish Territorial Waters

The Scottish government is in the process of conducting a Strategic Environmental Assessment (SEA) for offshore wind within Scottish territorial waters, to establish a clear and consistent approach to future development. Following completion of the SEA, The Crown Estate will award agreements for lease for suitable sites. Leases which enable the developers to progress with construction works will only be granted by The Crown Estate once the developer has obtained statutory consents and permissions from the Scottish Government.

NnaGOWL is following the Scottish Territorial Waters SEA process closely through the scoping exercise and involvements in groups such as the Scottish Renewables. Recommendations, data and reports from the SEA will contribute towards the NnGOWL EIA process.

2.3 Regional Policy

The proposed Neart na Gaoithe Offshore Wind Farm is located offshore from the constituencies of Edinburgh and Lothian, East Lothian and Fife councils. Each of the councils regional renewable policies are reviewed below.

The Edinburgh and Lothian's Structure Plan 2015 incorporates and supports the development of renewable energy resources where this can be achieved in an environmentally acceptable manner, and requires local plans to set out the criteria against which renewable energy development will be assessed.

The East Lothian Local Plan 2008 Written Statement and Plan, was adopted on 28th October 2008 and is available on the East Lothian Council website. They state:

"The Fife Council Structure Plan 2006 – 2026 sets out that they are encouraging the use of renewable energy technologies, including wind power, as an alternative to fossil fuels (Fife Matters, 2006). Although they do not specifically mention offshore wind, Fife council has thoroughly considered onshore wind development and produced supporting guidance documents".

3 Project Description

3.1 Site Location

The proposed site is 15.5 km east of Fife Ness and covers an area of 105 km^2. The proposed site is located 11.5 km south-east from Bell Rock and 16 km east of the Isle of May. This is shown in Figure 3-1.

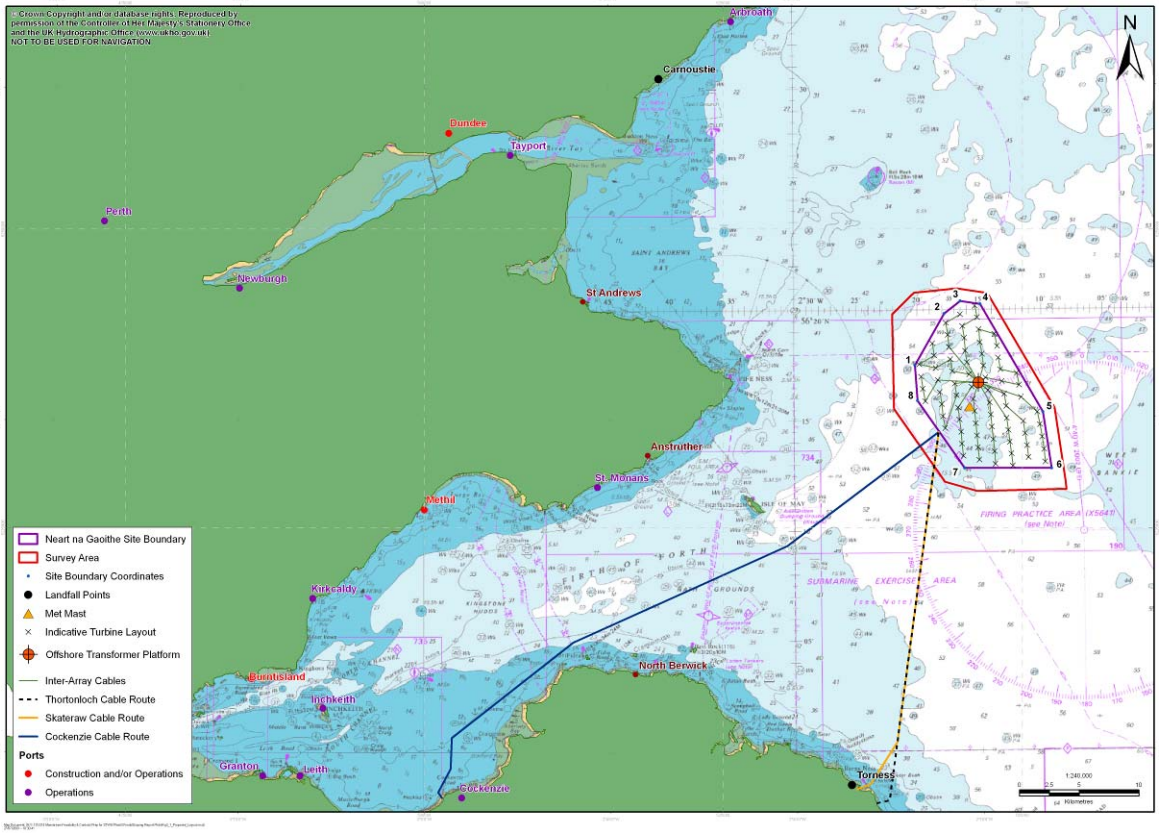


Figure 3-1 Illustrative Layout & Design

3.2 Wind Resource

Further to the initial assessment by Garrad Hassan (GH), NnGOWL undertook further analysis and estimated that the site could have an installed capacity of up to 450 MW.

GH established the wind resource for the Neart na Gaoithe site from a combination of data sources, including mesoscale modelling, Earth Observation data and published estimates, all of which have an element of uncertainty. The mesoscale results were compared to the Atlas of UK Marine Renewable Resources (DTI *et al.*, 2004). A validation of the mesoscale model results was also undertaken using three independent sources of Earth Observation (EO) wind speed data to create a wind map for the Firth of Forth.

The mesoscale model results were considered reliable first estimates of the wind regime, and indicate that Neart na Gaoithe is a relatively windy site within the Firth of Forth, with wind speeds of 8.9 to 9.1 ms^{-1}. In the absence of on-site measurements several other actions were undertaken:

- A review of available meteorological stations in the Firth of Forth;
- A review of long-term wind speed and direction frequency distribution from one of these stations;
- Scale the distribution to the mean wind speed of Neart na Gaoithe, according to mesoscale results; and

- Analysis of the change in the distribution from the meteorological station to Neart na Gaoithe using mesoscale wind climate results for validation purposes.

The wind speed and direction distribution was derived from an onshore meteorological station (Leuchars), located 25 km to the north-west of the proposed Neart na Gaoithe site. This was then scaled to the estimated mean wind speed at Neart na Gaoithe, to provide estimated wind values for use in a preliminary layout and energy yield assessments.

The wind direction data from the measurements at the Leuchars Meteorological Station show a clear westerly predominance, whilst the mesoscale model results at the same location were generally more omni-directional. The observations are considered more reliable and have therefore been used for defining wind direction distributions for Neart na Gaoithe.

Analysis of the energy content of the wind speed frequency distributions indicates that the measured data are less energetic than the model results. In addition, comparison of the model results indicates that the offshore wind climates may be more energetic than at the location of the Leuchars onshore measurements.

Following the GH report, NnGOWL intend to install a high quality offshore meteorological mast on the site and collect data for a period of at least 12 months and possibly up to 5 years. These data may then be used to refine the preliminary wind climate estimates presented in the GH report and to bring the uncertainties associated with such estimates within a quantifiable range.

3.3 Development Details

The co-ordinates of the proposed Neart na Gaoithe site (Figure 3-1) are given below in Table 3-1:

Coordinate Point	Longitude	Latitude
1	-2.33719	56.29046
2	-2.29708	56.32915
3	-2.27529	56.33848
4	-2.24848	56.33614
5	-2.16495	56.25447
6	-2.15424	56.21197
7	-2.27154	56.21272
8	-2.33423	56.26373

Table 3-1 Coordinates of Neart na Gaoithe (WGS84 Decimal Degrees)

The proposed development is likely to consist of 75 turbines, each having a capacity of 6 MW, giving a total installed capacity of 450MW. The capacity factor for the site is estimated to be 40-45%, although, a more accurate figure will be calculated with the site specific wind data. The estimated hub height is approximately 105 m with a rotor diameter of approximately 137 m. The proposed layout is presented in Figure 3-1. The layout is designed to maximise the wind from the south-west, the predominant wind direction.

At the time of publication of this document, potential turbines suppliers Repower and Siemens (both makers of standard 3 blade turbines) are being considered. However there is flexibility to use different technology if it proves suitable. The design life of the turbines is approximately 20 years but the lease term is expected to be in the region of 40 years. This therefore entails repowering 20 years after construction and then decommissioning a further 20 years later.

While monopiles have mainly been used as turbine foundations to date, these are considered unsuitable for the proposed water depths. Similarly, gravity base foundations have not yet been used for wind turbines at this depth. Consequently, alternatives such as jacket foundations are being considered. However, detailed foundation design, based on the geotechnical study, is required before the final decision is made.

There is a proposed central offshore transformer platform, with radial inter-array cables. The preferred export cable route is to Torness, south of Neart na Gaoithe. However, an alternative route to Cockenzie, located to

the south-west of Neart na Gaoithe, is also being considered. Six potential connection locations have been reviewed including, Tealing, Arbroath, Blyth, and Crystal Rig.

An offshore meteorological mast or similar, will be installed to measure the wind speed and thus estimate the energy produced by a proposed wind farm. The met mast location must be representative of the turbines in order to reduce uncertainties in this energy estimate. A proposed met mast location within the Neart na Gaoithe site is given in Table 3-2 below. It should be noted that this location is indicative only and may be subject to change.

	Longitude	Latitude
Proposed Mast Location (UTM Zone 31N WGS84)	-2.263697	56.259061

Table 3-2 Met Mast Location

As the turbine technology and hub height of the proposed wind farm have not yet been confirmed, the mast will measure up to 100 m above mean sea level.

The type of foundation for the offshore met mast depends on the water depth and geological conditions. The design will be informed by the geophysical survey and subsequent geotechnical investigations at the site. The mast is likely to be a robust free-standing lattice tower designed to withstand offshore conditions. The face width of the mast will be minimised, within technical constraints, to reduce the influence of the mast on measurements, especially at the lower levels.

Instrumentation will consist of an anemometer at 100 m above mean sea level and pairs of anemometers installed at various heights on the mast to allow measurement of the wind speed shear profile. Wind vanes will be mounted at various measurement heights to measure wind direction. Pressure, temperature and humidity sensors will also be installed on the mast. Other sensors to measure the wave and tidal climate may be installed.

3.4 Planning and Consent for Neart na Gaoithe

The consenting process for wind farms within Scottish territorial waters is a product of continuing devolution of key responsibilities throughout the UK. Whilst the statutory requirements, consents and licences themselves are broadly uniform across the UK, the regulatory bodies, the statutory advisors and stakeholders for the Neart na Gaoithe Offshore Wind Farm are distinct from projects in English and Welsh waters or those outside 12 nautical miles.

During the bid process, Mainstream consulted and met with the Scottish Government and FRS as regulators and SNH as a critical statutory advisor, to ensure clarity over consent requirements and to agree the appropriate way forward. On 1 April 2009, Marine Scotland took over the marine consenting functions of FRS. The existing consenting process is due to be overhauled when the Marine (Scotland) Bill is passed. It is envisaged that, at the time of application, the Marine (Scotland) Bill will have been passed and the consenting procedure will have been clarified through secondary legislation. At present the Bill does not set out the proposed application procedure in detail but one of the key changes will be the replacement of consents under the Food and Environment Protection Act 1985 (FEPA) and the Coast Protection Act 1949 (CPA) with a Marine Licence.

Under the current procedure consent is required from the Scottish Government under:

- Section 36 of the Electricity Act 1989 (Section 36) to construct and operate a generating station of over 50 MW;
- Section 5 of FEPA for the deposit/construction of installations such as foundations, cables and scour protection on or within the seabed;
- Section 34 of CPA for all works affecting navigation rights, including structures or investigative works that may create obstructions; and
- Section 57 of the Town and Country Planning (Scotland) Act 1997 (TCP(S)A) - deemed planning permission for onshore works if necessary.

Additional consents that may be required include:

- Works licences from the relevant port or harbour authorities;
- Permission under the Protection of Wrecks Act 1973 for the deposit of anything on the seabed that could damage, destroy or obstruct access to wrecks within areas designated under this Act;
- Approvals from Scottish Environment Protection Agency (SEPA) under Section 20 of the Water Environment & Water Services (Scotland) Act 2003 and Water Environment (Controlled Activities) (Scotland) Regulations 2005 for activities liable to pollute or significantly affect the water environment.

It is NnGOWL understanding that the regulatory bodies in Scotland propose to offer a 'one-stop shop' to administer these various applications. At present Section 36 is considered to be the primary consent and the Scottish Government (Energy Consents Unit) acts as the lead consenting body. The Energy Consents Unit is responsible for liaising with the Scottish government's Transport Directorate, Ports & Harbours Unit in relation to the CPA application and Marine Scotland for the FEPA application, as well as with other relevant authorities for additional consents. The Energy Consents Unit manages all statutory consultations, and provides a single point of contact within the Scottish Government. By way of example, the Energy Consents Unit seeks feedback from the MCA on navigational safety issues according to CPA, FEPA and Section 36 requirements, feeding back the response to colleagues in the Ports and Harbours Unit and Marine Scotland. Marine Scotland is expected to start advising on applications towards the end of 2009 and to start receiving applications for Marine Licences by April 2010.

NnGOWL is considering the various consenting approaches for the onshore elements of the project in conjunction with the Scottish Government. The first option is to apply for Section 36 consent for the development as a whole with deemed planning consent under Section 57 of the Town and Country Planning (Scotland) Act 1997 (TCP(S)A) for any onshore ancillary works. The second option is to apply for Section 36 consent for the offshore works and separate permission under Section 37 of the TCP(S)A for the ancillary onshore works. NnGOWL will continue to liaise with Scottish Government on this issue with the final decision being influenced by final design and grid connection requirements.

The consenting process itself can be split into four distinct phases:

Stage 1 – Project planning and scoping: Effective planning is key to an efficient and thorough assessment of the project prior to application for consent. Following the submission of the scoping document, NnGOWL will organise a stakeholder workshop to discuss any issues and determine an assessment plan. Initial discussions regarding the assessment of cumulative impacts (including the details of the appropriate methodology for such an assessment), taking into consideration other potential sites and Round 3 proposals, have already highlighted this is a key issue that will require extensive discussion and consideration going forward.

Stage 2 – Data collection, surveys and analysis: The outcomes of the scoping process and associated consultation will inform extensive data collection and surveys. The approach agreed with SNH and the regulators described above will accelerate the initiation of critical path surveys and will help ensure the associated analysis is robust. NnGOWL has already commenced critical path bird surveys and other offshore data collection.

Stage 3 – Consent Application and Determination: NnGOWL's work with regulators and advisors will continue after applications have been submitted. Early consultation will support a 'no surprises' philosophy and NnGOWL will retain close dialogue throughout the determination process. A core EIA element will be to apply lessons learned from previous projects and propose mitigation and monitoring measures at an early stage to avoid lengthy negotiations and discussions that could delay determination.

Stage 4 – Post Determination: The implementation of monitoring and mitigation provisions in the lead up to, during and following construction are an integral part of the consenting process. Securing workable conditions that do not expose construction or operation to unacceptable risks is a core objective. It is important that all monitoring is driven by clear objectives and hypotheses to ensure

it is targeted and produces meaningful results. NnGOWL will work with industry colleagues throughout the consent process to maximise knowledge transfer and streamline requirements.

A further 'consent' that must be obtained prior to construction relates to decommissioning. NnGOWL will be issued with a notice to produce a decommissioning plan upon receipt of consent. Responsibility for approval of decommissioning measures and accompanying financial security remains with the Department for Energy and Climate Change (DECC), with Scottish Government becoming a statutory consultee with other government bodies.

In addition to the above consents, land-owner and other agreements will be required for the project to progress to construction. In addition to securing a lease with The Crown Estate, a licence to cross the foreshore with export cables will need to be secured. It may also be necessary to seek consent under Section 37 of the Electricity Act 1989 should any overhead line works be required for connection into the transmission system. The project may also require an agreement under Section 75 of the TCP(S)A.

As part of the application process, an Environmental Impact Assessment (EIA) will be carried out. This EIA will detail the methods used and the outcomes of various surveys, consultations and analysis of the potential impacts of the project. The EIA has been planned to comply with appropriate legislation and best practise guidance and to support all necessary applications for consent. NnGOWL will produce a single EIA to cover all offshore and onshore consents.

3.4.1 Navigation Rights

During the EIA and consenting process it may be necessary to consider changes to the navigation rights within the offshore wind farm site. Public rights of navigation have been recognised in Scots law for centuries and are simply a right of way across navigable waters. Numerous public rights of navigation have been established over the years throughout Scottish waters, primarily for commercial purposes but also more recently for recreational purposes.

Prior to the Energy Act 2004, it was only possible to extinguish or interfere with these rights on the passing of an Act of Parliament, for example the Robin Rigg Offshore Wind Farm (Navigation and Fishing)(Scotland) Act 2003. To interfere with these rights without the passing of such an Act was unlawful. The Energy Act 2004 however, introduced section 36A of the Electricity Act 1989. This section allows an application to be made for a declaration from the Scottish Ministers extinguishing these rights.

It should be noted that the declaration need not be to extinguish the rights in their entirety. The declaration can be to extinguish the rights, suspend them for a period that is specified in the declaration, suspend them until such time as may be determined in accordance with provision contained in the declaration, or to allow the right to be exercisable subject to such restrictions or conditions, or both, as are set out in the declaration. In this way the declaration can deal with both the temporary impacts on navigation rights as a result of construction and also the ongoing / permanent impacts on navigation rights as a result of the operational development.

3.5 Engineering Considerations

Mainstream commissioned ode Ltd. to complete a geotechnical and structural review for Neart na Gaoithe during the bid phase. Initial geological interpretations were carried out by Emu Ltd., although there was limited borehole information. However, a broad overview was provided for preliminary consideration.

From the interpretation, Neart na Gaoithe is characterised by a sequence of weak silty muds (St Andrews Bay and Largo Bay member) overlaying a stronger sand gravelly till (Wee Bankie Formation), which in turn overlies argillaceous rock. The thickness of these quaternary sediments varies from 0 m to over 30 m thick. In the Firth of Forth there are areas where the upper weak strata are missing and the stronger Wee Bankie Formation outcrops at the seabed. At these locations, the depth of sediment above bedrock is shallow, from 0 m to 10 m. Construction within these areas may require that piles would be drilled and grouted into the underlying rock (ode Ltd, 2008).

Various types of foundation are being considered including monopiles, gravity bases and jacket structures. Considering the geology and water depth, the preferred foundation at this stage is a jacket foundation.

The final decision on the engineering considerations will be made on completion of a geotechnical campaign. This investigation would comprise an intrusive survey at each proposed wind turbine location and at regular points along the export cable. The wind farm layout will be finalised following completion of the first year of on-site wind data collection in 2011. This survey will enable detailed design to be optimised and for procurement to be completed in 2012 with a view to offshore construction in 2014, depending on lead times for key components at the time.

Subsea noise modelling will incorporate engineering advice on the maximum pile diameter (i.e. the 'loudest' option) to ensure flexibility to use optimum foundation designs is retained.

3.6 Grid Connection

In Scotland, the National Grid is considering two options for connection:

i) whether to invest in multiple connection points, with the individual developers charged separately for connections; or

i) whether to opt for one central point to which all offshore wind farms local to an area would connect (Business Green, 2009).

NnGOWL will be responsible for gaining all the consents and licences required for the transmission infrastructure. However, it is not their responsibility to design, construct and maintain the infrastructure, as this is the responsibility of the Offshore Transmission Owner (OFTO). NnGOWL has submitted an application to National Grid Electricity Transmission (NGET) to connect to the onshore transmission system, naming the connection point, cable route and landfall. NnGOWL will be reimbursed for any costs incurred in gaining the consents and licences. OFTOs will be appointed by an annual tender process on a fixed date, which will be run by Ofgem. Both NGET and NnGOWL will have key roles in the tender process, as the developer will determine what kind of electricity transmission infrastructure is most economic and efficient.

3.6.1 Offshore Cable Route

NnGOWL commissioned a grid connection study by SKM that identified two potential connection sites (SKM, 2008). These are at Cockenzie on the Firth of Forth, where there are lines at 275 kV and 400 kV connecting the coal fired power station, and at Torness, on the east coast south of Dunbar, where two 400 kV lines converge to serve the nuclear power station located there. At this stage of the project, specific locations for new substations have not been identified.

Although a connection point at Tealing was also considered, with an offshore cable route landing at Carnoustie, this was dismissed due to limited capacity early in the process. Once Tealing was ruled out, the preliminary design of the offshore cable routes to Torness and Cockenzie was initiated and completed.

Neart na Gaoithe will require two or three export cables operating at 132 kV. The potential routes that have been identified have been surveyed (geophysical and ecological) to further assess feasibility, although results are pending.

The substations at Torness, and Cockenzie were originally chosen as suitable connection points due to their proximity to Neart na Gaoithe and their coastal locations. NnGOWL commissioned an independent cable engineering consultant to review the offshore cable options for Neart na Gaoithe. The routes proposed are shown in Figure 3-2.

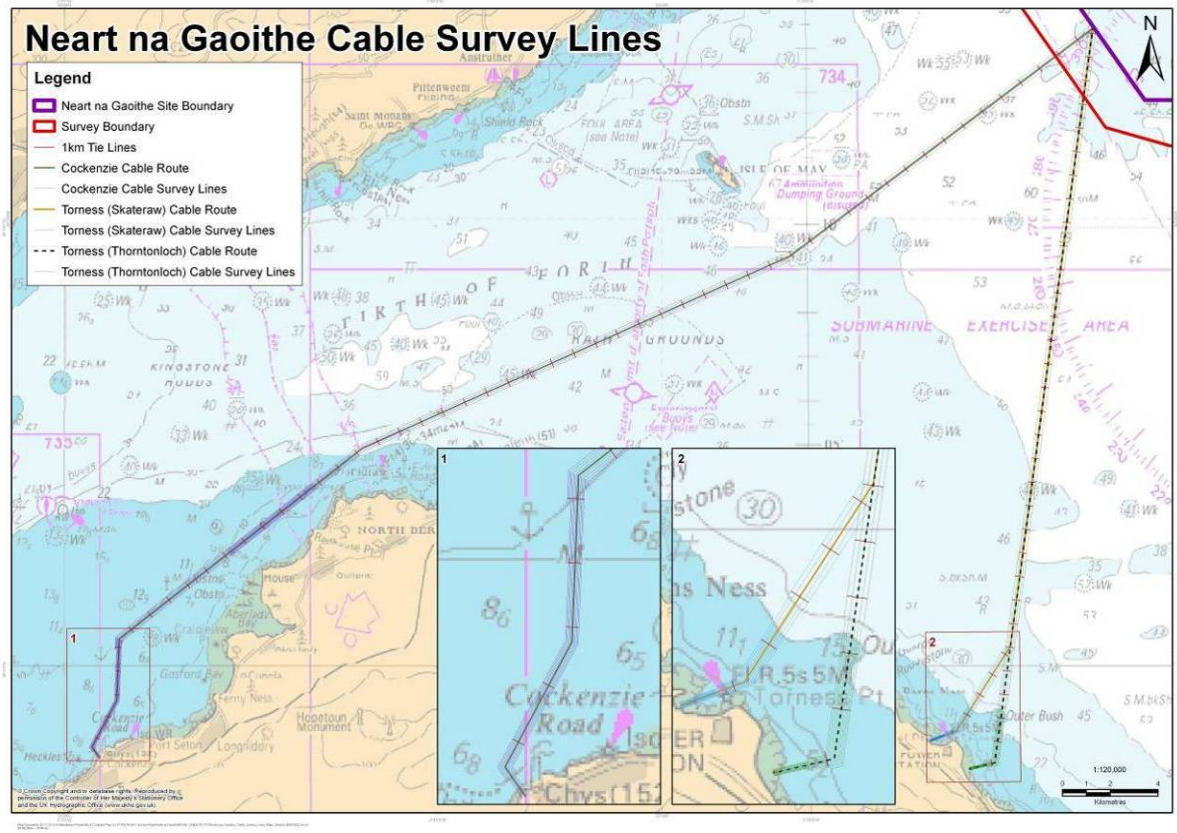


Figure 3-2 Proposed Cable Routes for the Neart na Gaoithe Offshore Wind Farm

Export routes to the two landing zones (Cockenzie (1) and Torness (2)) are similar over much of their route lengths until the 50 m isobath is reached (Connelly Contracting, 2009). From this point the Cockenzie route continues through what is essentially an estuarine environment characterised by shoaling waters, relatively modern sediments and a low relief landing. The Torness routes (2a & 2b) run through more open waters with thinner sediment over bedrock before approaching a rocky shoreline. The route length to either landing at Torness is significantly less than that to Cockenzie. The differences between the Torness Thorntonloch (2a) and Skateraw (2b) landings are not great but negotiating the confined Skateraw 'harbour' may be considered to be an unnecessary complication.

Further details on the each of the offshore cable routes are provided in Appendix A.

3.6.2 Onshore Substation

3.6.2.1 Potential Connection 1 – Cockenzie

Potential for a connection at the existing substation or a new build sub-station in the vicinity of the coal fired power station at Cockenzie has been identified by SKM. However, it should be noted that there is potential for a new gas fired power station at the same location which may reduce the available capacity for the grid connection.

3.6.2.2 Potential Connection 2a and 2b

There are two proposed landings that have been considered at Torness on the basis of suggestions by SKM and Connelly Contracting (2008):

i. Thorntonloch; and

ii. Skateraw harbour.

These would both lead to the same substation for connection.

3.6.2.3 Potential Connection 2a – Torness (Thorntonloch)

A landfall has been proposed on the beach at Thorntonloch, which is approximately 1 km to the south-east of the Torness nuclear power station and 400 kV sub-station site.

There appears to be adequate land in proximity to the power station for a sub-station although the availability of this land is unknown. As an alternative, SKM suggest a sub-station 2.5 km south-west of the village of Innerwick, which itself is 3 km west of the landing. However, there appears to be adequate land closer to the beach with Abnormal Indivisible Loads (AIL) access from the A1 road or by barge via the purpose built quay within the power station compound.

3.6.2.4 Potential Connection 2b – Torness (Skateraw)

An alternative landfall point has been suggested within the 'harbour' at Skateraw, adjacent to the Torness nuclear power station site. The harbour is a natural rocky bay that has been heavily modified by structures built as part of the power station, the most significant of which is the mole and quay complex at the mouth of the bay.

The sub-station site suggested by SKM is 4.5 km to the south-west of the landing; the 400 kV line sealing ends compounds are 2.5 km to the south.

3.7 Operation, Maintenance and Monitoring of Performance

There is likely to be an Operations and Maintenance base in a local port, with workboats to take personnel, tools, and equipment to the site on schedules that require each turbine to be visited between one and four times each year. Unscheduled maintenance will also be required.

4 Physical Environment

4.1 Metocean

4.1.1 General Description

Within the Neart na Gaoithe offshore area, fog is rare in winter, occurring for less than 1% of the time, but this increases to 3-4% of the time in the summer. It is usually associated with warm air over the water, so with winds from the south-east or south-west (UKHO, 2006).

The currents are relatively low, with spring tides only reaching 1 kn (0.514 ms^{-1}) in the Outer Firth of Forth. Within the Firth of Forth, near Rosyth, the currents are 0.7-1.1 ms^{-1} on the ebb, and 0.4-0.7 ms^{-1} on the flood. In general, the flood currents are stronger on the north side of the Firth and the ebb stronger on the southern shore. Consequently, there is a drift towards the west in the northern and central Firth, with an eastward flow along the southern shore. However, if the water near the northern coast becomes stratified in late winter to early spring, this can generate a seaward flow along the northern coastline as well (UK Offshore Energy SEA, 2009).

NEXT modelling of wind and waves showed that the 1% exceedence level for significant wave height in this area was 4.5 m, i.e. that waves remain under 4.5 m for 99% of the time (Offshore Technology Report, 2001). This also showed that there were two predominant directions: from the south-west and from the north. This is due to the dominant wind direction from the south-west creating local waves, but swell waves from the Atlantic coming from the north. Waves reach 4.5 m from both directions. In addition to this, the Angus Shoreline Management Plan lists a 100-year return period extreme wave height of 11.9 m at a distance of 9 km offshore from Montrose (Angus Council, 2004). This report also lists the 100-year return significant wave height 30 km offshore from the Tay Estuary as 8.95 m.

Mainstream commissioned a Wind Study (2008) from Garrad Hassan and partners which calculated the long-term mean wind speed estimates at 80 m AMSL derived from mesoscale modelling and EO data. The mesoscale results for the Neart na Gaoithe site had a minimum of 8.9 ms^{-1}, and maximum of 9.1 ms^{-1}, giving an average of 9.0 ms^{-1} (Garrad Hassan, 2008). The EO data give a mean of 9.2 ms^{-1}, and the Marine Renewables Atlas[1] estimate for the site is 9 ms^{-1}.

As winds tend to funnel along estuaries, such as the Firth of Forth, this can give local increases in winds offshore.

4.1.2 Available Data

In early September 2008, CEFAS deployed a directional waverider in the Outer Firth of Forth (56° 11.33'N, 002° 30.24'W, Figure 4-1) as part of their wavenet monitoring programme, which enables real-time wave direction and height to be viewed via the internet[2].

[1] Marine Renewables Atlas - http://www.renewables-atlas.info/

[2] Cefas Wave Net website link - http://www.cefas.co.uk/data/wavenet.aspx

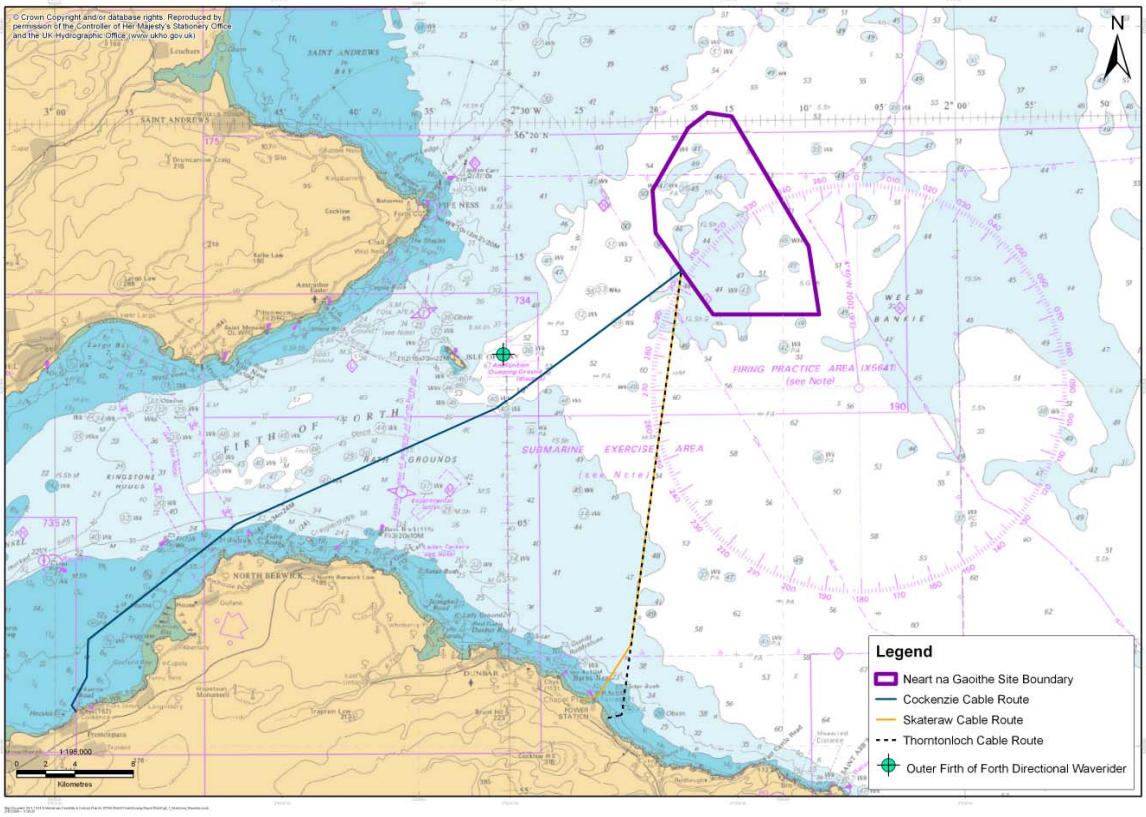


Figure 4-1 Waverider Location in Outer Firth of Forth

Other data sources and marine inventories include:

- BODC (British Oceanographic Data Centre);
- Wave Climate[3];
- BERR Atlas of UK Marine Renewable Energy Resources;
- Tide gauge data available from 1915 – August 2008[4];
- BADC (British Atmospheric Data Centre - atmospheric DAC);
- NERC EODC (Earth Observation Data Centre);
- UK Marine Information Alliance;
- MEDIN (Marine Environmental Data Information Network) formerly MDIP (Marine Data and Information Partnership);
- GLOSS (Global Sea Level Observing System);
- GOOSAG UK (Global Ocean Observing System Action Group);
- UKHO (UK Hydrographic Office);
- IODE (International Oceanographic Data and Information Exchange); and
- OceanNet (MEDIN) (web portal to MEDAG/MDIP/UK GOOS).

[3] Wave Climate Data website - www.waveclimate.com

[4] Proudman Oceanographic Laboratory - www.pol.ac.uk/ntslf/data.html

4.1.3 Method of Assessment

The assessment for oceanographic parameters will use a combination of field measurements and modelling. Significant impacts are difficult to define with regard to waves and currents, and therefore significance is dependent on whether changes in these aspects alter the ecology or sediment regime in a significant way.

The following guidance will be used:

- *Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements*, Version 2 – June 2004, CEFAS 2004.

A suitable model (as detailed in Appendix B) will be set up to determine the currents and waves in the area, and the processes controlling them. This will be validated by the existing datasets that are available plus site specific measurements. The model will cover an area large enough to study both near-field (within the wind farm) and far-field affects, and will also consider changes over the lifetime of the project (nominally 40 years) that would occur without the wind farm present. The oceanographic regime is expected to change over the next forty years due to factors such as 'global warming' and therefore these trends will be predicted to establish whether any observable changes are due to the proposed wind farm or other background changes.

4.1.4 Further Requirements

A data gap analysis study has been undertaken by HR Wallingford to determine exactly what information is required to inform the baseline study and model. Mainstream are working with several other Firth of Forth developers to procure a combined buoy based deployment.

It is anticipated that these site specific current measurements will be collected for a period of at least four months, or as otherwise advised, to inform the physical processes model. Longer term wave data will be acquired from the wavenet system. This will enable a comparison of short-term site specific data with a longer term dataset for more robust analysis.

4.1.5 Potential Mitigation and Monitoring

The turbine foundation structures are likely to alter the wave and current regime locally around each base. To ensure these affects are localised, the turbine spacing in the alignment of the predominant wave and tidal current directions will need to be sufficient to avoid cumulative effects. This will be determined through the modelling process, and incorporated within the proposed wind farm design as appropriate.

Post construction monitoring can be undertaken by deploying a similar instrument to measure currents for the same period, and at the same time of year as the pre-consent measurements. These can then be compared with each other and with the model to establish any noticeable changes. In addition, for long term monitoring, the wavenet data could continue to be studied periodically.

4.1.6 Cumulative Impacts

In the near-field scale, there is the potential for cumulative impacts between turbines as discussed above, which may be avoided by appropriate design of the wind farm. On the larger, far-field scale, there are not considered to be any structures or activities which are currently present to cause cumulative or in-combination effects.

However, due to the potential for three other offshore wind farms in the Outer Forth area, the interactions, particularly where the tidal excursions overlap, will be studied in detail (see Figure 4-2). As the tidal alignment is approximately north/south (with a tendency to north-north-west/south-south-east) the potential interaction with the proposed wind farms to the north and south will need to be considered. However, tidal currents are not particularly strong (of the order of $0.6ms^{-1}$ which will reduce the likelihood of cumulative interactions.

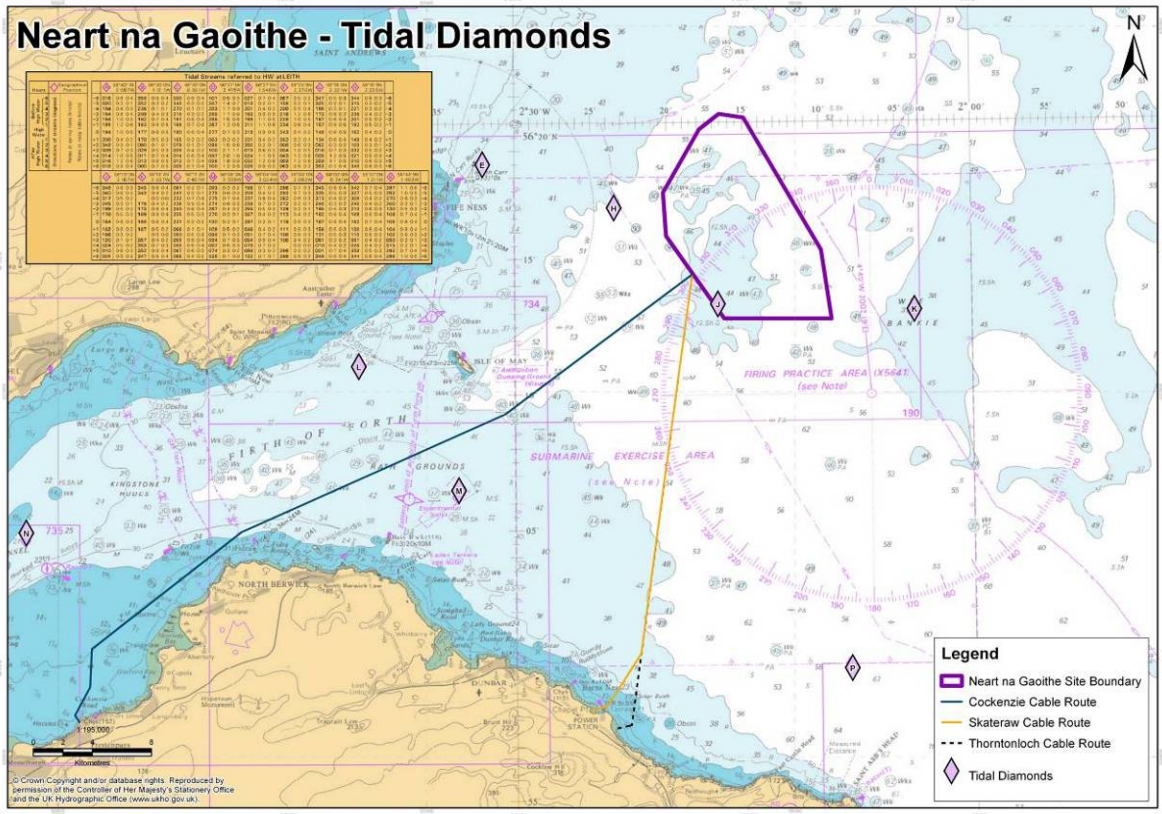


Figure 4-2 Tidal Diamond Information for the Outer Firth of Forth

4.2 Bathymetry

4.2.1 General Description

The seabed directly offshore the Fife Ness headland is the steepest within the Outer Firth of Forth region, descending to 40 m depth approximately 8 km offshore (Figure 4-3). The Neart na Gaoithe site is located on a slightly elevated section of the seabed, where depths range from 44 – 55 m. The deepest water is located along the eastern portion of the site.

4.2.2 Available Data

Data from the Hydrographic Office given on Admiralty Chart 190 and SeaZone Hydrospatial data have been used to assess the bathymetry.

4.2.3 Method of Assessment

A high-resolution swath bathymetry (multibeam) geophysical survey was undertaken in June and July 2009, providing 100% coverage of the survey area. In accordance with the Marine Guidance Note MGN 371, the swath bathymetry data were collected to comply with the International Hydrographic Organisation (IHO) Order 1 standard multibeam bathymetry requirements.

These data will be incorporated with the oceanographic and sediment regime model to predict any potential changes due to the presence of the proposed wind turbines. As with waves and currents, there are likely to be changes that occur over the next 40 years due to background changes, and thus any predicted or observed differences will be considered within the context of these larger scale predicted changes.

Significant impacts would be considered to be the removal or creation of identifiable seabed features such as sandwaves. Particular attention will be given to any changes predicted within nearby navigation routes.

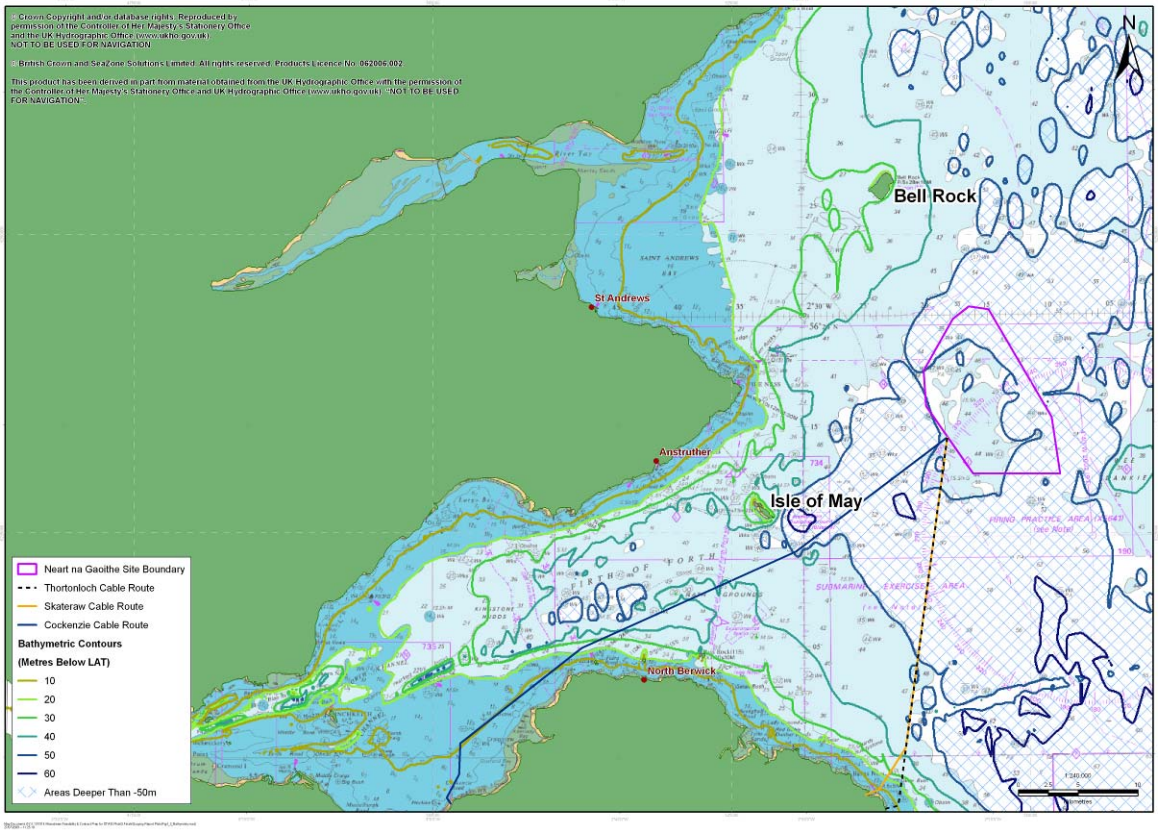


Figure 4-3 Bathymetry of the Surrounding Area

Figure 4-4 shows the bathymetry contours at 2 m depth intervals from 0 to 60 m. The contours are presented in a traffic light colour scheme from green (shallow) to red (deep).

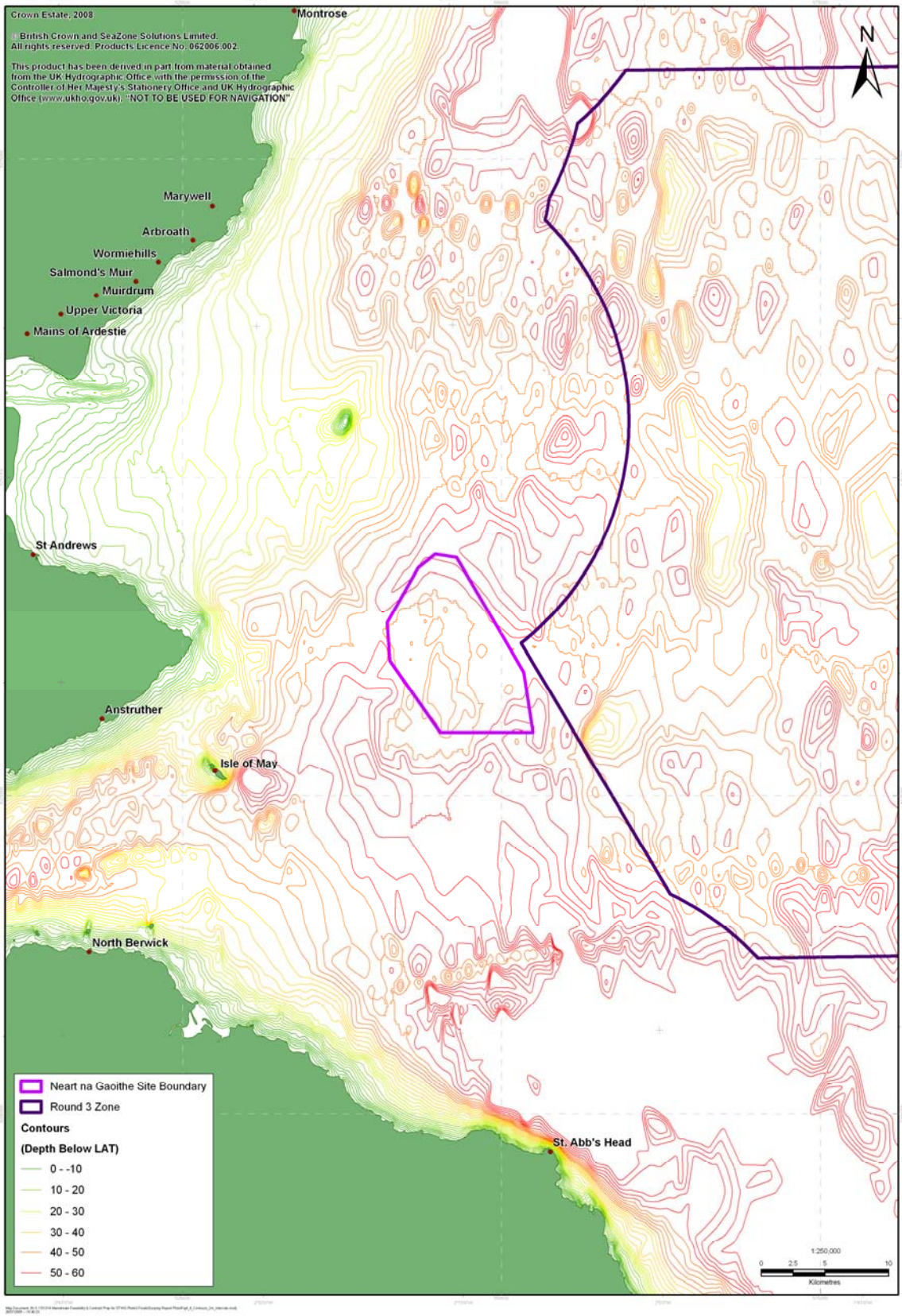


Figure 4-4 **2 m Interval Depth Contours for Neart na Gaoithe**

4.2.4 Further Requirements

The geophysical survey will be analysed across the proposed site and along the cable route. The specifications for this survey are given in Appendix C.

4.2.5 Potential Mitigation and Monitoring

The physical processes modelling will predict any potential changes due to wake and scour effects from the proposed turbines. Similar to the oceanographic mitigation, the spacing of the turbines may be designed to mitigate cumulative interactions. Furthermore, scour protection may be put in place in order to reduce scour associated sediment movement.

4.2.6 Cumulative Impacts

Locally, there is the potential for cumulative impacts between turbines as discussed above, which may be avoided by appropriate wind farm design. In the wider region, there appear to be no structures or activities (e.g. aggregate or channel dredging) which are currently undertaken to cause cumulative or in-combination effects. The results from the oceanographic study will inform whether there is potential for cumulative effects between the four proposed Firth of Forth offshore wind farms.

4.3 Geology

4.3.1 General Description

The Quaternary geology of the area is mostly dominated by the (early Holocene) St Andrews Bay member of the Forth Formation (variable muddy and pebbly estuarine sands and silty muds to muddy fluvial marine sands and silts). There are also localised areas composed of the Wee Bankie Formation, which comprises a cohesive sandy and gravelly till. The Neart na Gaoithe site is located mostly on the Wee Bankie Formation, with the St. Andrews Bay member present along the northern and southern flanks of the site, as shown in Figure 4-5.

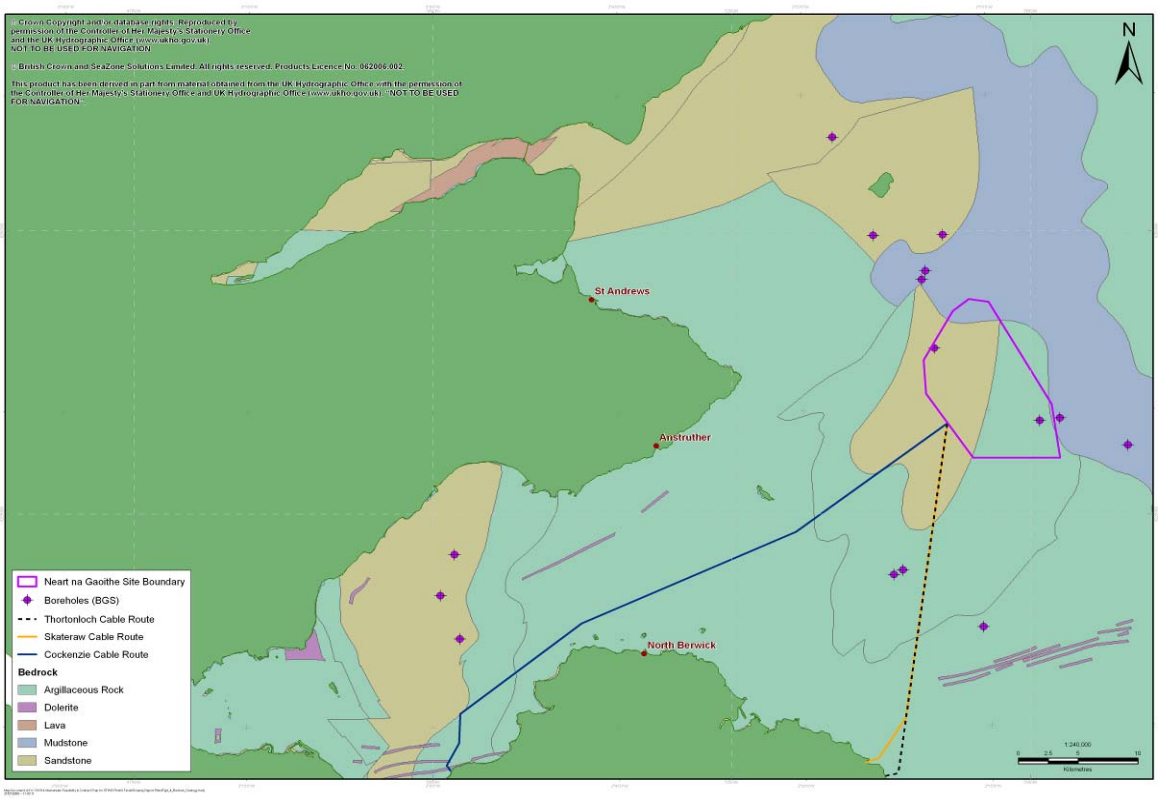


Figure 4-5 Bedrock Geology

4.3.2 Available Data

The preliminary review was undertaken with the following data sources:

- British Geological Survey (1986) Tay Forth 1:250 000 Series Sea Bed Sediments;
- British Geological Survey (1986) Tay Forth 1:250 000 Series Solid Geology;
- British Geological Survey (1987) Tay Forth 1:250 000 Series Quaternary Geology;
- Gatliff, R.W., Richards, P.C., Smith, K., Graham, C.C., McCormac, M., Smith, N.J.P., Long, D., Cameron, T.D.J., Evans, D., Stevenson, A.G., Bulat, J., and Ritchie, J.D. (1994). *United Kingdom offshore regional report: the geology of the central North Sea*. London: HMSO for the British Geological Survey;
- Golledge, N.R. & Stoker, M.S. (2006). *A palaeo-ice stream of the British Ice Sheet in eastern Scotland*. Boreas, 35, 231-243;
- Pantin, H.M. (1991*). The sea-bed sediments around the United Kingdom: their bathymetric and physical environment: grain size, mineral composition and associated bedforms*. British Geological Survey Research Report, SB/90/1;
- British Geological Survey (1984) Marr Bank 1:250.000 Series Seabed Sediments; British Geological Survey (1984) Marr Bank 1:250.000 Series Solid Geology, British Geological Survey (1985) Marr Bank 1:250.000 Series Quaternary Geology; and
- BGS borehole information[5].

Other data sources available include:

- BGS National Geosciences Data Collections (NGDC); and
- DECC Strategic Environmental Assessment 5.

4.3.3 Method of Assessment

A geophysical survey has been undertaken to establish the surface and subsurface geology of the site and the associated cable route. The data will be ground-truthed with available borehole information. The geophysical survey will provide information on the most appropriate foundation design, which will be confirmed by an additional site-specific geotechnical survey.

4.3.4 Further Requirements

To gain a further understanding of the surface and subsurface geology of the site and cable route, the geophysical survey (as described in Appendix C) includes high-resolution sidescan sonar and seismic reflection (boomer) data.

4.3.5 Potential Mitigation and Monitoring

A similar survey may be undertaken post-construction. However, specific mitigation and monitoring are not considered necessary for the geology, since it is not anticipated that the proposed wind farm will have an impact on the geology of the area.

4.3.6 Cumulative Impacts

No impacts on the geology are anticipated and therefore no cumulative impacts are considered.

[5] BGS Borehole Information (http://www.bgs.ac.uk/data/bmd.html)

4.4 Seabed Sediments and Bedforms

4.4.1 General Description

Figure 4-6 shows that the seabed sediments are classified as sand (with some areas of gravelly sand) over much of the site, with muddy sand located to the south and west.

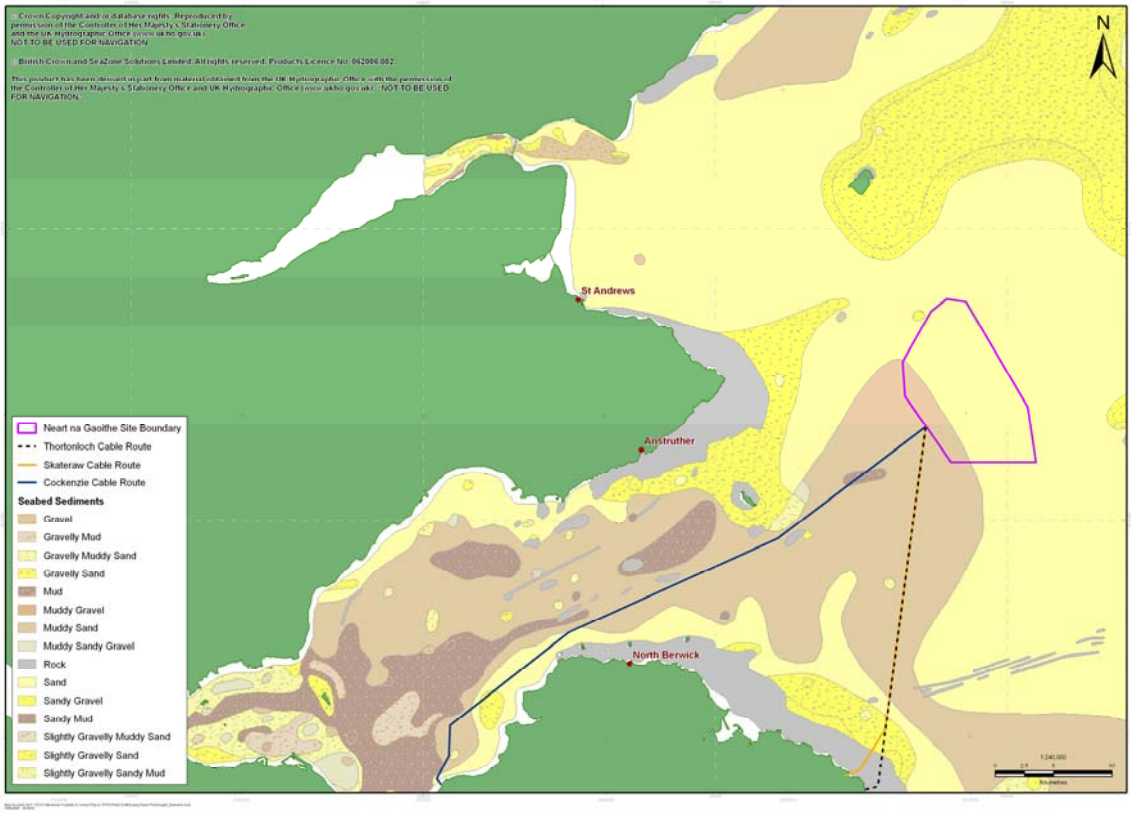


Figure 4-6 Seabed Sediments

An examination of the BGS Seabed Sediments Tay-Forth 1:250.000 Series (1986) map indicates the presence of sinuous sand waves/megaripples, extending as a narrow band across the central portion of the site. The sand waves/megaripples are oriented west-south-west/east-north-east, and are located in areas of both sandy and muddy sediments. A smaller band of linear sand waves/megaripples is located just to the south, and these are oriented mostly south-east/north-west. No other large-scale bedforms are apparent in the site.

4.4.2 Available Data

The following chart was used to characterise the seabed sediments in this area:

- British Geological Survey (1986) Tay Forth 1:250 000 Series Sea Bed Sediments.

4.4.3 Method of Assessment

The geophysical survey included sidescan sonar and Acoustic Ground Discrimination System (AGDS) measurements to determine the nature of the seabed. These were ground-truthed with drop down video and sediment sampling where appropriate. In addition, the swath bathymetry data (see Section 4.2) will further assist in identifying bedforms.

The oceanographic and sediment regime model will identify whether there are likely to be any changes due to the proposed wind farm, with particular attention to scour holes and any changes in navigation routes. Significant impacts would include the removal or creation of identifiable (large-scale) seabed features, e.g. the sandwaves and megaripples.

A further post-construction survey could be used to verify the model predictions. This will be considered further during the EIA process.

4.4.4 Further Requirements

The geophysical survey described in Appendix C will be used to establish and map the range of seabed sediments and bedforms that are present within the site and along the cable route.

4.4.5 Potential Mitigation and Monitoring

The modelling will predict any potential changes due to wake and scour effects from the proposed turbines. As with general bathymetry (see Section 4.2), the spacing of the turbines may be designed to mitigate cumulative interactions. In addition, scour protection may be put in place in order to reduce scour associated sediment movement.

4.4.6 Cumulative Impacts

Locally, there is the potential for cumulative impacts between turbines as discussed above, which may be avoided by appropriate design of the wind farm. In the wider region, there are currently no wind farms or other structures or activities (such as aggregate or channel dredging) which could cause cumulative or in-combination effects. However, the potential for cumulative effects on bedforms with the other proposed Firth of Forth offshore wind farms will be considered.

4.5 Sediment Transport

4.5.1 General Description

In general, sediment is transported when the currents at the seabed are strong enough to entrain the sediment, and then move it from one location to another. Consequently, the environment described in Section 4.1 and 4.4 determine the volume and pathways of sediment transport. In addition to this, storm conditions can alter the usual patterns of sediment transport. The sediment fluxes in the lower Forth have been shown to be related to the tidal cycle (Clarke and Elliot, 1998).

Around Scotland, SNH have divided the coast into a series of 'sediment cells' based on longshore drift observations, and other sediment derived features. Within these cells, sediment can move freely, but at the boundaries of each cell there is a geomorphological constraint that limits the movement of sediment into the next cell. Cells are usually bounded by prominent headlands, or contained within major estuaries. As such, under normal conditions the sediment is contained, and only in exceptional circumstances (such as long periods of a consistent wind, or storm conditions) sediment is transported further along the coast.

These cells are used for shoreline management purposes as activities, which may have an effect on the sediment within a particular cell are unlikely to impact adjacent coastal features.

Within the SNH Advisory Note 72, the coastal cells relevant to Neart na Gaoithe are:

- Cairnbuig Point to Fife Ness; and
- Fife Ness to St. Abb's Head.

4.5.2 Available Data

An initial desk study will be undertaken to identify the available sources of information, including:

- Clarke, S., and Elliott, A. J., (1998) *Modelling Suspended Sediment Concentrations in the Firth of Forth*. Estuarine, Coastal and Shelf Science, 47, 235-250; and
- Cooper, B., and Beiboer, F. (2002) *Potential effects of offshore wind developments on coastal processes.*
- Lambkin, D.O, Harris, J.M, Cooper, W.S, Coates, T *(2009) Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment: Best Practice Guide*

In addition to these, sediment samples have been taken during the benthic ecology survey (Appendix D) and particle size distributions will be determined. There will also be an oceanographic study (see Appendix B) which will incorporate suspended sediment measurements.

4.5.3 Method of Assessment

As mentioned above, a desk study will be undertaken to establish what is already known and available about the sediment regime in the region. This will be augmented by site specific measurements of seabed sediment particle size distributions and suspended sediment concentrations.

This information will then be used to calibrate a physical processes model looking at both near-field and far-field effects. This model will study current, wave, water level and sediment regimes, and the interaction between them. The model will be calibrated to ensure the baseline model is representative of the conditions on site.

The assessment will be undertaken by synthesising structures within the model and comparing the model results with and without these structures in place. In particular, key concerns will be studied; these will reflect stakeholder feedback, but may include:

- Sandbanks and seabed formations, including sandwaves;
- Any areas of sensitive species, and the likelihood of altered sediment deposition/turbidity; and
- Any changes to seabed levels, with particular notice to areas of navigation.

Both direct (e.g. scour around a foundation) and indirect (e.g. a decrease in suspended sediment transport due to lower wave heights) impacts will be assessed. The model will also consider cumulative impacts with other proposed offshore wind farms within the Firth of Forth and any other relevant activities identified through scoping.

The significance of any impacts on physical processes cannot be assessed in an absolute way as a particular change may or may not be important (e.g. a slight, temporary increase in suspended sediment may or may not impact the environment dependent on what other features are there, and what the background regime is). Consequently, the severity of an impact is judged by whether other features are measurably altered, and the context of any change, based on experience.

4.5.4 Further Requirements

A data gap analysis study will be undertaken to identify what further information is required.

The oceanographic data collection will include the deployment of an optical backscatter (OBS) sensor to determine sediment concentrations. This will provide *in situ* data to calibrate the sediment transport model, which is linked to the oceanographic model, as described in Appendix B.

Particle size distribution will be determined from grab samples during the benthic ecology survey.

These inputs will then be combined with measurements of currents and waves and included in regional and site specific model to simulate the environment as it is now, how it will change naturally over the next 40 years, and how the introduction of foundations could potentially alter it.

