Neart na Gaoithe Offshore Wind Farm

Environmental Impact Assessment Report

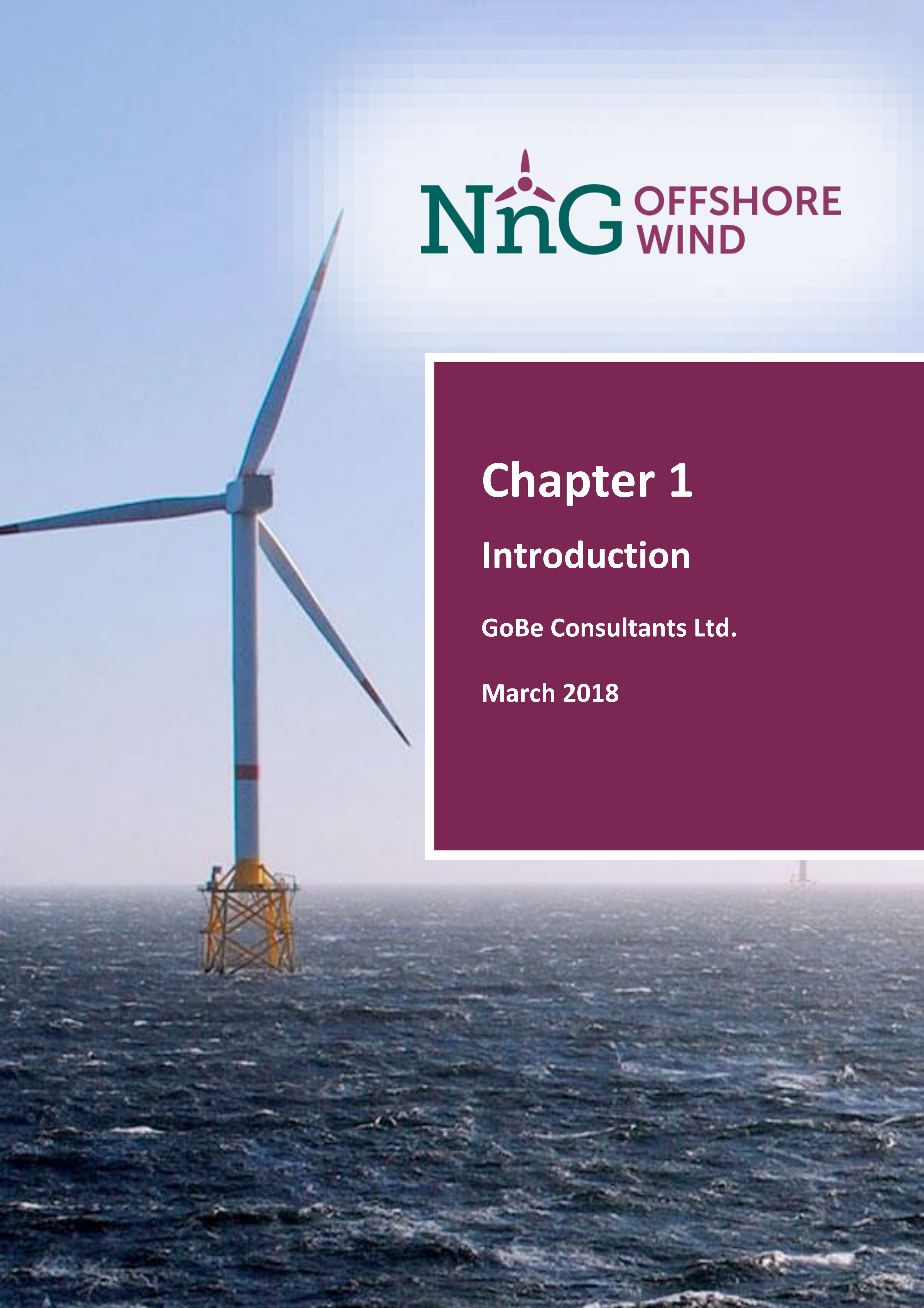
March 2018

Document Release and Authorisation Record	
GoBe Job Number	0052
MRP Document Reference	UK02-0504-0741-MRP-OFFSHORE_EIAR-RPT-A2
Date	16/03/2018

	Name	Position	Company	Signature
Prepared By	Fraser Malcolm	Senior Environmental Consultant	GoBe Consultants	[redacted]
Checked By	Steve Bellew	Director	GoBe Consultants	[redacted]
Reviewed By	Ewan Walker	Environment and Consents Manager	Mainstream Renewable Power	[redacted]
	Rosie Scurr	Environment Manager	Mainstream Renewable Power	[redacted]
Approved By	David Sweenie	Offshore Manager Scotland	Mainstream Renewable Power	[redacted]

Table of Contents

Volume 1: Main Text



Chapter 1

Introduction

GoBe Consultants Ltd.

March 2018

List of Acronyms

Abbreviation	Term
AA	Appropriate Assessment
ABZ	Aberdeen International Airport
AC	Alternating current
ACC	Area Control Centre
ADD	Acoustic Deterrent Device
ADR	Air Defence Radar
AEZs	Archaeological Exclusion Zones
AfL	Agreement for Lease
AGLV	Area of Great Landscape Value
AHD	Acoustic Harassment Device
AHER	Angus Historic Environment Record
AIP	Aeronautical Information Publication
AIRAC	Aeronautical Information Regulation and Control
AIS	Automatic Identification System
ANSP	Air Navigation Service Provider
AOD	Above Ordnance Datum
ASA	Archaeological Study Area
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
APS	Annual Population Survey
ATC	Air Traffic Control
AtoNs	Aids to Navigation
ATS	Air Traffic Service
ATDI	Advanced Topographic Development and Images
BAA	British Airports Authority
BEIS	Department for Business, Energy and Industrial Strategy
BERR	Department for Business, Enterprise and Regulatory Reform
BIS	Business Innovation and Skills
BDMPS	Biologically Defined Minimum Population Scales
BSI	British Standards Institute
BT	British Telecom (Radio Network Protection Team)
BW	Bureau Waardenburg
CAA	Civil Aviation Authority
CaP	Cable Plan
CAP	Civil Aviation Publication
CAS	Controlled Airspace
CCA	Coastal Character Assessment
CD	Chart Datum
CEC	Centre for Ecology and Hydrology
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CES	Crown Estate Scotland
CfD	Contract for Difference
CGNS	Celtic and Greater North Sea

Abbreviation	Term
CGOC	Coastguard Operations Centre
CIA	Cumulative Impacts Assessment
CICES	Chartered Institution of Civil Engineering Surveyors
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLVIA	Cumulative Landscape & Visual Impact Assessment
cm	centimetres
CMS	Construction Method Statement
CNS	Communication Navigation and Surveillance
CoP	Construction Programme
CoS	Chamber of Shipping
COWRIE	Collaborative Offshore Wind Research Into the Environment
CO_2e	CO_2 emissions
CPS	Counterfactual of Population Size
CRC	Control and Reporting Centre
cSAC	Candidate Special Area of Conservation
CTV	Crew transfer vessel
CZTVs	Cumulative ZTVs
dB	Decibels
DC	Direct current
DCC	Dundee City Council
DCF	Data Collection Framework
DECC	Department of Energy and Climate Change
dBht	decibel hearing threshold
DGC	Defence Geographic Centre
DIO	Defence Infrastructure Organisation
DMRB	Design Manual for Roads and Bridges
DOC	Declared Operational Coverage
DP	Dynamic positioning
DSC	Digital Selective Calling
DSLP	Design Specification and Layout Plan
DTI	Department of Trade and Industry
DTM	Digital terrain model
DWR	Deep Water Route
EC	European Commission
ECML	East Coast Main Line
EEZ	UK Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIA Report	Environmental Impact Assessment Report
ELC	East Lothian Council
ELCAS	East Lothian Council Archaeology Service
ELHER	East Lothian Historic Environment Record
EMF	Electro Magnetic Field
EMR	Electricity Market Reform
EPS	European Protected Species

Abbreviation	Term
ERCoP	Emergency Response Co-operation Plans
ES	Environmental Statement
ESAS	European seabirds at Sea
Esk DSFB	Esk District Salmon Fishery Board
EU	European Union
FAO	Food and Agriculture Organisation
FC	Fife Council
FCS	Favourable Conservation Status
FFA	Fife Fishermen's Association
Forth DSFB / FDSFB	Forth District Salmon Fishery Board
FHER	Fife Historic Environment Record
FL	Flight Level
FMA	Fishermen's Mutual Association (Pittenweem) Limited
FRS	Fisheries Research Services (now Marine Scotland)
FSA	Formal Safety Assessment
ft	Feet
FTE	Full Time Equivalent
FTOWDG	Forth and Tay Offshore Wind Developers Group
FTRAG	Forth and Tay Regional Advisory Group
FUs	Functional Units
GAAC	General Aviation Awareness Council
GDL	Site listed on the Inventory of Gardens and Designed Landscapes in Scotland
GES	Good Environmental Status
GHG	Greenhouse Gas
GIS	Geographic Information System
GPS	Global Positioning System
GVA	Gross Value Added
GW	Gigawatts
ha	hectares
HAT	Highest Astronomical Tide
HDD	Horizontal directional drilling
HER	Historic Environment Record
HES	Historic Environment Scotland
HGDL	Historic Garden and Designed Landscape
HMR	Helicopter Main Route
HPDI	highest posterior density intervals
HRA	Habitats Regulations Appraisal
HVAC	High Voltage Alternating Current
Hz	Hertz
IAMMWG	Inter-Agency Marine Mammal Working Group
IAIP	Integrated Aeronautical Information Package
IALA	International Association of Lighthouse Authorities
ICES	International Council for the Exploration of the Sea
ICOL	Inch Cape Offshore Limited

Abbreviation	Term
IEC	International Electrotechnical Commission
IEMA	Institute of Environmental Management and Assessment
IEEM	Institute of Ecology and Environmental Management
IFP	Instrument Flight Procedure
IHLS	International Herring Larvae Survey
IMO	International Maritime Organisation
INSPIRE	Impulsive Noise Sound Propagation and Impact Range Estimator
IPC	Infrastructure Planning Commission
iPCOD	Interim Population Consequences of Disturbance
IROPI	Imperative Reasons of Overriding Public Interest
JNAPC	The Joint Nautical Archaeology Policy Committee
JNCC	Joint Nature Conservation Committee
JR	Judicial Review
KIS - ORCA	Kingfisher Information Services – Offshore Renewables Cable Awareness
kg	Kilograms
kHz	Kilohertz
kJ	Kilojoules
km	Kilometres
km^2	Kilometres squared
l	Litres
LARS	Lower Airspace Radar Service
LAT	Lowest Astronomical Tide
LcCA	Lifecycle Carbon Analysis
LCA	Length Cohort Analysis
LCCC	Low Carbon Contracts Company
LCT	Landscape Character Type
LDP	Local Development Plan
LLA	Local Landscape Area
LoS	Line of Sight
LQ	Location Quotients
LSE	Likely Significant Effect
LVIA	Landscape and Visual Impact Assessment
m	Metre(s)
mm	Millimetres
m/s	Metres per Second
MAIB	Marine Accident Investigation Branch
MADS	Manual of Aerodrome Design and Safeguarding
MCA	Maritime and Coastguard Agency
MCEU	Marine Consents and Environment Unit
MCMP	Marine Pollution Contingency Plan
MEHRA	Marine Environmental High Risk Area
Met Mast	Meteorological mast
MGN	Marine Guidance Note
MHW	Mean High Water

Abbreviation	Term
MHWS	Mean High Water Springs
Mil AIP	Military Aeronautical Information Publication
MLS	Minimum Landing Size
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MMOb	Marine Mammal Observer
MMMP	Marine Mammal Monitoring Plan
MOD	Ministry of Defence
MPA	Marine Protection Area
MPS	Marine Policy Statement
MRCC	Maritime and Rescue Co-ordination Centre
MRP	Mainstream Renewable Power
MS	Marine Scotland
MSFD	EU Marine Strategy Framework Directive
MSL	Mean Sea Level
MS-LOT	Marine Scotland Licensing and Operations Team
MSS	Marine Scotland Science
µPa	Micropascal
MTI	Moving Target Indicator
MU	Management Unit
MV	Medium voltage
MW	Megawatts
NATS	National Air Traffic Services
NAIZ	Non-Automatic Initiation Zone
NCN	National Cycle Network
NEEMA	North-east England Management Area
NERL	NATS En-Route plc
NGET	National Grid Electricity Transmission
NnG	Neart na Gaoithe Offshore Wind Farm
NnGOWL	Neart na Gaoithe Offshore Wind Ltd.
NOAA	National Oceanic and Atmospheric Administration
NM	Nautical miles
NLB	Northern Lighthouse Board
NOTAM	Notice to Airmen
NPS	National Policy Statement
NTS	Non-Technical Summary
NtM	Notices to Mariners
NRA	Navigational Risk Assessment
NSA	National Scenic Areas
NSP	Navigational Safety Plan
OD	Ordnance Datum (Newlyn)
OFTO	Offshore Transmission Operator
O&M	Operation and maintenance
OLS	Obstacle Limitation Surfaces

Abbreviation	Term
OMP	Operation and Maintenance Programme
OfTW	Offshore Transmission Works
OnTW	Onshore Transmission Works
OREIs	Offshore Renewable Energy Installations
OS	Ordnance Survey
OSP	Offshore Substation Platform
OWEZ	Offshore Wind Farm Egmond aan Zee
OWF	Offshore Wind Farm
$\mu Pa^2 m2 \cdot s$	Pascal squared, per metre, per second
Pa	Pascal
PAC	Pre-application Consultation
PAD	Protocol for archaeological discoveries
PAM	Passive Acoustic Monitoring
PAR	Precision Approach Radar
PCH	Proportion of Birds at Collision Height
PEMP	Project Environmental Monitoring Plan
PEXA	Military Practice and Exercise Areas
PMFs	Priority marine features
PSA	Particle size analysis
PS	Piling Strategy
PSR	Primary Surveillance Radar
PTS	Permanent Threshold Shift
PVA	Population Viability Analysis
RAF	Royal Air Force
RAP	Recognised Air Picture
RCAHMS	Royal Commission for Ancient and Historic Monuments of Scotland
RCS	Radar Cross Section
RDDS	Radar Data Display Screen
RDP	Radar Data Processor
rms	root mean square
RMSE	Root-mean-square error
RNLI	Royal National Lifeboat Institution
ROCs	Renewables Obligation Certificates
ROVs	Remotely Operated Vehicles
RRH	Remote Radar Head
RSPB	Royal Society for the Protection of Birds
RTC	River Tweed Commission
RYA	Royal Yachting Association
RYAS	Royal Yachting Association (Scotland)
SAC	Special Area of Conservation
SAR	Search and Rescue
SBC	Scottish Borders Council
SBL	Scottish Biodiversity List
SCA	Scottish Canoe Association

Abbreviation	Term
SCADA	Supervisory control and data acquisition
SCANS	Small Cetaceans in the European Atlantic and North Sea
SEA	Strategic Environmental Assessment
SEL	Sound Exposure Level
SEMP	Site Environmental Management Plans
SESplan	Strategic Development Plan for South East Scotland
SEPA	Scottish Environmental Protection Agency
SFF	Scottish Fishermen's Federation
SF_6	Sulphur Hexafluoride
SIMD	Scottish Index of Multiple Deprivation
SLA	Special Landscape Area
SLVIA	Seascape, Landscape and Visual Impact Assessment
SME	Small and Medium Sized Enterprises (
SMRU	Sea Mammal Research Unit
SMS	Project Safety Management Systems
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Bodies
SNH	Scottish Natural Heritage
SOV	Service Operations Vessel
SPA	Special Protection Area
SPP	Scottish Planning Policy
SSC	Suspended sediment concentration
SSMEG	Scottish Marine Environment Group
SSS	Side Scan Sonar
SSSI	Site of Special Scientific Interest
SSR	Secondary Surveillance Radar
STW	Scottish Territorial Waters
SVQ	Scottish Vocational Qualifications
TAC	Total Allowable Catch
TAYplan	Tay Plan Strategic Development Plan
TCE	The Crown Estate (now Crown Estate Scotland (CES))
TMZ	Transponder Mandatory Zone
TRA	Temporary Reserved Area
TS	Transport Scotland
TS(P&H)	Transport Scotland (Ports and Harbours)
TSS	Traffic Separation Scheme
TTS	Temporary Threshold Shift
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKHO	United Kingdom Hydrographic Office
UPS	Uninterruptable Power System
V	Volt
VCUs	Vessel capacity units
VHF	Very High Frequency

Abbreviation	Term
VMS	Vessel Monitoring System
VP	Viewpoint
VFR	Visual Flight Rules
VRLA	Valve regulated lead acid
WA	Wessex Archaeology
WDC	Whale and Dolphin Conservation
WROWF	Westermost Rough Offshore Wind Farm
WSI	Written Scheme of Investigation
WWI	World War
WWII	World War II
YPEC	Young Planning & Energy Consenting
ZTV	Zones of Theoretical Influence

Table of Contents

Table of Figures

Table of Tables

1 Introduction

1.1 Neart na Gaoithe Offshore Wind Farm

1. Neart na Gaoithe Offshore Wind Ltd (hereafter referred to as 'NnGOWL'), a wholly owned subsidiary of Mainstream Renewable Power Limited (hereafter referred to as 'Mainstream'), is developing the Neart na Gaoithe Offshore Wind Farm (hereafter referred to as 'the Project'). The Project is a proposed offshore wind farm located in the outer Firth of Forth, with a maximum generating capacity of 450 megawatts (MW) (see Figure 1.1, Volume 2).
2. The Project will be comprised of the Offshore Wind Farm (the wind turbines, their foundations and associated inter-array cabling); and the Offshore Transmission Works (OfTW) (comprising the Offshore Substation Platform(s) (OSP(s)), their foundations and the Offshore Export Cables).
3. The overall objective of the proposed development is to generate renewable electricity to feed into the national grid, to reduce reliance on fossil fuels, thereby reducing future levels of atmospheric CO_2 and other greenhouse gases.
4. The Project will be connected to the national grid via the Onshore Transmission Works (OnTW), which were subject to a separate planning application (under the Town and Country Planning (Scotland) Act 1997) which was granted by East Lothian Council in June 2013. The permission was subsequently amended by an application under Section 42 of the Town and Country Planning (Scotland) Act 1997 (as amended) in November 2015 and advance construction works were undertaken in August 2016.

1.2 Purpose of this EIA Report

5. This Environmental Impact Assessment Report (EIA Report) is provided to accompany the application to the Scottish Ministers for a Section 36 Consent under the Electricity Act 1989 and Marine Licences under the Marine (Scotland) Act 2010. The EIA Report is submitted pursuant to the requirements of The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017. These regulations transpose the amendments made to the Environmental Impact Assessment (EIA) Directive 2011/92/EU by Directive 2014/52/EU and came into effect on 16 May 2017. Since NnGOWL requested a scoping opinion prior to this date, this EIA Report has been prepared in accordance with the transitional arrangements set out within these regulations. Further information on the relevant legislation and the consenting process is set out in Chapter 2: Policy and Legislation.
6. The scope of the EIA Report was developed through the 15/05/17 request by NnGOWL for a scoping opinion from the Scottish Ministers and through consultation with statutory and non-statutory consultees (see Chapter 5: Scoping and Consultation). The Scoping Report (NnGOWL, 2017) which accompanied the request for a scoping opinion is available online via the Scottish Government Marine Licensing website (http://www.gov.scot/Topics/marine/Licensing/marine/scoping/NnGRev2017).
7. The Scoping Opinion (Marine Scotland, 2017) was issued by Marine Scotland Licensing Operations Team (MS-LOT) on 8 September 2017 and is also available to download from the same website. Further information on the scoping of this EIA Report and the consultation undertaken is provided in Chapter 5: Scoping and Consultation.
8. This EIA Report provides a description of the Project and its likely significant effects on the environment seaward of Mean High Water Springs (MHWS). The OnTW are not considered in detail by this EIA Report, except where it has been necessary to address intertidal elements or other relevant inter-related effects, as they were subject to a separate EIA that accompanied the application for the OnTW planning permission (as described above in Section 1.1).

1.3 The Developer of the Neart na Gaoithe Offshore Wind Farm

9. NnGOWL is the developer of the Project. NnGOWL is a wholly owned subsidiary of Mainstream and was created specifically for the development of the Project.

10. The contact address of NnGOWL is shown in Table 1.1 below:

Table 1.1 Contact address for NnGOWL

Contact Address
Neart na Gaoithe Offshore Wind Limited **c/o Mainstream Renewable Power Limited** **2 West Regent Street** **Glasgow** **G2 1RW**

11. Mainstream was founded by Eddie O'Connor in 2008 to develop wind and solar plants around the world. The company has a global development portfolio of over 9 Gigawatts (GW), consisting of both onshore (wind and solar) and offshore wind projects across four continents.

12. Collectively, Mainstream has over 600 years of combined experience in those areas critical to project development. Mainstream has a set of values which create a strong foundation for decision making at the project and company level. These values include a focus on working with others and respecting those that the organisation works with, and these have been reflected in the extensive consultation carried out for the Project. Mainstream's values are illustrated in the box below, and further information is available at www.mainstreamrp.com.

Mainstream Renewable Power: Values

- **Safety: We believe in a safe environment for all our people.**
- **Respect: We believe in showing personal respect for everyone we deal with.**
- **Working Together: We believe that by working together as a team, we deliver more.**
- **Entrepreneurship: We believe that an entrepreneurial approach will find the solutions others can't see.**
- **Sustainability: We believe in a sustainable approach to everything we do.**
- **Innovation: We believe that by embracing innovation we will stay ahead of the game.**
- **Integrity: Integrity is always doing the right thing, even when no-one is watching.**

13. Health and Safety is integral to all that Mainstream does. Ensuring a safe working environment for personnel and the public is Mainstream's primary concern. In addition to ensuring all necessary and relevant legislation is adhered to, Mainstream applies its certified Integrated Management System to all operations.

14. The company has extensive offshore wind experience and was successful in progressing the Hornsea Zone off the east coast of England, developed by SMart Wind - a joint venture with Siemens Projects Ventures and investor DONG Energy (now Ørsted). In 2010, SMart Wind won The Crown Estate's Round 3 tender to develop the Zone. The project reached a number of milestones including consent for Project One (1,200MW), Project Two (1,800 MW), and the delivery of the very successful SMart Futures schools programme. In February 2015, DONG Energy bought 33% of the Hornsea Zone and in August 2015 they exercised the right to purchase the remainder of the Hornsea Zone.

15. Mainstream is also actively developing wind and solar plants onshore in the US, Canada, Chile and South Africa.

1.4 Project Overview

1.4.1 Project Background

16. In May 2008, The Crown Estate (TCE) (now Crown Estate Scotland (CES)) invited developers to bid for potential offshore wind farm sites within Scottish Territorial Waters (STW). Following the bid, TCE offered exclusivity agreements for ten sites around Scotland, with the potential to generate over 6 GW of offshore wind power. Mainstream was awarded one of these exclusivity agreements for the site now known as Neart na Gaoithe.

1.4.1.1 Original Application and Consents

17. NnGOWL submitted an application for consent under Section 36 of the Electricity Act 1989 and for associated Marine Licences under the Marine (Scotland) Act 2010 in July 2012. The application was supported by an Environmental Statement (ES) and subsequently in June 2013, by an Addendum of Supplementary Environmental Information (hereinafter referred to as the 'Addendum').

18. The Section 36 Consent and the Marine Licences were granted by the Scottish Ministers in October 2014, following over five years of project development, including environmental surveys, engineering design studies and wide-ranging stakeholder engagement. The development as consented in October 2014 is hereafter referred to as 'the Originally Consented Project'.

19. In 2015, NnGOWL applied for a Section 36 Consent Variation, seeking to vary the Section 36 Consent in order to modify a number of parameters relating to the wind turbines. Specifically, the variation was sought to allow:

- An increase in the maximum rated turbine capacity from 6 MW to 7 MW (the maximum generating capacity of 450 MW was to stay the same);
- A change in maximum wind turbine hub height, from 107.5 metres (m) to 115 m above Lowest Astronomical Tide (LAT); and
- A change in maximum turbine platform height from 18 m to 21 m above LAT.

20. The Section 36 Consent Variation was awarded by the Scottish Ministers in March 2016. This varied Section 36 Consent and the Marine Licences granted in October 2014 are collectively referred to as 'the Consents' hereafter.

21. The decision by the Scottish Ministers to consent the Originally Consented Project (and 3 other offshore wind farms) in 2014 was challenged by the Royal Society for the Protection of Birds (RSPB) by way of Judicial Review (JR) in January 2015. The Outer House of the Scottish Court of Session ruled in favour of the RSPB in July 2016. The JR decision was appealed by the Scottish Ministers, NnGOWL and the other affected developers at the Inner House of the Scottish Court of Session, and the outcome of that appeal was announced on 16 May 2017 whereby the original JR judgement was overturned. An application by the RSPB to the Scottish Court of Session to appeal to the Supreme Court was refused on 19 July 2017. On 15 August 2017, the RSPB made an application directly to the Supreme Court for permission to appeal. On 7 November 2017, the Supreme Court refused permission to appeal 'on the grounds that the application does not raise an arguable point of law of general public importance which ought to be considered at this time, bearing in mind that the case has already been the subject of judicial decision and reviewed on appeal.'

22. The original consents therefore remain valid. It is NnGOWL's intention to construct either the Originally Consented Project (as amended by the Section 36 Consent Variation) or the Project, but not both.

1.4.2 Overview of the Project

23. The Project is located in the outer Firth of Forth, approximately 15.5 kilometres (km) east of Fife Ness (see Figure 1.1 (Volume 2)). The area in which the Project will be located is referred to as the 'Development Area'. This is further divided into two discrete areas referred as the 'Wind Farm Area', comprising the geographical area where the wind turbines, inter-array cables, OSPs and other associated infrastructure will be located; and the 'Offshore Export Cable Corridor', comprising the geographical area within which the Offshore Export Cables will be located and the landfall area (see Figure 1.1 (Volume 2)).
24. The Wind Farm Area will cover an area of approximately 105 km^2. A detailed project description is presented in Chapter 4: Project Description, but the following provides a brief overview of the main aspects of the Project.
25. A maximum of 54 wind turbines will be installed in the Wind Farm Area. The turbine foundations will utilise a steel lattice jacket with piled foundation design.
26. In addition to the turbines, up to two OSPs will be installed, and a meteorological mast may also be installed within the Wind Farm Area.
27. Subsea inter-array cables will be required to connect the turbines to each other and to the OSP(s). In the event that two OSPs are installed, there will be interconnector cables installed between the OSPs. A pair of Offshore Export Cables, each 43km in length, will run from the OSP(s) to the landfall point at Thorntonloch, south of Torness Power Station in East Lothian.
28. Underground Onshore Export Cables will connect the Project to a new onshore substation located adjacent to the existing substation for the 'Crystal Rig II' onshore wind farm, where it will then connect to the national grid. The OnTW will also include up to two transition pits at the landfall (landward of MHWS) where the Offshore Export Cables and Onshore Export Cable will be connected. For the avoidance of doubt, onshore infrastructure is the subject of planning permission under the Town and Country Planning (Scotland) Act 1997 (as amended) and does not form part of the Project.
29. Construction activities are anticipated to commence offshore in early 2021 and will last for approximately 2 years.
30. The lease agreement with TCE is for up to 50 years, with the Project potentially operating over this full lease period.
31. At the end of the lease period, decommissioning of the offshore infrastructure will be required. A Decommissioning Programme will be submitted to Scottish Ministers prior to the commencement of construction in accordance with Chapter 3 of Part 2 of the Energy Act 2004.
32. Prior to the commencement of any decommissioning works, the Decommissioning Programme will be reviewed and revised as required to take account of good industry practice at that time. However, it is assumed at this stage that decommissioning would involve the complete removal of most or all structures and materials above the seabed, unless otherwise approved.
33. The decommissioning process is discussed further in Chapter 4: Project Description.

1.5 The EIA Team

34. The NnGOWL and Mainstream teams are highly experienced in the development and construction of renewable energy projects. The NnGOWL team has been supported during the EIA process by a number of specialist, independent and suitably qualified consultants.
35. GoBe Consultants Limited has project managed the production of this EIA Report, assisting NnGOWL with the compilation of the baseline data, analysis and interpretation, the assessment process including Cumulative Impact Assessment (CIA), consenting, mitigation and monitoring. GoBe also managed the

production of the Scoping Report (NnGOWL, 2017) which was submitted in support of the request for a scoping opinion.

36. Specialist consultants, listed in Table 1.2, have supported the EIA to date, including consultation with relevant stakeholders and preparation of the specialist chapters of the EIA Report. In line with the requirements of the 2017 EIA regulations, and as required by the Scoping Opinion, Table 1.2 provides a brief summary of the relevant expertise and experience of the technical consultants involved in preparing this EIA Report.

Table 1.2 Project EIA technical specialist consultants

Technical specialism	Consultant	Relevant expertise and experience
Introductory and summary chapters	GoBe Consultants Ltd	GoBe is an environmental and planning consultancy with a focus on providing EIA and consenting services to the offshore wind farm industry. Having involvement since the earliest UK sites, GoBe have been involved in the EIA and consenting of circa 19GW to date. GoBe staff are IEMA or CIEEM members (or working towards membership). GoBe is currently seeking IEMA Company membership.
	Young Planning & Energy Consenting Ltd	Young Planning & Energy Consenting (YPEC) are commercial town planning consultants based in Edinburgh, specialising in the consenting of major electricity and energy infrastructure. YPEC personnel have been involved in the consenting of a number of major energy developments across Scotland and the UK and regularly input to the drafting and co-ordination of application documentation, including EIA Reports. YPEC staff are chartered members of the Royal Town Planning Institute.
Fish and Shellfish Ecology	GoBe Consultants Ltd	See above.
Underwater Noise Assessment	Genesis Oil and Gas Ltd	Genesis is a leading provider of environmental consulting services offering robust, innovative and practical advice to the Energy Sector through: licencing & exploration; design; installation; and operations and decommissioning. We provide environment consultancy services globally spanning offshore to onshore, populated to remote and environmentally sensitive areas.
Marine Mammals and Habitats Regulation Assessment	Pelagica Environmental Consulting Ltd	Pelagica is an independent environmental consultancy providing advice and support in the consenting of offshore energy projects. Pelagica has been involved in the preparation of over 50 EIAs and other consent applications; specialising in assessing potential impacts on birds and marine mammals for developments in the UK and overseas. Having prepared 36 Habitats Regulations Assessments, including 19 for UK offshore wind farms, Pelagica has extensive experience in undertaking comprehensive and robust HRAs

Technical specialism	Consultant	Relevant expertise and experience
Ornithology	Cork Ecology (with input from Bureau Waardenburg)	Cork Ecology is an environmental consultancy specialising in bird surveys and reporting for EIA in both Ireland and the UK. Established in 2001, Cork Ecology staff have been involved in several offshore wind projects in Ireland and the UK, covering survey design, ESAS surveyor training, survey data analysis and EIA. Bureau Waardenburg is an independent research and advice consultancy working in the fields of ecology, nature, the environment and landscape design. Bureau Waardenburg have experience of assessing the effects of a variety of large infrastructures, such as wind turbines, power lines, ports, airports and roads, on birds. Since 1993, Bureau Waardenburg has carried out research into the impact of wind turbines and has studied the spatial and temporal movements of birds at various locations both in the Netherlands and abroad.
Commercial Fisheries	Poseidon Aquatic Resource Management Ltd	Poseidon Aquatic Resource management Ltd (Poseidon) are fisheries consultants working globally providing advice in support of sustainable fisheries and aquaculture, marine planning, and blue growth. Poseidon established in 2001 and has a core staff of five highly qualified technical experts, with a skill set that encompasses fisheries and aquaculture economics, environmental impact assessment, policy and management, capacity development and fisheries certification. Poseidon has a broad experience of delivering commercial fisheries impact assessments for a range of renewable energy developments, from tidal arrays to nationally significant offshore wind farm projects.
Shipping and Navigation	Anatec Ltd	Anatec has extensive experience of carrying out NRAs for offshore installation projects including offshore renewables, oil and gas installations, ports, marinas, cables, interconnectors and marine aggregate dredging in the UK and worldwide. Our key personnel have been at the forefront of the marine hazard analysis and risk management field for the past 15-25 years. In the past ten years, Anatec have completed NRA, PEIR and ES chapters for the majority of Scottish territorial water sites as well as The Crown Estate round one, two, two extension and three projects.
Military and Civil Aviation	Osprey Consulting Services Ltd	Osprey Consulting Services Ltd (Osprey) is a privately held, award winning specialist technical company founded in 2006. Osprey are a highly credible, informed consultancy operating exclusively on aviation projects. The majority of our staff have worked in either operational or influential stakeholder roles and many of them have previously been members of the Regulatory Community. Our services have been developed to apply across the broad spectrum of challenges met by the aviation market: from full system procurements through to regulatory support, specialist studies and due diligence. Osprey has supported over 300 wind farm projects in the UK and overseas which include onshore and offshore developments. Our assessments which cover the whole of a development life cycle include feasibility studies, site impact assessment (including radar line of sight analysis), stakeholder management, evaluation of mitigation options and authoring of technical and EIA documents to support the planning process.

Technical specialism	Consultant	Relevant expertise and experience
Marine Archaeology and Cultural Heritage	Wessex Archaeology Ltd	Wessex Archaeology is the leading provider of marine archaeological consultancy to the offshore wind industry, working on sites throughout the UK and Europe. Wessex are a Registered Organisation with the Chartered Institute for Archaeologists, and the majority of our staff are also members of CIfA, or other relevant professional body such as Fellows of the Geological Society.
Seascape, Landscape and Visual Impact Assessment	Land Use Consultants Ltd	LUC is an IEMA Quality Mark registered environmental consultancy providing planning, impact assessment, landscape design and ecology services to a wide range of public and private sector clients. LUC's team of Chartered Landscape Architects has been providing trusted advice on the design and impact of wind energy and marine renewables for over 15 years.
Socioeconomics	Regeneris Consulting Ltd	Regeneris Consulting is an independent economics consultancy and possesses strong experience in analysing the economic impacts of the UK offshore wind sector. Regeneris has produced ES Chapter Socio-Economic Assessments for eight UK offshore wind farms over the last five years, as well as completing numerous other economic impact reports for offshore wind farms outside of the planning process.

1.6 Structure of the EIA Report

37. The EIA Report comprises 17 chapters together with accompanying figures and appendices, and a stand-alone Non-Technical Summary (NTS) document. The full EIA Report is available to download on the Scottish Government Marine Licensing website: http://www.gov.scot/Topics/marine/Licensing/marine/scoping/NnGRev2017.

38. The EIA Report is set out in a logical and sequential manner. Topics are discussed in full within a single, stand-alone chapter, i.e. the baseline description, impact assessment (alone and cumulative), mitigation measures and conclusions for each receptor.

39. The EIA Report is structured as follows:

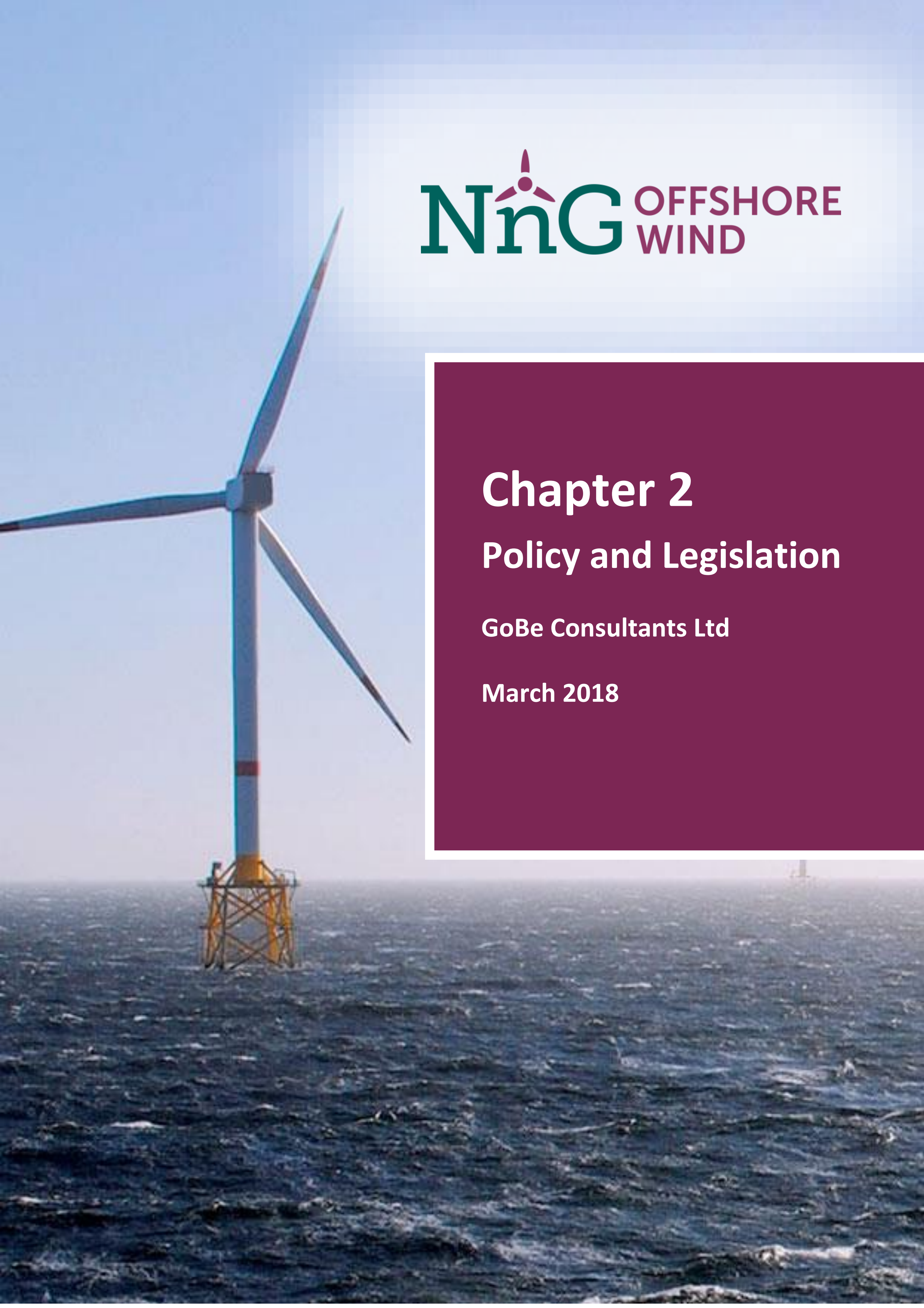
- Introduction and background:
  - Chapter 1 – Introduction;
  - Chapter 2 – Policy and Legislation;
  - Chapter 3 – The Need for the Project, Site Selection and Alternatives;
  - Chapter 4 – Project Description;
  - Chapter 5 – Scoping and Consultation; and
  - Chapter 6 – EIA Methodology.
- Offshore biological environment:
  - Chapter 7 – Fish and Shellfish Ecology;
  - Chapter 8 – Marine Mammals; and
  - Chapter 9 – Ornithology.
- Offshore human environment:
  - Chapter 10 – Commercial Fisheries;
  - Chapter 11 – Shipping and Navigation;
  - Chapter 12 – Military and Civil Aviation;
  - Chapter 13 – Cultural Heritage;
  - Chapter 14 – Seascape, Landscape and Visual Impact Assessment; and
  - Chapter 15 – Socio-economics.
- Summary and conclusion:

  - Chapter 16 – Summary of the EIA; and
  - Chapter 17 – Summary of Mitigation Measures.
- Appendices:

Appendix number	Appendix title
2.1	Marine Planning Policy Review
5.1	Offshore HDD Construction Noise Assessment
5.2	Construction Noise and Vibration Technical Note
6.1	List of Cumulative Projects
7.1	Benthic characterisation survey report (EMU, 2010)
7.2	Atlantic Salmon – Appraisal of Original EIA Determinations
8.1	Neart na Gaoithe Offshore Wind Farm Noise Modelling – Technical Report
8.2	iPCoD Population Modelling Technical Report
8.3	European Protected Species Licence Assessment
9.1	Population and density estimates of seabirds at within the Ornithology Study Area
9.2	Baseline surveys – Summary of key species data
9.3	Collision Rate Modelling Technical Appendix
9.4	Displacement matrices for Forth and Tay Area
9.5	Mainstream Kittiwake and Auk Displacement Study – Westermost Rough (APEM. 2017)
9.6	GPS tracking maps for kittiwake, guillemot and razorbill from CEH tagging studies.
9.7	GPS tracking maps for breeding gannets from Bass Rock.
9.8	Population Viability Analysis (PVA) Technical Report
9.9	Cumulative Assessment Additional Calculations
10.1	Commercial Fisheries Technical Report
11.1	Navigational Risk Assessment
11.2	AIS Traffic Validation Report
11.3	MGN543 Checklist
12.1	Radar Line of Sight Analysis Technical Report
13.1	Gazetteer of Wrecks, Obstructions and Geophysical Anomalies
13.2	Gazetteer of Onshore Setting Receptors
14.1	SLVIA Technical Report

1.7 References

- NnGOWL (2017) *Neart na Gaoithe Offshore Wind Farm Scoping Report. May 2017; Doc Ref: UK02-0504-0673-MRP-NNG SCOPING REPORT 2017-RPT-A1*
- Marine Scotland (2017) Scoping Opinion For The Proposed Section 36 Consent And Associated Marine Licence Application For The Revised Neart Na Gaoithe Cape Offshore Wind Farm And Revised Neart Na Gaoithe Offshore Transmission Works. Dated September 2017. Available from: http://www.gov.scot/Resource/0052/00524490.pdf



NnG OFFSHORE WIND

Chapter 2

Policy and Legislation

GoBe Consultants Ltd

March 2018

Table of Contents

Table of Tables

2 Policy and Legislation

2.1 Introduction

1. This Chapter of the EIA Report provides a summary of the policy and legislative context for the Project, specifically in relation to:
   - A brief overview of international obligations and policy, including European legislation, relating to climate change, reducing greenhouse gas (GHG) emissions and the role of renewable energy;
   - UK and Scottish climate change and energy legislation and policy;
   - The Scottish offshore wind consenting legislation and process;
   - Other legislation that may be relevant to the Project; and
   - Scottish offshore wind planning policy.
2. Where policy or legislation exists in respect of specific topics, particularly in respect of EIA, this is identified in the relevant topic chapters of the EIA Report.
3. Scotland and the UK as a whole, require new, renewable sources of energy to combat climate change through decarbonisation of the power sector and to ensure that a secure supply of electricity is available to meet increased future demand. The provision of new renewable energy capacity will help government meet legally binding national and international commitments on climate change.
4. Offshore wind generation has been identified at European and national levels as being capable of providing a significant contribution towards such commitments. The STW sites, which include the Project, are recognised as being important contributors to Scotland's and the UK's targets for reducing GHG emissions and generating electricity from renewable energy sources.
5. This Chapter provides the overarching policy context for the Project and the background to the need for the Project at an international and national level. Additional socioeconomic benefits of the Project are discussed in Chapter 15: Socioeconomic Assessment.

2.2 Climate Change and Renewable Energy Legislation and Policy

2.2.1 International Commitments

6. The Kyoto Protocol is an international agreement, linked to the United Nations Framework Convention on Climate Change, which commits its Parties to reduce GHG emissions by setting internationally binding emission reduction targets. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005.
7. At the Paris ('COP21') climate conference in December 2015, 195 countries adopted the first-ever universal legally binding global climate agreement (at the time of writing this had been ratified by 160 parties, including the EU and the UK). The agreement sets out a global action plan to put the world on track to avoid dangerous climate change by limiting a global temperature rise to well below 2°C.

2.2.2 European Legislation and Policy

8. The European Commission (EC) has developed a number of mechanisms to reduce GHG emissions and to focus effort on strengthening and diversifying the generation and supply of energy in response to the international commitments made at Kyoto and in Paris. The following section summarises some of the main targets and legislation relating to climate change and renewable energy.

2.2.2.1 2020 Targets

9. In 2008, the European Parliament and Council agreed a climate and energy package known as the 20-20-20 targets. The targets to be achieved by 2020 include:
   - A reduction in European Union (EU) GHG emissions of at least 20% below 1990 levels;
   - 20% of EU energy consumption to come from renewable energy sources; and
   - 20% reduction in primary energy use compared with projected levels, to be achieved by improvements in energy efficiency.

10. In order to meet these ambitious targets, the EU introduced Directive 2009/28/EC on the promotion of the use of energy from renewable sources (the Renewable Energy Directive). Article 3 and Annex I of this Directive set out the mandatory national targets for individual Member States to meet by 2020.

11. As part of this, the UK is subject to a mandatory national target of deriving 15% of gross final energy consumption from renewable sources by 2020. Due to the relative inflexibility of other sectors, meeting this 15% target will require between 30% to 40% of UK electricity consumption to come from renewable sources (DECC, 2009).

2.2.2.2 2030 Targets

12. In October 2014, EU countries agreed on a 2030 framework for climate and energy, which included targets and policy objectives for the period between 2020 and 2030. The targets to be achieved by 2030 include:
    - At least a 40% cut in GHG emissions compared to 1990 levels;
    - At least a 27% share of renewable energy consumption; and
    - At least 27% energy savings compared with the business-as-usual scenario.

13. To meet the targets, the EC has proposed:
    - A reformed EU emissions trading scheme;
    - New indicators for the competitiveness and security of the energy system, such as price differences with major trading partners, diversification of supply, and interconnection capacity between EU countries; and
    - First ideas on a new governance system based on national plans for competitive, secure, and sustainable energy. These plans will follow a common EU approach. They will ensure stronger investor capacity, greater transparency, enhanced policy coherence and improved co-ordination across the EU.

14. In order to meet these targets, the EC published a proposal for a revised Renewable Energy Directive on 30 November 2016 which is currently under consideration.

2.2.2.3 2050 Low Carbon Economy

15. In addition, the EC is looking at cost-efficient ways to make the European economy more climate-friendly and less energy-consuming. Its low-carbon economy roadmap suggests that:
    - By 2050, the EU should cut GHG emissions to 80% below 1990 levels;
    - Milestones to achieve this are 40% emissions cuts by 2030 and 60% by 2040;
    - All sectors need to contribute; and
    - The low-carbon transition is feasible and affordable.

2.3 UK Climate Change and Energy Legislation

2.3.1.1 The Climate Change Act 2008

16. The Climate Change Act 2008 introduced carbon budgets, which put legally binding limits on the amount of greenhouse gases the UK can emit over a five-year period. These carbon budgets are intended to set out a cost-effective path to achieving longer term climate targets. To date, five carbon budgets have been put into law that run up to 2032 as summarised in Table 2.1.

Table 2.1: Summary of the Five Carbon Budgets in United Kingdom (UK) Law to 2032

Budgetary Period	Years covered	Carbon Budget (MtCO2)	Average annual reduction (cf. 1990)
1	2008-2012	3018	-23%
2	2013-2017	2782	-29%
3	2018-2022	2544	-35%
4	2023-2027	1950	-50%
5	2028-2032	1725	-57%
6	2033-2037	Set by 30/06/21	-
-	-	-	-
-	2050	160	-80%

17. The government subsequently produced Carbon Plans (the first being published in 2009 and the second in 2011) which set out detailed proposals and policies for meeting the carbon budgets across government. The plans deal with matters such as energy efficiency, low carbon transport and industry and electricity generation. In relation to this last point the importance of offshore wind generation is noted in the most recent plan published in 2011.

2.3.1.2 The Energy Act 2013

18. The 2013 Energy Act contains provisions for Electricity Market Reform (EMR). The EMR sets out the framework for replacing Renewables Obligation Certificates (ROCs) with Contracts for Difference (CfD) to provide stable financial incentives to encourage investment in low carbon electricity generation.

19. CfDs are private contracts between a low carbon electricity generator and the UK Government owned Low Carbon Contracts Company (LCCC). Under a CfD, the electricity generating party is paid the difference between the strike price (the price for electricity reflecting the cost of investment in low carbon technology) and the reference price (a measure of the average market price for electricity in the Great Britain market) where the reference price is below the strike price.

20. The aim of CfDs is to give greater certainty and stability of revenues to electricity generators by reducing exposure to volatile wholesale prices, whilst at the same time protecting the consumer from paying for higher generation support costs when electricity prices are high. It is envisaged that CfDs will help to incentivise renewable energy development in the UK.

21. In April 2014, a total of eight projects were awarded Investment Contracts (i.e. early CfDs) under the 'Final Investment Decision (FID) Enabling for Renewables' process, thereby allocating the first CfDs that were introduced through the EMR programme. Of these eight projects, five were offshore wind farm projects (Beatrice, Burbo Bank Extension, Dudgeon, Hornsea Project One, Walney Extension). In February 2015, 27 projects were awarded CfDs in Allocation Round One, two of which were offshore wind projects. The Project was one of those awarded a CfD.

22. The results of the most recent CfD Allocation Round (Round Two) were announced in September 2017. The awarded contracts included allocations for three offshore wind farm projects – Hornsea Project Two, Triton Knoll and, in Scotland, the Moray East project in the Moray Firth.

2.3.2 Scottish Climate Change Legislation and Policy

2.3.2.1 The Climate Change (Scotland) Act 2009

23. The UK's target under the Renewable Energy Directive is delivered by individual targets for England, Wales, Scotland and Northern Ireland. The Scottish Government's commitment to tackling climate change is laid out in the Climate Change (Scotland) Act 2009, which sets an interim target of a 42% reduction in GHG emissions by 2020, in addition to the UK target of an 80% reduction by 2050.

2.3.2.2 Scottish Renewable Energy Policy

24. The Scottish Government and Marine Scotland have developed a number of strategy and policy positions that sit within and reflect broader global, EU and UK Government Directives, regulations, plans and policies aimed at tackling climate change and delivering energy security.

2020 Route Map for Renewable Energy in Scotland

25. At a local level, the 2020 Route Map for Renewable Energy in Scotland (Scottish Government, 2011a) sets out how Scotland will achieve its target to meet an equivalent of 100% demand for electricity from renewable energy by 2020, as well as its target of 11% renewable heat. The 2020 Route Map is an update and extension to the Scottish Government's Renewables Action Plan 2009.
26. Further updates to the Route Map were published in September 2015 (Scottish Government, 2015a). This update reports on progress on development across the renewables sector and towards reaching the 2020 targets, highlighting that provisional figures showed renewable sources generated a record 49.8% of Scotland's gross electricity consumption in 2014.
27. The 2020 Routemap for Renewable Energy in Scotland places considerable emphasis on the role of offshore wind in delivering targets. The Scottish Government is fully supportive of the offshore wind sector, recognising both the potential energy generation and economic development opportunities provided by the deployment of wind turbines around Scotland's shores.

Draft Scottish Energy Strategy: The Future of Energy in Scotland

28. In January 2017, the Scottish Government issued, for consultation, its Draft Energy Strategy for Scotland. This sets out Scotland's 2050 vision for energy, which encompasses the development of a strong low carbon economy, building on the 2020 Route Map, and development of a modern, integrated clean energy system for Scotland. The focus of the strategy is on continued growth of the economy through secure, reliable and affordable energy supplies. The strategy examines Scotland's current energy mix and provides a framework for the future growth of technologies and fuels that will be required to supply Scotland's energy needs over the coming decades (Scottish Government, 2017). With regard to offshore wind, the report highlights:

    - "There is huge optimism for further development of offshore wind in Scotland. Scottish waters remain open for business and the pipeline of development continues to grow.
    - 25% of Europe's offshore wind resource can be found around Scotland's coastline.
    - Offshore wind is a large-scale technology with the potential to play a pivotal role in our energy system over the coming decades.
    - Innovation in offshore wind, and especially in technologies like floating wind, which offer scope for development in deeper water, will play a significant role in positioning Scotland as a world centre for energy innovation."

2.4 Scottish Offshore Wind Consenting Regime and Legislation

29. This section describes the legislative requirements relevant to the consenting and development of the offshore aspects of the Project.

30. Table 2.2 below summarises the main consents which are being sought for the Project.

Table 2.2: Summary of the main consents required for the Project (seaward of MHWS)[1]

Key Legislation and Consent sought	Relevant Project Element	Requirements for the Project	Licensing Authority
Electricity Act 1989 – Section 36 Consent	Offshore Wind Farm	Section 36 consent from the Scottish Ministers is required for applications to construct and operate an offshore wind farm above 1 MW in generation capacity within STW.	MS-LOT acting on behalf of the Scottish Ministers
Marine (Scotland) Act 2010 – Marine Licences	Offshore Wind Farm and The OfTW.	Marine Licences granted by the Scottish Ministers are required for activities listed under Part 4 of the Marine (Scotland) Act 2010. This includes proposals to construct, alter or improve works within Scottish waters. A Marine Licence is required for the Offshore Wind Farm and a second is required for the OfTW,	MS-LOT acting on behalf of the Scottish Ministers

2.4.1 The Electricity Act 1989 (Section 36 Consent and 36A Declaration)

31. The construction and operation of a wind farm (of greater than 1 MW capacity) in STW requires consent under Section 36 of the Electricity Act 1989. A Section 36 Consent is required for all elements of the generating station and for the purposes of the Project this includes the wind turbines and inter-array cables (but does not include the OfTW).

32. In addition, under Section 36A of the Electricity Act, an application has been made to extinguish public rights of navigation in so far as they pass through those parts of Scottish waters where structures forming part of the Project are to be located (but not, for the avoidance of doubt, the areas of sea between those structures).

2.4.2 Marine (Scotland) Act 2010 (Marine Licences)

33. The Marine (Scotland) Act 2010 regulates activities within STW (where the Project is to be entirely located). A Marine Licence is required for the carrying out of licensable marine activities in Scottish waters. Licensable marine activities include, among other things, the deposit from a vessel of substances or objects on or under the seabed, and the construction, alteration and improvement of any works in or over the sea, or on or under the seabed. The Scottish Ministers are responsible for issuing Marine Licences under the Marine (Scotland) Act.

34. An application is being made for a Marine Licence for the licensable marine activities associated with the Offshore Wind Farm (the Generation Station Marine Licence), with a separate Marine Licence application being made for the OfTW seaward of MHWS (the OfTW Marine Licence).

35. In considering the Marine Licence applications the Scottish Ministers are required to take any decision in accordance with the "appropriate marine plans" (i.e. the National Marine Plan and any relevant Regional Marine Plan, unless relevant considerations indicate otherwise) (see Section 2.6 below).

36. When making their decision, the Scottish Ministers must also consider:

- The need to protect the environment;

[1] The planning permission for the OnTW landward of Mean Low Water Springs (MLWS) was granted by East Lothian Council in June 2013.

- The need to protect human health;
- The need to prevent interference with legitimate uses of the sea;
- The effects of any use intended to be made of the works in question when constructed;
- Any representations made by anyone with an interest in the outcome of the Marine Licence application; and
- Such other matters as the Scottish Ministers consider relevant.

2.4.3 The EIA Regulations

37. The EIA Regulations relevant to an application for Section 36 Consent are the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and in relation to Marine Licenses, the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017. These Regulations came into force on 16 May 2017 and set out the statutory process and requirements for EIA in accordance with the new EIA Directive (2014/52/EU).

38. A request for a scoping opinion was submitted to MS-LOT on 15 May 2017 (i.e. prior to the regulations noted above coming into force) and therefore the transitional arrangements set out within those regulations apply to the Project, meaning that certain aspects of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 and the Marine Works (Environmental Impact Assessment) Regulations 2007 (the 2000 EIA Regulations and the 2007 EIA Regulations respectively) continue to apply (i.e. in relation to the scope of the EIA Report etc.).

39. Further details on the EIA requirements and the EIA process are set out in Chapter 6: EIA Methodology.

2.5 Other Relevant Legislation

40. This section provides details of additional legislation that are, or may be, relevant to the Project. It is acknowledged that further legislation may be relevant in the context of specific topics and where appropriate, such legislation is detailed in the relevant topic chapter of this EIA report.

2.5.1 The Habitats and Bird Directives

41. Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive), provides for the conservation of natural habitats and of wild flora and fauna, including in offshore areas.

42. Directive 2009/147/EC on the conservation of wild birds (the Birds Directive) applies to the conservation of all species of naturally occurring wild birds including in offshore areas. In the UK, sites designated as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) form part of the Natura 2000 network, delivering the requirements of the Directives.

43. The Directives have been transposed into Scottish Law by various regulations. The regulations of relevance to the Project are the Conservation (Natural Habitats &c.) Regulations 1994 and the Conservation of Habitats and Species Regulations 2017 (the Habitats Regulations).

44. The Habitats Regulations require that wherever a project that is not directly connected to, or necessary to the management of, a European site, is likely to have a significant effect on a European site (directly, indirectly, alone or in-combination with other plans or projects), then an 'Appropriate Assessment' (AA) of the implications for that site in view of that site's conservation objectives must be undertaken by the competent authority. The AA must be carried out before consent or authorisation can be given for the Project.

2.5.1.1 Habitats Regulations Appraisal (HRA)

45. HRA is a step by step process which determines Likely Significant Effects (LSE) and, where appropriate, assesses adverse effects on the integrity of a European site. Where adverse effects on integrity cannot

be ruled out, the HRA then examines alternative solutions, and if necessary goes on to provide justification of Imperative Reasons of Overriding Public Interest (IROPI).

46. The HRA process comprises up to four-stages as set out below:

- HRA Stage 1 - Screening: Screening for LSE (alone or in-combination with other projects or plans);
- HRA Stage 2 - Appropriate Assessment: Assessment of implications of identified LSEs on the conservation objectives of a European site to ascertain if the proposal will adversely affect the integrity of a European site;
- HRA Stage 3 – Assessment of Alternatives: where it cannot be ascertained that the proposal will not adversely affect the integrity of a European site alternative solutions must be considered; and
- HRA Stage 4 – Assessment of IROPI: where it cannot be ascertained that the proposal will not adversely affect the integrity of a European site, and where no alternatives are identified at Stage 3, IROPI must be considered.

47. The information required to inform the AA has been gathered and presented in parallel with the EIA process. A HRA report has been prepared for submission to the Scottish Ministers alongside this EIA Report. The HRA report examines the potential for LSE for sites screened into the assessment and, for those sites where no LSE can be concluded, goes on to assess the potential for adverse effects on the integrity of those sites.

48. Whilst there is likely to be some repetition of information between the HRA Report and EIA report, the HRA report does not form part of the EIA process or the EIA Report and is therefore only mentioned to provide context and information.

2.5.1.2 European Protected Species (EPS) Licensing

49. The Habitats Regulations provide strict protection for certain animal and plant species referred to as EPS, however certain activities which would normally constitute an offence against EPS can be carried out legally under a licence. An example of such an activity is the installation of the piled foundations for the OSP(s) and wind turbines, which may generate underwater noise at levels that could disturb cetaceans, which are EPS.

50. EPS licences are granted by Scottish National Heritage (SNH) or the Scottish Ministers depending on the reason for the licence application. NnGOWL will apply for any EPS licences as appropriate prior to the start of construction.

2.5.2 The Energy Act 2004

2.5.2.1 Safety Zones

51. Under Section 95 of the Energy Act 2004, where a renewable energy installation is proposed to be constructed, and the Scottish Ministers consider it appropriate for safety reasons, designated areas may be declared as safety zones.

52. Safety zones are intended to ensure the safety of the renewable energy installation or other installations in the vicinity during construction, operation, extension or decommissioning. Safety zones may exclude non-Project vessels from navigating through a designated area for a designated period.

53. Applications for safety zones under the provisions of the 2004 Act will be made for the construction phase. These will have a radius of 500 m from the outer edge of the proposed wind turbine and OSP locations during periods when installation vessels are in operation at those locations. The construction-phase safety zones will reduce to a radius of 50 m around structures during periods when there are no installation vessels operating at a location and/or there are no personnel on the offshore structure. A

50m safety zone will also apply to completed but not yet commissioned structures. The safety zones will limit all non-project vessels from entering the safety zones.

54. During the operational phase, an advisory safe passing distance of 50 m radius will be advised around the wind turbines and OSP(s). In the event of major maintenance works, NnGOWL will apply for a notice declaring formal safety zones (under the Energy Act 2004) around the location where the maintenance work is taking place. These safety zones would have a radius of 500 m from the outer edge of the proposed wind turbine location / OSP during periods when major maintenance vessels (such as, for example, jack-up vessels required for major component repairs or replacements) are in operation.

55. Further information on safety zones can be found in Chapter 4: Project Description and in Chapter 11: Shipping and Navigation.

2.5.2.2 Decommissioning

56. Sections 105 to 114 of the Energy Act 2004 require a decommissioning scheme for an offshore renewable energy installation to be approved by the Scottish Ministers (this is also sometimes referred to as a decommissioning programme as is the case in the Consents). The potential effects of the decommissioning of the Project have been assessed within the EIA. A draft decommissioning scheme (or programme) will be prepared and submitted to Scottish Ministers for approval prior to the commencement of construction or as otherwise required.

2.5.3 The Crown Estate Act 1961

57. TCE Commissioners are the owner of much of the foreshore and the seabed below the territorial seas of the UK under the provisions of the Crown Estate Act 1961, and are the party entitled to exercise the right to exploit areas for the production of energy from water or winds within designated areas. The Commissioners require a lease of the seabed and foreshore to be entered into for developments on the marine estate, including cable laying and construction of offshore structures.

58. Following the Scotland Act 2016, TCE management in Scotland has now been devolved to Scottish Ministers. CES began operating on 1 April 2017 and is tasked with managing assets including agricultural and forestry land, most of the seabed, around half of the foreshore and some commercial property.

59. In May 2008, TCE invited expressions of interest from those companies wishing to be considered as potential developers of offshore wind farms in STW. In 2009 TCE awarded an exclusivity agreement to NnGOWL to develop the Project. Subsequently an Agreement for Lease (AfL) with TCE, which gives an exclusive right to NnGOWL to develop a wind farm and the opportunity to secure a lease giving rights to the seabed was entered into in August 2011. CES will now take on the management functions relating to the AfL under the provisions of the Scotland Act 2016.

2.5.4 Town and Country Planning (Scotland) Act 1997

60. Planning permission was separately sought by NnGOWL for the OnTW under the Town and Country Planning (Scotland) Act 1997. NnGOWL was granted planning permission for the OnTW by East Lothian Council in June 2013. The permission was subsequently amended by a Section 42 application in November 2015.

2.5.5 Consenting Process

61. The Scottish Ministers are the relevant decision-makers in respect of the Section 36 Consent and the Marine Licences. NnGOWL is applying for the Section 36 Consent and Marine Licences at the same time, with the application being supported by the information presented in this EIA Report. It is

expected that MS-LOT, on behalf of the Scottish Ministers, will process and determine the applications together.

62. The consenting process is summarised below, in line with the relevant MS-LOT guidance document (ABPmer, 2012).

2.5.5.1 Pre-application

63. At the pre-application stage developers undertake preparatory work and discuss proposals with MS-LOT as early as possible. The first step in the EIA process commences with screening and / or scoping exercises to confirm the requirement for and scope of the EIA. It is encouraged that developers consult on the proposal as part of the consenting and EIA process with a variety of statutory consultees and stakeholders. MS-LOT manage consultation with statutory and non-statutory consultees at EIA screening and scoping stages. In the majority of cases MS-LOT liaise directly with consultees but can also direct applicants to specific organisations, if appropriate.

64. NnGOWL elected to prepare an EIA Report rather than undertaking a screening exercise. A request for a Scoping Opinion accompanied by a Scoping Report was submitted to MS-LOT on 15 May 2017. MS-LOT consulted on the Scoping Report and returned a Scoping Opinion on 8 September 2017 advising on the scope of the EIA for the Project.

65. In performing its regulatory duties, MS-LOT seeks expertise from a variety of sources both within Marine Scotland and from expert external advisors, consultees, stakeholders and regulators as outlined above.

Pre-Application Consultation

66. Sections 22 to 24 of the Marine (Scotland) Act 2010 require pre-application consultation to be undertaken in respect of developments of a certain scale or involving particular works (for example, projects involving the deposit of a submarine cable exceeding 1,853m in length and crossing the intertidal boundary or the construction of a renewable energy structure where the total area in which such structure is to be located exceeds 10,000 m^2). The process provides opportunities to receive feedback from the public and third sector organisations that can then be addressed in the application and supporting EIA Report. MS-LOT require applicants to have undertaken pre-application consultation with stakeholders, consultees and the public in accordance with good practice. Full details of the pre-application consultation undertaken to inform this application are presented in Chapter 5: Scoping and Consultation.

2.5.5.2 Application and Determination

67. Based on the feedback and advice received from the scoping process and from additional pre-application consultation, developers compile an application comprising an EIA Report detailing the EIA process and conclusions, all supporting appendices and assessments, a HRA, all relevant completed application forms, a completed gap analysis, pre-application consultation report, cover letter and any relevant additional information. The aim of the EIA Report is to demonstrate that potential environmental impacts have been adequately assessed and any potentially significant environmental effects have been identified, with appropriate mitigation considered where appropriate.

68. Once the application has been submitted, MS-LOT will check the application is complete and decide whether or not to accept it. Once the application has been accepted, the developer circulates application information to those consultees identified by MS-LOT, and also places copies of the same information in public viewing places. In addition, the developer will be required to place public notices in newspapers or other publications.

69. MS-LOT aims to ensure, where possible, that Section 36 applications are determined within nine months of receipt where there is no public inquiry. Once the applications are determined, MS-LOT announces and publishes the decision.

2.5.5.3 Post Consent

70. Following a positive determination, MS-LOT may, following careful consideration of the application, attach various measures on the developer as consent / licence conditions detailed within the relevant licences and consents. The developer has a statutory duty to comply with the terms of the consent and licences and MS-LOT has statutory powers to enforce compliance.