4.5.5 Potential Mitigation and Monitoring

Localised sediment transport can be minimised by using appropriately designed scour protection to prevent excessive sediment being released into the water column.

During construction, monitoring can be undertaken in downstream locations from the installation works, this will determine whether levels are significantly above background levels due to the construction work. There can be similar monitoring with an OBS sensor post-construction to monitor the suspended sediment levels once the proposed wind farm is operational, which should be compared with the assessment model results.

4.5.6 Cumulative Impacts

Locally, there is the potential for cumulative impacts between turbines if no scour protection is present, but this may be avoided by appropriate design of the offshore wind farm through turbine location and suitable scour protection.

Using the results from the oceanographic assessment, the sediment transport will be assessed with regard to the other potential wind farms in the region. As the tide is expected to be the main influence on sediment transport routes and levels, it is anticipated that the assessment will be highly dependent on the tidal current results.

There are currently no other activities that have been identified locally to cause other cumulative or in-combination impacts, such as aggregate or navigation channel dredging.

5 Biological Environment

5.1 Marine Ecology

5.1.1 General Description

There is considerable information on the distribution and abundance of habitats and associated species (classified into biotopes by some authors) in the Forth Estuary, the coastal and offshore regions of the Firth of Forth, and adjacent areas (e.g. Elliott and Kingston, 1987; Elliot and Taylor, 1989; Brazier *et al.*, 1998; Mair *et al*., 2000; Posford Haskoning, 2002). They provide sufficient information to undertake a regional level assessment, although there are a number of site-specific data gaps.

The benthic ecology on the east coast of Scotland is characteristic of those found throughout many parts of the east coast of the UK. The distinct taxonomic and ecological communities are largely a function of the variable coastline. For example, west of the proposed wind farm site, the Firth of Forth coastline is composed of sandy bays and rocky headlands with extensive cliffed rocky shores. Subtidally, sediments are predominantly sandy, although the more outer parts of the Firth become finer (e.g. either muddy sand or sandy mud). By contrast, there are large parts of the inner Firth that have extensive gravelly deposits.

The nearshore benthic communities in the region are influenced by the Forth Estuary and the outflow of fine sediments. These sediments are transported by the prevailing westerly currents along the north coast and out towards the proposed wind farm site (see Eleftheriou *et al*., 2004). Anthropogenic activities also have an influence. The Firth of Forth is important in terms of navigation and commerce, much of it associated with the petrochemical and oil-refining industries. Consequently, it has been heavily impacted by pollution from the oil industry, general heavy industry and sewage, and through agricultural and urban run off, as well as loss of habitat through land reclamation and coastal defence development.

Many studies describe the strong association that exists between the biota and the physical conditions of estuarine system (e.g. Warwick, 1984; Mettam *et al*., 94; Kirby *et al*., 2004). Physical drivers such as strong salinity gradients, tidal range, turbidity, unstable and mobile sediments, and temperature contribute to the characteristic species found throughout estuarine systems. These strong bio-physical associations are important as the vulnerability of the estuary's biota to change depends on it. The Forth Estuary is no exception (see Elliott and Kingston, 1987*;* Elliot and Taylor, 1989). For example, fine sediments in the intertidal and subtidal zones are typically dominated by species tolerant of saline conditions at the top of the estuary. The lower estuary is dominated by species typical of intertidal mudflats and so provides an important source of food for overwintering birds and nursery grounds for many fish species.

The most significant factors driving benthic habitat distribution and species composition is bottom substrate, and to a lesser extent tidal currents. Distinct benthic species assemblages that characterise the region include, for example, an *Abra* community, *Echinocardium-filiformis* group (Petersen, 1914), *Venus* community, and a *Modiolus* community. *Abra* communities are typically found on muddy sand bottoms rich in organic material and generally occupy sheltered estuarine conditions. By contrast, the species *Modiolus modiolus* can form large beds, which if substantial can be designated as a biogenic reef under the Habitats Directive. However, no beds have been designated in the Firth of Forth (see Mair *et al*., 2000).

These and other characteristic habitats and biotopes and their species (recorded using the UK Marine Habitat Classification system of Connor *et al*., 2004) in the region and within the proposed wind farm site are summarised in Table 5-1. Note that the Marine Nature Conservation Review programme (Brazier *et al,* 1998), and the National Biodiversity Network (NBN) and Mapping European Seabed Habitats (MESH) programmes identified a number of benthic habitats of conservation interest within the Firth of Forth and around the Isle of May (including designation of a cSAC, and broadscale biotopes as part of the Forth Spatial Study). This included areas to the south of the proposed wind farm site on the St. Abbs ex-dumping grounds and off the coast of North Berwick.

Location	General habitat description and key species
Forth Estuary	**Intertidal areas:** Characteristic species include the cockle *Cerastoderma edule*, Baltic tellin *Macoma baltica*, polychaetes *Pygiospio elegans*, *Scoloplos armiger*, *Eteone flava*, *Nephtys caeca*, *N. incisa*, *N. pente*, *N,. hombergii*, *Ophelina acuminata*, *Pholoe inornata* and *Neoamphitrite figulus* with spider crabs *Hyas arenarius* and swimming crabs *Liocarcinus depurator*, *L. holsatus*, a few brown crab *Cancer pagurus* and the green shore crab *Carcinus maenas*. **Subtidal areas:** Species include the polychaete worms *Nephtys hombergii* and *Polydora ciliata*, the echiuran *Echiurus echiurus*, the bivalve *Abra alba*, and the oligochaete *Tubificoides scoticus*. A characteristic biotope is **LS.LMu.MEst** (polychaete/bivalve-dominated communities) found within mid estuarine mud shores.
Firth of Forth	**Inchkeith into Largo Bay**: Abra community with variants form the largest group, although an *Echinocardium-filiformis* is also associated with this community and is found in broad bands. **North and south coasts of the firth near Largo and Aberlady Bays**: A Venus community formed in bands offshore. **Northern and southern sides of the outer limits of the Firth**: *A Crenella* association (characterised by the bivalves *Crenella decussata* and *Timoclea ovata*, and an amphipod *Metaphoxus fultoni* recorded at these locations. **West near the bridges**: A classical Modiolus association with a local but substantial population of adult horse mussels was found. Community includes bivalves Tapes (*Venerupis) rhomboides*, the crab *Pisidia longicornis* and the brittle star *Amphipholis squamata*.
In the vicinity of the proposed wind farm site	**Subtidal habitats**: To the west of the proposed wind farm site include the biotopes SS.SMu (sublittoral cohesive muds and sandy mud communities). This is similar to the muddy habitats and associated communities found within the Forth Estuary. To the north-west of the proposed site contains a mixture of communities, although the dominant biotope recorded is **SS.SSa.CMuSa.AalbNuc** (*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand and slightly mixed sediment) and SS.SMu.CSaMu.ThyNten (*Thyasira* spp. and *Nuculoma tenuis* in circalittoral sandy mud). To the south-west towards North Berwick, offshore biotopes include **SS.SSa.IMuSa.FfabMag** (*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand), **SS.SMu.CSaMu.AfilMysAnit** (*Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral sandy mud) and **SS.SMx.CMx.MysThyMx** (*Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment). The ross worm *Sabellaria spinulosa* is very common in the North Sea and has been recorded in the region of the proposed wind farm. The ross worm itself is not a protected animal, although the biogenic reef structures the worms create under specific environmental conditions are in the Habitats Directive as an Annex I habitat of conservation importance.
Within the wind farm site	A few samples collected within site recorded the biotopes **SS.SMx.CMx** (Circalittoral mixed sediments), although it is possible that all or some of the communities listed above will be present within the wind farm site. There are no known or potential *Sabellaria spinulosa* biogenic reefs reported within the vicinity of the wind farm site.
Bell Rock	This area was a sewage sludge dumping ground and was described in 1991 as an offshore impacted muddy sand habitat dominated by bivalves and polychaetes including *Pholoe inornata*, *Prionospio fallax*, *Spio decorata*, *Spiophanes bombyx*, *Mediomastus fragilis*, *Nuculoma tenuis*, *Mysella bidentata*, *Amphiura filiformis*. The biotope logged in the vicinity of Bell Rock is SS.SMx.CMx.MysThyMx (*Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment).

The coast from North Berwick in Lothian to Flamborough Head (Yorkshire)	**Off North Berwick**: Biotopes include **CR.MCR.EcCr.FaAlCr.Bri** (Brittlestars on faunal and algal encrusted exposed to moderately wave-exposed circalittoral rock), **SS.SMx.CMx.MysThyMx**, **SS.SMu.CSaMu.AfilMysAnit**, **SS.SSa.IMuSa.EcorEns** (*Echinocardium cordatum* and *Ensis* spp. in lower shore and shallow sublittoral slightly muddy fine sand), **SS.SCS.ICS.SLan** (Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand), **SS.SSa.CMuSa.AalbNuc** and further offshore **SS.SBR.PoR.SspiMx** (*Sabellaria spinulosa* on stable circalittoral mixed sediment). **Isle of May**: Site specific studies using grab, diver and video data have been used to characterise kelp habitats and biotopes. This includes kelp forests and encrusting red algae on bedrock with flat surfaces and crevices associated with sea urchins, limpets, mussels and crabs. **1 km to the east of the island:** Mixed shelly gravel (**SS.SMx.CMx**) with patchy cobbles and small boulders (**SS.SCS.CCS**). The habitat contains frequent stands of dead man's fingers *Alcyonium digitatum*, erect hydroids, abundant brittlestars including *Ophiura albida* and *Ophiothrix fragilis*, common starfish *Asterias rubens*, sea urchins *Echinus esculentus*, sea cucumbers *Neopentadactyl mixta*, swimming crabs *Necora puber* and hermit crabs *Pagurus* spp. **Silver Sands on the northern end of the island**: Small populations of the horse mussel *Modiolus modiolus*. **Off the Isle of May and at the St. Abbs ex-dumping grounds**: Biotopes include **SS.SMu.CFiMu.BlyrAchi** (*Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud) and **SS.SMu.CFiMu.SpnMeg** (Sea pens and burrowing megafauna in circalittoral fine mud). It is possible that more examples of these biotopes are within the muddy zones in the vicinity of the proposed wind farm site. Sea pens have been afforded a UK Biodiversity Action Plan (UKBAP) under the 'Mud Habitats in Deep Water Action Plan'.

Table 5-1 Summary of the characteristic habitats, biotopes and associated species

5.1.2 Available Data

Many previous marine ecology studies in the region have been undertaken on the Firth of Forth by the Universities of Stirling and Heriot Watt, Napier College (now Napier University) and the Forth River Purification Board (FRPB, now incorporated into SEPA). This research is ongoing, although the greatest effort took place in the late 1970s and early 1980s (see Eleftheriou *et al.,* 2004).

Much of the existing data on species present is freely available to view online using the NBN Gateway website[6]. The online mapping facility MESH webGIS[7] comprises coastline and administrative areas, physical data (bathymetry, seabed geology), validation samples, seabed images, modelled outputs, seabed habitat data and biological sample data. The DECC SEA 5 report also provides a summary of the research and the data available for the region, and more specifically a report commissioned by SNH provides data for the intertidal habitats for the majority of the Firth of Forth (Posford Haskoning, 2002).

The following data sources were used to undertake the review on marine ecology:

- Elliot, M & Taylor, C.J.L. (1989) JNCC Marine Habitat Classification;. *The production ecology of the subtidal benthos of the Forth Estuary, Scotland*. Scientia Marina 53: 531-541;
- Hughes, D.J. (1998). *Sea Pens and Burrowing Megafauna (Vol III) – An Overview of Dynamics and Sensitivity Characteristics for Conservation Management of Marine SACs*. Scottish Association for Marine Science (UK Marine SACs Project). Pp. 105.
- MESH (Mapping European Seabed Habitats);
- NBN (National Biodiversity Network);
- Mair, J.M., Moore, C.G., Kingston, P.F. & Harries, D.B. (2000) *A review of the status, ecology and conservation of horse mussel Modiouls modiolus beds in Scotland*. Scottish Natural Heritage Commissioned Report F99PA08;

[6] NBN Gateway (http://data.nbn.org.uk/)

[7] MESH (http://www.searchmesh.net)

- Elliott M & Kingston PF, (1987). *The sublittoral benthos of the estuary and Firth of Forth, Scotland* in The Natural Environment of the Estuary and Firth of Forth, Proceedings of the Royal Society of Edinburgh **93B,** 449 – 465;
- Posford Haskoning (2002) *Broad scale intertidal survey of the Firth of Forth*. Scottish Natural Heritage Commissioned Report F01AA407;
- DECC SEA5 Eletheriou *et al.*, 2004[8];
- MarLIN Marine Life Information Network; and
- DASSH (Data Archive for Seabed Species and Habitats).

Whilst there is good coverage of data for the Firth of Forth, there are data gaps for the surrounding 'non-targeted' seabed in and around the proposed wind farm site itself, which will need further description. Site-specific data will be required for the site application and monitoring as appropriate, particularly with respect to potentially important habitats.

5.1.3 Method of Assessment

The assessment of impacts generated by the proposed wind farm development will require an overview of habitats and species (classified into biotopes where appropriate) in and around the development site. This needs to be assessed in the context of the wider environment. Data exists on the MarLIN website to allow an assessment of the sensitivities of individual biotopes and species to be included as part of any impact assessment.

In addition, information acquired by Acoustic Ground Discrimination Systems (AGDS) as part of the geophysical survey (Appendix C) will be used to augment and interpolate data collected from the site-specific benthic ecology surveys (Appendix D). These data will be sufficiently detailed to characterise the ecology of the site and cable route, including the intertidal area where the cable comes ashore.

The surveys utilised drop down video camera to assist in identifying the structural component of key habitats not captured when using grab samples. Where sensitive habitats are detected, no intrusive techniques were used, elsewhere grab samples were taken to identify the species present. To better understand the more mobile and sessile epibentic and demersal fish communities, a trawling programme using a 2 metre scientific beam trawl was undertaken alongside the benthic ecology surveys. Size and sexing measurements to assess the structure of the fish populations and the benthic sessile and mobile megafaunal communities in and around the proposed wind farm site and at several locations along the cable route, was also undertaken. Data collected included commercial fish and shellfish species were processed using Cefas protocols.

The construction of Neart na Gaoithe, including the installation of foundations and scour protection (if required), noise from piling and cable laying, could cause physical disturbance to sediment and benthos (e.g. crushing, damage, displacement of individuals into water column), habitat alteration, and suspension of fine sediment. More specifically, the assessment of potential impacts to the benthos will need to take account of the following potential impacts:

- Changes to the local hydrodynamic regime following turbine installation, which may affect the distribution and abundance of species;
- Colonisation of hard structures by epifaunal benthos; and
- Interaction with other anthropogenic activities (in-combination impacts).

The assessment of impacts will be undertaken using internationally recognised assessment protocols and guidance from the following sources:

- Federal Maritime and Hydrographic Agency (2003) *Standards for Environmental Impact Assessments - Impacts of offshore wind turbines on the marine environment* Status: 25. February 2003, Issued by Bundesamt für Seeschifffahrt und Hydrographie BSH[9];

[8] UK Offshore SEA (www.offshore-sea.org.uk/consultations/ SEA_5/SEA5_TR_Benthos_Elef.pdf)

- Davies, J., Baxter, J., Bradley, M., Connor, D., Khan, J., Murray, E., Sanderson, W., Turnbull, C. & Vincent, M., (2001), *Marine Monitoring Handbook*, 405 pp, ISBN 1 85716 550 0;
- JNCC, (2004), *Common Standards Monitoring Guidance for Marine*, Version August 2004, ISSN 1743-8160;
- Styles, P., Holt, T., and Thorne, P. (2001) *Assessment Of The Effects Of Noise And Vibration From Offshore Wind Farms On Marine Wildlife.* Department of Trade and Industry, Energy Technology Support Unit (DTI/ETSU) report w/13/00566/REP[10].

5.1.4 Further Requirements

The AGDS surveys were undertaken as part of the geophysical survey (Appendix C) and a further survey for the benthic ecology has been undertaken as described in Appendix D. The relative importance and sensitivity of habitats or species will be described using classifications such as whether species/habitats would qualify as Special Areas of Conservation (SAC) under the EU Habitats Directive or are considered using Species Action Plans (SAP) through UK Biodiversity Legislation. Potential Mitigation and Monitoring

Baseline environmental conditions for the proposed wind farm site will be established prior to construction and installation of the turbines with control sites established away from the impact zones. The cable route from the wind farm to the mainland has also been surveyed. The programme of baseline and regular monitoring post-installation will be agreed prior to installation and progressed post-installation to establish the immediate and long term effects of the construction and any recovery/evolution of the impacted site.

To mitigate the immediate disturbance to the communities and reduce impact at the construction stage, consideration will be made on the timing of the installation programme, Micro-siting of turbines and cabling may also be possible to avoid impacts to any sensitive features found as part of the surveys undertaken.

5.1.5 Cumulative Impacts

The potential for cumulative impacts exists between turbines, such as a change to the local current regime and new localised physical stresses, such as scouring or changes to local sediment deposition around the turbines. These may be lessened by appropriate design of the wind farm and scour protection as mentioned in previous sections. The turbines themselves may become surfaces for settlement of species otherwise excluded from the area and thus change the community dynamics of the existing system over the time they are present. The effect of the cable and any electrical emissions on marine fauna and their migratory routes will need to be evaluated. In the wider region, cumulative and/or in-combination effects from any other structures or activities currently present are unlikely to be significant. However, the presence of the other proposed offshore wind farms will need to be assessed for overall impact on benthic habitats and their species.

5.2 Fish and Shellfish Ecology

5.2.1 General Description

The fish in the Firth of Forth region follow a tidal and seasonal pattern of distribution with many species using the Forth Estuary and the Firth of Forth as an overwintering ground and for feeding, breeding and as a nursery. Many species of fish migrate in and out of the Forth Estuary and may pass over or remain for periods of time within the vicinity of the proposed offshore wind farm site. Fish in the estuary are typical of north-eastern Atlantic temperate estuaries (Greenwood and Hill, 2003). In the estuary, 36 species have been identified of which 28 were mainly marine adventitious species (Elliott *et al.,* 1990). These species are not observed below salinities of $30^{o}/_{oo}$ and diadromuos species, which migrate through the estuary to breed either in the sea or freshwater, are found in the upper reaches of the estuary.

[9] FMHA, 2003 (http://www.offshorewindenergy.org/reports/report_032.pdf)

[10] JNCC, 2004 (http://www.berr.gov.uk/files/file20261.pdf)

Mussels *Mytilus edulis* are plentiful in the Montrose Basin, along the south shore of the Firth of Tay at Tayport, in the Eden Estuary and along the south shore of the Firth of Forth (Doody, 1997). Stocks of lobster *Homarus gammarus* are found inshore on rocky substrate; juvenile edible crab *Cancer pagurus* are found on soft substrates within the estuaries, although the adults occur further offshore, and velvet crab *Necora puber* occur throughout the inshore area (Doody, 1997). Offshore there is a large population of Nephrops ('scampi'), and scallops *Pecten maximus* also occur in a large area offshore (Doody, 1997). The Atlantic salmon *Salmo salar* and sea trout *S. trutta* are present in large numbers in most rivers in the region and are especially abundant in the River Tay (Doody, 1997).

The ten most common demersal fish collected during a 1982-2001 Agassiz trawling programme in the mid/ lower Forth estuary are whiting (*Merlangius merlangus*), dab (*Limanda limanda*), pogge (*Agonus cataphractus*), Scorpion fish (*Myoxocephalus scorpius*), gobies (*Pomatischstus* spp.), sea snail (*Liparis liparis*), plaice (*Pleuronectes platessa*), flounder (*Platichthys flesus*), eelpout (*Zoarces viviparus*) and cod (*Gadus morhua*) (Greenwood and Hill, 2003). The distributions of all the fish species change with the tidal regime, month and location along the estuary.

Elliott *et al.,* (1990) assessed the seasonal and temporal patterns in the use of the estuary by several species to describe the long-term changes in their populations. The marine teleost species depending on the estuary are:

- Common dab and plaice (flatfish whose juveniles use the estuary as a nursery area; marine juvenile migrants);
- Whiting and cod (demersal gadoids which use the estuary as a nursery area although adults are present in low numbers; marine juvenile migrants); and
- Sprat and herring (pelagic clupeids which overwinter in the estuary; marine seasonal migrants).

Small numbers of Atlantic salmon (*Salmo salar*), sea trout (*Salmo trutta*), smelt (*Osmerus eperlanus*) and European eel (*Anguilla anguilla*) are also found within the estuary. Monkfish or Angelshark (*Squatina squatina*) are reported around the Isle of May at the mouth of the estuary.

Many fish feed on the brown shrimp *Crangon crangon*, the mysid *Neomysis integer* and pink shrimp *Pandulus montagui*. However, some fish have more specific feeding preferences such as juvenile cod and whiting, which feed on epibenthic crustaceans (Crossan, 1985; unpubl. data), although these vary across sites and between seasons due to prey availability.

5.2.1.1 Spawning and Nursery Areas

The Firth of Forth has a small nursery area for juvenile herring (originating from the spawning grounds off the west coast of Scotland) and, in common with the other shallow inlets in the region, is an overwintering ground for sprat *Sprattus sprattus* (Doody, 1997). A number of fish species spawn or have nursery grounds overlapping the study area. The proposed site is at the southerly edge of the lesser sandeel (*Ammodytes marinus*) spawning grounds, which spawn from November to February. Table 5-2 details the spawning periods for the species that are present in the Firth of Forth near to Neart na Gaoithe.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Whiting		X	X	X	X	X						
Plaice	X	X	X									
Lemon Sole				X	X	X	X	X	X			
Sandeel	X	X									X	X
Nephrops	X	X	X	X	X	X	X	X	X	X	X	X

Table 5-2 Spawning Periods for Species in the Firth of Forth

Source: Coull et al., 1998

Figure 5-1 shows the spawning and nursery areas in the vicinity of Neart na Gaoithe.

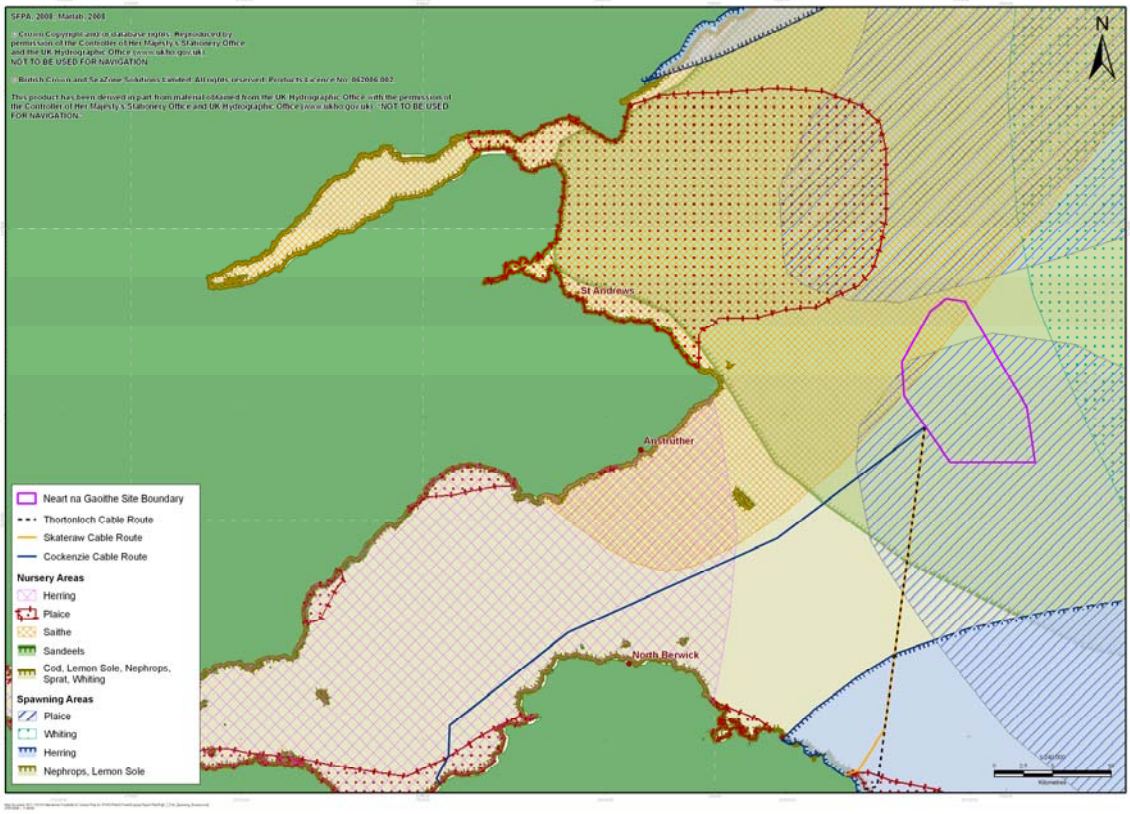


Figure 5-1 Fish Spawning and Nursery Areas

Sandeel nursery grounds range over the whole study area from Wee Bankie and Marr Bank, north to Montrose and at least 30 km offshore. Wee Bankie and Marr Bank have been extensively fished for sandeel; however, there is a temporary exclusion zone in place for sandeels along the east coast to allow the fish population to recover. This has been in place since 2000 and is regularly reviewed. Lemon sole (*Microstomus kitt*) have extensive spawning and nursery grounds all along the east coast of Scotland including the study area itself with spawning occurring from April to September. Plaice spawn from December to March on grounds located just to the east of the proposed site; however, the plaice have their nursery grounds within and around the Forth Estuary ranging into and over the study area. A herring (*Clupea harengis*) nursery ground is located within the Forth Estuary, however its estimated limits do not reach as far offshore as the Neart na Gaoithe site. Other fish whose nursery grounds are extensive along the east coast of Scotland and thus overlap the study area are cod, whiting, saithe (*Pollachius virens*) and sprat (*Sprattus sprattus*). Cod, herring, plaice and lemon sole are all listed in the North Sea under the UK Biodiversity Action Plan - Grouped Plan for Commercial Marine Fish as stocks have been in general decline in the whole North Sea since their maximum in the 1970s and 1980s. The bony fish, Atlantic salmon, sea trout, European eel, smelt and the lesser sandeel are also listed as UK Priority Species

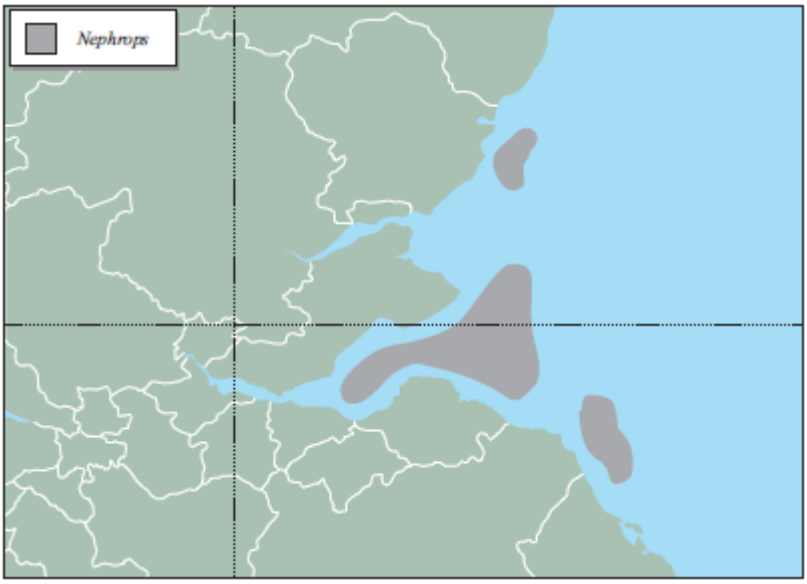


Figure 5-2 The distribution of *Nephrops*. Source: SOAEFD (in Robson, C.F. 1997).

5.2.1.2 Shellfish

Dublin Bay prawns (or langoustine) *Nephrops norvegicus* are found around St. Abbs Head and within the Forth Estuary, and are often associated with sea pen populations in muds (Figure 5-2). The *nephrops* spawning and nursery grounds are within the region, in suitable soft muddy habitats. Their extended spawning period lasts all year, peaking from April to June.

Lobster and edible crab are present in rocky reef habitat with crevices for protection (Robson, 1997). This habitat occurs off the east coast of the Firth of Forth, including around Bell Rock.

Compared to lobsters, edible crabs are often found on softer substrates (sand/gravel to rock). Juveniles tend to be found inshore and adults further offshore (Rees & Dare, 1993 in Robson, 1997). Velvet crabs can be found in the same areas as lobster and edible crabs.

Mussels are found around most of the east Scottish coast, from the mid shore to the subtidal zone in water of normal or variable salinity and in areas exposed to water currents. The south shore of the Firth of Forth is an important area for mussels. Cockles are found in the intertidal mud and sandflats of the estuaries in this region. Periwinkles are found on rocky shorelines, wherever suitable habitat is present. Scallops and queen scallops live on sandy/gravelly areas of sea bed. Important populations of scallops are present in a large area off the coast of the region and around the Isle of May. Whelks are widely distributed throughout the region, with *Neptunea* being rather more common in the more offshore areas. Concentrations of squid occur seasonally and octopus is also present in the region. Razor shells occur in the inshore areas of the Firths where the seabed is clean sand.

5.2.2 Available Data

The preliminary review was undertaken with the following data and literature sources:

- Callaway, R., Alsvåg, J., de Boois, I., Cotter, J., Ford, A., Hinz, H., Jennings, S., Kröncke, I., Lancaster, J., Piet, G., Prince, P. & Ehrich, S. (2002). *Diversity and Community Structure of the Epibenthic Invertebrates and Fish in the North Sea*. ICES J. Mar. Sci. 59: 1199-1214;
- Coull, K.A., Johnstone, R., and S.I. Rogers. 1998. *Fisheries Sensitivity Maps in British Waters. Published and distributed by UKOOA Ltd*.;
- Daan, N., Bromley, P.J., Hislop, J.R.G and Nielsen, N.A. (1990). *Ecology of North Sea Fish*. Neth. J. Sea. Res. 26 (2-4): 343-386;

- Ecological information and conservation status of UK species is also on the MarLIN website[11] and on the UK Biodiversity Action Plan website[12];
- Elliott, M., O'Reilly, M. G., and Taylor, C. J. L., *The Forth Estuary: a nursery and overwintering area for North Sea fishes*. Hydrobiologia 195: 89 – 103, 1990. Kluwer Academic Publishers;
- Fisheries Research Services (FRS) dedicated webpages on fish and shellfish[13];
- Greenwood M. F. D.; HILL A. S.; (2003). *Temporal, spatial and tidal influences on benthic and demersal fish abundance in the Forth estuary*. Estuarine, coastal and shelf science ISSN 0272-7714 CODEN ECSSD3. 2003, vol. 58, no2, pp. 211-225 [15 page(s) (article)] (1 p.1/4). Elsevier, London, ROYAUME-UNI (1981) (Revue)
- iSEA Maps[14];
- Fishbase online database[15];
- CEFAS web pages[16];
- Aquarium project[17];
- Robson, C.F. 1997. Chapter 5.5 *Exploited Sea Bed Species. In: Coasts and seas of the United Kingdom. Region 4 South-east Scotland: Montrose to Eyemouth*, ed. by J.H. Barne, C.F. Robson, S.S. Kaznowska, J.P. Doody, N.C. Davidson & A.L. Buck, 61-64. Peterborough, Joint Nature Conservation Committee. (Coastal Directories Series.); and
- Wanless, S., Harris, M.P. & Greenstreet, S.P.R. (1998). *Summer sandeel consumption by seabirds breeding in the Firth of Forth, south-east Scotland*. ICES J.Mar.Sci. 55: 1141-1151.

Other available data sources and literature include:

- CMACS (2003) *A baseline assessment of electromagnetic fields generated by offshore wind farm cables.* COWRIE Report EMF - 01-2002 66;
- DECC SEA5 and other DECC studies (Marine Renewable Research Advisory Group);
- European Review of Environmental Research on Offshore Wind Energy (2006). *Offshore Wind Energy*, published by Springer Berlin Heidelberg, ISBN 978-3-540-34676-0(Print) Part 9, Pages 331-341;
- Gill, A.B., Taylor, H., (2001) *The potential effects of EM fields generated by cabling between offshore wind turbines upon elasmobranches.*
- Gill, A.B., Gloyne-Phillips, I., Neal, K.J. & Kimber, J.A. (2005) *The potential effects of electromagnetic fields generated by sub-sea power cables associated with offshore wind farm developments on electrically and magnetically sensitive marine organisms – a review*. COWRIE-EM FIELD 2-06-2004, COWRIE 1.5;

[11] MARLIN website - www.marlin.ac.uk

[12] UK BAP website - www.ukbap.org.uk

[13] FRS Scotland website - http://www.frs-scotland.gov.uk

[14] ICES Maps available from www.cefas.co.uk

[15] FishBase - www.fishbase.org

[16] Cefas - www.cefas.co.uk

[17] Aquarium project www.web.ukonline.co.uk/aquarium

- Greenwood, M.F.D., Hill, A.S., and McLusky, D.S., *Trends in abundance of benthic and demersal fish populations of the Lower Forth Estuary, East Scotland*, from 1982 – 2001. Journal of Fish Biology (2002) 61 (Supplement A), 90-104;
- Food and Agriculture Organization of the United Nations website on fish biology / ecology[18];
- Marlab / FRS Leaflet on nephrops in the Firth of Forth[19];
- Mathieson S.; Berry A. J.; *Spatial, temporal and tidal variation in crab populations in the Forth Estuary, Scotland*. Journal of the Marine Biological Association of the United Kingdom ISSN 0025-3154 CODEN JMBAAK. 1997, vol. 77, no 1, pp. 1-158 (155 p.) (1 p.1/2), pp. 167-183;
- National Biodiversity Network (NBN) Gateway;
- Wheeler, A (1969). *The fishes of the British Isles and North-west Europe*. Michigan State University Press, 613pp.; and
- Whitehead, P.J.P., Bauchot, M.L/. Hureau, J.C., Neilsen, J. and Tortonese, E. (Eds.) (1984). *Fishes of the North-eastern Atlantic and the Mediterranean*, Vol. 1-3. UNESCO, Paris, 1473pp.

5.2.3 Method of Assessment

The fish and shellfish ecology element of the EIA will be approached in three ways: 1) data collation, 2) field surveys and 3) consultation.

The data collation stage will build on the description above and draw on the information on fish and shellfish for the UK coastal zone, namely, in published documents, scientific reports and commercial fisheries information. This will be augmented through 2m beam trawl measurements during the benthic ecology survey, as described in Appendix D.

The EIA will assess this information to determine the presence, distribution and seasonality of the fish and shellfish resources. Species of fish in the area that are of conservation importance will be considered. Elasmobranch fish in the area and cable route will be identified and potential impacts considered. In addition, species that have a restricted geographical distribution and are locally abundant in the area will be assessed. When the important fish and shellfish species present at or near the wind farm site have been identified, aspects of their ecology that may be affected by construction will be determined. For fish and shellfish, the following aspects of their ecology will be assessed where relevant:

- Spawning grounds;
- Nursery grounds;
- Feeding grounds; and
- Migration routes.

Modelling techniques will be used to assess noise impact on hearing specialists, as described in Section 5.4.

In parallel, NnGOWL will undertake consultation with Marine Scotland (FRS and SFPA) to ensure that all data sources are identified, and that the assessment addresses the relevant concerns for this area.

5.2.4 Further Requirements

If a joint effort for data collation in the Firth of Forth is agreed between the developers, then a standardised approach to fish and fisheries data collection will be employed to facilitate comparison between areas. This approach will enable assessment of cumulative impacts from nearby proposed wind farms.

[18] Food and Agriculture Organization of the United Nations - http://www.fao.org/fishery/en

[19] http://www.marlab.ac.uk/FRS.Web/Uploads/Documents/FM18Nephrop%20North%20Sea.pdf, http://www.frs-scotland.gov.uk/FRS.Web/Uploads/Documents/FM19NephropBiology.pdf

The cables of an offshore wind farm will generate an electro-magnetic field. Studies to date have not demonstrated any impact on fish and shellfish, however there remains a theoretical possibility that an impact could occur. There may be the requirement for further studies to ensure impact is limited.

5.2.5 Potential Mitigation and Monitoring

Changes in local fish populations within the area and associated megafauna can be assessed through scientific beam trawling as part of the ecological monitoring programme.

For some previous projects, a buffer zone has been placed around herring spawning grounds to minimise impacts. However, buffer zones have not been employed around nursery areas, as it is assumed that juvenile herring will move away from the sound source and spawning behaviour will not be affected. Other species, such as cod, spawn in the water column or over a wide area encompassing a number of substrate types, reducing their potential to be affected by wind farm or other localised developments.

The use of a buffer zone has large impacts on the viability of many projects and its use may not always be necessary. For example, the precise location of herring spawning grounds can change over time, the mechanism of which is not fully understood. Consequently, the nature of the impact will be fully determined before mitigation measures are proposed.

Potential mitigation measures include:

- Designing the route of the cable to avoid sensitive habitats;
- Avoidance of river lamprey, sea lamprey and Atlantic salmon migration seasons; and
- Soft-start piling during construction.

5.2.6 Cumulative Impacts

The coordination of data collection activities with other developers operating in the Firth of Forth is strongly encouraged. This will ensure a more standardised approach to fish and fisheries data collection, facilitate comparison between sites, allow easier cumulative impact assessment, and contribute to any coordinated post-construction monitoring programmes.

5.3 Marine Mammals

5.3.1 General Description

Marine mammals, which include pinnipeds (seals) and cetaceans (whales and dolphins), are present in the Firth of Forth throughout the year. There is a good general knowledge of the cetacean species likely to be present in the area. However, information as to density and distribution and how cetaceans may use the Firth of Forth, whether it is for feeding or breeding for instance, is more limited. In terms of pinnipeds, there is extensive information on the distribution and abundance of grey and harbour seals around Britain from annual aerial surveys of breeding colonies and from satellite telemetry studies (Hammond *et al.,* 2004). When considering marine mammals for EIA purposes, it is essential to consider the wider North Sea environment as many marine mammal species are likely to be wide ranging and highly mobile.

The species of cetacean mostly likely to be seen in the Firth of Forth include minke whales, harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin, killer whale, Risso dolphin and bottlenose dolphin (Cork Ecology, 2008).. Figure 5-3 shows the sightings of five of the key species listed in the Firth of Forth area. There have also been occasional records of sighting of species such as sperm, humpback and fin whales in the Forth.

Minke whales occur throughout the northern North Sea especially in summer months, harbour porpoises are widespread through the seas around Britain with the area to the north and east of Scotland having some of the highest densities of porpoises sighted (Hammond *et al.*, 2004). White-beaked dolphins have a wide distribution round the east and west coasts of Scotland, with Rissos, Atlantic white-sided dolphins and killer whales having a more limited distribution on the Scottish east coast but more widespread on the west coast.

The bottlenose dolphins observed in St. Andrews Bay are probably individuals who also use the waters of the Moray Firth SAC. It is thought that the bottlenose dolphins are likely to stay closer to the coast than the proposed offshore wind farm site however this will be investigated as part of the marine mammal survey programme and, if necessary, through photo identification work.

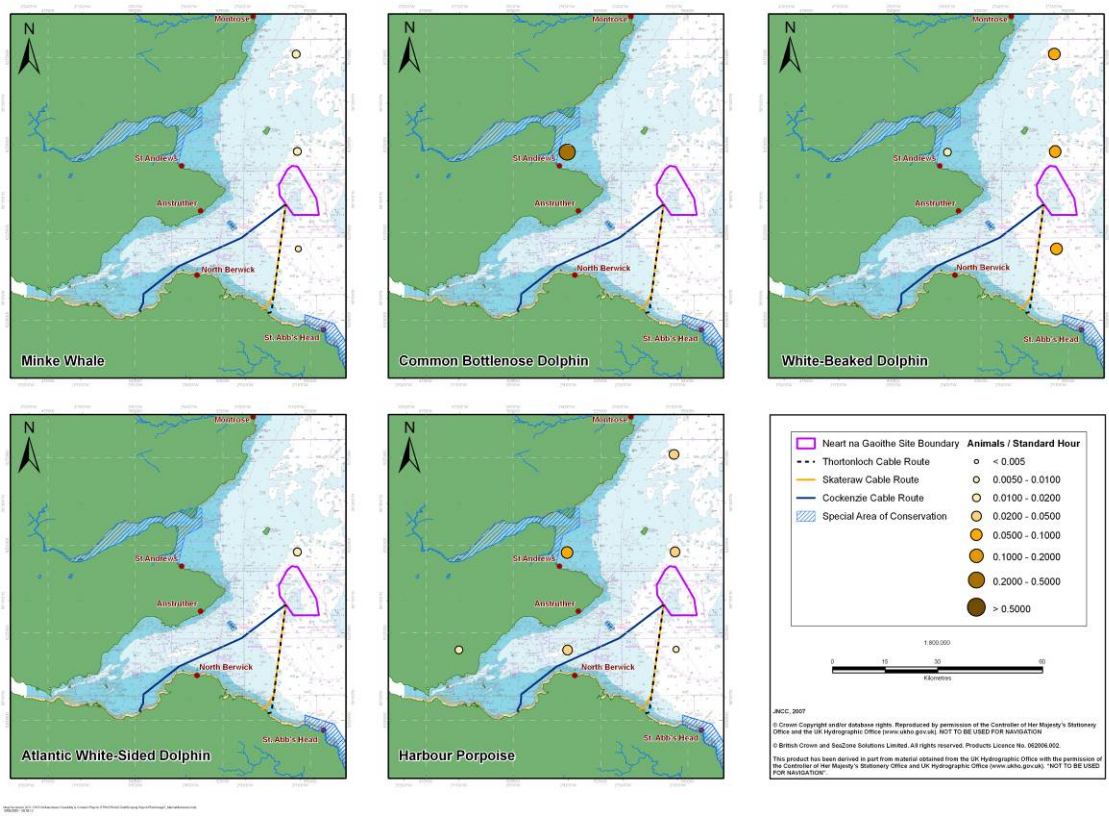


Figure 5-3 Marine Mammal sightings in Firth of Forth (Key Species)

The Firth of Tay and Eden Estuary is a Special Area of Conservation (SAC), with common seal an Annex II qualifying species (Figure 5-3). The Isle of May, at the entrance to the Firth of Forth, supports a breeding colony of grey seals *Halichoerus grypus*. The site is the largest east coast breeding colony of grey seals in Scotland and the fourth-largest breeding colony in the UK, contributing approximately 4.5% of annual UK pup production (JNCC, 2009a) (Figure 5-3). The proposed site is approximately 16 km from the Isle of May. The Firth of Tay and Eden Estuary supports a nationally important breeding colony of common seal *Phoca vitulina*, part of the east coast population of common seals that typically use sandbanks. Around 600 adults haul-out at the site to rest, pup and moult, representing around 2% of the UK population of this species (JNCC, 2009b). Any potential to impact upon these SACs will need to be assessed under the EU Habitats Directive Appropriate Assessment process.

In recent years, knowledge on the movement of seals outwith breeding colonies has been improving and now, extensive information on the distribution of grey seals at sea is available from studies of animals fitted with satellite relay data loggers. Figure 5-4 shows the tracks of grey seals fitted with satellite-relay data loggers over a period of about 10 years and harbour seal distribution in the north-western North Sea.

During baseline data collection for the EIA, the distribution of shark species such as basking sharks will also be considered.

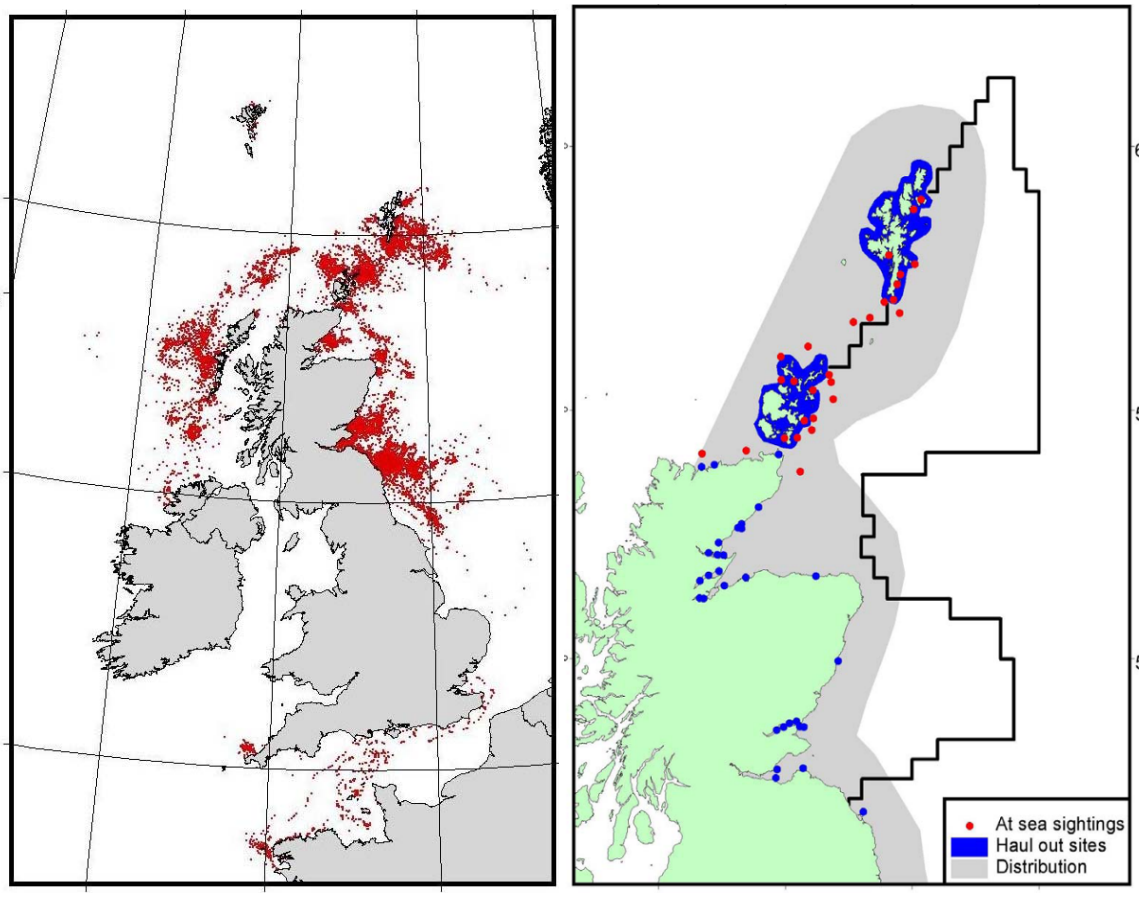


Figure 5-4 **Left Hand Side - Tracks of 108 grey seals fitted with satellite-relay data loggers over a period of about 10 years (McConnell *et al.* 1999; SMRU unpublished data). Right Hand Side – Harbour seal distribution in the northwestern North Sea after Reijnders *et al*. (1997). Also shown are haul-out sites during the moult (SMRU unpublished data) and at-sea sightings from JNCC surveys (Pollock *et al*. 2000). Source: Hammond *et al.,* 2004**

5.3.2 Available Data

An initial review of marine mammal distribution and densities has been undertaken using the following data and literature sources. Data and Literature associated with the assessment of noise impacts on marine mammals can be found in Section 5.4.2.

- Reid, J.B., Evans, P.G.H., & Northridge, S.P., (2003) *Atlas of Cetacean distribution in north-west European waters*[20]
- Hammond, P.S., Northridge, S.P., Thompson, D., Gordon, J.C.D., Hall, A.J., Sharples, R.J., Grellier K. and Matthiopoulos, J. 2004. Background information on marine mammals relevant to Strategic Environmental Assessment 5. SMRU.
- Hammond, P.S., Northridge, S.P., Thompson, D., Gordon, J.C.D., Hall, A.J., Aarts, G. and Matthiopoulos, J. Background information on marine mammals relevant to Strategic Environmental Assessment 6. SMRU.
- SCANS I and II – Small Cetaceans in the European, Atlantic and North Sea[21]

[20] http://www.jncc.gov.uk/page-2713

[21] http://biology.st-and.ac.uk/scans2/index.html

There are a number of reports on local distribution of marine mammals taken from shore by groups such as The Sea Watch Foundation[22] as well as information available from local academic organisations such as St Andrews University, Seal Mammal Research Unit[23] or Aberdeen University Lighthouse Field Station[24] and these will be further assessed during the EIA process.

5.3.3 Method of Assessment

The main potential impacts for marine mammals that will be assessed are as follows:

- Potential noise impacts on cetaceans and seals arising from:
  - construction of wind farm and cable route (i.e. piling and trenching cable route);
  - wind farm operations of wind farm and cable route;
  - wind farm decommissioning (i.e. removal of turbine bases)
- Potential impacts on seal haul out areas – noise, presence of vessels, maintenance routes (boats or helicopters etc);
- Potential effects on cetaceans through loss of prey (i.e. fish or invertebrates) due to disturbance or habitats loss;
- Potential behavioural impacts such as effects on breeding, nursery or feeding behaviours, use of haul outs, interruption of migratory routes as a result of disturbance generated by development activities – e.g. noise, visual disturbance, vessel activity;
- Potential for direct injury to marine mammals during the construction, operation and decommissioning of the wind farm through vessel strike.

For assessment methods on impacts from noise please refer to Section 5.4.3. In order to assess the potential for vessel strike, local records such as investigations into any stranded marine mammals will be researched to judge the current risk of marine mammal to vessel strike. In parallel with this work, global publications on the risk to marine mammals from different vessel types will be investigated to allow an assessment of risk from the spread of vessels used during construction and operation.

5.3.4 Further Requirements

If bottlenose dolphins from the Moray Firth SAC are using the area of the proposed wind farm, under the terms of the EU Habitats Directive as translated in Scottish Law, it may be necessary for the Scottish Government to undertake an Appropriate Assessment to ensure activities in the Firth of Forth do not adversely affect the conservation objectives of the Moray Firth SAC. During the EIA process, this will be discussed in greater detail with SNH and the Scottish Government to ensure information is provided within the ES to allow such an assessment to be undertaken.

It will also be necessary to consider whether the proposed activities will lead to deliberate disturbance of European Protected Species (EPS) as described in Regulation 39 and 43 of The Conservation (Natural Habitats &c.) Regulations 1994 (as amended) (Habitats Regulations) as well as The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended), which apply beyond Scottish territorial waters. If EPS species have the potential to be impacted, consideration will also be given as to how 'Favourable Conservation Status' will be addressed. Draft guidance on 'deliberate disturbance' is currently available from JNCC for those waters beyond territorial limits; however, this is not fully applicable inside Scottish territorial waters due to differences in the legal instruments. It will be necessary to work with SNH and the Scottish Government on how these issues should be addressed through the EIA process and subsequent ES.

[22] http://www.seawatchfoundation.org.uk/index.php

[23] http://www.smru.co.uk

[24] http://www.abdn.ac.uk/lighthouse/

The marine mammal monitoring programme will gather site specific data, which will inform the EIA with regard to the presence or absence of marine mammals. The monitoring programme is informed by, and builds upon, existing information about the distribution of marine mammals in the Firth of Forth. Monitoring will involve visual observations combined with the seabird surveys (see Appendix E for further details) plus acoustic monitoring from the seabird/marine mammal survey vessel. This will involve towing a hydrophone to record acoustic signals from marine mammals, namely minke whales, harbour porpoise and dolphin species. These data will then be processed by SMRU Ltd. to provide presence and absence information on species. Methods are currently being developed following work on SCANS (Small Cetaceans of the European, Atlantic and North Sea) to use acoustic information to estimate abundance of cetaceans. During the EIA process, if observations show that bottlenose dolphins are using the area of the proposed wind farm or vicinity, photo-identification of individuals may also be undertaken to assist with the Appropriate Assessment process as described above.

5.3.5 Potential Mitigation and Monitoring

In order to minimise risk of vessel strike, a bespoke Code of Conduct for interactions between marine mammals vessels associated with the proposed wind farm and operating in the Firth of Forth will be commissioned and actively communicated to all vessels and crew. This will be based upon the SNH Wildlife Watching Code of Conduct, previous wind farm operations and agreed with all interested parties.

Mitigation for noise issued is considered in Section 5.4.5.

5.3.6 Cumulative Impacts

There is potential for cumulative and in-combination impacts to marine mammals from the activities associated with building one or more wind farms in the Forth and Tay areas. The Forth and Tay Offshore Wind Farm Developers are working together on how these cumulative impacts can be best addressed. This will probably involve some form of both a spatial and temporal assessment of the noise likely to be produced during operation across all sites using the same assessment techniques.

5.4 Noise

5.4.1 General Description

There are a variety of noise sources that are present within UK territorial waters, both natural and anthropogenic. Natural noise sources include wind and wave action, fish and marine mammal species and geological events such as earthquakes. Anthropogenic sources range from land based construction noise transmitted through the seabed, to vessel noise, at sea seismic surveys or the use of fishing and navy sonar. The nature of the seabed topography and sediment will affect how quickly and easily any noise generated in the area will travel.

Noise sources relevant to this project include those generated by the construction techniques such as piling or drilling which may be required to install the turbine base and tower, construction of the offshore substation, dredging/cable trenching and project related vessel movements. Details of how these noise sources will be determined are given in Appendix F.

5.4.2 Available Data

The literature sources for the various aspects of noise sources are shown below. Through COWRIE there is a large resource of reports on marine mammals and wind farms of which a selection is included here.

Piling Noise

- Robinson, S.P., Lepper, P.A. and Ablitt, J., (2007) *The measurement of the underwater radiated noise from marine piling including characterisation of a "soft start" period*, Oceans 2007 – Europe, 18 – 21 June 2007.

- Blackwell, S.B., J.W. Lawson, and M.T. Williams (2004), *Tolerance by ringed seals (Phoca hispida) to impact pipe-driving and construction sounds at an oil production island*, J. Acoust. Soc. Am. Volume 115, Issue 5, pp. 2346-2357 (May 2004).
- De Jong, C.A.F. & Ainslie, M.A. (2008), *Underwater radiated noise due to the piling for the Q7 Offshore Wind Park*, Acoustics 08, June 29 – July 4 2008, Paris.
- Nedwell, J. R., Langworthy, J., and Howell, (2003), *Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore wind farms, and comparison with background noise*, Subacoustech Report No. 544 R 0424 (for the Crown Estate), May 2003.
- Thomson, F., Lüdemann , K., Kafemann,R., Piper, W (2006) Effects of offshore wind farm noise on marine mammals and fish. Translation for COWRIE Ltd
- Diederichs, A., Nehls, G., Dähne, M., Adler, S., Koschinski, S., Verfuß, U., (2008) Methodologies for measuring and assessing potential changes in marine mammal behaviour, abundance or distribution arising from the construction, operation and decommissioning of offshore wind farms COWRIE ENG-01-2007

Dredging and Drilling

- Greene, C.R. Jr. (1987) *Characteristics of oil industry dredge and drilling sounds in the Beaufort Sea*, J. Acoust. Soc. Am. Volume 82, Issue 4, pp. 1315-1324 (October 1987).
- Nedwell *et al*, see above.

Shipping and Ambient Noise

- A Holden, (2004) *Measured and predicted array response to the vertical directivity of ambient noise*, J. Acoust. Soc. Am. Volume 116, Issue 4, pp. 2650-2650 (October 2004)

Mitigation and Monitoring

- Diederichs, A., Nehls, G., Dähne, M., Adler, S., Koschinski, S., Verfuß, U., (2008) Methodologies for measuring and assessing potential changes in marine mammal behaviour, abundance or distribution arising from the construction, operation and decommissioning of offshore wind farms COWRIE ENG-01-2007
- Nehls. G., Betke, K., Eckelmann, S., Ros, M., (2007) Assessment and costs of potential engineering solutions for the mitigation of the impacts of underwater noise arising from the construction of offshore windfarms COWRIE ENG-01-2007

5.4.3 Method of Assessment

The EIA will assess the potential zones of acoustic effect from the installation operations, in particular any piling operations. The assessment will review published information on piling and vessel noise source levels, which will feed into a model of noise levels at various distances from the offshore installation operations. These data will then be assessed against the distribution and abundance of marine mammals in the area to estimate the likelihood that they may be exposed to noise levels that could result in behavioural or physical impacts. This will include an assessment of potential impacts to prey species.

Potential noise impacts are summarised in Nedwell *et al.,* (2007), a report commissioned by COWRIE, which considered the effects of noise generated by offshore wind farms on various marine species. This included an analysis of the potential negative impacts on marine mammals (both pinnipeds and cetaceans).

When assessing potential impacts on marine mammals it is important to understand the level (dB) and frequency (Hz) of sound that the marine mammals will encounter and the biological significance of this, for instance does this sound either cause direct injury or indirect effects such as modified behaviour? One tool available for assessment of potential noise impacts on marine mammals, and possibly fish, is Environmental Risk Management Capability (ERMC), a software package developed by BAE Systems in collaboration with the

Sea Mammal Research Unit (SMRU) and the Centre for Research into Ecological and Environmental Modelling (CREEM) at the University of St Andrews.

ERMC has previously been used to assess sonar impact (as detailed in Appendix F) but the software can be modified to be made applicable to offshore wind farms. The progression from sonar modelling to broadband noise modelling is well understood, and BAE already have a well defined process by which to estimate the propagation and subsequent impact on marine organisms. The model consists of various databases that include the marine mammal density within the area, the background noise, the hearing responses for different species (including Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS)), and the frequencies of the noise generated by the activity under consideration. The model is then able to calculate the likely risk to particular species, and, with multiple runs of the model, the dosage to a theoretical individual over time.

The output from the ERMC, typically consists of the quantitative findings from the computerised system coupled with an expert qualitative analysis from SMRU, creating an assessment that provides an interpretation of the risk to marine mammals, in terms of potential noise impacts, from a given activity or set of activities. This can be used to inform the EIA process throughout the design of the project.

5.4.4 Further Requirements

As the details of the project are confirmed it will be possible to build a database of sound profiles of the expected activities that can be used to inform any noise modelling. It is planned to collect information such as ambient noise measurements in the area surrounding the planned wind farm, noise measurements during any test construction work while using the information from the geophysical surveys to describe depth and sediment type.

The EIA team will work with SNH and the Scottish Government to ensure a thorough assessment of the potential for activities to disturb European Protected Species as described in Section 5.3.4.

5.4.5 Potential Mitigation and Monitoring

Mitigating noised produced during any marine activity is based upon either minimising the noise at source or ensuring a marine mammal is not in the vicinity of operations and exposed to the noise. For example:

- At design stages and integrated with the EIA process, the assessment of engineering options will include consideration of the noise produced during construction and operation of the wind farm.
- If piling is used it may be possible to mask the piling noise using bubble curtains or other devices as described in COWRIE Report ENG-01-2007.
- Depending upon the foundation design chosen, it may be necessary to use a soft start methodology to minimise risk of noise impacts to marine mammals. Site specific guidance such as that described in the '*Statutory nature conservation agency protocol for minimising the risk of disturbance and injury to marine mammals from piling noise*'[25] would be developed on the use of Marine Mammal Observers and Passive Acoustic monitoring.

All measures to minimise noise will be explored by NnGOWL as part of the EIA process. It is planned to collect both visual and acoustic survey information to improve the data set on marine mammals using the wind farm area. These surveys are combined with the seabird surveys as described in Appendix E. These surveys have been designed in such a way as to be useful in terms of post consent monitoring.

5.4.6 Cumulative Impacts

Through working with the other Forth and Tay Estuary Offshore Developer Group, and a thorough knowledge of current and planned activities in the Firth of Forth, the EIA process will assess the cumulative and in-combination impact of noise on marine mammals both temporally and spatially. The project team plan to use the ERMC tool to aid cumulative and in-combination assessment.
During the development of the EIA it is also expected that the UK Government will take forward recommendations for the Offshore Energy SEA Post Consultation Report which may provide further tools to

[25] http://www.jncc.gov.uk/pdf/Piling%20Protocol%20June%202009.pdf

aid the cumulative impact assessment. One of the Final Recommendations is that 'The effects of noise on marine mammals particularly from piling and seismic survey remain an issue of debate. A range of mitigation measures are available and their adoption is normally required through consenting. However, there is a need for cross industry coordination of what noisy activities are planned, where and when, to facilitate the assessment of cumulative effects and implementation of temporal/spatial mitigation actions. The approach would require a mechanism to facilitate the exchange of information, for example through a web-based forum hosted by DECC, JNCC or the future MMO'. The SEA for Scottish territorial wind farms is currently ongoing and full consideration of any recommendations from this SEA will be taken into account during the EIA process.

5.5 Ornithology

5.5.1 General Description

In the summer months the most abundant seabird species likely to occur in the area are gannet, kittiwake, puffin, fulmar, guillemot and razorbill. There will also be smaller numbers of large gulls and possibly tern species. All these species breed in colonies along the adjacent coast and are known to range large distances to feed. Of particular relevance to the development will be birds from colonies on the Isle of May and Bass Rock. These are situated to the south-west, approximately 20 km and 30 km away respectively. In addition, birds breeding at the St Abb's Head colonies, approximately 40 km to the south, may also range as far as Neart na Gaoithe during feeding trips. These colonies are included in either the Forth Islands or the St Abb's Head to Fast Castle SPAs. The boundaries of these seabird SPAs are in the process of being extended to 4 km offshore from the coast.

Many seabirds from these colonies are known to be particularly dependent on sandeels (Camphuysen 2005). These occur throughout the region but not uniformly or consistently, with the result that the most profitable feeding areas for seabirds change both seasonally and between years. Highly mobile pelagic prey species such as clupeids can also be important, resulting in rapid changes in feeding areas even within a season (e.g. guillemot chicks, Wilson *et al* 2005). Of particular relevance to the development is that the relatively shallow sandbanks (e.g. the Wee Bankie) lying broadly to the east of the site are known to be favoured seabird feeding grounds with prey species such as sandeels, herring and sprat available. The development site has also been shown to be important for feeding seabirds at times, for example, high densities of gannet, kittiwake and guillemot were regularly recorded in June and July (Camphuysen 2005).

Given the proximity of the development to European designated sites and the possibility that birds forming part of the qualifying interests of these sites could be adversely affected by the proposals, it is reasonable to assume that an appropriate assessment under the Habitats Regulations 1994 will be required. This would be in addition to assessment under the EIA Regulations. The tests under the Habitats Regulations are far more stringent than those of the EIA Regulations and therefore baseline studies will give particular emphasis to gathering detailed information on the SPA qualifying species that occur within the development site. These include gannet, shag, puffin, guillemot, razorbill, kittiwake, lesser black-backed gull, herring gull, arctic tern and common tern. Figure 5-5 shows the sensitivity of these species in relation to Neart na Gaoithe.

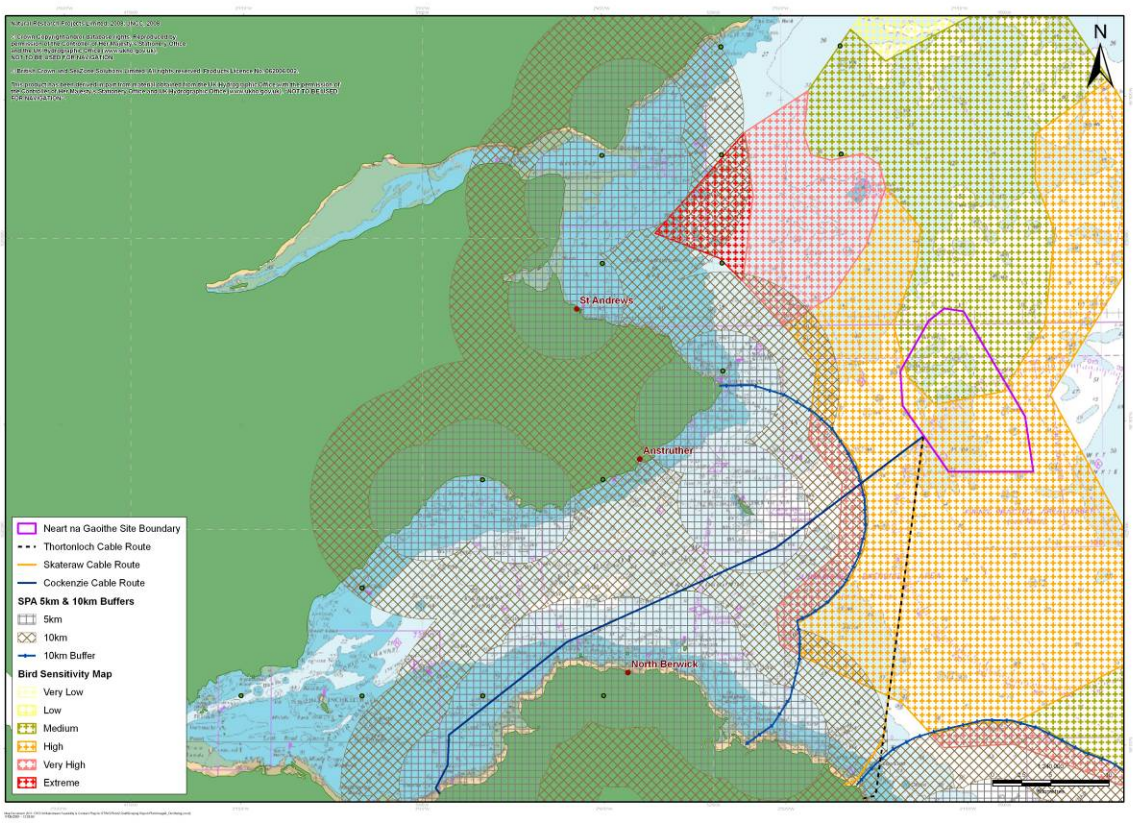


Figure 5-5 Bird sensitivity in the region of Neart na Gaoithe

The following Figures show the average density for each of the species mentioned above. Figure 5-6 shows the potentially sensitive species occurring in nationally important numbers in the Firth of Forth (red-throated diver, common scoter and little gull). Figure 5-7 to 5-9 shows the potentially sensitive species occurring within the Forth (guillemot, razorbill, puffin, black-throated diver, great northern diver, gannet, shag, eider, sandwich tern, common tern and arctic tern.

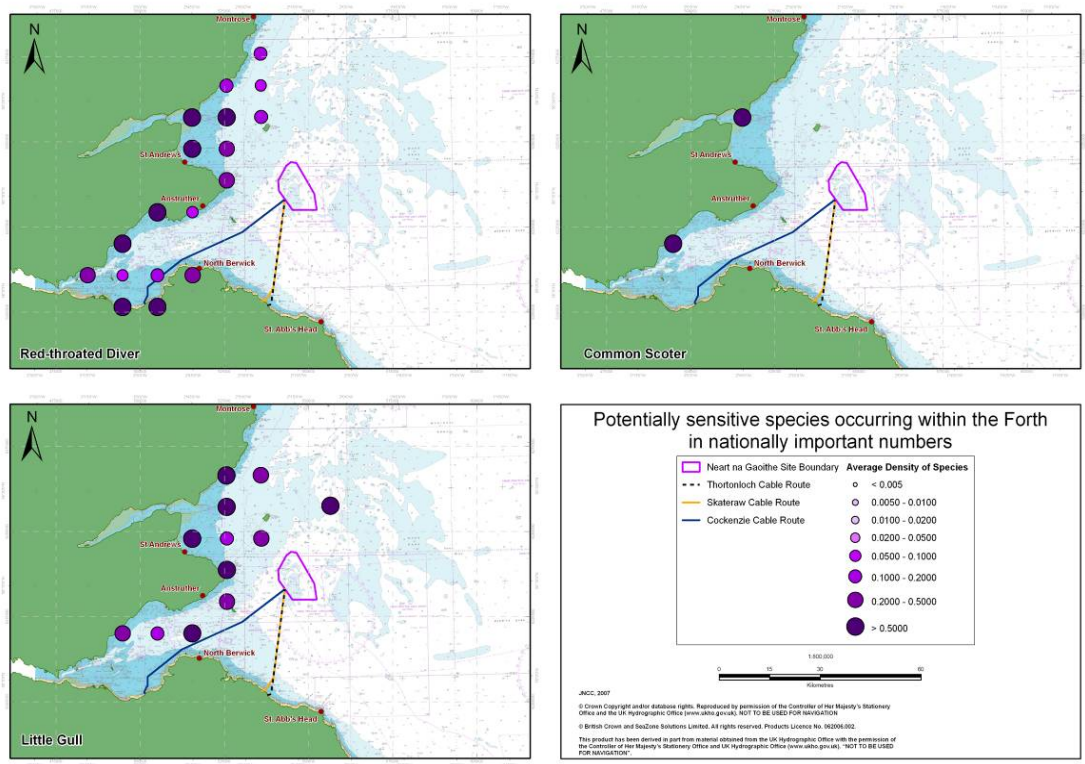


Figure 5-6 **Potentially sensitive species occurring within the Forth in Nationally important numbers**

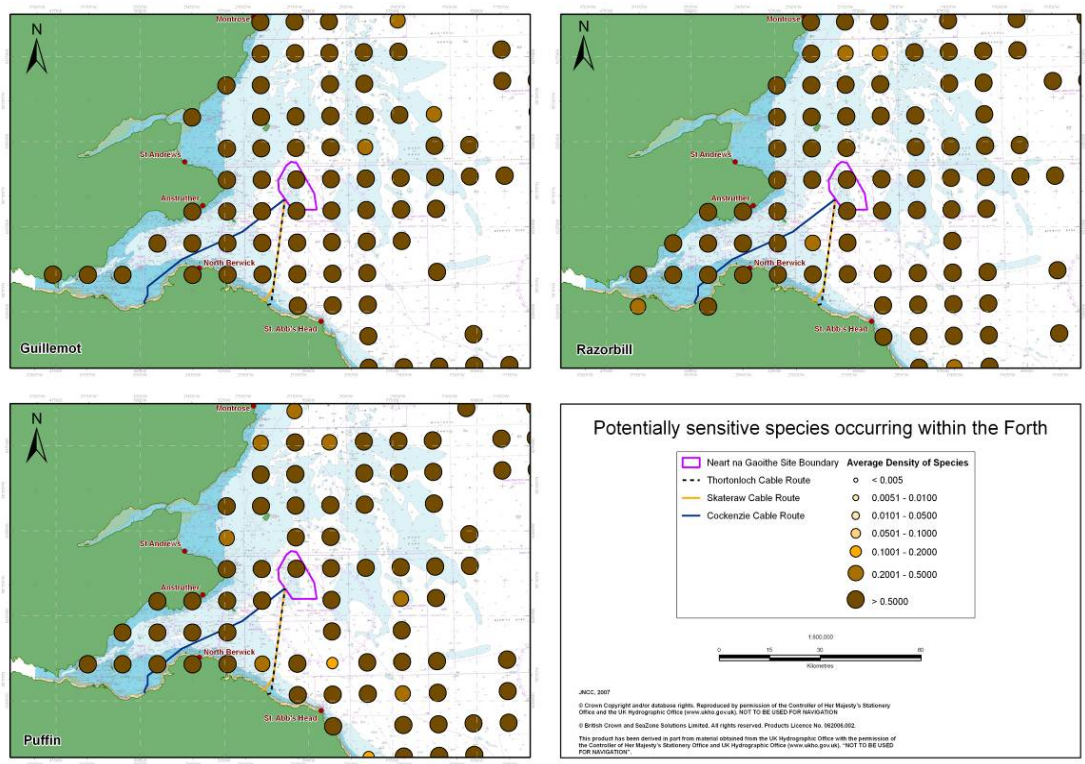


Figure 5-7 **Potentially sensitive species occurring within the Forth (1)**

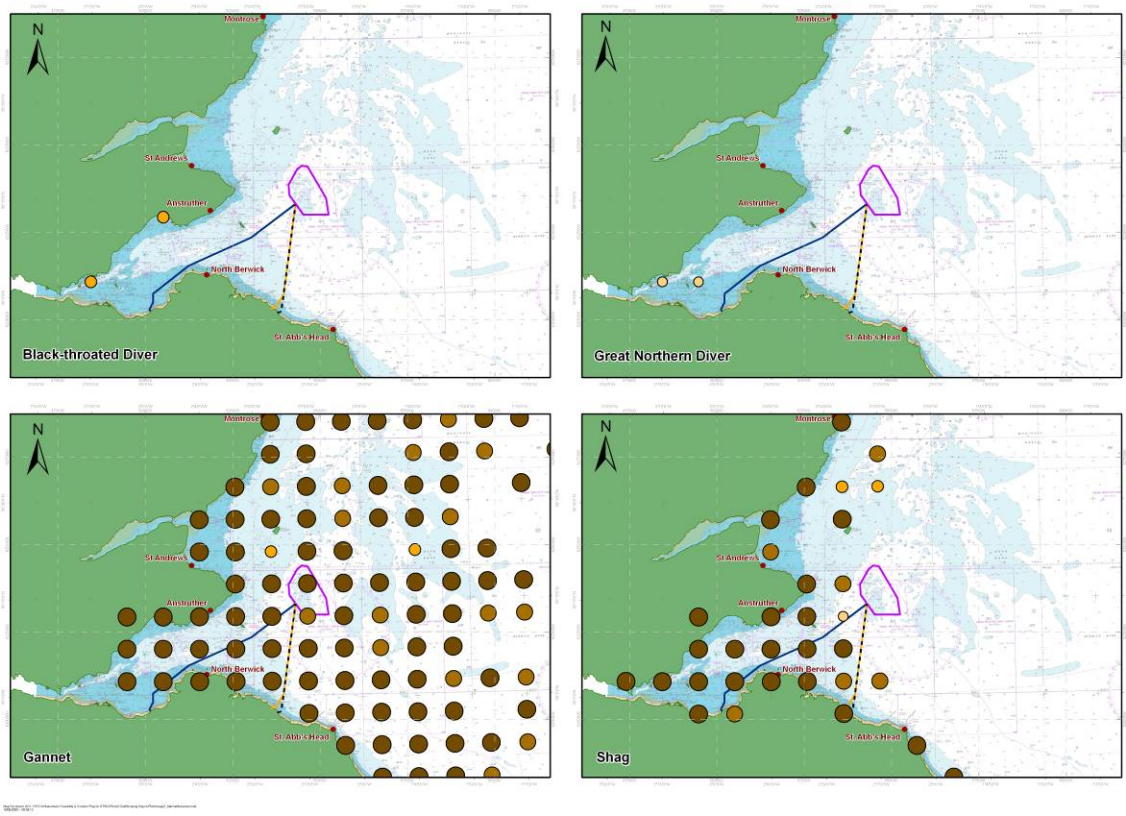


Figure 5-8 Potentially sensitive species occurring within the Forth (2)

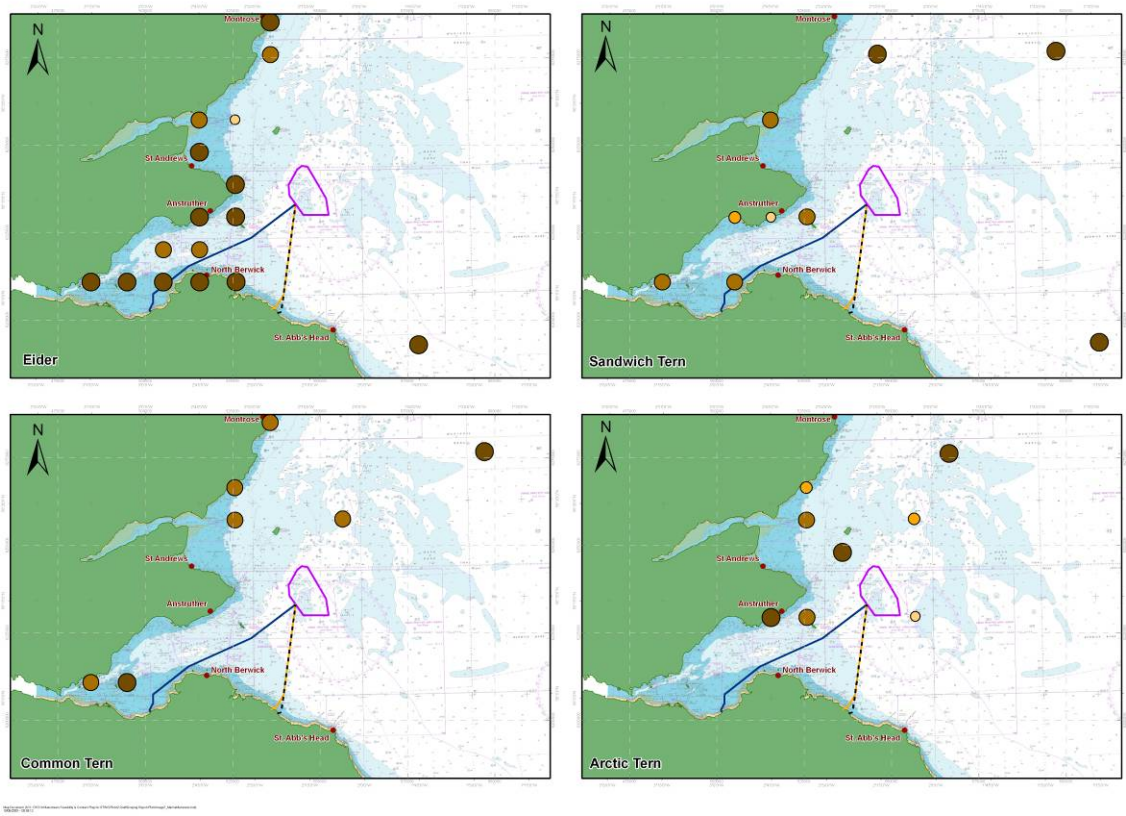


Figure 5-9 Potentially sensitive species occurring within the Forth (3)

For birds, potential impacts assessed will include:

- Collision with the proposed turbines, leading to death or injury;
- Disturbance, including displacement and barrier effects;
- Habitat loss;
- Indirect effects, e.g. caused by changes to currents, sediments, fish;
- The cumulative effects of more than one development in the region.

Particular attention will be paid to the issue of cumulative and in-combination impacts in relation to birds.

Appendix E of this scoping document is the Bird and Sea Mammal Scoping Report produced by Natural Research (Projects) Ltd (NRP), Cork Ecology (CE) and Craigton Ecological Services. This document includes a full species account and details of proposed survey methodologies.

5.5.2 Available Data

A gap analysis of existing data on birds will be undertaken as described in Appendix E. There is an extensive amount of literature now available on offshore wind farms, their potential impacts on birds and survey protocols as described in Appendix E. Below is an example of key references:

- Camphuysen, C.J., Fox, T., Leopold, M.F. & Petersen, I.K. 2004. Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the UK. A report for COWRIE.
- Maclean, I.M.D, Wright, L.J., Showler, D.A. and Rehfisch, M.M. (2009) A Review of Assessment Methodologies for Offshore Windfarms. British Trust for Ornithology Report Commissioned by Cowrie Ltd.
- Barton, C. and Pollock, C. 2004. Review of divers, grebes and seaduck distribution and abundance in the SEA 5 area. Report to the DTI as part of SEA 5 from Cork Ecology
- King, S., Maclean, I.M.D., Norman, T., and Prior, A. (2009) Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers. COWRIE.
- Maclean, I.M.D., Frederikson, M and Rehfisch, M.M. (2007) Potential use of population viability analysis to assess the impact of offshore windfarms on bird populations. BTO Research Report No. 480 to COWRIE. BTO, Thetford.
- Camphuysen, C.J. (ed.), 2005. Understanding marine food web processes: an ecosystem approach to sustainable sand eel fisheries in the North Sea. IMPRESS Final Report. Royal Netherlands Institute for Sea Research, Texel.

5.5.3 Method of Assessment

Analysis of the data collected will provide the following information required for the EIA:

- Estimates of the numbers of seabirds and marine mammals using the development area and its surrounding waters throughout the year. This will allow the site, and its surrounding waters, to be assessed for each species with respect to its conservation importance in the context of regional, national and international populations. This will allow key species to be identified.
- Maps showing the seasonal distributions of seabirds and marine mammals within the site and the surrounding 8 km buffer. This will allow the development site to be compared within the context of the surrounding area. Furthermore, should significant adverse impacts be identified then such data would potentially allow the development of potential mitigation measures based upon the siting of individual turbines or scheduling of operations.
- Estimates of collision risk for flying birds.

- Estimates of the potential effects due to habitat loss and displacement under various scenarios with respect to the distance such effects extend from the development, and the availability of alternative suitable habitats.
- An assessment of the potential cumulative assessment of the development along with others proposed in the region.

The impact assessment of birds will be undertaken using both quantitative tools such as PVA and qualitative reports. This will include assessment of:

- Collision risk to bird movements such as daily flights between roosting and foraging areas or annual migrations The subject of collision is reviewed in the Offshore Energy SEA (DECC 2009). Various techniques have been developed to study the problem and predict its affects (Band *et al* 2007
- Disturbance concerns behavioural response to either specific events associated with the development (such as noise or a moving vessel) or their response in general to the presence of wind turbines. Disturbance can lead to displacement. This occurs when birds no longer make use of an area, or use it less frequently than they would otherwise because of the development. This may be a temporary effect or a permanent one. In ecological terms, it is equivalent to habitat loss.
- Loss of feeding habitat because of the footprint of turbine foundations, scouring, power cables, and zones of avoidance about each turbine;
- Barrier effects – preventing birds moving in a chosen direction;
- Indirect effects, e.g. caused by changes to currents, sediments, fish;
- The cumulative effects of more than one development in the region.

The assessment will establish a baseline through published data and vessel surveys, which can be compared with historical data. Details of the proposed vessel surveys are given in Appendix E. The Crown Estate has been undertaking aerial surveys over the proposed Scottish territorial waters wind farms which will provide a valuable dataset for assessment purposes.

A literature review will be undertaken to determine the likely response of species to the offshore wind farm. A collision risk assessment for kittiwakes and gannets which fly through the area will be undertaken as part of the EIA. In addition, the implications for birds flying to Wee Bankie to feed will be considered.

5.5.4 Further Requirements

Appendix E details the survey strategy for birds and marine mammals. NnGOWL plans to survey the area of the proposed wind farm plus a 4km buffer for baseline description as well as an additional 4 km to provide further context for the EIA process. The 8 km buffer will allow NnGOWL to examine displacement and habitat loss effects along a distance gradient from the development site. This is consistent with the surveys and analyses conducted for the Horns Rev and Nysted wind farms in Denmark (Petersen *et al.* 2006).

5.5.5 Potential Mitigation and Monitoring

There is a range of standard mitigation which can be incorporated into any wind farm development including the layout and siting of turbines (to avoid key areas for birds), the timing of construction (to avoid key periods for certain bird species), the routes taken by construction vessels (including following existing shipping lanes) and taking precautions to avoid rafts of moulting flightless birds (by using dedicated observers on the vessels).

This mitigation would be informed by the baseline survey. NnGOWL plan to wait until the first years bird surveys are complete prior to deciding which further surveys may be required such as radar or other remote sensing techniques.

5.5.6 Cumulative Impacts

The Firth of Forth and adjacent coastline is a very important area for birds. The Wee Bankie and Marr Bank area is particularly sensitive as it is an important feeding area for colonies based on the Isle of May and other Forth islands. While it may be possible for birds to avoid one wind farm, and still easily reach their feeding

grounds, multiple obstacles may introduce significantly further flight times and therefore use too much energy. It is commonly stated that all of these potential impacts on birds may become more significant where several wind farms occur in close proximity.

The potential effects on any given species must be considered in relation to the wider population, particularly where these are of conservation interest.

5.6 Terrestrial Ecology

5.6.1 General Description

The potential onshore substation sites are both located near existing power stations: Cockenzie and Torness however, limited baseline ecological data are available. Information on protected species has been sourced from the NBN Gateway[26] and for designated sites from the MAGIC[27] website. Ordnance Survey maps and aerial photographs have been used to assess the potential habitat and interest of the sites.

5.6.1.1 Option 1 – Cockenzie

The proposed location for the landing point, associated substation and connection to Cockenzie power station is on an area of land immediately adjoining the power station site to the south-west. The site is bounded by the Firth of Forth to the north, and the entire north shore of the site is designated as part of the Firth of Forth SPA, Ramsar site and SSSI (Figure 5-10). This site is designated as an SPA and Ramsar site due to the importance of its bird populations including internationally important assemblages of waterfowl, individual populations of wintering wading species and its importance for passage species, specifically sandwich tern. The SSSI which covers the same area is designated for a wider number of features including coastal habitats (saltmarsh, sand dune, fen and saline lagoon, dune and maritime grassland), mussel beds, eelgrass beds, nationally scarce invertebrate and plant species and wading and wildfowl bird species.

[26] www.nbn.org.uk

[27] www.magic.gov.uk

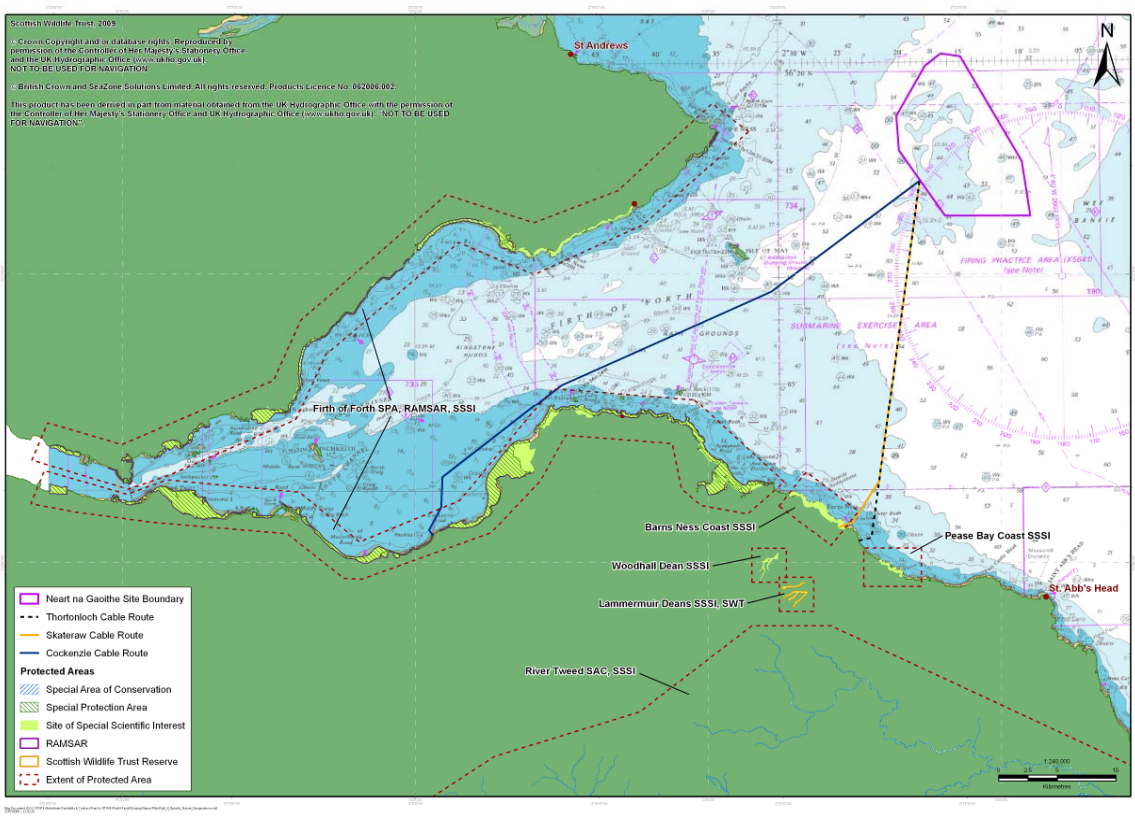


Figure 5-10 Nature Conservation Designations Association with the Neart na Gaoithe Cable Routes

Beyond the shoreline, the site may have potential to support a number of faunal species. At this stage the most likely ecological receptors present include reptile species (common lizard, adder and slow-worm) which are known to favour coastal embankments and waste ground; and bat species which may forage or roost on the site. There are only a limited number of species records for the area. The only relevant records are of Daubenton's bats and Pipistrelle bats which have been recorded in the Musselburgh area.

A cable route here is likely to result in the loss of habitats in the designated area and disturbance of bird species for which the site is designated. The integrity of this part of the site may be adversely affected and an Appropriate Assessment would be required under the Habitat Regulations to determine impacts. There is a presumption against developments that will have an adverse impact on internationally designated sites. Limited impacts may also result from loss of habitats and construction disturbance on land adjoining the shoreline.

5.6.1.2 Option 2a – Torness – Thortonloch

The proposed location for the landing point at Thortonloch is a sandy beach, sloping away from soft sea defences, coastal scrub and dune habitat. The site is not covered by any conservation designations. There is an SSSI on the coast, approximately 1.5 km south of the site (Pease Bay Coast SSSI, designated for its geological features).

This would require construction of a landing point on shoreline habitats at Thortonloch. There would be a permanent loss of an unknown type and extent of coastal habitats. No designated sites are expected to be affected by construction.

5.6.1.3 Option 2b – Torness – Skateraw Harbour

The proposed location for the landing point at Skateraw Harbour falls directly in the Barns Ness Coast SSSI. This site is designated on the basis of the coastal habitats that it supports including saltmarsh, rocky stacks, limestone grassland and a large area of mineral enriched dune grassland. The site supports a number of locally rare plant species and is also of considerable importance geologically.

This option would require construction of a landing point within the Barns Ness Coast SSSI. It is likely that there would be damage to, and loss of, habitats for which this site is designated. There is a presumption against developments that will have an adverse impact on nationally designated sites.

5.6.1.4 Connection Route for Option 2a and 2b

A connection would be required from either of the two proposed landing routes to a location 2.5 km south-west of Innerwick. No specific route has been proposed at this stage. However, the general area through which the connection would pass is a rolling, pastoral landscape lying between, and west of, Thurston, Thorton and Innerwick. Habitats here are likely to include enclosed, improved farmland, and some areas of open moorland potentially supporting bog and heath land habitats. These areas are separated by steep sided valleys formed by rivers and burns including the Thorton Burn, Thurston Mains Burn, Elmscleugh Water and Aikengall Water. These watercourses may provide potentially suitable habitat for otter and water vole, and a network of ponds throughout the area may also have the potential to support great crested newt. Wooded cleuchs have developed on a number of the burnsides and this habitat mosaic offers a number of opportunities for bat species, red squirrel and badger.

There are three designated sites in the vicinity of the search area. The River Tweed SAC and SSSI is located approximately 4 km away and is designated for its internationally important populations of Atlantic salmon, otter, lamprey (brook, sea and river) and its water crowfoot plant communities. A further two sites lie within 1 km of the western end of the search area. These are Woodhall Dean SSSI, a site designated for its oak and yew woodlands, and, Lammermuir Dean SSSI and SWT Reserve which supports a number of woodland and grassland habitats as well as designated Ancient Woodland. Several other blocks of ancient woodland, recorded on the Ancient Woodland Inventory are found within the connection route search area.

A number of records of relevant protected species are available for the 10 km square in which the search area lies. This includes records of badger, red squirrel, common pipistrelle bat and great crested newt.

Construction of the connection route for Option 2a and 2b would result in a temporary loss and disturbance of various habitats. Following the completion of trenching or overhead line works, most habitats would be allowed to revert to their original state or would be restored where possible. The area of permanent habitat loss is expected to be small-scale. A number of protected species and their shelters may be disturbed by short-term construction activities. Only in the worst case scenario would there be a closure or loss of setts, holts, dreys or burrows or accidental harm to species. It is anticipated that early consideration of species during design of the scheme will allow a flexibility to avoid damage to these structures or populations. The most likely effects would therefore be short-term disturbance, fragmentation or disruption to foraging habitat and movement corridors of the species using the site.

5.6.2 Available Data

The following data sources will be used in the ecological impact assessment to inform the assessment of ecological effects:

- NBN (National Biodiversity Network) records;
- Biological records from the Lothian Wildlife Information Centre;
- SNH Ancient Woodland Inventory;
- MAGIC (web based interactive map of sites with designated conservation interest);
- Ordnance Survey map data;
- Aerial photography where available;
- National, local and regional planning policy, in terms of policies which are relevant to ecological effects.

5.6.3 Method of Assessment

5.6.3.1 Overview

The proposed approach to the ecological impact assessment would comprise:

- A desk review of development plans and additional policy documents to identify the policy background and any potentially important ecological receptors within, and adjacent to, the sites, including the relevant National and Local Biodiversity Action Plans (LBAP);
- Confirmation of sites designated for nature conservation, including statutory and non-statutory designations within and surrounding the site;
- An Extended Phase 1 Habitat Survey of the sites and an appropriate buffer zone;
- National Vegetation Classification (NVC) survey for habitats of particular nature conservation interest;
- Following consultation, protected animal and plant species surveys where required;
- Input to the design, and construction methods / programme, of the development to avoid/ minimise potential adverse ecological impacts;
- An assessment of residual impacts on ecology following mitigation following IEEM Guidelines, and an evaluation of ecological mitigation requirements;
- Consideration of the need for, and scope and feasibility of, further nature conservation compensation and enhancement opportunities.

5.6.3.2 Consultation

A formal consultation response will be sought from the following organisations:

- East Lothian Council Biodiversity Officer;
- Scottish Natural Heritage;
- The Scottish Wildlife Trust.

5.6.3.3 Survey

An Extended Phase I Habitat Survey will be carried out on:

- The three proposed landing points (and associated works areas and connections), plus a 50 m buffer;
- The proposed connection route(s) for Option 2 (Torness options), with a 200 m survey buffer either side of the route(s), or the potential search area for the connection routes, plus a 50 m buffer of that area;
- The footprint of additional substations, plus a 50 m buffer where these do not fall under the survey areas described above.

A Phase I Habitat Survey will be carried out to assess the type and area of habitats in the survey areas described. This is a standard ecological survey technique developed by the JNCC (1990) for the audit of ecological resources within a site. Habitats would be classified and mapped on a 1:10,000 scale base map (or equivalent CAD plan if provided) in accordance with standard mapping codes, and then transferred to a Geographical Information System (GIS).

The Phase I Habitat Survey will be 'extended' to include an assessment for the potential for species protected by European and UK law, or species included in national and local Biodiversity Action Plans to be present on site.

A Phase I Habitat Survey can be carried out at any time of year but the optimal time is between April and October. If habitats which are included in the Annexes of the Habitat Regulations are found, or habitats covered by relevant Biodiversity Action Plans, these shall be subject to a National Vegetation Classification

(NVC) survey (Rodwell, 1993). NVC classification will be carried out between May and August, though the earliest part of this period is best for coastal habitats.

Preliminary data searches have indicated that the survey areas may have the potential to support the following faunal species:

- Otter;
- Water vole;
- Badger;
- Bats;
- Red squirrel;
- Reptiles; and
- Great crested newt.

Surveys will be required if any part of the development may affect areas where these species are potentially present. The survey methods that would be used are presented in Appendix G.

5.6.3.4 Ecological Impact Assessment

Ecological Impact Assessment (EcIA) is based on a number of factors, primarily consideration of the value of a site or feature being assessed, and the anticipated magnitude of the resulting impacts. The Institute of Ecological and Environmental Management (IEEM) has produced guidelines to assist with ecological evaluation and impact assessment (IEEM, 2006) these will be used as a general guide in the assessment. These guidelines have no legal standing and are not a substitute for professional judgement and interpretation, particularly where the ecological value of a site and/or the magnitude of impacts are not clear or are borderline between two categories of value/magnitude.

5.6.3.4.1 Sensitivity/Value of Ecological Receptors

A summary of the approach that will be used to value ecological receptors can be found in Table 5-3. The table shows how ecological value or level of sensitivity can be ascertained using a combination of statutory measures (legally protected sites and species) and non-statutory but widely accepted measures, such as the presence of notable habitats and species listed in Biodiversity Action Plans. Use can also be made of the Ratcliffe assessment criteria for the selection of sites with nature conservation value (Ratcliffe, 1977).

Level of sensitivity or value	Examples
International	An internationally designated site or candidate site (SPA[28], pSPA[29], SAC[30], cSAC[31], pSAC[32], Ramsar site[33], Biogenetic Reserve[34]) or an area which Scottish Natural Heritage has determined meets the published selection criteria for such designations, irrespective of whether or not it has yet been notified. A viable area of a habitat type listed in Annex 1 of the Habitats Directive, or smaller areas of such habitat that is essential to maintain the viability of that ecological resource. Any regularly occurring population of an internationally important species, i.e. those listed in Annex 1, 2 or 4 of the Habitats Directive.

[28] Special Protection Area classified under the EU Birds Directive for their importance to birds.

[29] Potential Special Protection Area

[30] Special Area of Conservation Area classified under the EU Habitats Directive for important habitat or non bird species.

National	A nationally designated site (SSSI[35], NNR[36], and Marine Nature Reserve[37]) or a discrete area which SNH has determined meets the published selection criteria for national designation irrespective of whether or not it has yet been notified. A viable area of a Priority Habitat identified in the UK BAP[38], or smaller areas of such habitat which are essential to maintain the viability of that ecological resource. A regularly occurring population of a nationally important species i.e. a priority species listed in the UK BAP and/or Schedules 1, 5 (S9 (1, 4a, 4b)) or 8 of the Wildlife and Countryside Act. A regularly occurring and viable population of a UK Red Data Book species.
Council	Viable areas of key habitat identified in Council BAPs and/or the Natural Heritage Zone profile or smaller areas of such habitats that are essential to maintain the viability of that ecological resource. Any regularly occurring, locally significant population of a species listed as being nationally scarce (occurring in 16-100 10km squares in the UK) or in a relevant Council BAP or Natural Heritage Zone profile on account of its rarity or localisation. Non-statutory designated wildlife sites (e.g. SNCIs[39], SINCs[40]), including semi-natural ancient woodland greater than 0.25ha. Networks of species-rich hedgerows.

[31] Candidate Special Area of Conservation

[32] Potential Special Area of Conservation

[33] Wetland of international importance designated under the Ramsar Convention.

[34] Sites deemed representative examples of particular habitats in Europe.

[35] Site of Special Scientific Interest designated under UK law as being the best examples of the UK's flora, fauna, geological or physiographical features.

[36] National Nature Reserve designated under UK law as containing the best examples of natural or semi-natural ecosystems in Britain.

[37] Marine Nature Reserve designated under UK law to conserve marine flora, fauna and geological features.

[38] Biodiversity Action Plan identifies targets for improving and protecting biodiversity in an area to meet the UK's commitments under the Rio Convention.

[39] Site of Nature Conservation Importance Locally important sites of nature conservation adopted by local authorities for planning purposes

[40] Sites of Importance for Nature Conservation Locally important sites of nature conservation adopted by local authorities for planning purposes

District	District sites and other sites which the designating authority has determined meet the published ecological selection criteria for designation, e.g. Local Nature Reserves. Semi-natural ancient woodland smaller than 0.25ha. Sites/features that are scarce within the district or which appreciably enrich the district habitat resource.
Neighbourhood	Commonplace and widespread semi-natural habitats e.g. scrub, poor semi-improved grassland, coniferous plantation woodland, intensive arable farmland etc.
Less than Neighbourhood	Habitats of little or no ecological value e.g. amenity grassland or hard standing.

Table 5-3 An Approach for Assessing the Value or Sensitivity of Ecological Receptors in Scotland

5.6.3.4.2 Impact magnitude

Impact magnitude seeks to characterise the degree of change in an ecological receptor. It will take into consideration the fact that different sources of change can result in permanent or temporary impacts, that different impacts have different probabilities of occurring, and that some changes may be positive (beneficial). The magnitude of impacts is also dependent on their timing and/or frequency of occurrence, and whether they can be reversed. These factors are all components of ecological impact magnitude.

Impact magnitude can be high, medium, low, or neutral. A summary of this approach is provided in Table 5-4.

Impact magnitude	Description
High	High impacts may include those that result in large-scale, permanent changes in an ecological receptor, and are likely to change its ecological integrity. These impacts are therefore likely to result in overall changes in the conservation status of a species population or habitat type at the location(s) under consideration.
Medium	Medium impacts may include moderate-scale permanent changes in an ecological receptor, or larger-scale temporary changes, but the integrity of the feature is not impacted. This may mean that there are temporary changes in the conservation status of a species-population or habitat type at the location(s) under consideration, but these are unlikely to be long-term.
Low	Low impacts may include those that are small in magnitude, have small-scale temporary changes, and where integrity is not affected. These impacts are unlikely to result in overall changes in the conservation status of a species population or habitat type at the location(s) under consideration, but it does not exclude the possibility that mitigation or compensation will be required.
Neutral	There is no change in the ecological receptor.
Positive	The changes in the ecological receptor are considered to be beneficial.

Table 5-4 Criteria for Describing Impact Magnitude

Combining ecological value/sensitivity and impact magnitude gives ecological impact significance (Table 5-5). Ecological receptors with impacts of moderate or major significance will be priorities for mitigation and/or enhancement. In some cases, such as protected species, there may also be a legal obligation to provide such mitigation. Impacts judged to be of major or moderate significance will be considered to be 'significant

impacts' in accordance with the EIA Regulations. However, the matrix is not intended to be applied without professional judgement to test and refine ratings of significance.

Impact Significance Level		Magnitude of Impact				
		High	Medium	Low	Neutral	Positive
Value/sensitivity of ecological receptor	International	Major	Major	Moderate	No impact	Can be Minor, Moderate or Major. Moderate and Major positive impacts are of material consideration to the planning application
	National	Major	Moderate	Moderate	No impact	
	Council	Moderate	Moderate	Minor	No impact	
	District	Moderate	Minor	Minor	No impact	
	Neighbourhood	Minor	Minor	Negligible	No impact	
	Less than Neighbourhood	Minor	Negligible	Negligible	No impact	

Table 5-5 Matrix for Determining Significance of Ecological Impacts

5.6.3.5 Relevant Legislation, Standards and Guidance

The ecological impact assessment would be carried out in line with the relevant legislation, standards and guidance, notably:

- The Wildlife and Countryside Act 1981, (as amended);
- The 1994 Habitat Regulations (1992 EC Habitats Directive);
- The Nature Conservation (Scotland) Act 2004;
- The Protection of Badgers Act (1992);
- NPPG14: Natural Heritage;
- Institute of Environmental Assessment (1995) *Guidelines for Baseline Ecological Assessment*;
- Institute of Ecology and Environmental Management (IEEM) (2006) *Guidelines for Ecological Impact Assessment in the United Kingdom (version 7)*;
- JNCC (2004) *Handbook for Phase 1 Habitat Survey: a technique for environmental audit (revised reprint 2003)*;
- Scottish Executive *Interim Guidance on European Protected Species, Development Sites and the Planning System* (2001);
- SNH (2005) *Handbook on Environmental Impact Assessment (EIA): Guidance for Competent Authorities, Consultees and others involved in the Environmental Impact Assessment Process in Scotland*.

5.6.4 Further Requirements

Once a development boundary has been set for the proposed landing points, and proposed routes or a search area has been confirmed for connections, further consultation with local authorities and SNH will seek to agree the assessment methodology, including the requirement for specific faunal surveys. This consultation, as well

as the findings of the Extended Phase I Habitat Survey may result in the requirement for species specific surveys which have not been identified in this assessment – for example fisheries surveys or terrestrial invertebrate surveys, depending on the habitats that will be affected by the development and the potential construction methods that will be used.

5.6.5 Potential Mitigation and Monitoring

It is expected that most potential impacts can be avoided or effects reduced at the design stage of the scheme through early consideration of ecological constraints, which along with consideration of other environmental features will be used to refine scheme layout, siting and design. Further avoidance of impacts may also be possible at the construction stage by micro-siting infrastructure.

A range of standard mitigation measures are likely to be required throughout construction to protect ecological features, as well as the wider environment. These may include:

- Pre-construction checks for protected species, and the potential requirement for an Ecological Clerk of Works to supervise all or part of the construction works;
- Strict pollution prevention measures built into Construction Method Statements, following SEPA guidance;
- Restrictions on the timing and design of watercourse crossings to avoid impacts on fish communities at sensitive periods and to ensure the passage of fish and aquatic mammals is facilitated and maintained during and after construction;
- Specific on site rules such as speed limits, storage of materials and chemicals hazardous to wildlife, capping and ramping of trenches; and,
- Methods for site (habitat) clearance, to reduce impacts on faunal species, reduce habitat damage, and to maintain turfs for potential re-use in habitat restoration schemes or for restoring infrastructure edges.

Only in exceptional circumstances where features such as great crested newt ponds and terrestrial habitat, bat roosts, badger setts, otter shelters, squirrel dreys and water vole burrows cannot be avoided or where works encroach into an area which will cause disturbance to these features, would more specific mitigation measures be required. This may include specifying timing of works, methods of working and supervision of works, or, at its most extreme, the need to exclude and destroy features (though we would aim to design out these impacts) and the requirement to implement habitat creation and animal translocation schemes or other ecological compensation methods. Any such mitigation would require a licence from the relevant licensing authority.

Only where work would need to be carried out under the remit of a protected species licence, would there be a specific need to carry out monitoring of species or habitats. This monitoring, its type and frequency would be a condition on any licence granted by SNH or the Scottish government (as appropriate).

5.6.6 Cumulative Impacts

It is not anticipated that the impacts associated with the relatively small-scale terrestrial (onshore) works will be sufficient as to require cumulative assessment. NnGOWL is working with The Crown Estate and the other Forth and Tay Offshore Wind Farm Developers to ensure cumulative impacts are assessed across the sites. Consultation would be carried out with SNH to agree the approach to the individual scheme and cumulative assessment.

5.7 Nature Designations

5.7.1 General Description

This section provides an overview of the statutory protected sites that are designated under European Directives and/or implemented through British legislation by a statutory body, thereby having recognised legal protection.

The region around the Firth of Forth is known as an important area for both birds and marine mammals, with several Special Protected Areas (SPAs) and Special Areas of Conservation (SACs). Figure 5-11 shows the Sites of Special Scientific Interest (SSSIs), Important Bird Areas (IBAs), RAMSAR sites, marine conservation areas, local nature reserves, SPAs and SACs. The SPAs have a 5 km and 10 km buffer applied around them. Neart na Gaoithe is located beyond the extent of these buffers.

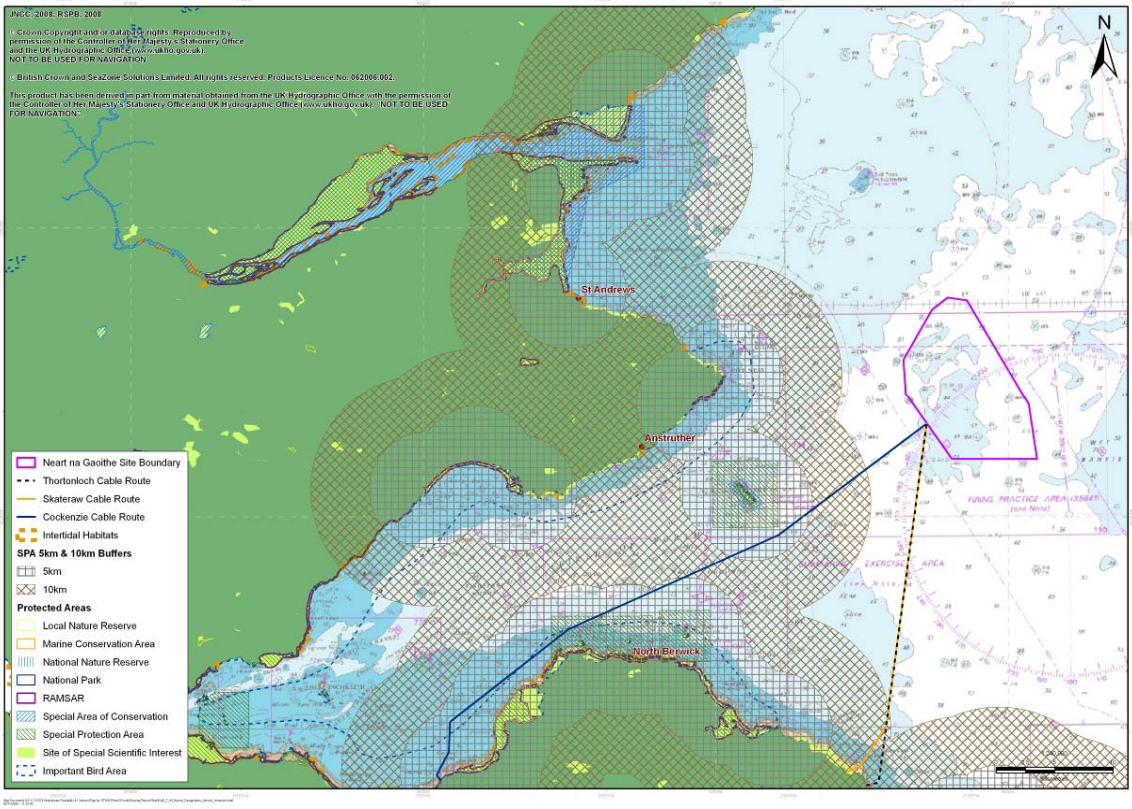


Figure 5-11 Nature Conservation Designations Onshore from Neart na Gaoithe

5.7.1.1 Special Areas of Conservation

Member states are required to identify for designation fauna and flora that represent outstanding areas of selected habitat type of importance to non-bird species, known as Special Areas of Conservation (SAC). Protection is based around a series of six annexes considering designated habitats and species. In the UK, the Directive is implemented through the Conservation (Natural Habitats etc.) Regulations 1994 (subsequently amended in 2000 and 2007), which again requires that all sites are first designated as SSSIs. Potential SACs become candidate SAC or cSAC when submitted to the EC, thereby activating those provisions of the Habitats Regulations relating to Appropriate Assessment. Once accepted by the EC, cSAC become European Sites and are known as SAC.

The SACs in this region are:

- Firth of Tay & Eden Estuary;
- Isle of May;
- River South Esk;
- St Abb's Head to Fast Castle.

Details of these sites are provided in Appendix H.

5.7.1.2 Special Protected Areas

The 1979 EC Directive on the Conservation of Wild Birds (the Birds Directive) requires member states to take special measures to protect migrating and wintering birds, and those birds listed in Annex 1 of the Birds Directive. These measures involve the designation of SPAs. A development which would affect a designated feature of an SPA (i.e. a particular species) must assess the implications for the SPA.

The relevant SPAs are:

- Montrose Basin;
- Firth of Tay & Eden Estuary;
- Firth of Forth;
- Cameron Reservoir;
- Forth Islands;
- St Abb's Head to Fast Castle.

Details of these sites are provided in Appendix H.

5.7.1.3 Ramsar Sites

The International Ramsar convention requires contracting parties, including the UK, to identify and protect significant wetland for wildlife, in particular waterfowl. Sites are designated following agreed criteria and should be considered for international designation if it regularly supports over 20,000 waterbirds and/or if it supports 1% of the individuals in a population of one species or subspecies of waterbird.

The RAMSAR sites within the region are:

- Montrose Basin;
- Firth of Tay & Eden Estuary;
- Cameron Reservoir.

Details of these sites are provided in Appendix H.

5.7.1.4 Important Bird Area

An Important Bird Area (IBA) is an area recognised as being a globally important habitat for the conservation of bird populations. The programme was developed by BirdLife International. IBAs are determined by an internationally-agreed set of criteria. Specific IBA thresholds are set by regional and national governing organisations (BirdLife International, 2009).

The Important Bird Areas (IBAs) within the region are:

- Eden Estuary, Tentsmuir Point and Abertay Sands;
- Firth of Forth;
- Firth of Tay;
- Forth Islands;
- Montrose Basin;
- St Abb's Head to Fast Castle.

Further details on these IBAs are provided in Appendix H.

5.7.2 Available Data

The Marine Bill (Scotland) aims to designate more areas of nature conservation importance as part of Natura 2000. At the end of July 2008, a total of 385 Natura 2000 sites had been identified in Scotland. These

comprise a total of 239 SACs and 145 SPAs, accounting for approximately 10% of Scotland's land surface. These sites protect 79 bird species, such as Golden Eagle and Capercaillie, 18 other types of animal species, including seal, dolphin, wild Atlantic salmon, and 56 types of habitat, including reefs, Scotland's rugged upland habitats and machair (grassy plains). It will be necessary to continue consultation with the Scottish government and SNH to ensure that any conservation updates are considered throughout this process.

Other data sources and literature references include:

- Barne, J.H., Robson, C.F., Kaznowska, S.S., Doody, J.P., Davidson, N.C., & Buck, A.L., eds. (1997). *Coasts and seas of the United Kingdom. Region 4 South-east Scotland: Montrose to Eyemouth*. Peterborough, Joint Nature Conservation Committee. (Coastal Directories Series.)
- BirdLife International. *Towards the identification of marine IBAs in the EU: an exploration by the Birds and Habitats Directives Task Force*[41]
- CCW, EN, JNCC, SNH (2004). *Nature Conservation Agency Guidance on Offshore Wind Farm Development. A guidance note for developers undertaking offshore wind farm developments*.
- Christensen, Per & Lund, Henrik, (1998), *Conflicting views of sustainability: the case for wind power and nature conservation in Denmark*, European Environment 8(1), January/February
- Davidson, N.C., Laffoley, D., Doody, J.P., Way, L.S., Key, R., Drake, C.M., Pienkowski, M.W., Mitchell, R. and Duff, K.L. (1991) *Nature Conservation and Estuaries in Great Britain*. Nature Conservancy Council
- DEFRA (2005) *Nature Conservation Guidance on Offshore Wind Farm Development*. Version R1.9
- DECC SEA5; and Offshore Energy SEA and Scottish Territorial Waters SEA (if available)
- English Nature, (1994), *Nature conservation guidelines for renewable energy projects*, EN, Peterborough
- Foster-Smith, R.L. and Hendrick, V.J. (2003). Sabellaria spinulosa *in the Wash and Norfolk cSAC and its approaches: Part III, Summary of knowledge, recommended monitoring strategies and outstanding research requirements*. A report for the Eastern Sea Fisheries Joint Committee and English Nature by Envision Mapping
- Harrison, P.A., Berry, P.M., and Dawson, T.P. (2000) *Climate Change and Nature Conservation in Britain and Ireland. MONARCH- Modelling Natural Resource Responses to Climate Change*. The UK Climate Impacts Programme
- Scottish Executive (1995) *Implementation in Scotland of EC Directives on the Conservation of Natural Habitats and of Wild Flora and Fauna and the Conservation of Wild Birds* ("The Habitats and Birds Directive"). Revised Guidance Updating Scottish Office circular No 6.1995
- Langston, R.H.W. and Pullan, J.D., (2003) *Wind farms and Birds*: *An analysis of the effects of wind farms on birds, guidance on environmental assessment*
- Power, B., Girling, A., Fisk, P. (2003). *Guidelines for managing water quality impacts within UK European marine sites*. Version 2, edited by N Hailey, A Burn, J Burt & M Coyle, English Nature. ISBN 85716 747 3
- Royal Society for the Protection of Birds (RSPB), English Nature, WWF-UK and BWEA, (2001) *Wind Farm Development and Nature Conservation: A Guidance Document for Nature Conservation Organisations and Developers when consulting over wind farm proposals in England,* March 2001
- Scottish Executive Development Department (2006), *Assessing Development Plans in terms of the need for Appropriate Assessment. Interim Guidance*, May 2006 Crown Copyright
- Soker, Holger *Offshore wind energy in the North Sea - Technical possibilities and ecological considerations*

[41] http://www.birdlife.org/action/science/sites/marine_ibas/birdlife_marine_iba_id.pdf

- *Standards for Environmental Impact Assessments of Offshore Wind Turbines in the Marine Environment*
- Stone, C.J., Webb, A., Barton, C., Ratcliffe, N., Reed, T.C., Tasker, M.L., Camphuysen, C.J. & Pienkowski, M.W. (1995) *An atlas of seabird distribution in north-west European waters*. Joint Nature Conservation Committee and Nederlands Instituut voor Onderzoek der Zee, Peterborough

Plus websites for the following national bodies:

- CEFAS (Centre for Environment, Fisheries and Aquaculture Science);
- JNCC (Joint Nature Conservation Committee);
- SEPA (Scottish Environment Protection Agency);
- ICES International Council for the Exploration of the Sea;
- OSPAR International Convention on the protection of the marine environment;
- SNH (Scottish Natural Heritage's Information service);
- Scottish Executive;
- FRS Fisheries Research Services.

5.7.3 Method of Assessment

A detailed conservation review will be undertaken in the EIA, utilising both survey data and consultation.

Along with the literature sources referenced above the following guidance documents will be considered:

- Nature Conservation Guidance on Offshore Wind farm Development – *A guidance note on the implications of the EC Wild Birds and Habitats Directives for developers undertaking offshore wind farm developments*. March 2005. Defra (UK)[42]
- BWEA consultation response[43]:

These sources will be consulted upon, along with statutory nature conservation advisors to make sure that the development of Neart na Gaoithe does not have any implications for nature designations.

With regard to Annex I habitats, such as reefs, it is important to survey Neart na Gaoithe to establish the presence or absence of the following main reef types that may be sensitive to offshore wind farm development:

- Horse mussel *Modiolus modiolus*;
- Ross worm *Sabellaria spinulosa*;
- Honeycomb worm *Sabellaria alveolata;*
- Stony/cobble/bedrock reefs.

This will be undertaken as part of the benthic ecology survey and interpretation (Appendix D).

5.7.4 Further Requirements

Pending the implementation of new Natura 2000 sites in the vicinity of Neart na Gaoithe, sensitive habitats or species that are identified as 'Primary' features elsewhere will need to be identified near the proposed site, and any potential impacts determined.

[42] Defra 2005: http://www.defra.gov.uk/wildlife-countryside/ewd/windfarms/windfarmguidance.pdf

[43] BWEA Consultation Response: http://www.bwea.com/pdf/defra_guidance_consult.pdf

SAC status does not necessarily preclude wind farm development. However, development can only be undertaken if it is shown that there will not be a significant impact on the features that are listed in the SAC citation.

5.7.5 Potential Mitigation and Monitoring

As there are no designated areas in the vicinity of Neart na Gaoithe, no mitigation or monitoring is expected. However, if survey results later reveal potential Annex I habitat and interest features, then these will be reported to SNH and monitored accordingly.

5.7.6 Cumulative Impacts

The location of Neart na Gaoithe is not expected to cause any impacts on designated areas. Further investigation is needed as to whether the installation of the foundations in conjunction with other activities may impact on marine mammals designated as Annex II species.

6 Human Environment

6.1 Landscape, Seascape and Visual Assessment

6.1.1 General Description

The coastline of Fife extends into the North Sea and consists of coastal flats, low rolling hills, cliffs and terraces. The landscape has a generally large scale and open character which allows extensive seaward views from certain locations (Land Use Consultants, 2008). Scattered coastal villages, local attractions and holiday resorts lie along this coastline; connected by coastal trails, making the area a popular visitor destination. Some of the key sensitive locations and features along the Fife coast include:

- St Cyrus Bay;
- St Andrews, and the associated golf course (The Links);
- The villages of Arbroath, Boarhills, Kingsbarns, Crail, Kilrenny and Anstruther;
- Cambo Garden and Designed Landscape (open to the public);
- Fife Ness Nature Reserve;
- Small but prominent hills (former volcanic plugs) such as Kellie Law and Largo Law which are used by recreational walkers;
- The Fife Coastal path[44];
- The Fife Coastal Route (A917)[45];
- The Isle of May;
- Bell Rock lighthouse;
- St Abb's Head.

Further inland sloping arable fields, which dominate the flatter coastal strip, gradually reduce in scale as plantations and shelterbelts become more frequent. Large areas of this coastal landscape are locally designated as *Areas of Great Landscape Value*. As such, these areas are recognised as being valued locally, for the character and scenic qualities of their landscapes.

The exposed coastal landscapes with their open views across the sea (St Andrews Bay, the outermost extent of the Firth of Forth) are considered to be of *medium* sensitivity, although there are localised pockets where landscape sensitivity is higher (e.g. area around Cambo Sands), or lower (e.g. the disused airfield at Fife Ness). More detailed landscape and seascape sensitivity will be identified as part of EIA studies.

As the proposed distance offshore is greater than 15 km for the closest turbines, the effects of any wind development at Neart na Gaoithe on the coastal landscape are likely to be limited. These will be strongly influenced by weather conditions, particularly the occurrence of sea fog across the east coast. When weather conditions are clear, wind turbines are likely to be apparent on the horizon in views from coastal and hinterland locations near Fife Ness.

Although visible from the coast, it is unlikely that the proposed development will significantly affect the character of the landscape itself. It may however alter the experiential qualities of the landscape, such as the perception of the undeveloped horizon. Other activity, such as shipping, will need to be considered in examining the existing seascape character.

[44] Fife coastal path - www.fifecoastalpath.co.uk

[45] Fife coastal route - perfectday.visitscotland.com/perfect-days/by-the-sea/take-the-fife-coastal-route.aspx

Very long distance views may be obtained in clear weather conditions from the Angus, East Lothian or Borders coastlines, however due to the distance to the proposed site, no significant effects are expected.

The coastal area which will potentially be affected by a wind farm at Neart na Gaoithe extends from St Andrews to Elie. The closest turbines at Neart na Gaoithe will lie 15.5 km from the nearest coastal location at Fife Ness (Figure 6-1). The closest relevant designated areas and landmarks are:

- St Andrews Area of Great Landscape Value (15.5 km);
- Cambo Garden and Designed Landscape (18 km);
- John Muir Country Park (30 km).

SNH in their Policy Statement recognises that offshore renewable developments, and especially those at a distance from the shore, are less likely to have significant visual effects (Scottish Natural Heritage, 2000). In SNH's long term plan, they state that "*the visual impact of large-scale renewable generation means that future bulk electricity supply is likely to be served best by encouraging at least a proportion of such generation to take place offshore*".

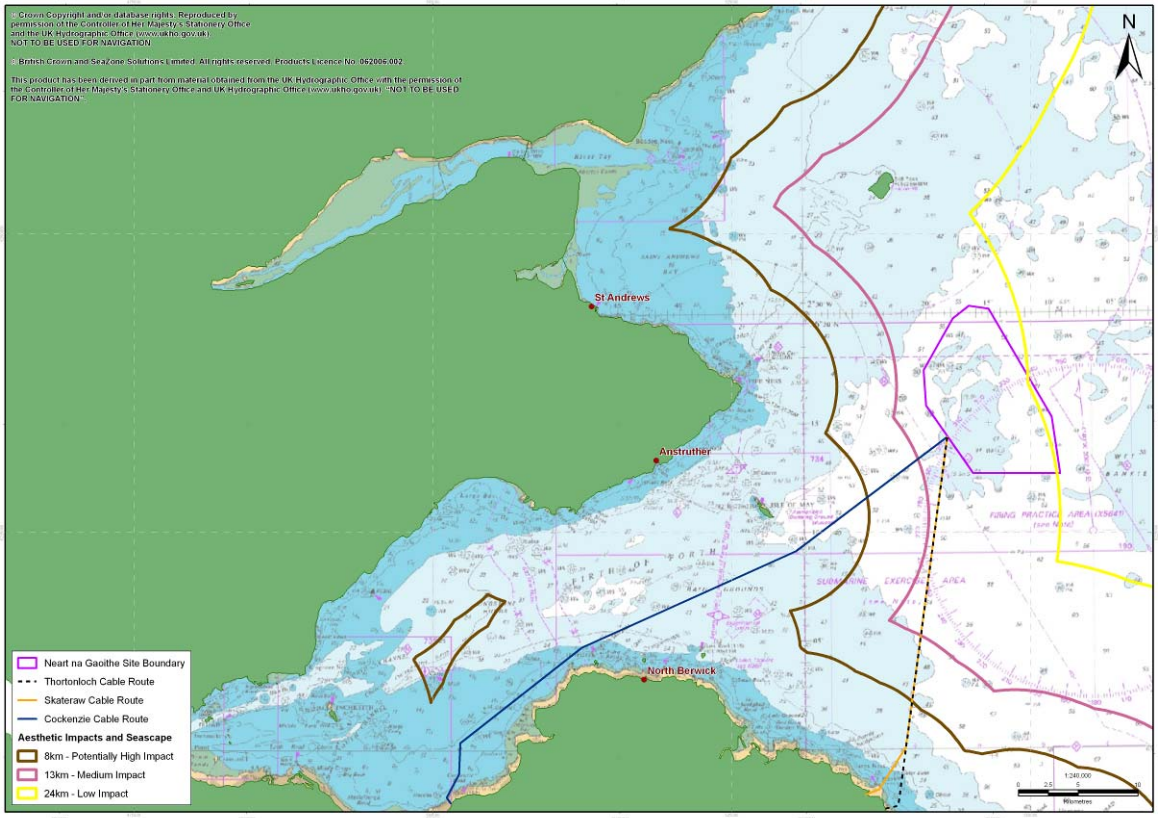


Figure 6-1 Site Location in Relation to the Fife and East Lothian Coasts

6.1.2 Available Data

The following data sources will be use to inform the assessment of landscape, seascape and visual effects.

- Ordnance Survey map data (including the location of key tourist destinations, and concentrations of visual receptors);
- Chart data;
- Landscape/seascape designations across the area;
- Information about weather conditions from the local meteorological office;

- Air photography;
- Scottish Natural Heritage's Landscape Character Assessment series;
- SNH Commissioned Report/University of Newcastle (Final Report July 2004) *An Assessment of the Sensitivity and Capacity of the Scottish Seascape in Relation to Offshore Wind Farms*;
- Zone of theoretical visibility (ZTV) maps plotted for the proposed development, and for other sites in terms of examining cumulative effects;
- National, regional and local planning policy, in terms of policies which are relevant to landscape, seascape or visual effects.

6.1.3 Method of Assessment

To assess the effect of the offshore wind farm on landscapes, seascapes, areas designated for their landscape importance, and views, including from potentially sensitive visitor destinations, a study area with a radius which extends to a distance of up to 35 km from the edge of the proposed site will be considered. For the cumulative assessment this will be extended to up to 60 km from the proposed site boundary, as advised by Scottish Natural Heritage (2005)[46].