2.6 Scottish Waters Offshore Wind (Marine) Planning Policy

71. Marine planning matters in Scotland's inshore waters are governed by the Marine (Scotland) Act 2010 (and in its offshore waters by the Marine and Coastal Access Act 2009). Under the Marine (Scotland) Act 2010 Scottish Ministers must prepare and adopt a National Marine Plan covering Scottish inshore waters.
72. In addition, the Marine and Coastal Access Act 2009 requires Scottish Ministers to seek to ensure that a marine plan is in place in the offshore region when a Marine Policy Statement (MPS) is in effect.
73. A separate marine planning policy appraisal is provided as Appendix 2.1: Marine Planning Policy Review to this EIA Report.

2.6.1 UK Marine Policy Statement

74. The MPS is the framework for preparing Marine Plans and taking decisions affecting the marine environment. It is intended to contribute to the achievement of sustainable development in the United Kingdom Marine Area. Marine Plans must be in conformity with the MPS and public authorities taking decisions that affect or might affect the marine area are to do so in accordance with the MPS unless relevant considerations indicate otherwise.
75. The MPS notes that a significant part of the renewable energy required to meet the UK's climate change targets and objectives will come from marine sources highlighting that offshore wind is expected to provide the largest single renewable electricity contribution to 2020 and beyond.

2.6.2 Scotland's National Marine Plan

76. The Scottish Government adopted its National Marine Plan in early 2015 (Scottish Government, 2015b). The purpose of the plan is to provide an overarching framework for marine activity in Scottish waters, in an aim to enable the sustainable development and use of the marine area in a way that protects and enhances the marine environment whilst promoting both existing and emerging industries. This is underpinned by a set of core general policies, which apply across all existing and future development and use of the marine environment and sectoral specific policies.
77. With respect to offshore wind, the plan emphasises the growth of the global wind industry and Scotland's contribution to this industry by becoming a key hub for the design, development and deployment of the next generation of offshore wind technologies. The plan highlights the importance of offshore wind in achieving Scotland's targets for generating the equivalent of 100% of Scotland's own electricity demand from renewable resources by 2020, and to deliver an 80% reduction in GHG emissions by 2050 (Scottish Government, 2015b). The plan also highlights that within the Scottish Marine Area, there are a number of planned development sites for offshore wind including the STW sites of which the Project is one (Scottish Government, 2015b).
78. The core objectives and marine planning policies seek to:

- Ensure sustainable development of offshore wind in the most suitable locations;
- Maximise economic benefits from offshore wind by securing a competitive local supply chain in Scotland;
- Align marine and terrestrial planning and efficient consenting and licensing processes including, but not limited to, data sharing, engagement and timings, where possible;

- Align marine and terrestrial transmission grid planning and development in Scottish waters;
- Contribute to achieving the renewables target to generate electricity equivalent to 100% of Scotland's gross annual electricity consumption from renewable sources by 2020;
- Contribute to achieving the decarbonisation target of 50 g CO_2/kWh by 2030 (to cut carbon emissions from electricity generation by more than four-fifths);
- Encourage sustainable development and expansion of test and demonstration facilities for offshore wind and marine renewable energy devices; and
- Ensure co-ordinated government and industry-wide monitoring.

2.6.3 Regional Marine Plans

79. The National Marine Plan sets the wider context for marine planning within Scottish waters, including what should be considered when creating regional marine plans. Eleven Scottish Marine Regions have been created which cover sea areas extending out to 12 nautical miles (NM). Regional Marine Plans will be developed for these areas by Marine Planning Partnerships in due course.

80. The Project lies within the Forth and Tay region. At the time of writing, a Marine Planning Partnership for the Forth and Tay has not been established and there is currently no regional marine plan in place for the region.

2.6.4 Sectoral Planning – Offshore Wind

2.6.4.1 Blue Seas - Green Energy: A Sectoral Marine Plan for Offshore Wind Energy in STW

81. This plan, published in 2011 sets out proposals for the development of offshore wind in territorial waters at the regional level to 2020 and beyond (Scottish Government, 2011b). The plan identifies six short term sites considered to be suitable for development by 2020 and 25 medium term areas of search for development between 2020 and 2030. The Project is identified as one of the six short term sites. The plan recommends that the Project should be taken forward to the licensing stage. A key finding was that there is significant potential for the Project in the short term, and it appears at this stage to be publicly and environmentally acceptable. Of the six sites, at the time of writing this EIA Report, only three are currently being developed: the Project, Inch Cape and Beatrice.

2.6.4.2 Scotland's Offshore Wind Route Map: Developing Scotland's Offshore Wind Industry to 2020 and Beyond

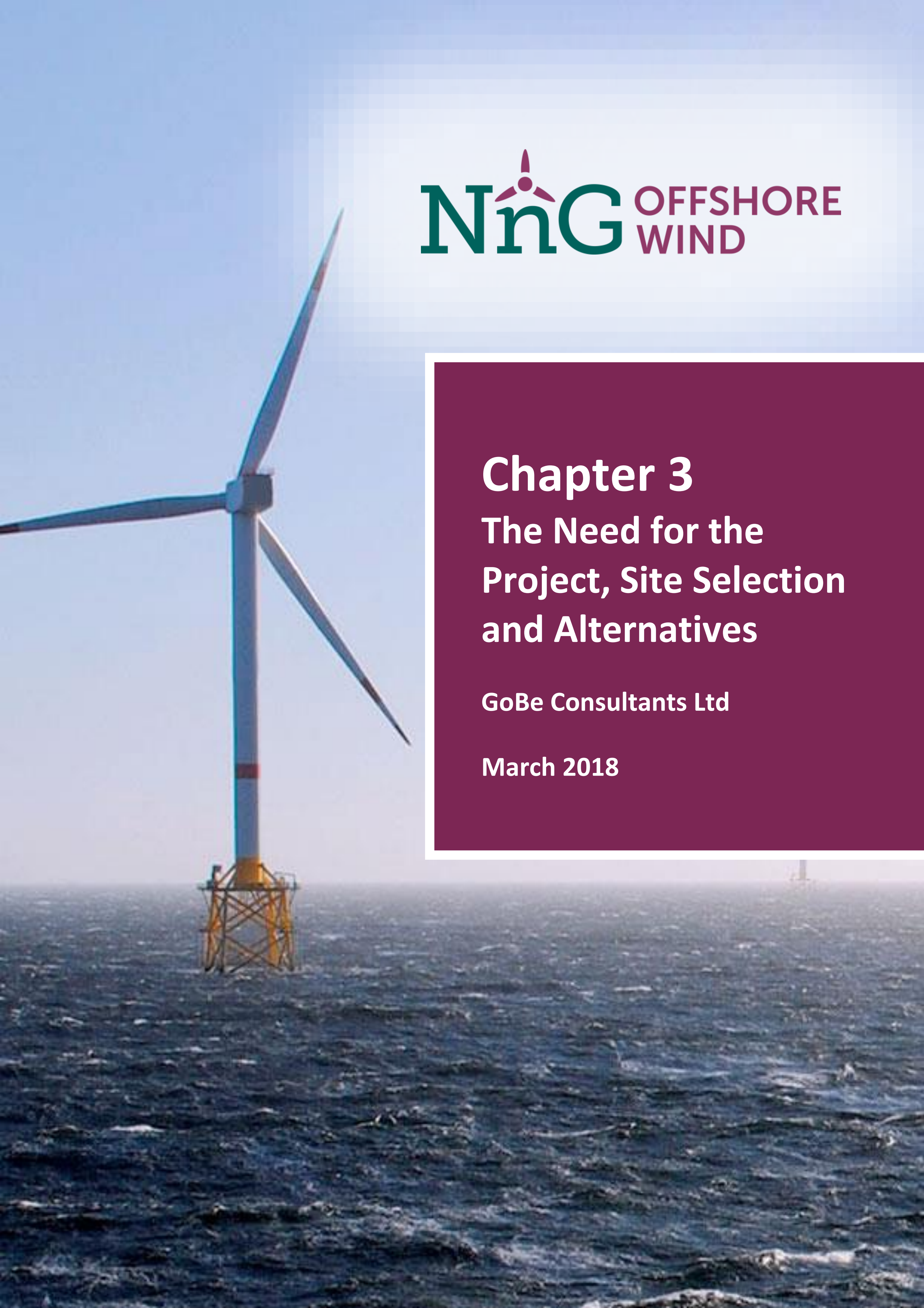
82. Scotland's Offshore Wind Route Map (Scottish Government, 2010; 2013a) recognises that, with 25% of Europe's offshore wind potential, the large-scale development of offshore wind represents the biggest opportunity for sustainable economic growth in Scotland.

2.7 References

- DECC (Department of Energy and Climate Change) (2009) *Renewable Energy Strategy.*
- Scottish Government (2017) *Draft Scottish Energy Strategy: The Future of Energy in Scotland.* Available from: http://www.gov.scot/Publications/2017/01/3414/downloads. [Accessed from 28 August 2017.]
- Scottish Government (2015a) *2020 Routemap for Renewable Energy in Scotland.* Available online from: http://www.gov.scot/Resource/0048/00485407.pdf [Accessed on 28 August 2017].
- Scottish Government (2015b.) *Scotland's National Marine Plan.* Available from: http://www.gov.scot/Resource/0047/00475466.pdf. [Accessed on 28 August 2017]
- Scottish Government (2013a) *Scotland's Offshore Wind Route Map: Developing Scotland's Offshore Wind Industry to 2020.* Available online from:

http://www.gov.scot/Publications/2013/01/5856/downloads [Accessed on 28 August 2017].

- Scottish Government (2011a.) *2020 Routemap for Renewable Energy in Scotland.* Available online from: http://www.scotland.gov.uk/Publications/2011/08/04110353/0 [Accessed on 1 September 2011].
- Scottish Government (2011b.) *Blue seas – Green Energy: A sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters.* Available from: http://www.gov.scot/Resource/Doc/346375/0115264.pdf [accessed on 28 August 2017]
- Scottish Government (2011c.) *Scoping Study for Offshore Wind Farm Development in Scottish Waters Scottish Marine and Freshwater Science Volume 2 Number 13.* Available from: http://www.gov.scot/Resource/Doc/363758/0123511.pdf
- Scottish Government (2010) *Scotland's Offshore Wind Route Map: Developing Scotland's Offshore Wind Industry to 2020.* Available online from: http://www.gov.scot/Publications/2010/09/28115850/0



NnG OFFSHORE WIND

Chapter 3

The Need for the Project, Site Selection and Alternatives

GoBe Consultants Ltd

March 2018

Table of Contents

Table of Figures

Table of Tables

3 The Need for the Project, Site Selection and Alternatives

3.1 Introduction

1. This chapter provides an overview of the need for the Neart na Gaoithe Project (with cross reference to the main legislative and policy drivers summarised in Chapter 2: Policy and Legislation), it identifies the process of site selection and sets out the alternatives considered during the project development and design leading to the preparation of this EIA Report.

3.2 The Need for the Project

2. As described in Chapter 2: Policy and Legislation, Scotland has great potential for renewable energy development. Current estimates are that Scotland has up to 25% of Europe's offshore wind resource (Scottish Government, 2011). Chapter 2: Policy and Legislation provides more information on the policy context in support of renewable energy and offshore wind in Scottish Waters.

3. The Project will act to offset greenhouse gas (GHG) emissions that might otherwise be produced by other means of electricity generation and will also increase the security of electricity supply, thereby assisting with the delivery of UK and Scottish government policy and the meeting of renewable energy commitments. It will also provide socioeconomic benefits to Scotland and the UK and contribute to the development of the offshore wind industry in the domestic markets (see Chapter 15: Socioeconomics).

3.2.1 Emissions Reduction

4. As part of the renewable generation mix, the Project will help to reduce the emissions of CO_2, NO_X, and SO_2 during the operational phase equivalent to the annual emissions of CO_2, NO_X, and SO_2 from traditional thermal generation sources for the generation it replaces.

5. Mainstream participates in the Carbon Disclosure Project; an organisation that works with companies to disclose the GHG emissions of major corporations.

6. A Lifecycle Carbon Analysis (LCA) is a method of measuring a product or process's effect on the environment with regard to GHG emissions throughout its lifetime. During the fabrication, construction and operation of the Project, and as a result of its eventual decommissioning, carbon emissions will be generated and released. Over the lifetime of the Project, these carbon emissions will be offset by the net reduction in emissions through the low carbon wind energy technology.

7. A relevant parameter to measure this offset is the tonnes of coal equivalent saved over the lifetime of the Project. The range of tonnes of coal equivalent for the turbine sizes being considered was found by taking the range of expected energy production figures for the year and dividing by the tonnes of coal equivalent factor (8,141 kWh/ToCE) (Natowitz and Ngo, 2016).

8. The exact value for the Project will ultimately depend on the size of the wind turbines installed. However, indicative figures for 8 MW and 9.5 MW turbines are provided in Table 3.1 and Table 3.2 which demonstrate, for illustrative purposes, the estimated offset values for the Project over a 25-year operational period and over a 50-year operational period.

9. These indicative calculations provide an estimate of the tonnes of coal equivalent saved of 5.25 to 6.30 million ToCE for an 8 MW turbine choice, and between 4.98 to 6.03 million tonnes of coal equivalent for a 9.5 MW turbine over a 25-year period. Over a 50-year period these figures are doubled to up to

12.6 million ToCE for an 8 MW turbine choice and up to 12.06 million ToCE for a 9.5 MW turbine choice.

10. The lower production estimate for one year and over a 25-year period for both turbine sizes was analysed and found to be equivalent to the carbon sequestered by approximately 1.4 to 1.5 million acres of United States forests in one year.

Table 3.1: Tonnes of coal equivalent for lower production estimate

Turbine capacity	Tonnes of coal equivalent per year	Tonnes of coal equivalent (25 year[1])	Tonnes of coal equivalent per turbine (25 year[2])	Tonnes of coal equivalent (50 year[2])	Tonnes of coal equivalent per turbine (50 year[2])
8 MW	210,180	5,254,500	97,300	10,509,000	194,600
9.5 MW	199,410	4,985,250	106,060	9,970,500	212,120

Table 3.2: Tonnes of coal equivalent for higher production estimate

Turbine capacity	Tonnes of coal equivalent per year	Tonnes of coal equivalent (25 year[2])	Tonnes of coal equivalent per turbine (25 year[2])	Tonnes of coal equivalent (50 year[2])	Tonnes of coal equivalent per turbine (50 year[2])
8 MW	252,140	6,303,500	116,730	12,607,000	233,460
9.5 MW	241,190	6,029,750	128,290	12,059,500	256,580

3.2.2 Energy Provision

11. The Project will provide renewable electricity throughout its operational life. The number of homes equivalent that can be supplied with energy generated by the Project has been calculated using Equation 3.1 below, following Renewable UK guidance (Renewable UK, 2017).

Equation 3.1: Homes supplied equation

$$\text{Homes Supplied} = B \times 0.372 \times 8760/3900$$

12. In Equation 3.1, B is the installed capacity of the wind farm in kW, in this case taken to be 450 MW (450,000 kW), 0.372 is the decimalised capacity factor for offshore wind calculated by Renewable UK as a rolling average of the past five years using data (on an Unchanged Configuration Basis) from the Digest of UK Energy Statistics published by the Department of Business, Energy and Industrial Strategy (dimensionless) (Renewable UK, 2017) and 8,760 is the number of hours in one year. The average UK household annual energy consumption is taken to be 3,900 kWh/household (Renewable UK, 2017).

13. Applying this equation to the Project, using the Renewable UK published capacity factor for offshore wind of 37.2%, it is estimated to produce enough electricity each year to meet the needs of the equivalent of 376,000 households. Using a project specific capacity factor of approximately 45%, it is estimated that enough electricity will be produced each year to meet the needs of the equivalent of approximately 454,800 households.

14. The City of Edinburgh had approximately 230,831 households in 2015 (National Records of Scotland, 2016). As an indication of scale, in applying Equation 3.1, the Project would generate more locally produced electricity each year than the annual domestic demand of a city of this size.

[1] Assumes a 25-year operational period
[2] Assumes a 50-year operational period

3.2.3 Carbon Emissions Offset

15. During the fabrication and construction of the Project, carbon emissions will be generated and released. Over the lifetime of the Project these carbon emissions will be offset by the net reduction in emissions through the use of low carbon technology. As described above in Section 3.2.1, LCA can be used to calculate this.

16. The carbon payback period is analogous to the financial payback period, and represents the period of time before a product or project has saved more CO_2 emissions (CO_2e) than has been produced by its construction and operation.

17. For a 25-year operational period of the wind turbines, the Project will displace CO_2e from other energy sources by between 4.98 and 6.30 million tonnes coal equivalent and over the 50-year operational period this will be between 9.97 and 12.61 million tonnes coal equivalent (see Section 3.2.1 for further information).

18. The payback range for the Project has been calculated to be 0.8 years from the start of full commercial operation.

3.3 Site Selection

19. With the need for new generating sources having been established and the role of offshore wind developments recognised as a key element of Scotland's long-term energy mix in Scottish and UK Government policy, as summarised in Chapter 2: Policy and Legislation, the following section sets out the process that led to the location of the Project in the Forth and Tay region.

20. In May 2008, TCE invited expressions of interest from those companies wishing to be considered as potential developers of offshore wind farms within STW.

21. Prior to submitting a bid for the Project, Mainstream carried out a series of desk-based assessments to determine those sites in STW with the potential to be taken from development sites to fully consented and constructed wind farms.

22. Specifically, the following initial process was applied during the site selection process:

- Areas within STW of less than 60 metres (m) water depth were identified; and
- Areas were refined to those that were within an economic distance of major grid connection points and suitable ports but that avoided areas with excessive wave heights.

23. This initial process identified three large areas for further assessment:

- The outer Firth of Clyde;
- The outer Solway Firth; and
- The area to the east of the Firths of Forth and Tay.

24. These three areas were then subject to detailed environmental constraints analysis, which identified that the east coast sites were the least constrained (the outer Firth of Clyde having significant ornithology, and water depth challenges, and both west coast zones having shipping and Ministry of Defence (MOD) issues, as well as possible limitations with the geology and grid connection opportunities).

25. The east coast sites were subsequently investigated further by Mainstream and in greater detail to select the preferred sites for development.

26. Having assessed bird, marine mammals and navigation data, further technical appraisals of six potential east coast sites were undertaken in relation to:

- wind resource and energy yield;
- environmental (incorporating ornithology and marine mammals and landscape/seascape and visual impact);
- grid; and
- geotechnical conditions and foundation design.

27. These assessments led to the selection of the Development Area.
28. In addition to these assessments, consultation was undertaken at that time with the Scottish Government, Maritime and Coastguard Agency (MCA), Chamber of Shipping, RSPB, SNH, Fisheries Research Services (FRS) (now Marine Scotland), Scottish Environmental Protection Agency (SEPA), Scottish Fishermen's Federation (SFF), Montrose Port, MOD, British Airports Authority (BAA), Civil Aviation Authority (CAA), Visit Scotland and Fife Council.
29. Following this process, the NnG site was selected as the preferred site and exclusive rights to develop the site were granted by TCE.
30. At a national level, a total of ten sites within STW were identified by different developers, with exclusive development rights granted by TCE. The sites were subject to a Strategic Environmental Assessment (SEA) by the Scottish Government, as part of the development of a draft national plan for offshore wind within STW (Scottish Government, 2010). The SEA ensured that environmental considerations were taken into account in selecting the sites to be taken forward to the development phase. A number of sites were dropped and those remaining were included in the Scottish Government's strategic plan 'Blue seas – Green Energy: A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters' (Scottish Government, 2011). Following the publication of this plan, Mainstream was awarded an AfL by TCE in July of 2011.
31. Of the original ten sites within STW, seven have been dropped; either due to environmental concerns identified through the SEA, or for technical feasibility reasons.
32. It is clear from the above assessments and plans, that the location of the Project is supported not only by Mainstream's analysis of relevant constraints but also by the sectoral planning policy developed by Scottish Government for STW.

3.4 Alternatives

33. The EIA Regulations require that an EIA Report must include details of the main alternatives studied by the applicant and the main reasons for selecting the chosen option taking into account the environmental effects.

3.4.1 The Application vs the Originally Consented Project

34. In considering alternatives, it is important to note that the primary alternative to the Project is the Originally Consented Project; if the Application is not successful NnGOWL will progress the originally Consented Project.
35. The Originally Consented Scheme itself was subject to revisions as it progressed through the consenting process and subsequently by variation to the Section 36 consent granted in 2016. The revisions in the Application were made for varying reasons, including reducing potential environmental impacts and incorporating up-to-date turbine technologies. The increased output per turbine that is now achievable means that a significant reduction in turbine numbers is possible whilst still delivering the overall 450 MW output. A reduction in turbine numbers is considered beneficial from environmental, technical and commercial perspectives.
36. The key changes in turbine numbers that have occurred since the original consent application in 2012 are summarised in Table 3.3.

Table 3.3: Reductions in Maximum Turbine Numbers for NnG

Milestone	Date	Maximum Number of Wind Turbines	Reason for Amendment
Original Application	2012	125	-
Addendum	2013	90	Technological advancement – increased turbine capacity, reduced number of turbines
Consent	2014	75	Technological advancement – increased turbine capacity, reduced number of turbines
Section 36 Variation	2016	75	Technological advancement – increased turbine capacity, reduced number of turbines
Application	2017	54	Technological advancement – increased turbine capacity, reduced number of turbines

37. The Consents allow for up to 75 turbines, whereas the Project will be constructed with a maximum of 54 turbines, if consent is granted within the expected timescale. The reduction in turbine numbers (compared with the Consents) would also result in a need for fewer foundations, plus a shorter construction period and less time installing driven piles.

38. It can be concluded that in all respects the Project (when applying worst case scenarios) would give rise to lesser environmental effects than the worst case considered for the Originally Consented Project.

3.4.2 Project Design Decisions and Alternatives

39. The following sections identify project design alternatives that have been considered in refining the Project to the form described in Chapter 4: Project Description. It considers:

- Turbine capacity, numbers and type;
- Turbine layout;
- Foundation options;
- OSP design;
- Grid connection;
- Offshore Export Cable route; and
- Offshore Export Cable landfall location.

3.4.2.1 Turbine capacity, numbers and type

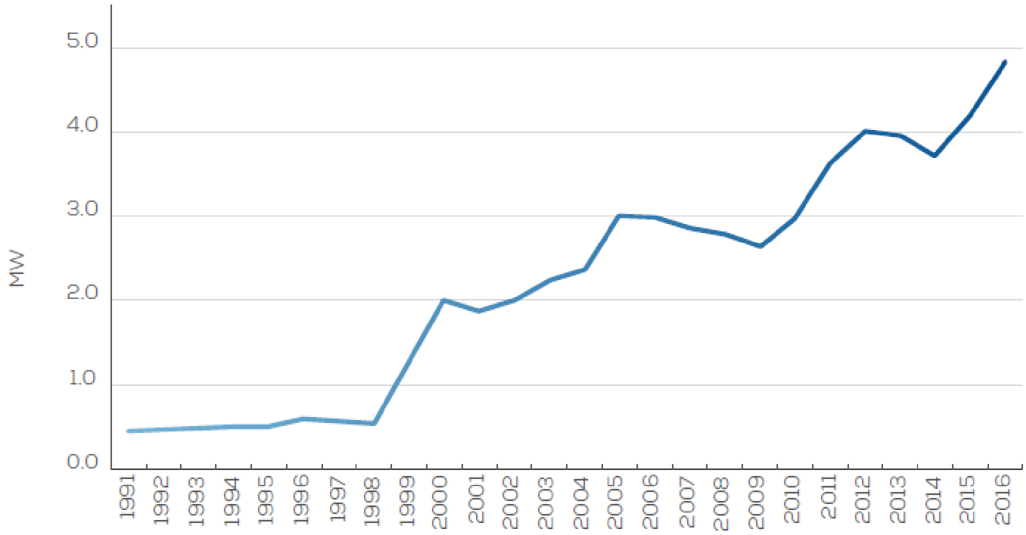
40. As noted in Section 3.4.1, the Project design has been subject to revisions through the process of developing the Project so that the Original Application comprising up to 125 turbines is now reduced to the Application for up to 54 turbines (for the same 450 MW maximum installed capacity).

41. This design decision has been predominantly driven by the increasing capacity of individual turbines available on the market; as individual turbine capacity has increased, the corresponding number of turbines needed to meet the 450 MW project capacity has decreased.

42. This trend in offshore turbine size is identified in the 2016 offshore wind trends and statistics report by Wind Europe (Wind Europe, 2017) and is summarised in Figure 3.1, it is noted that the average turbine size installed in 2016 was 4.8 MW; by comparison in 2010, average turbine rated capacity was in the order of 3 MW. The Wind Europe report also notes that in 2016 8 MW turbines were installed and

operational for the first time, reflecting the rapid pace of technological development. Vestas, one of the world's leading turbine supplier already offers a 9.5 MW turbine, whilst Siemens (another leading turbine manufacturer) is currently offering the aforementioned 8 MW machine.

Figure 3.1: Average offshore wind turbine rated capacity over time (source: Wind Europe, 2017)



43. The specific turbine model that will be installed at the Offshore Wind Farm is yet to be identified. However, the turbine type will comprise of a three-bladed, horizontal axis unit, with nacelle based generators.

44. Two-bladed, vertical axis, hydraulic transfer or other novel turbine types have not been included in the Project design envelope as such turbines for a development of this scale will not be commercially available by the time construction commences.

3.4.2.2 Turbine Layout

45. Turbine layout design refers to the positioning of the turbines within the Wind Farm Area taking into account localised constraints such as ground conditions, environmental constraints, navigation or technological considerations. The final layout for the Project will be determined as part of the final Project engineering design process and following the award of consents and the appointment of the relevant suppliers and contractors. It is expected that any consents granted by the Scottish Ministers would require the final layout to be approved, in consultation with relevant stakeholders, prior to construction (as is the case for the Originally Consented Project).

3.4.2.3 Foundation Design

46. Both site and market conditions have an effect on the design selection of the wind turbine and OSP foundations. Water depth and underlying geology significantly influence the selection of specific foundation types. Economics and long-term maintenance requirements are also a powerful driver. The combination of a harsh and challenging environment and the relative difficulties associated with arranging access increases the cost of a single foundation relative to the overall cost of the wind farm and can have a significant effect on the overall financial viability of the development.

47. The physical conditions at the Wind Farm Area mean that monopile and tension leg platform foundations have been discounted since the water is too deep and too shallow respectively for the use of these solutions. Insufficient sediment depth over a large part of the site means that suction caisson foundations have also been ruled out on technical grounds.

48. Table 3.4 below summarises those foundation options, which are not considered feasible for the Project.

Table 3.4: Discounted foundation types

Foundation type	Reason for unsuitability
Monopile	This type of structure is best suited to water depths ranging between 0 m to 30m. Depths on the site are between 45 – 55 m. XL monopiles could, in theory, be installed in up to 50m water depths, but monopiles of the size that would be needed are not yet commercially available. In any event the shallow bedrock at the site would render installation very challenging
Tension leg platform	Water depth under 60 m is considered too shallow.
Suction caisson	Insufficient sediment depth across the site.
Gravity base	Insufficient number of foundations needed to make it an economically viable solution.
Floating	Floating foundations have not been deployed on a major commercial scale to date although a number of demonstrator sites have utilised or are in the process of deploying floating foundation solutions. It is not anticipated that these will be commercially available for installation by the time construction commences.

49. Steel jackets with pile foundations are, therefore, considered to be the most feasible option for the Project on both a technical and economic basis. Chapter 4: Project Description provides more detail on the design, fabrication and installation of these foundation types.

3.4.2.4 OSP Design

50. The most efficient location for any OSP is chosen based on optimising the electrical design and this can often result in selection of a position located at the geographic centre of the Wind Farm Area. However, locating the OSP(s) at this point may have implications on access and maintenance logistics, and such location may not have favourable ground conditions. The final OSP locations (a design involving either one or two OSPs may be selected) will be assessed throughout the detailed design process taking into consideration a number of criteria, including:

- Energy loss through cabling;
- Redundancy in equipment to ensure maximisation of generation transmission;
- Operation and maintenance considerations; and
- Capital expenditure of installation of one versus two OSP(s).

3.4.2.5 Grid Connection

51. Whilst this EIA Report covers only the offshore aspects of the Project, it is important to highlight the work undertaken to identify the onshore grid connection locations as this informs the rationale for the selected Offshore Export Cable Corridor and landfall location.

52. Options for grid connection were examined in advance of submission of the Original ES. Onshore grid connections are offered by National Grid Electricity Transmission (NGET) depending on grid capacity and proposed connection date. The potential connection options considered were Arbroath, Tealing, Cockenzie, Torness, a new substation at Branxton, and Crystal Rig II Onshore Wind Farm. Following a high-level study by NGET in 2009, a connection point was offered to NnGOWL at Crystal Rig II Onshore Wind Farm.

3.4.2.6 Offshore Export Cable Route

53. Early environmental and technical assessments as well as the location of the grid connection point resulted in the Offshore Export Cable route to Thorntonloch being taken forward as the only option.

54. There will be two High Voltage Alternating Current (HVAC) cables installed within the Offshore Export Cable Corridor. The width of the Offshore Export Cable Corridor is 300 m, which will allow for micrositing of the Offshore Export Cable. Once laid, each Offshore Export Cable will be within a ~30 m wide corridor which will be marked on Admiralty charts. CES leases the designated areas to ensure the integrity of the Offshore Export Cable and to manage the requirements of other potential users of the seabed.

3.4.2.7 Offshore Export Cable Landfall Location

55. Following the decision on the preferred Offshore Export Cable route, two potential landfall locations were identified: Thorntonloch and Skateraw. Detailed intertidal, environmental and technical surveys were conducted at each of the two landfall options.

56. Although technically feasible, Skateraw was considered to be more technically challenging due to exposed rock on the beach and environmental sensitivity due to the presence of a Site of Special Scientific Interest (SSSI). Thorntonloch beach was considered to be more suitable for the landfall due to the increased sediment cover and the lack of environmental designations.

57. As a result, the landfall at Thorntonloch is the option considered in the EIA process.

3.4.3 The Do Nothing Approach

58. EIA practice suggests that an EIA Report should consider the 'do nothing' potential alternative. The 'do nothing' scenario details what would happen at a location should the Project not proceed. In this context, the 'do nothing' scenario at this particular location will include the construction of an offshore wind farm in accordance with the Original Consent, along with natural environmental changes or established activities in the area such as climate change or commercial fishing activity.

59. As discussed in Chapter 2: Policy and Legislation, addressing the causes of climate change through the development of a low carbon economy, and specifically renewable energy, is encapsulated in legislation from both the Scottish and UK Governments as well as being a cornerstone of energy policy.

60. Furthermore, climate change will give rise to significant adverse social and economic impacts. Natural changes in climate are now understood to be accelerated above background levels by human activity, in particular by the creation and release of greater volumes of GHGs. The Project will contribute in combatting climate change by reducing GHG emissions from the electricity generation sector. When viewed at a Scottish level, the Project's contribution to the Scottish Government's renewable energy target is significant, potentially offsetting the CO_2 of 252,140 tonnes coal equivalent annually (see Section 3.2.3.)

61. As described in Chapter 2: Policy and Legislation, the increase in offshore wind development is in line with current European, UK and Scottish Government policy. Exploring alternative sources of energy, increasing efficiency and reducing the national carbon footprint are key aims set out in national legislation, policy and European Directives.