Locations within this study area will be assessed to examine effects upon landscape, seascape and visual amenity as a result of offshore wind development at the proposed location. The ability of areas to accommodate change will be considered in the assessment. Examination of the likely effects of wind generation on the seascape, the coastal landscapes and hinterlands within this study area will be undertaken. Effects could extend up to 20 km inland from the shore (i.e. extending a maximum distance of 35 km from the development edge, itself located 15 km offshore).

Popular areas for marine and coastal recreation, as well as ferry routes (e.g. Rosyth ferry) and other offshore users, will be taken into consideration in identifying potentially sensitive receptors. Potential sequential effects on viewers using shipping lanes, as well as people moving along linear routes such as the Fife Coastal Route, and Fife Coastal Path, will also be included.

Climatic and atmospheric conditions will be included in the assessment of the likely visual effects of the proposed offshore wind development. The east coast of Scotland is frequently subject to sea fog, particularly in the summer months, and further research will be needed to assess how visibility conditions will affect the frequency and significance of visual effects. The approach will consider the visual significance limits recommended to apply to offshore wind farms as set out in SNH (2004). This document suggests that seascape visual range is likely to be greater in Scotland than England, allowing clarity of view at distances of up to 35 km from the nearest turbine.

The distances quoted in DTI (2005a) *Guidance on the Assessment of the Impact of Offshore Wind Farms: Seascape and Visual Impact Report*, together with the predicted level of significance of visual impacts, are:

- 0-8 km – high visual impact;
- 8-13 km – moderate visual impact;
- 13-24 km – low visual impact;
- >24 km – not significant.

It is recognised that this varies according to the nature of the proposed site, the weather conditions, and the technology proposed, in particular the height and size of the turbines.

The significance (*major, moderate minor*) of landscape, seascape and visual effects will be judged by considering the nature and sensitivity (*high, medium, low*) of the existing landscapes and seascapes, and visual receptors, against the proposed magnitude of change (*high, medium, low*), which will reflect the nature, scale, layout and proximity of the proposed project. Effects will be assessed in accordance with the Landscape

[46] SNH, 2005 http://www.snh.org.uk/pdfs/strategy/Cumulativeeffectsonwindfarms.pdf

Institute and the Institute of Environmental Management and Assessment (Second Edition 2002) *Guidelines for Landscape and Visual Impact Assessment*.

The work will be informed and illustrated through the preparation of zone of theoretical visibility (ZTV) maps. ZTVs will be modelled to show the extent of theoretical visibility of tips and hubs (two separate maps) of the proposed turbines, across the 35 km radius study area. These will be produced in accordance with Scottish Natural Heritage (2006) *Visual Representation of Wind Farms Good Practice Guidance*. Effects across the study area will be reported, focusing upon significant effects.

In addition to the ZTVs, a series of maps will be produced showing the distribution of designated landscapes, landscape and seascape character areas, and the location of viewpoints and other sensitive receptors in relation to the ZTV. These maps will inform the assessment of potential effects upon these areas.

A series of viewpoints will be agreed with the local authorities and SNH. These will be illustrated by generating wireframes and/or photomontages of the proposed wind farm. Photomontages (and matching wireframes for all locations) will be produced from the closer land based locations, where the view will be clearest, for example from the coastlines to the north, west and couth of the proposed site, and from areas where there is an elevated open view from near to the coast. Wireframes will be used to illustrate the view from more distant locations. These viewpoints will be used as an assessment tool in order to inform examination and description of effects upon visual amenity and views. Typically, about 15-20 locations will be examined, with around 8-10 of these being illustrated with photomontages, and the rest being illustrated with wirelines.

Potential viewpoint locations include:

- St Cyrus Bay;
- St Andrews, and the associated golf course (The Links);
- The villages of Arbroath, Boarhills, Kingsbarns, Crail, Kilrenny and Anstruther;
- Cambo Garden and Designed Landscape (open to the public);
- Fife Ness Nature Reserve;
- Small but prominent hills such as Kellie Law and Largo Law which are used by recreational walkers;
- The Fife Coastal path;
- The Fife Coastal Route (A917);
- The Isle of May;
- Bell Rock lighthouse;
- St Abb's Head.

The relevant guidance will be followed, and is listed below.

Landscape Institute

- Landscape Institute Advice Note 01/09 *Use of Photography and Photomontage in Landscape and Visual Assessment*;
- Landscape Institute and the Institute of Environmental Management and Assessment (Second Edition 2002) *Guidelines for Landscape and Visual Impact Assessment;*
- The Landscape Institute (1999) *Use of the Guidelines for Landscape and Visual Assessment; Practical Advice Note*.

Department of Energy and Climate Change (DECC) (former department for Business, Enterprise and Regulatory Reform (BERR) and Department of Trade and Industry (DTI))

- DTI (2000) *Cumulative Effects of Wind Turbines; A Guide to Assessing the Cumulative Effects of Wind Energy Development;*

- DTI (2005) *Guidance on the Assessment of the Impact of Offshore Wind Farms: Seascape and Visual Impact Report*.

Natural England

- The Countryside Agency/Scottish Natural Heritage (2004) *Topic paper 6: Techniques and Criteria for Judging Capacity and Sensitivity*;
- The Countryside Agency/Scottish Natural Heritage (2003) *Landscape Character Assessment Series Topic Paper 9: Climate change and natural forces, the consequences for landscape character*;
- Countryside Agency and SNH (2002) *Landscape Character Assessment Guidance for England and Scotland;*
- Countryside Commission (1991) *Wind Energy Development and the Landscape, CCP 357.*

Scottish Natural Heritage

- Scottish Natural Heritage (2001) *Guidelines on the Environmental Impacts of Wind Farms and Small Scale Hydro-electric Schemes*;
- University of Newcastle (2002) *Visual Assessment of Wind Farms Best Practice*. Scottish Natural Heritage Commissioned Report F01AA303A;
- Scottish Natural Heritage (2005) *Cumulative Effects of Wind Farms*;
- Scottish Natural Heritage (2006) *Visual Representation of Wind Farms Good Practice Guidance;*
- Scottish Natural Heritage (2008) *Designing Wind Farms in the Landscape (Consultation Draft);*
- SNH Commissioned Report/University of Newcastle (Final Report July 2004) *An Assessment of the Sensitivity and Capacity of the Scottish Seascape in Relation to Offshore Wind Farms.*

Countryside Council for Wales

- Countryside Council for Wales, Hill, Briggs, Minto, Bagnall, Foley, Williams (2001) *Guide to Best Practice in Seascape Assessment*.

6.1.4 Further Requirements

Consultation with local authorities and SNH will include seeking agreement for the assessment methodology, and the use of appropriate guidance, as well as obtaining further information that is relevant to the area, and agreeing locations for viewpoints, as discussed above.

6.1.5 Potential Mitigation and Monitoring

The main form of mitigation available is the layout of the turbines within the proposed wind farm, as well as the extent of the wind turbines across the potential development area. The orientation and ordered design of the layout may reduce the level of significance of effects, although it is recognised that seabed conditions and currents will be a key consideration in determining the layout.

It will also be important, where possible, that the design and layout of the site, including such issues as array orientation and turbine size, appears relatively consistent with other nearby proposed developments so that potentially discordant relationships between adjacent wind farms are avoided. The feasibility of this will depend upon technical issues, as well as upon timeframes, but it will be beneficial to have this overall objective in mind.

Mitigation will also be achieved by the proposed colour of the turbines and any ancillary structures (a light grey is favoured). The location and design of lighting or markers will be determined by Northern Lighthouse Board. From a visual perspective, mitigation measures will aim to make the development appear as discrete as possible when seen from land based receptors, while remaining clear at sea for safety of navigation.

Mitigation measures will be of relevance to land based infrastructure (i.e. where cables come ashore and the route of the grid connection) in terms of avoidance of sensitive features through siting and design, and consideration of planting to replace any vegetation which may need to be removed. Typical good construction practice to reduce adverse effects (e.g. hoarding, maintaining a tidy site, topsoil stripping and storage) will also be expected. This will be set out in the ES and should be monitored on site by an environmental clerk of works.

6.1.6 Cumulative Effects

There are four proposed sites located to the east of the Firth of Forth, Fife and St Andrews, as well as potential sites within the Round 3 zone, for which details are as yet unknown. Consequently, cumulative effects between the sites will need to be examined, in order to set out the additional effects which will arise as part of development at Neart na Gaoithe.

It will be necessary to map and consider land based wind farms to within 60 km of the edge of the site, which may include onshore wind farms in the Lammermuir Hills.

ZTV maps will be prepared to examine the proposed site together with each of the cumulative sites. A combined ZTV map will also be produced so that the number of wind farms which are seen from the areas across it can be determined.

Cumulative viewpoint locations will be selected from which to illustrate the combined effects, covering a 360 degree radius of view where appropriate.

Typically 3-4 cumulative wirelines will be produced. Suggested locations include:

- Fife Ness;
- Isle of May;
- Anstruther;
- Dunbar/St Abb's Head.

Cumulative effects upon sea based recreational receptors will also be considered.

In line with Scottish Natural Heritage (2005) *Cumulative Effects of Wind Farms*, '*combined, successive* and *sequential* effects' will be examined, considering the seascape, landscape and both static and moving (i.e. Fife Coastal Route, Fife Coastal path) visual receptors.

Relevant guidance on cumulative effects includes:

- Scottish Natural Heritage (2005) *Cumulative Effects of Wind Farms.*
- Department of Trade and Industry (2000) *Cumulative Effects of Wind Turbines; A Guide to Assessing the Cumulative Effects of Wind Energy Development*.
- Entec Ltd (2008) *Review of Guidance on the Assessment of Cumulative Impacts of Onshore Wind Farms*.

6.2 Archaeology and Cultural Heritage

6.2.1 General Description

The study area comprises the proposed offshore development area and a 1 km 'buffer' zone extending from the site boundary (Figure 6-2). This area extends beyond the proposed development footprint to ensure that peripheral activities associated with the development do not impact on cultural heritage assets, and to ensure that the cultural heritage aspects noted within the development are placed in their wider context.

6.2.1.1 Maritime Losses

A preliminary assessment has identified six recorded wrecks within Neart na Gaoithe. Two sites are designated as 'Protected Places' (K4 and K17), both submarines which sank in 1918 and protected under the Protection of Military Remains Act, 1986. Consequently, there must be no disturbance to these sites.

The four remaining recorded wrecks located within Neart na Gaoithe are well provenanced 'charted' wrecks (not protected by legislation). One further recorded wreck is located in the 1 km 'buffer' zone immediately adjacent to the proposed development site. These sites will be assessed as to their sensitivity to potential impacts (Figure 6-2) within the EIA.

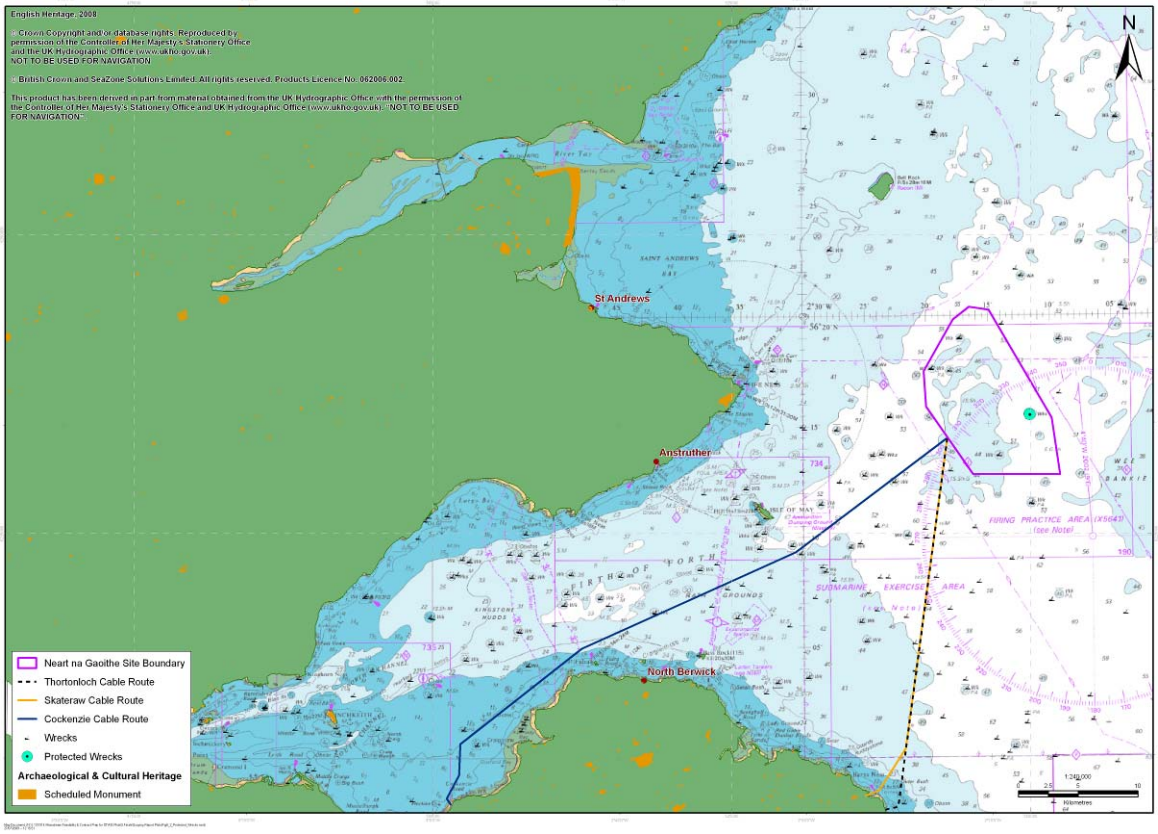


Figure 6-2 Protected Wrecks and Charted Wrecks within the Study Area

6.2.1.2 Prehistoric landscapes

Applying current models of relative sea level (RSL) it is likely that the proposed development area has been submerged since at least 9300 BP (Shennan *et al*., 2000). Consequently, archaeological issues are exclusively maritime from this time onwards, as has been discussed above. Prior to this date there would have been periods when the area was above sea level. For much of this period the area would have been under ice sheets, the eastern limit of which is marked by the Wee Bankie Moraine. There would have been periods, particularly in the late Pleistocene, when the ice sheets would have retreated but sea level had not significantly risen (Fleming, 2004). For most of this period the area would still have been coastal in nature, an environment of great value to late Palaeolithic and Mesolithic cultures due to the relatively rich resources these provide (Smith, 1992).

The nature of the seabed sediments and sub-strata in the area of the proposed development site has been identified as comprising mainly sand and mud sediments (see Section 4.4).

Large scale mapping of the area suggests that deposits are not deep and have been reworked, but have considerable potential for lithic remains to be present. In addition it should be noted that survival of archaeological sites and palaeo-landscape elements is reliant on local topographic variation. Examples might include depressions and channels indicative of relict landscape topography overlain by more recent marine

deposits. Therefore, there is the potential for currently unknown areas of better preserved deposits occurring within the proposed development area (Fleming, 2004). Similar to the maritime losses, the nature of the seabed topography and sediments will have to be assessed in order to establish areas of palaeo-landscape and prehistoric potential and consequent sensitivity to potential impacts from the proposed development.

6.2.2 Available Data

As part of the assessment a systematic search will be undertaken of all readily available and relevant historic environment sources and archives. This will include:

- UK Hydrographic Office (UKHO) Wrecks Database (record of wrecks and obstructions), and review of cartography, historic charts and sailing directions;
- Information held by Historic Scotland (HS) on Designated Wrecks;
- Marine archaeological records held in the National Monuments Record for Scotland (RCAHMS Canmore and Pastmap database);
- Records held in the Historic Environment Records (HER) for East Lothian, Angus (Aberdeenshire) and Fife;
- National Archive of Scotland (NAS);
- National Library of Scotland (for cartographic sources and historic charts);
- Ministry of Defence (MOD) - information on protected wreck remains and military losses;
- Records held with the Receiver of Wreck (RoW) (Maritime and Coastguard Agency);
- Relevant Strategic Environmental Assessment (SEA) reports (UK Continental Shelf SEA Archaeological Baseline; SEA 5);
- Information and collections held in national and local museums (National Museum of Scotland);
- Records held with the Archaeology Data Service (ADS);
- Marine Environment Data information Network (MEDIN).

Other sources will include accessible published sources and grey literature, external marine historic environment specialists, and local dive groups in the area. Data collected in site specific geophysical and geotechnical studies will also be used.

In addition to the data sources above, the following stakeholders/bodies will also be consulted:

- Historic Scotland (Senior Inspector for Marine Archaeology);
- Fife Council Archaeology Service;
- East Lothian Council Archaeology Service;
- Aberdeenshire Council on behalf of Angus Council;
- MOD (protected remains and military losses);
- Receiver of Wreck (MCA);
- BGS regional guide and previous work in the area.

The assessment will be conducted in line with industry best practice and the relevant offshore renewables and marine historic environment guidance. This includes:

- Joint Nautical Archaeology Policy Committee (JNAPC) (2006) *Code of Practice for Seabed Development*;
- COWRIE Historic Environment Guidance for the Offshore Renewable Energy Sector (2007) (COWRIE/Wessex Archaeology);

- COWRIE Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore renewable Energy (2007) (COWRIE/Oxford Archaeology).

Reference is also made to the Historic Scotland Policy document (HP6): *Conserving the Underwater Heritage* (1999), and Historic Scotland's Environmental Impact Assessment (Scoping) of Wind Farm Proposals (Historic Scotland, 2007) and Historic Scotland's *Scottish History* Environment Policy 1 – Scotland's Historic Environment (Historic Scotland 2008).

A list of the relevant Charters, Conventions, Legislation and Policy is given in Appendix I.

6.2.3 Method of Assessment

The assessment of potential impacts on the marine historic environment resulting from the development of Neart na Gaoithe will reflect best practice and be carried out in accordance with the guidance noted above, and in carrying out archaeological desk-based assessments, as codified by the Institute for Archaeologists (IfA) *Standard and Guidance for Archaeological Desk-based Assessment* (IfA 2008). The assessment will be carried out in accordance with the EIA (Scotland) Regulations 1999 and the considerations regarding setting outlined in Historic Scotland's *Scoping of development proposals Assessment of Impact on Setting of the Historic Environment Resource* (Historic Scotland, 2009).

6.2.3.1 Baseline

The baseline aims to identify all known sites and features of cultural heritage interest within the specified study area associated with the proposed development. In addition, the assessment will consider sites and features of cultural heritage interest within the broader local and regional maritime landscape to help establish the potential for the discovery of unrecorded cultural heritage assets within the area of the proposed development. A baseline review will be undertaken which consists of a literature review, including interrogation of the available archaeological data sources. In addition, the geophysical survey and available geotechnical data will be subject to archaeological review in order to identify any previously unknown sites, features and artefacts of cultural heritage interest. The results of a drop-down video survey may also provide information about the nature and extent of targets of cultural heritage interest identified during the geophysical marine survey and review of geo-technical data. The baseline review will also include consultation with the stakeholders noted above.

6.2.3.2 Assessment of impacts

After the baseline review has been completed the known and potential impacts of the development will be assessed. This will include categorisation of known sites, features and artefacts to assess their importance, and thus sensitivity. The magnitude of an impact on sites and features of cultural heritage interest will also be assessed. The sensitivity of a site and magnitude of the impact will then indicate the significance of any potential impacts. The impacts will also be assessed within the regional context. Where the date and type of a wreck is unknown it will be difficult to ascribe a level of importance or sensitivity to the site, and, even when some details are known, more detailed research will be required to gauge the importance. There are several types of importance that can be attached to any single wreck. These are as follows:

- Wreck incidents in which the vessel and/or some or all of the crew were involved;
- Vessels lost in times of war or any vessel associated with loss of life at the time of sinking;
- Vessels with a rarity value that can add degrees of importance;
- Vessel cargoes may also be considered important due to their rarity within the archaeological record.

The construction of the Neart na Gaoithe offshore wind farm has the potential for a number of types of impact upon sites, features and artefacts of cultural heritage interest:

6.2.3.2.1 Direct impact

The assessment will determine the direct impacts on archaeological sites, features and artefacts that may be affected by the development. These might include the introduction of foundations for turbines, the

meteorological mast and the offshore substation; the introduction of scour protection; and the laying of inter-array cables and export cables.

6.2.3.2.2 Indirect impact

Indirect impacts assessed will include a range of activities including scour around turbine foundations; scour around cables, and changes to the sediment regime within the area of the development. Some indirect impacts may be beneficial, for instance the burial of sites and features by increased sedimentation.

While it is unlikely that there will be significant impacts upon the setting of cultural heritage features, the potential for such impacts will be considered, and assessed in the event that such impacts are identified.

6.2.3.2.3 Secondary impact

The assessment will also determine the potential secondary impacts which might include the effects of the anchoring of maintenance vessels, or the impacts of jack-up or sheer legs; and the associated activities during the construction, operation and decommissioning of a scheme.

6.2.3.2.4 Potential for unrecorded cultural heritage assets

The assessment will establish the potential for unrecorded archaeological remains to be discovered in the proposed development area; including the remains of relict submerged landscapes and associated deposits, and produce guidelines to be followed should these be found.

6.2.4 Potential Mitigation and Monitoring

There are various ways that impacts can be mitigated once these have been identified. Mitigation measures usually involve avoidance (the implementation of exclusion zones and design alterations), reduction (the introduction of measures to deal with unexpected discoveries during works), or offsetting (excavation and recording of a site before an impact occurs).

Ideally, sites and features of cultural heritage interest should be subject to as little disturbance as possible, where national policy dictates a presumption in favour of preservation *in situ* (Scottish Executive, SPP23 p.11, 2008). Overall the aim is to minimise the impact on cultural heritage assets through the appropriate siting of infrastructure and works. As such, the preferred mitigation for the disturbance of a wreck or site of cultural heritage interest would be avoidance, so that the turbines and associated components are micro-sited to avoid wrecks or identified sites and features of cultural heritage interest. Consequently, 'exclusion zones' will be marked on project charts to avoid potential wrecks or sites and features. The size of the exclusion zone would be dependent on the certainty the target represents a wreck or site and the potential importance of that asset (historically significant or not). Thus, all vessels working on the project will avoid these areas. Adherence to the implementation of the exclusion zones during scheme operations can be checked through procedures and protocols set out in the Written Scheme of Investigation (see below). For buried landscapes, the mitigation may include the analysis of borehole cores by a suitably qualified geo-archaeologist and archaeo-botanist so that any new information about palaeoclimates or prehistoric landscapes can be obtained.

A site specific 'Written Scheme of Investigation' will be developed, which outlines all procedures such as: input into survey strategies designed to assess the effectiveness of mitigation measures; more detailed geophysical survey designed to assess assets that lie within those areas of the seabed that could be impacted by the development; archaeological assessment of data gathered from further geophysical and geo-technical surveys (i.e. post-consent); details of exclusion zones and any alteration or removal of such in light of further investigations; providing for input and involvement in any diver/ROV investigations undertaken for the scheme; establishing the reporting, conservation and archiving requirements of any archaeological works..

Protocols will be established before the start of scheme operations detailing instructions to follow in the event of unexpected discoveries, with contact details of the relevant stakeholders. There will be an archaeological representative nominated in the development company to ensure the correct procedures are followed and the relevant archaeological curators and contractors are kept up to date.

The WSI would be subject to the approval of Historic Scotland's Senior Inspector of Marine Archaeology and the relevant Local Authority Archaeologist.

6.2.5 Cumulative Impacts

The assessment will consider the potential for the effects of cumulative impacts on sites, features and artefacts of cultural heritage interest associated with the proposed development. Possible impacts may include effects within the proposed development such as the effect of multiple piles through a relict landscape surface or deposit. Impacts outside the development area may include the effects of several developments within the same locality on the cultural heritage resource. There may also be cumulative impacts upon the setting of features, although this is considered unlikely.

6.3 Navigation

6.3.1 General Description

There are two main shipping routes out of the Firth of Forth estuary, but no IMO routes in the region. The Isle of May acts as a natural diversion for the ships and Neart na Gaoithe is located in the shadow zone created by the island, as shown in Figure 6-3. Density data from Anatec (December 2008c) indicate that fewer than 60 vessels each year are found in each 1 km block within the proposed wind farm area.

With regard to sailing, the Royal Yachting Association's UK Coastal Atlas of Recreational Boating shows one route which crosses the proposed site in a north-west/south-east direction. This is classed as a 'medium' use route.

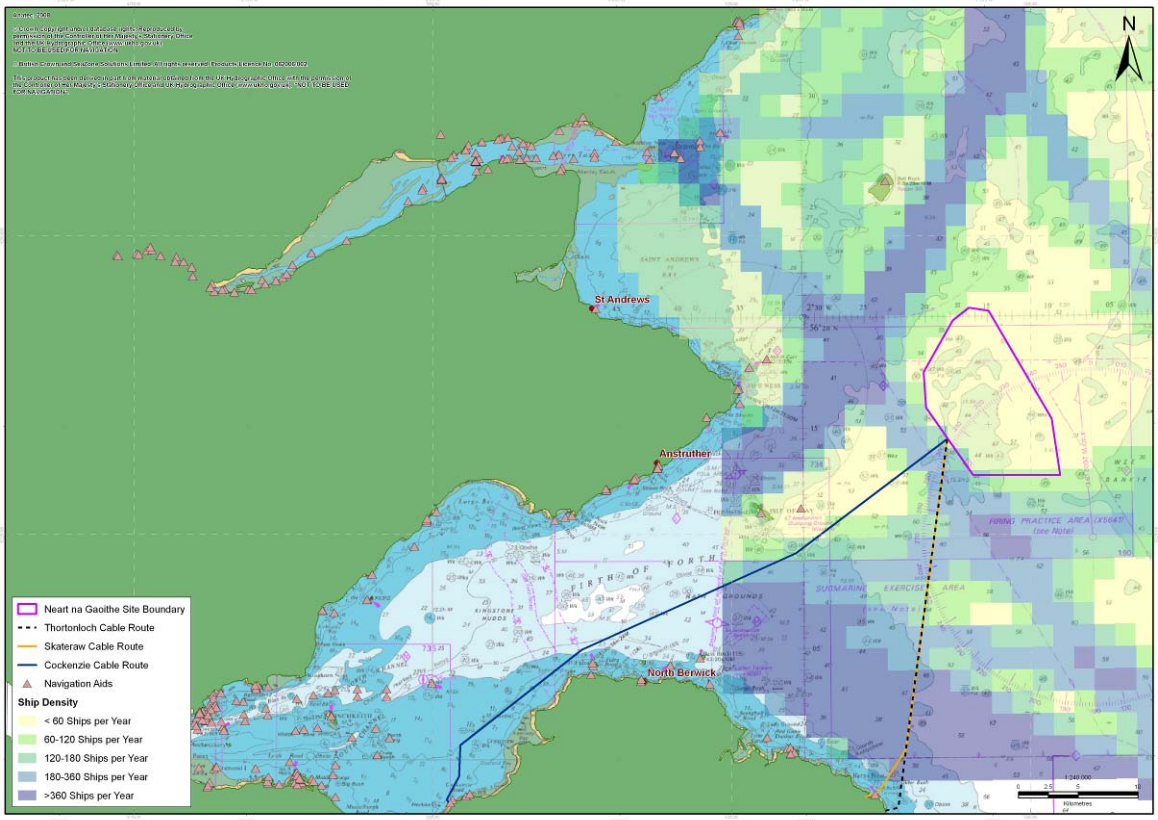


Figure 6-3 Shipping Density

6.3.2 Available Data

For the initial description, data have been sourced from:

- BERR online GIS[47];

[47] BERR online GIS - www.maritimedata.co.uk

- Anatec Ltd;
- Admiralty Charts.

Additional information can be obtained from:

- MCA – MGN 371[48] , MGN 372 (2007);
- BWEA Guidelines for Health & Safety in the Wind Energy Industry;
- Local port and harbour authorities;
- Northern Lighthouse Board;
- RYA Cruising Authority;
- DECC SEA5;
- UK Deal (BERR Offshore Oil and Gas / SEA data);
- SeaZone (UKHO Marine data);
- MCA (Maritime and Coastguard Agency);
- OSPAR International Convention on the protection of the marine environment;
- OWE Offshore Wind Energy Europe.

6.3.3 Method of Assessment

Navigation safety is of paramount importance when considering the development of a wind farm. Guidance notes published by Defra, Cefas and DTLR (*Offshore Wind farms: Guidance Note for EIA in respect of FEPA and CPA requirements*, 2004)[49], MCA, Trinity House/Northern Lighthouse Board and other relevant authorities will be taken into account.

As previously mentioned, the sites were originally determined from the distribution of shipping density data, in areas where relative shipping densities were low. The navigation assessment will refine this by using Automatic Identification System (AIS) and radar data for the area to identify the exact routes of vessels, the types of vessels, and the timings (e.g. whether there are more vessels seen in the area during high tide, or how long transit times are and therefore how long a specific vessel would be affected by the proposed wind farm). The assessment will also consider non-routine vessels such as fishing vessels and leisure craft, through consultation with the SFF, the Royal Yachting Association (RYA) and the Cruising Association (CA).

Factors to be considered will include those described below.

6.3.3.1 Traffic survey

The traffic survey will incorporate AIS and radar data covering at least 28 days in the 12 months before submission (or adjusted according to MGN371), over more than one occasion. This will help define:

- Distance from shipping route as identified from the AIS data (application of MCA shipping template);
- Type of traffic using the proposed area/surrounding area;
- Non-transit uses of the area e.g. fishing, diving, recreation;
- Prescribed routeing schemes or precautionary areas;
- Proximity of the zone to areas used for anchorage, safe haven, port approaches and pilot boarding or landing areas;

[48] MCA MGN 371: http://www.mcga.gov.uk/c4mca/mcga-mnotice.htm?textobjid=0BD60265A97A9E76

[49] Defra, Cefas and DTLR, 2004 http://www.cefas.co.uk/publications/files/wind farm-guidance.pdf

- Proximity of the zone to offshore firing/bombing ranges and areas used for any maritime military purposes;
- Proximity of the zone to existing or proposed OREIs, offshore oil/gas platform and marine aggregate dredging, marine archaeological sites or wrecks, or other exploration/ exploitation sites;
- Proximity of the zone relative to any designated areas for the disposal of dredging spoil;
- Proximity of the zone to aids to navigation and/or Vessel Traffic Services (VTS) in or adjacent to the area and any impacts thereon;
- Assessment of where the existing traffic could be displaced to and whether there is potential for choke points/conflicts to be created.

6.3.3.2 Effects on navigation of auxiliary OREI structures

This will describe:

- The implication of tidal regimes in and around the proposed zone;
- Whether current maritime traffic flows and operations in general area are affected by the depth of water;
- The set and rate of the tidal stream, at any state of the tide;
- Whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream;
- The implication of adverse weather conditions in and around the proposed zone;
- Whether the zone in bad weather restricted visibility conditions could present difficulties or dangers to craft including sailing vessels.

6.3.3.3 Visual navigation and collision avoidance

An assessment will study whether:

- Structures could block or hindes the view of other vessels under way on any route;
- Structures could block or hinder the view of the coastline.

6.3.3.4 Communication, radar and positioning systems

The following will be identified:

- Potential for the structures to produce radar reflections, blind spots, shadow areas or adverse effects;
- Potential for communications to be adversely affected;
- Whether sound signals could be masked by the structures.

6.3.3.5 Emergency response

This will consider whether there would be potential navigational or communication difficulties caused to any mariners or emergency services using the area.

6.3.3.6 Cable routes

The study will also consider the potential effect of the cable route on navigation or maritime structures.

As part of the impact assessment, a Navigational Risk Assessment will be undertaken. This will make certain assumptions as the final details of the project and construction schedule will not be known pre-consent. It will follow the BERR guidance for navigational risk assessments (DTI 2005b, *Guidance on the assessment of the*

impact of offshore wind farms: Methodology for assessing the marine navigational safety risks of offshore wind farms).

6.3.4 Further Requirements

As described in section 6.3.3.1, a radar and AIS survey will be required. This will cover 28 days and be collected within 12 months of the application.

In addition, there will be regular consultation with the Northern Lighthouse Board, the MCA and local ports to keep them informed of progress and enable appropriate feedback.

6.3.5 Potential Mitigation and Monitoring

The appropriate use of marking and lighting will be compliant with advice from the Northern Lighthouse Board. Mitigation for potential radar interference could include measures such as a reference buoy located outside the boundary of the wind farm.

Offshore operations with vessels will be broadcast in Admiralty 'Notices to Mariners', and good communications maintained with local ports.

6.3.6 Cumulative Impacts

The potential for cumulative impacts on shipping from multiple wind farm sites will be assessed and a building block approach adopted, where the impact of a new project should consider the in-combination effects of all previous or existing projects. Given the potential for four offshore wind farms within territorial waters, plus the Round 3 zone further offshore, the cumulative displacement of shipping will be a key issue that is considered.

6.4 Commercial Fishing

6.4.1 General Description

The waters of the Outer Firth of Forth are known to support various types of commercial species, including herring, mackerel, haddock, whiting, dab, lemon sole, dogfish, *nephrops* and plaice (Murison and Robson, 1997). Consequently, there are several local ports within the region which support fishing.

The Neart na Gaoithe site falls within ICES square 41E7 which had 2,000–4,000 tonnes landed in 2006/7. However, SFPA data, collected by its patrol aircraft in the Firth of Forth during the same period, show that the area is not heavily used relative the areas around it (Figure 6-4). These data included the position of each sighting, and the nationality, activity, and fishing gear of each vessel sighted. This figure also shows that creel fishing occurs north of the proposed site.

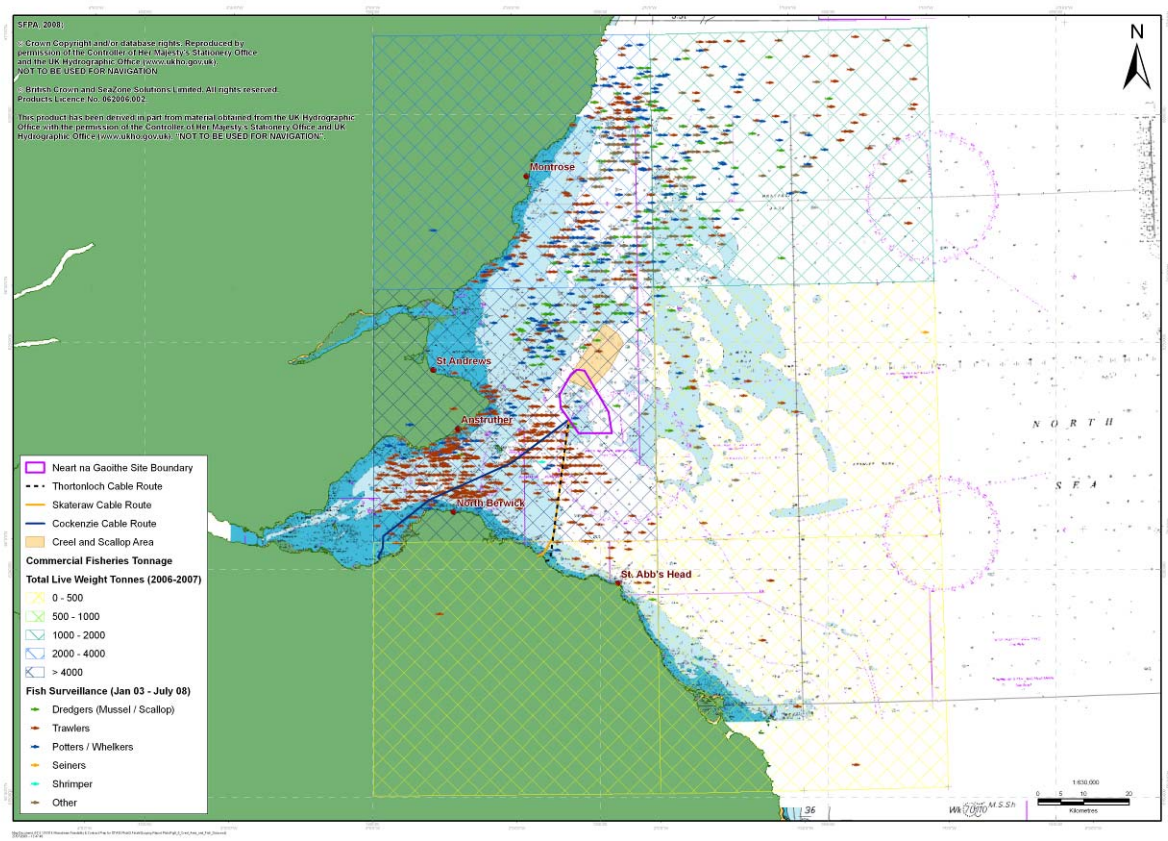


Figure 6-4 Creel Area and Fish Landings and Surveillance Data

To the east of the proposed site the banks support sandeels. Since 2000, an area from Alnwick to the north of Peterhead, extending eastwards to 1°W has been closed to sandeel fishing. This closure was to support the local bird population as the depletion of sandeel stocks coincided with poor bird breeding years (European Commission, 2003)[50]. However, the closure is regularly reviewed and the area may be opened once stocks fully recover.

There is also a restriction on sprat fishing. This is prohibited in the inner waters of the Firth of Forth west of longitude 3°00'W, from 1 January to 31 March and from 1 October to 31 December (Defra, 2008)[51]. This ban is designed to protect the commercial North Sea herring stocks as large numbers of juvenile herring are taken with sprats.

In the outer Firth of Forth region, there is trawling for *nephrops*. From the Firth of Forth northwards, the whole area is used for scallop fishing; this is cyclical and can be heavily fished for a couple of years, then left for a couple of years to let the stocks recover.

Under the European Community Shellfish Waters Directive (79/923/EEC) there are 115 coastal waters in Scotland designated as 'shellfish growing waters'. Along the coastal fringe onshore from Neart na Gaoithe there are shellfish growing waters and SEPA monitoring sites. To develop fish or shellfish farms The Crown Estate Commission (CEC) must issue a lease for development. No such leases have been issued for the St Andrews to Fife Ness coastline area west of Neart na Gaoithe, although there are known to be lobsters and razorfish in the area (SEPA, 1998a)[52]. From Fife Ness to Elie directly west of Neart na Gaoithe, there are winkles, prawns, razorfish, lobsters, crabs and clams (*Spisula* sp.), but again no CEC leases have been granted

[50] European Commission, 2003 http://ec.europa.eu/fisheries/publications/factsheets/legal_texts/sec_2003_550_en.pdf

[51] Defra fishing ban, 2008 - http://www.defra.gov.uk/marine/pdf/fisheries/tech-pelagic.pdf

[52] SEPA, 1998 http://apps.sepa.org.uk/shellfish/pdf/3.pdf

(SEPA, 1998b)[53]. Along the North Berwick to Dunbar stretch of the coast, south-west of Neart na Gaoithe, there are no known commercial interests in the shellfish waters (SEPA, 1998c)[54].

6.4.2 Available Data

Information and data that will be used for the baseline include:

- Department of Energy and Climate Change (DECC) SEA5;
- Scottish Fisheries Protection Agency (SFPA) / Marine and Fisheries Agency (MFA), effort, value and landings data;
- Scottish Fisheries Protection Agency (SFPA) / Marine and Fisheries Agency (MFA) over-flight and patrol vessel surveillance records (including VMS);
- Scottish Fisheries Protection Agency (SFPA) / Marine and Fisheries Agency (MFA) vessel satellite monitoring data;
- The Navigation risk assessment;
- Scottish Fisheries Federation (SFF);
- National Federation Fishermen's Organisation (NFFO;
- Scottish Environment Protection Agency (SEPA) have detailed and dedicated webpages for commercial shellfish waters[55];
- Fisheries Research Services (FRS) also have dedicated webpages on Scottish commercial fish species and shellfisheries[56];
- Centre for Environment Fisheries and Aquaculture Science, (Cefas) Lowestoft;
- Barrett, C. & Irwin, C. eds (2008). *UK Sea Fisheries Statistics 2007*. Defra Publications;
- ICES fish landings data[57];
- Current and proposed relevant national and EU fisheries controls and legislation;
- Gear manufacturers and agents.

6.4.2.1 Consultation

Consultation will be undertaken in collaboration with the SFF, and will include:

- Anglo-Scottish Fishermen's Association;
- Scottish Pelagic Fishermen's Association;
- The relevant branches of the Scottish Whitefish Producers Association;
- Local fishermen's associations;
- A representative sample of owners and skippers fishing the general area of the wind farm site;
- SFPA District Inspectors.

[53] SEPA 1998 http://apps.sepa.org.uk/shellfish/pdf/4.pdf

[54] SEPA 1998 http://apps.sepa.org.uk/shellfish/pdf/5.pdf

[55] SEPA - http://www.sepa.org.uk

[56] FRS - http://www.frs-scotland.gov.uk

[57] ICES - http://www.ices.dk/advice/fishstocks.asp

6.4.3 Method of Assessment

The guidance to be followed for the assessment includes the following sources:

- ABPmer Ltd (2009) *Development of spatial information layers for commercial fishing and shellfishing in UK waters to support strategic siting of offshore wind farms*. Commissioned by COWRIE Ltd (project reference FISHVALUE-07-08);
- BWEA *Best Practice Guidelines for Consultation and Recommendations for Fisheries Liaison*;
- OSPAR (2008). *Guidance on Environmental Considerations for Offshore Wind Farm Development*. Reference number: 2008-3;
- Offshore Wind Farms (2004), *Guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements*, version 2 – June 2004.

Details of the local fish and shellfish resources will be assessed, including:

- The major species of fish and shellfish in the area that are of significant importance in commercial and recreational fisheries;
- Those species of fish in the area that are of conservation importance;
- Elasmobranch fish (which are often also of commercial and recreational importance);
- Species that have a restricted geographical distribution and are locally abundant in the area.

There is potential for the construction, development and operation of wind farms to adversely affect fish and shellfish resources, including spawning, overwintering, nursery and feeding grounds, and migratory pathways[58]. Both direct and indirect effects can occur on commercial fisheries operating in or close to a proposed offshore wind farm area or along the export cable route. Consequently, the assessment will draw on studies that have already been undertaken to establish suitable fishing techniques within wind farms and apply the conclusions to Neart na Gaoithe and the local fishing fraternity. The potential effects cited by Cefas which will need assessment are summarised as:

- Loss or restricted access to traditional fishing grounds;
- Safety issues for fishing vessels;
- Increased steaming times to fishing grounds;
- Seabed obstacles which could represent a hazard to vessels and gears;
- Any other concerns raised by fishermen or their representatives.

The assessment will consider how the effects listed above will occur in terms of site specific, cumulative and in-combination impacts for the construction, operational and decommissioning phases. The effects will be identified by studying each of the commercial fisheries components in turn. Desk studies, field studies and consultation will be carried out to gather information. On completion of the data gathering exercise, the following will be assessed:

- The magnitude (size) of change that is likely to result;
- The sensitivity to change (for example, whether the component is considered to be of local, regional, national or international importance).

The findings of this impact assessment will give an impact description, significance statement, assign a level of uncertainty and suggest possible mitigation and monitoring requirements.

The assessment adopts the conceptual model 'source-pathway-receptor' to address impacts of the proposed activities on the receiving environment. The term 'source' describes the origin of the potential impacts (e.g. the effects of installing turbines, noise creation) and the term 'pathway' as the means (e.g. turbine installation

[58] Cefas Offshore Wind Farm Guidance http://www.cefas.co.uk/publications/files/windfarm-guidance.pdf

causing scour effects and sediment transport) by which the effect reaches the receiving sensitive 'receptor' (e.g. fisheries).

6.4.4 Further Requirements

Based on the findings and recommendations , from the desk based review, a trawling programme may be necessary using commercial gear to assess the commercial fish stocks within the impact zones of the wind farm and the cable route prior to and post-installation. The involvement of local fishermen in the survey design and data collection would be considered. Scientific advice on the survey design would also be incorporated to ensure that data and analyses are adequate to meet regulatory requirements and provide a robust environmental impact assessment.

An alternative to specific surveys may be to undertake observer trips with fishermen active in the area, as this will provide a better understanding of the methods employed in the area, and the range of fish caught. Further advice on this is sought from FRS.

Following the analysis of landings and surveillance data (including VMS), there will further consultation with the SFF and the Fife Fishermen's Association.

6.4.5 Potential Mitigation and Monitoring

Appropriate mitigation measures will be identified as part of the assessment. Realistic measures may include setting up exclusion zones to prohibit fishing during construction for the safety of the fishermen. Future discussions with the SFF and local fishermen will help form suitable mitigation.

6.4.6 Cumulative Impacts

The effects on fish stocks need to be considered with regard to the existing constraints caused by fisheries, pollution, existing cables and other disturbances (European Commission, 2005)[59]. While the exclusion of a fishery in a wind farm area can have a positive effect on fish stocks, the overall economic impact must be considered.

The physical presence of the turbines and the behaviour and possible displacement of fish and shellfish over time will be assessed. The presence of the turbines may change the local fish and shellfish population dynamics but this could be either negative (e.g. fish temporarily avoiding the area) or positive (e.g. creating artificial reef which provides more food). The effect of the export cable and its electrical emissions on fish such as elasmobranchs and migratory species will be considered. In the wider region, there are not known to be any structures or activities which could cause cumulative effects, but this will be investigated in more detail within the assessment.

6.5 Military and Aviation

6.5.1 General Description

The majority of Neart na Gaoithe is located within a submarine exercise area, as shown in Figure 6-5 . There is also a firing practice area to the east of the site, but this is no longer in use. There are two Military Protected Places within the site: K4 and K17, as described in Section 6.2.

[59] http://www.offshorewindenergy.org/cod/COD_Env_Issues%20Report_17_11.pdf

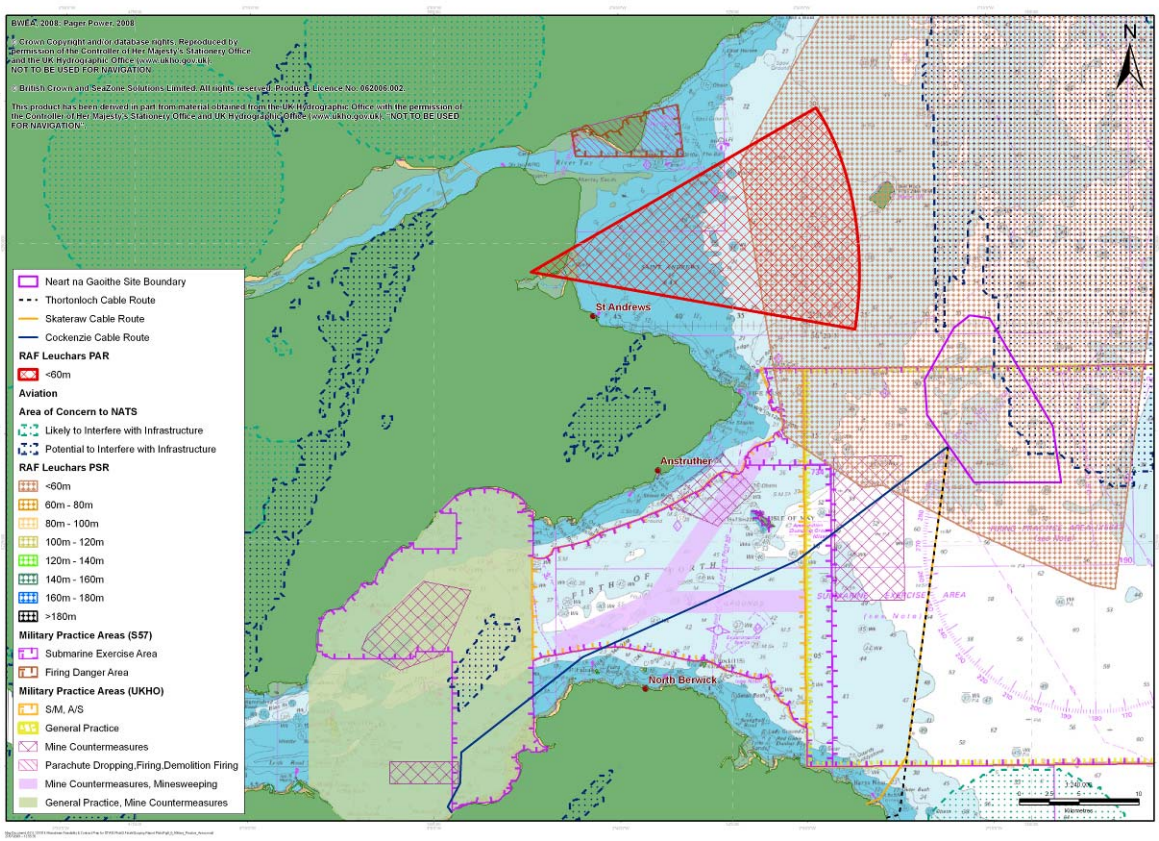


Figure 6-5 Military Practice Areas and RAF Leuchars

In the Firth of Forth region, there are several radar installations that may be affected by the development of Neart na Gaoithe. These include:

- RAF Leuchars Primary Surveillance Radar;
- RAF Leuchars Precision Approach Radar;
- Edinburgh Airport Primary Surveillance Radar;
- NERL Perwinnes Primary Surveillance Radar;
- RAF Buchan Primary Surveillance Radar.

Pager Power (2009) has initiated consultation with the Civil Aviation Authority (CAA), MOD and Edinburgh Airport (via the safeguarding section of BAA plc – formerly British Airports Authority). MOD Safeguarding was consulted during The Crown Estate bid phase and raised a concern with regard to Aviation Radar interference at RAF Leuchars:

"*Air Traffic Control (ATC) radar – the turbines will be 33 km from, in line of sight to; and will cause unacceptable interference to the ATC radar at RAF Leuchars. 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 Traffic Radar service in the area of the proposed wind farm*."

In addition, they stated that the navy representative had been consulted, and there were no concerns regarding the submarine exercise zones.

Responses from the consultation to date are given in Appendix J, together with details of specific potential radar interaction. The responses showed that the proposed site could not be seen by the radar at Edinburgh airport, and that the CAA Directorate had no observations.

With regard to Unexploded Ordnance (UXO), Neart na Gaoithe has a low to moderate risk associated with it. During the Second World War, the German Air Force targeted Edinburgh and in particular the Forth Road Bridge. If the German Air were unable to drop all their bombs on the Clyde, they would off-load their unused bombs by aiming for the ships in the Firth of Forth. Many small islands and peninsulas were fortified to protect inlets and other strategic targets.

Recent evidence of UXOs in the vicinity of Neart na Gaoithe is available. In December 2008, a fisherman reeled in a live World War II bomb. Members of the Royal Navy bomb disposal unit subsequently had to carry out a controlled explosion. A Royal Navy spokesperson commented that "there are still tens of thousands of these in the Forth from the war... " (McLeod, 2008)[60]. The Northern Royal Navy Diving Group also blew up a mine in the Firth of Forth area in April 2007 (BBC News Scotland, 2006)[61]. In 2006, Royal Navy explosives disposal experts examined a World War 2 mine found in The Firth of Forth, by a crew of fishermen off Methil in Fife (Clipped News, 2006)[62]. In 1998, an unexploded mine was reported to the Coastguard[63] when a fishing vessel pulled up a 2,000 lb unexploded mine dating from the Second World War. The vessel `Shalimar' reported trawling the unexploded ordnance in Largo Bay, in the Firth of Forth (BNET UK, 1998)[64].

6.5.2 Available Data

The studies and guidelines that are available include:

- Department of Energy and Climate Change SEA5;
- Zetica Regional Unexploded Bomb Risk Maps;
- Wind Energy and Aviation Interests – Interim Guidelines, Report ETSU W/14/00626/REP, 2002;
- NATS / NERL / MOD online self assessment tool;
- The Effects of Wind Turbine Farms on ATC Radar, (5 October 2005);
- Civil Aviation Authority Publication (CAP) 764, CAA Policy and Guidelines on Wind Turbines.

6.5.3 Method of Assessment

The assessment will cover various concerns as discussed below.

The main concerns regarding offshore wind farms focus on the increased 'clutter' interference caused by wind turbines, which affects both Air Traffic Control (ATC) and Air Defence (AD) primary surveillance radars, reducing their ability to fulfil their operational duties in the vicinity of wind farms.

There are a number of different types of radar in operation; Primary Surveillance Radar (PSR), Secondary Surveillance Radar (SSR), Precision Approach Radar (PAR), Instrumented Landing System (ILS), Maritime Navigation Radars and Weather Radars. Each performs a specific function, and much of the research to date has been on the effects of wind turbines on PSR (Air Defence and Air Traffic Control). There is increasing interest in the effects of wind turbines on SSR, although the effects of wind turbines on SSR and other types of radar are less understood.

Although modern radars can filter out stationary objects, they cannot filter out the rotating blades of a wind turbine. Wind turbines also have a very large Radar Cross Section (RCS), both due to their physical size and the materials used in construction. Rotating turbine blades are therefore easily detected by the radar and appear

[60] News Article 2008 http://deadlinescotland.wordpress.com/2008/12/09/francis-wwii-catch-has-an-explosive-ending/

[61] News Article, 2006 http://news.bbc.co.uk/2/hi/uk_news/scotland/edinburgh_and_east/5378234.stm

[62] News Article, 2006 http://clippednews.wordpress.com/2006/09/25/ww-2-unexploded-bomb-found/

[63] (c)1994-98 m2 communications ltd rdate:100698

[64] News Article, 1998 http://findarticles.com/p/articles/mi_hb5243/is_199806/ai_n19782401/

or 'paint' on a radar display, in a similar manner as radar returns from an aircraft. These false radar returns are referred to as 'clutter'.

The effect is three-fold; there is an increase in the number of false returns (clutter) on the radar display; there is an area of desensitisation of the radar around the wind turbine (the size of this area will depend on the radar performance characteristics); and the possible loss of track identity or track seduction of a real aircraft return in over-flying the wind farm.

The primary concern from the ATC community is that operational safety will be impaired. The primary concern from the AD community is that national security will be compromised.

A 'safeguarding' assessment will be undertaken, to ensure the protection of civil aviation interests and will prevent the positioning of turbine structure such that they would impact on the safety of air navigation. There are two elements of Air Traffic Safeguarding which need to be taken into account: radar interference as an issue for Air Traffic Control and physical obstruction as a hazard to low flying.

6.5.3.1 Air Traffic Control

Offshore, the primary safeguarding concern encountered relates to the effects of turbines on civil radar – either from NATS En Route providing en-route surveillance services, or from Terminal Air Navigation Service providers (ANSPs), providing airfield Air Traffic Control (ATC) services.

Wind turbines will appear as 'paints' on a radar display, very similar to that of an unknown aircraft. Known aircraft may also have SSR information associated with the primary radar return, which would differentiate the wind turbine from an aircraft, but that would rely upon the aircraft carrying a transponder. It is possible to fly in uncontrolled airspace without a transponder, and controlled airspace does not extend to ground/sea level; therefore, even offshore, an air traffic controller could see a radar return from a wind turbine as that of a non-transponding aircraft.

6.5.3.2 Physical Obstruction

The concerns for low flying aircraft are most commonly regarding helicopter transit and approach routes for helicopters servicing offshore oil and gas installations; however, no helicopter routes are found in the vicinity of the proposed site.

6.5.4 Further Requirements

Further consultation will be required with RAF Leuchars to determine suitable mitigation measures for the PAR interference. A UXO desk study will be undertaken due to the low to moderate risk of unexploded bombs and the legacy from WWII.

6.5.5 Potential Mitigation and Monitoring

Aviation stakeholders (DfT, CAA, NATS En Route and MOD) signed a Memorandum of Understanding (MOU) in June 2008 with BERR and BWEA in order to progress solutions to the wind turbine issue for radar.

Under this MOU, an Aviation Plan identifies key workstreams which are being sponsored by the aviation stakeholders to develop technical mitigation to the wind farm/radar issue. It is also important to identify operational or procedural mitigation which may also be employed to allow wind farms and radar to co-exist. The use of Mandatory Transponder Zones is one such mitigation, whereby aircraft are not allowed to transit a defined area without carrying a transponder, and therefore being detected by SSR. Therefore, it is possible to blank out the Primary radar returns from the wind turbines. This is not however, a solution that would be appropriate for Air Defence, as a key national security requirement is to detect non-transponding traffic.

A summary of mitigation techniques which are being looked at includes:

- RCS reduction techniques for the turbines (stealth blades, stealth 'cloaking' of the turbine towers);
- Mandatory Transponder Zones (MTZs);
- Gap Fill Radar;

- Holographic Radar ('staring' radar technology as a gap fill);
- Upgrading of existing radar technology.

The suitability of mitigation solutions depends upon the size of the wind farm, proximity to the radar, and implementation timescales and economic considerations.

Further specific mitigation methods are discussed in Appendix J.

6.5.6 Cumulative Impacts

The RAF Leuchars radar covers the whole region from Montrose to the Firth of Forth. It may be possible to mitigate the effect of one site by installing additional radar, or using a software modification to combine radar signals from other existing sites. However, with more than one site this form of mitigation would become much more complex.

6.6 Socio-economics

6.6.1 General Description

Research undertaken for the Scottish government has found that wind farms will have little or no impact on Scotland's tourism industry (Scottish Renewables Forum, 2007)[65]. There are relatively few direct socio-economic effects from offshore wind farms, mainly related to tourism potential; however, there are indirect effects through the created of jobs within the supply chain. Some of the potential effects are listed below:

- Job creation: direct, indirect and through induced economic multiplier effects (e.g. re-circulating income in local area);
- The opportunity for UK innovators/academic institutions to develop expertise in manufacturing, and potentially research and development;
- Increased security and reliability of supply: through more distributed generation, closer to the point of use. In addition, localised generation means less power is wasted in transmission over long distances;
- Cheaper fuel bills: integrating renewable energy generation offers the double benefit of supplying site-generated power which will recoup installation costs before the lifetime of the equipment expires, thus reducing the requirement to buy power from commercial utility companies;
- Tourism potential: many boat operators offer tours of wind farms such as Kentish Flats;
- Possibilities of indirect benefit through marketing of the local area as forward-looking and 'green' (e.g. inward investment by related technologies, or those attracted by improved image of area);
- Revitalisation of ports and local industry diversification;
- The use of locally manufactured content where possible;
- The use of local contractors during construction for onshore infrastructure and potential offshore construction work.

6.6.2 Available Data

Although there are no specific guidance documents for assessing the socio-economics of an offshore wind farm, there are existing data sources and literature including:

- European experience;
- DECC SEA5;

[65] Scottish Renewables Forum, 2007 http://www.scottishrenewables.com//Default.aspx?DocumentID=909554be-f7f8-49cf-95b0-a7ae02908f7c

- ESRC (Economic and Social Research Centre Data archive);
- Glasgow Caledonian University, (2007). *Economic Impact of Wind Farms on Scottish Tourism* (commissioned by the Tourism Unit of the Scottish Government);
- Scottish Renewables Economic Impact Report, (2007);
- *Tourist Attitudes Towards Wind Farms*, Scottish Renewables and British Wind Energy Association;
- The Crown Estate, (2008*) Socio-economic indicators of marine-related activities in the UK economy*. Project OSR 07-04;
- Food and Resource Economic Institute, (2005), *Economic Valuation of the Visual Externalities of Offshore Wind Farms* Report No. 179;
- *Sociological Investigation of The Reception of Horns Rev and Nysted Offshore Wind Farms In the Local Communities*, (2005);
- *The need for integrated assessment of large-scale offshore wind farm development*, Environmental Science, Managing European Coasts, Published by Springer Berlin Heidelberg, (2005), Pages 365-378;
- ANEMOS IDSS (2007) – *An interactive Game for Offshore Wind Energy: A powerful tool for informing the broad public, improving planning processes and societal decision-making (Information & Decision Support System (IDSS))*. ICBM, University Oldenburg; Germany; June 2007;
- Scottish Tourist Board;
- HM Treasury;
- Government Regional Snapshot;
- *Renewable Supply Chain Gap Analysis Report*, DTI, Scottish Executive (2004);
- Energy for Sustainable Development Ltd (2004) *Offshore wind, onshore jobs, - A new industry for Britain*, Report for Greenpeace UK.

6.6.3 Method of Assessment

A desk study and consultation will be undertaken to establish the socio-economic climate within the region, and identify areas where the offshore wind farm might benefit the local community and economy. This could include tourism opportunities, or increased recreational fishing. The facilities in the local ports will also be assessed to judge their suitability as a base during the construction activities or for operation and maintenance. Interviews will be undertaken with key industries, organisations and individuals in the region.

The assessment will focus on four elements, with the aim of analysing the extent of which the local industry and ports can provide support for offshore wind energy in the Firth of Forth during establishment and operation of Neart na Gaoithe:

1) Economic vitality in the general region;
2) Port activities;
3) Characteristics of the industry;
4) Recreational activities.

The ES will set out the potential impacts from each phase of the offshore wind farm on the hinterland associated with the development. A full description of the location and the national, regional and local socio-economic context will be reported. This will include the population structure and change; employment (i.e. employers, income/outcome, earnings, unemployment, change and wealth creation); transport, deprivation, social and human issues; tourism, recreation and leisure and education and the skills pool.

6.6.4 Further Requirements

Consultation with the local councils and the estuary forum will be important in establishing how the wind farm can integrate with the local economy.

6.6.5 Potential Mitigation and Monitoring

There is the potential for visitor centres and tourist facilities which would support educational visits and school groups. Other mitigation includes:

- The use of locally manufactured content where possible;
- The use of local contractors during construction for onshore infrastructure and potential offshore construction work;
- Potential involvement in the development process by local landowners, groups or individuals of onshore infrastructure;
- Possibility of local community facility improvements;
- Employment and training possibilities for local people on the operation and maintenance of a wind farm;
- Potential improvements to local environment and wildlife habitats;
- Supporting the community through sponsorship of local groups and teams.

6.6.6 Cumulative Impacts

If several wind farms are successfully developed in the area it is an opportunity for the local ports, research establishments and engineering facilities to become centres of excellence for offshore wind requirements. The opportunity for potential collaboration and co-operation for the developers in the Firth of Forth should be considered.

6.7 Other Human Activities

6.7.1 General Description

Figure 6-6 shows the other human users and activities that take place in the Firth of Forth region. This section describes each user and activity in greater detail below.

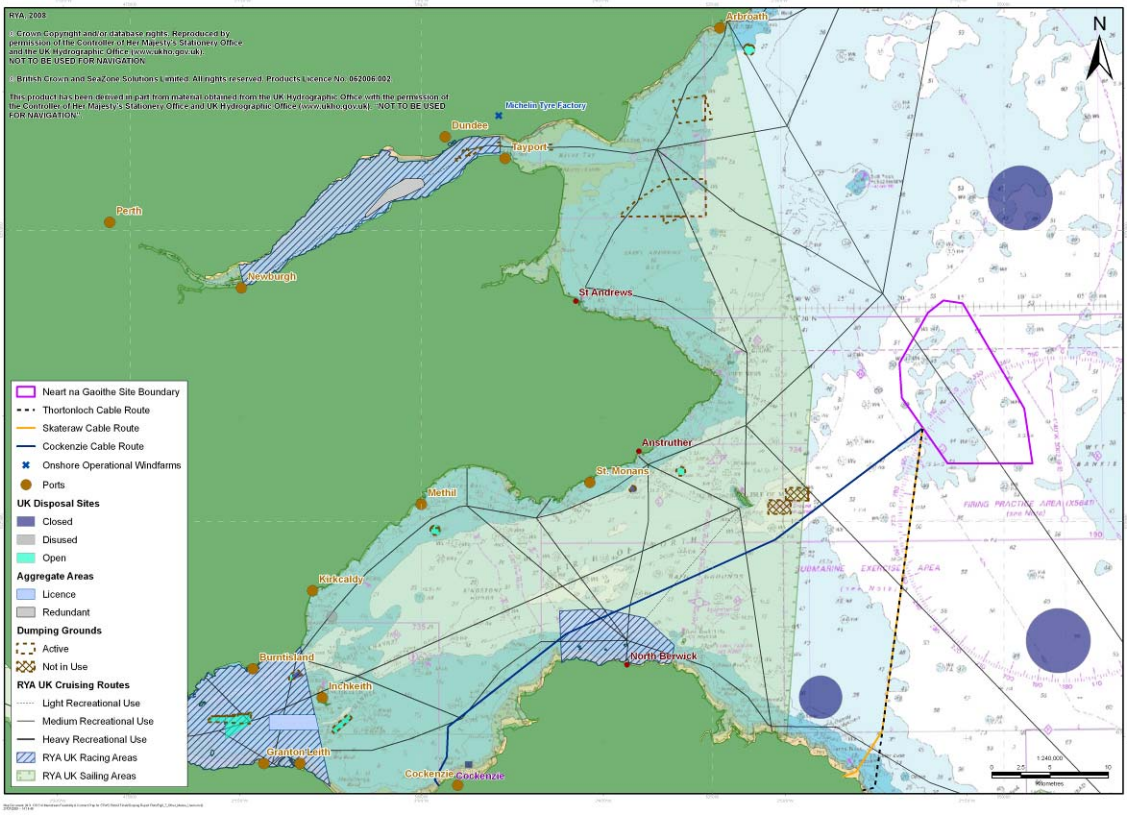


Figure 6-6 Other Marine Users and Activities

6.7.1.1 Pipelines cables

There are no cables or pipelines in the vicinity of Neart na Gaoithe, as shown in Figure 6-6.

6.7.1.2 Oil and Gas

The Firth of Forth forms a focus for oil and gas activities with the Grangemouth refinery, oil storage and tanker terminals. No oil and gas activity has been identified near the proposed site.

6.7.1.3 Marine Aggregate Extraction

There are two aggregate dredging sites, one located in the Tay Estuary (now redundant) and the other in the Inner Forth (licensed). These are both located inshore from the proposed Neart na Gaoithe development and associated infrastructure (Figure 6-6).

6.7.1.4 Waste Disposal

Although there are no disposal sites or dumping grounds within Neart na Gaoithe, there are disposal sites to the north-east and south-west of the site. The nearest disposal site is 7.5 km north-east of Neart na Gaoithe. All of the disposal sites are closed. Considerable amounts of dredge spoil were disposed of at sites close to Aberdeen, Montrose, and within the Firths of Tay and Forth (Pers. comm. P Hayes, FRS, in UK Offshore Energy SEA, 2009)[66]. There is a dumping ground for ammunitions and boom gear, located 11.5 km south-west of Neart na Gaoithe that is not in use (Figure 6-6). Given the industrial past of the Firth of Forth, during the benthic ecology survey, contaminants will be assessed.

[66]Offshore SEA 5 - http://www.offshore-sea.org.uk/consultations/SEA_5/SEA5_TR_Users_UOA.pdf

6.7.1.5 Recreation

There is one medium use RYA route running in a north-west to south-east direction in the middle of the area (Figure 6-6). Bird and marine mammal watching, golf courses, bathing waters along the coast of the Firth of Forth are of excellent quality.

There is also a surf school in Berwick, and therefore the assessment of any potential impacts on waves will extend to this area.

6.7.1.6 Mariculture

In the Firth of Forth, onshore from Neart na Gaoithe, there are four production areas for mariculture. Three of these are for surf clams and one is for the common mussel.

6.7.1.7 Other Wind Farms

The nearest operational wind farms to Neart na Gaoithe are The Michelin Tyre Factory, which has two turbines, to the east of Dundee and 41 km from Neart na Gaoithe, and Crystal Rig which has a capacity of 50 MW, located 39 km from Neart na Gaoithe. Table 6-1 below shows the operational, under construction, consented and submitted wind farms onshore with, the nearest onshore wind farm located approximately 40 km from Neart na Gaoithe.

Wind Farm	Status	Online / Date	MW
Michelin Tyre Factory	Operational	May 2006	4
Aikengall	Operational	May 2009	48
Crystal Rig	Operational	May 2004	50
Crystal Rig 1a	Operational	May 2007	12.5
Dun Law	Operational	July 2000	17.6
Black Hill	Operational	February 2007	28.6
Bowbeat	Operational	September 2002	31.2
Crystal Rig 2a	Under Construction	August 2008	117.3
Dun Law Extension	Under Construction	January 2008	29.75
Toddleburn	Under Construction	-	27.6
Ark Hill	Consented	June 2006	7
Little Raith	Consented	February 2007	27
Carcant	Consented	September 2006	4.5
Tormywheel	Consented	June 2007	30
Tullo	Consented	July 2005	12
St John's Hill	Consented	December 2007	13
Clochnahill	Consented	-	6
Herscha Hill	Consented	April 2007	0
Mid Hill 1a	Consented	January 2008	62.5
Minch Moor	Submitted	April 2003	28
Auchencorth Moss	Submitted	August 2008	45
Fallago Rig	Submitted	August 2007	144
Meikle Carewe Resubmission	Submitted	October 2006	10.2
Moorsyde	Submitted	June 2006	20

Table 6-1 Onshore Wind Farms in the region

6.7.2 Available Data

Information will be gained from the DECC SEA5, as well as local websites which promote activities in the area, and national websites, such as The Crown Estate and Kingfisher charts, which detail aggregate proposals, cables and pipelines. Oil and gas developments will be monitored through the BERR oil and gas website and consultation.

6.7.3 Method of Assessment

To assess the impact on other human activities from the development of Neart na Gaoithe, it is necessary to determine what other activities there are in the area. A comprehensive desk study will be undertaken, plus local consultation.

6.7.4 Further Requirements

Consultation on future plans in the area will be required. No site specific surveys are anticipated.

6.7.5 Potential Mitigation and Monitoring

During construction, safety exclusion zones will be necessary to ensure other users are not adversely affected. Good communication of the activities through Notices to Mariners and directly to local ports will ensure impacts are minimised throughout the life of the project.

The use of Marine Spatial Planning should avoid or minimise overlaps with recreation and other users.

6.7.6 Cumulative Impacts

It is considered unlikely that there will be impacts on other marine users caused by the proposed Neart na Gaoithe. The impacts with the other proposed offshore wind farms will be assessed when more detail is known of those schemes.

7 Conclusions and Recommendations

Based on the information that has been set out in this Scoping report, clear work areas for the EIA have been established, particularly for the key issues: birds, marine mammals and aviation. Methods of assessment have been proposed for those and other potential concerns. The scopes of work for the full EIA will be informed by the stakeholder responses, and prepared through consultation with experienced offshore wind farm consultants and topic specialists. This ensures that important issues are dealt with by appropriate sub-consultants and managed from the start of the project.

Consultation with the appropriate bodies will be undertaken.

As The Crown Estate have issued exclusivity rights to four developers in the Firth of Forth region, there is a good basis for cumulative assessments following matching methodologies and sharing data and data collection costs. Several collaborative studies have been suggested, including birds and mammal surveys, navigation and metocean measurements. Regular meetings are held between the developers and The Crown Estate to ensure effective communication and the most efficient assessment of potential issues.

It is considered that cumulative assessments are not required for low impact and low incidence aspects within the region, such as archaeology and nature conservation.

References

Anatec (2008a). *Ship Density for East Coast of Scotland*, June 2008, Report reference A2029

Anatec (2008b). *Ship Density for East Coast of Scotland*, August 2008, Report reference A2086

Anatec (2008c), *Ship Density Data for East Coast of Scotland*, December 2008.

Angus Council, (2004) *Angus Shoreline Management Plan* http://www.angus.gov.uk/ac/documents/roads/SMP/default.html

BBC News Scotland, (2006)-09-25. "*War mine found in Firth of Forth*"

Birdlife International (2009) Introduction webpage http://www.birdlife.org/action/science/sites/index.html

BNET UK Find Articles News Publications (1998) -*Maritime and Coastguard Agency: "Huge unexploded mine reported to Coastguard"*

Brazier, D.P., Davies, J., Holt, R.H.F., & Murray, E. (1998). *Marine Nature Conservation Review Sector 5. South-east Scotland and north-east England: area summaries*. Peterborough, Joint Nature Conservation Committee. (Coasts and seas of the United Kingdom. MNCR series).

Business Green Website (2009) "*Offshore wind developers given green light to size up Scottish sites*", Tom Young, 27 Feb 2009 http://www.businessgreen.com/business-green/news/2237457/wind-firms-size-scottish-sites

Clarke, S., and Elliott, A. J., (1998) *Modelling Suspended Sediment Concentrations in the Firth of Forth* Estuarine, Coastal and Shelf Science, 47, 235-250

Clipped News, (2006)-09-25 "*WW-2 Unexploded Bomb Found*!"

Commission of the European Communities, (2003). *15th report of the Scientific, Technical and Economic Committee for Fisheries*, Brussels,12.05.2003 SEC(2003) 550. Commission Staff Working Paper, Brussels, 04-08 November 2002

Connelly Contracting. (2009) Submarine Cable Engineer, *Neart na Gaoithe Offshore Wind Farm, Export Cable Route* Report for Mainstream Renewable Power (CC/MRE/001/250509) May 2009

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O. & Reker, J.B., (2004). *The Marine Habitat Classification for Britain and Ireland*. Version 04.05. Joint Nature Conservation Committee, Peterborough.

Cork Ecology, (2008). *Synopsis of birds and marine mammals in areas under consideration for offshore wind farms in Scottish waters*, August 2008.

Coull, K.A., Johnstone, R., and S.I. Rogers. (1998). *Fisheries Sensitivity Maps in British Waters*. Published and distributed by UKOOA Ltd.

Crossan, R., (1985). *Observations on the abundance, growth and feeding of whiting and cod in the Forth Estuary*. Unpublished Hons. Thesis. University of Stirling.

D. Murison & C.F. Robson. (1997). *Chapter 9.1 Fisheries. In: Coasts and seas of the United Kingdom. Region 4 South-east Scotland: Montrose to Eyemouth*, ed. by J.H. Barne, C.F. Robson, S.S. Kaznowska, J.P. Doody, N.C. Davidson & A.L. Buck, 61-64. Peterborough, Joint Nature Conservation Committee. (Coastal Directories Series.)

De Jong C.A.F. & Ainslie M.A., (2008) *Underwater radiated noise due to the piling for the Q7 Offshore Wind Park*, Acoustics 08, June 29 – July 4 2008, Paris.

DECC, (2009a). DECC European Energy and Climate Change web pages (2009) http://www.decc.gov.uk/en/content/cms/what_we_do/change_energy/european/european.aspx

DECC, (2009b). DECC Renewable Energy web pages (2009) http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/renewable.aspx

Defra, (2008), *Non-paper Specific Technical Measures for the Pelagic Stocks*.

Defra, Cefas and DTLR, (2004). *Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements*, Version 2, June 2004

Doody, J.P. 1997. *Chapter 1.2 Overview*. In: *Coasts and seas of the United Kingdom. Region 4 South-east Scotland: Montrose to Eyemouth*, ed. by J.H. Barne, C.F. Robson, S.S. Kaznowska, J.P. Doody, N.C. Davidson & A.L. Buck, 61-64. Peterborough, Joint Nature Conservation Committee. (Coastal Directories Series.)

DTI (2005a), *Guidance on the Assessment of the Impact of Offshore Wind Farms: Seascape and Visual Impact Report*

DTI (2005b), *Guidance on the assessment of the Impact of Offshore Wind Farms: Methodology for assessing the marine navigational safety risks of offshore wind farms*.

DTI, ABPmer, UK Met Office, Proudman Laboratory and Garrad Hassan, (2004) *Atlas of UK Marine Renewable Energy Resources, A Strategic Assessment Report*, December 2004.

East Lothian Council web page, (2008). http://www.eastlothian.gov.uk/site/scripts/documents_info.php?documentID=286&pageNumber=8

Eleftheriou, A., Basford D., and Moore. D.C., (2004) in Offshore SEA 5 Benthos. *Synthesis of Information on the Benthos of Area SEA* 5 Final Draft 1 May 2004 Report for the Department of Trade and Industry http://www.offshore-sea.org.uk/consultations/SEA_5/SEA5_TR_Benthos_Elef.pdf

Elliot, M & Taylor, C.J.L. (1989). *The production ecology of the subtidal benthos of the Forth Estuary, Scotland*. Scientia Marina 53: 531-541

Elliott M & Kingston PF, (1987). *The sublittoral benthos of the estuary and Firth of Forth, Scotland* in The Natural Environment of the Estuary and Firth of Forth, Proceedings of the Royal Society of Edinburgh 93B, 449 – 465.

Elliott, M., O'Reilly, M. G., and Taylor, C. J. L., (1990) *The Forth Estuary: a nursery and overwintering area for North Sea fishes*. Hydrobiologia 195: 89 – 103, 1990. Kluwer Academic Publishers

European Commission,(2005). *Concerted Action for Offshore Wind Energy Deployment (COD): Work Package 4: Environmental Issues*

European Union Law web pages (2008), *Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources* {COM(2008) 30 final} {SEC(2008) 57} {SEC(2008) 85} http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52008PC0019:EN:NOT

Fife Matters, (2006). *Finalised Fife Structure Plan*, 2006-2026, Written Statement http://www.fifedirect.org.uk/uploadfiles/publications/c64_Structv2.pdf

Finneran, J.J., Carder, D.A., Schlundt, C., & Ridgway, S.H. (2005) *Temporary threshold shift in bottlenose dolphins (Tursiops truncatus) exposed to mid-frequency tones*. Journal of the Acoustics Society of America, 118, 2696-2705

Flemming N. C., (2004); *The scope of Strategic Environmental Assessment of North Sea Area SEA5 in regard to prehistoric archaeological remains*. UK Department of Trade and Industry offshore energy Strategic Environmental Assessment programme

Garrad Hassan and Partners Ltd, (2008). *Review of the Wind Resource for Eastern Scottish Territorial Waters*, 101112/BR/01, A, Draft.

Global Energy Network Institute (2007). The Herald, Glasgow (UK) News Article November 28 2007 "*Mather Aims for 50% of Electricity From Renewable Sources By 2020"* http://www.geni.org/globalenergy/library/technical-articles/generation/general-renewable-energy/energy-central/mather-aims-for-50-percent-of-electricity-from-renewable-sources-by-2020/index.shtml

Greene C.R. Jr. (1987*) Characteristics of oil industry dredge and drilling sounds in the Beaufort Sea*, J. Acoust. Soc. Am. Volume 82, Issue 4, pp. 1315-1324 (October 1987).

Greenwood M. F. D.; Hill A. S.; (2003). *Temporal, spatial and tidal influences on benthic and demersal fish abundance in the Forth estuary*. Estuarine, coastal and shelf science ISSN 0272-7714 CODEN ECSSD3. 2003, vol. 58, no2, pp. 211-225 [15 page(s) (article)] (1 p.1/4). Elsevier, London, ROYAUME-UNI (1981) (Revue)

Hammond P.S., Northridge S.P., Thompson D., Gordon J.C.D., Hall A.J., Sharples R.J., Grellier K., & Matthiopoulos J. (2004) *Background information on marine mammals relevant to Strategic Environmental Assessment 5* UK Department of Trade and Industry offshore energy Strategic Environmental Assessment programme http://www.offshore-sea.org.uk/consultations/SEA_5/SEA5_TR_Mammals_SMRU.pdf

Historic Scotland, (2009). *Annex Scoping Of Development Proposals Assessment Of Impact On The Setting Of The Historic Environment Resource – Some General Considerations* http://www.historic-scotland.gov.uk/scoping_of_development_proposals_2009.pdf

IEEM, (2006). *Guidelines for Ecological Impact Assessment in the United Kingdom*. IEEM, Winchester.

Institute For Archaeologists (2005) *Standards and guidance: desk-based assessment*. Last updated: 05 November 2008 http://www.archaeologists.net/modules/icontent/inPages/docs/codes/dba2.pdf

JNCC , (2009b), Protected sites, SAC site webpage: http://www.jncc.gov.uk/protectedsites/SACselection/SAC.asp?EUCode=UK0030311

JNCC, (2009a). Protected sites, SAC site web page http://www.jncc.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0030172

JNCC, (2009c). Protected sites, SPA sites web page (Firth of Forth Islands) http://www.jncc.gov.uk/default.aspx?page=1970

Land Use Consultants, (2008). *East coast Scotland and offshore wind development site review*,

Landscape Institute and the Institute of Environmental Management and Assessment (Second Edition 2002) *Guidelines for Landscape and Visual Impact Assessment*.

Mair, J.M., Moore, C.G., Kingston, P.F. & Harries, D.B. (2000) *A review of the status, ecology and conservation of horse mussel Modiouls modiolus beds in Scotland*. Scottish Natural Heritage Commissioned Report F99PA08.

Marine Guidance Note MGN 371 (2007) (M+F) *Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues*. (http://www.mcga.gov.uk/c4mca/mcga-mnotice.htm?textobjid=0BD60265A97A9E76)

McLeod, (2008). Deadline Press and Pictures Agency, "*Francis' WWII catch has an explosive ending*".

Monaghan, P. (1992). *Seabirds and sandeels: the conflict between exploitation and conservation in the northern North Sea*. Biodiversity and Conservation 1:98-111

Natural Research Projects Ltd, (2008). *Report on the ornithological sensitivity to wind farm development of the South-east Scotland offshore area*

Nedwell, J. R., Langworthy, J., and Howell, (2003) *Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore wind farms, and comparison with background noise*, Subacoustech Report No. 544 R 0424 (for the Crown Estate), May 2003.

Ode Ltd (2008) *Scotland Territorial Waters site selection, Geotechnical / Structural Review* Document Number: 8031-AS-M-0001

Offshore Technology Report (2001). *Wind and wave frequency distributions for sites around the British Isles,* 2001/030. Prepared by Fugro GEOS for the Health and Safety Executive

Pager Power Aviation Studies, (2009). *Neart na Gaoithe Offshore Wind Ltd Development Scoping Opinion*. Report Reference 6185A

Petersen, C.G.J. (1914): *Valuation of the sea II. The animal communities on the sea bottom and their importance for marine zoogeography*. Rep. Dan. Biol. Sfn. 21: 1-44.

Posford Haskoning (2002) *Broad scale intertidal survey of the Firth of Forth*. Scottish Natural Heritage Commissioned Report F01AA407.

Ratcliffe, D.A. (1977). *A Nature Conservation Review*. Volumes 1 and 2. Cambridge University Press, Cambridge.

Robson, C.F. (1997). *Chapter 5.5 Exploited Sea Bed Species*. In: Coasts and seas of the United Kingdom. Region 4 South-east Scotland: Montrose to Eyemouth, ed. by J.H. Barne, C.F. Robson, S.S. Kaznowska, J.P. Doody, N.C. Davidson & A.L. Buck, 61-64. Peterborough, Joint Nature Conservation Committee. (Coastal Directories Series.)

Rodwell, J.S. (ed.) (1991). *British Plant Communities Volume 2: Mires and Heaths*. Cambridge University Press, Cambridge.

Scottish Executive (2008). *Scottish government and forum for renewable energy development in Scotland (FREDS), Framework for the development and deployment of renewables in Scotland* (2008) http://www.scotland.gov.uk/Resource/Doc/243461/0067751.pdf

Scottish Natural Heritage, (2000). *SNH's Policy on Renewable Energy*, Policy Statement Number: 01/02 (2000) http://www.snh.org.uk/pdfs/polstat/renewenergy.pdf

Scottish Natural Heritage, (2004). *An Assessment of the Sensitivity and Capacity of the Scottish Seascape in Relation to Offshore Wind Farms*. Commissioned Report/University of Newcastle (Final Report July 2004)

Scottish Natural Heritage, (2005) *Guidance: Cumulative Effects of wind farms* (http://www.snh.org.uk/pdfs/strategy/Cumulativeeffectsonwindfarms.pdf)

Scottish Natural Heritage, (2006). *Visual Representation of Wind Farms Good Practice Guidance*

Scottish Natural Heritage, (2009). Web pages '*Isle of May Conservation Information*' http://www.snh.org.uk/publications/on-line/designatedareas/nnrs/IsleofMay/IsleofMay2.asp

Scottish Executive Planning Department (2007) *Scottish Planning Policy (SPP 6) Renewable Energy*. http://www.scotland.gov.uk/Resource/Doc/171491/0047957.pdf

Scottish Executive Planning Department (2008) *Scottish Planning Policy SPP 23: Planning and the Historic Environment*, 2008 (http://www.scotland.gov.uk/Publications/2008/02/13134354/0)

Scottish Renewables Forum, (2007): *Economic Impact of Wind Farms on Scottish Tourism*

SEPA, (1998a) Shellfish Growing and Monitoring Sites Information for *St Andrews to Fife Ness*

SEPA, (1998b) Shellfish Growing and Monitoring Sites Information for *Fife Ness to Elie*

SEPA, (1998c) Shellfish Growing and Monitoring Sites Information for *North Berwick to Dunbar*

Shennan I. & Andrews J., (2000) *An introduction to Holocene land-ocean interaction and environmental change around the western North Sea* in Geological Society Special Publication No. 166. The Geological Society. London

SKM, (2008), *Possible Grid Connection Sites in the Firth of Forth*, A report to Mainstream Renewable Power Ltd

Smith, C. (1992); *The Population of Late Upper Paleolithic and Mesolithic Britain*. in Proceedings of the Prehistoric Society 58, pp.37-40

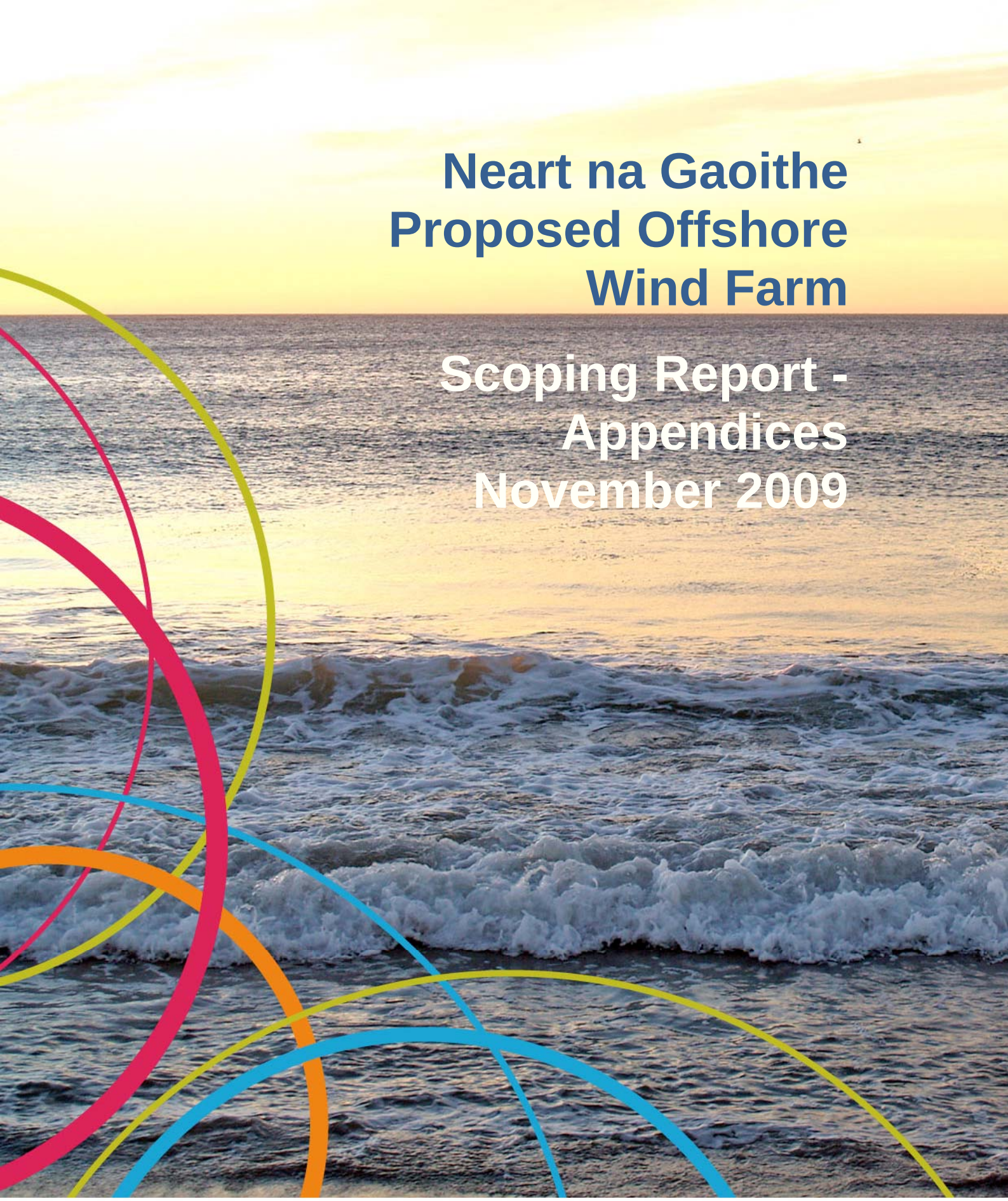
Sohle, I., McSorley, C., Dean, B.J, Webb, A and Reid, J.B, (2007), T*he numbers of inshore waterbirds using Tay Bay during the non-breeding season, and an assessment of the area's potential for qualification as a marine SPA*, JNCC Report 401, ISSN 0963 8901

UK Offshore Energy Strategic Environmental Assessment, (2009). *Future Leasing for Offshore Wind Farms and Licensing for Offshore Oil & Gas and Gas Storage*, Appendix 3d Water Environment, January 2009 http://www.offshore-sea.org.uk/consultations/Offshore_Energy_SEA/OES_A3d_Water.pdf

United Kingdom Hydrographic Office, (2006), *Admiralty Sailing Direction North Sea (West) Pilot, NP 54, East coasts of Scotland and England from Rattry Head to Southwold*. Seventh Edition. UK Hydrographic Office, Taunton.

Neart na Gaoithe Proposed Offshore Wind Farm

Scoping Report - Appendices November 2009



MAINSTREAM RENEWABLE POWER

Table of Contents

Appendix A **0**

A. Cable Route Descriptions (from Connelly, 2009) **1**

Potential Landfall Points **1**

A.1.1 Potential Connection 1 – Cockenzie 1

A.1.2 Potential Connection 2a – Torness (Thorntonloch) 2

A.1.3 Potential Connection 2b – Torness (Skateraw) 3

Onshore Cable Route **3**

Tealing **4**

Alternative Cockenzie Route **4**

Appendix B **1**

B. Proposed Specification for Oceanographic Measurements and Modelling **2**

Overview **2**

Oceanographic Parameters **2**

Programme Design **3**

Physical Processes Model **4**

Appendix C **1**

C. Specification for Geophysical Survey **2**

Overview **2**

Survey Methodologies **2**

C.1.1 Bathymetry and Surface Geophysical Survey 3

C.1.2 Seismic Survey 3

Appendix D **1**

D. Specification for Benthic Ecology Survey **2**

Overview **2**

Design of Benthic Array **2**

D.1.1 Type of Impact 2

Survey Methodologies **5**

Seabed Video **5**

Grab Sampling **5**

Epibenthic Beam Trawling **6**

Intertidal Survey **6**

Data Presentation **10**

Data Analysis **10**

Reporting **10**

Appendix E **1**

E. Bird and Marine Mammal Scoping Report (Cork Ecology, NRP and Craigton Ecological Services, June 2009) 2

E.1 Introduction 2

E.2 Scope of bird and marine mammal studies 2

E.3 Potential effects and issues 5

E.3.1 Collision effects 5

E.3.2 Disturbance effects 6

E.3.3 Habitat Loss 7

E.3.4 Indirect effects 7

E.3.5 Cumulative effects 7

E.3.6 Key issues 8

E.4 Key species and designated sites 8

E.4.1 SEA reviews 8

E.4.2 Seabirds overview 8

E.4.3 Marine mammals overview 14

E.5 Information requirements 16

E.5.1 Acquisition of existing survey information 16

E.5.2 ESAS database gap analysis 16

E.6 Survey strategy 19

E.6.1 Distribution and abundance 20

E.6.2 Marine mammal acoustic surveys 20

E.6.3 Survey phases 21

E.6.4 Consultation 22

E.7 Proposed Field Methods 22

E.7.1 Survey vessel 22

E.7.2 Survey design 22

E.7.3 European Seabirds At Sea (ESAS) method 23

E.7.4 ESAS surveyors 23

E.7.5 Marine Mammal visual survey method 23

E.7.6 Marine mammal acoustic surveys 24

E.7.7 Aerial surveys 24

E.7.8 Additional studies 24

E.8 Data management 25

E.9 Analysis 25

E.9.1 Outputs 25

E.9.2 Further details of analyses to provide outputs for EIA 26

E.9.3 Study design and analyses to allow subsequent monitoring of impacts 27

E.10 Reporting & Assessment 29

References 29
Appendix F 1
F. ERMC – Noise Assessment (BAE Systems) 2
F.1 Potential Noise Sources 2
F.1.1 Noise Sources Due to Construction 2
F.2 ERMC Approach to Quantifying the Effects of Sonar on Marine Mammals 3
F.3 ERMC Approach to Quantifying the Effects of Sonar on Fish 7
F.4 ERMC Limitations and Assumptions 8
Appendix G 1
G. Terrestrial Ecology (Land Use Consultants) 2
G.1 Survey Techniques 2
G.1.1 Otter and Water Vole Surveys 2
G.1.2 Badger Surveys 2
G.1.3 Bat Surveys 2
G.1.4 Red Squirrel Surveys 2
G.1.5 Great Crested Newt Surveys 3
G.1.6 Reptiles Surveys 3
Appendix H 1
H. Nature Conservation 2
H.1 Designated Areas 2
H.1.1 Special Areas of Conservation 2
H.1.2 Special Protection Areas 2
H.1.3 The Ramsar Convention 4
H.1.4 Important Bird Areas 6
Appendix I 1
I. Archaeological Analysis Techniques (Headland Archaeology) 2
I.1 Methodology for the Archaeological Review, Assessment, Interpretation and Reporting of Geophysical Marine Survey Data 2
I.1.1 Introduction 2
I.1.2 Aims & objectives 2
I.1.3 Archaeological review of the survey data 2
I.1.4 Archaeological assessment of identified anomalies 3
I.1.5 Reporting 3
I.2 Methodology for the Geoarchaeological Review and Assessment of Geotechnical Data 3
I.2.1 Introduction 3
I.2.2 Assessment of existing data 4
I.2.3 Further geotechnical work 4
I.2.4 Coring and logging 4

I.2.5 Sub-sampling and assessment 4
I.2.6 Analysis 4
I.3 Relevant Legislation 4
Appendix J 6
J. Military and Aviation (Pager Power) 7
J.1 Consultation Responses 7
J.1.1 Civil Aviation Authority 7
J.1.2 BAA – Edinburgh Airport 8
J.2 Specific Details for Neart na Gaoithe 9
J.2.1 RAF Leuchars Primary Surveillance Radar 9
J.2.2 RAF Leuchars Precision Approach Radar 9
J.2.3 Edinburgh Airport Primary Surveillance Radar 10
J.2.4 NERL Perwinnes Primary Surveillance Radar 10
J.2.5 RAF Buchan Primary Surveillance Radar 11
J.2.6 Summary 11
J.2.7 RAF Leuchars PSR 11
J.2.8 RAF Leuchars PAR 12
J.2.9 Edinburgh Airport PSR 12
J.2.10 NERL Perwinnes PSR 12
J.2.11 Submarine Exercise Area 12
J.2.12 Other Issues 12

Appendix A

A. Cable Route Descriptions (from Connelly, 2009)

Potential Landfall Points

A.1.1 Potential Connection 1 – Cockenzie

The location of the nominal landing point on the undeveloped area adjacent to the power station is provided in **Error! Reference source not found.** (main document). From the landing point the marine route runs north-west for a short distance before turning to the north-east and then the north through Cockenzie Road to skirt an area of foul ground. The route reaches the 5 m isobath approximately 500 m from the landing. Upon attaining 10 mCD depth at about 5 km from the landing, the route turns to the north-east and skirts the 10 m isobath until in the vicinity of the island of Fidra, where the route turns more to the east and runs across the Rath Grounds towards Neart na Gaoithe. One further alteration of course is made south-east of the Isle of May where the route has to negotiate a cluster of charted wrecks. Thereafter the route runs straight to the nominal Neart na Gaoithe site entry point agreed with NnGOWL mid-way between the 4th and 5th perimeter coordinate points of the Neart na Gaoithe site boundary.

A summary of points considered against the routing criteria is contained in Table A-1 Considerations against Criteria: Cockenzie

and the route position is shown in **Error! Reference source not found.**.

Criteria	Comment
Route Length	59.39 km
Bathymetry and Tides	Bathymetry gradually increases along the route length to a maximum of c.50mCD; Approx 500m of route >5m; cables are commonly floated ashore from similar distances. Approx 5km route <10mCD suggesting use of cable barge rather than DP vessel in this area. Maximum tidal current 0.7 kt (Tidal diamond P)
Geology	The route crosses areas of muds within the Firth that can have localised thicknesses of several metres over the Quaternary material. Effective cable burial likely although will possibly be in (difficult) glacial till the further offshore the route is.
Oil and Gas Infrastructure	Gas pipeline crosses route at approx KP15 in 18m of water; crossing structure will be needed. No other linear infrastructure noted.
Wrecks	Numerous wrecks are charted and have been avoided by routing. Many uncharted wrecks may be revealed by survey.
Navigational infrastructure	Constrained at western end of route by foul ground designation and proximity of designated anchorages, some of which are impossible to avoid. Anchorage usage patterns not known. Establishment of a TSS possible in future; no routing implication at this time. Discussions with Port Authority recommended idc.
Environmental designations	The cable route crosses both an SPA and SSSI designation at the landing. Designation of the SSSI is 'mixed' in nature pertaining to geological and biological reasons. The SPA is designated for wintering and migrating birds which may result in seasonal restrictions to installation. Shallow water features may be subject to designation in the future.
Commercial Shipping	The small ports of Cockenzie, and Port Seton are located in close proximity to the cable route but cable installation activities are unlikely to be affected. Shipping density on the route increases east of Fidra but is only considered significant for operations, not routing.

	Discussion with Forth Pilots recommended idc.
Commercial Fishing	Trawling for nephrops (prawns) may take place in the vicinity of the cable route inshore. MCA data indicates fishing activity west of Isle of May; route skirts densest activity. Consultation with local fishing organisations and the Fisheries Research Service is recommended to determine any issues in relation to inshore fisheries.
Military exercise areas	Much of route in outer Firth designated as a submarine exercise area; impacts on installation unlikely.

Table A-1 Considerations against Criteria: Cockenzie

A.1.2 Potential Connection 2a – Torness (Thorntonloch)

From the landing, the route runs to the east to attain 10 mCD water depth at approximately 1 km from the landing. At the 10 m isobath the route turns to the north and runs directly to the perimeter of Neart na Gaoithe at the agreed point mid-way between perimeter coordinates 4 and 5. The route is almost featureless although a large number of charted wrecks are passed enroute. A summary of points considered against the routing criteria is contained in Table A-2 and the route position is shown in **Error! Reference source not found.**.

Criteria	Comment
Route Length	32.22 km
Bathymetry and Tides	Bathymetry gradually increases along the route length to a maximum of c.50mCD; less than 500m of route is 5m or less. The 10mCD contour is 1km offshore; cables have been floated ashore from similar distances. Use of a DP vessel for the whole route should be possible. Maximum tidal current 0.9 kt (Tidal diamond N)
Geology	Bedrock extends offshore from the landing (full extent of beach unknown) for a distance of some 1.1 km. The route crosses areas sands gravels and muds than may be locally several metres thick over the Quaternary material. Effective cable burial likely although will possibly be in (difficult) glacial till the further offshore the route is. Dolorite dykes may sub-crop in the first 15km from the landing which would inhibit burial.
Oil and Gas Infrastructure	No infrastructure present on route.
Wrecks	Numerous wrecks are charted and have been avoided by routing (closest 89m). Many uncharted wrecks may be revealed by survey. Dynamic route development may be required during survey.
Navigational infrastructure	None noted
Environmental designations	The cable route does not cross any designated or candidate features.
Commercial Shipping	There are no ports in close proximity. Shipping density *relatively* high over most of the route but is only considered significant for operations, not routing. Establishment of a Forth TSS possible in future; no implications for this route.
Commercial Fishing	No information sourced for fisheries. Consultation with local fishing organisations and the Fisheries Research Service is recommended to determine any issues in relation to fisheries. Most of route is inside 6 mile fishing boundary.
Military exercise areas	Much of route designated as a submarine exercise area; impacts on installation unlikely.

Table A-2 Routing Considerations against Criteria: Torness 2a

A.1.3 Potential Connection 2b – Torness (Skateraw)

The marine route runs east-north-east from the landing between a low-relief rocky shore to the north and the power station mole to the south. Continuing offshore for a distance of approximately 2.5 km the route joins the alignment of the Thorntonloch route described above.

A summary of points considered against the routing criteria is contained in Table A-3 and the route position is shown in **Error! Reference source not found.**.

Criteria	Comment
Route Length	31.6 km
Bathymetry and Tides	Bathymetry gradually increases along the route length to a maximum of c.50 mCD; less than 500 m of route is 5 m or less; harbour depths are unknown. The 10m CD contour is 1 km offshore; cables have been floated ashore from similar distances although the confined harbour could prove difficult. Use of a DP vessel for the whole route should be possible. Maximum tidal current 0.9 kt (Tidal diamond N)
Geology	Bedrock extends offshore from the landing (full extent of beach unknown) for a distance of some 1.2 km. The route crosses areas sands gravels and muds than may be locally several metres thick over the Quaternary material. Effective cable burial likely although will possibly be in (difficult) glacial till the further offshore the route is. Dolorite dykes may sub-crop in the first 15 km from the landing which would inhibit burial.
Oil and Gas Infrastructure	No infrastructure present on route.
Wrecks	Numerous wrecks are charted and have been avoided by routing (closest 89m). Many uncharted wrecks may be revealed by survey. Dynamic route development may be required during survey.
Navigational infrastructure	Power station mole in close proximity to route; subsea extent of structure unknown. Establishment of a Forth TSS possible in future; no routing implications.
Environmental designations	The cable route does not cross any designated or candidate features.
Commercial Shipping	There are no ports in close proximity. Shipping density *relatively* high over most of the route but is only considered significant for operations, not routing.
Commercial Fishing	No information sourced for fisheries. Consultation with local fishing organisations and the Fisheries Research Service is recommended to determine any issues in relation to fisheries. Most of route is inside 6 mile fishing boundary.
Military exercise areas	Much of route designated as a submarine exercise area; impacts on installation unlikely.

Table A-3 Routing Considerations against Criteria: Torness 2b

The chosen preliminary cable routes were chosen because of the minimised length of cable required while avoiding areas various constraints.

Onshore Cable Route

Varous onshore grid connection points were originally considered, including Tealing, Cockenzie and Torness. The Tealing route, and one of the options for Cockenzie (which had a landfall near Dunbar and then continued onshore) were eliminated from the possible cable route planning process for the following reasons:

Tealing

- The report produced for NnGOWL by SKM (2008) in August indicated that capacity constraints reduce the maximum connectable capacity at Tealing to 800 MW;
    - This limited capacity along with the fact that two large competing sites exist (total capacity of 1.6 GW) between Neart na Gaoithe and Tealing, which suggests that this substation is unlikely to have sufficient for capacity to connect Neart na Gaoithe;
    - Both Torness and Cockenzie have greater available capacity and Neart na Gaoithe is closer to these than the other wind farms in the Firth of Forth.
- Connecting Neart na Gaoithe to Tealing would require a cable route of over 65 km (25 km of this being onshore);
    - The long onshore segment could make gaining all necessary permissions and way-leaves problematic;
    - Advice from electrical experts indicates that cable routes longer that approximately 60 km cause technical problems making AC technology solutions inadequate, prompting more expensive HVDC solutions;
    - Torness and Cockenzie would require shorter routes, with short sections over land.
- By connecting at Tealing, the environmental constraints that affect connection solutions to Cockenzie and Torness (such as shipping, sensitive habitats, seabed geology) would not be avoided.

Alternative Cockenzie Route

- The offshore cable route to Cockenzie could have been altered to come ashore east of the headland to the east of Cockenzie, thereby avoiding entering the mouth of the Forth harbour. This option was dismissed because of the long over-land portion of this route, which would cause undue complication when compared to the offshore routes to the Cockenzie sub-station.

Based on this assessment, there is very little onshore cable routing proposed for Neart na Gaoithe.

Appendix B

B. Proposed Specification for Oceanographic Measurements and Modelling

Overview

To understand the physical processes within the region, and the potential impacts an offshore wind farm could have, the wave, current and sediment regimes will need to be modelled. To inform this model on both a site specific and regional scale, measurements will be taken. As these processes are driven on a regional scale, the measurements to inform the model are being considered as a collaborative project between the Firth of Forth developers.

The physical processes modelling will investigate whether the proposed wind farm and cable routes are likely to affect the wave, current and sediment regimes in any way. In particular, there is concern whether the structures could cause increased erosion at the coast, or alter navigation channels. In addition, the study will investigate whether any changes to suspended sediment concentrations are likely to affect sensitive species in key areas, or alter the biodiversity which will then affect the dependent food chain. Ultimately, the model can be used for engineering parameters to study the type of scour expected, predict extreme values (wave heights and current speeds) and thus the forces likely to affect the foundations over the life-time of the project.

In order for the modelling to be realistic and provide a true indication of likely consequences, the model must be calibrated and validated with robust data. The oceanographic measurements will be used in conjunction with data that are already available, particularly any long term datasets which can identify changes over periods of years. Consequently, a gap analysis exercise will need to be undertaken initially to inform the design of the monitoring programme.

Once the data have been collected they will be used to understand the processes within the region. This will include analysis of storm events, wind driven events, and the influence of discharge from the Firth of Forth and the Tay. They will then be used to set-up a suitable model or suite of models which can accurately describe the currents, waves and sediment transport baseline, and then be used to predict impacts with the wind farm in place. The impacts will need to be considered at both a near-field scale (within the wind farm site - such as scour around a turbine, and whether this interacts with scour from an adjacent turbine), and a far-field scale (considering the wider region including neighbouring coastlines).

Oceanographic Parameters

The physical processes models mentioned above consider a number of oceanographic parameters:

- Wave regime;
- Current regime;
- Water level (including tides and surges);
- Sediment transport (concentrations and pathways).

Measurements used to inform the model will need to encompass the above aspects, over near and far-field scales. Consequently, observations are needed towards the periphery of the broadscale, regional model, and within each proposed site. At each of these locations, the following will be observed:

- Wave height and period;
- Wave direction and spread;
- Current profile (velocities throughout the water column);
- Water surface levels;
- Suspended sediment values (near bed).

A potential solution is to deploy an AWAC (Acoustic Wave And Current meter) or equivalent on the seabed, collecting data through the water column. In addition, there should also be a turbidity sensor mounted on the

frame with water samples collected through the water column on deployment and recovery to relate the turbidity to suspended sediment concentrations.

The mooring will include a bespoke seabed frame, surface marker with light and radar reflector, ground line suitable for grappling and acoustic locator beacon (Figure B-1). The acoustic locator beacon will be attached to the frame to aid recovery in the event that the mooring buoy becomes detached from the frame. The frame is designed to both keep the sensors above the seabed sediments and to be "trawl resistant".

The Acoustic Wave and Current Meter will be configured to record current, tide, wave and acoustic backscatter (ABS). The ABS data will be used to monitor coarser, sand sized particles in the water column. The optical backscatter (OBS) sensor that will be attached to the frame is more sensitive to variations in concentrations of fine particles and will monitor the sediment load in the near seabed region.

Wave action within the agreed sites will be calculated using the pressure signal at 1 Hz and the acoustic surface track (AST) at 2Hz, both data types will be used to calculate wave parameters independently to allow a higher degree of certainty over the resulting values.

After initial deployment and prior to recovery, water samples will be taken at the seabed level in addition to samples throughout the water column, at a time that corresponds with the instrument sampling. Samples would be collected using Casella sampler or equivalent. The water samples will then be analysed in the laboratory to determine total suspended solids (TSS). Calibration curves can then be drawn up to convert Nephelometric Turbidity Units (NTU) and the Acoustic Backscatter intensity into milligrams per litre.

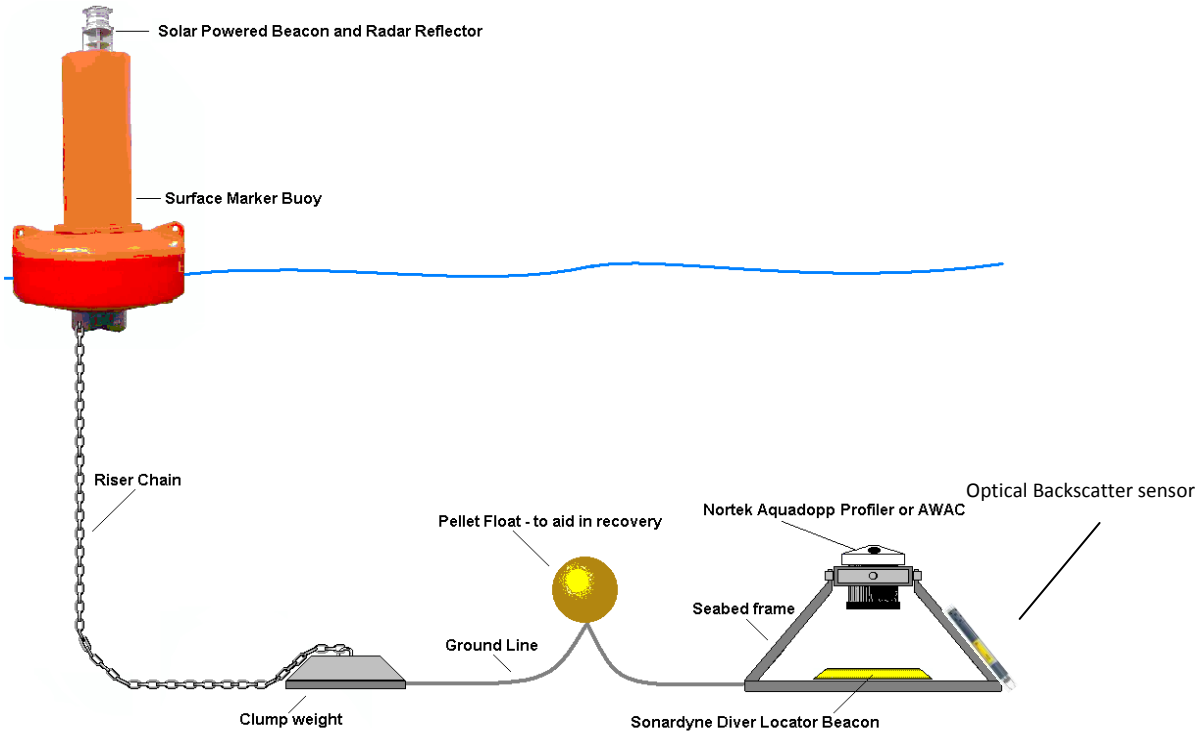


Figure B-1 Seabed Frame Deployment Diagram

Programme Design

To verify both the far-field and near-field models at least three moorings should be deployed near the boundaries of the regional (far-field) model, and one mooring on each site. The exact locations of these should be determined after a desk study has been undertaken to identify any important local currents, as well as identifying where the gaps in knowledge are. The proposed locations will then be discussed with FRS to ensure they are acceptable, and any recommended changes incorporated as appropriate.

In order to support the model for 'extreme' analysis, the measurements need to cover the full range of conditions, and must therefore be in place during storm periods, i.e. over winter. The duration of the

deployment will be agreed in consultation with FRS. The data collection is planned over the 2009/2010 winter to allow time for the analysis and modelling of the physical processes, which can take several months to complete.

Physical Processes Model

The model itself will follow the *Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements, Version 2 – June 2004*, CEFAS 2004, or the equivalent most up to date guidance documents.

The model shall consider, as a minimum:

- scour effects;
- wave interference and interaction;
- current regime;
- sediment mobility and turbidity;
- the function of the sandbanks;
- different installation and cable laying methods;
- different types of foundation, including driven piles, drilled piles, tripod and gravity foundations;
- the impact of potential sediment movement on navigation channels in the area shall be determined.

In addition, consideration shall be given to coastal defences, identifying the different types along the coast and assessing any potential impacts that the Neart na Gaoithe development may have.

The cumulative impacts shall include the impact that other users have at present (e.g. dredging), as well as other potential wind farms, and how Neart na Gaoithe will interact with these users throughout its life cycle.

The study will be undertaken in two phases, detailed below.

i) Phase 1 shall consist of:

- Baseline model of an area sufficient to competently model the processes at the wind farm site and any affects to nearby coasts. The baseline model shall incorporate expected changes over the next 50 years (until 2060);
- Verification of the baseline model;
- A report describing the baseline model and giving advice on the sensitivity of the different processes and seabed, and how this varies over the development area.

This information will be used, in conjunction with other baselines, to inform the layout design to be used for assessment.

ii) Phase 2 shall consist of:

- Assessment of any direct and indirect impacts of the project, including turbines, substations and cables throughout construction, operation and decommissioning;
- Assessment of cumulative effects with other offshore wind farms and with other marine and seabed users;
- Suggestions for mitigation measures that may be required to address any potential significant impacts.

The model will also be suitable to inform engineering requirements, such as:

- Assessment of scour (required and inclusive to main EIA studies);
- Assessment of natural seabed variations (supported by consideration of historic charts, inclusive to main EIA studies), to support risk assessment of cable burial;
- Peak metocean parameters to specified return periods (e.g. 1:50 and 1:100 year events) - including currents, surges, waves, water levels;
- Joint probability of extreme events (water levels and waves), if necessary.

Appendix C

C. Specification for Geophysical Survey

Overview

A geophysical survey was undertaken in the initial stages of the investigations for the Neart na Gaoithe offshore wind farm. Geophysical data were collected across the site itself with an appropriate buffer, plus along three potential cables routes, two of which connect to Torness, and one to Cockenzie. The aims of the survey were to:

- Determine accurate depths, giving full coverage across the site and collected to IHO Order 1 standards;
- Determine the nature of the seabed sediments;
- Determine seabed habitats;
- Identify any seabed surface features, such as sandwaves, and potential mobility;
- Identify any wrecks or surface obstructions;
- Identify subsurface strata and relate these to existing known geology.

The methods described in Table C-1 were used.

Geophysical survey requirement	Implementation
100% multibeam bathymetry coverage	Swath bathymetry with line spacing optimized to ensure 100% seabed coverage.
Sidescan sonar survey to depict seabed features, seabed classification and seabed debris	High (400 KHz) and Low (100 KHz) resolution sidescan sonar with line spacing optimized to ensure 100% seabed coverage.
High resolution seismic survey to determine subsurface layers which will inform the foundation design	Seismic boomer with survey lines spaced at 100 m and cross lines at 1000 m.
Ultra high resolution seismic survey to determine the nature of the surface layers of the seabed, informing the suitability for cable installation	Seismic pinger survey with survey lines spaced at 100 m and cross lines at 1000 m.
Magnetometer survey to identify major items of debris, wreck or changes in near surface bedrock	Marine magnetometer survey with survey lines spaced at 100m and cross lines at 1000 m.

Table C-1 Geophysical Survey Methods

More detailed benthic habitat information was obtained through a subsequent benthic ecology survey. Ground truthing for the AGDS was completed during the ecology survey (see Appendix D).

FRS previously advised that AGDS is considered to be a useful tool in this area.

Survey Methodologies

Throughout the surveys comprehensive logs were kept including daily logs which detailed survey activities, weather conditions, navigation and safety issues. The vessel had an anemometer linked to the navigation software which logged wind speed and direction regularly throughout the survey operations.

Prior to the survey, a Notice to Mariners (NtM) was issued and the following organisations were informed of the intended site operations:

- Local fisheries organisations;
- Local harbour masters;
- Coastguards;

- Vessel Traffic Authorities.

This NtM was updated when additional work was completed along the cable routes.

C.1.1 Bathymetry and Surface Geophysical Survey

The initial line plan was based on 100 m line spacing throughout the proposed wind farm and cable corridors. On site, water depths are generally greater than 40 m, this spacing provided excellent overlap for the multibeam bathymetry data. Inshore, in shallower water, additional lines were run at 50 m spacing, with extra infill where required to ensure 100% data coverage was obtained up to Low Water Mark for the multibeam bathymetry. In addition, to ensure swath data were collected in the most efficient way, the swath system was changed from a Seabat 7125 system in deeper water to a Kongsberg EM3002.

Outcrops of volcanic dykes were identified at the surface in several places along the cable routes, and additional lines were run to investigate the extent of these features.

C.1.2 Seismic Survey

All data were collected on the line spacing detailed above. In addition to the 100 m line spacing, there were also crosslines at 1000 m intervals, to aid in quality assurance for the seismic data. This provided very high resolution data for all datasets.

The line plans for the site and cable routes, plus the summary methods that were used for each technique are presented in the following pages.

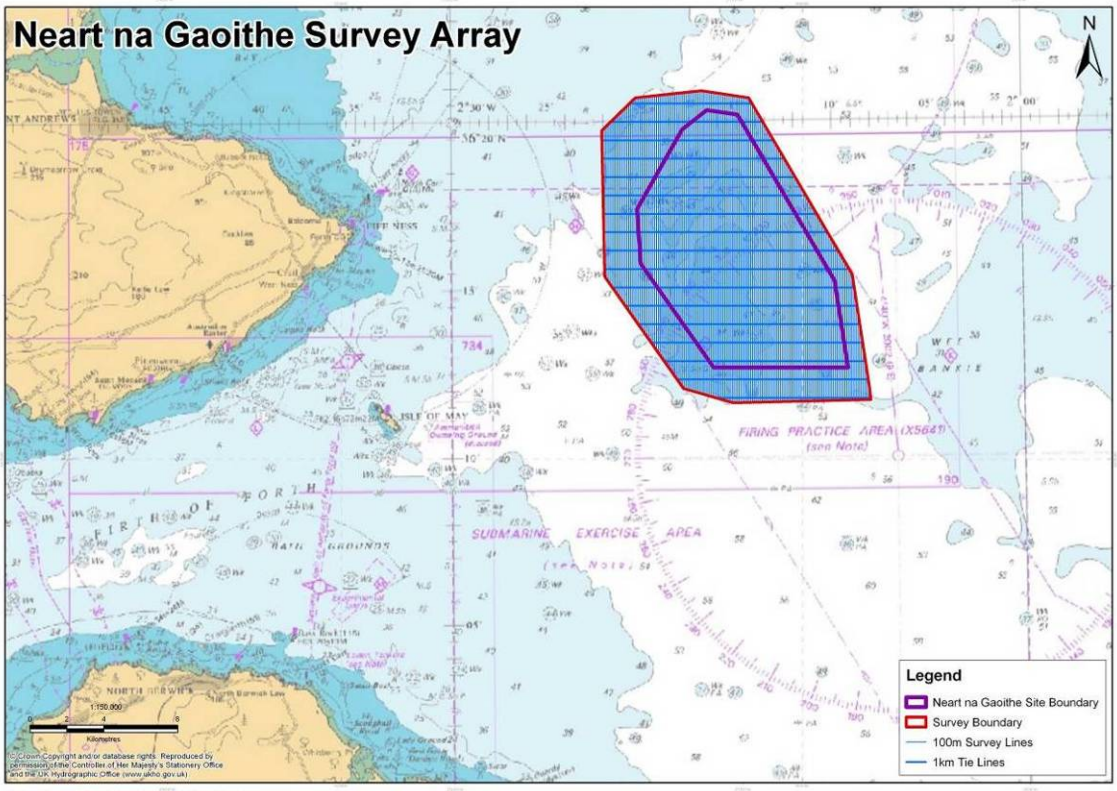


Figure C-1 Summary Geophysical Line Plan

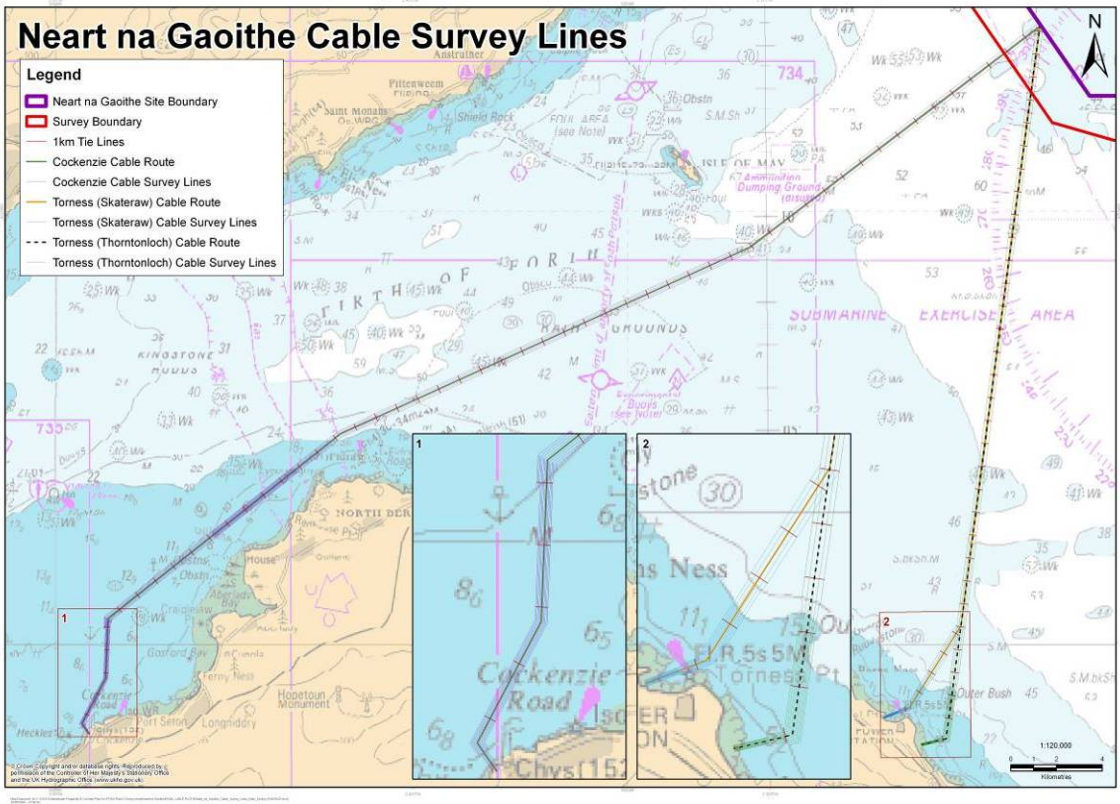


Figure C-2 Geophysical Line Plan for Cable Routes

Vessel Navigation	
Requirement	Accurate vessel positioning for all aspects of the marine survey. Vessel position accuracy to be better than 3m RMS. Within 3km of the coast RTK GPS corrections can be obtained enabling an accuracy of better than 20cm, where there is sufficient Leica SMARTNET coverage.
Equipment	CSI Minimax Differential GPS receiver QINSy 8.0 Data Acquisition and Data Processing software Leica 1200 RTK receiver
Data Collection	Navigation data will be collected in accordance with Emu Ltd Standard Procedures (ISO 9001:2000, Emu Met 06/008/009). Further details can be provided on request. At the start of the survey the navigation system will be checked against at least one known reference point and a scatter plot of position quality for both the DGPS and RTK GPS system obtained. DGPS positions will be logged by the QINSy software at 1 second intervals for the geophysical and hydrographic survey. Data quality will be continually monitored and the system will be set to reject position solutions which do not meet the accuracy requirements of this contract.
Deliverables	All data will be processed and reported according to Emu Ltd Standard Procedures (ISO 9002, Emu Met 008/009). The outputs will include a vessel trackplot both in paper and digital format. There will also be a brief written report detailing methods used and results obtained, which will include information such as daily progress reports, navigation checks and offsets and equipment calibration checks.

Table C-2 Vessel Navigation

Multibeam Bathymetry Survey	
Requirement	To determine seabed levels and topography throughout the survey area.
Equipment	Reson 8101 multibeam system Crescent R120 DGPS system Reson SVP 14 profiler CODA F180 MRU Leica 1200 RTK receiver Knudsen 320M single beam echosounder
Data Collection	Swath data will be collected in accordance with Emu Ltd Standard Procedures (ISO 9002, Emu Met 008/009), ensuring that data is collected in accordance with IHO Order 1 vertical standards. Post Processed Kinematic (PPK) tides will be used for tidal reduction. These data will be compared against any local sources of tidal data co-tidally corrected to the site. SVP dips shall be made prior to commencement of survey operations at each corner of the site and at each turn in the tide. Prior to commencement of the survey a complete calibration procedure will be undertaken at the following variables: i) latency, ii) pitch, iii) roll, iv) yaw, v) pitch/roll correlation, vi) determination of optimum heave period for the MRU and vii) stabilisation period of the MRU after rapid manoeuvres. The calibration data will be processed on line before the start of the survey. Expected data accuracy will exceed the requirements of IHO Order 1.
Deliverables	All data will be processed and reported according to Emu Ltd Standard Procedures (ISO 9002, Emu Met 008/009). Brief section in factual report detailing equipment used, positioning, acquisition procedures, and operation parameters. Shaded colour charts of bathymetry Contour charts of bathymetry Data in digital format suitable for importing in to the client's GIS Raw data in digital format

Table C-3 Multibeam Bathymetry Survey

Sidescan Sonar Survey	
Requirement	Collect high quality sidescan sonar data throughout the survey area to determine variations in seabed type and nature and location of any seabed features such as debris and rock outcrop.
Equipment	Edgetech 4200 dual frequency sidescan sonar system (100KHz or 400KHz) CSI Minimax Differential GPS receiver Electric winch with 300m of armoured cable
Data Collection	Sidescan sonar data will be collected in accordance with Emu Ltd Standard Procedures (ISO 9002, Emu Met 008/009). The sidescan sonar will be operated at 100m per channel, providing 200% seabed coverage and very high resolution data. Both high and low frequency data will be recorded simultaneously in digital XTF format and printed on paper records. Survey logs listing the data collection parameters will be maintained throughout the survey. Sidescan sonar data will be of very high resolution and exceed IHO Order 1 specification.
Deliverables	All data will be processed and reported according to Emu Ltd Standard Procedures (ISO 9002, Emu Met 008/009). Brief section in factual report detailing equipment used, positioning, acquisition procedures, and operation parameters. Sidescan sonar mosaics. Detailed images of features of interest with description and dimensions Data in digital format suitable for importing in to the client's GIS Raw data in digital format

Table C-4 Sidesacn Sonar Survey

Seismic Profiling Survey	
Requirement	To collect high resolution and ultra high resolution seismic data suitable for determining sub-seabed geology for turbine foundations and power export cable trenching.
Equipment	Applied Acoustics boomer system including spare plate AA CSP-1500 power supply C Boom high resolution hydrophone + spare CODA digital acquisition and processing system GeoAcoustics GeoPulse Pinger system/ Edgetech 3200 Chirp System 2 x Ultra 120 Thermal Printer.
Data Collection	Seismic data will be collected in accordance with Emu Ltd Standard Procedures (ISO 9001:2000, Emu Met 008/009). Further details can be provided on request. An Applied Acoustics boomer system with C-boom hydrophone will be supplied for high resolution seismic data collection. The Boomer system will provide resolution of up to 0.5m and penetration through unconsolidated sediments of up to 30-50m. Ideal for determining sub-seabed geology for turbine construction. A GeoAcoustics Pinger system or Edgetech 3200 Chirp system (conditions dependant) will be supplied for the ultra high resolution survey. These systems will provide a resolution of up to 0.2m and a penetration through the surface sediments of 0.5-10m. Ideal for determining sub-seabed geology for cable trenching. A test will be undertaken at the start of the survey to determine the optimum settings to achieve the best records with the system. As the survey progresses the system will be adjust to obtain the best records. Each change will be logged on the survey logs. All data will be recorded digitally on the CODA system along with positional data from the DGPS system. Data will also be printed real time on a thermal printer.