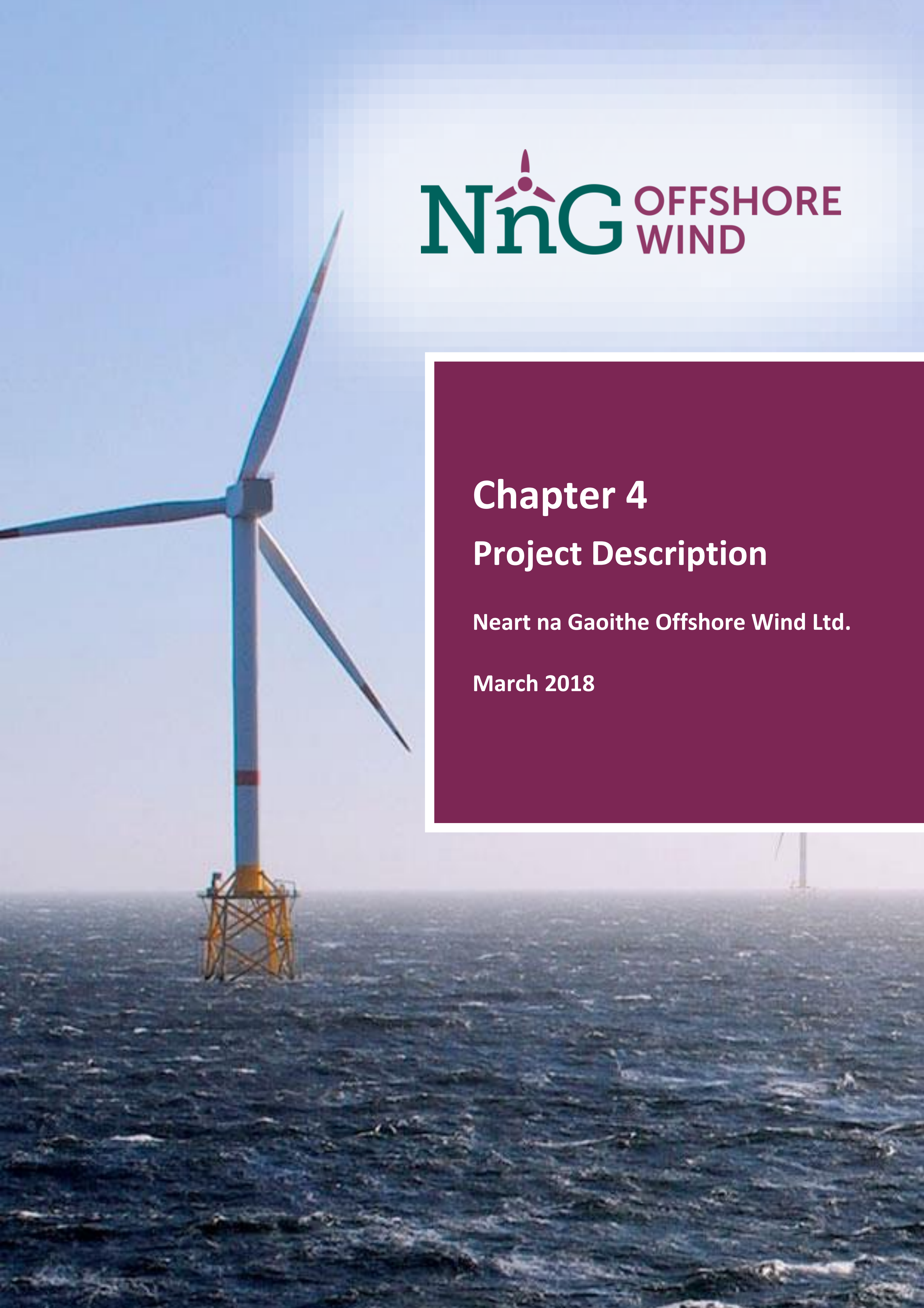
62. In addition to contributing to Government emissions targets, developing an alternative source of energy in Scotland is vital to maintain a secure long-term electricity supply. An over reliance on imported fuels leaves the nation vulnerable to fluctuations in supply and cost and competition for resources.

63. The principle of offshore wind as suitable development in this location has been established through the consenting of the Original Application for 75 turbines. If the Project is not delivered or consented, the reduction in turbine numbers to 54 (maximum) will not be realised and the 'do nothing' scenario

will be the construction and operation of NnG in accordance with the Original Application and Consents.

3.5 References

- National Records of Scotland, *City of Edinburgh Council Area – Demographic Factsheet* (2016) https://www.nrscotland.gov.uk/files/statistics/council-area-data-sheets/city-of-edinburgh-factsheet.pdf [accessed 6/09/17]
- Natowitz, J. and Ngo, C. (2016) *Our Energy Future: Resources, Alternatives and the Environment* (2nd Ed.). Wiley
- Renewable UK (2017) *Energy Statistics Explained*: http://www.renewableuk.com/page/UKWEDExplained [accessed 6/09/2017]
- Scottish Government (2010) *Strategic Environmental Assessment (SEA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters. May 2010.* http://www.gov.scot/Resource/Doc/312161/0098588.pdf [Accessed on 6/09/2017]
- Scottish Government (2011) *Blue Seas - Green Energy A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters. March 2011.* http://www.gov.scot/Publications/2011/03/18141232/0 [Accessed on 6/11/2017]
- Wind Europe (2017) *The European Offshore Wind Industry. Key Trends and Statistics 2016. Published January 2017.* https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Offshore-Statistics-2016.pdf [Accessed on 6/11/2017]



Chapter 4

Project Description

Neart na Gaoithe Offshore Wind Ltd.

March 2018

Table of Contents

Table of Figures

Table of Illustrations

Table of Tables

4 Project Description

4.1 Introduction

1. This chapter provides a description of the components of the Neart na Gaoithe Offshore Wind Farm (the Project) and describes the likely activities associated with the construction, operation and maintenance, and decommissioning of the Project.

2. The Project description is based on a 'design envelope' (which captures the full range of potential design scenarios) and is intended to provide sufficient flexibility to accommodate further expected refinement in design as the Project moves through consenting and towards construction (see also Chapter 6: EIA Methodology for more on the use of the design envelope approach).

3. This chapter therefore sets out a series of design options and parameters, for which maximum values are typically provided. The maximum values set out in this chapter generally constitute the 'realistic worst-case scenario' in relation to the Project, although in some cases a minimum value may constitute the worst-case scenario. In each case the worst-case scenario for a particular impact or receptor is specified in the relevant topic chapter.

4. The fabrication of individual Project components is not the focus of this EIA Report and is not considered in this document in relation to the EIA process.

5. Preferred contractors for the supply and installation of the major Project components have not been identified at the time of submission of this consent application. The method of construction ultimately selected will be within the parameters of the design envelope described in this chapter and will be determined as part of the final engineering design and procurement process.

4.2 Project Location

6. The Project location (Development Area) comprises the Wind Farm Area and the Offshore Export Cable Corridor. The Wind Farm Area lies in the outer Firth of Forth and covers an area of approximately 105 kilometres squared (km^2). The Wind Farm Area is located approximately 15.5 km east of Fife Ness and approximately 29 km from the coast at Thorntonloch.

7. Water depths across the site range from approximately 40 to 60 metres (m) below Lowest Astronomical Tide (LAT).

8. The final, precise route of the Offshore Export Cables will lie within the Offshore Export Cable Corridor, running in an approximately southwest direction from the Wind Farm Area, making landfall at Thorntonloch beach to the south of Torness Power Station in East Lothian.

9. Figure 4.1 (Volume 2) shows the location of the Development Area, also highlighting the Wind Farm Area and Offshore Export Cable Corridor. The co-ordinates for the Development Area are given in Table 4.1.

Table 4.1 Development Area co-ordinates

Easting UTM30N	Northing UTM30N	Longitude (degrees decimal minutes)	Latitude (degrees decimal minutes)
Wind Farm Area Co-ordinates			
551736	6234720	002° 9.898' W	056° 15.271' N
552458	6229999	002° 9.255' W	056° 12.721' N
547554	6229998	002° 13.998' W	056° 12.752' N
545182	6229999	002° 16.293' W	056° 12.766' N
541685	6234997	002° 19.628' W	056° 15.479' N
541238	6235637	002° 20.055' W	056° 15.827' N
541026	6238611	002° 20.232' W	056° 17.430' N
543465	6242941	002° 17.826' W	056° 19.752' N
544801	6243993	002° 16.518' W	056° 20.312' N
546461	6243751	002° 14.910' W	056° 20.171' N
Offshore Export Cable Corridor Co-ordinates			
542888	6233277	002° 18.4792' W	056° 14.5455' N
543142	6232914	002° 18.2372' W	056° 14.3487' N
538777	6202296	002° 22.7292' W	055° 57.8662' N
539047	6202052	002° 22.4715' W	055° 57.7335' N
537836	6201965	002° 23.6358' W	055° 57.6926' N
537939	6201685	002° 23.5393' W	055° 57.5408' N
537646	6201808	002° 23.8203' W	055° 57.6086' N
537666	6201763	002° 23.8015' W	055° 57.5843' N

4.3 Project Overview

10. The Project will be capable of transmitting a maximum of 450 MW from the metering point on the Offshore Substation Platforms (OSPs). Key infrastructure is summarised below.

4.3.1 Offshore Wind Farm and Offshore Transmission Works

11. The Offshore Wind Farm will comprise a maximum of 54 turbines connected to each other and to OSPs via inter-array cables[1].

12. The Offshore Transmission Works (OfTW) will comprise up to two high voltage alternating current (AC) OSPs which will each connect to shore via two Offshore Export Cables.

13. The key components of the Project comprise:

- Up to 54 jacket foundations attached to the seabed with steel piles, plus ancillary equipment such as J-tubes and access facilities;
- Up to 2 jacket foundations for OSPs plus ancillary equipment such as J-tubes and access facilities;
- Up to 54 turbines (each comprising of tower sections, nacelle and three rotor blades);

[1] For the purposes of this EIA Report and the Application, the term 'inter-array cables' is taken to mean both the cables that connect individual wind turbines to form 'strings' (sometimes known as *intra*-array cables) and the cables that connect the strings of turbines to the OSP(s).

- Up to two OSP topsides housing electrical infrastructure and potentially welfare facilities for operation and maintenance staff (NB. for the purposes of this EIA Report, the term OSP is used to refer collectively to the platform structure and the topside);
- Up to 140 km of inter-array cabling including back-feeds between collector strings and up to 4 interconnector cables between the two OSPs (if two are installed);
- Two subsea Offshore Export Cables each of up to 43 km in length;
- Scour protection and cable protection, as required; and
- Meteorological mast (met mast).

Table 4.2: Summary overview of Project parameters

Parameter	Maximum design envelope
Wind Farm Area	105 km^2
Offshore Export Cable Corridor width	300 m
Offshore Export Cable length (per cable)	43 km
Distance from shore to closest point of Wind Farm Area	Approximately 15.5 km
Project Output	450 MW
Number of wind turbines	54
Number of OSPs	2
Number of met masts	1

4.3.2 Onshore Transmission Works (OnTW)

14. Planning permission for the OnTW was sought separately by NnGOWL under the Town and Country Planning (Scotland) Act 1997.

15. NnGOWL was granted planning permission for the OnTW by East Lothian Council in June 2013. The permission was subsequently amended by an application under S42 of the Town and Country Planning (Scotland) Act 1997 in November 2015, and implemented via an initial phase of work in August 2016.

16. Terrestrial underground cables will transmit the energy generated by the wind turbines from the landfall location to an onshore substation. The onshore substation will collect the power transmitted from the onshore export cables and transform it up to a higher voltage for connection and export to the national grid.

17. NnGOWL's grid connection agreement is to connect to an extension to the existing 400kV substation at Crystal Rig II onshore wind farm (see Figure 4.2, volume 2).

18. The consented OnTW includes:

- Transition pit landward of the mean high-water springs (MHWS) mark;
- Underground transmission cabling from the transition pits to the electrical substation;
- Electrical substation; and
- Underground transmission cabling from the electrical substation to the National Grid substation.

4.4 Construction and Installation of Offshore Infrastructure

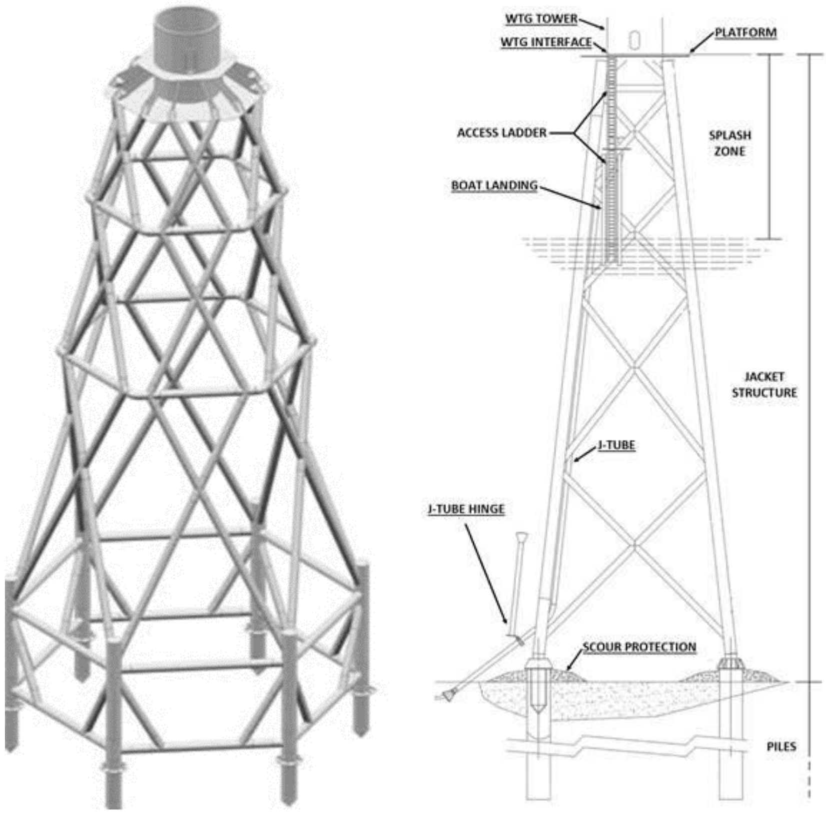
4.4.1 Wind Turbine Foundations

19. Steel jackets with pile foundations are considered the most appropriate turbine foundation design due to the prevailing site conditions and these are the only foundation solution being considered. For the purposes of this EIA Report, the term 'foundation' is used to refer collectively to both the steel jacket and the piles.

20. Steel jackets are formed of a lattice structure comprising tubular steel members and welded joints. Jackets are fixed to the seabed using steels piles below each leg. Jackets will comprise a maximum of six legs (Illustration 4.1).

21. Typically, piles of tubular steel are drilled or driven into the seabed sub-strata, relying on the frictional and end-bearing properties of the seabed for support.

Illustration 4.1: Illustrative steel framed jacket with pile foundations



4.4.1.1 Key design elements of wind turbine foundations

22. The dimensions for the key design elements of the wind turbine jackets and piles are summarised in Table 4.3 below.

Table 4.3: Wind turbine foundation parameters

Parameters	Maximum design envelope
Jacket type	Steel lattice
Jacket leg spacing at seabed level	35 m x 35 m
Details of seabed preparation	Clearance of any debris found A seabed template with up to 6 legs will sit temporarily on the seabed during pile installation for the turbine foundations.
Pile diameter	3.5 m
Number of piles per foundation	6
Pile penetration depth	50 m
Pile installation method	Driven only piling; Drive-drill-drive; or Drill only.

Parameters	Maximum design envelope
Indicative foundation installation duration (per foundation)	Pile Driving (6-21 hours for up to 6 piles) Pile Drilling (62-180 hours for up to 6 piles) This includes time for setting up and changing equipment between piling locations. Jacket installation (12-24 hours). Concurrent piling activities: pile driving or pile drilling at two locations concurrently (either on same vessel or on an independent vessel)
Weight of jacket	1,000 tonnes
Diameter of main jacket tubulars	3m
Seabed occupied by jacket leg (piles and scour protection)	300 m^2 per leg for four-legged jacket. 108 m^2 per leg for a six-legged jacket.

23. The typical amounts of material per wind turbine foundation are:

- Jacket: up to 1,000 tonnes (steel);
- Piles: up to 300 tonnes per pile (steel);
- High strength grout for fixing jacket legs to piles: up to 30 m^3 per foundation; and
- Cementitious grout in annulus of drilled piles: up to 25 m^3 per pile.

24. The grout used in the annulus of drilled piles and for fixing the jacket to the piles is expected to be high strength anti-washout grout, such as Masterflow 9500. This is a blend of ingredients including, for example, Ordinary Portland Cement and a polymeric additive. The setting time of the grout is typically less than 10 hours.

25. In addition, it is likely that the jackets will require cathodic protection to prevent corrosion. Usually this takes the form of galvanic anodes; these are usually affixed during the fabrication process to parts of the jacket that will be submerged when installed in the final location, but can be retrofitted in-situ using Remotely Operated Underwater Vehicles (ROVs) or divers. A typical arrangement is shown on Illustration 4.2

Illustration 4.2: Anodes affixed to jacket members (source: Keystone)

26. In addition to this protection, the area of the foundation between the splash zone and the wind turbine tower may also be protected with the following coatings during fabrication:

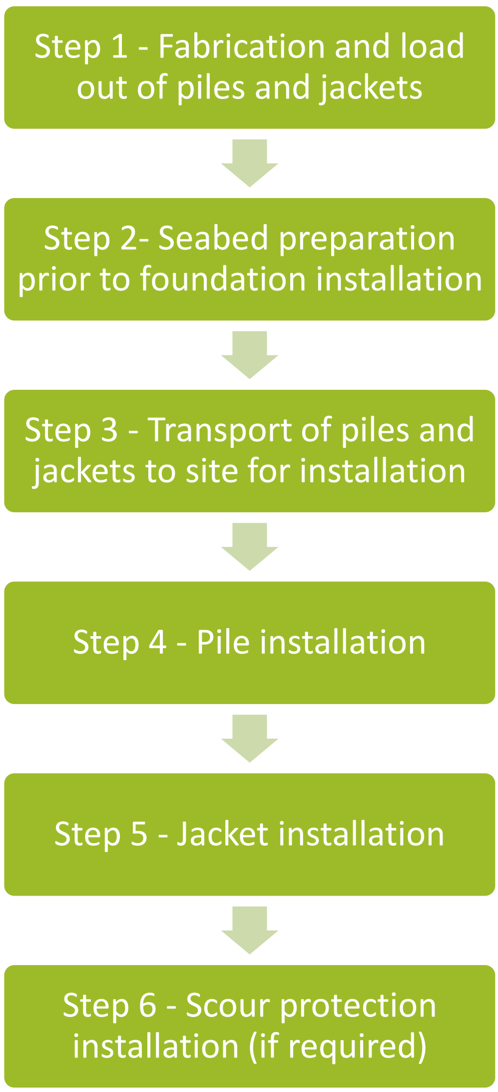
- Zinc primer applied preferably as a thermal spray;
- A silicon epoxy resin sealant;
- A coating of two-part liquid epoxy coating; and
- A final coat consisting of polyurethane, is applied by brush or spray, and is normally moisture curing and drying if solvent free.

27. All coatings/paints used will be suitable for the marine environment and will conform to the provisions of ISO 20340 and Norsok M-501 standards.

4.4.1.2 Installation of Wind Turbine Foundations

28. The installation of the foundations is likely to be performed in two separate operations/campaigns using different types of vessels and equipment. The pile installation may be performed well in advance of the jacket installation. The general sequence of foundation installation is shown in the flow chart in Illustration 4.3 below and subsequently described in more detail in the following sections.

Illustration 4.3: Foundation fabrication and installation sequence



Step 1: Fabrication and Load Out

29. The piles and jackets will be pre-fabricated at onshore fabrication facilities and transported to site (piles initially and later jackets with transition pieces attached) either by transport barges or by suitably equipped installation vessels. The onshore bases for fabrication have not yet been identified.

Step 2: Seabed Preparation

30. Seabed preparation necessary for piling and jacket placement is considered minimal, and at worst will consist of the removal of problem debris.

Step 3: Transportation for Installation

31. The piles and jackets will likely be transported directly from the onshore fabrication facilities to the Wind Farm Area. This may be carried out by means of a transport barge that does not have the required crane capacity for installation, in which case additional installation vessels will be required to complete the installation works.

32. Alternatively, transport and installation may potentially be carried out using a suitably equipped single vessel. In this case, it may be possible to transport multiple piles and jackets using a single vessel. An illustration of such a vessel is provided in Illustration 4.4 below.

Illustration 4.4: Transportation and installation vessel concept (Source: W3G Marine 2012)

Step 4: Pile Installation

33. The jacket can be pinned to the seabed in one of two ways:

- Using pre-installed piles installed with the use of a seabed piling template (as shown in Illustration 4.5); or
- Installation of piles after the jacket placement by either:
- Installing piles through special footplates on each leg of the jacket; or
- Installing the piles through the legs of the jacket.

Illustration 4.5: Jack-up barge installing seabed template (source: Fugro Seacore)

34. Owing to the nature of the seabed sediments at the site and the presence of shallow bedrock, there are three main installation methods that could be used for the installation of the piles:

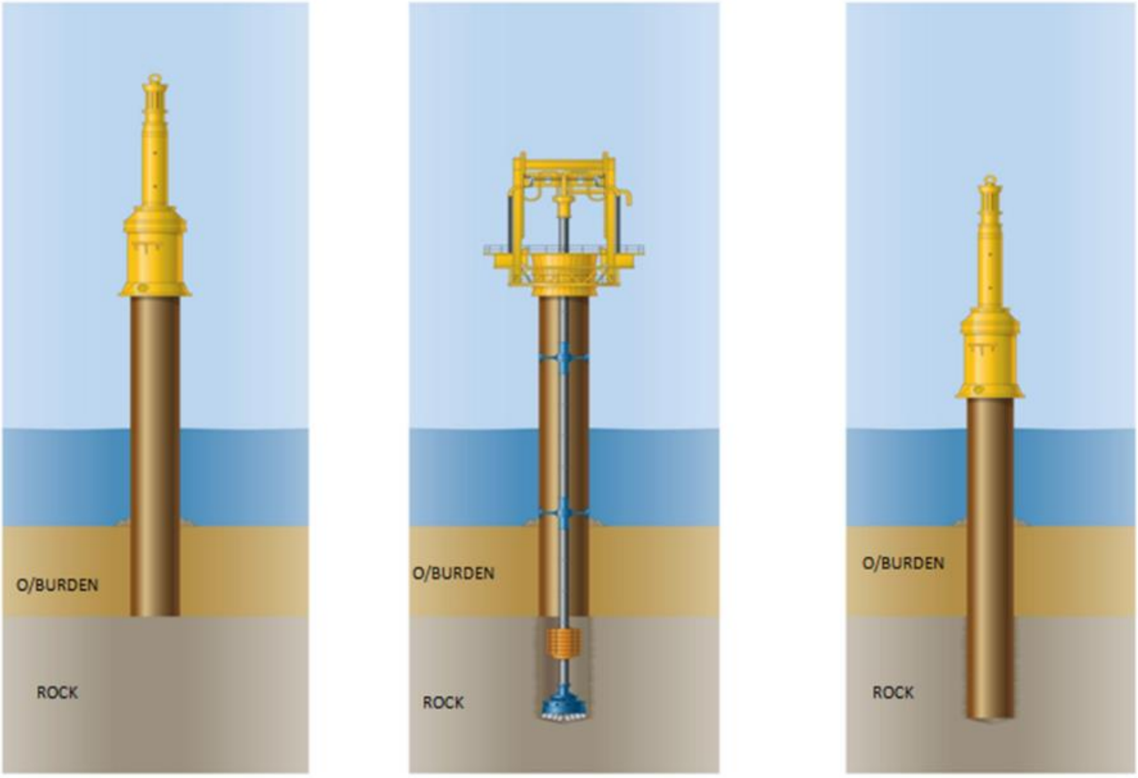
- Driven only pile - driving with a hydraulic hammer;
- Driven and drilled pile - the 'drive–drill-drive' method (as shown in Illustration 4.6 below) where successive driving and drilling phases are used; and
- Drill only pile - drilling out the entire hole for the pile and subsequently grouting the pile in (as shown in Illustration 4.7). In this method, a sacrificial casing may be installed by driving to bedrock level ahead of the drilling operation. This is to prevent the sediment layer collapsing in to the drilled hole prior to pile installation.

35. The ground conditions at each location will dictate the method that will be used for each foundation. Preliminary geotechnical investigations of the seabed suggest that:

- 0 to 10 % of piles can be installed by driving without assistance from use of a drill (i.e. driven only piling); and
- 90 to 100 % of piles can be installed using one or either of drive-drill-drive method or the drill only method. Where drill only is adopted, the sacrificial casing is expected to be driven to an average length of 30% of the pile length.

36. Whilst significant geotechnical data has been gathered to inform potential pile installation techniques, future geotechnical investigations will be used to refine these estimates.

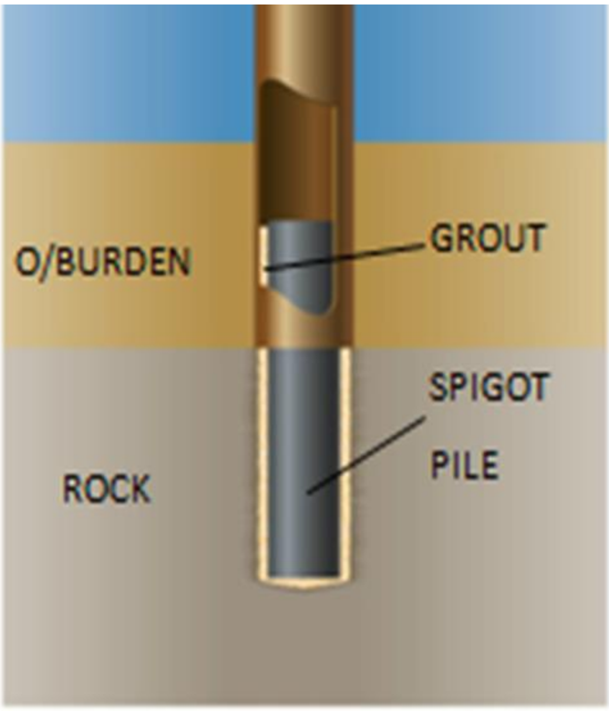
Illustration 4.6 Drive-drill-drive installation sequence for each pile (Source: Fugro Seacore 2012)



37. The 'driven only' piles will be installed without generating any arisings or rock fragments. The drive-drill-drive or drill-only pile installation methods generate rock fragments during the drilling element of the installation process. As these rock fragments are generated, they will be mixed with seawater and drawn into the inlet of a hydraulic chute at the drill-head. This will then be discharged from deck level on the supporting vessel and dispersed over the seabed surface adjacent to the pile installation works.

38. It is anticipated that guar gum will be used in drilling. Guar gum is used in drilling due to its ability to suspend solids; it regulates the viscosity of mud solution, and stabilises and regulates the flow properties of the drilling muds. Guar gum is a natural product that is biodegradable, has no bioaccumulation potential and is not a persistent, bioaccumulative, toxic (PBT) substance. Guar gum has little or no environmental impact. As is normal practice, the suspension of guar gum, water and fine rock particles will be discharged into the adjacent sea and the fine rock particles will settle out on the seabed.

Illustration 4.7 Grouted pile arrangement (Source: Fugro Seacore 2012)



39. Preliminary pile driveability studies have been completed to inform the selection of a maximum hammer energy that would be used to drive the piles into the seabed (and to inform the underwater noise modelling). As stated above pile driving using hammers may be used for each of the techniques under consideration:

- Drive Only – where pile driving will be continuous and used to achieve the full penetration depth;
- Drill-Drill-Drive – where pile driving will be intermittent and alternated with drilling; and
- Drill Only – where driving will be continuous but only be used for casing installation.

40. The pile driveability study has concluded that the sequence set out in Table 4.4 should be used for noise modelling to represent the worst case of continuous pile driving at a single pile location:

Table 4.4: Pile installation parameters

Parameter	Maximum design envelope
Soft start duration	30 mins
Applied hammer energy during soft start	360 Kilojoules (kJ) (20% of max energy for an IHC 1800 hammer)
Driving duration at maximum energy	up to 180 mins
Applied hammer energy at maximum energy	1,635 kJ (approx. 90% of max energy for an IHC 1800 hammer)

41. A jack-up platform or floating vessel will be used to install the piles (and also the jackets). Jack-ups require a footing on the seabed; to increase this footing area, and hence reduce bearing pressure on the seabed surface, the jack-up may use spud cans. Spud cans are conical shaped plates fixed to the

bottom of the jack-up legs; the diameter of the spud cans will vary depending on the jack-up barge and soil conditions, although a typical spud can diameter is approximately 8 m.

42. Depending on the number of piles and spacing, the jack-up may need to be relocated more than once to complete the full foundation installation process. Table 4.5 provides indicative details of the potential installation vessel activity.

43. If a floating vessel is used it is possible that anchors may be used to maintain position; the maximum expected anchor spread of a floating vessel up is 1.2 km. If a dynamic positioning (DP) system is deployed on the floating vessel the vessel holding position is maintained by thrusters and anchors may be unnecessary. The installation vessel (jack-up or floating) will require up to three support vessels. It is possible that up to four installation vessels will operate on site at any one time.

Table 4.5 Installation vessel parameters

Vessel Type	Vessel parameter	Minimum design envelope	Maximum design envelope
Jack up Vessel	Jack-up moves per foundation installation	1 (pile installation) 1 (jacket installation)	3 (pile installation) 1 (jacket installation)
	Leg spacing of jack-up	50 m x 50 m	100 m x 100 m
	Number of spud cans	4	8
	Spud can footing area (per vessel)	1 m^2 (leg area without spud can)	106 m^2
Floating Vessel	Number of anchors	0 (position on DP only)	8
	Anchor mooring length	200 m	1,200 m

Step 5: Jacket Installation

44. Once at the wind turbine position, the jackets will be lifted by crane barge, appropriately orientated and placed either on pre-installed piles in the seabed (or directly on to a prepared seabed in the case where piles are not pre-installed). In the former case, the jacket legs will incorporate pointed ends that are 'stabbed' into the pre-installed piles. In both cases, the annulus between the jackets legs at the pile wall will be grouted using a cementitious grout.

Step 6: Scour Protection Installation (if required)

45. As part of the final, detailed design phase, and prior to the start of construction, the need for scour protection around the foundation will be defined. Should scour protection be required, the area of seabed protected will depend on the number of jacket legs and the diameter of the piles. The area protected may be up to a maximum of 1,200 m^2. The volume of material to be placed on the seabed for the purpose of scour protection, should scour protection be required, is expected to be in the range of 200 to 600 m^3 per jacket.

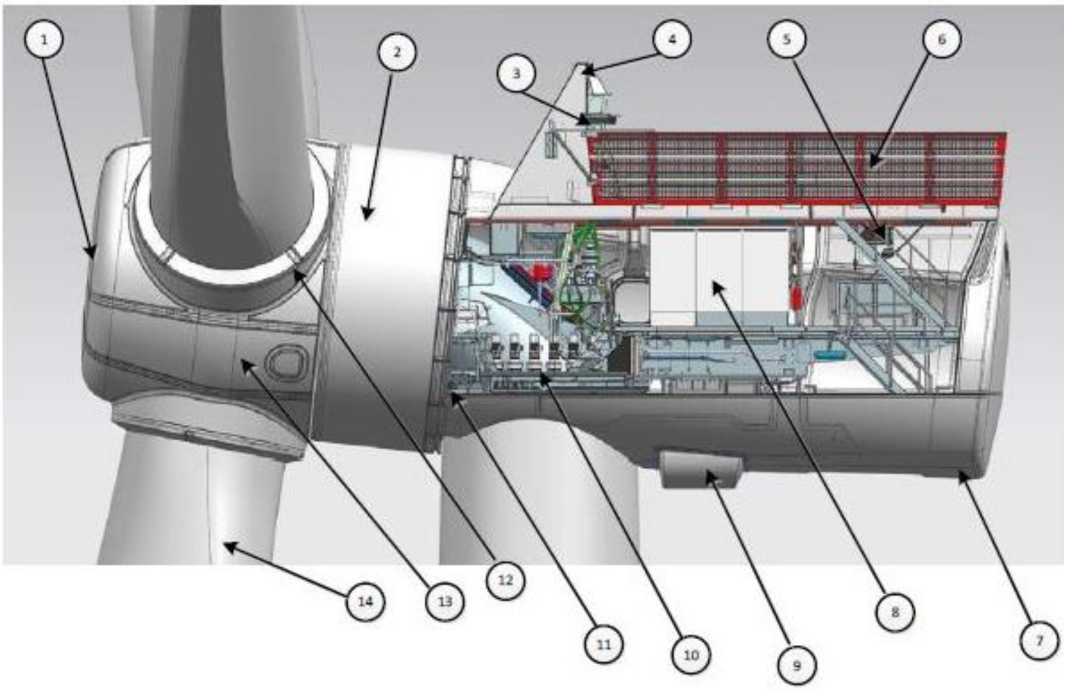
4.4.2 Wind Turbines

46. The turbines to be installed will be chosen based on a range of factors, including commercial availability and economics. Each turbine will have the same three bladed design overall incorporating the following internal mechanics (refer to Illustration 4.8).

- The blades or rotor converts wind energy to low speed rotational energy. The pitch blades are attached to the hub and the rotor is attached to the nacelle;
- The nacelle (see Illustration 4.8 and Illustration 4.9 below) houses the electrical generator, the control electronics, and a gearbox, if required, for converting the low speed incoming rotation to electricity;
- The tower supports the nacelle; and

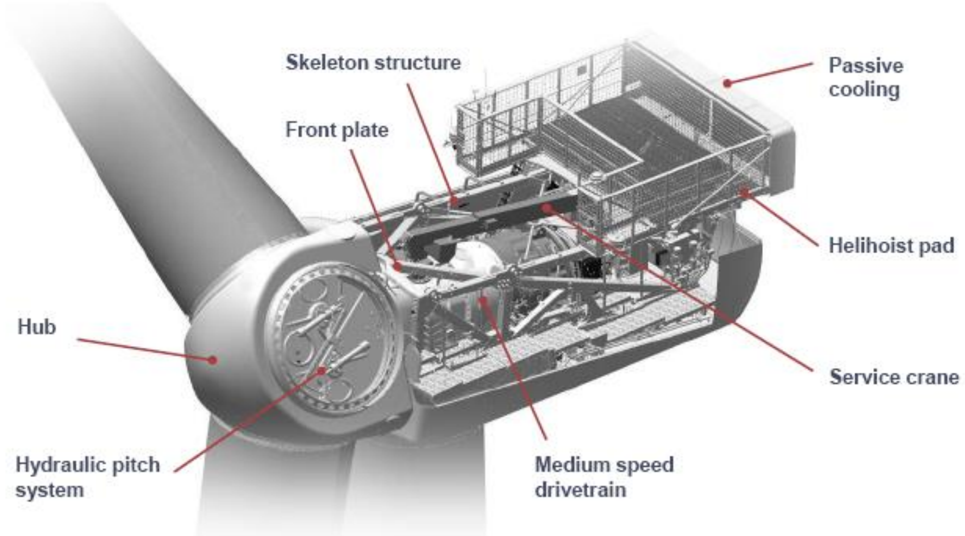
- The turbine transformer is either located within the wind turbine tower, usually at platform level above the foundation, or in the nacelle. The transformer is housed in a hermetically sealed unit and serves to step up the generator voltage to the inter-array voltage level.

Illustration 4.8: Components of a typical offshore wind turbine without gearbox (Source: Siemens Gamesa)



Item	Description	Item	Description
1	Spinner	8	Converters (2 pcs.)
2	Generator	9	Transformer
3	Wind Instruments and Aviation Light	10	Yaw Gear
4	Passive Cooler and Active Cooling Fans	11	Bed Frame
5	Portable Nacelle Service Crane	12	Blade Bearing
6	Heli Hoist	13	Hub
7	Canopy	14	Blade

Illustration 4.9: Components of a typical offshore wind turbine with gearbox (Source: Vestas MHI)



47. The Project requires flexibility in the choice of turbine to ensure that anticipated changes in available technology and economics can be accommodated. The design envelope therefore sets maximum and, where relevant, minimum realistic worst-case scenario parameters against which environmental effects can be assessed. The turbine options being considered range in power output. The turbine parameters outlined in Table 4.6 are considered to represent the worst-case design parameters associated with the turbines currently being considered. Illustration 4.10 defines the terminology used to describe the dimensions of the wind turbine.

Illustration 4.10. Wind turbine dimensions, adapted from Renew (2011)

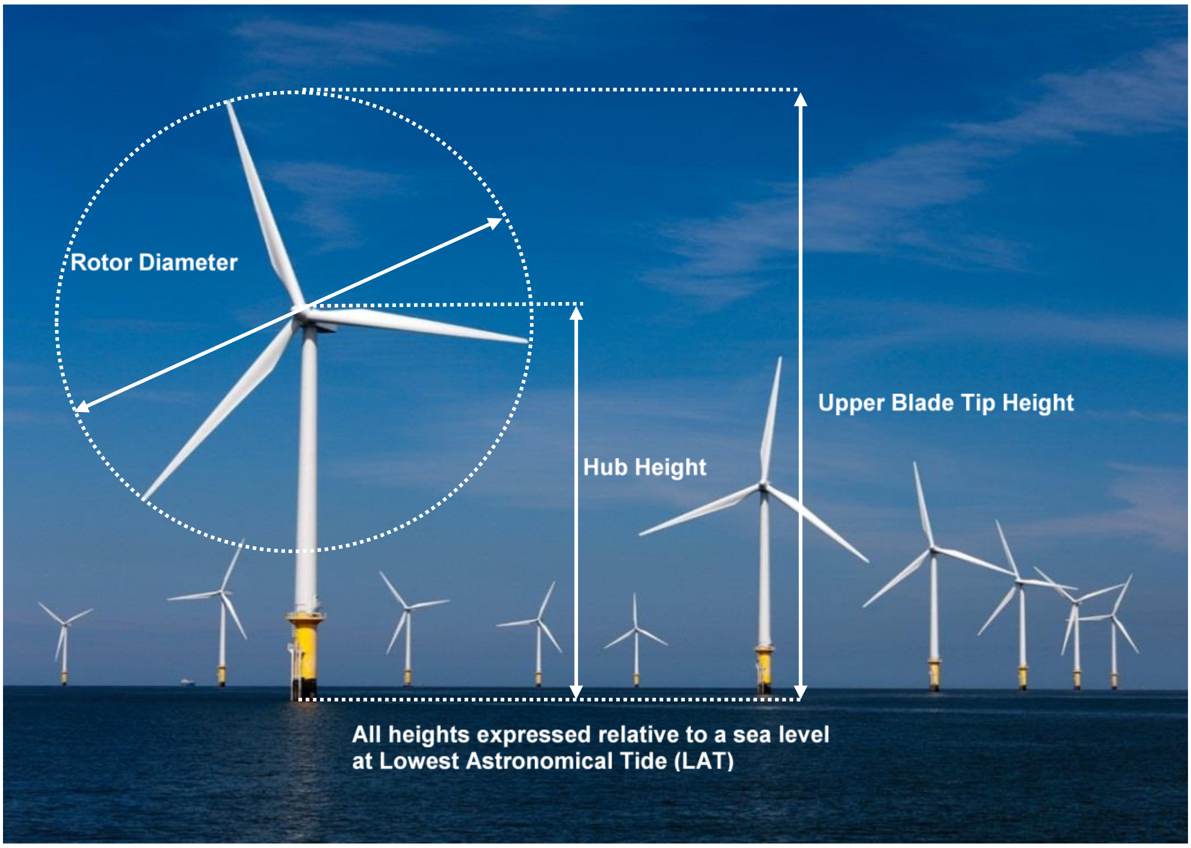


Table 4.6: Wind turbine design envelope parameters

Parameter	Minimum / maximum design envelope (or indicative range)
Number of turbines	54
Maximum rotor tip height (above LAT)	208 m
Rotor diameter	167 m
Maximum hub height (above LAT)	126 m
Minimum air gap clearance to blade tip (above LAT)	35 m
Maximum height of platform (above LAT)	21 m
Minimum wind turbine spacing (approximate)	800 m

4.4.2.1 Layout

48. The Project will transmit a maximum of 450 MW from the metering point on the OSP(s). The exact number of turbines required to reach this output will depend on the rated capacity of the individual turbines used, however the total number of turbines will not exceed 54.

49. For the purposes of conducting the EIA, an indicative layout has been developed based on the current understanding of ground conditions within the Wind Farm Area (Figure 4-3, Volume 2). The layout is based on the maximum design envelope of 54 turbine locations and 2 OSPs. The layout will be refined following further geotechnical investigations. The final layout will be confirmed post-consent and will be subject to consultation and approval by Marine Scotland Licensing Operation Team (MS-LOT).

4.4.2.2 Oil and Fluids

50. Each wind turbine will contain components which require lubricants and hydraulic oils in order to operate. The turbine transformer may be oil filled or ’dry type’. The volume of oil is dependent on the size of the turbine and typical maximum figures are shown in Table 4.7. The table presents the typical quantities of lubricating and hydraulic oils likely to be present in the turbine. The nacelle, tower and rotor are designed to retain any leaks.

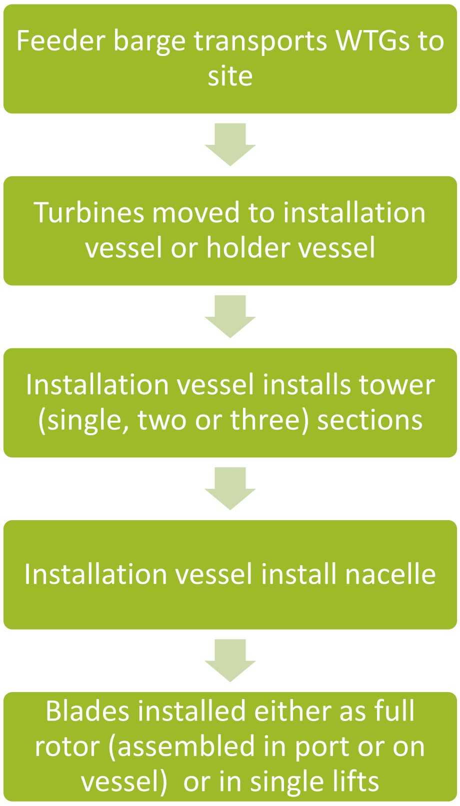
Table 4.7: Wind turbine oil and fluid parameters

Wind turbine oil or fluid	Maximum design envelope
Grease	250 litres (l)
Hydraulic oil	600 l
Gear oil	2,100 l
Transformer silicon / ester oil	3500 kilograms (kg)

4.4.2.3 Installation of the Wind Turbines Generators

51. Turbine installation will follow on from the installation of the foundations and will, preferably, take place after the installation of the associated inter-array cable. Turbines are likely to be transported from a pre-assembly harbour where some pre-assembly of, for example, tower sections will take place.

Illustration 4.11: General sequence of turbine installation



52. A typical indicative installation process detailing the base case turbine installation scenario is outlined in Illustration 4.11; however, this may be subject to change following the selection of the turbine supplier.

53. Wind turbine sub-assemblies (nacelle, rotor blades and towers) will be loaded either on to the installation vessel or on to a feeder vessel and shipped to the installation site. Depending upon which vessel is used it is likely that between three and ten complete wind turbine sub-assemblies will be loaded at a time.

54. At the installation location, the tower will be erected first, followed by the nacelle and blades. The blades may be installed one at a time (single blade installation as shown in Illustration 4.12) or pre-assembled.

55. The vessels to be employed for this installation will largely be determined by the final choice of wind turbine model and the availability of suitable vessels at the time of installation. In general, the installation sequence depicted above is expected to be followed, whereby separate vessels are used for the transport and installation of each wind turbine. This may, however, potentially be carried out using a single larger floating vessel, should such be commercially available at the time of construction.

56. The installation of each wind turbine (tower, nacelle and blades) is expected to take between approximately 12 and 24 hours.

Illustration 4.12: Wind turbine single blade installation (Source: Siemens Gamesa)

4.4.2.4 Turbine Commissioning and Testing

57. Turbine installation will preferably not commence until a power supply from the onshore grid connection is available. Once each turbine has been installed and the cabling connected, a process of testing and commissioning will be carried out before the turbine is put into service. Testing and commissioning of each turbine is estimated to take approximately eight days.

58. The turbine testing process consists of checking all of the control systems on the turbine, generator, switchgear, transformer gearbox (if required), yaw control and meteorological measurement functions, before running up the turbine through its normal design sequences. All interlocks and safety systems are checked for functionality in both the static and running modes. Ancillary systems such as the hydraulics also go through a pre-testing regime before the turbine is rotated. A standard checklist will be prepared before the turbine is put into service. The last phase of the commissioning is

energising the turbine via the inter-array cables. In the event that the grid connection is not completed at the time of wind turbine installation, an alternative method involving a temporary power supply will be implemented (see Section 4.4.5.6).

4.4.3 Met Mast

59. Meteorological or anemometry masts (met masts) are typically installed on site to measure wind speed and direction over a given time period.

60. It is currently planned for one offshore meteorological mast to be installed within the Wind Farm Area.

61. The met mast will be up to 140m high (above LAT). Anemometers will be located on the mast to measure wind speed and direction. Additional instrumentation will include sensors to measure wave height and direction, sea temperature and salinity, and structural response data. Safety features will include a fog detector that will provide input signals to trigger a fog horn.

62. A typical met mast is shown in Illustration 4.13.

Illustration 4.13: Met mast at Hornsea offshore wind farm (Source: SMart Wind)

63. As per the turbines and OSP(s), the met mast will be supported on a steel jacket with pile foundation with a maximum of four legs (supported on one pile per leg); the key parameters are summarised in Table 4.8, with other maximum dimensions and installation techniques as per those described for turbine foundations.

Table 4.8: Met Mast parameters

Parameter	Maximum design envelope
Number of met masts	1
Maximum height	140 m (above LAT)
Jacket leg spacing	35 m x 35 m
Foundation pile diameter	3.5 m
Foundation material	Steel (jacket and piles)
Pile depth below sea-bed	50 m

Parameter	Maximum design envelope
Met mast safety features	▪ Fog Detector – VF-500 Visibility Sensor: Uses forward scatter sensor technology to measure visibility in all weather conditions. The visibility sensor acts as the on/off switch for the foghorn. ▪ 2 nautical mile (NM) fog horn: Automatically broadcasts (when required by the fog detector) a 360° beam of sound to a pre-selected code audible for 2 NM. Sound Signal: Morse.

4.4.4 Offshore Electrical Infrastructure

64. The electricity generated by the turbines offshore will be transmitted to the national grid; it is anticipated that the following infrastructure will be required offshore for the purposes of transmission:

- A maximum of two 43 km long Offshore Export Cables, each comprising of an electricity cable and an internal fibre optic cable from the OSP(s) to the landfall location at Thorntonloch. An option to install separate fibre optic cables, laid in parallel with the power cables in the same cable trench is also being considered in place of internal fibre optic cables;
- Up to 140 km of buried inter-array cables (including backfeeds) linking the wind turbines in strings and connecting cables from wind turbines to the OSP(s). An option to install separate fibre optic cables, laid in parallel with the inter-array cables in the same cable trench is also being considered in place of internal fibre optic cables;
- Up to two OSPs; and
- If two OSPs are installed, up to four interconnector cables may be installed between the two OSPs to ensure standby power supply to each OSP.

65. Several different design options for the electrical systems are being considered and the final decisions will be reliant on the final turbine and inter-array cable voltage choice.

4.4.4.1 Offshore Substation Platform(s)

66. The purpose of the OSP is to transform the electricity generated offshore from medium voltage (MV) (up to 72.5 kV) to a higher voltage (220 kV). This increase in voltage allows the power to be transmitted to the onshore substation efficiently and with lower transmission losses. There will be a maximum of two high voltage alternating current (HVAC) OSPs installed within the Wind Farm Area.

67. The location of the OSP(s) will be confirmed following detailed geotechnical investigations and finalisation of inter-array cable layout design.

68. Each OSP will consist of a steel jacket with piles foundation and a topside which houses the electrical equipment in addition to other people facilities.

4.4.4.1.1 *Topside Design*

69. The topside structure will accommodate the OSP electrical equipment and provide access and temporary or emergency accommodation for personnel as well as areas for cable marshalling and other services. The topside size and weight are determined by the equipment that is to be accommodated at the substation. Due to the offshore conditions, the OSP(s) will be built to withstand corrosion and prevent equipment damage; hence, all electrical equipment is enclosed to protect it from the environment.

70. The main parameters of the OSP are shown in Table 4.9.

Table 4.9 Topside Design Envelope Parameters

Parameter	Maximum design envelope (or indicative range)
Number of OSP(s)	2
Maximum height of topside (above LAT)	21 m
Height to top of crane / helicopter pad (above LAT)	60 m
Length x width of topside	40 m x 40 m
Weight of topside	1,000 to 3,500 tonnes

71. The OSPs will incorporate more than one deck and each deck will contain different modules, enclosures or systems including, for example:

- Transformers;
- Transformer cooling system;
- Transformer dump tank;
- 220 kV gas insulated switchgear room;
- MV (rated up to 72.5kV) switchgear;
- Heating, ventilation and air conditioning;
- Fire suppression systems;
- Temporary emergency diesel generation system;
- Batteries, battery chargers and Uninterruptable Power System (UPS);
- Control and protection room;
- People facilities (possibly including temporary or emergency accommodation and lifeboats); and
- Helicopter pad or helihoist platform.

72. If only one OSP is used there could be up to six transformers (two large power transformers and four small auxiliary transformers and associated equipment). If two OSPs are used, one large power transformer and two small auxiliary transformers will be accommodated within each.

73. The major plant items likely to be present on each OSP for the two OSP scenario are summarised (in Table 4.10).

Table 4.10 Summary of major plant contained on each OSP (for the two OSP scenario)

OSP plant item	Quantity	Features
Transformer	One large transformer and up to 2 small auxiliary transformers on each of the two OSPs.	Oil filled transformer complete with oil bunding designed to capture any leakages. NB. gas-insulated (using sulphur hexafluoride (SF_6)) and dry auxiliary transformers are also being considered, which would not require oil.
Transformer cooler	To be determined during detailed design of the transformer.	Contained within ventilated (louvres on external wall), perimeter enclosure
Medium voltage switchgear	One 33 kV switchboard with a minimum of 11 circuit breakers on each OSP.	Modular, gas insulated switchgear (up to 72.5 kV)
220 kV breakers	One on each OSP	Modular, gas insulated unit. Number depending on final design of protection system

4.4.4.1.2 Foundation Design

74. Each OSP will be supported by a steel jacket with piles foundation. Table 4.11 below shows the dimensions of the key design parameters for the OSP foundation.

Table 4.11 OSP foundation design envelope parameters

Parameter	Maximum design envelope (or indicative range)
Jacket type	Steel lattice
Jacket leg spacing at seabed level	60 m x 60 m
Details of seabed preparation	Clearance of any debris found. A seabed template with up to 8 legs will sit temporarily on the seabed during pile installation for the OSP foundations.
Maximum pile diameter	3.5 m
Maximum number of piles per foundation	8
Maximum pile penetration depth	50 m
Pile installation method	Drive only, drive-drill-drive or drill only
Indicative foundation installation duration (per foundation)	Pile Driving (maximum of 21 hours for up to 8 piles) Pile Drilling (maximum of 180 hours for up to 8 piles) This includes time for setting up and changing equipment between piling locations. Jacket installation (maximum of 24 hours).
Weight of jacket	2,500 tonnes
Diameter of main jacket tubulars	3 m
Seabed occupied by jacket leg (piles and scour protection)	300 m^2 per leg

75. Scour protection, if required, will be similar to the scour protection outlined under Section 4.4.1 for wind turbine foundations, the quantity will depend on the final foundation design.

4.4.4.1.3 *Hazardous Substances*

Transformer Oil

76. Oil is used primarily as a cooling medium for transformers. Each transformer will be filled with up to 2,500 l of oil at the docks in advance of transportation offshore.

77. An oil collection (bunding) system will be installed underneath the power transformers. This will consist of collection pans, which cover areas at risk from spillage, including the transformers. Oil-resistant and fire-resistant plastic or rubber liners may be installed on the floor or underneath/around catchment pans for added protection. The collection pans will feed into an oil sump that will have a capacity of at least 110% of the stored volume of oil.

Sulphur Hexafluoride (SF_6)

78. SF_6 is used in gas insulated switchgear as an arc-quenching agent. It facilitates the design of compact and highly reliable switchgear. SF_6 is likely to be used in the MV and 220 kV switchgear and may be considered for use in the HVAC transformers. SF_6 switchgear is long established and is a proven product used both onshore and offshore.

79. Under operational conditions, including fault conditions, SF_6 remains completely inert and is totally contained within the switchgear. Normal risk mitigating measures include switchgear SF_6 pressure monitoring. The SF_6 components of gas-insulated switchgear are designed to be maintenance free for their life.

Batteries

80. A direct current (DC) system consisting of dry type valve regulated lead acid (VRLA) batteries, battery chargers and a distribution board will all be housed in standalone floor mounted cabinets to cater for the OSP 48 volt (V) DC supplies. The batteries will be mounted on terraced shelves covered with an acid resistant sheet behind secure front opening doors. Telecommunications equipment may have

dedicated batteries such as nickel cadmium. These battery cells typically have a design life of 10 to 12 years and will be recycled and properly disposed of at the end of their useable life, and replaced with equivalent.

Diesel Fuel

81. There may be a diesel generator, with integral fuel tank included at the OSPs, which will be used to provide emergency electrical supplies for a period of time in the event of loss of connection to shore. The amount of fuel needed will be based on the auxiliary load of the OSP and the suggested runtime fuel needed for emergencies. Based on existing wind farm experience, a diesel fuel volume of the order of 10,000 l is anticipated. Standard offshore practice, using containerised bunded generator sets, or generator sets enclosed within a purpose-built enclosure will be used. The generator will run for test purposes, typically at 1-year intervals. Fuel top-ups to replace volumes of fuel used in testing, will take place using a flexible retractable hose from a licensed diesel supply vessel. Alternative designs are also being considered with no permanent diesel generator installed on the OSPs; in this scenario provisions will be in place to connect a diesel generator quickly to the OSP with the diesel generator and fuel tank being brought from shore as required.

Fire Extinguishing Agents

82. A fire detection and suppression system complying with relevant regulations will be installed during the manufacturing of the topside. As a minimum, this will comprise mains powered smoke detectors with rechargeable battery backup. These detectors will be wired through to the site remote telecommunications supervisory control and data acquisition (SCADA) system and control operators onshore will be alerted of a fire at the OSP. A fire suppression system will be in place and manual fire extinguishers with appropriate extinguishing agents will be installed in all rooms.

Anti-Corrosion Coatings

83. The steelwork and other materials vulnerable to corrosion used in the construction of the topside will be either hot dip galvanised or coated with other corrosion protection coating during fabrication. Electrical equipment such as cooling radiators can be coated to provide resistance to scratches and impacts. Minor volumes of touch up corrosion protection coating (anticipated less than 50 l) will be housed on the OSP to deal with any areas that require maintenance.

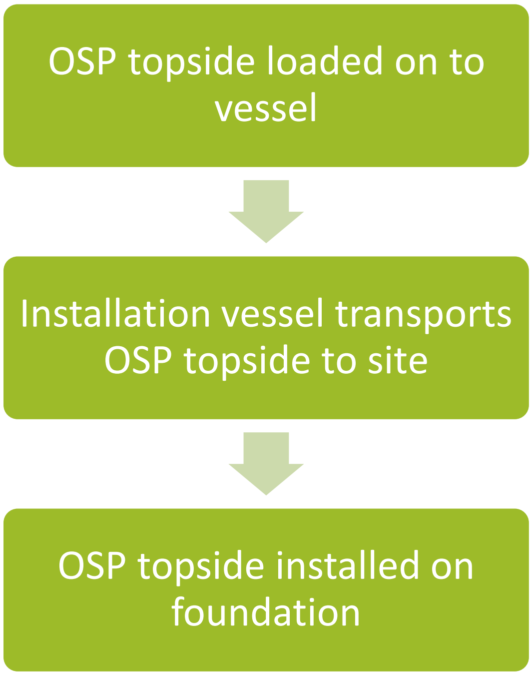
4.4.4.2 Installation of the OSP

84. Installation of the OSP foundations will be similar to the process for the installation of the wind turbine foundations described in Section 4.4.1.

85. Installation of the topside is expected to follow the general sequence shown in Illustration 4.14. The complete topside will be manufactured onshore and all electrical and mechanical equipment will be installed and pre-commissioned onshore before being transported offshore.

86. The topside will be transported offshore on either a barge that does not have an installation capability or on a heavy lift vessel that does have an installation capability. If a barge is used for transport, a separate heavy lift vessel or a jack up vessel will be used for lifting the topside onto the pre-installed foundation; it is likely the installation vessel will be supported by up to four vessels including tugs and fast response vessels.

Illustration 4.14: General sequence of topside installation



87. Once the substation is in place, the inter-array, interconnector and Offshore Export Cables will be brought into the topside and the OSP commissioning work will be undertaken.

88. Total installation is expected to take approximately 30 days per OSP exclusive of weather downtime. Illustration 4.15 shows an example of a fully installed OSP.

Illustration 4.15: Installed substation (Pictures courtesy of CG. Copyright ®vanoordbv-mennomulder.com)

4.4.4.3 OSP Interconnector Cables

89. In the event that two OSPs are used, both will be connected to shore via independent 220 kV Offshore Export Cables. If one of these Offshore Export Cables goes out of service, a level of redundancy will be provided by MV (up to 72.5 kV) interconnector cables connecting the two OSPs. Such interconnection improves export power flexibility and will be made using MV (up to 72.5kV) cables similar to that used

for the inter-array cable system. The installation and burial of this cable will be the same as that described in Section 4.4.4.4.

4.4.4.4 Inter-Array Cables

90. Inter-array cabling used to connect turbines may be rated at up to 72.5 kV (MV) AC. The cables will be steel wire armoured and will have three electrical conductor cores varying in size up to 800 millimetres squared (mm^2) with cross-linked polyethylene (XLPE) insulation. Optical data cables for SCADA, control and protection will be included within the cable bundle (or alternatively may be laid separately alongside the main inter-array cables).
91. The inter-array cabling layout will be optimised to minimise losses and capital expenditure costs and as part of the final scheme design process. There will be up to 14 collector circuits (7 connecting to each OSP), connecting up to ten turbines each, dependent on the wind turbine mode layout; these will directly link to the OSP. This connection will, mostly likely, be made after the turbine foundation installation but before the turbine installation.
92. The total length of inter-array cabling will vary slightly depending upon the final turbine layout and ground conditions but will not exceed 140 km (for inter-array and interconnector cables combined).
93. Details of the inter-array cable design and burial parameters are summarised in Table 4.12.

Table 4.12: Summary of Inter-array cable design envelope parameters

Parameter	Maximum design envelope (or indicative range)
Number of cables	14 circuits (7 connecting to each OSP)
Total length of cabling (including interconnectors if required)	140 km
Design of array	10 turbines per collector circuit
Specification of cables	XLPE AC cable rated up to 72.5 kV Size ranges from 50 mm^2 to 800 mm^2
Burial method / scour protection	Likely ploughing/cutting/jetting or rock cover, options finalised when layout is confirmed.
Width of seabed affected (per cable)	Approximately 2 m direct impact width, 8 m width of zone of minor disturbance (approximately 10 m in total).
Burial depth	Target depth 1 to 1.5m. However likely to vary across site up to 3 m. Burial may not be possible in limited areas where bedrock outcrops at seabed level or in zones where thin sediment exists over the bedrock, in this instance protection will be used.

4.4.4.5 Installation of the Inter-Array Cables

94. Inter-array cables will be buried and protected where burial is not possible in order to:
    - Prevent movement or exposure of cables over the lifetime of the Project due to seabed movement;
    - Protect the cables from other activities such as fishing or anchor placement;
    - Protect against the small risk of dropped objects; and
    - Limit the potential effects on environmental receptors from the effects of heat and or induced magnetic fields caused by the cables.

95. Due to the relatively small diameter, greater inherent flexibility and shorter route lengths involved in inter-array cable installation, different approaches can be adopted for cable installation:
    - Cables can be cut to length prior to the offshore installation phase;
    - Uncut cable can be loaded into a vessel cable tank or carousel (with capacity up to 80 km of cable); or

- Shorter lengths can be spooled on to an installation reel or reels, which can then be lifted onto the installation vessel.

96. The inter-array cables will be buried where possible using cable ploughs (Illustration 4.16) and/or mechanical cutters as necessary. The cable plough uses a remotely operated adjustable steel cutting tool to achieve the required trench depth. In harder soils, a mechanical cutter with a hydraulically operated chain cutter can be used. A cable installation plan that will identify specific areas for the use of the plough and mechanical cutter tools will be prepared following the detailed geotechnical investigation and cable burial assessment.

Illustration 4.16: Cable plough (Source: Prysmian Group)

97. An installation rate of approximately 2 to 3 km per day on average depending on weather conditions and soil conditions is expected to be achieved.

98. The use of water jetting is considered unlikely to be viable due to the hard soils anticipated and the potential for very shallow rock outcropping; however, it may be used in some areas of the Wind Farm Area where conditions allow, as guided by the detailed geotechnical investigation and cable burial assessment.

99. It is currently expected that additional cable protection will be required over approximately 20% of the inter-array cable length, in locations where desired burial depths are difficult to achieve; such instances would occur where bedrock outcrops at seabed level or in zones where thin sediment exists over the bedrock.

100. Several materials can be used to provide additional protection to cables, which include:

- Durable crushed or original rock of defined size range;
- Artificial fronds or seaweed;
- Concrete 'mattresses'; and
- Bags (high strength nylon fibre) of gravel, hardened sand-cement grout, or concrete (grout/concrete pre-filled and hardened onshore). The bag option may include a technique where the grout is introduced to the nylon fibre bag offshore through proprietary pipes (the bags being permeable to water but not to grout).

101. The amount of cable protection is dependent on the mobility of the seabed near the cables and the depth of burial achieved. The width of any cable protection that may be installed above the cable is expected to be approximately 2 m and the height of the cable protection is expected to be in the order of 0.5 m above the surrounding seabed level.

102. Cable protection material, where required, would be installed using a fall pipe vessel, a vessel equipped with a wire crane with grab or by rock dumping.

103. Either a single vessel or twin vessels as detailed below may be used to undertake the inter-array cable installation.

4.4.4.5.1 *Single Vessel Installation Process*

104. A single vessel may be used to both lay and bury the cable simultaneously. Support vessels will be used to manage the recommended safe passing distance around the inter-array cable installation works (refer to Section 4.5). The single vessel inter-array cable installation process may be summarised as follows:

- The cable laying vessel approaches the first structure and the cable end is over-boarded, transited to the structure, probably by ROV, and carefully pulled into the first J-tube and temporarily fixed in position at platform level ('hung off');
- The installation vessel then over-boards the plough or trenching unit, and cable loading takes place either on the vessel back deck or subsea;
- Simultaneous lay and burial of the cable then begins using the cable burial equipment;
- At the end of the cable where the next wind turbine is approached, the plough or trenching would cease and the vessel would transit past the wind turbine foundation leaving a length of cable exposed on the seabed; and
- Following recovery of the plough or trenching tool, an ROV would be used to recover the cable end which will then be pulled up through the J-tube.

105. The length of cable - approximately up to 100 m - left unburied at the approach to each turbine has to be protected. This can be done by any of the cable protection measures identified above in Section 4.4.4.5 or alternatively an ROV can mechanically cut a trench to accomplish burial of the cable in this area.

4.4.4.5.2 *Twin Vessel Installation Process*

106. Alternatively, two vessels can be used to complete the inter-array cable installation process - one to lay the cable and the other to bury it. In this scenario, the lay and bury activities occur in much the same way as described above, but cable burial takes place from a separate trenching vessel, either simultaneously or immediately after installation and cable hang off. Post-lay trenching is likely to be less well suited for ploughing operations and better suited to a mechanical trencher. It is possible that multiple vessels could be used to install the cables simultaneously.

4.4.4.5.3 Cable Crossings

107. Inter-array cable layout designs will seek to ensure that cable crossing is avoided; however, should this prove impractical, cable crossing protection measures will be necessary. No third-party cabling or pipelines have been identified within the Development Area. However, should a cable or pipeline crossing be required, the protection would consist of one or more of the scour protection materials identified in Section 4.4.4.5.

4.4.4.5.4 *Post Burial*

108. Following the completion of burial activities, a further cable protection phase may be required to protect the cable transitions and any areas of cable exposure around the J-tubes. This cable protection will be installed using one of the processes outlined for foundation scour protection (see Section 4.4.1). The final decision concerning optimal burial methodologies will be made at a later date when further geotechnical investigations and a cable burial assessment have been carried out.

4.4.4.6 Offshore Export Cable

109. The Offshore Export Cable route selected was a balance of the shortest route possible between the OSP and the landfall, seabed conditions and environmental considerations. The Offshore Export Cable Corridor has been determined and surveyed, but the exact location of the Offshore Export Cable will be micro-sited based on a pre-cable lay survey.

110. The total length of installed Offshore Export Cable will be up to 86 km (two cables at 43 km each). The Offshore Export Cables will be laid within the Export Cable Corridor which will be a maximum width of 300 m (150 m either side of the Offshore Export Cable Corridor centre line). The Offshore Export Cables will be separated by a minimum spacing at sea of 70m, potentially extending to the edges of the 300m wide corridor in some areas, dependent on water depth. Towards the landfall at Thorntonloch, the cables will be closer. 220 kV HVAC 3-core insulated cable will be used.

111. The final design of the Offshore Export Cable system will be determined by results of geophysical and geotechnical surveys and the electrical design of the Project. Consideration will be given to minimising the number of cable joints, of both factory and offshore types, however it is currently anticipated that offshore joints will not be required. The parameters for the Offshore Export Cable are shown in Table 4.13.

Table 4.13 Offshore Export Cable design envelope parameters

Offshore Export Cable parameter	Maximum design envelope (or indicative range)
Number of cables	2
Total length of cabling	86 km
Length per cable	43 km
Specification of cables	220 kV (Um 245 kV) 3-phase AC XLPE insulated
Spacing between cables	Minimum 70 m / maximum 300 m (3x water depth but no less than 70 m)
Width of Offshore Export Cable Corridor	300 m (i.e. 150 m either side of Offshore Export Cable Corridor centre line)
Burial method / scour protection	Likely ploughing/cutting/jetting or rock cover, options finalised when layout is confirmed.
Width of seabed affected (per cable)	10 m (2m direct impact width in the centre of an up to 10m wide zone of minor disturbance from the plough skids).
Burial depth	Target depth 1 to 1.5m. However likely to vary across site up to 3 m. Burial may not be possible where bedrock outcrops at seabed level or in zones where thin sediment exists over the bedrock, in this instance protection will be used.

112. Offshore Export Cable characteristics vary depending upon cable manufacturer. An example of a typical 220 kV 3-core HVAC cable cross section is shown in Illustration 4.17. The cable typically comprises three copper conductors insulated by cross-linked polyethylene and an integral optical fibre cable (24 single mode fibres). Individual cables have an insulation screen, a lead alloy sheath and a polyethylene over sheath. The 3-core assembly is encased with a single layer steel wire armour covering and a final outer polypropylene sheath.

113. The fibre optic data cables may be included within the cable bundle for SCADA functions or alternatively separate fibre optic cables, laid in parallel with the power cables in the same cable trench may be installed.