Deliverables	All data will be processed and reported according to Emu Ltd Standard Procedures (ISO 9002, Emu Met 008/009). Brief section in factual report detailing equipment used, positioning, acquisition procedures, and operation parameters. Isopachs of up to 2 significant reflectors. Up to 10 cross-section profiles. Detailed images of features of interest with description and dimensions Data in digital format suitable for importing in to the client's GIS Raw data in digital format and Raw data in Paper format

Table C-5 Seismic Profiling Survey

Appendix D

D. Specification for Benthic Ecology Survey

Overview

A benthic ecology survey was undertaken in the initial stages of the proposed Neart na Gaoithe offshore wind farm development. This section presents the specifications for the benthic and intertidal characterisation survey. It includes the design and rationale of the sampling array, and descriptions of the survey techniques, plus methods for the subsequent laboratory analyses and data treatments.

Information from the geophysical survey, the Acoustic Ground Discrimination System (AGDS) measurements and subsequent data from site specific ecology surveys were used to characterise the ecology of the site and potential cable routes, including the intertidal area. The aims of the ecological survey were to:

- Ground truth the geophysical data;
- Determine the physical nature of the seabed sediments including contaminants;
- Define seabed habitats;
- Determine both the benthic and epibenthic fauna associated with the seabed habitats and enable biotope definition;
- Identify any Annex I habitats.

The methods are given in Table D-1. :

Ecological survey requirement	Implementation
Mini Hamon grab	Grabs will acquire quantitative information on seabed sediments and associated benthic fauna.
Drop Down Video	The benthic survey will utilise drop down video to identify the full range of habitats, including hard seabed areas, where epifaunal communities may be described. In areas where sensitive habitats are noted the use of video will inform the survey design, such that intrusive techniques will be avoided where possible.
Intertidal biotope mapping and coring	Biotopes will be mapped in the intertidal zone with cores collected where relevant. Options for shallow water snorkelling in rocky areas exist where video access is restricted.
2m Beam trawl	A trawling programme using a 2 metre scientific beam trawl will be undertaken alongside the benthic ecological survey to assess the benthic sessile and mobile megafaunal communities in and around the proposed wind farm site and at several locations along the cable route.

Table D-1 Ecological Survey Requirements Methodology

Design of Benthic Array

D.1.1 Type of Impact

There is the potential for a number of construction and operational related impacts on the benthos which may be categorised in terms of zones as shown in Table D-2 below. The array was designed to provide adequate coverage of each area of possible impact. Table D-2 refers to the main site survey array.

Type of impact	Character of impact	Number of sites
Primary Impact Zone (PIZ)	Comprising the entire application site and boundary, subject to direct physical construction and operational impacts.	27 grab and drop down video sites providing coverage of seabed habitat types based on acoustic data. 4 video tows to collect data on

		cobble habitats where grab sampling was not appropriate
Secondary Impact Zone (SIZ)	Outside the construction and operational boundary but subject to peripheral and indirect impacts as a result of movements of disturbed sediments, including potential contaminants, along the tidal axes.	42 grab and drop down video sites based on Admiralty Chart data. 2 video tows.
Cable routes (PIZ)	Comprising the entire length of both cable route options, subject to direct construction effects of cable laying.	13 grab and drop down video sites providing coverage of seabed habitat types based on acoustic data. 6 video tows. 2 long video transects inshore along the Skateraw and Thorntonloch options.
Cable routes (SIZ)	Areas adjacent to the cable route but within the influence of mobilized fine sediments as a result of cable laying operations.	20 grab and drop down video sites.
Reference Zone (RZ)	These encompass seabed types that are similar in terms of their physical and biological attributes to those found within the PIZ and SIZ but which are located beyond the predicted influence of construction and operation impacts, i.e. outside of the SIZ.	7 grab and **drop down video** sites targeting **comparable** habitats in terms of depth and substrate type based on Admiralty Chart data.

Table D-2 Impact Zones and Numbers of Grab Samples

The grab sample array was based on the geophysical data results and is shown in Figures D-1 and D-2.

Grab sites located outside of the primary impact zone (PIZ, directly impacted by turbine/cable placement) and secondary impact zones (SIZ, potentially impacted by secondary effects) provide context to the characterisation survey and assist with the identification of future reference areas that will be required for the baseline and operational monitoring.

Specific sensitivities were identified in relation to two Annex 1 habitats; reef and shallow water sand (<20m), which needed to be specifically addressed. The shallow water sand feature occurs along the line of the Cockenzie cable route, while the reef habitats are found in close proximity to all three cable options. The surveys were structured to address these specific issues, with grab sampling in the vicinity of the sands and video across areas that border on reef habitat. Consideration was also given to the transit of the Cockenzie cable route in close proximity to a former ammunition disposal ground.

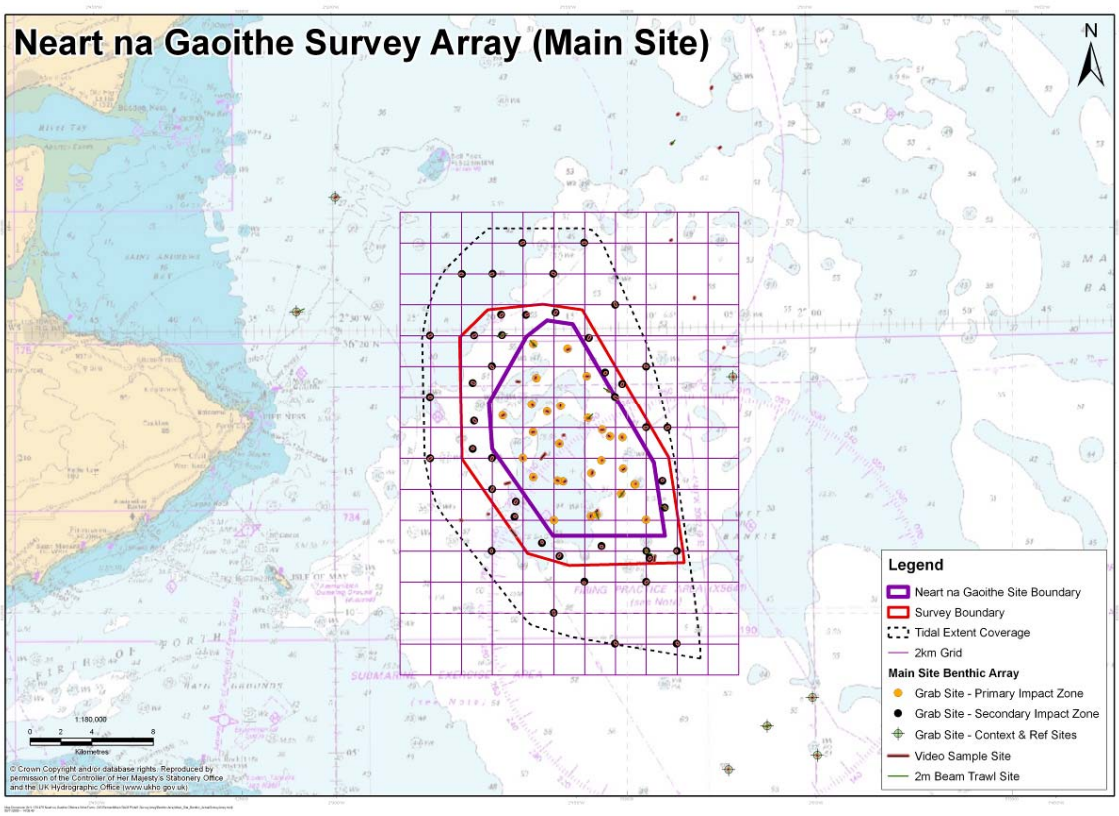


Figure D-1 **Sample Locations within the Main Survey Area, Tidal Excursions and Possible Control Areas**

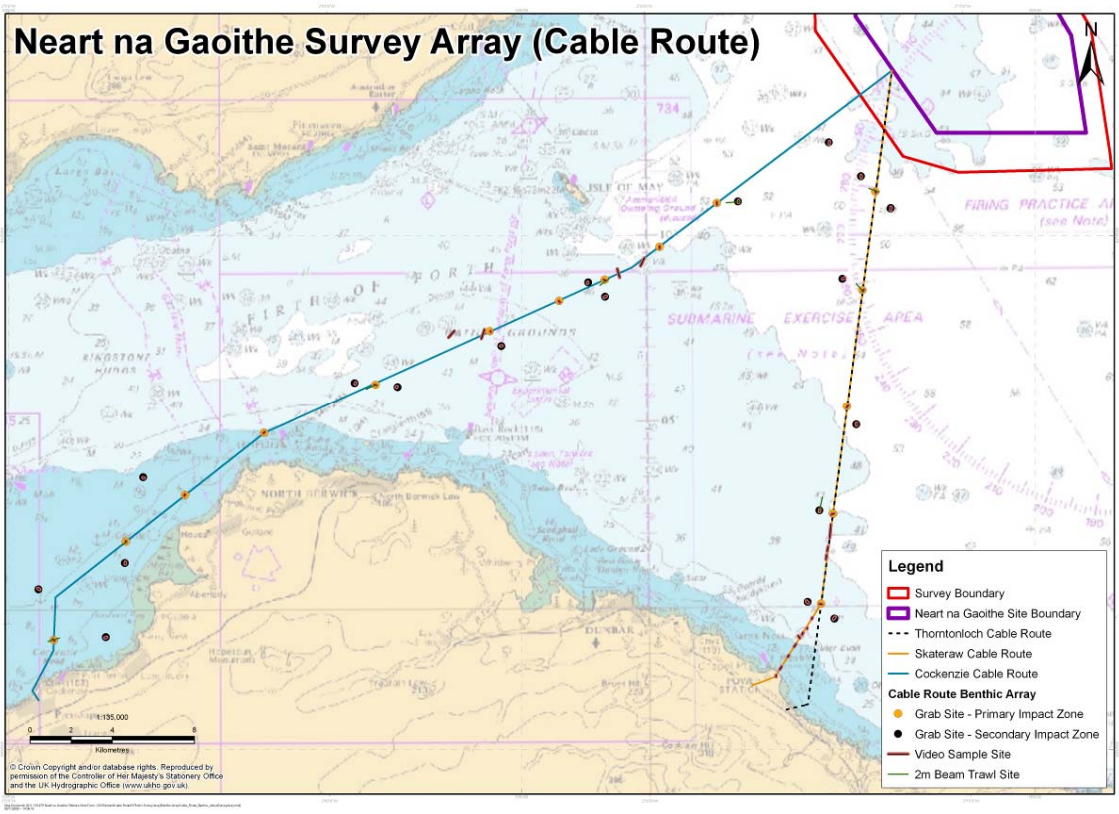


Figure D-2 **Sample Locations along the Potential Cable Routes**

Survey Methodologies

Throughout the surveys, comprehensive logs were kept, detailing survey activities, weather conditions, navigation and safety issues.

A Notice to Mariners (NtM) was issued before the survey and the following organisations were informed of the intended site operations:

- Local fisheries organisations;
- Local harbour masters;
- Coastguards;
- Vessel Traffic Authorities.

The survey was undertaken over two periods – in July and October. NtMs were issued on both occasions.

Seabed Video

Seabed imagery surveys (including video footage and stills imagery) provide a non intrusive survey method for physical and ecological assessment of the seabed. At all sites where grabbing was planned, the video system was deployed, with approximately three minutes of footage collected per site. During the deployment, the video signal was monitored onboard the vessel to assess the quality of the footage and make adjustments as necessary. The video footage was geo-referenced and the image area referenced for each deployment. Video footage was recorded simultaneously on both mini-DV tape and HDD, with back up provided on DVD-R. Survey logs listing the data collection parameters were maintained throughout the survey.

Grab Sampling

Samples were collected with the use of a 0.1m^2 mini-Hamon grab. This device is typically more successful than other grabs at obtaining acceptable faunal samples over a wide range of substrate types. Additional samples (10-20% of total) were also collected in appropriate sediments using either a stainless steel Day Grab or Shipeck to obtain undisturbed contaminant samples.

Upon recovery of the Hamon grab sample, the sediment was released into a sample hopper. An assessment of sample volume (expressed in litres) was then made and a visual description completed. The minimum acceptable sample volume was 5 litres. Repeated attempts (up to 3 times) were made within a 50 m target area. If these attempts failed to achieve this volume, the sample was accepted as a low volume sample. Low samples volumes (<4 litres) were collected at sites 35, 36 and 86. A photograph of the sediment was taken prior to any sample processing. Any conspicuous sediment features and obvious fauna were recorded.

A sub-sample for particle size distribution (PSD) analysis was then taken. Dependent on sediment type this volume would have been between 300 and 500 ml. The PSD sub-sample was transferred into a pre-labelled heavy duty plastic bag, and sealed to ensure no loss of fines.

The remaining sample was sieved on a 1 mm aperture mesh sieve to remove the finer sediment fractions (using an onboard sediment chute). The contents of the sieve were transferred into a pre-labelled bucket with internal label and fixed on-site using 4% buffered saline formaldehyde solution.

The Day Grab or Shipeck samples were used to obtain undisturbed sediments for contaminant analysis. This sediment was scraped from the top few centimetres of the sample and was retained in pentane washed glassware for organic contaminants and plastic bags for metals. All samples were stored in appropriate conditions prior to transfer to a UKAS accredited laboratory for analysis.

The contaminants analysis consisted of:

- A suite of metals (As, Cd, Cu, Pb, Zn, Ni, Cr, Hg, plus Organo-tins)
- PAHs
- Organochlorine pesticides
- Total Petroleum Hydrocarbons

Epibenthic Beam Trawling

Data on epibenthic communities were collected with an industry standard (Lowestoft design) 2 m scientific beam trawl fitted with a knotless 5 mm cod end liner. No positions were identified on the figures at present as these were based on the outcomes of the geophysical survey and video/grabbing surveys. The split between different survey areas was as follows:

Main site PIZ	-	5 sites
Main site SIZ	-	3 sites
Cable routes	-	8 total
Reference areas	-	3 sites

Recent CEFAS advice suggests that a tow of approximately 500 m (5-10 minutes tow) is sufficient to describe the epibenthic community at most sites although the exact length of tow was determined by the ground conditions. All trawls conducted over coarse ground were fitted with a chain mesh to prevent cobbles and boulders entering the trawl. The seabed was predominately flat muddy sand and sandy mud with occasional cobble patches. Mixed sandy gravel sediments occurred inshore along the Cockenzie cable route.

The position of the trawl was logged at 5 or 10 second intervals throughout the duration of the tow with the use of HydroPro software to record an accurate path for the trawl sample. At the end of each trawl tow the catch was brought on board the vessel and initially washed over a 5 mm aperture mesh and sorted into fish boxes. Records of the catch, together with photographs were taken. This included notes on any substrate material.

The majority of the catch was processed on site including the identification and enumeration of fish, prawns and crabs, prior to its return to the sea. Where the on-site identification was uncertain, a representative of that species was returned to the laboratory for confirmation.

Fish species were measured (total length cm) and enumerated. Commercial shellfish were measured (mm) and enumerated. Colonial encrusting fauna on stones and cobbles were described and recorded as presence only. Foliose species (e.g. hydrozoa) were weighed.

Intertidal Survey

Mapping of habitats and biotopes was conducted in the intertidal zone, from the splash/lichen zone (supra-littoral) to the sub-littoral fringe, with an area extending 250 m either side of the proposed cable routes. The survey was conducted over a low spring tide to allow access to the lowest reaches of the shore and to maximize working time. Methods followed the JNCC Procedural Guideline 3-1[1]. Base maps derived from aerial survey were annotated in the field, with total species inventories obtained where possible.

It was proposed that in addition to the biotope mapping, quantitative sampling will be conducted on transects perpendicular to the shore, where particulate sediments dominate (e.g. Skateraw). Sampling was consistent with the methods provided in the JNCC Procedural Guideline 3-6[1]. Samples were taken at the lower, mid and upper shore using a 11.3 cm diameter core. At each intertidal sample location, between 3-5 replicates were collected. Due to the very coarse nature of the surface sediments it was not possible to take cores at some of the proposed sample sites. In these instances, a known area was dug over. All core and dig over samples were sieved on site via a 1mm aperture mesh for the identification of infaunal species. A separate sample was collected for particle size distribution analysis at each core site.

The biotope maps were augmented by target notes. These are vital in biotope surveys to record un-mappable information. Target notes were also used to describe human activities, such as outfalls, coastal protection measures and other man made features that were considered to be potential habitat modifiers.

Further details of the procedures and equipment involved are given in the following pages.

[1] JNCC Guidance: www.jncc.gov.uk.PDF.MMH

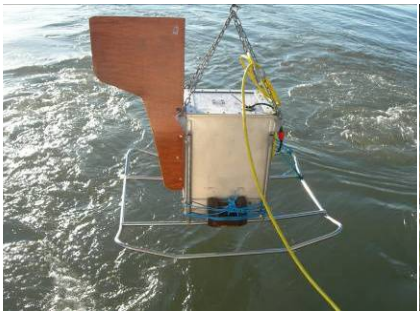
Benthic Sampling	
Requirement	Benthic (seabed) sampling is undertaken to acquire quantitative and semi-quantitative marine biological community data for a particular site. These samples are then transferred to Emu Ltd.'s marine biological laboratories for taxonomic analysis. All survey work adheres to the relevant Emu method statements (Emu Met/05 for infaunal and epifaunal sampling; Emu Met/06 for sediment sampling and processing), each of which comprises a component of our QA procedures.
Equipment	• $0.1m^2$ Hamon grabs, • *'Lowestoft design'* 2m beam trawls • Hemisphere DGPS positioning systems • HydroPro navigational software
Data Collection	Grabs will acquire quantitative information on seabed sediment habitats and associated biological communities. Trawls are used to obtain additional information on communities of larger, more mobile species such as fish, shrimps and prawns which live close to the seabed surface. Both types of sampling method are typically undertaken during a single survey campaign. Taxonomic analysis is undertaken in accordance with in-house method Emu Met07. A 1mm sieve mesh will be employed for all samples. Emu's marine biological laboratories are participants within the National Marine Biological association Quality Control scheme for quality assurance. Outputs of the laboratory analyses include a full enumerated species list, with phyla level biomass. The particle size distribution (PSD) will be undertaken within Emu's sediment laboratory under Emu Met/01. Emu has UKAS accreditation for PSD analysis via dry sieving. Contaminants will be analysed on a subset of sediment samples, by a UKAS accredited laboratory.
Deliverables & Reporting	A full technical, interpretative report will be provided detailing methods for the field survey, laboratory and data analyses. A full species abundance list will be provided with the report. Appropriate univariate and multi-variate statistical analyses will be employed via the PRIMER v6.0 package to investigate community data. Reporting is undertaken according to EMU ISO 9001:2000 procedures (Met 009).

Grab Faunal Processing

2m Beam Trawl Sampling Processing

Taxonomic Analysis

Seabed Imagery	
Requirement	Seabed imagery surveys (including video footage and stills imagery) provide a non intrusive survey method for physical and ecological assessment of the seabed. In addition, Emu Ltd. has the capability to house the subsea video system in a bespoke clear water box system, ELViS (Extreme Low Visibility System), allowing video footage to be obtained in areas of low visibility or in turbid waters.
Equipment	• Kongsberg OE14-208 new generation digital stills colour camera. Stills images are framed using real time video. • ELViS (Extreme Low Visibility System) • Drop down/towed video frame with adjustable weight system • Subsea camera telemetry cable system (200m) • Bespoke topside control unit (comprising a 400GB Hard Disk Drive (HDD) incorporating a DVD recorder for use as the primary video recording system, 15" LCD monitor, with GPS Overlay) • Mini-DV player and full screen colour monitor for simultaneous backup. • Differential GPS accurate to ±5m.
Data Collection	The method for the conduct of drop-down video surveying will be based on JNCC Procedural Guideline No. 3-5 Identifying biotopes using video recordings (Holt, R. & Sandersen, B., 2001). At selected sites, the video system will be deployed, with approximately three minutes of footage collected. Extended survey will be undertaken in areas of conservation interest. During the deployment, the video signal will be monitored onboard the vessel to assess the quality of the footage and adjustments made if appropriate The video footage will be geo-referenced for each deployment. Video footage will be recorded simultaneously on both mini-DV tape and HDD, with back up provided on DVD-R. Survey logs listing the data collection parameters will be maintained throughout the survey.
Deliverables & Reporting	A survey report will be produced which will present the results of the drop down video survey, including definition of biotopes where possible. Within the appendices the report will present the field logs, the static images and the static image analysis results. Depending on the requirements, video footage can be produced for the client on DVD-R, with accompanying stills images on CD.



Deployment of drop down video system housed within ELViS

Example stills image of gravel habitat

Example video capture from ELViS

Intertidal Survey	
Requirement	Intertidal habitat mapping surveys will be consistent with JNCC Procedural guidelines and MNCR methods (Hiscock, 1996[2]; Wyn *et al.,* 2000[3]). Mapping of habitats and biotopes will include the splash/lichen zone (supra-littoral) to the sub-littoral fringe. Sampling of sediments will adhere to JNCC Procedural Guideline 3-6. The survey will be conducted over a low spring tide to allow access to the lowest reaches of the shore and to maximize working time.
Equipment	• 11.3 diameter stainless steel core • Handheld Garmin 48 GPS
Data Collection	Classification of biotopes will be consistent with Connor *et al* (2004)[4]. The biotope mapping will extend 250m either side of the proposed cable route. Features less than 25m^2 in area will be subject to target notes and not mapped. Conspicuous species (faunal and flora) will be identified on site. Representative specimens may be returned to Emu's marine laboratories for confirmation of the field identification. Photographs of all habitats and biotopes will be taken. Representative core samples of sediment will be taken and analysed for macrofaunal content (1mm mesh) and particle size distribution to quantify the fauna present and to aid biotope classification. Proposed sampling will be based on transects, to be modified by the outcome of the initial habitat/biotope assessment. The data will be sufficient to characterise the intertidal area in terms of its habitats, invertebrate communities and component species. Taxonomic analysis and PSD analysis will be undertaken as described previously for Benthic sampling with biomass of key species/species groups required to support assessment of the bird prey value of the area.
Deliverables & Reporting	A full technical, interpretative report will be provided detailing methods for the field survey, laboratory and data analyses. A description of the habitats and intertidal communities will be given and discussed in the context of the wider area. A full species abundance list and site plans (biotope / habitat map) will be provided with the report.

Example of transect survey

ase of chalk cliff

ocky shore

[2] Hiscock, K (ed.) (1996) Marine Nature Conservation Review: rational and methods. Coasts and seas of the United Kingdom. MNCR Series. Joint Nature Conservation Committee, Peterborough.

[3] Wyn, G, Brazier, D P and McMath, A J (2000) *CCW handbook for marine intertidal Phase 1 survey and mapping.* CCW Marine Sciences Report: 00/06/01.

[4] Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O. & Reker, J.B., (2004). The Marine Habitat Classification for Britain and Ireland. Version 04.05. Joint Nature Conservation Committee, Peterborough.

Data Presentation

The data derived from the surveys comprised the following:

- Site by species matrices derived from grab samples and core samples for inclusion in PRIMER;
- Site by sediment type matrices derived from grab samples and cores for inclusion in PRIMER;
- Site by contaminant matrices;
- Site by species and physical description matrices derived from video/still surveys for derivation of sub-tidal biotopes;
- Site by species matrices derived from 2m Beam Trawl surveys for inclusion in PRIMER;
- Annotated draft intertidal biotope maps with associated species inventories and habitat descriptions.

Data Analysis

Grab sample data have been subject to a preliminary classification analysis. This has revealed the presence of 2 principal sediment/faunal associations. These included a muddy sand assemblage characterised by seapens and infaunal brittlestars at the main array and a sandy mud assemblage typified by Nephrops prawn along the proposed cable routes. A number of small sandy and gravel assemblages supporting hydrozoans and tunicates were recorded at inshore along the Cockenzie cable route.

Further data analysis is on-going and will include the linking of abiotic variables with the distribution of macrofauna. Video data shall also be analysed for the assessment of cobble areas which host dense populations of brittlestars and colonies of soft corals. Trawl data will provide data on the presence of larger, mobile epibenthos. Finally, species and habitat data will be tagged with biotope descriptions and a biotope map produced. Extents of biotopes will be inferred from interpreted acoustic data.

Contaminants data will be discussed in the context of current guidelines for the assessment of seabed sediments.

Reporting

Report will include descriptions of methods, including explanation of variation from proposed methods (main text), all raw data plus modified data employed in the analyses (appendices), outcomes of the analyses (main text, figures, charts and appendices), with interpretation expressed in the text and illustrated with charts where appropriate. In all possible cases GIS based maps were generated of the data outputs, such that clear links to the potential impacts of the proposed development can be visualised.

Appendix E

E. Bird and Marine Mammal Scoping Report (Cork Ecology, NRP and Craigton Ecological Services, June 2009)

E.1 Introduction

Mainstream Renewables has recently successfully bid for the wind farm development rights for an area of sea bed lying approximately 15 km off the Fife coast. The development will be known as Neart na Gaoithe. Mainstream have commissioned Natural Research (Projects) Ltd (NRP) Cork Ecology (CE) and Craigton Ecological Services to undertake studies of birds and marine mammals to inform an assessment of the effects due to the proposal. This scoping document sets out the information requirements of the assessment process, and a work plan for gathering and analysing this information.

Offshore wind power is a relatively new technology in Scotland and assessment protocols are currently less standardised than those used in respect of terrestrial wind farms. This situation offers some scope for flexibility with regard to data gathering and analysis, provided that it can be demonstrated that assessment is based on reasonable and defendable expectations of the effects caused by the development. Conversely, there is perhaps a greater likelihood of novel or unexpected situations arising in the case of offshore developments, and increased likelihood of changes in assessment procedures as our understanding of the potential effects of offshore wind farms improves. Recognising this situation, it is important that the study design is able to accommodate changing circumstances.

EIA has to consider the effects of a development acting on its own and in combination with other potential developments. Therefore, it is important that the data collected at Neart na Gaoithe is easy to integrate with data collected in adjacent areas by other developers.

Finally, the studies must perform repeatable measures of the baseline conditions in order that future changes can be evaluated. For example, ideally, the data should allow all changes in the abundance, distribution and behaviour of species to be quantified, following the construction of the development.

This report considers the following issues:

- Scope of bird and marine mammal work
- Potential effects of the Development
- Key species and designated sites
- Information requirements
- Survey strategy
- Proposed fieldwork methods
- Data management
- Data analysis
- Reporting

E.2 Scope of bird and marine mammal studies

The assessment of effects will primarily consider the direct effects of the proposed offshore windfarm on birds and marine mammals. However, marine ecosystems are highly complex and there are potentially many ways that offshore wind farms could cause indirect effects on species. For example, there may be effects on currents, turbidity, temperature profiles etc, all of which might affect the distribution and availability of phyto and zoo plankton, which could in turn affect animals higher up the food chain, in particular fish, upon which seabirds and marine mammals feed. Therefore the assessment of effects will also need to consider indirect effects (for example changes to fish prey and availability) as much as these can be inferred through existing studies or the work of the other specialists involved (e.g. fish ecologists, oceanographers etc). While it is beyond the scope of the bird and marine mammal specialists to collect new data on other aspects of the

ecology of the site (e.g. plankton or fish surveys) it is pertinent to draw attention to those aspects that have particular relevance to sea birds and marine mammals, and where relevant, to work in collaboration with other specialists.

Given the strong links between the various components of the marine environment and, in this case, the likelihood of indirect effects on birds and marine mammals, it is recommended that an ecological review group is set up comprising the various specialist advisers and the client and, perhaps, key statutory and non-statutory organisations too. The complexity of marine ecosystems means there will inevitably be some 'grey areas' as regarding who is responsible for what and therefore a danger of confusion. An ecological review group would have a brief to look at the environmental aspects of the development as a whole and would foster communication and collaboration between the specialists involved. It would also reduce the likelihood of duplication of effort and, most importantly, help ensure all relevant subjects are covered.

Large offshore wind turbines are a relatively novel technology in Scotland, although there is now moderate experience from constructed sites elsewhere, for example off England and Denmark. Considerable insight regarding the likely impacts on birds and marine mammals can be gained from these existing installations. However, the proposed Neart na Gaoithe site has circumstances that differ in two important respects to those of most of the existing offshore windfarm around the UK. Firstly it is situated in an area of relatively deep water (around 50m) and although still in coastal waters, this means that the range of species potentially affected is likely to be somewhat different. Secondly, the adjacent coast of Scotland contains several large breeding seabird and seal colonies, most of which are designated as Special Protection Areas (SPAs) or Special Areas of Conservation (SACs)(Tables E.1 and 2). Many of the qualifying seabird species and both the qualifying seal species are known to range far offshore to feed, including the vicinity of the Neart na Gaoithe site.

Name	Annex II species that are a primary reason for site selection	Other Annex II species present as a qualifying feature
Isle of May	Grey seal, ca 4.5% UK pup production	none
Firth of Tay and Eden Estuary	Harbour seal, ca 2% UK pop. Breed/moult	none
Moray Firth	Bottlenose dolphin, ca 130 individuals	none
Berwickshire and North Northumberland Coast	none	Grey seal, ca 2.5% UK pup production

Table E-1 Special Areas of Conservation (SACs) with qualifying Annex II species that could potentially be affected by the development. Data from JNCC website.

Name	Qualifying Interest	Likely use of development site
Firth of Forth Islands	Arctic Tern (c 540 pairs breed)	Low
	Common tern (c 800 pairs breed)	Low
	Roseate tern (was c 9 pairs breed, recent declines)	Low
	Sandwich tern (c 22 pairs breed)	Low
	Gannet (34,400 pairs breed Bass Rock)	High
	Lesser black-backed gull (2920 pairs breed)	Low

	Puffin (21,000 pairs breed)	High
	Shag (2,887 pairs breed)	Low
	Seabird assemblage of international importance (90,000 individuals breed). Above species plus guillemot, razorbill, kittiwake, fulmar, cormorant and herring gull.	High - auk species., kittiwake and fulmar. Medium - herring gull Negligible - cormorant
Firth of Forth	Sandwich Tern (1611 birds passage)	Low
(not islands)	Bar-tailed godwit (2,600 birds winter)	Negligible
	Golden plover (2,970 birds winter)	Negligible
	Red-throated diver (88 birds winter	Low
	Slavonian grebe (71 birds winter)	Negligible
	Knot (8,013 birds winter)	Negligible
	Pink-footed goose (12,400 birds winter)	Negligible
	Redshank (3,700 birds winter)	Negligible
	Shelduck (3,586 birds winter)	Negligible
	Wetland bird assemblage of international importance (over 86,000 waterfowl). Numerous species in addition to those listed above, including sea duck.	Low - sea duck species Negligible - all other species.
St Abb's Head to Fast Castle	Seabird assemblage of international importance. (79,560 individuals breed). Species include: guillemot, razorbill, kittiwake, shag and herring gull.	Medium – auks species. and kittiwake Low – herring gull. Negligible - shag
Firth of Tay and Eden Estuary	Little tern (44 pairs breed)	Negligible
	Marsh harrier (4 pairs breed)	Negligible
	Bar-tailed godwit (2,400 birds winter)	Negligible
	Greylag goose (1,355 birds winter)	Negligible
	Pink-footed goose (3,769 birds winter)	Negligible
	Redshank (1,800 birds winter)	Negligible
	Wetland bird assemblage of international importance (34,074 waterfowl) Numerous species in addition to those listed above, including sea duck.	Low - sea duck species Negligible - all other species.
Fowlsheugh	Guillemot (40,140 pairs breed)	Medium
	Kittiwake (34,870 pairs breed)	Medium
	Seabird assemblage of international importance (170,000 individuals breed). Above species plus razorbill, herring gull and fulmar	Medium
Montrose Basin	Pink-footed goose (31,622 winter)	Unknown
	Greylag goose (1080 winter)	Unknown

	Knot (4,500 winter)	Negligible
	Oystercatcher (2,368 winter)	Negligible
	Redshank (2259 winter)	Negligible

Table E-2 **SPAs with qualifying species and assemblages that could potentially be affected by the development. Data on qualifying interest are taken from JNCC website (Note, the data are for the numbers at the time of designation, more recent survey work has shown that in many cases numbers have since changed.)**

E.3 Potential effects and issues

Before assessing what information is required it is useful to briefly consider the nature and likely strength of the potential effects of the proposed development on birds and marine mammals. These key potential effects are:

- Collision with the proposed turbines, leading to death or injury;
- Disturbance, including displacement and barrier effects;
- Habitat Loss
- Indirect effects, e.g. caused by changes to currents, sediments, fish etc;
- The cumulative effects of more than one development in the region.

The range of potential effects on birds and links between them are reviewed in Fox et al (2006) and the Offshore Energy SEA (DECC 2009). The Department of Trade and Industry Offshore Wind Round 2 SEA (DTI 2003) also has useful review information on potential effects of offshore wind developments on seabirds and marine mammals.

E.3.1 Collision effects

The most obvious risk involving collision is that of flying birds being killed or injured through striking rotors (Desholm et al 2006, Drewitt and Langston 2006). The subject of collision is reviewed in the Offshore Energy SEA (DECC 2009). Various techniques have been developed to study the problem and predict its affects (Band et al 2007). One of the main limitations of this work is the lack of knowledge on birds' abilities to avoid turbines, particularly for marine species. There have been some recent efforts to calculate species vulnerability to wind turbines, although this has been mainly subjective e.g. Garthe & Hüppop (2004).

There have only been a few post-construction studies of collision rates between birds and offshore wind turbines published. Although not based on post-construction radar studies, assessments of collision risks for other offshore wind farms have generally concluded that collision risks are not likely to be significant. This may be for a variety of factors. For example, the Kentish Flats offshore wind farm EIA concluded that disturbance or collision effects on feeding, roosting, breeding or migratory behaviour of all bird species would not be significant due principally to the small numbers of birds recorded at the site (Global Renewable Energy Partners 2002). Other offshore wind farm EIAs have concluded that possible collision risks would be reduced by displacement effects (i.e. birds avoiding the wind farm area due to the presence of turbines) (e.g. AMEC 2002).

Overall birds are generally able to avoid collisions and do not tend to fly into wind turbines. Collision rates are typically in the range of only 1 in 1,000-10,000 bird flights through a wind farm (Percival 2003). For some species collision rates may be considerably lower, for example at Utgrunden offshore wind farm, where over 500,000 Eider flights through the wind farm study area have been recorded without a single collision being seen (Pettersson and Stalin 2003). Studies using radar at several offshore wind farm indicate that migrating birds, mostly seabirds and waterfowl, show strong avoidance of wind turbines (Desholm and Kahlert 2005, Christensen and Hounisen 2005). There are however concerns over how well birds can avoid turbines in low visibility conditions and the difficulties of quantifying collision rates by finding carcasses in the marine environment (Hüppop et al 2006). Scottish Natural Heritage currently recommend the application of an avoidance factor of 95 %, i.e. 95 % of flights which might in theory give rise to collision will in fact result in

successful avoidance, although more refined factors of up to 99 % are recommended for some species (SNH 2009a).

Migrating birds, especially passerines, can be attracted to lights fixed to marine structures such as oil rigs, leading to fatal collisions, particularly in misty conditions (Wiese et al 2001). The effects of navigation lights on offshore wind-turbines on migrating birds are poorly understood (Hüppop et al 2006).

E.3.2 Disturbance effects

Disturbance concerns birds and marine mammals' behavioural response to either specific events associated with the development (such as noise or a moving vessel) or their response in general to the presence of wind turbines. Disturbance can lead to displacement. This occurs when animals no longer make use of an area, or use it less frequently than they would otherwise because of the development. This may be a temporary effect or a permanent one. In ecological terms, it is equivalent to habitat loss. The potential for offshore windfarms to cause displacement and barrier effects to birds is widely recognised (Drewiit and Langston 2006, Fox et al 2006) though the actual importance of such effects is poorly understood. If birds and marine mammals are reluctant to closely approach wind turbines then this may cause them to deviate from the most efficient route of travel, perhaps causing them to take longer to complete their journey or prevent then from easily accessing critical resources. Studies using radar in Denmark (Christensen & Hounisen 2005) showed that some flying bird species almost completely avoided a windfarm, causing them to deviate from their intended flight route. Barrier effect issues are potentially highly relevant to offshore windfarm assessments, particularly where several windfarms are proposed in close proximity, as is the case for this development. Understanding bird and marine mammal movement patterns and their tolerance of wind turbines has implications for windfarm location and design. In theory, even if birds and marine mammals are displaced from the vicinity of wind turbines, it is possible to design layouts that allow their free movement through the windfarm as a whole, for example by providing turbine-free corridors.

Attraction is the opposite of displacement. It occurs when birds and marine mammals use an area more than they did before the development was constructed. It is analogous to habitat gain and in most cases would be considered to benefit a species. However, this may not always be the case because attraction may expose the species to elevated risk. For example, flying birds attracted to fish aggregated around a wind turbine may be at increased risk of collision with turbine blades.

The affects of disturbance on marine mammals, especially cetaceans, are not well understood and this is likely to be an important issue. Of particular concern will be disturbance caused by loud noises during construction, for example pile driving operations. This issue is reviewed in detail in the Offshore Energy SEA (DECC 2009). The main recommendation was that 'within the key areas of marine mammal sensitivity identified, [which included the Moray Firth and coastal waters south to the Forth (bottlenose dolphin); including Smith Bank (grey and harbour seals), inner Firths (harbour seal), St Andrews Bay and outer Forth (grey seals)] operational criteria are established to limit the cumulative pulse noise "dose" (resulting from seismic survey and offshore piledriving) to which these areas are subjected.'

Disturbance from piling operations and other construction processes has been recognised as a major potential impact on marine mammals in the area. Intense sounds during pile driving of monopiles in the construction phase of a wind farm are at levels that could cause hearing loss or physical damage to marine mammals. Modelling has shown that the hearing of marine mammal species could be affected at ranges of several kilometres in some cases (Gordon et al 2008).

Pre- and post-construction studies of Harbour Porpoise at the Nysted Offshore Wind farm in Denmark recorded a decrease in Harbour Porpoise activity in the area during construction and in the first two years of operation compared to baseline data (Tougaard et al 2006).

There is some evidence of the impacts of offshore wind farms on the two species of seals found regularly in UK waters. Post-construction studies from Scroby Sands Offshore Wind Farm which is approximately 2 km from a Common Seal breeding area and haul-out site and a Grey Seal haul-out site, showed that while numbers of Grey Seals were similar pre- and post-construction, numbers of Common Seals declined in relation to baseline figures (Skeate 2008). Conclusions from the Scroby Sands study stated that future sites close to seal colonies should be assessed with caution, as response to pile driving noise is likely at distances up to 20 km. The nationally important breeding colony of Harbour Seals in the Firth of Tay and Eden Estuary SAC is

approximately 30 km from the proposed Neart na Gaoithe site. Seals may also be vulnerable to cumulative impacts if construction is carried out several sites at the same time within their home range.

E.3.3 Habitat Loss

Offshore windfarm development is likely to cause relatively limited direct habitat loss. This may be caused by destruction or change to existing marine habitats in particular the seabed in the vicinity of turbines and along cable routes. Any effects on this on birds are likely to be small. The most likely mechanisms leading to habitat change are physical disturbance of the seabed during construction and tidal scour of sediments upstream from turbine bases. These issues are reviewed in the Offshore Energy SEA (DECC 2009). The potential for indirect habitat loss caused by disturbance effects (discussed above) is likely to be of much greater importance to birds and marine mammals.

E.3.4 Indirect effects

The complexity of marine ecosystems and the consequential scope for numerous indirect effects that an offshore windfarm may have on seabirds and marine mammals has already been outlined above. Of particular relevance are any changes to the abundance or availability of fish species that form the main prey of seabirds and marine mammals in the area, e.g. sand eel, mackerel and herring. The many potential effects that offshore windfarms could have on the marine ecology of an area are reviewed in detail in the Offshore Energy SEA (DECC 2009) and include:

- Physical damage to biotopes from construction;
- Potential behavioural and physiological effects on marine mammals, birds and fish associated with construction and operation noise;
- Behavioural disturbance to fish, birds and marine mammals from physical presence of infrastructure and support activities;
- Collision risks to birds;
- Barriers to movement of birds (e.g. foraging, migration);
- Electromagnetic field effects on fish;

E.3.5 Cumulative effects

Existing effects on birds and mammals are part of the baseline conditions and therefore do not need to be considered in an assessment of cumulative effects under the EIA Regulations. Ecological Cumulative Impact Assessment (eCIA) should be ideally undertaken at the population scale. However, this is rarely possible due to data limitations (e.g. lack of information on the ranging behaviour of individual animals mean that it is not possible to know how many proposed developments they might be affected by, or with what frequency). To date therefore, eCIA has been driven by pragmatic decisions concerning the sources of effect that need to be considered. Given the artificiality of such decisions, they are invariably taken by the statutory agencies and it is beyond the scope of this document to predict which developments might need to be included. Therefore the principal relevance of eCIA at this stage is the need to ensure data is gathered that is compatible with data gathered at the adjacent development sites. Ideally a single eCIA would be undertaken on behalf of all the stakeholders involved.

COWRIE (Collaborative Offshore Wind Research into the Environment) have recently published guidance on how developers should assess ornithological cumulative impact for offshore wind farms (King et al 2009). The key points include:

- The process of scoping is essential to the provision of robust Cumulative Impact Assessment (CIA), requiring regular communication and iterative information exchange between developers, statutory bodies and stakeholders;
- Data gathering and analysis methods should follow guidelines covering selection of species for consideration, projects to be included in the assessment and the spatial scale of the bird reference population to be used;

- Quantitative data on raw numbers, densities and population estimates for all species must be included, and impacts should be assessed in a quantitative rather than a qualitative way;
- Cumulative effects of collision risk and displacement should be assessed by summing the impacts from each component project;
- Disturbance and barrier-effects should be considered in a qualitative manner and, if thought likely to be significant, then a more detailed quantitative study of bird bioenergetics in relation to the effect should be carried-out.

E.3.6 Key issues

Stakeholder consultations that took place as part of the DECC Offshore Energy SEA identified a number of key issues for offshore wind farm development (DECC 2009 Appendix 1). Those that have particular relevance to birds and marine mammals are as follows:

- Impacts on designated sites,
- Bird displacement (what is biologically significant?),
- Noise effects, particularly marine mammals and fish spawning (what is biologically significant?),
- Assessment of cumulative effects,
- Ongoing studies to fill data gaps,
- Adopting a precautionary approach to unknown impacts,
- Identification of areas suitable and not suitable for offshore wind farm development.

E.4 Key species and designated sites

It is useful at this pre-survey scoping stage to identify what species are most likely to be affected by a wind farm development at Neart na Gaoithe and whether the individuals involved are likely to belong to populations designated as qualifying interests for sites protected under international legislation (SPAs and SACs) or designated as notified features for sites protected under national legislation (Sites of Special Scientific Interest).

The sensitivity analyses for south-east Scotland undertaken for Mainstream Renewables by NRP and CE (NRP 2008, Cork Ecology 2008a) examined the range of seabirds using the region and their sensitivity to offshore wind farm developments. These assessments can now be refined for the more restricted area of the Neart na Gaoithe site.

E.4.1 SEA reviews

The site lies within Regional Sea 1, as described in the Offshore Energy SEA (DECC 2009). This extends over a huge area from eastern Shetland to Flamborough Head, Yorkshire. The baseline descriptions of seabird and marine mammals occurring in this area, and around the UK in general, have been reviewed in various reports as part of the Department of Energy and Climate Change's (DECC) offshore energy Strategic Environmental Assessment programme. Most recently the seabird and marine mammals occurring in this area have been reviewed in the Offshore Energy SEA (DECC 2009 Appendices 3a.6 and 3a.7). The marine mammals using the area are also reviewed in Hammond et al (2004). There is also relevant review information in the Scottish Marine Renewables SEA 2007 (Scottish Executive 2007) although this is primarily concerned with tide and wave energy developments. The coastal and marine conservation sites in the area have been reviewed in detail in for the SEA 5 Area (DTI 2004).

E.4.2 Seabirds overview

The Neart na Gaoithe site lies 15 km east of the nearest coast (Fife Ness, Fife) and has a water depth of approximately 50m throughout. In the summer months the most abundant seabird species likely to occur in the area are gannet, kittiwake, puffin, fulmar, guillemot and razorbill (Table E.3). There will also be smaller

numbers of large gulls and possibly tern species (Table E.3). All these species breed in colonies along the adjacent coast and are known to range large distances to feed. Of particular relevance to Neart na Gaoithe will be birds from colonies on the Isle of May and Bass Rock (Table E.2). These are situated to the south-west, approximately 20 km and 30 km away respectively. In addition, birds breeding at the St Abb's Head colonies, approximately 40 km to the south, may also range as far as Neart na Gaoithe during feeding trips. These colonies are included in either the Forth Islands or the St Abb's Head to Fast Castle SPAs (Table E.2). The boundaries of these seabird SPAs are in the process of being extended to 4 km seaward from the coast.

Species	SE Scotland population	SE Scotland as % of British population*	SE Scotland as % of W European population**
Gannet	44,110	19.2%	14.1%
Guillemot	109,175	12.3%	3.8%
Razorbill	18,874	17.2%	3.6%
Kittiwake	65,314	17.7%	2.9%
Herring gull	21,181	15.0%	2.8%
Shag	1,781	6.1%	2.6%
Lesser black-backed gull ***	7,888	8.9%	2.5%
Roseate tern****	14	26.9%	1.6%
Puffin	73,169	12.2%	1.3%
Cormorant (carbo sub sp.)	528	7.7%	1.2%
Common tern	1,390	13.5%	0.6%
Sandwich tern	300	2.7%	0.4%
Fulmar	8,335	1.7%	0.3%
Arctic tern	992	1.9%	0.2%
Great black-backed gull	80	0.5%	0.1%
Little tern	7	0.4%	0.1%

Table E-3 **The size of seabird breeding populations (pairs) in south-east Scotland (Aberdeen to English border) and their national and international importance. Based on figures in Mitchell *et al* (2004). Seabird species not listed do not breed in south-east Scotland.**

* Includes Isle of Man and Channel Islands but excludes Ireland,

** Includes Iceland and Scandinavia but excludes Russia

*** Coastal breeding colonies only, large numbers also breed inland.

**** The Scottish population of roseate tern has since declined to <5 pairs

Many seabirds from these colonies are known to be particularly dependent on sand eels (Camphuysen 2005). These occur throughout the region but not uniformly or consistently, with the result that the most profitable feeding areas for seabirds change both seasonally and between years. Highly mobile pelagic prey species such as clupeids can also be important, resulting in rapid changes in feeding areas even within a season (e.g. guillemot chicks, Wilson et al 2005). Although this topic is highly relevant to assessment of the effects of the development it is also highly complex and beyond the scope of this report to examine in detail. Fortunately, it has received considerable study (e.g. IMPRESS study, Camphuysen 2005). Of particular relevance to the development is that the relatively shallow sand banks (e.g. the Wee Bankie) lying broadly to the east of the site

are known to be favoured seabird feeding grounds with prey species such as sandeels, herring and sprat available. The development site has also been shown to be important for feeding seabirds at times, for example, high densities of gannet, kittiwake and guillemot were regularly recorded in June and July (Camphuysen 2005).

Given the proximity of the development to European designated sites (Map 1) (i.e. the SPAs noted above), and the possibility that birds forming part of the qualifying interests of these sites could be adversely affected by the proposals, it is reasonable to assume that an appropriate assessment under the Habitats Regulations 1994 will be required. This would be in addition to assessment under the EIA Regulations. The tests under the Habitats Regulations are far more stringent than those of the EIA Regulations and therefore baseline studies will give particular emphasis to gathering detailed information on the SPA qualifying species that occur within the development site. These include gannet, shag, puffin, guillemot, razorbill, kittiwake, lesser black-backed gull, herring gull, arctic tern and common tern (Table E.2, Table E.4).

Species	Nature Conservation Importance listings	Species a qualifying interest for a regional SPA* (see Table E.2)
Red-throated diver	A1, S1	Yes
Shag		Yes
Common eider		No
Sandwich tern	A1	Yes
Great black-backed gull		No
Long-tailed duck	S1	No
Common scoter	S1, UK BAP, RL	No
Gannet		Yes
Razorbill		Yes
Arctic tern	S1	Yes
Common tern	S1	Yes
Roseate tern	A1, S1, UK BAP, RL	Yes
Lesser black-backed gull		Yes
Great skua		No
Guillemot		Yes
Herring gull	UK BAP	Yes
Little auk	A1, S1	No
Atlantic puffin		Yes
Arctic skua	UK BAP	No
Little gull	A1, S1	No
Kittiwake		Yes
Fulmar		No
Sooty shearwater		No

Manx shearwater		No
Storm Petrel	A1	No

Table E-4 **List of seabird species occurring in south-east Scotland, their nature conservation listings and whether they are qualifying species for Special Protection Areas (SPAs) in the region. The conservation listings are as follows: A1 = Annex 1 of EU Birds Directive, S1= Schedule 1 of Wildlife and Countryside Act, UK BAP = UK Biodiversity Action Plan species, RL = Birds of Conservation Concern red-listed.**

* excludes species that only qualify as part of assemblages.

E.4.2.1 Gannet

Gannet breed in a few, typically very large, colonies around the UK. The second largest UK colony is at Bass Rock situated in the outer Firth of Forth, indeed, the species, Morus bassanus, is named after this site. The Bass Rock is part of the Forth Islands SPA and supports approximately 44,000 breeding pairs, representing 19.2% of the UK population (Table E.3). Gannets feed by plunge diving for fish, often from a considerable height above the surface. Breeding birds from the Bass Rock colony have been shown by satellite-tagging to range widely across the North Sea, at times travelling as far as the Norwegian coast (Hamer et al 2007). The Neart na Gaoithe site lies within the core area of the foraging range of Bass Rock gannets.

Gannets were rated by Garthe and Hüppop (2004) to have a high potential vulnerability to collision risk from offshore windfarms, but only moderate vulnerability to helicopter and ship disturbance (Table E.5). Preliminary results from Horns Rev windfarm in Denmark indicate that gannets are displaced from offshore windfarms, but this is based on a small sample of observations (Christensen and Hounisen 2005).

Species	Collision vulnerability score.	Aircraft/ship disturbance vulnerability score.	Likely displacement from windfarm
Red-throated diver	10	4	(High)
Shag	(10)	4	(Low)
Common eider	10	3	Unknown
Sandwich tern	10	2	Low
Great black-backed gull	10	2	Unknown
Long-tailed duck	(9)	Unknown	Unknown
Common scoter	9	5	High
Gannet	11	2	(High)
Razorbill	7	3	Unknown
Arctic tern	8	2	Low
Common tern	9	2	Low
Roseate tern	(8)	Unknown	Unknown
Lesser black-backed gull	10	2	Unknown
Great skua	9	1	Unknown
Guillemot	8	3	Unknown

Herring gull	11	2	Low
Little auk	(6)	Unknown	Unknown
Atlantic puffin	6	2	Unknown
Arctic skua	10	1	Unknown
Little gull	7	1	Medium
Kittiwake	9	2	Medium
Fulmar	10	1	Unknown
Sooty shearwater	(10)	Unknown	Unknown
Manx shearwater	(10)	Unknown	Unknown
Storm Petrel	(low)	Unknown	Unknown

Table E-5 **List of seabird species occurring in south-east Scotland their indicative vulnerability to collision with wind turbines, disturbance from helicopters and ships and to wind farm displacement effects. The collision and disturbance vulnerability are from Garthe and Hüppop 2004, scores in parentheses indicate that the value shown is for a closely related species. Likely displacement ratings are based on the results from Horns Rev windfarm Denmark (various reports including Christensen and Hounisen 2005), parentheses indicate ratings that are based on small samples.**

The combination of the close proximity to a large SPA colony and the apparent high potential for collision and displacement effects will mean that gannet will be a key species that the assessment process will need to scrutinise particularly closely. The potential for collision strikes during foggy conditions is an issue of particular concern that will need to be addressed (see section E.7.8).

E.4.2.2 Auks

Three species of auks breed in the region, puffin, guillemot and razorbill. A fourth species, the little auk, occurs in the winter months. Breeding auks are concentrated at a few large breeding colonies in the region, in particular the Isle of May, Fowlsheugh and St Abb's Head, all of which are part of SPAs (Table E.2). All these breeding auk species commonly fly up to several tens of kilometres from breeding colonies to forage. They feed by surface diving and swimming down to a wide range of depths to catch small fish, in particular sandeels. In the late summer guillemots and razorbills congregate in large numbers away from the coast to moult, during which time they are flightless.

Auks are strong fliers and tend to fly relatively close to the sea surface. As a consequence they were rated by Garthe and Hüppop (2004) as having only moderate vulnerability to potential collision effects with wind turbines (Table E.5). They were also rated by Garthe and Hüppop as having moderate vulnerability to helicopter and ship disturbance. Studies at Horns Rev showed lower numbers of guillemots and razorbills used the windfarm area and its vicinity after the windfarm was constructed (Peterson et al 2007).

Auks are the commonest group of seabirds in the region, together numbering over 200,000 breeding pairs. These south-east Scotland populations are very important, representing approximately 12-17% of the national populations (Table E.3). Because of the high importance of the regional populations and the likely displacement effects, the three breeding auk species will be key species in the assessment of effects of the development.

E.4.2.3 Gulls and skuas

Six species of gull breed in the region, of these, kittiwake, herring gull and lesser black-backed gull all make extensive use of the marine environment and occur in large numbers. Kittiwake and lesser black-backed gull are qualifying species of interest for local SPAs (Table E.2). These species, and great black-backed gull, forage

widely out to sea. Several other gull species occur in the region in small numbers outside the breeding season, the regular gathering of little gulls (an EU Birds Directive Annex I species) in the outer Tay estuary being notable (Söhle et al 2007).

No skuas breed in the region but four species occur as passage migrants in spring and autumn, in particular arctic skua and great skua. Published information on the distribution of seabirds in the region (Stone et al 1995) indicate that the waters of the Forth and Tay, including the area around Neart na Gaoithe, may have high importance in a UK context for arctic skua in the late summer and autumn.

The gull and skua species considered by Garthe and Hüppop (2004) were all rated as having moderate to high vulnerability to collision risk and low vulnerability to helicopter and ship disturbance (Table E.5). Results on displacement from Horns Rev indicate that herring gulls were less affected by displacement than most other species, with birds regularly making use of the area inside the wind farm (Christensen and Hounisen 2005).

Kittiwake will be one of the key species in the assessment of effects of the development on account of the large SPA populations that use the area (Table E.2) and this species' current poor UK conservation status (Mitchell et al 2004).

E.4.2.4 Terns

Five species of tern breed in the region and all of these are listed on Annex 1 of the EU Birds Directive. Most of the breeding sites within the region are part of SPAs (Table E.2). Terns typically forage close inshore, at least in the breeding season. The development site is expected to have relatively low importance for terns due to its distance from the shore, although this will need to be confirmed by survey work. This is supported by published results on seabird distributions at sea (e.g. Stone et al 1995). Garthe and Hüppop (2004) considered tern species to have high vulnerability to collision and disturbance effects (Table E.5). Results on displacement from Horns Rev indicated that tern species were little affected by displacement from the wind farm area (Christensen and Hounisen 2005).

E.4.2.5 Sea duck

Small non-breeding aggregations of seaduck species occur in the Firth of Forth and Firth of Tay and Eden Estuaries, in particular common scoter and eider (Dean et al 2004, Söhle et al 2007). These birds primarily feed on benthic invertebrates in areas with a depth of <30m depth. The Neart na Gaoithe site is likely to be too deep for these species to feed profitably. This is supported by published results on seabird distributions in the region (Barton and Pollock 2004, Söhle et al 2007, Stone et al 1995). However, sea duck moving between sites around the UK coast are likely to fly through the area. Garthe and Hüppop (2004) rated seaduck species as having relatively high potential vulnerability to collision and disturbance. Initial results from Horns Rev for common scoter indicated a very high level of displacement from the wind farm (Christensen and Hounisen 2005). Later results from Horns Rev showed less severe displacement of common scoter and indicated that over times scoter can habituate to offshore windfarms (Petersen et al 2007). Results of studies on eider from Tunø Knob windfarm in Denmark found mixed evidence of displacement effects (Guillemette and Larsen 2002, Larsen and Guillemette 2007).

E.4.2.6 Divers and grebes

Red-throated divers winter in small numbers in the region (Dean et al 2004, Barton and Pollock 2004, Söhle et al 2007) and are a qualifying interest species for the Firth of Forth SPA (Dean et al 2004, Söhle et al 2007). Great-crested and Slavonian grebes also winter in moderate numbers in the region, mainly in the inner parts of the Firth of Forth and Firth of Tay (Dean et al 2004, Barton and Pollock 2004, Söhle et al 2007). Wintering divers and grebes mainly use sheltered waters of <30m depth. The Neart na Gaoithe site is likely to be too deep to be attractive to feeding divers or grebes. This is supported by published results on seabird distributions in the region (Barton and Pollock 2004, Söhle et al 2007, Stone et al 1995). However, large numbers of red-throated divers) are known to congregate in large flocks along the east coast of Scotland in late spring and some of these are likely to pass through the site on migration.

Divers were considered by (Garthe and Hüppop (2004) to have high vulnerability to potential collision and disturbance effects. Observations at Horns Rev wind farm showed that red-throated divers almost completely avoided the wind farm area during the three years post construction period, despite being present in average

densities prior to construction. (Christensen and Hounisen 2005, Peterson et al 2007). Similar avoidance was reported for red-throated divers at the Arklow Bank Offshore Wind Farm following construction of seven turbines (Barton et al 2008).

E.4.2.7 Cormorant and shag

Shag breed in moderate numbers in the region, in particular on the Isle of May SPA, where it is a qualifying-interest species (Tables E.2 and E.3). Shags are surface-diving bottom-foraging species that generally find it unprofitable to forage in areas greater than about 30m depth and located many kilometres from the coast (Wanless et al 1991, Wanless et al 1997, Wanless et al 1998). For this reason the Neart na Gaoithe site is not expected to be important as a feeding area for breeding shags. This is supported by published results on seabird distributions in the region (Stone et al 1995, Camphuysen 2005). Small numbers of cormorant breed in the region, mainly on islands in the Firth of Forth (Table E.3). This species is restricted to coastal, estuarine and inland waters and is not expected to use the Neart na Gaoithe site.

Garthe and Hüppop (2004) did not assess shag in their review of offshore windfarm sensitivity, but cormorant was rated as having potentially high vulnerability to both collision and disturbance (Table E.5). Limited observations of shag at the Horns Rev windfarm suggest that this species may be little affected by displacement from windfarms, indeed not only were birds noted feeding within the windfarm but they also perched on parts of the windfarm infrastructure (Christensen and Hounisen 2005).

E.4.2.8 Shearwaters and petrels

Fulmars are the only member of the tubenose family that breed in the region (Table E.3). Several other species (including Manx shearwater, sooty shearwater, storm petrel and Leach's petrel) also occur regularly though generally in smaller numbers than found off western Scotland (Stone et al 1995). Garthe and Hüppop (2004) considered fulmar to be at high potential risk of collision and low risk of disturbance (Table E.5). No information is available on these species' vulnerability to windfarm displacement effects.

E.4.2.9 Terrestrial birds

Millions of terrestrial birds migrate across the North Sea, these include waders, ducks, geese, and passerines (Hüppop 2007). The migration routes of some of these birds will almost certainly pass over the Neart na Gaoithe site, though existing published data are too course to identify which species may be at greatest risk. Most of this migration is expected to occur at altitudes too high to be affected by wind turbines, but some will be at lower altitudes (especially during inclement weather) and could therefore be potentially affected by collision. Migration activity by terrestrial species often occurs at night, making it difficult to observe. Radar studies are the most effective means for quantifying bird migration at night, although identification to species is usually not possible.

E.4.3 Marine mammals overview

Based on existing information, the three species of marine mammal most likely to occur regularly in the vicinity of the Neart na Gaoithe site are harbour porpoise, minke whale and grey seal. Bottlenose dolphin, white-beaked dolphin and common seal may also occur (Reid et al 2003).

Four Special Areas of Conservation (SACs) along the east coast of Scotland have qualifying marine mammal species whose populations may make use of the development site. These are Isle of May (grey seal), Firth of Tay and Eden Estuary (harbour seal), Moray Firth (bottlenose dolphin) and Berwickshire and North Northumberland Coast (grey seal) (Table E.2).

It is anticipated that harbour porpoise, bottlenose dolphin, grey and harbour seals are likely to be the key species for the assessment process, with particular focus on impacts arising from construction activities such as pile-driving.

The following species summaries are based largely on information for Regional Sea 1 contained in Appendix 3a.7 of the recent Offshore Energy SEA (DECC 2009). Regional Sea 1 covers the northern and central North Sea.

E.4.3.1 Harbour porpoise

Harbour Porpoise is the most common cetacean species in UK waters. While present throughout the year, peak numbers are generally recorded in summer months from June to October.

The 1994 SCANS survey showed Regional Sea 1 to be one of the most important for harbour porpoise in the North Sea, with high densities predicted throughout the area (Hammond et al. 2002b). While a more southerly distribution in the North Sea was observed in the 2005 repeat survey, high acoustic detection rates for harbour porpoise were recorded in waters off northeast Scotland and the outer Moray Firth (SCANS-II 2008).

E.4.3.2 Bottlenose Dolphin

A small population of bottlenose dolphins is resident off the east coast of Scotland, ranging from the inner Moray Firth to the Firth of Forth, with occasional observations from further offshore in the North Sea. The species is likely to occur in waters inshore of the development site, most often in the summer months, as peak sightings of bottlenose dolphin in St Andrews Bay occur between June and August (Hammond et al. 2004).