Illustration 4.17 Illustrative export cable cross section

114. Currently, it is assumed that the Project will use subsea cables with aluminium conductors of up to 1,200 mm^2 and galvanized steel wire armouring to protect the cables. However, copper conductors may also be used.

4.4.4.7 Installation of the Offshore Export Cable

115. The cable installation methods to be adopted will be dependent on the ground conditions along the route, the final decision will be made following detailed geotechnical investigation and a burial assessment. Installation methods currently under consideration for the installation of the Offshore Export Cable include:

- Use of high-pressure pump/jets to cut trenches where sandy conditions exist. Having laid the cable, the trenches will close naturally without backfilling;
- Use of mechanical cutters or cable ploughs (as described above in Section 4.4.4.5 for the inter-array cables); and
- Laying of the cable on the seabed and covering with cable protection (protection methods as previously described for the inter-array cables - see Section 4.4.4.5) (where bedrock outcrops at seabed level or thin sediment layer is present over the bedrock).

116. The current intention is to bury the cable as far as is practicable along the entire Offshore Export Cable Corridor but the extent to which the cables will be buried will be dependent on the result of a detailed geotechnical survey and associated burial assessment process. In suitable seabed conditions, cables could be buried to a depth of up to 3 m, however, a target depth of 1 – 1.5 m is mor likely where seabed conditions allow. It is estimated that 15% of the Offshore Export Cable will require cable protection.

117. Subsea export cables are thicker and heavier than inter-array cables and land cables, and somewhat larger vessels are, therefore, typically required for installation. Illustration 4.18 depicts an example of a typical vessel commonly used for the installation of subsea export cables. The vessel has a mechanised cable turntable on deck to wind the cable on-board and to wind it off again. This vessel uses dynamic positioning and other navigational aids to maintain accurate cable laying.

Illustration 4.18: Cable lay vessel Giulio Verne (Source: Prysmian Group)

118. There are three common vessel arrangements used to install long distance cables:

- Lay and protect the cable from a single cable installation vessel (typically 2 to 3 km per day);
- Lay the cable using a cable installation vessel and protect the cable using a separate vessel, but with both vessels travelling together and working as a single unit to achieve a typical installation rate of 2 to 3 km per day; or
- Lay the cable using a cable installation vessel with a separate ship protecting the cable and both ships travelling independently. The cable installation ship could in this case travel much faster (15 to 20 km per day) and the protection vessel travelling at 2 to 3 km per day.

119. The Offshore Export Cable will need to be installed in varying water depths from the OSP to the landfall and in the intertidal zone. Based upon the water depths and nature of the seabed along the route, a dynamic positioning vessel is currently expected to offer the optimal operational flexibility across the range of cable installation operations necessary. Based upon the length and assumed weight of the cable, it is currently considered likely that each Offshore Export Cable would be laid in a single length without the requirement for a midline joint.

4.4.4.8 Installation of the Offshore Export Cable in the Intertidal Zone

120. The Offshore Export Cable landfall will be at Thorntonloch beach, to the south of Torness Power Station in East Lothian. At the landfall, the two Offshore Export Cables will be brought from the offshore cable-laying vessel, up the intertidal zone, to two adjacent transition pits located landward of MHWS – where the Onshore Export Cable and Offshore Export Cable will be connected. The transition pits and other work landward of MWHS fall under the OnTW planning permission. East Lothian Council granted planning permission for all onshore works in June 2013. For completeness, these works are described below although they are outwith the current applications for Section 36 consent and Marine Licenses.

121. This EIA assesses effects seaward of MHWS, with the EIA for the OnTW assessing effects from mean low water springs (MLWS) landward, however, information is provided below regarding works landward of MHWS for context.

122. Although a minimum spacing of between 70 and 300 m will separate the two Offshore Export Cables offshore, this will be reduced to a minimum of 10 m as the cables approach the landfall and the connection with the Onshore Export Cable. At landfall, the Offshore Export Cable will be housed in high-density polyethylene ducts installed under the beach.

4.4.4.8.1 Intertidal Zone Installation Method

123. The method of installation for intertidal works will be dependent on the ground conditions and the equipment used. Two potential options are currently being considered for installation, horizontal directional drilling (HDD) and open cut trenching. Both methods are described below.

Horizontal Directional Drilling (HDD)

124. HDD involves drilling a channel underground between two points, into which an electrical cable can be installed, without needing to excavate an open trench along the channel route (Illustration 4.19). To achieve this, an onshore drill rig commences drilling at the start of the underground channel (labelled here as the 'Rig Site'), toward the end of the channel (labelled here as the 'Pipe Site'). Using HDD, it estimated that the duration of cable installation works at the intertidal zone would be approximately 4 months.

125. The rig site will be located landward of MHWS behind Thorntonloch beach and will comprise a construction area of approximately 30 m long by 40 m wide which will contain a drill rig, an electrical generator, a water tanker, a mud recycling unit and a temporary site office. Drilling mud containing bentonite will be used to aid the drilling process and will use the output from the mud-recycling unit mixed with water for this purpose. The rig site will contain a receiving pit for the cable. This will be similar to a conventional manhole and will be approximately 2.5 m long by 1 m wide by 1 m deep.

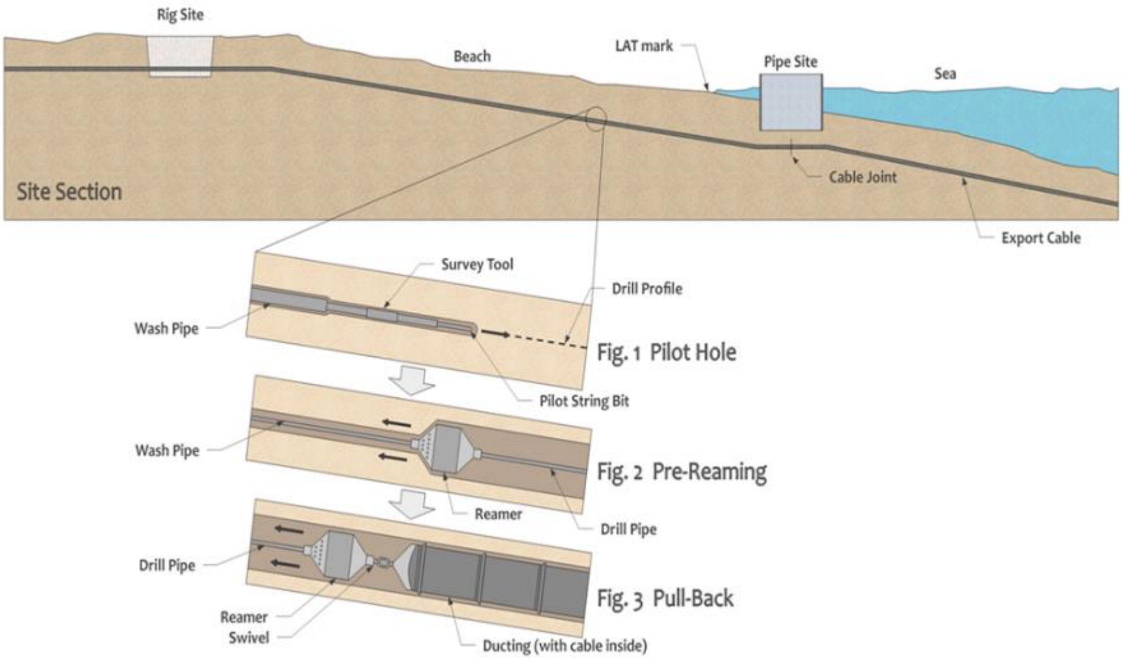
126. The pipe site would be located below (i.e. seaward of) MLWS on Thorntonloch beach and will comprise an area of up to 20 m long by 20 m wide. The precise location of the pipe site will be confirmed following the detailed design process and will be based on the geotechnical survey data that has been acquired for the intertidal zone. A jack-up platform equipped with an excavator could be used to carry out the works at this location. A circular/rectangular steel casing may be installed into the seabed to facilitate the excavation of a dry area within which a second receiving pit would be constructed. This would involve interlocking steel sheets being lifted in to place by an excavator. Here, the cable will emerge from the channel and, if required, be joined with the Offshore Export Cable. The cable will then be buried, the disturbed area reinstated and the casing removed.

127. The HDD drilling/cable installation process will comprise four stages as described below and illustrated in Illustration 4.19 below:

- A small diameter pilot hole will be drilled from the rig site to the pipe site, for the purpose of defining the path of the channel into which the cable is to be installed;
- A steel reamer will then be pulled back through the pilot hole from the pipe site to the rig site, enlarging the diameter of the hole as it progresses. This may need to be repeated a number of times, depending on the nature of the soil through which it passes, in order to enlarge the channel diameter sufficiently as to accommodate the electrical cable;
- The cable and the ducting within which it rests will then be attached to the reamer and pulled through the channel from the pipe site to the rig site, at which point it will be secured in place by means of precast concrete thrust blocks within the transition pit (or alternatively a smaller length of cable may be used with the ducting, which will then be connected to the remainder of the Offshore Export Cable and buried into the seabed); and
- The jack-up platform will be removed.

128. At the pipe site, the cable will be supplied by a cable installation vessel such that it can be drawn through the channel behind the reamer. This vessel will be required to remain a minimum distance from shore to ensure adequate water depth for operation. This distance is currently estimated to be up to approximately 1 km; however, this will be confirmed following the cable installation vessel selection and final route design process.

Illustration 4.19: Illustration of HDD process



Open Cut Trenching

129. Open cut trenching may be used as an alternative to HDD to install the Offshore Export Cable through the intertidal zone. The cables will be laid in PVC ducts (a tube that facilitates the passage of the cable and offers some protection). The required burial depth will be determined in detailed design and will include a burial risk assessment. It is currently anticipated that the burial depth to be in the order of 1 m below the current beach levels. Illustration 4.20 depicts a typical open trenching scenario.

130. Preparatory works along the intertidal zone will depend on the underlying geology. Excavators will be used to dig the necessary trenches. Should the sediment depth be insufficient, rock breakers or other mechanical cutting methods may be required to achieve the designed burial depth. Excavation will be achieved using an excavator mounted on a barge or jack-up platform in water depths up to approximately 5 m below LAT. In the deeper water beyond this point, cable burial into the bedrock can be handled by rock cutting or trenching using an ROV. The works corridor at landfall will be 30 m wide and will extend up to the onshore cable transition bays.

131. Cable ducts will be installed in the trenches from the transition pit and a temporary winch will be installed landward of MHWS for cable pull in.

132. Once the preparatory works are complete, the cable will be winched to shore from the cable-laying vessel and through the cable ducts to the onshore cable transition bays.

133. For installing cable ducts, recommended safe passing distances around the works could be required for up to circa 3 months depending on the extent of clay/bedrock excavation required with an additional minor exclusion period (estimated at 1 day) during the cable pull in. These are expected to be of the order of 50 m.

Illustration 4.20: Open cut trenching beach excavations – tracked excavators and barge-mounted excavators (Source ETA Ltd)

4.4.4.8.2 *Construction of Transition Pits*

134. The transition pits will consist of an underground structure and will house the joints that link the multi-core Offshore Export Cable with the single core Onshore Export Cable. Each circuit may have its own transition pit; located adjacent to each other with up to 5 m separation. Alternatively, both circuits could be accommodated in a single pit.

135. Each transition pit will be within a below ground excavated trench with reinforced concrete sides and base. The dimensions are likely to be approximately 10 m length by 4 m width by 3 m depth. A concrete cover will be placed over the top of the pit for protection and land above will be reinstated to its previous condition. A manhole cover may be incorporated to provide permanent access.

136. The transition pits will be excavated by a mechanical excavator after which a concrete chamber will be installed. The concrete chamber will either be constructed on site or will be brought in prefabricated. A small container will be temporarily placed on top of the transition pit to allow a clean, secure and weatherproof working environment during cable jointing. A generator will be required to provide power supplies during jointing operations and a temporary security fence and lighting will be constructed to enclose and secure the transition pits during construction.

137. An access track will need to be made to the transition pit location during construction. It is anticipated that access will be made via the Onshore Cable Corridor haul road, requiring the use of a temporary bridge across Thornton Burn.

138. Once the transition pit has been established, the Offshore Export Cable will be winched into place as part of the Offshore Export Cable installation process. A joint is then made to join the Offshore Export Cable to the Onshore Export Cable.

4.4.5 Ancillary Equipment

4.4.5.1 J-Tubes

139. A J-tube is the conduit for the inter-array cables to travel from the seabed to the work platform on the wind turbines and the OSP(s). J-tubes will be attached to the foundations as part of the onshore fabrication works. The inter-array cables within the J-tubes have to be protected where they emerge

at the base of the foundation. Where necessary, cable protection in the form of, for example, durable mattresses pre-filled with stone, will be used to protect the cable between the base of the foundation and the point of burial. Further details on such cable protection measures are provided in Section 4.7.1.4.

4.4.5.2 Access Facilities

140. A boat landing, ladders, hoists and fenders will be located on the foundation to allow safe access to the wind turbine / OSP(s) for maintenance and operation. These facilities will be constructed and installed on the structure during the fabrication of the foundation at the onshore fabrication yard.

4.4.5.3 Transition Piece

141. Dependent upon the nature of the foundation, a means of connecting wind turbine towers to the foundation is required. Hence, a transition piece, which has standard tower attachments, typically bolted flanges on one end and a foundation specific arrangement on the other, is used.

4.4.5.4 Colour Scheme and Navigational Markings

142. The turbines and associated support structures will be marked according to the requirements of the Northern Lighthouse Board (NLB). Consultation is ongoing but the colour of the turbine tower, nacelle and blades is likely to be light grey RAL 7035. The transition piece and tower will be yellow above LAT to an agreed height above highest astronomical tide (HAT).

143. As for the turbines, the OSP(s) will be marked according to the requirements of the NLB. Navigation markings may be allocated solely to a number of wind turbines in the field.

4.4.5.5 Aviation Lighting

144. The legal requirement for offshore wind turbine aviation lighting is stipulated in Article 223 of the Air Navigation Order 2016 (reproduced in CAP393 Air Navigation: The Order and the Regulations), with other documents providing further policy information and guidance. It is noted that the Air Navigation Order only requires medium intensity red lighting to be fitted to turbines on the periphery of a group of turbines subject to approval by the Civil Aviation Authority (CAA). Additional requirements relate to the requirement for lighting and marking relating to the use of helicopter landing facilities on turbines and also for the purposes of assisting Search and Rescue (SAR) operations.

145. Aviation lighting for the final layout design will be agreed with the CAA (and in relation to SAR operations with the Marine Coastguard Agency (MCA)).

146. Three types of lighting are mandatory on wind turbines: medium intensity red lights, low intensity green lights, and low intensity red lights. In addition, low intensity infrared (i.e. invisible to the eye) lighting may be requested.

4.4.5.6 Diesel Generators

147. In the event that the grid connection works are late, then completion and ‘cold’ commissioning works can instead be performed using diesel generators in combination with dehumidifiers and ’soft starters’ all to work with and be governed by the wind turbine controller. These diesel generators, with a fuel tank capacity of 1,000 l, will be housed in offshore-certified double-skin containers (akin to standard shipping containers) that will be mounted on the wind turbine platforms. The generators will also serve to provide back up in the event of a grid outage.

4.5 Safety Zones

148. NnGOWL will apply to the Scottish Ministers for a notice declaring safety zones around construction activities and in the vicinity of offshore structures thereafter under specific scenarios. The safety zone notice will be applied for under Section 95 of the Energy Act 2004 in accordance with Schedule 16 of the Energy Act 2004 and the Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007.

149. The safety zones during the construction period will have a radius of 500 m from the outer edge of the proposed turbine and OSP locations during periods when installation vessels are in operation. The safety zone will reduce to a radius of 50 m if there is no installation vessel operation in the location and/or there are no personnel on the offshore structure. This would also apply to locations where piles have been installed but jackets have not yet been attached. The safety zones will limit all non-project vessels from entering the safety zones.

150. From time to time during the construction programme and in consultation with the regulators, NNGOWL may issue Notices to Mariners (NtM) suggesting recommended safe passing distances in addition to that covered by the safety zone notice to accommodate installation vessels with larger anchor spreads. NtM will also be issued suggesting recommended safe passing distances in respect of the Offshore Export Cable and inter-array cable installation works. This is to protect both the construction vessels and other vessels using the surrounding area.

151. During the operational phase, NnGOWL may apply for a safety zone of 50 m radius around the turbines and OSP(s). This will be considered in discussion with the MCA. An alternative would be to issue Notices to Mariners (NtM) suggesting recommended safe passing distances around the operational turbines and the OSP(s) to protect both the operational turbines, routine turbine maintenance vessel and technicians and other vessels using the Wind Farm Area or surrounding area.

152. In the event of major maintenance works, NnGOWL will apply for a notice declaring safety zones around the location where the maintenance work is taking place. The safety zone would have a radius of 500 m from the outer edge of the proposed wind turbine location / OSP during periods when major maintenance vessels (such as, for example, jack-up vessels required for major component repairs or replacements) are in operation.

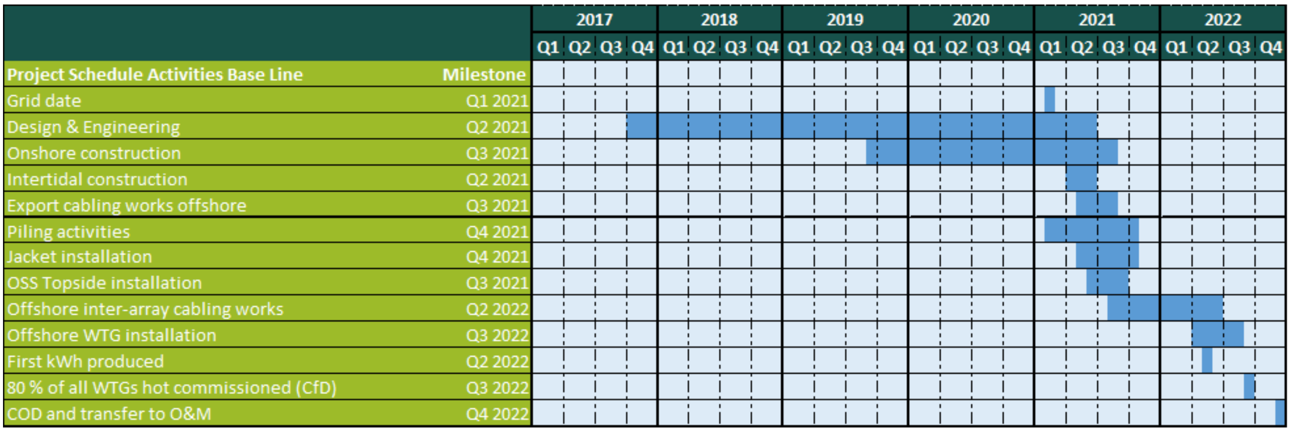
4.6 Construction Programme

153. The construction programme for the Project will be dependent on a number of factors, which include:

- Grid connection dates specified in the grid connection agreements with National Grid Electricity Transmission plc;
- The date that consents are granted; and
- The availability and lead times associated with procuring and installing the Project components.

154. An indicative Project construction schedule is shown in Illustration 4.21. This is based on consent being achieved in the fourth quarter (Q4) of 2018. The offshore construction activities are expected to start in 2020/21 and work will occur over approximately 2 to 3 years. Activities may not be continuous and the sequence of activities may change.

Illustration 4.21: Indicative construction programme



155. The nature of offshore work requires operations to be planned on a 24 hour, seven days a week basis; however, work will not be continuous over the whole construction programme.

156. The above durations for the major works are subject to change, which may arise, for example, from weather, site conditions, equipment lead times and supply programmes, detailed execution planning, sequential work requirements, plant availabilities and logistical issues.

4.7 Operation and Maintenance

157. The Project will be designed to operate with minimum day-to-day local intervention over its lifetime. Individual turbines will be monitored and controlled in the first instance using on-board microprocessor controls, faults can then be diagnosed and the turbine will shut down automatically if necessary. The SCADA system will transmit signals and commands to and from the Wind Farm to an onshore control room, to provide oversight and control.

158. Each turbine and the OSP control system will be linked to the onshore monitoring facilities via optical cables contained within the inter-array cables and Offshore Export Cable (or laid parallel to the inter-array and Offshore Export Cables).

159. Provision will be made to control the Offshore Wind Farm from a number of locations, which will be determined as part of the final project design, this may include:

- Onshore operations base;
- Operation and maintenance (O&M) offshore facility – e.g. Service Operations Vessel (SOV); and
- All wind turbines and the OSP(s) will have an internal emergency shutdown capability, which would automatically be triggered in the event of certain key component or system malfunctions.

4.7.1 O&M Requirements

4.7.1.1 Maintenance of Wind Turbine and OSP Foundations

160. Each foundation will be subject to routine inspections that will check the structural integrity of the foundation, ancillary equipment such as access ways and J-tubes, and the effectiveness of anti-corrosion measures in place. Marine growth may be removed in certain circumstances, particularly if near any access points, or if its loading effect on the foundation is considered excessive. In typical normal operating conditions, it is expected that up to two such inspection visits will be necessary per year per foundation.

161. Alternative approaches to prevention and removal of marine growth, including using semi-submersible scrubbers powered by waves (Illustration 4.22) are also being considered. In the event that marine

growth needs to be removed, conventional power washing using a high-speed water spray will typically be used. Subsea investigations and remedial works will be carried out by ROV or by divers as necessary.

Illustration 4.22: Marine growth prevention solutions (Source: FoundOcean Ltd)

4.7.1.2 Maintenance of the Wind Turbines

162. Maintenance can be categorised into different levels, as follows:

- **Local Resets** - frequent events where a maintenance crew does a local visual inspection. It is estimated that there will be up to 10 such visits per turbine per year.
- **First Line routine scheduled maintenance** - visits include changing out consumables and worn parts as part of a preventative maintenance regime. It is anticipated that two such visits per year per turbine will be required. Lubricants, hydraulic oils and any other hazardous liquids and materials will be disposed of through licensed recycling contractors onshore.
- **Second Line unscheduled maintenance** - to replace parts that have failed, where access is achieved using conventional workboats.
- **Third Line unscheduled maintenance** - to replace major components, requiring the use of a jack-up or similar large vessel on site. These major visits are typically infrequent and have a likelihood of occurrence of up to three times per annum across the full Wind Farm. Activities might involve disassembly and replacement of components, such as, for example, blades, gearboxes etc.

4.7.1.3 Maintenance of the OSP(s)

163. The OSP(s) will be subject to regular inspections and planned maintenance regimes. Emergency systems, circuit breakers and transformers will be checked regularly. Dissolved gas analysis and protection testing will be carried out on the transformers.

164. Control and protection equipment tends to have an operational life of between 15 and 20 years and may therefore require replacement within the lifetime of the Project. Transformers typically have useful life spans in excess of 20 to 25 years and may therefore also require replacement within the lifetime of the Project.

4.7.1.4 Maintenance of the Offshore Export Cable and Inter-Array Cables

165. The inter-array and Offshore Export Cables will be inspected regularly by use of a crew transfer vessel (CTV) mounted sonar or other suitable technology. The frequency of such inspections will be determined on a risk basis but will most probably be carried out during the summer months. Such operations will seek to check the integrity of the cable, cable burial and cable protection around J-tubes.

166. Should remedial action become necessary, a variety of measures may be viable, including additional rock dumping, mattressing, or the use of cable laying vessels with remote cable burial ROV to rebury the cable.

4.7.1.5 Resourcing the O&M Requirements

167. Careful consideration is being given to the nature of O&M for the Project. There are two options currently being considered: an offshore operations base and an onshore operations base.

168. A preferred solution has not been selected at this time. Both options are described in more detail in Sections 4.7.1.6 and 4.7.1.7.

4.7.1.6 Offshore Operations Base

169. An offshore operations base would be expected to include:

- Operations control centre;
- Accommodation quarters;
- Storage facility for spare parts;
- Workshop facilities;
- Medical centre;
- Walk-to-work system;
- Helideck or a wind zone (heli-hoisting area);
- Helicopter fueling facilities; and
- Workboats to convey maintenance crews within the Wind Farm Area.

170. A number of options are available to serve the purposes of an offshore operations base. A typical example is a SOV that incorporates the features above and moves around the site to transfer personnel using a specialised transfer system and position keeping system.

171. Maintenance crews would be deployed either directly from the SOV, or by smaller special purpose workboats, which can be recovered to the SOV using on-board cranes/davits.

172. A typical operational crew roster would probably contain the following disciplines:

- Turbine maintenance technicians;
- Marine traffic and works controllers;
- HVAC engineers and technicians;
- Offshore supervisory staff;
- Offshore technical staff; and
- Ship and work boat crew.

173. Workboats associated with the SOV would probably be catamaran type vessels. The davit arrangements proposed would be capable of launching or recovering vessels and crew from the water on the lee side of the SOV even during relatively severe weather, due to the shelter afforded by the SOV.

174. The intention, however, would be for the majority of transfers to take place directly from the SOV to a wind turbine or OSP. Additionally, crew transfers and provisioning, and spare parts replenishment would take place on a fortnightly basis at port, further minimising risk to personnel during the transfer process.

4.7.1.7 Onshore Operations Base

175. The alternative to an offshore-based O&M approach is the use of a local port or harbour. The onshore operations base would ideally be situated within 50 km of the Wind Farm Area. A port / harbour facility, with capability for mooring the respective vessels would be necessary. Local offices, together

with storage facilities for spare parts and portside light duty craneage would also be required. In addition, it would be advantageous if the location had facilities for vessel maintenance.

176. In this scenario, technicians together with their tools and spares will be transferred from the O&M port or harbour to the respective wind turbine or OSP. There are a number of different vessels available that can be used for this purpose, including CTVs or large offshore supply vessels equipped with a 'walk-to-work' system. The best vessel will be chosen for the respective campaign to be undertaken and for regular corrective maintenance it is estimated that two or three CTVs will be operated from the onshore operations base supported by a helicopter based close to the facilities (see Section 4.7.1.8).

177. The CTVs will be capable of making the transit to shore as and when necessary in all but the most extreme conditions. They will most likely be dual hull for added stability and have purpose built access platforms to assist transits to and from offshore structures (Illustration 4.23). The vessels will be certified and be licensed to carry up to 14 persons (12 technicians, plus crew).

178. Methods for the transfer of maintenance personnel from CTVs to Wind Turbines and OSPs are continually being developed. It is likely that by the date of operation, effective systems will be commercially available. This factor may also have a significant impact on the O&M strategy selected.

Illustration 4.23 Example of CTV (Source: Windcat Workboats)

179. Major non-routine maintenance activities as described in Section 4.7.1.2 and Section 4.7.1.3 would likely involve the use of a jack-up vessel or similar large vessel. Such a vessel would not be based at the onshore operations base, but rather contracted as necessary from the market.

4.7.1.8 Helicopter Access

180. Under the onshore operations base scenario, helicopter transfers may also be used. The use of a helicopter is envisaged for troubleshooting, particularly when performing wind turbine resets and addressing minor defects, or to facilitate access by technicians at times when sea states do not permit access by the vessels described above.

181. Approximately 80 round trips to the Wind Farm Area are anticipated per annum for a small helicopter.

4.7.1.9 Repairs

4.7.1.9.1 Cable Repair or Replacements

182. The cable burial and protection measures are designed to avoid accidental cable damage from third parties. However, industry experience suggests that it is prudent to plan for less than five unexpected cable repairs. The process involved means that approximately 100 – 150 m of cable would be replaced on each occasion.

183. In the event that major repairs are necessary, it is envisaged that the following processes will be followed:

- Identify location of cable damage (this will use SCADA system);
- Mobilise cable repair vessel and use an ROV to Instigate cable de-burial and cutting of the cable at the damage location;
- Pull one end of the cable on board and remove the damaged section;
- Connect a repair section of cable with a cable joint prepared on the vessel;
- The jointed end of repaired section is over-boarded leaving the other end on the vessel;
- The cable repair vessel is moved and recovers the second end of the damaged cable (and removes the damaged section there). A second joint is made on the vessel; and
- The repaired cable loop on overboarded and the cable buried.

4.7.1.9.2 Turbine Nacelle or Blade Replacement

184. The turbine nacelle and blades are subject to type testing and certification, and therefore replacement is not expected. However, industry experience suggests that it is prudent to plan for accidental damage on up to 10% of the turbines.

185. In the event of a major turbine repair being required (e.g. gear box or blade replacement), the replacement elements will be delivered on a either a jack-up platform or a floating vessel with a crane. The characteristics of such a jack-up platform or floating vessel would be similar to those described in Table 4.5. The repair works would be completed from a single location (i.e. no moves required).

4.8 Decommissioning

186. A Decommissioning Programme (or Decommissioning Scheme) will be submitted to Scottish Ministers, for approval, prior to the commencement of construction in accordance with Section 62 of the Scotland Act 2016, which transfers the functions of the Energy Act 2004 (Section 105-114) where it relates to decommissioning of offshore renewable projects.

187. Prior to the commencement of any decommissioning works, the Decommissioning Programme will be reviewed and revised as required to take account of good industry practice at that time. The following sections set out the currently anticipated approach to the decommissioning process.

4.8.1 Decommissioning and Removal of Foundations

188. Current practice for offshore jacket installations is to cut pile foundations below the seabed level using either an abrasive water jet or a diamond wire cutter. The jacket is then raised to the surface and removed to a suitable onshore site for recycling. Removal of the entire embedded pile is currently considered impractical and is also considered likely to lead to unnecessary environmental impacts.

189. The following sequence of operations is likely to be followed during foundation decommissioning:

- Underwater inspection using ROV;
- Heavy lift anchoring points will be established and made good;
- Removal of any marine growth and or debris with the potential to impact later cutting activities;
- Establish lifting points for decommissioning vessel;
- Cut piles at circa 1 m below seabed level;
- Raise jacket to the surface for removal from site; and
- Seabed inspection and final clearance.

4.8.2 Decommissioning and Removal of Wind Turbines

190. Removal of wind turbines, either for replacement or for final decommissioning, is likely to be the reverse of the installation procedure. The sequence of activity is expected to be:

- Conduct inspection to identify any safety or operational hazards;
- Disconnect wind turbine from electrical and control networks;
- Removal and appropriate disposal of any hazardous liquids or materials;
- Mobilise decommissioning vessel or barge to site;
- Remove blades, rotor, nacelle and tower section in that order; and
- Transport components to designated recycling site onshore.

4.8.3 Decommissioning of Offshore Electrical Infrastructure

4.8.3.1 OSP(s)

191. The OSP(s) will be removed and processed for decommissioning after the operational lifetime of the Project. The following steps will be taken:

- De-energise and isolate the Wind Farm from the grid system;
- Marshal the appropriate lift vessels to the wind farm location;
- Cut or disconnect and remove cables from the OSP;
- Removal and proper processing of all hazardous substances and fluids such as oil from reservoirs;
- Transport the topside to shore, intact if possible. Otherwise, it may be necessary to deconstruct the topside into smaller modules to be transported; and
- Once onshore, the topside will be deconstructed. All components will be taken to the appropriate facility for processing for either reuse, recycling, or disposal.

192. Where possible, components will be removed from the Wind Farm Area intact and disassembly will take place onshore at an appropriate facility to minimise risks of spillage and to optimise safety.

193. Foundations will be removed in line with the procedures outlined in Section 4.8.1.

4.8.3.2 Inter-Array Cables

194. The current industry standard is to leave Inter-array cables in situ. However, as per foundations, best practice will be followed at the time of decommissioning.

195. If cable removal is required, this will typically be done using a water jetting or grapnel tool. The cable will be lifted at both ends and spooled onto a cable drum. Typically, the cable can be recycled after recovery.

196. Any cables that are cut during removal of the wind turbines or OSP(s) will be removed and reused, recycled and/or disposed of appropriately.

4.8.3.3 Offshore Export Cable

197. The Offshore Export Cables will be removed if necessary in a similar manner to that described for the inter-array cabling (Section 4.8.3.2).

4.8.3.4 Transition Pit(s)

198. Similar to the remainder of the Onshore Export Cable, it is likely that the transition pit(s) will be left in situ, as removal will result in significant disturbance to the local environment. Contingency plans will be developed to ensure that appropriate actions are taken should the transition pit be disturbed or exposed following decommissioning of the Project.

4.8.4 Repowering

199. The Crown Estate Scotland (CES) lease for the Development Area is for 50 years and this EIA assesses the Project over that lifetime. If, during that time, repowering is considered necessary, that would require a new consent application and a new EIA. The Application and the Project EIA therefore do not include for repowering.

4.9 The Forth and Tay Offshore Wind Farms

200. There are currently several major offshore wind farm development sites in the Firth of Forth and Tay – Inch Cape, Seagreen and the Project (Figure 4-4). The original consents for these projects, issued by Scottish Ministers in 2014, were subject to lengthy Judicial Review proceedings. In parallel with the judicial review proceedings, both Inch Cape and Seagreen submitted requests for scoping opinions, accompanied by Scoping Reports, seeking an opinion on the matters to be addressed in an EIA Report to accompany new consent applications. It is the current understanding that these new applications are likely to be submitted to Scottish Ministers in the coming months. Based on information provided by the developers of each project and the information set out in the respective Scoping Reports and Scoping Opinions, NnGOWL understands that these applications will be for revised project design envelopes (when compared to the originally consented projects).

201. Table 4.14 summarises the key changes to the design parameters for the Inch Cape and Seagreen revised consent applications when compared to the parameters set out in the existing consents.

Table 4.14 Summary of changes between original and revised project design envelopes – Inch Cape and Seagreen phase 1 (based on the summary provided in the respective scoping opinions issued by the Scottish Ministers and additional information provided by Inch Cape

Parameter	Inch Cape		Seagreen	
	2014 Consent	Proposed Application	2014 Consent (Alpha and Bravo Combined)	Proposed Application – Phase 1
Maximum number of turbines	110	Up to 72	150	120
Maximum turbine capacity	-	-	7 MW	15 MW
Minimum blade clearance (above LAT)	27 m	30.5 m	29.8 m	29.8 m
Maximum Hub Height (above LAT)	129 m	176 m	126 m	140 m
Maximum blade tip height (above LAT)	215 m	291 m	209.7 m	280 m
Maximum rotor diameter	172 m	250 m	167 m	220 m
Minimum separation between turbines	820 m	1,278 m	835 m	1,000 m
Jacket piling:				
Maximum drilling/piling events (based on four piles per turbine)	852	288	600	480[2]

[2] The Scoping Report for Seagreen Phase 1 stated that monopile foundations were being considered. No design information is available for monopile foundations, therefore, only jacket foundations are considered throughout this EIA Report.

Parameter	Inch Cape		Seagreen	
	2014 Consent	Proposed Application	2014 Consent (Alpha and Bravo Combined)	Proposed Application – Phase 1
Maximum piling hammer energy	1,200 kJ	2,400 kJ	1500 kJ	2300 kJ

4.10 Summary of the Neart na Gaoithe Design Envelope – Key Parameters

Table 4.15 Table of Project Specifications

Parameter	Design envelope (maximum or indicative range unless otherwise stated)
Project	
Wind Farm Area	105 km^2
Offshore Export Cable Corridor width	300 m
Offshore Export Cable length	43 km
Distance from shore to closest point of Wind Farm Area	Approximately 15.5 km
Project output	450 MW
Number of wind turbines	54
Number of OSPs	2
Number of met masts	1
Wind Turbine Foundations	
Jacket type	Steel lattice
Jacket leg spacing at seabed level	35 m x 35 m
Details of seabed preparation	Clearance of any debris found A seabed template with up to 6 legs will sit temporarily on the seabed during pile installation for the OSP foundations.
Foundation pile diameter	3.5 m
Number of piles per foundation	6
Foundation bed penetration depth (piling)	50 m
Piling installation method	▪ Driven only piling; ▪ Drive-drill-drive; or ▪ Drill only.
Indicative Foundation installation overall duration (per foundation)	Pile Driving (6-21 hours for up to 6 piles) Pile Drilling (62-180 hours for up to 6 piles) This includes time for setting up and changing equipment between piling locations. Jacket installation (12-24 hours). Concurrent piling activities: pile driving or pile drilling at two locations concurrently (either on same vessel or on an independent vessel).
Weight of jacket	1,000 tonnes
Diameter of main jacket tubulars	3m
Seabed occupied by jacket leg (piles and scour protection)	300 m^2 per leg for four-legged jacket. 108 m^2 per leg for a six-legged jacket.

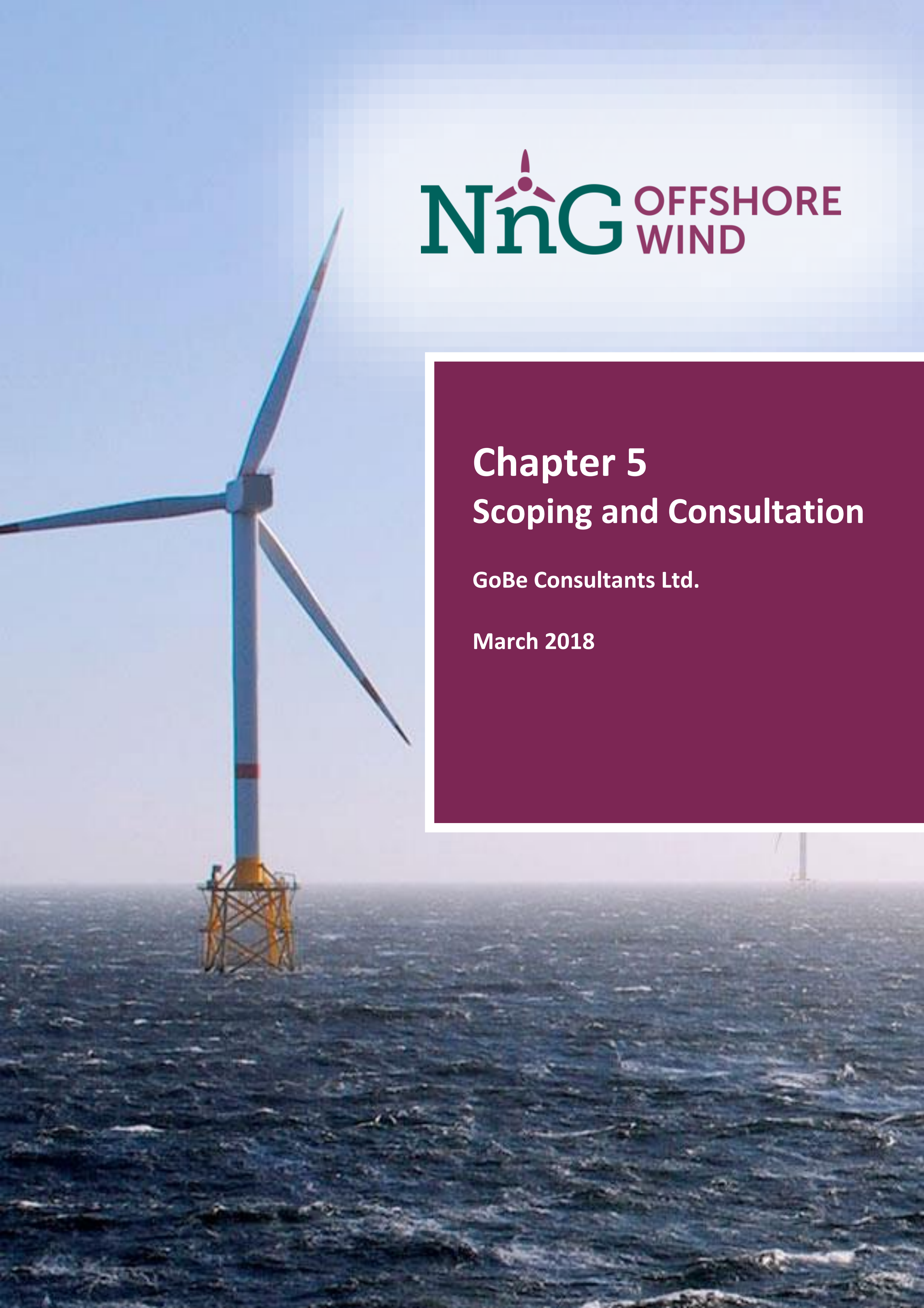
Parameter		Design envelope (maximum or indicative range unless otherwise stated)	
Pile Installation			
Soft start duration		30 min	
Applied hammer energy during soft start		360 Kilojoules (kJ) (20% of max energy for an IHC 1800 hammer)	
Driving duration at maximum energy		up to 180 min	
Applied hammer energy at maximum energy		1,635 kJ (approx. 90% of max energy for an IHC 1800 hammer)	
Installation Vessel			
Vessel Type	**Vessel parameter**	**Minimum design envelope**	**Maximum design envelope**
Jack up Vessel	Jack-up moves per foundation installation	1 (pile installation) 1 (jacket installation)	3 (pile installation) 1 (jacket installation)
	Leg spacing of jack-up	50 m x 50 m	100 m x 100 m
	Number of spud cans	4	8
	Spud can footing area (per vessel)	1 m^2 (leg area without spud can)	106 m^2
Floating Vessel	Number of anchors	0 (position on Dynamic Positioning (DP) only)	8
	Anchor mooring length	200 m	1,200 m
Wind Turbines			
Number of turbines		54	
Rotor tip height (above LAT)		208 m	
Rotor diameter		167 m	
Hub height (above LAT)		126 m	
Minimum air gap clearance to blade tip (above LAT)		35 m	
Height of platform		21 m	
Minimum wind turbine spacing (approximate)		800 m	
Wind Turbine Oil or Fluid			
Grease		250 litres (l)	
Hydraulic oil		600 l	
Gear oil		2,100 l	
Transformer silicon / ester oil		3500 kilograms (kg)	
Met Mast			
Number of met masts		1	
Height (above LAT)		140 m	
Jacket leg spacing		35m x 35 m	
Foundation pile diameter		3.5 m	
Foundation material		Steel (jacket and piles)	
Pile depth below sea-bed		50 m	

Parameter	Design envelope (maximum or indicative range unless otherwise stated)
Met mast safety features	▪ Fog Detector – VF-500 Visibility Sensor: Uses forward scatter sensor technology to measure visibility in all weather conditions. The visibility sensor acts as the on/off switch for the foghorn. ▪ 2 nautical mile (NM) fog horn: Automatically broadcasts (when required by the fog detector) a 360o beam of sound to a pre-selected code audible for 2 NM. Sound Signal: Morse.
Offshore Substation Platforms (OSPs)	
Number of OSPs	2
Height of topside (above LAT)	21 m
Height to top of crane / helicopter pad (above LAT)	60 m (above LAT)
Length x width of topside	40 m x 40 m
Weight of topside	1,000 - 3,500 tonnes

OSP Major Plant (two OSP scenario)		
Plant item	**Quantity**	**Features**
Transformer	One large transformer and up to 2 small auxiliary transformers on each of the two OSPs.	Oil filled transformer complete with oil bunding designed to capture any leakages. NB. gas-insulated (using sulphur hexafluoride (SF_6)) and dry auxiliary transformers are also being considered, which would not require oil.
Transformer cooler	To be determined during detailed design of the transformer.	Contained within ventilated (louvres on external wall), perimeter enclosure
Medium voltage switchgear	One 33 kV switchboard with a minimum of 11 circuit breakers on each OSP.	Modular, gas insulated switchgear (up to 72.5 kV)
220 kV breakers	One on each OSP	Modular, gas insulated unit. Number depending on final design of protection system

OSP Foundations	
Jacket type	Steel lattice
Jacket leg spacing at seabed level	60 m x 60 m
Details of seabed preparation	Clearance of any debris found. A seabed template with up to 8 legs will sit temporarily on the seabed during pile installation for the turbine foundations.
Pile diameter	3.5 m
Number of piles per foundation	8
Pile penetration depth	50 m
Pile installation method	Drive only, drive-drill-drive or drill only
Indicative foundation installation duration (per foundation)	Pile Driving (maximum of 21 hours for up to 8 piles) Pile Drilling (maximum of 180 hours for up to 8 piles) This includes time for setting up and changing equipment between piling locations. Jacket installation (maximum of 24 hours).
Weight of jacket	2,500 tonnes
Diameter of main jacket tubulars	3 m

Parameter	Design envelope (maximum or indicative range unless otherwise stated)
Seabed occupied by jacket leg (piles and scour protection)	300 m^2 per leg
Inter-array and Interconnector Cables	
Number of cables	14 circuits (7 connecting to each OSP)
Total length of cabling (including interconnectors if required)	140 km
Design of array	10 turbines per collector circuit
Specification of cables	XLPE AC cable rated up to 72.5 kV Size ranges from 50 mm^2 to 800 mm^2
Burial method / scour protection	Likely ploughing/cutting/jetting or rock cover, options finalised when layout is confirmed.
Width of seabed affected (per cable)	Approximately 2 m direct impact width, 8 m width of zone of minor disturbance (approximately 10 m in total).
Burial depth	Target depth 1 to 1.5m. However likely to vary across site up to 3 m. Burial may not be possible in limited areas where bedrock outcrops at seabed level or in zones where thin sediment exists over the bedrock, in this instance protection will be used.
Offshore Export Cables	
Number of cables	2
Total length of cabling	86 km
Length per cable	43 km
Specification of cables	220 kV (Um 245 kV) 3-phase AC XLPE insulated
Spacing between cables	Minimum 70 m / maximum 300 m (3x water depth but no less than 70 m)
Width of Offshore Export Cable Corridor	300 m (i.e. 150 m either side of Offshore Export Cable Corridor centre line)
Burial method / scour protection	Likely ploughing/cutting/jetting or rock cover, options finalised when layout is confirmed.
Width of seabed affected (per cable)	10 m (2m direct impact width in the centre of an up to 10m wide zone of minor disturbance from the plough skids).
Burial depth	Target depth 1 to 1.5m. However likely to vary across site up to 3 m. Burial may not be possible where bedrock outcrops at seabed level or in zones where thin sediment exists over the bedrock, in this instance protection will be used.



Chapter 5
Scoping and Consultation

GoBe Consultants Ltd.

March 2018

Table of Contents

Table of Figures

Table of Tables

5 SCOPING AND CONSULTATION

5.1 Introduction

1. This chapter of the EIA Report summarises the formal scoping exercise undertaken by NnGOWL. Specifically, this chapter presents the following:

- Background to the scoping process;
- The scoping process (including scoping consultation, the Scoping Opinion and matters scoped in / out of the EIA);
- Embedded mitigation measures;
- Consent condition commitments; and
- Other consultation and stakeholder engagement.

5.2 Background to the Scoping Process

5.2.1 The Original Application

2. NnGOWL submitted an application for consent under Section 36 of the Electricity Act 1989 and for associated Marine Licences under the Marine (Scotland) Act 2010 in July 2012 (hereafter referred to as the 'Original Application'). The Original Application was supported by an Environmental Statement (ES) (hereafter referred to as the 'Original ES') reporting the findings of an EIA (hereafter referred to as the 'Original EIA') and subsequently, in June 2013, by an Addendum of Supplementary Environmental Information (hereinafter referred to as the 'Addendum').

3. The Addendum submitted in June 2013 reassessed the effects on some (but not all) receptors based on a reduced Project design envelope comprising of up to 90 turbines (compared to 125 in the Original ES) and also included an additional 3rd year of bird survey data, plus other design refinements including a commitment to higher rotors (which has been increased further with this new application).

4. The Section 36 Consent and the Marine Licences were awarded by the Scottish Ministers in October 2014, following over five years of project development, including environmental surveys, engineering design studies and wide-ranging stakeholder engagement. The development as consented in October 2014 is hereafter referred to as 'the Originally Consented Project'.

5. In 2015, NnGOWL applied for a Section 36 Consent Variation, seeking to vary the Section 36 Consent in order to modify a number of parameters relating to the wind turbines. Specifically, the variation was sought to allow:

- An increase in the maximum rated wind turbine capacity from 6 megawatts (MW) to 7 MW (the maximum generating capacity of 450 MW remained the same);
- A change in maximum wind turbine hub heights, from 107.5 metres (m) to 115 m above Lowest Astronomical Tide (LAT); and
- A change in maximum turbine platform height from 18 m to 21 m above LAT.

6. The Section 36 Consent Variation was awarded by the Scottish Ministers in March 2016. This varied Section 36 Consent and the Marine Licences granted in October 2014 are collectively referred to as 'the Consents' hereafter.

7. The decision by the Scottish Ministers to consent the Originally Consented Project (and three other offshore wind farms in the Forth and Tay region) in 2014 was challenged by the Royal Society for the Protection of Birds (RSPB) by way of Judicial Review (JR) in January 2015. The Outer House of the

Scottish Court of Session ruled in favour of the RSPB in July 2016. The JR decision was appealed by the Scottish Ministers and developers, including NnGOWL, at the Inner House of the Scottish Court of Session. The outcome of that appeal was announced on 16 May 2017 whereby the original JR judgement was overturned. An application by the RSPB to the Scottish Court of Session seeking leave to appeal to the Supreme Court was refused on 19 July 2017. On 15 August 2017, the RSPB made an application directly to the Supreme Court for permission to appeal and this was refused on 6 November 2017.

8. NnGOWL has decided to submit a new consent application for the Project (hereafter referred to as 'the Application'), supported by the findings of this EIA Report. If consented, the Application will enable NnGOWL to take advantage of new developments in offshore wind technology, allowing for example, the same maximum generation capacity as previous designs but using fewer turbines. This will lead to a reduction in the potential environmental impacts (when compared to the Original Application and the Originally Consented Project).

9. Notwithstanding the new application, the Original Consents remain extant and NnGOWL reserves the ability to implement the Original Consents, for example in the event that determination of this application is unduly delayed.

10. It is NnGOWL's intention to construct either the Originally Consented Project (as amended by the Section 36 Consent Variation) or the Project as described in the Application, but not both.

11. The Project now proposed by NnGOWL is broadly analogous in terms of location and most aspects of its design to the Originally Consented Project. The principle differences between the design envelope of the Originally Consented Project and this Application are summarised in Table 5. 1.

Table 5. 1: Summary of changes between the design envelopes for the Consents and the Project Application

Parameter	Design envelope for the Originally Consented Project (as amended)	Design envelope for Application
Maximum number of wind turbines	75	54
Maximum rotor tip height (above LAT)	197 m	208 m
Maximum hub height (LAT)	115 m	126 m
Maximum rotor diameter	126 - 152 m	167 m
Minimum spacing between turbines	450 m	800 m
Minimum air gap clearance to blade tip (above LAT)	30.5 m	35 m
Maximum number of piles per foundation (turbines)	4	6
Number of piles per foundation (Offshore Substation Platforms (OSP))	8	8
Foundation options	Gravity Base Structures Jackets	Jackets
Inter-array cables	Up to 6 turbines per collector circuit Up to 15 circuits 75 - 120 km cable length	Up to 10 turbines per collector circuit Up to 14 circuits Up to 140 km cable length
Minimum height to bottom of OSP topside (above LAT)	21 m	18 m
Maximum Offshore Export Cable length (per cable)	33 km	43 km

5.3 The Scoping Process

5.3.1 Introduction

12. Scoping of an EIA is a voluntary process under the EIA Regulations. A proponent of a project can request a Scoping Opinion from Scottish Ministers as to the proposed content of the EIA Report in order to identify those potentially significant environmental effects that should be considered for further assessment.

13. A Scoping Report was submitted to MS-LOT on 15 May 2017, supporting a request for a formal Scoping Opinion from Scottish Ministers. The Scoping Report (NnGOWL, 2017) which accompanied the request for a scoping opinion is available online via the Scottish Government Marine Licensing website (http://www.gov.scot/Topics/marine/Licensing/marine/scoping/NnGRev2017).

14. The Scottish Ministers initiated a 28-day consultation process on the Scoping Report, which commenced on 29 May 2017. The Scoping Opinion (Scottish Ministers, 2017) was issued on 8 September 2017 and is also available to download from the same website (http://www.gov.scot/Resource/0052/00524490.pdf). Further detail on the Scoping Opinion and the scope of this EIA Report is set out under Section 5.3.4 below.

5.3.2 The Approach to Scoping

15. Whilst the Project is broadly analogous in terms of location and most aspects of its design to the Originally Consented Project, it should be noted that the Original EIA was conducted for a design comprising of up to 125 wind turbines (and associated foundations etc.) with the Addendum considering 90 turbines and the Consents allowing for 75 turbines. This compares with a substantial reduction to 54 turbines (maximum) being considered for this Application.

16. In the Original EIA, the potential effects of the Originally Consented Project on the environment were thoroughly assessed, and the outcomes of that assessment were considered by the Scottish Ministers in their determination of the Original Application. The Original ES also presents a large body of existing data and knowledge regarding the environmental characteristics of the Project location, acquired through site specific surveys, technical studies and data gathering to inform the Original EIA. Therefore, the approach to the Scoping Report was to apply the findings of the Original EIA as a basis for the scoping of the likely significant effects that could arise from the Project.

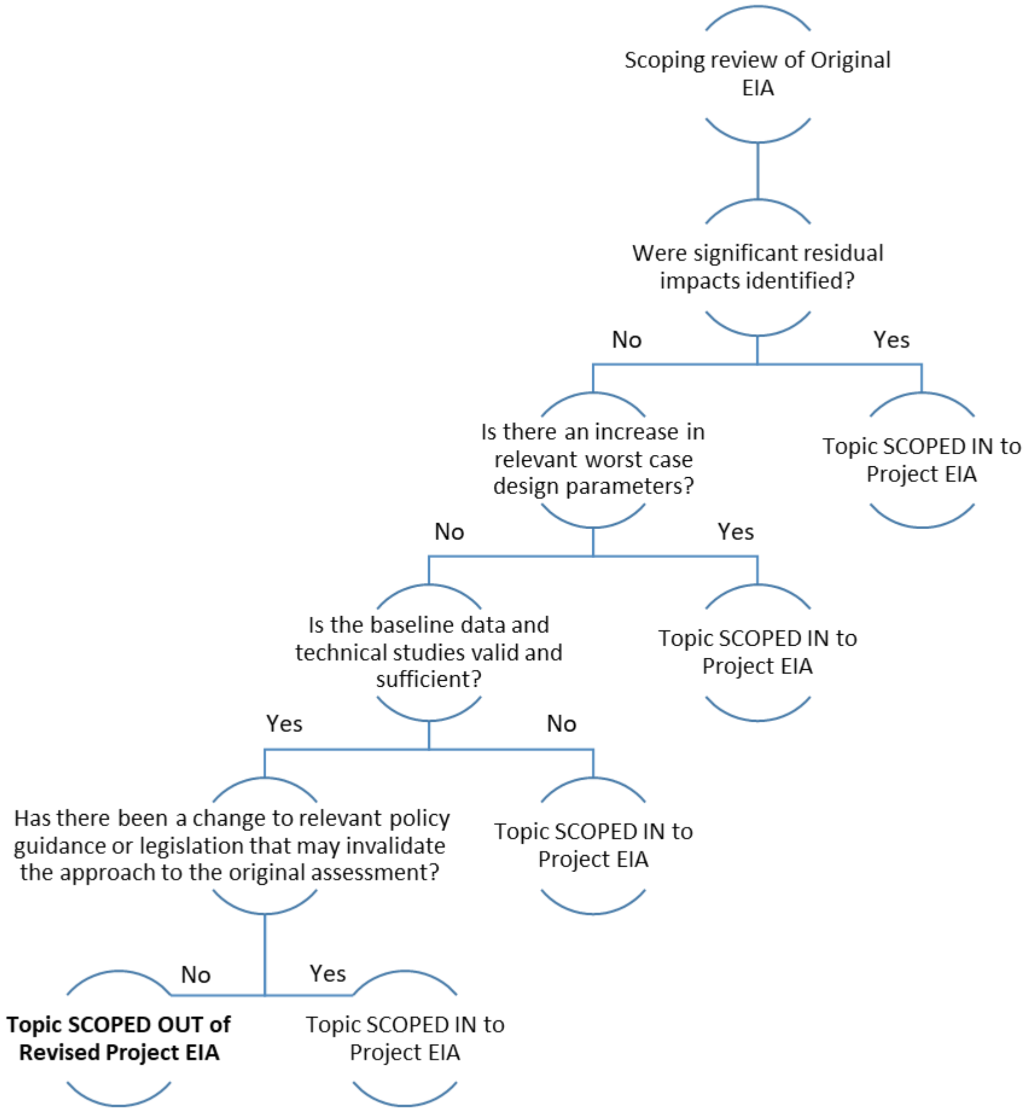
17. The Scoping Report therefore drew on the Original EIA in order to:

- Characterise the baseline environment to inform the Scoping Report, where data was sufficient and it was appropriate to do so;
- Scope out impacts where there was clear justification for doing so; and
- Where impacts were scoped in, use the available data to inform the baseline conditions where appropriate in carrying out the Project EIA.

18. The approach to scoping, summarised in Figure 5.1, reviewed the assessments presented in the Original Application and scoped receptors and impacts out of the Project EIA based on the following principles:

- No significant impacts were identified in the Original ES;
- The design envelope parameters have been reduced or remain the same as those considered in the Original EIA;
- The baseline data and technical studies used to inform the Original EIA remain valid and sufficient to characterise the current baseline conditions within and adjacent to the Development Area; and
- There has been no change to the policy guidance or legislation that would invalidate the approach applied within the Original EIA.

Figure 5.1: Scoping of the Project EIA based on the Original EIA.



19. The approach to scoping was intended to focus the Project EIA on the potential impacts that were most likely to give rise to significant effects (or where significant uncertainty existed in relation to the validity of the previous assessments) and thereby avoid revisiting assessments where the conclusions reached previously in the Original ES and Addendum demonstrate that significant effects would not be likely to occur.

20. The Scoping Report set out, for each of the topic chapters, a series of questions for Scottish Ministers asking them to confirm their views on the conclusions of the Scoping Report and, where relevant, the detailed requirements for considering the topic in the EIA Report (questions relating to, for example, data, methodology, cumulative impact scope etc.).

21. Further detail on the approach to the scoping process is set out in the Scoping Report.

22. In concluding as to whether a particular impact or receptor should be scoped in to the EIA Report, the commitment to embedded mitigation was considered. More detail on embedded mitigation relevant to this EIA Report and the Application is set out under Section 5.4.

5.3.3 Consultation on the Scope of the Project EIA

23. The Scottish Ministers consulted with a range of stakeholders on the scope of the Project EIA, as listed in Table 5.2. The purpose of the consultation was to obtain advice and guidance from each consultee or advisor as to which potential effects should be scoped in or out of the Project EIA and to inform the Scoping Opinion.

Table 5.2: List of stakeholders consulted by the Scottish Ministers during the scoping consultation

Angus Council (AC)	Arbroath Sailing and Boating Club
Bond Offshore Helicopters	Bristow Helicopters
British Telecom (Radio Network Protection Team) (BT)	Civil Aviation Authority
Chamber of Shipping (CoS)	CHC Helicopters
Crown Estate Scotland	Defence Infrastructure Organisation (DIO)
Dundee City Council (DCC)	East Lothian Council (ELC)
Esk District Salmon Fishery Board (Esk DSFB)	Fife Council (FC)
Fife Fish Producers Organisation	Firth of Forth Lobster Hatchery
Fisheries Management Scotland	Fife Fishermen's Association (FFA)
Fishermen's Mutual Association (Pittenweem) Limited (FMA)	Forth District Salmon Fishery Board (Forth DSFB)
Forth Ports	Health and Safety Executive
Historic Environment Scotland (HES)	Inch Cape Offshore Limited
Marine Safety Forum	Marine Scotland Compliance – Anstruther
Marine Scotland Compliance – Eyemouth	Marine Scotland Compliance – Aberdeen
Maritime and Coastguard Agency (MCA)	Marine Scotland Science (MSS)
National Air Traffic Services (NATS)	National Trust for Scotland
North Sea Regional Advisory Council	North East Regional Inshore Fishery Group
Planning Aid Scotland	Northern Lighthouse Board (NLB)
Royal Society for the Protection of Birds (RSPB)	Royal Yachting Association (Scotland) (RYAS)
Scottish Borders Council (SBC)	River Tweed Commission (RTC)
Scottish Enterprise	Scottish Canoe Association (SCA)
Scottish Federation of Sea Anglers	Scottish Environment LINK
Scottish Fisherman's Organisation	Scottish Fishermen's Federation (SFF)
Scottish Natural Heritage (SNH)	Scottish Government Planning
Scottish Surfing Federation	Scottish Seabird Centre
Seagreen Wind Energy Limited	Scottish Wildlife Trust
Surfers Against Sewage	Scottish Environment Protection Agency (SEPA)
The 10 Metre and Under Association	Tay District Salmon Fishery Board
Transport Scotland (TS)	Torness Power Station
Transport Scotland (Ports and Harbours) (TS(P&H))	Whale and Dolphin Conservation (WDC)

24. From the list above, a total of 20 responses were received. The consultee responses received were used to inform the Scoping Opinion advice (all responses are reproduced in full in the Scoping Opinion).

25. In addition, to support the scoping process, a number of meetings were organised by MS-LOT in order to facilitate structured discussion between the Scottish Ministers, NnGOWL and stakeholders. The meetings were intended to allow for early engagement between stakeholders and NnGOWL. The meetings were topic related and covered marine mammals, fish, shellfish and benthic ecology, commercial fisheries and ornithology. Table 5.3 sets out the dates and stakeholders who participated

in the face-to-face scoping meetings. Details of the items discussed and how they have been incorporated into this EIA Report are detailed within the relevant technical chapters.

Table 5.3: Details of the Scoping stakeholder consultation meetings

Date	Discipline	Attendees
13 June 2017	Marine Mammals	MSS, SNH
13 June 2017	Ornithology	MSS, SNH, RSPB
13 June 2017	Fish and Shellfish	MSS, SNH
27 June 2017	Commercial Fisheries	SFF

26. In addition, a further meeting between MS-LOT, MSS, SNH and RSPB was held to further discuss the ornithology receptors, including common approaches to cumulative impact assessment, collision risk modelling, and displacement assessment and non-breeding season effects, for all three Forth and Tay projects. A further teleconference meeting was held between MS-LOT, MSS, SNH and WDC to allow further discussions on marine mammals.
27. The aim of these meetings was to provide clarity and answer any questions the stakeholders had with regard to the Scoping Report. This was intended to allow an opportunity to discuss issues in detail in advance of stakeholders completing their scoping responses. The meetings took the form of an overview from NnGOWL and then a discussion on specific issues of concern. The meetings informed the responses to the Scoping Opinion made by the relevant stakeholders.

5.3.4 The Scoping Opinion

28. The Scottish Ministers, having consulted on the Scoping Report and having considered the responses received from consultees, issued their Scoping Opinion (Scottish Ministers, 2017) on 8 September 2017. The Scoping Opinion confirmed that the Scottish Ministers were satisfied that the topics identified in the Scoping Report encompass those matters identified in Schedule 4 of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 and Schedule 3 of the Marine Works (Environmental Impact Assessment) Regulations 2007, as required by the transitional arrangements of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and the Marine Works (Environmental Impact Assessment) Regulations 2017 (for more information on the 2017 Regulations and the transitional arrangements see Chapter 6: EIA Methodology).
29. Following the consultation with the statutory consultees and other environmental stakeholders, the Scottish Ministers, where they had confidence that the Original EIA could be relied upon to inform a conclusion of no significant environmental effects in relation to the Project, were also content to conclude that certain topics could be scoped out of the Project EIA. The Scottish Ministers provided a response to each of the questions set out in the Scoping Report as part of their Scoping Opinion.
30. Full details of the scoping requirements set out by the Scottish Ministers, along with the responses from stakeholders, are included in the Scoping Opinion.
31. The scope of the Project EIA based on the Scoping Opinion (Scottish Ministers, 2017) is presented in Table 5.4.

Table 5.4 – Summary of impacts scoped into and out of the Project EIA (based on Scottish Ministers, 2017)

Topic	Scoped in (and scoping advice)	Scoped out (and scoping advice)
Geology and Water Quality	East Lothian Council (ELC) raised a concern with regard to a proposed Local Geodiversity Site at Thorntonloch Coast (see Table 5.5 below); the Scoping Opinion required that, if this site is designated, the EIA Report will need to consider whether there is potential for any impact on the site – see Table 5.5 below.	All other potential impacts on geology and water quality.
Physical Processes	None	All potential impacts on physical processes.
Air Quality	None	All potential impacts on air quality.
Ornithology	Assessment of potential impacts on key seabird species including SPAs / pSPA as listed in and in line with the recommendations of Section 8.6 of the Scoping Opinion. Collision and displacement effects for specifically named species as listed in and in line with the recommendations of Sections 8.7 and 8.8 of the Scoping Opinion. Apportioning effects in line with the recommendations of Section 8.9 of the Scoping Opinion. Population Viability Analysis (PVA) in line with the recommendations of Section 8.10 of the Scoping Opinion. Assessment of cumulative impacts in line with the recommendations of Section 8.11 of the Scoping Opinion.	Need for additional site survey data (unless submission of Application is delayed in which case advice may change, NnGOWL must seek advice again if the Application is not submitted within 12 months of the date of issue of the Scoping Opinion).
Marine Mammals	Assessment of noise impacts on Bottlenose Dolphin, Harbour Seal, Grey Seal, Harbour Porpoise, Minke Whale and White Beaked Dolphin. Use of management unit populations and additional recommended literature to assess distribution and impacts on Bottlenose Dolphin, Harbour Seal, Grey Seal, Harbour Porpoise, Minke Whale and White Beaked Dolphin. Underwater noise effects on specifically named species. Species specific impact assessments, including CIA, as recommended. Population level effects on specifically named species.	All other impacts on marine mammals. Need for additional baseline data.