E.4.3.3 White-beaked Dolphin

Along with harbour porpoise, white-beaked dolphin is the most commonly occurring cetacean in the central and northern North Sea, and is regularly encountered in coastal and offshore waters in the region throughout the year, with more frequent sightings between July to October.

E.4.3.4 Minke Whale

Minke whales are predominantly a summer visitor to the waters off the east coast of Scotland, with animals well distributed (both coastally and offshore) throughout the central and northern North Sea during the summer months. They are frequently sighted in small numbers off the Scottish east coast between July and October, and are likely to occur in the vicinity of the Neart na Gaoithe site at this time of year.

E.4.3.5 Grey Seal

Grey seals are important marine predators in UK waters, taking primarily sandeels but including a variety of other species including cod, haddock, whiting, ling and flatfish. Their diet varies seasonally and from region to region (Hammond & Grellier 2006).

Grey seals haul out on land between foraging trips and for pupping and moulting, when they can form large colonies or aggregations. Timing of pupping differs throughout the range of the species. In Northern Britain pupping occurs from October to late November, while moulting occurs between February and April. Many animals remain on land during these periods, and the at-sea densities may be lower at these times, as a consequence (Hammond et al 2004).

Grey seals forage in areas that are up to at least 100m deep and that tend to have gravel/sand seabed sediments, which is the preferred burrowing habitat of their primary prey, sandeels. Grey seal foraging movements are on two geographical scales: long and distant trips from one haul-out site to another; and local repeated trips to specific offshore areas. Long-term telemetry studies show that grey seals will occur regularly in the waters around the Neart na Gaoithe site (Hammond et al 2004).

Major grey seal colonies on the east coast of Scotland/England include the Isle of May, Fast Castle and the Farne Islands, some of which are SACs for the species (Table E.1).

E.4.3.6 Harbour Seal

Harbour seals are also important predators in UK waters, eating a variety of prey species including sandeels, gadoids, herring and sprat, flatfish, octopus and squid, although their diet varies both seasonally and regionally.

Harbour seals are widely distributed along the east coast of Scotland. There are many important haul-out and breeding sites on these coastlines, several of which contain internationally important numbers. Harbour seals are abundant in the coastal waters surrounding these sites. Modelling studies have shown that harbour seals have foraging areas off much of the east coast of Scotland, including “hotspots” north of St Andrews and in the

Moray Firth, (DECC 2009). Continuing declines have been observed at major harbour seal colonies throughout Britain (Lonergan et al. 2007).

E.5 Information requirements

The scoping and sensitivity analyses undertaken by NRP and CE in 2008 have been used as the starting point to guide bird and marine mammal survey requirements (see Survey Strategy and Proposed Field Methods sections). However, additional work will be required to gather relevant information from other sources and incorporate this into a strategic assessment of information requirements for the EIA process. The main areas that need to be addressed are recent EIAs for other offshore windfarms, acquisition of key ecological data sets (especially ESAS data) for the area and keeping up to date with new information as it occurs, for example scientific studies and statutory guidelines. It will also be valuable to keep abreast of how statutory agencies and other organisations are responding to other offshore developments.

Relevant organisations will be consulted over the information needed for this assessment, in particular SNH. It is already clear from scoping work to date and preliminary discussions with SNH and RSPB (August 2008) broadly what the main survey requirements are. These are described in the Survey Strategy and Proposed Field Methods sections below.

Although such data will not be collected as part of this project, data from population monitoring at breeding seabird and seal colonies will be of crucial importance in allowing any actual effects of impacts on such populations to be detected. There are existing programmes that periodically monitor the numbers of seabirds and seals breeding in coastal colonies in the region organised by JNCC and SMRU respectively. These monitoring data will be obtained from these organisations. The frequency of this monitoring varies and the organisations involved will need to be consulted at an early stage to ensure that the data they plan to collect will be adequate to inform the assessment.

E.5.1 Acquisition of existing survey information

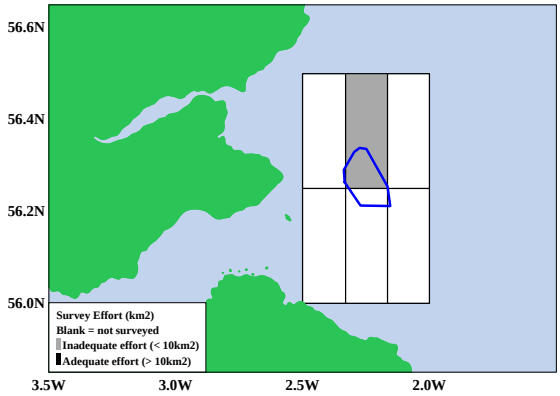
Key datasets are known to be held by the Joint Nature Conservation Council (JNCC), Centre for Ecology and Hydrology (CEH) and the Sea Mammal Research Unit (SMRU). It is understood that these can be made available for a modest charge. Existing data will be particularly valuable for putting survey results into a wider context and assessing the extent to which animals using the area are from SPA /SAC populations.

E.5.2 ESAS database gap analysis

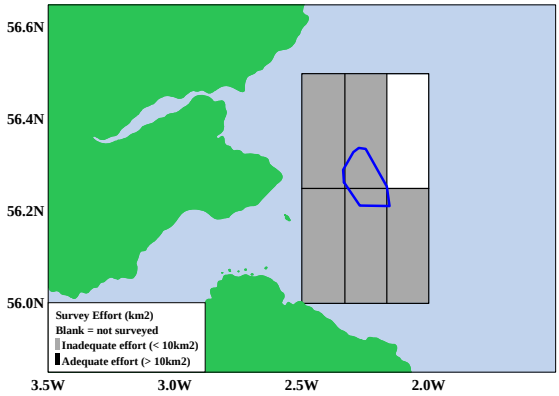
An analysis of gaps in seabird and marine mammal survey coverage in UK waters was conducted recently on the European Seabirds at Sea (ESAS) database (Cork Ecology 2006). Relevant information from this report was used to assess the quality of survey effort in the vicinity of the proposed Neart na Gaoithe development site.

The ESAS Gap Analysis reviewed the extent of ESAS survey coverage in UK waters for data collected between 1984 and 2003. Inshore waters were mapped at a scale of 15' N x 10' W (an area of approximately 288 km2). Three of these rectangles make up a ¼ International Council for the Exploration of the Seas (ICES) rectangle, which is the scale typically used by JNCC for data analysis (e.g. Stone et al 1995). Six of these 15' N x 10' W rectangles surround the proposed Neart na Gaoithe site plus a 5 km buffer. These six rectangles correspond to two ¼ ICES rectangles (Figures E.1a & E.1b). In previous JNCC studies, the level of desired survey coverage within a ¼ ICES rectangle was 20 km2 (e.g. Pollock et al 2000). However, the ESAS Gap Analysis considered 10 km2 of coverage per month would be adequate coverage for inshore waters, where the smaller scale was used (15' N x 10' W rectangles) (Cork Ecology 2006).

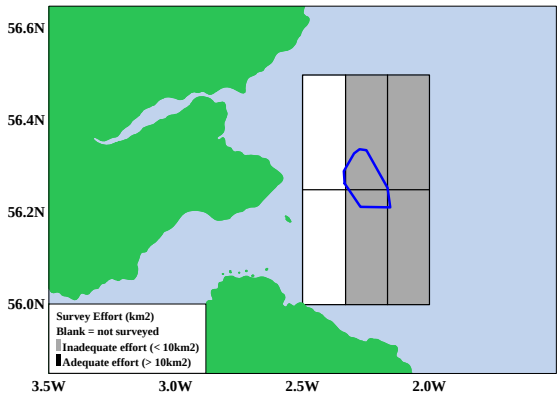
April **May**



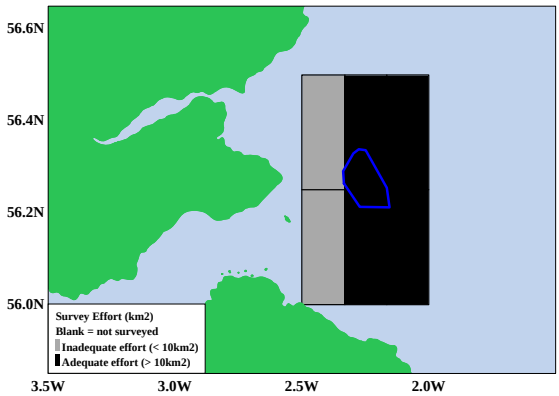
June



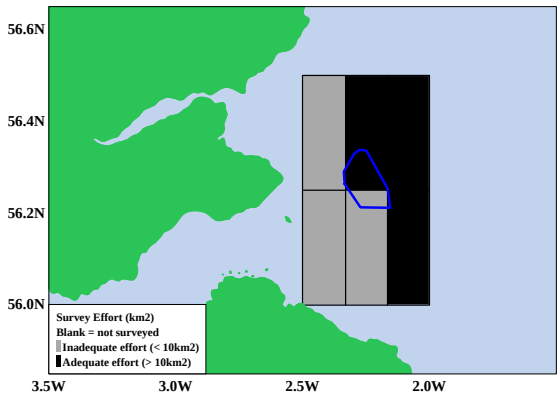
July



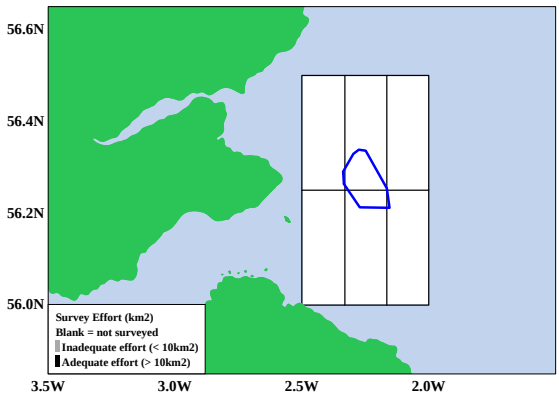
August



September



October



November

Figure E-1a **Summary of monthly ESAS survey coverage around the proposed site in summer (April to September) Summer (April to September)**

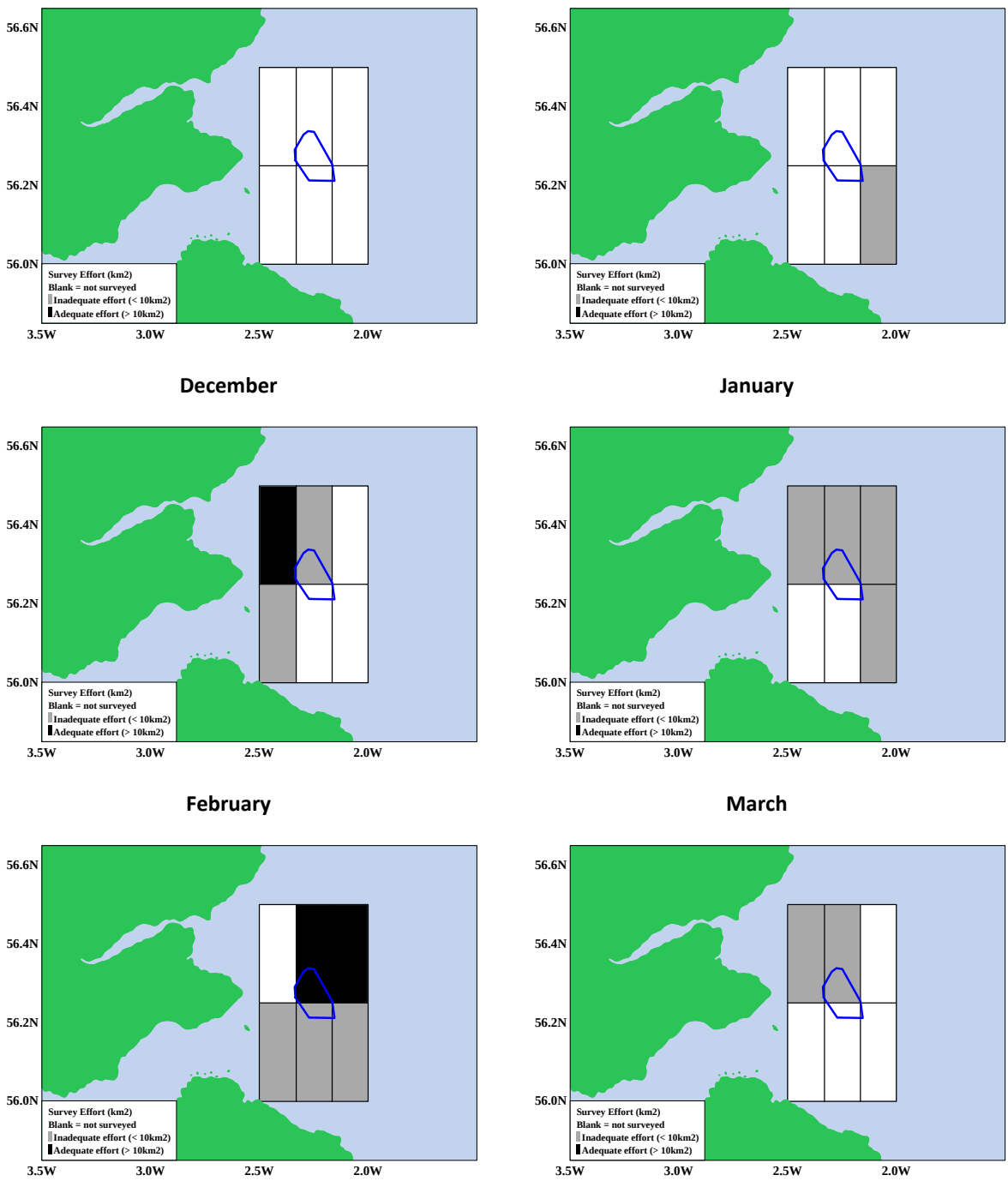


Figure E-1b **Summary of monthly ESAS survey coverage around the proposed site in winter (October to March)**

The ESAS Gap Analysis suggested that four months coverage during both summer (April to September) and winter (October to March) would be adequate. These suggestions are in the context of large-scale surveys in UK waters, and are not applicable to the recommended survey coverage at offshore windfarm sites, where a much greater level of detail is necessary. Maps shown in this report summarise the ESAS Gap Analysis data and are purely to put existing survey effort data in context.

Overall, survey coverage was not adequate for all six rectangles in all months of the year (Figures E.1a and E.1b). In summer, July and August had the best coverage, while April and September had the least coverage. In winter, coverage in October, November and March was very low, with slightly better coverage between December and February.

However, it should be noted that some recent seabird and marine mammal survey work was conducted in the vicinity of the development site in September 2008, as part of the UK Department of Energy and Climate Change's (DECC) offshore energy Strategic Environmental Assessment programme (Cronin 2008). The areas covered in 2008 are mapped in DECC 2009 (Fig A3a.6.6). These data have yet to be added to the ESAS database.

E.6 Survey strategy

The Offshore Energy SEA (DECC 2009) states:

"Although there has recently been significant survey effort in coastal waters, the lack of modern data on waterbirds in offshore areas is noted. Developers need to be aware that access to adequate data on waterbird distribution and abundance is a prerequisite to effective environmental management of activities for example in timing of operations".

It also identifies that the current understanding of certain aspects of the ecology of seabirds and marine mammals is limited and needs to be enhanced. In particular:

- Detail of bird migration patterns, and variability in space and time including flight heights in different weather conditions,
- An understanding of the marine areas routinely used by breeding birds for foraging, in particular those adjacent to SPAs,
- Ecology of most marine mammal species and in particular important areas or breeding, foraging and resting.

Table E.6 provides a summary of the survey methods we will use to meet the information requirements for this project, identifying the target taxon and objectives for each element of the survey work proposed. Further details for each of the survey methodologies are provided below.

Method	Aims	Cetaceans	Seals	Seabirds	Seaduck & divers	Terrestrial migrant birds
ESAS visual transect surveys	Distribution and abundance through the year. Diurnal flight activity of birds	Secondary	Secondary	Primary	Primary	Secondary
Marine mammals visual transect surveys	Distribution and abundance through the year	Primary	Primary	N.A.	N.A.	N.A.
Aerial visual/HD video surveys	Distribution and abundance through the year	Secondary	Secondary	Primary	Primary	N.A.
Hydrophone transect acoustic surveys	Distribution and abundance through the year	Primary, esp. harbour porpoise	N.A.	N.A.	N.A.	N.A.
C-Pod Array acoustic monitoring	Distribution and abundance through the year	Primary, esp. harbour porpoise	N.A.	N.A.	N.A.	N.A.

Radar studies	Quantify the diurnal and nocturnal flight activity by birds.	N.A.	N.A.	Primary	Primary	Primary
Breeding colony monitoring *	Regional population size and trends	N.A.	Primary	Primary	N.A.	N.A.
Photo-identification of bottlenose dolphin	Individual recognition of SAC bottlenose dolphin	Primary, esp. bottlenose dolphin	N.A.	N.A.	N.A.	N.A.
Telemetry tags *	Ranging areas of SPA breeding seabirds	N.A.	N.A.	Primary	N.A.	N.A.

Table E-6 **Summary of survey methods, their aim and the taxonomic groups they apply to. 'Primary' indicates taxon that are the primary objective of a method. 'Secondary' indicates taxon that are not the primary objective but will be recorded. 'N.A.'indicates methods that are not appropriate for the taxon.**

* indicates methods that are not included in the current fieldwork proposal but may be required following discussion with statutory authorities

E.6.1 Distribution and abundance

Year-round information on distribution and abundance of regularly occurring bird and marine mammal species that could be affected will be required. Birds and marine mammals use the sea off the east of Scotland year round, however, there are likely to be larger numbers present in the spring and summer months (this will be quantified from existing data). For this reason, survey work needs to be year round though it may be appropriate to spend more effort at certain times of year than others. Spring and summer (approximately March to August) corresponds to the breeding season of most seabirds, a time when a high proportion of seabirds will be tied to coastal breeding colonies, many of which are designated SPAs. The July to September period is a time when large numbers of moulting auks may use the area.

During seabird surveys, details of flying and feeding activity will be recorded. Such information will inform particular aspects of the assessment process.

E.6.2 Marine mammal acoustic surveys

Cetaceans may be difficult to observe at sea for a number of reasons such as sea conditions, the 'chance' that observers will be watching when the marine mammals surfaces and weather conditions. Another way to survey for marine mammals is to 'listen' for them using Passive Acoustic Monitoring (PAM). PAM consists of a hydrophone – basically an underwater microphone, being towed behind the survey vessel. Software will interpret and record the vocalisations from marine mammals and from this data, presence or absence of certain species can be concluded. Using a hydrophone from a vessel can be challenging due to the amount of boat noise so Mainstream may also need to consider the use of fixed passive acoustic monitoring.

The hydrophone system consists of a 4 element hydrophone array which is capable of recording sounds made by cetaceans including bottlenose dolphins and harbour porpoises. . Sounds are digitised and cetacean sounds detected by automated click and whistle detection software. The system is available in real time so that observers can listen at sea but also recorded for further analysis.

Analysis of the data can be carried out at a series of levels such as simple plots of the number of porpoise clicks and dolphin whistles detected and their locations to provide a spatial representation of animals during the survey. Further analysis of acoustic data can provide information such as range from the trackline of

individual cetacean groups. It may be useful to compare sightings and acoustic contacts for marine mammal and this will be further explored as the survey progresses.

E.6.3 Survey phases

To ensure adequate pre and post-construction control data are available, the development area and 8 km buffer will need to be surveyed throughout the various phases of the project (Figure E.2). This will allow comparison between data collected during the pre-construction, construction and operational phases of the project.

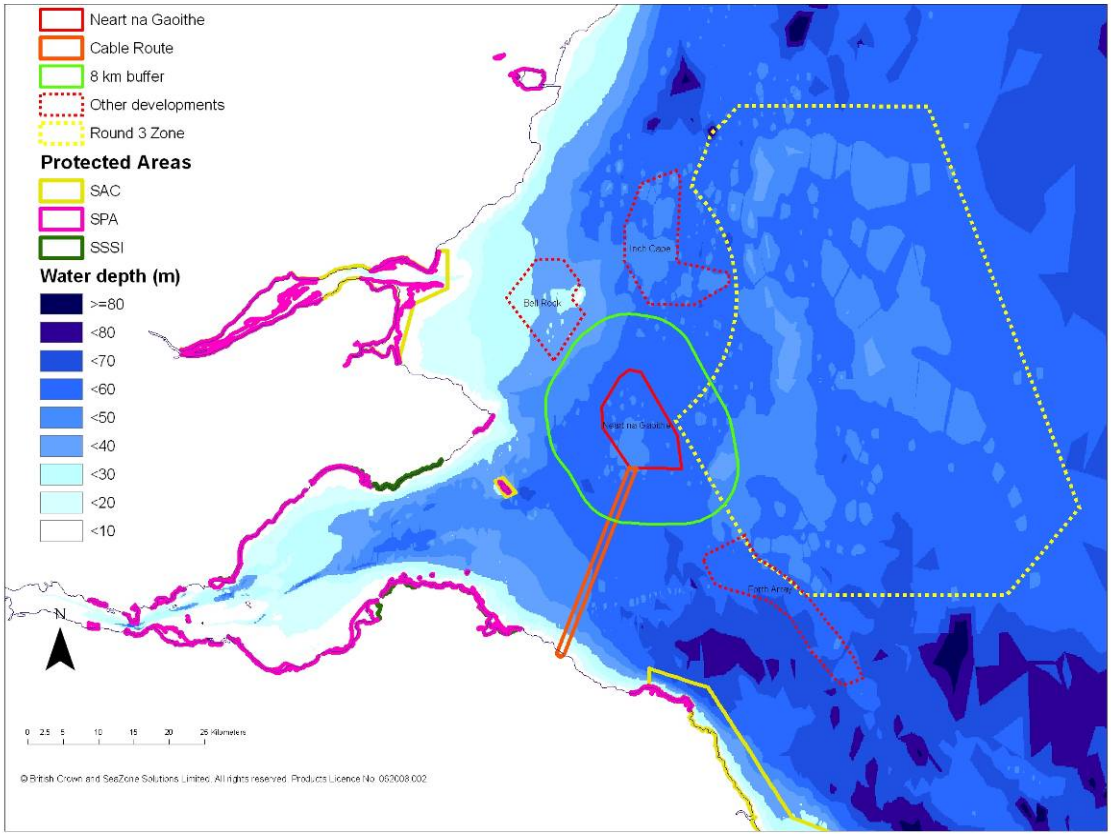


Figure E-2 **Showing location of Neart na Gaoithe offshore wind farm site along with other potential offshore wind development sites, and protected areas The green line represents the edge of the survey area at 8km from wind farm boundary.**

Although for the actual assessment of effects, two years pre-construction data is the absolute bare minimum necessary for comparison with post-construction data, any increase on this greatly increases the power of the surveys to detect potential impacts. Furthermore, the pre-construction baseline data must be collected over the period immediately pre-construction. Therefore, following submission of the assessments after 2 years, site-specific surveys should continue during the consents & procurement phases, up to the start of construction. This will ensure data is available for the period immediately pre-construction, and will increase the number of years for which baseline data is available, resulting in 3 years detailed baseline data.

Site-specific surveys should continue during the construction phase (estimated 1 year). Two years (immediate) post-construction survey is the minimum recommended sampling period for a valid comparison, three or more would be preferable. In order to detect longer term impacts, 2 years of post-construction site-specific surveys should be repeated after periods of 5, 10, and 20 years etc until the end of the project.

E.6.4 Consultation

Relevant organisations (for example, Scottish Natural Heritage (SNH), Joint Nature Conservation Committee (JNCC), Sea Mammal Research Unit (SMRU) and the Centre Ecology and Hydrology (CEH)) will need to be consulted over the proposed programme of survey work and information they hold in their databases. The aim of this would be to open a dialogue through which broad agreement can be reached that the survey programme is adequate, existing data sets identified (and later acquired) and that issues that might cause a problem to the proposed development are discussed at the earliest opportunity. These organisations are also expected to play a wider role in deciding how the overall programme of survey work related to offshore windfarms in the region should be coordinated and information shared (if at all), and how cumulative impacts should be assessed. This should include the regular monitoring of regional SPA seabird breeding populations.

Relevant non-statutory organisations, in particular RSPB, should also be consulted. It will also be relevant to consult with university academics with specialist knowledge of sea bird and marine mammal ecology.

E.7 Proposed Field Methods

A series of monthly boat-based transect surveys of birds and marine mammals will be conducted over a two-year period, over the development area, plus an 8 km buffer area around the site (Figure E.2). Given the great variability in seabird and marine mammal numbers and distribution at sea, two years survey work is the absolute minimum required to provide the information needed for an adequate assessment. Boat-based transect surveys are the standard approach for offshore wind farm survey work and standard, internationally recognised survey techniques (Camphuysen et al. 2004) will be followed throughout.

Details of the standard methods for the transect surveys are described below together with brief details of other methods that may be used to collect additional data. All aspects of the methods and fieldwork programme will be regularly reviewed in light of the new data collected and other information, so that the work can focus on issues of greatest relevance and take advantage of method improvements and respond to new information or regulations.

E.7.1 Survey vessel

Vessels and operators will need to be inspected for suitability, and must conform to COWRIE recommendations (Camphuysen et al 2004).

Due to the high costs of survey vessels, it would be most cost effective to conduct both seabird and marine mammal surveys from the same vessel concurrently. These methods are explained in greater detail later. In order to achieve this, the survey vessel would need to have space on the survey platform to accommodate four persons.

Survey work will be restricted to suitable weather conditions (sea state 4 or less for ESAS surveys, per Camphuysen et al 2004). The survey vessel will be available for extended periods each month to take advantage of suitable weather conditions when they occur.

E.7.2 Survey design

All areas within 8 km of the proposed development area (Figure E.2) will be surveyed, using parallel transects spaced 2 km apart. This is consistent with Camphuysen et al (2004)'s recommendation that transects should be 0.5 - 2 nautical miles (0.9 - 3.7 km) apart, and also with the transect spacing used in previous studies (e.g. Petersen et al. 2006). Transects will run parallel to the survey area's south-western boundary, in a north-west to south-easterly direction, yielding transects running roughly perpendicular to the major environmental gradients associated with water depth and distance from the coast (as recommended in Camphuysen et al. 2004). Transects would also be roughly perpendicular to the major expected flight path of seabirds moving between the closest breeding colonies and feeding grounds to the east, increasing their likelihood of detection. Weather conditions permitting, the survey programme will aim to complete full coverage of the study area each month in the minimum time possible, to provide a monthly picture of the distribution of birds and marine mammals present over the two-year period.

The same survey routes will be used on all trips to minimise the variance in the number of birds recorded, increasing the potential power of subsequent analyses to detect genuine changes in numbers. This will also eliminate the possibility of bias inadvertently creeping into results if survey routes change slightly without this change being noticed. Any such changes would constrain the statistical analyses which are possible and complicate the actual process of analysis. Survey routes will be adhered to by continually monitoring the position of the vessel (as revealed by GPS) during surveys and adjusting course accordingly. Careful route planning will minimise distance travelled & survey duration.

The use of 2 km spacing between transects for the site surveys is a reasonable, conservative, choice, on the basis of what has been recorded during other studies, elsewhere. However, ideally the spacing between transects would be determined by the observed scale of seabird aggregations for target species in the area. All available historical data for the vicinity of Neart na Gaoithe will be examined together with the initial data collected using variography (Cressie 1993) to determine the scale of seabird aggregations, and thus the optimum spacing between transects. This will allow the spacing between transects to be modified, to ensure survey work is sufficiently detailed to ensure important aggregations of key species are not missed, whilst not expending unnecessary survey effort

As seabird and marine mammal numbers at sea are highly variable, the initial assessment of likely impacts required for the EIA will be based on a minimum of two years data.

It is estimated that it will take two days to survey the development site and the 8 km buffer in summer months, and three days in winter, when days are shorter.

E.7.3 European Seabirds At Sea (ESAS) method

The survey method to quantify the distribution and abundance of bird and marine mammals will follow ESAS survey methods (Webb & Durink 1992), and will comply with COWRIE recommendations (Camphuysen et al 2004), with modifications for recording height of flying birds. In addition, all terrestrial bird species seen will be recorded. The ESAS survey method includes recording of marine mammals and these data can be used to augment that from dedicated marine mammal surveys. Any turtles, sharks and sunfish seen will also be recorded.

E.7.4 ESAS surveyors

Ideally, all surveyors will be experienced in surveying both birds and marine mammals, and will be ESAS accredited. Three ESAS surveyors will be on board, with two surveyors on watch at any one time, and the third on a break. Surveyors will be rotated regularly. Regular breaks will reduce fatigue and improve surveyor performance.

All surveyors will be ESAS accredited. It is anticipated that there will be a requirement to train additional suitably experienced observers. Colin Barton and Claire Pollock of Cork Ecology are accredited ESAS trainers.

E.7.5 Marine Mammal visual survey method

Monthly ESAS surveys within the development area and 8 km buffer zone will record all marine mammals encountered, at the same time as recording seabirds. In addition, angle and distance of the animals from the transect line will also be recorded using angleboard and rangefinder. Only marine mammal data in suitable sea state (i.e. sea state 3 or less) will be used for analysis.

Where weather forecasts indicate that weather conditions will be good (i.e. sea state 3 or less), a fourth surveyor will join the survey team to conduct dedicated marine mammal observations. Surveyors will rotate duties throughout the survey day, with three surveyors on watch, and one on a break.

In other months, if areas of high densities of marine mammals or birds are encountered in sea state less than three with only three surveyors on board, the third surveyor would be used to record marine mammals. In this situation, surveyors would continue to rotate duties, to keep concentration up. Survey effort would be stopped at intervals during the survey day, so that all surveyors could have a break.

Additional dedicated marine mammal surveys will also be conducted as weather conditions/vessel time allows, i.e. if bird surveys have been completed, but a spell of good weather is available, then additional dedicated marine mammal surveys would be conducted.

If survey data from initial surveys indicates that the study area is a high density area for marine mammals, then marine mammal survey effort would be increased accordingly.

Data from the surveys will be used to estimate relative species abundance. If there are sufficient sightings of a marine mammal species, distance analysis will be used to calculate total numbers of that species in the study area – harbour porpoise is the most likely species that this would be possible for.

E.7.6 Marine mammal acoustic surveys

Cetaceans are easily overlooked during conventional visual survey work, especially when sea conditions are other than calm. Therefore, the visual marine mammal survey data will be augmented by acoustic data from a hydrophone towed from the survey vessel. The hydrophone will be linked to a computer to record cetacean vocalisations, in particular those made by harbour porpoises and other dolphin species. Depending on the vessel, it is possible to operate a hydrophone successfully up to sea state 6 (Scheidat et al 2007). Given suitable weather conditions, the hydrophone will be deployed and the computer recording system software set running at the start of each survey day, by one of the surveyors. Training will be provided for this, as required. The hydrophone will record throughout a survey day and then be retrieved. Such a system was successfully operated on recent surveys over the Dogger Bank for DECC, and on other surveys (Cork Ecology 2008b, Scheidat et al 2007).

Additional hydrophone surveys will also be conducted at night (if feasible), to investigate any differences in harbour porpoise activity in the study area compared to day time.

E.7.7 Aerial surveys

Aerial surveys may also be used to survey seabirds and marine mammals. For example they have proved particularly effective for surveys of seaduck and divers in inshore waters. There was an aerial survey component for marine mammals in SCANS II (Desportes 2005), and IMARES are currently considering the feasibility of conducting aerial marine mammal survey work over the Dogger Bank (M Schiedat pers comm.)

For the Scottish Territorial Waters wind farms, The Crown Estate has undertaken a series of aerial surveys throughout 2009 and into 2010 in order to inform the existing aerial data sets. This survey programme was primarily focussed on Round 3 wind farms and undertaken by WWT on behalf of The Crown Estate.

Mainstream have not yet been given access to the aerial survey data collected but once received this data will be reviewed and taken into account during any gap analysis process. Mainstream will, along with the other developers, consider whether additional aerial surveys are required following completion of one year of aerial surveys and boat-based surveys.

Mainstream should also consider the use of hi-def surveys as this technology develops.

E.7.8 Additional studies

Prior to undertaking any additional studies it is recommended that at least one year's bird data is collected to ensure studies are focussed in the correct areas.

E.7.8.1 Radar and thermal imaging studies

Radar and thermal imaging technology could be used to survey nocturnal flight activity by birds, and post-construction, to quantify turbine avoidance.

E.7.8.2 SPA species

In addition to distribution and abundance data, more detailed information will be required for qualifying species of nearby SPAs, other species of high conservation importance, and those that appear to be at particular risk from the development (Tables 4 and 5). Such additional information may include knowledge of

where birds are nesting and data on flying and feeding activity that is required to inform particular aspects of the assessment process. There is likely to be a strong case, although perhaps not initially, for deploying 'high-tech' methods to address specific information gaps. For example, telemetry tags mounted on individual birds to better understand the whereabouts of feeding areas used by qualifying species of nearby SPAs.

Conducting telemetry studies on breeding seabirds is not initially recommended. This is a matter to decide after initial data collection and analysis of existing data sets have identified specific issues and knowledge gaps. Given that several seabirds with large breeding concentrations in the area range large distances (>50km) from breeding colonies to feed, this approach is another area that might benefit from renewable energy companies working in collaboration. There have been large technological advances in tag technology in recent years and a decrease in costs. Potentially it is now possible to attach tags to a sample of birds and obtain large quantities of ranging data for moderate costs. An example of the sort of information telemetry can obtain are the results of the satellite-tagging studies of gannets breeding on the Bass Rock (Hamer et al 2007).

E.7.8.3 Photo-identification of bottlenose dolphins

If bottlenose dolphin are encountered regularly, it would be valuable to obtain photographs of their dorsal fins. These could then be compared to the photo-database of individuals that has been built up for the Aberdeen Harbour and Moray Firth SAC populations.

E.8 Data management

It will be necessary to set up a master database for all transect survey data. Survey data will be entered into a relational database using the JNCC data entry system, checked and then incorporated into the master database. Ultimately, it is intended that the data will be passed on to JNCC for inclusion in the ESAS database, in line with the recommendation of Fox et al (2006).

Data from additional surveys will be entered into custom designed databases or spreadsheets as appropriate.

E.9 Analysis

For assessment purposes, all aspects of the data analyses will be underpinned by appropriate statistical analyses. These are required to ensure that any conclusions drawn are scientifically valid and that survey data are used to their maximum value.

All aspects of the methods and fieldwork programme will be regularly reviewed in light of the new data collected and other information, so that the work can focus on issues of greatest relevance and take advantage of method improvements and respond to new information or regulations.

E.9.1 Outputs

E.9.1.1 Outputs for pre-construction EIA

Analysis of the data collected will provide the following information required for the EIA:

1. Estimates of the numbers of seabirds and marine mammals using the development area and its surrounding waters throughout the year. This will allow the site, and its surrounding waters, to be assessed for each species with respect to its conservation importance in the context of regional, national and international populations. This will allow key species to be identified.
2. Maps showing the seasonal distributions of seabirds and marine mammals within the site and the surrounding 8 km buffer. This will allow the development site to be compared within the context of the surrounding area. Furthermore, should significant adverse impacts be identified then such data would potentially allow the development of potential mitigation measures based upon the siting of individual turbines or scheduling of operations.
3. Estimates of collision risk for flying birds

4. Estimates of the potential effects due to habitat loss and displacement under various scenarios with respect to the distance such effects extend from the development, and the availability of alternative suitable habitats.
5. An assessment of the potential cumulative assessment of the development along with others proposed in the region.

E.9.1.2 Outputs for Impact Monitoring

With respect to the monitoring of effects on birds and marine mammals that may be linked to the construction and operational phases of the development this two-year project will provide the following outputs:

1. Two years data on the baseline conditions against which subsequent data monitoring any effects of the development can be compared
2. The sophisticated statistical tools (programs) required to analyse such data.
3. Power analyses (DECC 2009, Maclean et al. 2007b) determining the ability of our survey and statistical methodologies to detect any effects which do occur. Such analyses will :
    a. Allow an appraisal of what can realistically be achieved, facilitating debate with statutory agencies;
    b. Potentially allow survey methods to be modified (e.g. concentrating survey effort at certain times of year rather than others) so as to ensure significant effects on key species do not go undetected;
    c. Allow impact assessments to consider the potential effects of impacts too small to be detected reliably.

E.9.2 Further details of analyses to provide outputs for EIA

E.9.2.1 Abundance

For each species, monthly population estimates, with accompanying confidence limits, will be estimated for the development area and its surrounding waters using distance sampling (Buckland et al. 2001, 2007), a statistically robust methodology for the analysis of line transect data which explicitly takes into account the effects of distance from the observer on detectability. This method can also be extended so as to take into account other factors influencing detectability, such as weather conditions, and variation between observers, providing a very flexible and robust framework in which to calculate accurate population estimates, along with confidence limits.

E.9.2.2 Predictive modelling and Distribution maps

Surveys will yield a large data set over several years, at a suitable spatial scale for constructing predictive models relating seabird numbers to physical and biological parameters such as water depth, temperature, salinity, phytoplankton productivity, seabed substrate, distance from the coast and distance from breeding colonies. A recent COWRIE review advocated applying such modelling to temporal variation, to help explain year to year changes in numbers, thus increasing the power of (aerial) surveys to detect the potential displacement of birds by offshore wind farms (Maclean et al 2007b).

Such modelling applied to spatial variation, in combination with other spatial statistical techniques such as kriging will potentially allow more accurate maps of seabird distribution across the site, and total population estimates for the site to be derived. This modelling will also help identify patterns in seabird distribution within the site with respect to (simple) explanatory variables, which could potentially generate hypotheses suitable for testing by more detailed studies.

For key species distribution maps will be created using a combination of generalised linear or additive mixed models and kriging within a distance sampling framework (distance sampling: Buckland et al. 2001, 2007; kriging :Pebesma, et al. 2005, Pebesma et al. 2000, Zuur et al. (in prep.); generalised linear and additive mixed

modelling: Zuur et al. 2009). This should provide maps of the distribution of seabirds across the study area throughout the year, which are as accurate and statistically robust as possible, given the data available.

The accuracy of such maps is critically dependent on the reliability of the inevitable interpolation between survey transects. Survey transects can only accurately capture the distribution of a species across an area if the spacing between them is small compared to the typical spatial scale of aggregations of that species. Therefore, using both historical data and data collected in this study we will use variography (Cressie 1993) to determine the scale of seabird aggregations in the area, and thus the spatial scale at which we can assume our maps are accurate. Such analyses would also potentially allow transect spacing to be adjusted if necessary in parts of the study area to accurately capture the distribution of key species.

E.9.2.3 Collision Risk Modelling

The potential mortality of birds due to collision with the turbines will be quantified using Collision Risk Modelling (Band et al. 2007). During survey work, the altitude of birds in flight will be recorded, to allow the number of bird transits through rotor swept space per year to be estimated, as required under Band et al's model. Collision Risk Modelling will aim to quantify measures of likely bird mortality from the survey data based on various assumptions on avoidance rates and displacement. It will examine how collision risk varies between species and seasons and spatially across the site.

E.9.2.4 Cumulative Impact Assessment

COWRIE has recently published guidelines on the processes, methods and techniques to be utilised for cumulative impact assessment for birds and offshore wind farms (King et al. 2009). A key recommendation of these guidelines was that quantitative data should be provided on raw numbers, densities and population estimates for all species and that, wherever possible, impacts should be assessed in a quantitative rather than a qualitative way. Data gathering and analysis should follow standardised methods.

The approaches to data gathering and analysis proposed in this document will allow full compliance with the recommendations of these guidelines, providing similar data is available from other developments in the area. This will allow the cumulative impacts particularly as mediated via collision risk, displacement and barrier effects to be assessed.

In line with these guidelines, and the recommendations of the recently published SEA (DECC 2009), population modelling, in particular Population Viability Analysis (DECC 2009, Maclean et al. 2007a), will be used to assess whether cumulative impacts, particularly from collision risk, are likely to adversely affect regional populations.

E.9.3 Study design and analyses to allow subsequent monitoring of impacts

E.9.3.1 Before-After-Gradient Study Design

A serious constraint on the design of any scheme to monitor the effects of an offshore wind farm, is the high mobility of seabirds and marine mammals, which makes identifying truly independent but comparable control areas practically impossible. For example, breeding gannets from the Bass Rock colony have been shown by satellite-tagging to range across the North Sea, at times travelling as far as the Norwegian coast (Hamer et al 2007). Breeding kittiwakes and auks commonly forage up to 70 km from their colonies (Daunt et al. 2002, Camphuysen 2005). If such seabirds were displaced from the development area, they could potentially shift their feeding grounds by tens of kilometres, for example. Thus, to be truly independent, control areas have to be considerable distances from the development sites, but this would result in other problems e.g. concerning the wider comparability of the environment and dynamics of animal populations that live there.

Therefore, rather than pursue the unobtainable ideal of absolutely independent, but comparable, control areas the design we propose takes the much more practical and statistically no less powerful approach of examining displacement and habitat loss effects along a distance gradient from the development site. We have chosen to collect survey information in all areas up to a distance of 8 km from the proposed development site. This is consistent with the surveys and analyses conducted for the Horns Rev and Nysted wind farms in

Denmark (Petersen et al. 2006). To avoid underestimation of effects operating at scales greater than 8 km, additional modelling may also be necessary for some species.

The Before-After/Control-Impact (BACI) design first described by Green (1979) is routinely used for determining the effects of wind farms on birds (SNH 2009b, Drewitt and Langston 2006, Fox et al 2006). This study is premised on a Before-After-Gradient study design, which is a variant of the BACI design, which assumes that impacts decline with increasing distance from the source of the impact (Ellis and Schneider 1997, Morrison et al. 2008, Manly 2009, Smith 2002). There are several reasons for choosing this type of design:

- It is likely that any effects of the wind farm will decline with increasing distance from the turbines.
- A gradient design can be more powerful than a control impact design in detecting impacts when impacts do decline with distance from their source (Ellis and Schneider 1997).
- A statistically significant trend in bird/marine mammal numbers with distance from the wind farm appearing after turbine installation would provide stronger evidence that the wind farm is responsible than a simple comparison of "impacted" and "non-impacted" areas before and after turbine installation, reducing the chances of mistaking other effects as an impact of the development (Manly 2009).
- It avoids the intractable problem of finding discrete control sites, which are at a sufficient distance to be independent of the impacts at the development site, but are comparable in other aspects (Ellis and Schneider 1997).
- The results of the gradient model are easy to interpret and present to statutory and non statutory consultees (Ellis and Schneider 1997).

Whilst developing this design we considered a BACI type design, with control areas of a similar size to the development area. All the candidate control areas we identified on the basis that they were comparable to the development area in terms of distance from the shore, water depths and distance from large seabird colonies all fell within 8 km of the development area, i.e. inside the boundary of the area we propose surveying for this study.

The analyses of the ornithological impacts of the Horns Rev, Nysted and Arklow Bank offshore wind farms (e.g. Petersen et al. 2006, Barton, Pollock and Harding 2008) have all employed a BAG type design. This approach has also been advocated as good practice by Fox et al. 2006 for assessing the impact of offshore wind farms on birds.

E.9.3.2 Proposed statistical methodology for impact assessment

We propose carrying out such analyses by including covariates within detection function modelling (Buckland et al. 2004), using mixed models to control for spatial and temporal autocorrelation, which might otherwise falsely inflate estimates of statistical significance. Using such state of the art statistical techniques will provide the greatest probability of identifying a genuine impact if it does occur, whilst minimising the chances of spuriously concluding there is an impact where none exists.

E.9.3.3 Power Analyses

The statistical methods described above will be developed within the context of power analyses which will evaluate the power of our survey and statistical methodologies to detect impacts on key species (DECC 2009, Maclean et al. 2007b). For example, such analyses might allow us to say that our methodologies have an 80% chance of detecting a 50% decline in a key species at 10% statistical significance. This will allow us to robustly defend our methodologies and modify them if necessary to ensure significant impacts on key species do not go undetected (e.g. Innogy 2003).

This will be achieved by applying the statistical tools described above to data sets which include the real data collected to date, plus simulated data modelling the data expected to be collected subsequently. The simulated data will have similar characteristics to the real data (in particular its variability), but, for data simulating the post turbine installation period, will have known changes in abundance and distribution associated with the developments built in. Subsequently, as more data is collected, simulated data will be replaced with real data.

E.10 Reporting & Assessment

Quarterly reports will be produced summarising progress on the survey programme. This would include basic results from the monthly surveys.

Shortly after the end of each 12-month period of survey work, an Annual Technical Report will be produced. This will assess how well the objectives have been met, whether any changes to the survey programme are required and provide an opportunity to 'benchmark' the survey programme against changes in guidance / best practice and/or results of new research that may have occurred.

The Annual Technical Report will also include details of survey results. For the monthly surveys this would include summary accounts and maps of species' distribution and abundance for each season or month as appropriate. Other results will also be presented, for example on the height and direction of flying birds and acoustic monitoring of cetaceans. Attention will also be drawn to what are considered to be key findings and potential issues.

It is envisaged that assessment of the likely effects of the development will be undertaken at the end of the second year of survey, based on the information contained in the two Technical Reports. This would include modelling work to predict the numbers of flying birds that might be killed by turbine strikes.

The proposed development is in a location where it may influence the qualifying interest of one or more SPAs/SACs. Therefore the proposals may require an assessment under the Habitats Regulations 1994 (refer to SERAD 2000). In such cases it is good practice for a developer to provide sufficient environmental information to enable the competent authority to undertake such an assessment, and to enable the nature conservation body (SNH) to advise the competent authority. The information provided may be congruent with that provided for assessment under the EIA Regulations or it may be somewhat different in scope and content. In the current case it is likely that separate assessments will be required. These will be written in the form of a chapter or chapters within the Environmental Statement that accompanies the planning application.

References

AMEC. 2002. Lynn Offshore Wind Farm Non-Technical Summary.

Band, W, Madders, M, & Whitfield, DP. 2007. Developing field and analytical methods to assess avian collision risk at wind farms. In: de Lucas, M, Janss, GFE & Ferrer, M (eds.) Birds and Wind Farms: Risk Assessment and Mitigation, pp. 259-275. Quercus, Madrid.

Barton, C. and Pollock, C. 2004. Review of divers, grebes and seaduck distribution and abundance in the SEA 5 area. Report to the DTI as part of SEA 5 from Cork Ecology.

Barton, C., Pollock, C., & Harding, N. 2008. Analyses of seabird and marine mammal monitoring for the Arklow Bank Offshore Wind Farm. Poster at International Scientific Meeting on Marine Renewable Energy and the Environment (MAREE).

Buckland, S. T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers and L. Thomas 2001. Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford University Press.

Buckland, S. T., Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2007. Advanced distance sampling. Oxford University Press.

Camphuysen, C.J. (ed.), 2005. Understanding marine food web processes: an ecosystem approach to sustainable sand eel fisheries in the North Sea. IMPRESS Final Report. Royal Netherlands Institute for Sea Research, Texel.

Camphuysen, C.J., Fox, T., Leopold, M.F. & Petersen, I.K. 2004. Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the UK. A report for COWRIE.

Christensen, T.J. and Hounisen, J. P. 2005. Investigations of migratory birds during operation of Horns Rev offshore wind farm 2004: Annual Status Report 2004. National Environment Research Institute, Denmark.

Cork Ecology. 2006. An analysis of ESAS seabird surveys in UK waters to highlight gaps in coverage. A report to the DTI.

Cork Ecology. 2008a. Synopsis of birds and marine mammals in areas under consideration for offshore wind farms in Scottish waters. A report for Mainstream Renewable Power Ltd.

Cork Ecology. 2008b. Seabird and marine mammal surveys in the North Sea in February and March 2008. A report to DECC.

Cressie, N. 1993. Statistics for Spatial Data. Wiley, NY, 1993 (900pp.)

Cronin, C. Seabird and Marine Mammal Survey on M.V. Englishman 17th to 30th September 2008. A report for DECC. Available online at: www.offshore-sea.org.uk/site/scripts/consultation_download_info.php?downloadID=235

Daunt, F., Benvenuti, S., Harris, M.P., Dall'Antonia, L., Elston, D.A. & Wanless, S. 2002. Foraging strategies of the black-legged kittiwake Rissa trydactyla at a North sea colony: evidence for a maximum foraging range. Marine Ecology Progress Series 245: 239-247.

Dean, B.J., Webb, A., McSorley, C.A., Schofield, R.A. and 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. JNCC, Peterborough.

Department of Energy and Climate Change 2009. UK Offshore Energy Strategic Environmental Assessment. Future Leasing for Offshore Wind Farms and Licensing for Offshore Oil & Gas and Gas Storage. Environmental Report.

Department of Trade and Industry. 2003. Offshore Wind Energy Generation: Phase 1 Proposals and Environmental Report (Wind Round 2 SEA). Report to DTI prepared by BMT Cordah.

Department of Trade and Industry. 2004. Conservation Sites in the SEA 5 Area: Report to the Department of Trade and Industry. Prepared by: Aberdeen Institute of Coastal Science and Management University of Aberdeen with Hartley Anderson Limited.

Desholm, M., Fox, T. and Beasley, P., 2005. Best practice guidance for the use of remote techniques for observing bird behaviour in relation to offshore windfarms. A report commissioned by COWRIE. COWRIE Ltd.

Desholm, M. & Kahlert, J. 2005. Avian collision risk at an offshore windfarm. Biology Letters 13: 1-4

Desholm, M., Fox, A.D., Beasley, P. & Kahlert, J. 2006. Remote techniques for counting and estimating the number of bird-wind turbine collisions at sea: a review. In Wind, Fire and Water: Renewable Energy and Birds. Ibis 148 (Suppl. 1): 76–89.

Desportes, G. 2005. SCANS II – Northern North Sea Cruise Report. Online at: www.fiskeridir.no/fiskeridir/content/download/7792/63634/version/1/file/050620b(3).pdf

Drewitt, A. & Langston, R.H.W. 2006. Assessing the impacts of wind farms on birds. Ibis, 148, 29–42.

Ellis, J. I. & Schneider D.C. 1997. Evaluation of a gradient sampling design for environmental impact assessment. Environmental Monitoring and Assessment 48:157-172.

Fox, A.D., Desholm, M., Kahlert, J., Christensen, T.K. & Krag Petersen, I.B. 2006. Information needs to support environmental impact assessments of the effects of European marine offshore wind farms on birds. Ibis (2006), 148, 129–144.

Garthe, S. and Hüppop, O. 2004. Scaling possible adverse effects of marine windfarms on seabirds: developing and applying a vulnerability index. J. Ap. Ecol. 41: 724-734.

Global Renewable Energy Partners. 2002. Kentish Flats Offshore Wind Farm Non-Technical Summary.

Gordon, J., Thompson, D., Gillespie, D., Lonergan, M., Calderan, S., Jaffey, B., Todd, V. and Hastie, G. 2008. Acute risks to marine mammals from pile driving: an assessment of mitigation procedures, knowledge gaps and research requirements. Maree 2008, book of abstracts.

Guillemette, M. and Larsen, J.K., 2002. Post-development experiments to detect anthropogenic disturbances: the case of sea ducks and wind parks. Ecological Applications, 12(3), 2002, pp. 868–877

Green, R.H. 1979. Sampling Design and Statistical Methods for Environmental Biologists. Wiley, New York, NY.

Hamer, K. C., Humphreys, E. M., Garthe, S., Hennicke, J., Peters, G., Grémillet, D., Phillips, R. A., Harris, M. P. and Wanless, S., 2007. Annual variation in diets, feeding locations and foraging behaviour of gannets in the North Sea: flexibility, consistency and constraint. Marine Ecology Progress Series 338: 295–305.

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich S., Hirby, A.R., Leopold, M.F. & Øien, N. 2002b. Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology 39: 361-376.

Hammond, P.S., Northridge, S.P., Thompson, D., Gordon, J.C.D., Hall, A.J., Sharples, R.J., Grellier, K. & Matthiopoulos, J. 2004. Background information on marine mammals relevant to Strategic Environmental Assessment 5. Report to DTI prepared by Sea Mammal Research Unit, St Andrews.

Hammond, P.S. & Grellier, K. 2006. Grey seal diet composition and prey consumption in the North Sea. Report to Department for Environment, Food and Rural Affairs, project ref. MF0319. Sea Mammal Research Unit, University of St. Andrews, UK, 18pp. plus appendices.

Hammond, P.S., Northridge, S.P., Thompson, D., Gordon, J.C.D., Hall, A.J., Murphy, S.N. & Embling, C.B. 2008. Background information on marine mammals for Strategic Environmental Assessment 8. Report to the Department for Business, Enterprise and Regulatory Reform. Sea Mammal Research Unit, St. Andrews, Scotland, UK, 52pp.

Hüppop, O., Dierschke, J., Exo, K-M., Fredrich, E. & Hill, R. 2006a. Bird migration studies and potential collision risk with offshore wind turbines. In Wind, Fire and Water: Renewable Energy and Birds. Ibis 148: (Suppl. 1): 90-109.

Hüppop, O. 2007. How to see the invisible: Remote Techniques for Study of Offshore Bird Migration. In: PNWWRPM VI. 2007. Proceedings of the NWCC Wildlife Workgroup Research Planning Meeting VI. San Antonio, TX November 14-15, 2006. Prepared for the Wildlife Workgroup of the National Wind Coordinating Collaborative by RESOLVE, Inc., Washington, DC, Susan Savitt Schwartz, ed. 138 pp.

Innogy 2003. North Hoyle Offshore Wind Farm Baseline Monitoring Report June 2003.

King, S., Maclean, I.M.D., Norman, T., and Prior, A. .2009. Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers. COWRIE.

Larsen, J.K. & Guillemette, M. 2007. Effects of wind turbines on flight behaviour of wintering common eiders: implications for habitat use and collision risk. Journal of Applied Ecology 44: 465-702.

Lonergan, M., Duck, C.D., Thompson, D., Mackey, B.L., Cunningham, L. & Boyd, I.L. 2007. Using sparse survey data to investigate the declining abundance of British harbour seals. Journal of Zoology 271:261-269.

Maclean IMD, Frederiksen M & Rehfisch MM (2007a). Potential use of population viability analysis to assess the impact of offshore windfarms on bird populations. British Trust for Ornithology Research Report No. 480 to COWRIE. BTO, Thetford.

Maclean IMD, Skov H & Rehfisch MM (2007b). Further use of aerial surveys to detect bird displacement by windfarms. BTO Research Report No. 482 to COWRIE. BTO, Thetford.

Maclead, K., Schiedat, M. & Hammond, P. 2006. Taking stock of European Cetaceans: the SCANS II Surveys. Proceedings of the 20th Annual Conference of the European Cetacean Society.

Manly, B.F. J. 2009. Statistics for Environmental Science and Management, Second Edition. Chapman & Hall/CRC.

Mellor, M. & Maher , M., 2008. Full Scale Trial of High Definition Video Survey for Offshore Windfarm Sites. A report commissioned by COWRIE Ltd.

Mitchell, P.I., S.F. Newton, N. Ratcliffe & T.E. Dunn 2004. Seabird populations in Britain and Ireland. T. & A.D. Poyser, London.

Morrison, M.L., Block, W.M., Strickland, M.D., Collier, B.A. & Peterson, M.J. 2008. Wildlife Study Design 2nd Edition. Springer. 386p.

Norman, T.B., Buisson, R.S.K., & Askew, N.P. 2007. Report on the COWRIE workshop on the cumulative impact of offshore windfarms on birds. Report prepared by RPS for COWRIE. COWRIE CIBIRD-01- 2007.

NRP, 2008. Report on the ornithological sensitivity to windfarm development of the south-east Scotland offshore area. Unpublished report commissioned by Mainstream Renewable Power Ltd. Natural Research Projects Report Ltd.

Pebesma, E.J., Duin, R.N.M., Bio, A.M.F. 2000. Spatial Interpolation of Sea Bird Densities on the Dutch Part of the North Sea. ICG report 00/10, Utrecht University.

Pebesma, E.J., Duin, R.N.M., Burrough, P.A. 2005. Mapping sea bird densities over the North Sea: spatially aggregated estimates and temporal changes. Environmetrics 16: 573–587.

Percival, S.M. 2003. Birds and Wind Farms in Ireland: A review of potential issues and impact assessment.

Petersen, I.K., Christensen, T.K., Kahlert, J., Desholm, M. and Fox, A.D. 2006. Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark. Commissioned by DONG Energy and Vattenfall A/S. National Environmental Research Institute. 166 pp.

Pettersson, J. and Stalin, T. 2003. Influence of offshore windmills on migration birds in southeast coast of Sweden. Report to GE Wind Energy.

Pollock, C.M., Mavor R., Weir, C.R., Reid, A., White, R.W., Tasker, M.L., Webb, A. & Reid, J.B. 2000. The distribution of seabirds and marine mammals in the Atlantic Frontier, north and west of Scotland. Joint Nature Conservation Committee.

Reid, J., Evans, P.G.H. and Northridge, S.P., 2003. Cetacean Distribution Atlas. Joint Nature Conservation Committee, Peterborough.

SCANS-II 2008. Small Cetaceans in the European Atlantic and North Sea. Final Report to the European Commission under project LIFE04NAT/GB/000245. Available from Sea Mammal Research Unit, University of St. Andrews, 54pp. plus appendices.

Scheidat, M., Verdaat, H., Leopold, M., Caillat, M., Gillespie, D. & Swift, R. 2007. Pilot study to investigate the use of a towed hydrophone array for monitoring of porpoises in Dutch waters. IMARES.

Scottish Executive. 2007. Scottish Marine Renewables SEA 2007 Environmental Report Section C SEA Assessment: Chapter C8: Marine Birds.

SNH (Scottish Natural Heritage). 2009a. Online guidance and information specific to bird interests. Available at: http://www.snh.org.uk/strategy/renewable/sr-we00a2.asp

SNH (Scottish Natural Heritage) 2009b. Guidance on Methods for Monitoring Bird Populations at Onshore Wind Farms. January 2009.

Skeate, E. and Perrow, M. 2008. Assessing the impacts of offshore wind farms on seals – experiences from Scroby Sands. Maree 2008 book of abstracts.

SERAD (Scottish Executive Rural Affairs Department) 2000. Habitats and Birds Directives, Nature Conservation: Implementation in Scotland of EC Directives on the Conservation of Natural Habitats and of Wild Flora and Fauna and the Conservation of Wild Birds ('The Habitats and Birds Directives'). Revised Guidance Updating Scottish Office Circular No 6/1995.

Stone, C.J., Webb, A., Barton, C., Ratcliffe, N., Reed, T.C., Tasker, M.L., Camphuysen, C.J. & Pienkowski, M.W. 1995. An atlas of seabird distribution in north-west European waters. Peterborough, Joint Nature Conservation Committee.

Smith. E.P. 2002. BACI design. pp 141–148 In Encyclopedia of Environmetrics Volume 1. Abdel H. El-Shaarawi and Walter W. Piegorsch (eds). John Wiley & Sons, Ltd, Chichester, 2002

Söhle, I., McSorley, C.A., Dean, B.J., Webb, A. and Reid, J.B. 2007. The numbers of inshore waterbirds using Tay Bay during the non-breeding season, and an assessment of the area's potential qualification as a marine SPA. JNCC Report No. 401.

Stone, C.J., Webb A., Barton C., Ratcliffe N., Reed T.C., Tasker M.L., Camphuysen C.J. & Pienkowski M.W. 1995. An atlas of seabird distribution in north-west European waters. JNCC, Peterborough.

Teilmann, J., Henriksen, O.D. and Cartensen, J., 2001. Porpoise detectors (PODs) as a tool to study potential effects of offshore wind farm on harbour porpoises at Rødsand. National Environmental Research Institute, Denmark.

Tougaard, J., Carstensen, J., Bech, N.I. and Teilmann, J. 2005. Final report on the effect of Nysted Offshore Wind Farm on harbour porpoises. Technical report to Energi E2 A/S.

Wanless, S., Harris, M. P., Morris, J. A. 1991. Foraging range and feeding locations of shags Phalacrocorax aristotelis during chick rearing. Ibis, 133 (1). 30-36

Wanless, S., Bacon, P. J., Harris, M. P., Webb, A. D., Greenstreet, S. P. R. and Webb, A.. 1997. Modelling environmental and energetic effects on feeding performance and distribution of shags (Phalacrocorax aristotelis): integrating telemetry, geographical information systems, and modelling techniques. ICES Journal of Marine Science, 54: 524–544.

Wanless, S., Harris, M.P., Burger, A.E. and Buckland, S.T. Use of time-at-depth recorders for estimating depth and diving performance of European shags. J. Field Ornithol., 68(4):547-561

Webb, A. & Durinck J. 1992. Counting birds from ships. In: Manual for aeroplane and ship surveys of waterfowl and seabirds, eds,. J. Komdeur, J. Bertelsen & G. Cracknell, 24-37. Slimbridge, IWRB Special Publication No. 19.

Wilson, L.J., Wanless, S., Harris, M.P. & Jones, G. 2005. JNCC Report No. 362 Isle of May seabird studies in 2003. JNCC Peterborough/CEH Banchory.

Wiese, F.K., Montevecchi, W.A., Davoren, G.K., Huettmann, F., Diamond, A.W. & Linke, J. 2001. Seabirds at risk around offshore oil platforms in the north west Atlantic. Marine Pollution Bulletin 42: 1285-1290.

Zuur, A. Ieno, E., Saveliev, A. & Jolliffe, I. (in prep). Poisson kriging applied to JNCC bird data. Report to JNCC from Highland Statistics.

Zuur, A.F., Ieno, E.N., Walker, N.J., Saveliev, A.A., Smith, G.M. 2009. Mixed Effects Models and Extensions in Ecology with R. Springer, New York. Series:

Appendix F

F. ERMC – Noise Assessment (BAE Systems)

F.1 Potential Noise Sources

F.1.1 Noise Sources Due to Construction

F.1.1.1 Piling

Marine piling will probably be the most intrusive source of underwater sound during construction. A number of papers describing measurements of piling noise are available in the published literature. Most agree that the acoustic energy is largely confined to below ~1 kHz and that pulse durations are typically between 100 ms and 200 ms. There is far more uncertainty regarding estimated source levels that would be needed for modelling impact on marine species. In the main, this is because the acoustic energy radiated depends upon the energy of the hammer, the diameter of the pile and the substrate composition. Estimation of the source level also requires working back energy/pressure levels at the measurement ranges to the virtual level 1 m from a point source. Comparison of measurements between papers is also complicated by different measures of acoustic levels being reported; peak to peak pressure, root-mean-square (rms) pressure and sound exposure level (energy flux density) are all commonly used measures.

A brief survey of reported energy source levels at 1 m vary from 172 dB re 1 μPa^2m^2 s for a 0.51 m diameter pipe driven by a 224 kJ hammer to 209 dB re 1 μPa^2m^2 s for a 2 m diameter pile driven by a 800 kJ hammer. Nedwell *et al.,* (2003) have reported peak to peak source levels as high as 261 dB re 1 µPa for a 4 m diameter pile and a 450 kJ hammer, but the form of the transmission loss as a function of range used is not physically realistic and consequently the inferred source level is too high. De Jong & Ainslie (2008) have calculated for a 800 kJ hammer the maximum energy source level is 230 dB re 1 μPa^2m^2 s assuming all the hammer energy is transferred to acoustic energy, note though that Nedwell *et al.,* are reporting peak to peak source levels not pulse energy.

The literature suggests that source levels are higher as the pile diameter increases and that difference in bottom substrate and increasing resistance to the pile can cause variability of up to 18 dB. Source levels seem to increase linearly with the hammer energy.

F.1.1.2 Dredging/Cable Trenching

Greene (1987) has reported measurements of oil industry drilling and dredging noise in the Beaufort Sea. For both sources most of the energy was at frequencies below 1 kHz. For cutter suction dredgers energy source levels in the band 20 – 1000 Hz of between 157 to 165 dB re 1 μPa^2m^2 s were reported. For hopper dredgers, measurements were only made for a single range so no estimate of source level was made. Reported levels in the band 20 – 1000 Hz were approximately 140 dB re 1 μPa^2m^2 s at ranges of 0.43 to 0.93 km.

Nedwell *et al* measured noise levels during cable trenching for the North Hoyle Wind Farm. They reported inferred source levels of 178 dB re 1 µPa, but again there are questions over the transmission loss assumed.

F.1.1.3 Drilling

The measurements reported by Greene (1987) in the Beaufort Sea give inferred source levels during drilling of between 159 to 170 dB re 1 μPa^2m^2 s across the bandwidth 20 – 1000 Hz. These measurements included drilling from a conventional drill ship, a specially constructed drill ship and on a caisson retained island. Levels from a conventional drill ship whilst well-logging were significantly lower at 146 dB re 1 μPa^2m^2 s across the bandwidth 20 – 1000 Hz. All of these measurements included the contributions from standby vessels in close vicinity.

Nedwell *et al* also measured rock socket drilling into sandstone at North Hoyle Wind Farm. There were significant tonals 20 dB or more above the background noise, most significantly between 100 Hz and 1 kHz. The source levels could not be established but they concluded that there is little likelihood of the noise from the drilling causing an environmental effect.

F.1.1.4 Shipping

At this stage shipping associated with construction is considered to consist of vessels involved in surveying, transport of materials or crew, or general support ships. Noise from vessels involved in operations such as dredging or drilling would normally be included as part of those activities.

The spectrum of individual ships consists of a broadband background with most of the energy below 1 kHz with tonals superimposed. The broadband spectrum is usually dominated by propeller cavitation noise or by hull vibration. The tonals are caused by rotating propulsion machinery, though singing from a badly designed or damaged propeller can be loud.

Noise from individual ships cannot easily be predicted but empirical formulae that represent overall levels, typically as functions of frequency, ship length and speed, exist. These formulae are based on vessels underway and would not be valid during manoeuvring or holding position for example.

F.1.1.5 Pre-existing Background Noise Sources

The most significant pre-existing background noise sources are likely to be other local shipping, long distance shipping noise and wind noise. Other noise sources that may need consideration are military activities and Oil and Gas Exploration or Production.

The Firth of Forth is a high density shipping area and consequently the ambient noise levels will be relatively high. As was the case for shipping associated with the wind farm construction, predicting source levels of individual ships is not feasible, but predicting general levels is. Noise level estimates for averaged local shipping, distance shipping and wind noise can be estimated using ambient noise prediction models such as CANARY.

The extent of military activities in the Firth of Forth will need further investigation. Neart na Gaoithe is very close to a mine countermeasures exercise area but it is currently unknown how often this area is used.

F.2 ERMC Approach to Quantifying the Effects of Sonar on Marine Mammals

ERMC provides a flexible approach to the management of risk and generation of the required Environmental Impact Assessment (EIA) during sonar operations. The system is underpinned by a combination of global scientific research and data, statistical modelling and open-systems design and implementation.

ERMC provides five key elements to support a risk assessment:

- Risk Assessment Methodology - developed by SMRU and CREEM, which provides a fully quantitative EIA process. The algorithms, called SAFESIMM (Statistical Algorithms For Estimating the Sonar Influence on Marine Megafauna), provide a quantitative evaluation of the risks to marine mammals posed by sonar, whilst accounting for uncertainties in our knowledge of both marine mammal densities and the likely biological consequences of exposure to sound;
- Risk Mitigation – through which alternative scenario options are assessed to allow trades between desired operational performance and risk to be managed;
- Approval and Auditing Process – makes decision making and responsibility clear, and records the risk assessment inputs and outputs on which they were based;
- Cumulative Sound Exposure – caters for extended durations by accumulating exposure over longer periods of noise emitting activities. This process ensures the cumulative effects of exposure to multiple sequential elements of a scenario are considered;
- Data – is at the core of the ERMC system and the adaptability and maintenance of it is fundamental to the quality of the output as discussed below.

The predictive power of the algorithms and models in the ERMC system ultimately depend on the quality, quantity, variability and breadth of the data that are available. The following categories of data are stored within the system and can be accessed and updated as required:

- Acoustic device parameters;

- Environmental descriptors – water depth, sediment characteristics, sound speed profiles;
- Marine Species - maps for species' density; and species (or group) specific information on behaviour (e.g. dive patterns) and sensitivity to sound (audiograms);
- Areas and Limits – coastlines, marine protected areas, fishing areas, legal boundaries, etc.

The majority of the above datasets are loaded from an extension to the IHO's S-57 Electronic Chart Transfer Format called Additional Military Layers (AML). One example of such an extension is the dataset that maps species densities to world locations provided as part of the United Kingdom Hydrographic Office's Integrated Water Column product. The data have been derived from the Relative Environmental Suitability models of Kaschner (2006)[5], and calibrated by the University of St Andrews using published survey data for each species. The data is global, stored at half degree resolution and gives both a density estimate and an uncertainty measure for 115 marine mammal species. Due to the availability of information, 46 marine mammal species (including all species occurring in UK waters) have additional estimates for the seasons of the year. Figure F-1**Error! Reference source not found.** shows the combined predicted marine mammal density data for all marine mammals around the Scottish coast in July.

[5] Kaschner, K., Watson, R., Trites, A.W. and Pauly, D. (2006). Mapping world-wide distributions of marine mammal species using a relative environmental suitability (RES) model. Marine Ecology Progress Series, 316: 285–310.

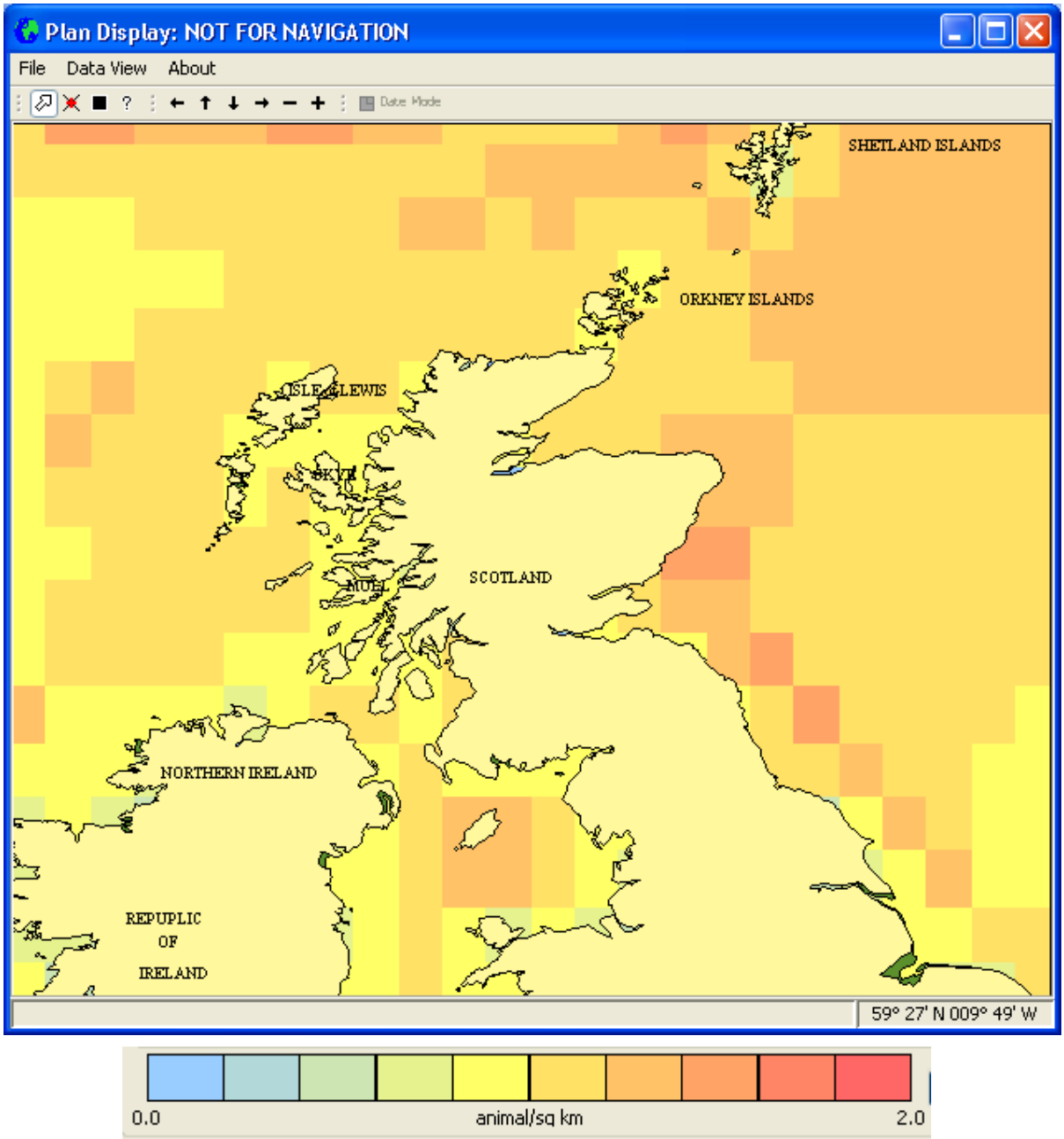


Figure F-1 Combined Predicted Marine Mammal Density Data for all Marine Mammals around the Scottish Coast in July

To calculate the potential risk to marine fauna of noise, the component within ERMC called SAFESIMM has been developed. The SAFESIMM component (as depicted in Figure F-2) comprises a sound propagation model, a simulation model and databases of marine mammal data. Output from the sound propagation model is combined with probabilistic information on the location of marine mammals through time to give sound exposure histories for individual simulated animals. These sound exposure histories are used to determine the probability for each individual of it suffering a Permanent Threshold Shift (PTS) or Temporary Threshold Shift (TTS) in hearing or modification of its natural behaviours (such as feeding habits or maternal characteristics). SAFESIMM uses a dose-response curve based on the results of Finneran et al (2005) to link the probability of experiencing TTS to Sound Exposure Level (SEL) accumulated over the period of a survey. Due to the lack of data on dose-response parameters for PTS, SAFESIMM assumes that the dose-response curve for PTS has the

same shape as for TTS with an offset by +20dB; following the approach adopted by Heathershaw (2001)[6] and Chief of Naval Operations (2006)[7]. These dose-response curves predict the probability that an individual will experience TTS or PTS as a result of a particular SEL. Uncertainty in these biological consequences is captured by sampling from a Binomial distribution with this probability, to determine whether or not an individual does actually experience either of these threshold shifts.

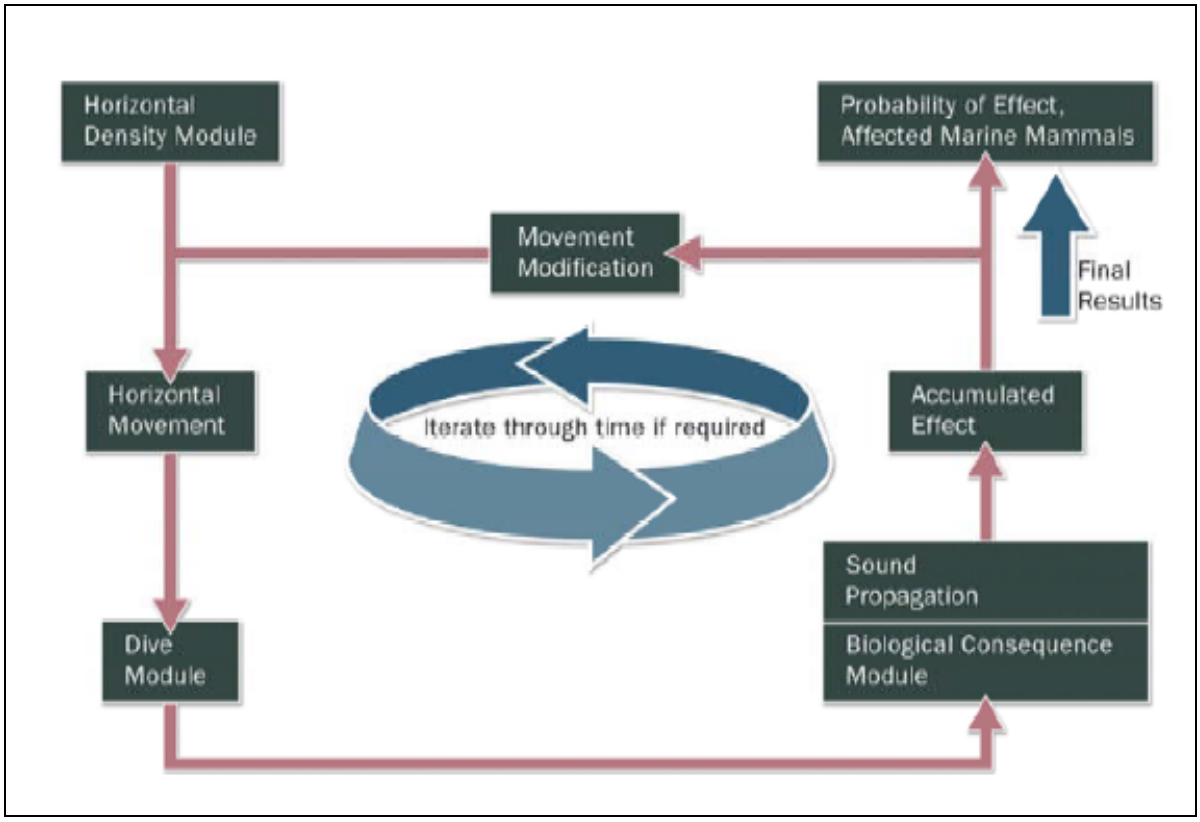


Figure F-2 Broad Overview of the ERMC Risk Assessment Framework

SEL is calculated relative to the hearing sensitivity of each species determined from an audiogram following the approach suggested by Heathershaw (2001). The following decision framework is used to assign an audiogram to each species:

- If species-specific information is available then it is used;
- If no species-specific information is available but information from a similar species (i.e. within the same guild and thus sharing similar ecological, behavioural, physiological or taxonomic characteristics) is available then the related species' information is used;
- If no guild-specific information is available, a generic function (e.g. the Global EIA audiogram in Heathershaw (2001)) is used (see Figure F-3).

[6] Heathershaw, A.D., Ward, P.D., & David, A.M. (2001) The environmental impact of underwater sound. Proceedings of the Institute of Acoustics, 23, 51-64.

[7] Chief of Naval Operations (2006) Mid-frequency active sonar effects analysis interim policy. In Memorandum for circulation. US Department of the Navy.

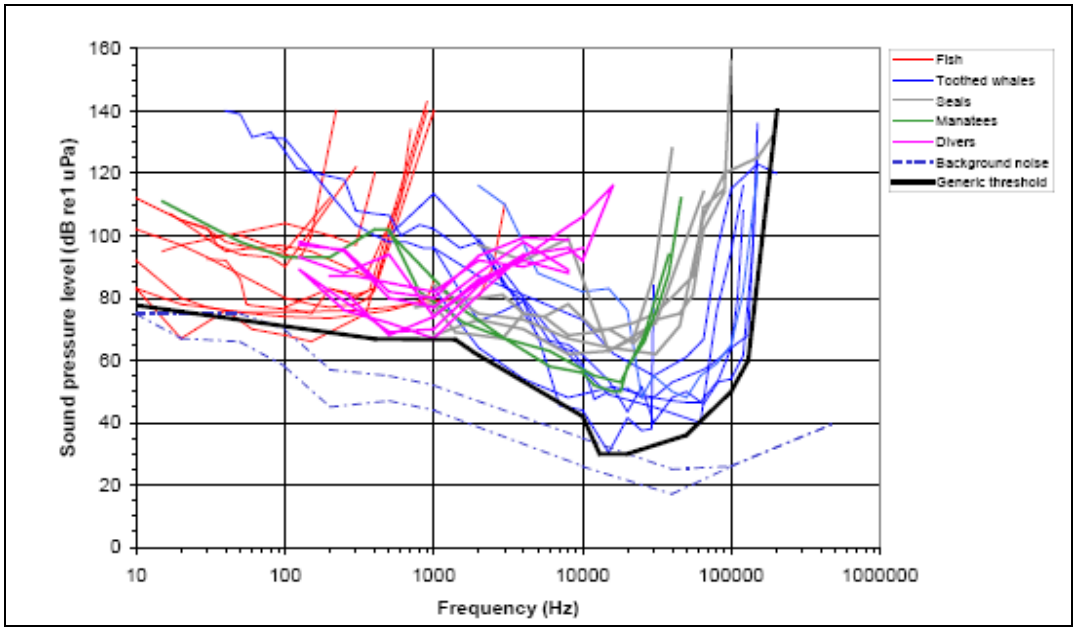


Figure F-3 Audiogram in Heathershaw (2001) is used in ERMC if no Species or Guild Specific Audiogram Information is Available

Information on the predicted density and behaviour of marine mammals from the ERMC databases is used by SAFESIMM to give repeated realisations of marine mammal locations and movements during a sonar scenario. Simulated movement includes representative diving behaviour and horizontal travel. The information necessary to carry out such movements is held in a comprehensive database of marine mammal diving behaviour, mostly derived from tagging surveys. This is used, together with information on local bathymetry, to model the duration and depth of individual dives

To take into account the effect that noise will have on species movement characteristics, both horizontal and vertical movements can be modified when a simulated animal experiences a SEL above their hearing threshold if there is scientific evidence that a species or guild's movement is affected by exposure to sound, such as with beaked whales,.

To model the stochastic nature of real life, SAFESIMM samples from the statistical distribution of density values for each grid cell during every simulation run, rather than using mean values. This allows it to take account of the uncertainty associated with these density estimates. This uncertainty is not currently displayed within the system due to the confusion that could arise from displaying confidence intervals to the user, particularly around thresholds, however there is scope for this to be included with an intuitive visualisation to enable better understanding of the risk assessment output.

The simulation results can be used to estimate a variety of risk metrics derived from the statistical distribution of SELs that could be expected at a particular geographic location which can then be visualised through the systems' Human Computer Interface. The current system configuration displays the probability that any marine mammal will suffer PTS during a scenario and the expected number of animals that might suffer TTS.

F.3 ERMC Approach to Quantifying the Effects of Sonar on Fish

ERMC currently uses the peer reviewed Stand-off Range algorithms from Heathershaw (2001) to assess the impact of sonar operations on fish. These algorithms calculate the in-situ stand-off ranges based on acoustic threshold levels (Permanent and Temporary Threshold Shift (PTS/TTS)), the sonar parameters and the local environmental conditions. The stand-off ranges can then be compared visually against all local known marine protected areas for fish to determine if any adverse effects will occur and used in monitoring the local region.

The SAFESIMM algorithms have been developed in such a way as to maximise generality and to allow for future developments and data availability. One way in which the capability of ERMC could increase is through the availability of analogous data for marine fauna other than marine mammals, for example fish, seabirds or

marine reptiles. Quantitative risk assessments for such species could then be made, provided the AML Integrated Water Column (IWC) product was extended to contain appropriate encyclopaedic and spatial density information.

The inclusion of fish would require some minor changes to the current ERMC Vertical Movement module because these species do not return periodically to the water surface. However, the vertical distribution of many fish species could be modelled by assuming that they are distributed over a favoured depth range and it may be unnecessary to explicitly simulate their movement. Some fish species make marked diurnal migrations through the water column which could be modelled stochastically. All other ERMC modules could be directly applied to fish without modification.

F.4 ERMC Limitations and Assumptions

The following points are known limitations of the system at the present time. However, these issues will be worked on in the coming months and the system adapted to ensure the model results are appropriate for the proposed wind farm environmental assessment.

1) Marine Mammal Sensitivity to Sound - The sensitivity (physiological, behavioural) of marine mammals to sound is based on the data available within ERMC. The audiogram data is limited to a few species and it should be noted that this data is based on a few individual animals. More information is needed to adequately quantify the potential behavioural and physiological effects.

2) Biological Environment - The known densities of marine mammals in the EIA area are based on the information provided by the ERMC system. The densities are based on habitat suitability and it is possible that other marine mammals may be located in the EIA area as many species are mobile and populations may move over time.

3) Physical Environment - The climatological, sediment and bathymetry environments are based on the data available in ERMC. These environments will not exactly replicate the oceanographic conditions which will be encountered when the various devices producing anthropogenic noise are deployed, and so cannot provide a forecast of all possible conditions. Greater precision in the calculation of SORs and Risk Levels will result from collecting localised data.

4) Anthropogenic Noise generated by Offshore Wind Farms - The operating characteristics and manner of deployment of the various devices producing anthropogenic noise will have to be correct at the time the EIA is generated by ERMC.

5) Acoustic propagation loss modelling - Acoustic propagation loss modelling will be carried out in ERMC using the RAM/INSTANT models. These models are considered sufficiently accurate to undertake the modelling required.

6) JNCC's guidelines for The Protection of marine European Protected Species from injury - SAFESIMM provides an estimate of the risk that any animal will experience PTS, which is the JNCC definition of "injury", as a standard output.

7) JNCC's guidelines for The Protection of marine European Protected Species from disturbance – SAFESIMM does not currently produce an output which meets the JNCC definition of "disturbance".

Appendix G

G. Terrestrial Ecology (Land Use Consultants)

G.1 Survey Techniques

G.1.1 Otter and Water Vole Surveys

Otter survey would be carried out on all sections of watercourse and coastline falling within the potential zone of impact and within 200 m of this area. Some sections of these watercourses will also provide suitability for water vole where the stream gradient is less than 3 degrees and on these sections a water vole survey will also be carried out.

Surveys will involve standard techniques including searches for spraints/latrines, shelters/burrows and evidence of runs and feeding. The survey must be carried out in suitable weather and flow conditions.

Survey for otter can be undertaken throughout the year in suitable conditions. Survey for water vole must be undertaken between April and September.

G.1.2 Badger Surveys

Badger survey would be carried out on all potentially suitable areas of habitat within the proposed development footprint(s) plus a 50 m buffer. Surveys would involve standard survey techniques including searches for setts, latrines, paths and runs, prints, hair and feeding signs. Survey can be carried out at any time of year but would ideally be timed for late autumn, winter or early spring, when die back of vegetation assists locating setts.

G.1.3 Bat Surveys

Bat survey will only be required if features suitable for roosting bats will be affected by the development. A Bat Roost Potential (BRP) assessment will be carried out on any trees that will be felled by the development. Surveys will follow current bat survey guidance (Bat Conservation Trust, 2007)[8]. This survey will examine the trees for features which could prove attractive to summer roosting bats such as holes, splits, ivy cover and loose bark. The survey will consist of a physical examination of the trees from roots to crown using binoculars and a powerful handlamp to examine features at height. If safe to do so, potential roost sites will be examined using an endoscope. This work would be carried out by an SNH licensed bat worker. This assessment can be carried out at any time of the year.

Where potential roost trees are identified but cannot be confirmed by use of an endoscope, emergence and return surveys using ultrasonic bat detectors would be required. Two dusk surveys and one dawn survey will be carried out to assess bat use of the trees for roosting. Best practice stipulates three survey visits between May and August, with at least one of the surveys comprising both a dusk and dawn survey within one 24-hour period.

G.1.4 Red Squirrel Surveys

If trees or areas of woodland will be affected by the scheme initial surveys will be carried out to identify potential dreys in the case of individual trees, or feeding signs of squirrel (chewed cones) in the case of blocks of trees or woodland. These surveys should be undertaken between March and September.

Where squirrel signs are identified or potential dreys are found, hair tube transect surveys may be required to establish whether the squirrels present in the trees/dreys are red or grey squirrel. Survey work can be carried out at any time of year.

[8] Bat Conservation Trust (2007). Bat Surveys – Good Practice Guidelines. BTC, London.

G.1.5 Great Crested Newt Surveys

Any ponds falling within 500 m of the proposed development footprint would be subject to a Habitat Suitability Appraisal (Oldham *et al*. 2000)[9] to assess their potential to support a population of breeding great crested newts. If any of the ponds exceed a threshold score they will be subject to full great crested newt surveys.

Surveys would follow guidance provided by Natural England (English Nature, 2001)[10] as no equivalent guidance is available specifically for Scotland. Four visits would be undertaken to establish presence or absence of the species using egg search, torch and bottle survey. If the species is found, two further surveys would be required to establish population estimates.

Survey would be undertaken between April and June.

G.1.6 Reptiles Surveys

Where the Extended Phase I Habitat Survey identifies habitat suitable for reptiles, and where loss of that habitat as part of the scheme may result in the death of reptiles, or may reduce the ability of the population to maintain itself, reptile survey will be carried out. Surveys will involve setting and checking of artificial refugia on a total of seven occasions, in suitable weather conditions between late March and early June. Guidance in the Herpetofauna Workers Manual (JNCC, 1998) will be followed.

[9] Oldham, R. S., Keeble, J., Swan, M. J. S., Jeffcote, M. (2000). Evaluating the suitability of habitat for the great crested newt (Triturus cristatus). Herpetological Journal 10: pp143-155.

[10] English Nature (2001). Great crested newt mitigation guidelines. English Nature, Peterborough

Appendix H

H. Nature Conservation

H.1 Designated Areas

H.1.1 Special Areas of Conservation

The Special Areas of Conservation that have been designated along the coastline adjacent to Neart na Gaoithe are given in the table below. The features that are important with regard to the potential development of an offshore wind farm include the presence of seals and the designations near the potential cable landfall points, such as the Firth of Forth SPA, Barns Ness SSSI and Pease Bay SSSI.

Site	Statutory Designation	Remarks	Reason for Designation
Firth of Tay & Eden Estuary	SAC	This is a marine area with sea inlets, tidal rivers, estuaries, mudflats, sandflats, lagoons, saltmarshes, coastal sand dunes, sand beaches and sea cliffs.	Annex I habitats that are a primary reason for selection of this site – estuaries. Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site – sandbanks which are slightly covered by seawater all the time, mudflats and sandflats not covered by seawater at low tide. Annex II species that are a primary reason for selection of the site – Common seal.
Isle of May	SAC	Marine area with sea inlets, saltmarshes, salt pastures, salt steppes, shingle and sea cliffs.	Annex I habitats present as a qualifying feature, but not as a primary reason for selection of site – reefs. Annex II species that are a primary reason for selection of this site – grey seal
River South Esk	SAC	Tidal rivers, estuaries. mud flats, sand flats, lagoons, inland water bodies, bogs, and terrestrial elements.	Annex II species that are a primary reason for selection of this site – freshwater pearl mussel and Atlantic salmon.
St. Abb's Head to Fast Castle	SAC	Shingle, sea cliffs and islets.	Annex I habitats that are a primary reason for selection of this site – vegetated sea cliffs of the Atlantic and Baltic coasts.

Table H-1 SACs in the Vicinity of Neart na Gaoithe

H.1.2 Special Protection Areas

Table H-2 shows the SPA designations and important species in the vicinity of Neart na Gaoithe.

Montrose Basin	SPA	Tidal river, estuaries, mud flats, sand flats and lagoons, inland water bodies and arable land.	Article 4.2 qualification: Over the winter the area regularly supports *Anser anser* (1.1% of the population), *Anser brachyrhynchus* (16.5% of the population) *Calidris canutus* (1.5% of the population) *Haematopus ostralegus* (0.7% of the population) and *Tringa tetanus* (1.3% of the population). There are internationally important assemblages of over wintering waterfowl (54,930).
Firth of Tay & Eden Estuary	SPA	Tidal rivers, estuaries, mud flats, sand flats, lagoons, salt marshes, coastal sand dunes, seacliffs, bogs and marshes.	Article 4.1 qualification: During the breeding season the area regularly supports *Circus aeruginosus* (2.5% of the GB breeding population) and *Sterna albifrons* (1% of the population in GB). Over winter the area regularly supports *Limosa lapponica* (4.6% of the GB population). Article 4.2 qualification: Over the winter the area regularly supports *Anser anser* (1.2% of the population), *Anser brachyrhynchus* (1.2% of the population) and *Tringa tetanus* (1% of the population). The internationally important assemblages of birds that the area regularly supports over winter include 48,000 waterfowl.
Firth of Forth	SPA	Tidal rivers, estuaries, mud flats, sand flats, lagoons, salt marshes, salt pastures, slat steppes, coastal sand dunes, sand beaches, machair, shingle, sea cliffs and islets.	Article 4.1 qualification: Over the winter the area regularly supports *Podiceps auritus* (21% of the GB population) *Haematopus ostralegus* (2% of the GB population) *Limosa lapponica* (4% of the GB populations) *Gavia stellata* (2% of the GB populations) and *Pluvialis apricaria* (1% of the GB populations). On passage the are regularly supports *Sterna sandvicensis* (6% of the GB population). Article 4.2 qualification: over the winter the area regularly supports *Anser brachyrhynchus* (6% of the population) *Arenaria interpres* (1% of the population), *Calidris cantus* (3% of the population) *Tadorna tadorna* (2% of the population) and *Tringa tetanus* (3% of the population).
Cameron Reservoir	SPA	Inland water bodies with bogs, marshes, water fringed vegetation and fens, with mixed woodland.	Over winter the area regularly supports 7.2% of the *Anser brachyrhynchus* population.

Forth Islands	SPA	Marine areas, sea inlets, coastal sand dunes, sand beaches, shingle, sea cliffs, islets, inland water bodies, heath, scrub, dry grassland and steppes.	Article 4.1 qualification: During the breeding season the area regularly supports *Sterna dougallii* (12.5% of the GB breeding population) *Sterna hirundo* (2.7% of the GB breeding population) and *Sterna sandvicensis.* Article 4.2 qualification: Over the winter the area regularly supports *Alca torda Fratercula arctica, Larus fuscus, Morus bassanus, Phalacrocorax aristotelis, Phalacrocorax carbo, Rissa tridactyla* and *Uria aalge*.
St. Abb's Head to Fast Castle	SPA	Marine areas, sea inlets, heath, scrub, humid grassland.	Article 4.2 qualification: during the breeding season the area regularly supports *Uria aalge* (9.3% of the population). There is also an internationally important assemblage of 79,560 seabirds during the breeding season.

Table H-2 SPAs in the Vicinity of Neart na Gaoithe

H.1.3 The Ramsar Convention

The Ramsar sites in the vicinity of Neart na Gaoithe that conform to this description are presented in Table H-3.

Site	Statutory Designation	Remarks	Reason for Designation
Montrose Basin	Ramsar	Situated on the east coast of Scotland, on the western side of the town of Montrose, within a predominantly agricultural catchment. Enclosed estuary of the South Esk containing areas of mudflat, marsh and agricultural land, and Dun's Dish, a small eutrophic freshwater loch. It is a good natural example of an estuary, relatively unimpacted by development, a high species diversity in the intertidal zone and supporting a large population of wintering waterfowl.	The site is also important internationally for wintering populations of pink-footed goose *Anser brachyrhynchus*, greylag goose *Anser anser* and common redshank *Tringa totanus*. A particularly good example of an estuary, being relatively unaffected by land-claim, industrial development or pollution. Montrose Basin has a remarkably high species diversity in the intertidal zone when compared with other sites. The site hydrology is unusual, although the main mudflat is exposed for a long period during each tidal cycle, it remains wet, and therefore supports this high diversity. The complete exchange of water in the Basin with each tide gives the site a high overall water quality. Assemblages of international importance: Species with peak counts in winter: 29116 waterfowl (5 year peak mean 1998/99-2002/2003) and species/populations occurring at levels of international importance.
Firth of Tay & Eden Estuary	Ramsar	On the east coast of Scotland, immediately adjacent to Dundee, Broughty Ferry, St Andrews and 10 km east of Perth. The Firth of Tay and Eden Estuary is a complex of estuarine and coastal habitats in eastern Scotland. The site includes extensive invertebrate-rich intertidal mudflats and sandflats created by the massive sediment load deposited by the River Tay. Also present are large areas of reedbed and sand-dune and a small amount of saltmarsh.	The site supports an internationally important assemblage of wintering waterfowl including internationally important populations of several species. Fourteen species of bird breed in nationally important numbers. Abertay Sands are also important as a major haul-out site for both grey seals *Halichoerus grypus* and breeding common seals *Phoca vitulina*.
Cameron Reservoir	Ramsar	Cameron Reservoir lies 6 km south-west of St Andrews, in east Scotland. Cameron Reservoir is an artificial mesotrophic loch with beds of aquatic and marginal vegetation.	The open water is used as a roost by an internationally important wintering population of pink-footed geese that feed on the surrounding farmland.

Table H-3 Ramsar Sites in the Vicinity of Neart na Gaoithe

H.1.4 Important Bird Areas

The season codes below are used in the following individual Important Bird Areas (IBA) description tables:

- B = Breeding
- P = Passage
- W = Wintering

Eden Estuary Tentsmuir Point & Abertay Sands

Species	Season	Year	Population
Bar-tailed godwit	W	1995	1650
Little tern	B	1994	40

Protection Status

The IBA partly or wholly overlaps with the following national designated areas: Barry Links, Earlshall Muir, Eden Estuary, Morton Lochs and Tayport – Tentsmuir Coast Sites of Special Scientific Interest (SSSI). It also overlaps with the Firth of Tay and Eden Estuary Special Protection Areas (SPA).

Firth of Forth

Species	Season	Year	Population
Pink-footed goose	W	1995	12800
Shelduck	W	1995	3560
Scaup	W	1995	195
Golden plover	W	1995	3130
Golden plover	P	1995	3340
Knot	W	1995	7550
Dunlin	W	1995	8650
Bar-tailed godwit	W	1995	2380
Bar-tailed godwit	P	1995	1530
Curlew	W	1995	2220
Redshank	W	1995	4190
Redshank	P	1995	4150
Turnstone	W	1995	1080
Lesser black-tailed gull	B	1990	865
Common tern	B	1996	690

Protection Status

The IBA partly or wholly overlaps with the following national designated areas: Local Nature Reserves- Aberlady Bay, Cambus Pool, Skinflats, Torry Bay; Sites of Special Scientific Interest (SSSI) - Abbey Craig, Aberlady Bay, Alloa Inches, Barnsmuir Coast, Blackness Bay, Burntisland – Kirkcaldy Coast, Carlingnose, Dumbarnie Links, Dunbar Coast, East Wemyss – Anstruther Coast, Fife Ness Coast, Forth Bridge – Granton Shore, Gosford Bay to Port Seton, Gullane to Broad Sands, Kinneil Kerse, Leith to Prestonpans, North Berwick Coast, Ruddons Point, Skinflats, Torry Bay, Tyninghame Shore and Wardie Shore.

Firth of Tay

Species	Season	Year	Population
Bar-tailed godwit	W	1996	1500

Protection Status

The IBA partly or wholly overlaps with the following national designated areas: Balmerino – Wormit Shore, Barry Links, Flisk Wood, Inner Tay Estuary and Monifieth Bay Sites of Special Scientific Interest (SSSI). This overlaps with Firth of Tay and Eden Estuary Special Protection Areas (SPA).

Forth Islands

Species	Season	Year	Population
Gannet	B	1994	39800
Cormorant	B	1995	470
Shag	B	1995	885
Lesser black-backed gull	B	1995	7200
Herring gull	B	1995	13000
Sandwich tern	B	1994	130
Roseate tern	B	1995	17
Common tern	B	1994	305
Guillemot	B	1995	20700
Razorbill	B	1994	2480
Puffin	B	1995	20000

Protection Status

The IBA partly or wholly overlaps with the following national designated areas: Isle of May National Nature Reserve (NNR); Fidra Islands, Inchmickery, Long Craig Local Nature Reserves (LNR); Bass Rock, Forth Islands, Gullane to Broad Sands, Inchmickery, Isle of May, Long Craig Sites of Special Scientific Interest (SSSI). The Forth Islands IBA is partly covered (105ha) by the Firth of Forth Islands Special Protection Area (SPA).

Montrose Basin

Species	Season	Year	Population
Whooper swan	W	1995	105
Pink-footed goose	W	1995	26000
Knot	W	1995	3120
Redshank	W	1995	2450
Redshank	P	1995	2320

Protection Status

The IBA partly or wholly overlaps with the following national designated areas: Dun's Dish and Montrose Basin Site of Special Scientific Interest (SSSI). 984 ha of the IBA is covered by Montrose Basin Special Protection Area (SPA) and Ramsar.

St Abb's Head to Fast Castle

Species	Season	Year	Population
Shag	B	1995	430
Guillemot	B	1993	20800
Razorbill	B	1993	1470

Protection Status

The IBA partly or wholly overlaps with the following national designated areas: St Abbs Head National Nature Reserve (NNR), Berwickshire Coast Intertidal, Coldingham Loch, St Abbs Head – Fast Castle Sites of Special Scientific Interest (SSSI). 247 ha of the IBA is covered by ST Abbs Head – Fast Castle Special Protection Area (SPA).

Appendix I

I. Archaeological Analysis Techniques (Headland Archaeology)

I.1 Methodology for the Archaeological Review, Assessment, Interpretation and Reporting of Geophysical Marine Survey Data

I.1.1 Introduction

The marine survey data to be assessed will include the results from side-scan sonar, magnetometer survey, seismic profiling survey and bathymetry. This methodology is presented in concert with that provided by the EMU Ltd. survey team. Headland's marine archaeologist will liaise with the survey team on a regular basis to optimise the results of the archaeological assessment.

The archaeological benefits of the techniques employed during the survey include:

Sidescan survey may identify wrecks and other related debris of all periods that lie either partly or wholly on the surface of the seabed;

Magnetometer survey may identify wrecks and other related debris of all periods both on the surface of the seabed and within the seabed sub-strata;

Seismic profiling survey may identify features and deposits that relate to the topography of an area prior to its burial and inundation during the prehistoric period, and buried objects such as wrecks;

Bathymetry may be used to characterise wrecks and other related debris of all periods that lie (at least in part) on the surface of the seabed.

I.1.2 Aims & objectives

The specific aims and objectives of the assessment are:

- to confirm the presence of previously identified marine historic assets and to comment on their characteristics;
- to identify, locate and characterise unrecorded marine historic assets;
- to assess available data in respect of seabed and sub-seabed deposits likely to be of archaeological interest;
- to recommend mitigation measures, such as temporary exclusion zones for those marine historic assets potentially subject to impacts from the proposed development.

I.1.3 Archaeological review of the survey data

The data will be reviewed in its 'raw' digital state with appropriate software. This will allow the data to be replayed and interrogated in order to effectively asses the position, extent and nature of potential targets. All information with regard to the survey conditions will be provided by the EMU survey team in order to gauge the quality of the data for the effective identification of cultural heritage assets.

The data will be subject to an initial scan for any objects of cultural heritage interest in order to:

- familiarise the assessor with the survey area;
- check the position of targets in relation to known maritime losses;
- check the accuracy of the position, extent and nature of known maritime losses;
- locate and assess unrecorded targets identified by the EMU survey team.
- Locate and assess any further targets identified by the marine archaeologist that may be of archaeological interest
- identify deposits on and within the seabed sub-strata that may be of archaeological interest

The position and dimensions of these targets along with any additional anomalies will be recorded into a gazetteer and a labelled image of each anomaly acquired. The marine archaeologist will liaise with the survey team on a regular basis to cross-reference and verify the target information in order to ensure the accuracy of

the findings of the archaeological assessment within the wider marine survey objectives and integration into GIS.

I.1.4 Archaeological assessment of identified anomalies

All targets will be 'flagged' and then assessed as to their archaeological potential. The size, form, nature and extent of an anomaly can often dictate the likely archaeological potential. As such, the initial potential of identified targets will be gauged using a ranking system (see table below) as a means of prioritising potential assets in order to inform upon subsequent interpretation. It must be stressed that the ranking system is only seen as a guide and is not used as a substitute for professional judgment, where consequent investigation may confirm (or not) the initial ranking of an asset.

Potential of cultural heritage asset	Character of anomaly
HIGH	An anomaly that is identified as a known archaeological asset or in the vicinity of such; or an anomaly that is clearly recognisable as a well preserved feature such as a relict prehistoric surface or deposit; or maritime loss such as a vessel or aircraft (or parts of) and any associated debris
MEDIUM	An anomaly that exhibits characteristics likely to represent the remains of an archaeological asset such as a relict prehistoric surface or deposit; or maritime loss such as a vessel or aircraft including any associated debris; or fragments of the same
LOW	An isolated or fragmentary anomaly that is recognised to be of some archaeological interest but may represent a natural feature

Table I-1 Table Showing the Prioritisation of Identified Targets

In addition, the magnitude of impacts of the development on potential targets will also be assessed based on their archaeological potential and proximity to proposed impacts. The magnitude of an impact on an asset will also help determine the requirement for the introduction of temporary exclusion zones prior to further investigation. The archaeological potential (and if known, likely sensitivity) and characteristics of a marine historic asset or assets will normally dictate the size of the temporary exclusion zone.

I.1.5 Reporting

The archaeological results of the geophysical survey will be compiled as a technical report, and will be presented as an Appendix to the Cultural Heritage Chapter of the Environmental Impact Assessment. The results will be presented in such a way as to ensure accurate cross-referencing and integration into the main text. If appropriate, the report will also include likely requirements for further archaeological work.

I.2 Methodology for the Geoarchaeological Review and Assessment of Geotechnical Data

I.2.1 Introduction

The following presents the methodology for the initial assessment of geotechnical data associated with the Environmental Impact Assessment and any subsequent phases of work. Analysis of geotechnical borehole and vibrocore data will enable the recovery of evidence relating to submerged terrestrial archaeology within the proposed development area. In particular, evidence relating to the formation processes and environments of deposits will be obtained.

I.2.2 Assessment of existing data

An initial archaeological desk-based assessment of core logs generated by geotechnical contractors will be undertaken by Headland's geo-archaeologist. This assessment will seek to establish the presence of deposits of archaeological potential and characterise them in terms of composition and probable mode of deposition. The results of this assessment will be included in the initial baseline and impact assessment. From this assessment it will be decided what further work will be required, including the recording and sub-sampling of any retained cores from previous geotechnical work. The results, an assessment of potential and a proposal for consequent work will be formally reported at this point.

I.2.3 Further geotechnical work

Further geotechnical work will include archaeological input from the maritime and geo-archaeological specialists to advise on the placing of boreholes for maximising archaeological information or avoiding potential damage to archaeological features and deposits as a result of development impacts.

I.2.4 Coring and logging

Cores with archaeological potential, both retained and newly taken, will be cleaned and logged. A report from the logging results will be prepared giving the archaeological results and a proposal for any sub-sampling and consequent assessment that is appropriate.

I.2.5 Sub-sampling and assessment

Where appropriate deposits suitable for geo-archaeological assessment have been identified, sub-samples of the agreed analysis type[s] will be taken from the cores. Such analyses may include: pollen, diatoms, foraminifera, plant macrofossil and microscopic charcoal analysis. The location of all sub-samples taken from the cores will be recorded and the cores will be retained in the event of any further sub-sampling being required.

Laboratory assessment will be undertaken to allow the palaeoenvironmental and dating potential of the sub-sampled material to be identified. The assessment report will set out the results of each type of class of evidence, any emergent archaeological interpretation and a proposal for any appropriate further, detailed analytical work.

I.2.6 Analysis

Full analysis of the appropriate classes of evidence will be undertaken, including radiocarbon dating of suitable material. If full analysis is undertaken the results will be integrated into the final archaeological report covering all aspects of the cultural heritage of the development area. The results of the analysis will be combined with the results of the previous phases of work to produce a deposit model and environmental history of the development area.

I.3 Relevant Legislation

Relevant Charters, Conventions and Legislation and Policy to be referenced include:

International:

- UN Convention on the Law of the Sea (1982) Articles 149 and 303;
- UNESCO Convention on the Protection of the Underwater Cultural Heritage (UNPUNCH) (2001) - the UK has not signed the Convention but has adopted its guidelines as best practice (in line with the ICOMOS Charter below);
- ICOMOS Charter on the Protection and Management of Underwater Cultural Heritage (1996);
- Valletta Convention (1992) – Archaeological Heritage;
- Granada Convention (1985) – Architectural Heritage;

- Aarhus Convention (1996) – Environmental information: SEA, EIA;
- Florence Convention (2000) – European Landscape.

UK Legislation and Policy:

Devolved responsibilities and associated legislatures in Scotland provide for separate measures inclusive of the territorial sea adjacent to the Scottish coast. Historic Scotland act as statutory advisors on behalf of Scottish Ministers for heritage matters concerned with marine development. Historic Scotland offers advice on the management, protection and investigation of the marine historic environment within Scottish territorial waters.

Legislation and Policies include:

- Ancient Monuments and Archaeological Areas Act (1979) (as amended);
- Protection of Wrecks Act (1973);
- Protection of Military Remains Act (1986);
- Merchant Shipping Act (1995);
- Scottish Planning Policy 23 (SPP23) – Historic Environment;
- Planning (Listed Buildings and Conservation Areas) Act 1990;
- NPPG5 Archaeology and Planning Advice Note: Archaeology – the Planning Process and Scheduled Monument Procedures (PAN 42);
- Historic Scotland Operational Policy Paper HP6 Conserving the Underwater Heritage (1999);
- Scottish Historic Environment Policy: Consultation - The Marine Historic Environment (2008);
- Adopted Local Development Plans;
- Emerging Local Development Frameworks and relevant Supplementary Planning Guidance.

Reference is also made to current draft legislation in Scotland;

- Draft Scottish Marine Bill (April 2009).

Appendix J

J. Military and Aviation (Pager Power)

J.1 Consultation Responses

J.1.1 Civil Aviation Authority

The following was received in an email on 30 June 2009.

Our Ref: DAP/Wind/Neart Na Gaoithe Offshore\961
Your Ref: 6185A

Dear Mr Stuteley
Wind Farm Proposal – Neart Na Gasithe Offshore

Thank you for notification of the title proposal. This Directorate has no observations.

There may however be issues related to en route navigational facilities. Accordingly details of your proposal have been copied to National Air Traffic Services for any comment. If you do not hear from NATS or wish to contact them, they can be contacted at:

National Air Traffic Services Ltd
Navigation Spectrum & Surveillance
Corporate and Technical Centre
4000 Parkway, Whiteley
Fareham
Hampshire
PO15 7FL

For completeness it would also be sensible to establish the related viewpoint of local emergency services air support units. This is because of the unique nature of their operations in respect of operating altitudes and potentially unusual landing sites.

You should be aware that there will be a need to install aviation obstruction lighting to some or all of the associated wind turbines should this development be progressed; The UK statutory requirement for aviation warning lighting on offshore wind turbines is set out at Article 134 of the UK Air Navigation Order (available at http://www.caa.co.uk/docs/33/CAP393.pdf - Section 1, Part 13, Page 5). In essence, the Article requires that each turbine is fitted with medium intensity (minimum 2000 candela) steady red lighting on the top of the nacelle such that the light or lights are visible from all directions and that such lighting is displayed at night. With the permission of the Civil Aviation Authority, only those turbines on the perimeter of a windfarm need such lighting. Such aviation warning lighting has the potential to cause difficulty to the maritime community. The Article describes a number of provisions aimed specifically at mitigating against such impact. With this in mind, your attention is drawn to several portions of text taken from Article 134:

When displayed:

a. the angle of the plane of the beam peak intensity emitted by the light shall be elevated to between 3 and 4 degrees above the horizontal plane;
b. not more than 45% or less than 20% of the minimum peak intensity specified….shall be visible at the horizontal plane;
c. not more than 10% of the minimum peak intensity….shall be visible at a depression of 1.5 degrees or more below the horizontal.

Note that the above requirements are just that, requirements as opposed to a recommendation of

allowance.

When the visibility in all directions from every wind turbine generator…. is more than 5km, the light intensity required….may be reduced to not less than 10% of the minimum peak intensity.

Note that this is not a mandated requirement, but more of a standing permission to reduce lighting intensity under certain conditions. At the risk of repetition, before the lighting intensity may be reduced the visibility in all directions from every wind turbine generator needs to be more than 5km.

It is possible that strict adherence to the requirements detailed at the first bullet and the subsequence employment of the allowance to reduce lighting intensity subject to visibility criteria will go some way to mitigating maritime concerns related to aviation lighting requirement. Should you wish to discuss this issue further, you should contact my colleague Mr Mark Smailes on 0207 453 6545.

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.

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.

Developers are advised that there is a civil aviation requirement in the UK for all structures over 300 feet high to be charted on civil aviation maps (I understand that the ministry of defence utilises a lower threshold height). Should this proposed wind turbine development progress and the 300 feet height be breached, to achieve this civil aviation charting requirement, developers will need to provide details of the development to:

Defence Geographic Centre, AIS Information Centre, Jervis Building, Elmwood Avenue, Feltham, Middlesex,TW13 7AH Telephone: 020 8818 2708 (This number is for Defence Geographic, not the CAA.)

An amendable version of the proforma is available electronically at http://www.bwea.com/docs/developers_proforma.doc and can be E-mailed to windfarms@caa.co.uk when submitting preplanning information.

Please be aware that due to the rationalisation of CAA Email addresses the windfarms Email address is now windfarms@caa.co.uk, the previous address windfarms@dap.caa.co.uk will no longer work.

Regards

Delpha

J.1.2 BAA – Edinburgh Airport

Letter sent on 25 July 2009

Dear Charles

Re: Proposal for 75 Wind Turbines 173.5m high to blade tip at Neart na Gaoithe

Our Ref: EDI1635

In response to the request for advice contained in your email of 28/05/2009, received in this office on 29 May 2009, we would advise as follows:

The site lies 74.3Km in a north-easterly direction from the Aerodrome Reference Point for Edinburgh Airport. This site is outside of the Obstacle Limitation Surfaces for the airport.

An assessment was arranged with respect to the radars utilised by the airport and it was found that none of the turbines would be visitble to the airport radar or the radr located at Lowther Hill.

Therefore if the proposal were to be submitted forPlanning Approval, Edinburgh Airport would not raise an objection.

Please be advised tht the advice given is informal and without prejudice to the consideration of any planning application which may be referred to us pursuant to Planning Circular 02/2003 in consultation under the safeguarding procedure. It cannot be assumed that any response to consultation under Planning Circular 02/2003 will necessarily coincide with the informal advice now given. We will not have any liability to you or third parties who may follow this advice.

It should also be made clear that provision o fhtis advice does not constitute support for the development nor an opinion that the development is acceptable under local planning policy.

Yours sincerely

Lesley Duggan (Mrs)

For and on behalf of Edinburgh Airport Limited

J.2 Specific Details for Neart na Gaoithe

J.2.1 RAF Leuchars Primary Surveillance Radar

Neart na Gaoithe is likely to unacceptably affect the Primary Surveillance Radar at RAF Leuchars, and robust mitigation is an anticipated requirement for the site to be developed. Such mitigation is likely to involve a new in-fill radar installed at a suitable location and associated equipment at the ATC facilities at RAF Leuchars. These mitigation options will provide adequate coverage without being affected by Neart na Gaoithe, although it is possible that an existing radar may be suitable. Although provision of a new radar may be expensive (£5-10m is likely to be the upper bounds of the cost), experience at Glasgow Airport shows that it is feasible, so the technical risk is low. Alternatively, wind farm tolerant radar technology may become available as an upgrade to the radar.

J.2.2 RAF Leuchars Precision Approach Radar

Neart na Gaoithe may unacceptably affect the Precision Approach Radar at RAF Leuchars. This may simply be a constraint to the wind farm layout, or it may require robust mitigation. Mitigation options include radar beam steering, blanking out of wind turbine returns, or building a 'radar fence' (a raised area of ground) to shield the wind turbines.

Figure J-1 shows the line-of-sight area analysis for Neart na Gaoithe. The red lines show the safeguarding zones for the PAR system (the true safeguarding criteria are unknown). Within all three arcs, wind turbines of less than 100 m tip height will be within the radar's line of sight (and as for the RAF Leuchars PSR, this also applies to turbines of less than 60 m tall within each arc):

- the solid red line indicates the minimum safeguarding criteria that may be applied: 15 nm (27.8 km) range from the radar, and within 20° of the runway's extended centreline at the radar;
- the dashed red line represents the current MoD policy: to safeguard PAR Systems to 20 nm (37.0 km) range, within 20° of the runway's extended centreline;
- the dotted red line indicates the most stringent safeguarding criteria, as described in a report published in 2005, but understood not to have been implemented, is 25 nm (46.3 km) range, within 25° of the runway's extended centreline.

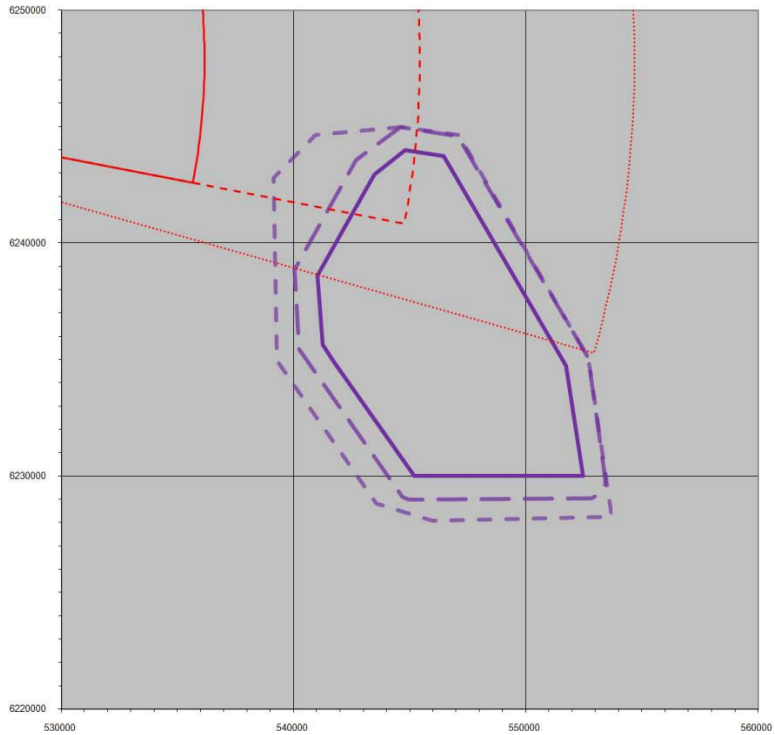


Figure J-1 RAF Leuchars PAR Analysis

If PAR mitigation proves to be necessary, although radar-end modifications should be technically feasible, this mitigation carries the most risk, as it is not known to have been conducted before. Discussions with the MoD will be conducted to confirm PAR constraints and mitigation options.

J.2.3 Edinburgh Airport Primary Surveillance Radar

Edinburgh Airport operates a PSR and an SSR system. Neart na Gaoithe may have a minor impact on the Edinburgh Airport PSR, although due to the distance from the airport, no concerns are expected. If mitigation is required, the selected mitigation option for the RAF Leuchars Primary Surveillance Radar issue is likely to be suitable. In terms of future development, BAA Glasgow Airport may be replacing its PSR by the end of 2010. When this is complete, it is understood that Edinburgh Airport may also replace its PSR so as to minimise disruption to radar coverage, this is unlikely to occur before the Glasgow Airport radar is operational again. A new radar may or may not be in the same location as the existing radar. However, due to the range, it is considered unlikely that Edinburgh Airport will object to the proposal, so this change is unlikely to be significant. However, Edinburgh Airport radar may be identified as a suitable location for an in-fill radar for RAF Leuchars.

J.2.4 NERL Perwinnes Primary Surveillance Radar

NERL operates a PSR and an SSR system at its Perwinnes site. Neart na Gaoithe may have a minor impact on the NERL Perwinnes PSR, although due to the local airspace structure, it is expected to be operationally acceptable. It should be noted that NERL and the MoD are likely to use different technical specifications for Air Traffic Control radar, so if a new radar is installed, it should accommodate NERL requirements as well as those of the MoD. In terms of future development, the PSR is scheduled for replacement in 2010-11, which will involve shutting down for several months. The new radar is expected to be in the same location, and will be a Raytheon ASR23. Raytheon are known to be considering development of wind farm tolerant radar technology which may become available as an upgrade to this radar in the future. Even without such technology, the ASR23 is likely to be more adaptable to wind turbine effects (through adjustment of radar operating parameters), especially where wind farm effects are minor (as is expected at Neart na Gaoithe). Any change due to this new radar is therefore likely to be positive for Neart na Gaoithe.

Consultation has not been undertaken with NERL to date, however minor technical concerns may be raised in the future. Operationally, any minor technical impact is likely to be acceptable, since the airspace of most concern to NERL is expected to be the P18 airway, and this is approximately 10 km east of Neart na Gaoithe. Technical mitigation may be required.

J.2.5 RAF Buchan Primary Surveillance Radar

RAF Buchan is a long range air defence radar site, utilising both Primary Surveillance Radar (PSR) and Secondary Surveillance Radar (SSR – also referred to by military sources as IFF – Identification Friend or Foe). The radar identified of possible concern is the Type 92 PSR. Due to the range to the wind farms, only the PSR may be affected. Overall, there are no issues with the RAF Buchan radar at Nearth na Gaoithe.

J.2.6 Summary

Table I-1 below summarises the distance and bearing from each radar in the vicinity of Neart na Gaoithe and the resulting impact to the radar.

Radar	Distance / Bearing	Impact Result
Distance between the RAF Buchan PSR and wind farm centre	135km/ 73nm	Nil
Bearing of wind farm centre relative to the RAF Buchan PSR	191° (G)/ 195° (M)	
Distance between the Edinburgh Airport PSR and wind farm centre	79km/ 42nm	Negligible
Bearing of wind farm centre relative to the Edinburgh Airport PSR	063° (G)/ 067° (M)	
Distance between the RAF Leuchars PSR and wind farm centre	40km/ 22nm	Major
Bearing of wind farm centre relative to RAF Leuchars PSR	108° (G)/ 112° (M)	
Distance between the RAF Leuchars PAR and wind farm centre	40km/ 22nm	Nil - Moderate
Bearing of wind farm centre relative to the RAF Leuchars PAR	107° (G)/ 111° (M)	
Distance between the RAF Leuchars SSR and wind farm centre	39km/ 21nm	Nil
Bearing of wind farm centre relative to the RAF Leuchars SSR	106° (G)/ 111° (M)	
Distance between the NERL Perwinnes PSR and wind farm centre	105km/ 57nm	Nil - Moderate
Bearing of wind farm centre relative to the NERL Perwinnes PSR	183° (G)/ 187° (M)	

Table J-1 Radar Distance, Bearing and Impact in relation to Neart na Gaoithe

In addition to Pager Powers assessment, NERL's online self assessment tool was consulted and shows that for a turbine blade height of 140 m there is the potential to interfere with civil aviation on the eastern edge of Neart na Gaoithe. However, the Pager Power report recognises these concerns and considers that they can be mitigated.

For Neart na Gaoithe, the following mitigation options are to be considered:

As the consultation process is already initiated and serious issues have been predicted, acceptable mitigation options will be identified early and pursued aggressively. Initial discussions will be structured as the following:

J.2.7 RAF Leuchars PSR

The RAF Leuchars PSR is highly likely to require robust mitigation to allow Neart na Gaoithe to be built. At this time, the most likely option is expected to be provision of a new in-fill radar that will not be affected by the wind turbines, but that provides adequate coverage above the wind farms. This could be achieved by terrain shielding, or perhaps by tilting the radar antenna.

If concerns are raised regarding variations in atmospheric conditions that would affect either the coverage or cause temporary wind turbine effects, it may be possible to build in easily adaptable radar parameters (such as antenna tilt) to maintain near optimum coverage through all likely atmospheric conditions. Either RAF Leuchars itself or Edinburgh Airport are possibly ideal locations for such a radar from a practical, though not necessarily from a technical, perspective, as servicing and security provisions will already be in place, and planning permission may not be required. If terrain shielding is required to avoid wind turbine effects, it may be desirable to initiate site identification work early in the site development; however, it may be preferable to

ascertain whether a radar at RAF Leuchars or Edinburgh Airport may be acceptable first. This option is also likely to require an upgrade to the infrastructure and display equipment at RAF Leuchars. It is possible that using more than one in-fill radar may not be acceptable as this may cause excessive technical complications.

An alternative mitigation option is to identify an existing radar that meets the coverage requirements. Even if a technical upgrade were required for the specific task, this is likely to be less expensive and simpler than installing and integrating a new radar. Possible radars that may be suitable include Edinburgh Airport PSR, Perwinnes PSR, and possibly even the RAF Buchan PSR. Further analysis and engagement with the MoD is required to confirm this.

J.2.8 RAF Leuchars PAR

The PAR system employed by the MoD is a 3-dimensional radar (showing aircraft location and level – most ATC radars only show aircraft location), and is particularly sensitive as it is used to guide aircraft to very low levels on approach to land in bad weather. Any impact is unlikely to be acceptably mitigated by provision of an in-fill radar. However, several factors should be considered. As the radar provides a 3-dimensional picture, it should be possible to blank out volumes of space affected by wind turbines without deleting coverage of the approach path. The radar has an advanced antenna which allows electronic beam steering. Software may be available, or may feasibly be developed, to allow the radar beam to be steered away from the wind turbines, avoiding any effects. Finally, as the radar antenna is only 5 m above ground level, if the above options are not feasible, it may be possible to build a 'radar fence', perhaps a small area of raised ground, to shield the turbines. Such an idea is not known ever to have been accepted for a surveillance radar, but it may be acceptable for a PAR system which does not need long range low level coverage that may be desirable for a surveillance system.

The MoD is understood to be currently investigating mitigation options with the radar supplier, prompted by onshore wind developments.

J.2.9 Edinburgh Airport PSR

Due to the distance from the airport, no concerns regarding the proposal are expected. However, if concerns are raised, the mitigation applied to the RAF Leuchars PSR is likely to be applicable.

J.2.10 NERL Perwinnes PSR

If a concern is raised due to the technical impact on the Perwinnes radar, it is likely that it will be deemed operationally acceptable. However, if this is not the case, the mitigation applied to the RAF Leuchars PSR is likely to be applicable.

J.2.11 Submarine Exercise Area

Concerns are not expected to be raised with respect to the submarine exercise area. If this is not the case, it seems reasonable that that the area may be relocated.

J.2.12 Other Issues

No other issues in the scope of this report are expected to require mitigation.

A further option that may become available is development of wind turbine tolerant radar technology. This could enable a radar upgrade, or perhaps a new radar to replace the existing radar (instead of providing an in-fill system). A replacement radar is likely to be simpler and cheaper than an in-fill system as it would be more easily integrated into the existing infrastructure at RAF Leuchars.

There have been several false starts in the development of such technology: it may or may not become available within required time frames required for Neart na Gaoithe.