Topic	Scoped in (and scoping advice)	Scoped out (and scoping advice)
	Assessment of cumulative impacts in relation to the projects listed in Section 8.12 of the Scoping Opinion.	
Benthic Ecology	None	All potential impacts on benthic ecology.
Fish and Shellfish Ecology	Clarity on the effects of suspended sediment on scallop populations and catching grounds. Potential impact of particle motion effects. Review of cumulative impact assessment with justification if no updated needed.	All other potential impacts on fish and shellfish ecology. Effects on diadromous fish (pending confirmation that no significant effects would occur using updated literature provided by marine Scotland science).
Commercial Fisheries	All potential impacts on commercial fisheries. Assessment of cumulative impacts in relation to the projects listed in Section 8.15 of the Scoping Opinion.	None
Shipping and Navigation	Updating shipping baseline data with marine traffic survey data. Discuss and agree specific requirements for an updated Navigational Risk Assessment (NRA) with the Maritime Coastguard Agency (MCA) (Subsequently agreed updated NRA not required). Assessment of cumulative impacts in relation to the projects listed in Section 8.16 of the Scoping Opinion.	Shipping and navigation receptors not considered to be significantly affected by the Project.
Military, Civil Aviation and Telecommunications	Impacts of increased turbine blade tip height on defence radar and other radar systems. Consultation with Ministry of Defence's (MOD) Defence Infrastructure Organisation (DIO) regarding embedded mitigation for effects on military and aviation receptors as listed in Section 8.17 of the Scoping Opinion. Assessment of cumulative impacts in relation to the projects listed in Section 8.17 of the Scoping Opinion.	Impacts on all other radar and telecommunications.
Maritime Archaeology and Cultural Heritage	Visual impacts on cultural heritage setting based on the increase in turbine size. Assessment of cumulative impacts where they apply to visual impacts on cultural heritage setting based on the increase in turbine size.	All other potential impacts on maritime archaeology and cultural heritage.
Seascape, Landscape and Visual Impact	All seascape, landscape and visual impacts, including lighting. Assessment of cumulative impacts in relation to the projects listed in Section 8.19 of the Scoping Opinion.	None
Other Marine Users	None	All potential impacts on other marine users.

Topic	Scoped in (and scoping advice)	Scoped out (and scoping advice)
		The Scoping Report did not consider the impacts on other marine users from Airborne Noise. NnGOWL commissioned two noise assessments to determine the likelihood of impacts resulting from construction related airborne noise on other marine or coastal users. These assessments are presented in Appendix 5.1 and Appendix 5.2. The findings of these reports confirm that impacts on coastal receptors are unlikely from construction activity and as such no further assessment is presented within this EIA Report.
Socioeconomics	Potential socioeconomic impacts (GVA and employment).	Potential impacts on tourism.

32. The Scoping Opinion raised a number of other points for consideration in the Project EIA that were not dealt with in the Scoping Report, resulting from input to the scoping consultation from stakeholders. These are summarised in Table 5.5 below along with an indication of how these have been dealt with in preparing the application.

Table 5.5: Other issues raised in the Scoping Opinion (based on Scottish Ministers, 2017)

Stakeholder	Topic Area	Specific Request	Scottish Ministers Response	How Addressed?
ELC	Geodiversity interest	ELC have raised a concern with regard to a proposed Local Geodiversity Site at Thorntonloch Coast.	If this site is designated, the EIA Report will need to consider whether there is potential for any impact on the site.	The proposed Local Geodiversity Site (site ELC 26 in the East Lothian Geodiversity Audit – Whitbread et al, 2015) lies to the south-eastern end of the beach and shows good examples of natural arches and rocky shore platform. ELC26 lies to the south-east of the landfall location which will be situated on the northern half of the beach (so that there will be no spatial overlap with the proposed Local Geodiversity Site). NnGOWL have written to ELC identifying this spatial separation and providing an assessment for the potential for indirect effects on ELC26. Given that the site Is not yet designated, it is not considered further in this EIA Report.

Stakeholder	Topic Area	Specific Request	Scottish Ministers Response	How Addressed?
Transport Scotland **Scottish Borders Council**	Access, traffic and transport	Requirement for an 'Access, Traffic and Transport' chapter in the EIA Report - consistent with the approach adopted in the Original ES but updated as required. Transport Scotland note that they sent a response on 21 September 2015 and given the conclusions of this response note that there are unlikely to be significant traffic impacts or associated issues on the Trunk Road Network.	The Scottish Ministers advise NnGOWL to consider the response from Transport Scotland and provide updated information on 'Access, Traffic and Transport' in the EIA Report.	NnGOWL note that in fact the Original ES did not consider traffic and transport (that is onshore transport associated with the offshore construction) – not least because no port had been selected – which remains the case for the current application. However, the Consents included the following condition (condition 22) requiring a Traffic and Transportation Plan for approval:: The TTP must set out a mitigation strategy for the impact of road based traffic and transportation associated with the construction of the Development. The Development must, at all times, be constructed and operated in accordance with the approved TTP (as updated and amended from time to time, following written approval by the Scottish Ministers). Reason: To maintain the free flow and safety of the Trunk Road network. NnGOWL would anticipate s similar condition in the Section 36 consent for the Project which would ensure that traffic and transport issues are addressed once the final port(s) are selected Note that matters relating to traffic, transport and access relating to the onshore works were assessed in the ES accompanying the town and country planning application for the onshore works and that any traffic relating to development in the intertidal area is separately the subject of a Traffic Management Plan under condition 6 of the onshore planning permission.
ELC	Onshore works – inclusion in the EIA	ELC state their view that both onshore and offshore works are an integral part of the Project. ELC are of the view that the EIA Report would require to consider	NnGOWL should consider the detailed comments provided by ELC and take these into account when	See Chapter 6: EIA Methodology - Inter-related Assessment

Stakeholder	Topic Area	Specific Request	Scottish Ministers Response	How Addressed?
		the impacts of the offshore works together with the impacts of the onshore works as consented and in respect of an up to date baseline.	preparing the EIA Report.	

5.3.5 Scoping Gap Analysis

33. The Scoping Opinion included a template for a gap analysis, which is to be used to record the environmental concerns identified during the scoping process and is to be completed and used to inform the preparation of the EIA Report and submitted as part of the Application.

5.3.6 Post-scoping

34. Following receipt of the Scoping Opinion, NnGOWL have continued to engage with key stakeholders in developing the approach to the assessments and discussing the issues arising. A summary of these further consultations is set out in Section 5.6.3.

35. Following the Scoping Opinion, there have been a number of further amendments to the Project design, these are detailed in Table 5.6 below.

Table 5.6: Project changes that have occurred post-scoping

Parameter	Value at Scoping	Value for Application
Number of turbines	56	54
Seabed occupied by jacket (jackets, legs and scour protections)[1]	225m^2	300m^2 per leg for four leg jacket; 108 m^2 per 6 leg jacket
Foundation installation method[1]	3% driven only; 7% of piles will be drilled only; 90% drill-drive-drill	0-10% driven only; 90-100% drill-drive-drill Drill only may be used at a small number of locations
Maximum rotor tip height (m)	230	208
Rotor Diameter (m)	180	167
Length x width of OSP Topside (m)	30 x 30	40 x 40
Total weight of topside (tonnes)	Up to 2500	Up to 3500

5.4 Embedded Mitigation

36. The Scoping Report, and the resulting Scoping Opinion, were based on an assessment of the potential significant effects that might arise from the Project taking into account embedded mitigation as identified for each of the topics considered.

37. Embedded mitigation is the term applied to mitigation measures that are effectively 'built in' to the Project i.e. they are assumed to be in place as up-front commitments rather than mitigation proposed in response to the EIA process and being necessary to specifically mitigate a significant effect.

[1] Following submission of the Scoping Report a number of Project parameters have been refined upwards. These project parameters still fall within the worst case design scenario assessed in the Original Application and therefore does not compromise the scoping process as detailed within Section 5.3.

38. The Scoping Opinion therefore relies on these embedded mitigation measures being in place (and ultimately secured in some form in the consents granted), in addition to any additional mitigation identified through the detailed EIA process.

39. For those topics scoped into the Project EIA (in whole or in part) (as identified in Table 5.4) the relevant embedded mitigation measures are listed in each respective chapter of this EIA Report (together with any additional mitigation that may be required).

40. For those topics wholly scoped out of the EIA Report, embedded mitigation measures must, where appropriate, be retained in considering and determining the Application.

41. The embedded mitigation is derived from the following:

- Mitigation and management measures that formed 'embedded mitigation' applied during the Original EIA; and
- Additional mitigation and management measures identified as a result of the Original EIA.

42. For each of the topics set out in the Scoping Report, the question was asked as to whether the embedded mitigation provides a suitable means for managing and mitigating the potential significant effects of the Project and whether the receptors should be scoped out of the Project EIA. Table 5.7 summarises the embedded mitigation for those topics wholly scoped out of the EIA process as detailed in the Scoping Report.

43. For each of the topics listed in Table 5.7, Marine Scotland has confirmed that they are content that the embedded mitigation is sufficient to manage or mitigate the potential significant effects and can be used as a basis for scoping out.

Table 5.7: Summary of embedded mitigation measure commitments for topics scoped out of the Project EIA

Topic	Embedded mitigation measures
Geology and Water Quality	▪ Construction contractors will be required to produce Site Environmental Management Plans (SEMP) and Pollution Control and Spillage Response Plans prior to construction works. These plans will reduce the probability of accidental spillage and formalise a contingency plan in the event that one does occur.
Physical Processes	▪ A nearshore survey will be completed to inform the design of the intertidal and nearshore cable laying, and thus minimise impacts; ▪ A variety of techniques may be employed to reduce or eliminate scour. The following measures will be considered: rock armouring, mattressing, and frond mats; and ▪ Cables will be suitably buried or will be protected by other means when burial is not practicable.
Air Quality	▪ As all atmospheric emissions associated with the development are from vessel emissions, total emissions will be reduced by taking total vessel emissions / fuel use into account when designing the final installation, operation and maintenance, and decommissioning strategies to minimise as far as practicable the number of vessel movements and installation time required; and ▪ Additionally, all vessels employed during the Project development will comply with the Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008 and where practicable, contracts with the vessels will include a requirement for energy management, to minimise energy usage.

Topic	Embedded mitigation measures
Benthic Ecology	▪ Cable burial to an appropriate trenching depth to limit the rise in sediment temperature and prevent macrozoobenthic fauna from direct harm as well as limit physical changes that may impair the ecological functioning of benthic communities and to increase the distance between benthic species and electro-magnetic field (EMF) associated with subsea cabling; ▪ Conduct a pre-construction cable route survey to identify any sensitive seabed habitats. Should such habitats be recorded, the Offshore Export Cable Corridor will be micro-sited, in consultation with Scottish Natural Heritage (SNH) and other stakeholders via submission, for approval, to MS-LOT of a Cable Plan (CaP) (see section 5.5); and ▪ Although no significant impact arising from the installation of the cables is predicted, it is considered good practice to minimise the extent of any unnecessary habitat disturbance. On this basis, material displaced as a result of cable burial activities should, where techniques allow, be back-filled in order to promote recovery.
Maritime Archaeology and Cultural Heritage (excluding settings analysis)	▪ Direct physical impact on all sites of cultural heritage interest identified will be avoided where possible through micro-siting of both turbines and installation equipment (e.g. jack-ups); ▪ Where cultural heritage assets may potentially be subject to direct or indirect impacts, Archaeological exclusion zones (AEZ) will be implemented to prevent potential impacts from anchoring or installation of jack-up vessels; ▪ Exclusion zones of at least 100 m will be established around sites identified as being of high vulnerability, while an exclusion zone of a minimum 50 m will be established around those of medium vulnerability. In addition to the construction phase it is also anticipated that the implementation of AEZs will ensure cultural heritage assets are protected from potential impacts during the operation and decommissioning phases; ▪ Absolute exclusion zones of at least 300 m around all protected wrecks within the Development Area; ▪ Should further survey or investigation confirm the nature and characteristics of an identified asset then an AEZ can be maintained or removed as appropriate and in consultation and agreement with Historic Scotland (now Historic Environment Scotland (HES)); ▪ The implementation and monitoring of the AEZs will be maintained through the Written Scheme of Investigation (WSI) and Protocol for Archaeological Discoveries (PAD) highlighted below; ▪ In order to mitigate the risk of damage to any previously unrecorded archaeological remains a WSI and PAD will be prepared to mitigate construction impacts in the event of any unexpected archaeological discoveries during construction. This protocol will also include appropriate archaeological briefings for all personnel involved in the construction, operation and decommissioning activities associated with the proposed development. The PAD will be in place for the life of the proposed development and will be updated when required should details within the document change, for example contact details for key stakeholders; and ▪ Should it not be possible to avoid sites of cultural heritage interest, a full programme of archaeological investigation, which may include diver survey or Remotely Operated Vehicle (ROV) investigation, will be undertaken to identify the nature and extent of these sites. Subject to these investigations, an appropriate mitigation strategy will be agreed with HES.

Topic	Embedded mitigation measures
Other Marine Users	▪ Marking of the proposed Project on Admiralty charts to aid navigation; ▪ Appropriate information circulation such as use of Notice to Mariners (NtM), Navigation Broadcasts and other appropriate media; ▪ Appropriate marking and lighting of structures associated with the Offshore Wind Farm in accordance with international guidance; ▪ Adequate turbine air draught: the lowest point of the rotor sweep will exceed the 22 m above MHWS as recommended by the MCA; ▪ Cables to be appropriately protected and post installation surveys may be undertaken to indicate status of cable burial to allow fishing practices and anchoring to recommence; ▪ The Project will be compliant with the MCA's Marine Guidance Note 71; ▪ Emergency Response and Cooperation Plans will be developed as per MCA recommendations; ▪ Best practice measures may be implemented, which include development of a Marine Control Centre, routine subsea surveys to monitor cable burial status, and use of construction safety zones; ▪ A UXO risk assessment will be carried out prior to construction; and ▪ Full seabed magnetometer scan, or other industry accepted method of UXO identification, may be undertaken prior to construction.

5.5 Consent Condition Commitments

44. The Consents included a number of conditions and requirements relating to the mitigation or management of the Project (many of which incorporate the requirements set out as embedded mitigation).

45. NnGOWL recognises that the Scottish Ministers, in granting consents for the Project, are likely to require similar conditions and requirements (where they are considered to remain relevant) – and indeed may wish to prescribe additional conditions. However, NnGOWL would expect that, broadly, the main requirements encapsulated by the conditions set out in the Consents, where relevant and necessary to the Project, will remain a requirement in some form.

46. For example, NnGOWL would envisage a condition requiring the Project to be constructed and operated in accordance with this EIA Report, and the requirement for some or all of the following plans to be submitted for approval by the Scottish Ministers prior to the commencement of construction - each of which act to limit the final design of the Project to that detailed within the design envelope in this EIA Report:

- Construction Programme (CoP) to confirm the timing and programming of construction;
- Design Specification and Layout Plan (DSLP) detailing the final specification and layout of the Offshore Wind Farm and OfTW;
- Construction Method Statement (CMS) to confirm the installation methods and management of construction taking into account any required mitigation measures;
- Piling Strategy (PS) setting out the key pile parameters, installation method and mitigation to be applied during construction;
- Cable Plan (CaP) setting out the installation methods taking into consideration all environmental and navigational issues; and
- Operation and Maintenance Programme (OMP) setting out the requirements and programme of ongoing operation and maintenance activities.

47. In addition, a variety of other conditions were attached to the Consents which acted to mitigate or control particular aspects of the Originally Consented Project. NnGOWL would expect similar conditions to be required where they remain relevant to the Application. Reference to anticipated consent condition commitments are referenced within specific topic chapters where they are relevant to the management and mitigation of environmental risk for specific receptor groups.

5.6 Other Consultation and Stakeholder Engagement

5.6.1 Legislative Requirements for Pre-Application Consultation

48. There are no statutory requirements for consultation during the pre-application stage for Section 36 consent applications made under the Electricity Act 1989.

49. Draft guidance on applications for consents for marine renewables projects in Scotland (Marine Scotland, 2012) notes that although not required under the Section 36 Consent process, MS-LOT will require applicants to have undertaken pre-application consultation with stakeholders, consultees and the public in accordance with good practice.

50. For applications for Marine Licences under the Marine (Scotland) Act 2010, the Marine Licensing (Pre-application Consultation (PAC)) (Scotland) Regulations 2013 set out specific requirements for pre-application consultation (Marine Scotland, 2013). The purpose of these requirements is to allow local communities, environmental groups and other interested parties to comment upon proposed marine developments at an early stage, before an application is submitted to Marine Scotland (for relevant applications in the Scottish Inshore Region, from MHWS to 12 nautical miles).

51. The PAC requirements consist of at least one public event (local to the location of the project) and notification, at least 12 weeks prior to the submission of the application, of the intention to submit a marine licence application to a number of prescribed statutory consultees (The Commissioners of Northern Lighthouses, The Maritime and Coastguard Agency, The Scottish Environment Protection Agency, Scottish Natural Heritage, and any delegate for the relevant marine region or regions where these have been established). Notification to submit an application for a Marine Licence was given to statutory consultees on the 3 August 2017. In addition, and no less than 6 weeks in advance of the public pre-application consultation event, a notice must be published in a local newspaper giving details of the Project and the timing and location of the public event and the date by which comments are to be provided.

52. Section 24(1) of the Marine (Scotland) Act 2010 requires that a PAC report be prepared and submitted with the Marine Licence application.

5.6.2 Project Pre-Application Consultation

53. NnGOWL has undertaken pre-application consultation in compliance with the specific requirements set out under the Marine Licensing (Pre-application Consultation) (Scotland) Regulations 2013.

54. The details of the consultation and the outcomes of the consultation are presented separately in the PAC Report, which accompanies the Application (Facilitating Change, 2017) and conforms to the prescribed requirements set out in the Marine Licensing (Pre-application Consultation) (Scotland) Regulations 2013. It summarises the results of a number of public events at the following locations:

- 25 September 2017 – North Berwick;
- 26 September 2017 – Dunbar;
- 27 September 2017 – Carnoustie;
- 28 September 2017 – Crail; and
- 4 October 2017 – St Andrews.

55. The PAC Report also includes a summary of any responses received in response to the public notices placed in local newspapers.

5.6.3 Other Stakeholder Engagement

56. NnGOWL undertook extensive consultation on the Originally Consented Project and Section 36 Variation with a range of statutory and non-statutory stakeholders and the general public. In doing so,

NnGOWL has well developed stakeholder relationships and a good understanding of the interests and issues associated with the Project.

57. For the current application, NnGOWL has continued that engagement, principally through the scoping and pre-application consultation processes outlined above, in developing the Application for the Project. Further meetings, following on from the scoping process, have been held with a number of key stakeholders including:

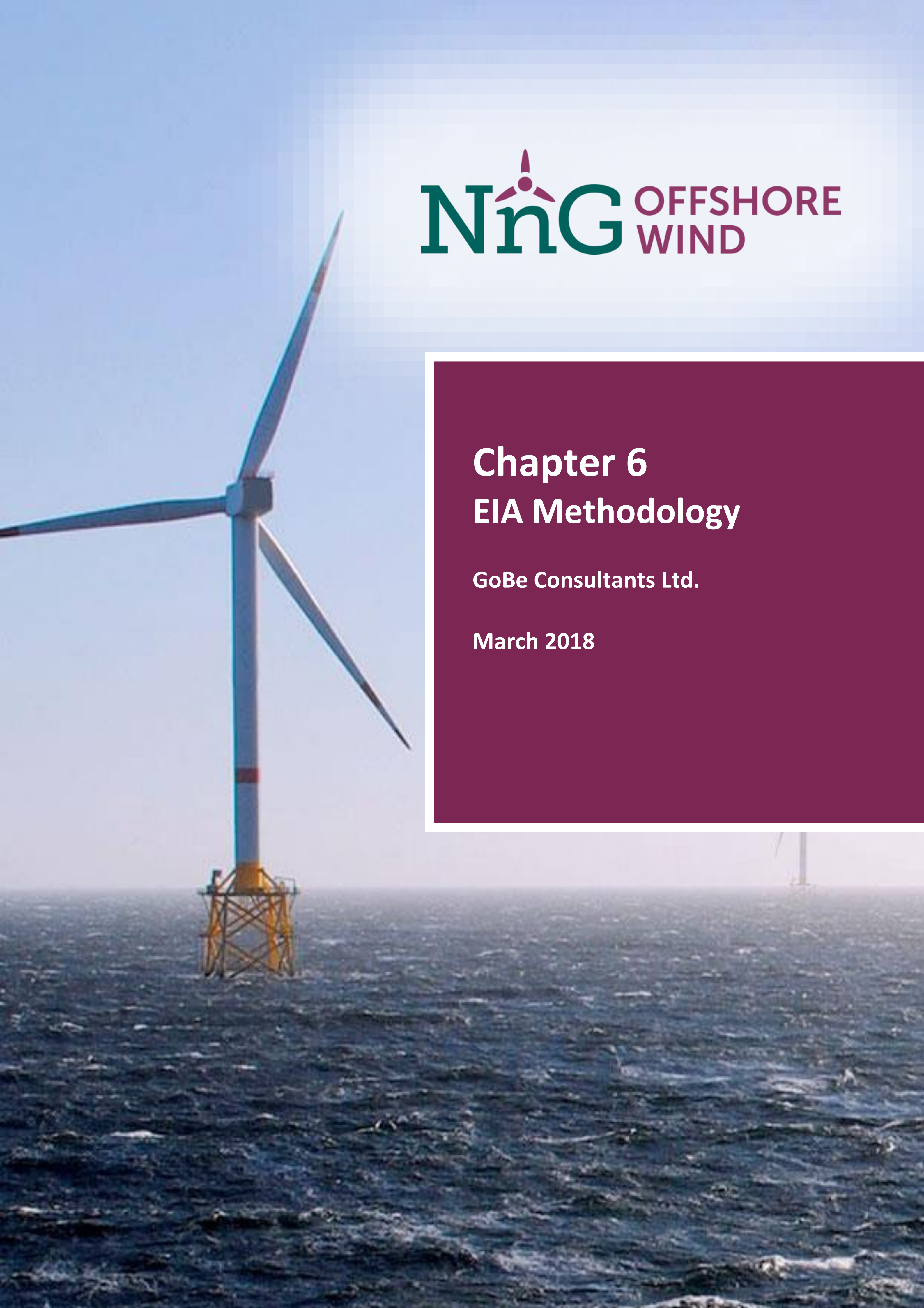
- Community Councils;
- Members of Parliament, Members of the Scottish Parliament and Local Councillors;
- MCA (shipping and navigation);
- Local planning authorities (SLVIA, cultural heritage and geology);
- Commercial fisheries stakeholders;
- Marine Scotland Science (benthic ecology, ornithology, marine mammals, fish and shellfish ecology);
- SNH (SLVIA, ornithology and marine mammals); and
- RSPB (ornithology).

58. Further detail on these consultations are provided in the respective topic chapters.

59. NnGOWL will continue to engage through the post-application process and in seeking determination of the Application.

5.7 References

- Marine Scotland (2013) *Guidance on Marine Licensable Activities Subject To Pre-Application Consultation*. Available from http://www.gov.scot/Resource/0043/00439649.pdf
- Marine Scotland (2012) *Marine Scotland Licensing and Consents Manual, covering Marine Renewables and Offshore Wind Energy Development. Date: October 2012.* Available from http://www.gov.scot/Resource/0040/00405806.pdf
- Faciliating Change (2017) *Neart na Gaoithe Offshore Wind Farm Pre-Application Consultation Report. UK02-0504-0744-MRP-PAC_REPORT-RPT-A1*
- NnGOWL (2017) *Neart na Gaoithe Offshore Wind Farm Scoping Report. Dated May 2017.* Report ref: UK02-0504-0673-MRP-NNG SCOPING REPORT 2017-RPT-A1. Available from http://www.gov.scot/Topics/marine/Licensing/marine/scoping/NnGRev2017/NnG-ScopingReport-May2017
- NnGOWL (2013) *Neart na Gaoithe Offshore Wind Farm Addendum of Supplementary Environmental Information. Dated June 2013.* Available from http://marine.gov.scot/datafiles/lot/nng/Addendum_of_supplementary_Environmental_Information/
- NnGOWL (2012) *Neart na Gaoithe Offshore Wind Farm Offshore Environmental Statement.* Available from http://marine.gov.scot/datafiles/lot/nng/Application/
- Scottish Ministers (2017) *Scoping Opinion for the Proposed Section 36 Consent and Associated Marine Licence Application for the Revised Neart Na Gaoithe Cape Offshore Wind Farm and Revised Neart Na Gaoithe Offshore Transmission Works. Dated September 2017.* Available from http://www.gov.scot/Topics/marine/Licensing/marine/scoping/NnGRev2017/SO-092017
- Whitbread, K, Ellen, R, Callaghan, E, Gordon, JE and Arkley, S (2015). *East Lothian Geodiversity Audit. British Geological Survey Open Report, OR/14/063. 192pp.*



NnG OFFSHORE WIND

Chapter 6
EIA Methodology

GoBe Consultants Ltd.

March 2018

Table of Contents

Table of Tables

6 Environmental Impact Assessment Methodology

6.1 Introduction

1. Under European legislation, transposed into UK and Scottish law (see Chapter 3: The Need for the Project, Site Selection and Alternatives for further information), it is a requirement to undertake an Environmental Impact Assessment (EIA) for certain projects, to identify likely significant effects that may arise as a result of the Project and, where necessary, to propose measures to prevent, reduce or offset these effects.

2. This EIA Report supports an application for consent for the Project (under Section 36 of the Electricity Act 1989) and Marine Licences (one for the Offshore Wind Farm and a second for the Offshore Transmission Works) under the provisions of Part 4 of the Marine (Scotland) Act 2010). As outlined in Chapter 1: Introduction (Section 1.4.1), a previous, separate EIA (NnGOWL, 2012) was undertaken to underpin the Original Application for an offshore wind farm, which was submitted in 2012 to Marine Scotland. After submission of an Addendum to the EIA in 2013, consent was granted for this application in 2014 (the Originally Consented Project).

3. A separate EIA was submitted to assess the potential environmental impacts of the associated OnTW (covering the area from the MLWS to the onshore substation) in support of a planning application, under the Town and Country Planning (Scotland) Act 1997, which was made to East Lothian Council (ELC) in 2012. NnGOWL was granted planning permission for the OnTW in June 2013 (12/00922/PM) with the permission subsequently amended by a Section 42 application which was granted in November 2015 (15/00634/PM). The permission was implemented in August 2016.

4. This EIA Report considers inter-related effects of the offshore components of the Project together with any relevant impacts arising from the OnTW, as consented.

6.2 The Need for EIA

5. The EIA requirements relevant to an application for Section 36 consent are enacted by the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and in relation to marine licensing by The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017. These Regulations came into force on 16th May 2017 and set out the statutory process and requirements for EIA in accordance with the new EIA Directive.

6. A request for a Scoping Opinion was submitted to MS-LOT on the 15th of May 2017 (i.e. prior to the regulations noted above coming into force) and therefore the transitional arrangements set out within the regulations apply to the Project (meaning that certain aspects of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 and the Marine Works (Environmental Impact Assessment) Regulations 2007 (the 2000 EIA Regulations and the 2007 EIA Regulations respectively) continue to apply (i.e. in relation to the scope of an Environmental Statement (now referred to as an EIA Report)).

7. The requirement to undertake an EIA for a given type of development is set out in the EIA Directive and corresponding Scottish Regulations. For some types of development (i.e. those listed in Annex I of the EIA Directive and Schedule 1 of the EIA Regulations) EIA is mandatory but for others (i.e. those listed in Annex II of the EIA Directive and Schedule 2 of the EIA Regulations) EIA may be required, subject to screening by the competent authority. An offshore wind farm falls within Annex II of the EIA Directive

(as "an installation for the harnessing of wind power for energy production (wind farms)"). NnGOWL has opted not to request a screening opinion and due to the scale and location of the Project has voluntarily undertaken and EIA.

8. In addition to the primary EIA legislation listed above, other legislation may be relevant to the EIA process in so far as it determines the sensitivity of a given receptor (principally in relation to nature conservation designation) as well as requiring, in certain cases, separate assessment in relation to the implications of the Project on features designated under the respective legislation. This includes, but may not be limited to, the following:
   - The Conservation (Natural Habitats, &c.) Regulations 1994;
   - The Conservation of Habitats and Species Regulations 2017;
   - The Conservation of Offshore Marine Habitats and Species Regulations 2017;
   - Wildlife and Countryside Act 1981; and
   - Nature Conservation (Scotland) Act 2004.

9. These and other, related legislative instruments and frameworks are discussed in more detail in Chapter 2: Policy and Legislation, as well as in individual topic chapters where appropriate.

6.3 EIA Guidance and Best Practice

10. A variety of guidance and best practice documents have been developed to assist with the production of a 'fit for purpose' EIA, both in relation to the generic EIA process, and specifically in relation to the EIA of offshore wind farm developments in UK waters. The EIA process reported in this EIA Report has been completed in recognition of the various guidance, including but not limited to, the following:
    - Environmental Impact Assessment of Projects Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU) (EC, 2017);
    - Guidance for Marine Licence Applicants - Version 2 (Marine Scotland, 2015);
    - A Handbook on Environmental Assessment. Guidance for competent authorities, consultees and others involved in the Environmental Assessment Process in Scotland (Scottish Natural Heritage, 2013 – 4th Edition);
    - Environmental impact assessment for offshore renewable energy projects (British Standards Institute (BSI), 2015);
    - Guidelines for Environmental Impact Assessment (Institute of Environmental Management and Assessment (IEMA), 2004);
    - Guidelines for Ecological Impact in Britain and Ireland. Marine and Coastal. (IEEM, 2010);
    - Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects (Centre for Environment, Fisheries and Aquaculture Science (Cefas), 2012);
    - A Review of Assessment Methodologies for Offshore Wind Farms (COWRIE METH-08-08) (Maclean et al., 2009);
    - Cumulative Impact Assessment Guidelines – Guiding Principles for Cumulative Impacts Assessment in Offshore Wind Farms (Renewable UK, 2013); and
    - A Strategic Framework for Scoping Cumulative Effects (Marine Management Organisation (MMO), 2014).

11. Additionally, specific guidance is available for certain individual topics (for example, landscape, seascape and visual impact assessment, ornithology, aviation etc.) and these have been referenced where applicable within the relevant topic chapters (Chapters 7 to 15).

6.4 The EIA Process

12. An EIA is intended to identify, describe and assess, the direct and indirect likely significant effects of a proposed project on the receiving environment (and specifically on the receptors listed under the relevant regulations – but broadly summarised as effects on the physical, biological and human environments).

13. The process includes preparation of an EIA Report by the project proponent and consultation on the EIA Report by the Scottish Ministers. The findings of the EIA Report and responses to the consultation are then considered during the determination process by the Scottish Ministers prior to a decision being made on the applications for consent.

14. The key steps undertaken in the EIA process can be summarised as follows (SNH, 2013):

- Gathering of relevant baseline environmental information: describes the existing environmental and social conditions of the development site as a basis for the impact assessment process;
- Description of the development: setting out the proposed project in relation to the construction, operation and decommissioning phases;
- The impact assessment process: identifying and assessing the potentially significant effects that could arise from the Project – direct and indirect, alone and cumulatively, including any inter-related effects;
- Mitigation and residual effects: for potentially significant effects, identifying mitigation to avoid, prevent or reduce and, if possible, offset likely significant adverse effects on the environment reduce or compensate for that effect, and the subsequent assessment of the residual level of significance;
- Monitoring: identifying, in relation to potentially significant effects, requirements for any monitoring studies.
- Publication of the EIA Report;
- Consultation with key bodies; and
- Consideration of consultation and decision-making.

15. The EIA process is informed through ongoing consultation and engagement with relevant stakeholders throughout the EIA process (see Chapter 5: Scoping and Consultation).

6.5 The Impact Assessment Methodology

16. The assessment of potential effects arising from the Project is intended to evaluate those changes to baseline conditions that could occur above the level of background environmental variation (positive or negative), and the level of significance at which they may occur (this being a product of the magnitude of the change and the sensitivity of a receptor to that change). Effects that are considered significant may be considered material to the decision-making process and may require mitigation to reduce the significance of the effect to an acceptable level.

6.5.1 Key Principles of the Assessment

17. The assessment of each topic is presented as a separate chapter within the EIA Report (Chapters 7 to 15).

18. Each topic chapter includes the following sections (as appropriate to each topic):

- Guidance, Policy and Legislation: provides a summary of the relevant legislation, national policy and guidance that have been taken into account in assessing each individual topic;
- Data Sources: provides a summary of the data sources used to inform the baseline description;

- Relevant Consultation: provides a summary of the topic-specific consultation responses received to date and outcomes of the Scoping process (both formal EIA Scoping and subsequent discussions with consultees);
- Impact Assessment Methodology: provides detail confirming the extent of the study area and topic specific detail on the approach to the impact assessment;
- Baseline Description: provides a description of the existing environment;
- Impact Assessment: presents the key design envelope parameters for assessment (the most likely (or realistic) worst-case scenario (See Section 6.5.3) and identifies the potential impacts to be addressed. This section goes on to present the magnitude of the potential impacts that may arise during the construction, operation and decommissioning of the Project, taking account of any embedded mitigation measures, and presents the subsequent significance of the effects. An assessment of any cumulative impacts arising from interaction with other projects, plans or activities is also presented;
- Mitigation and Residual Impacts: identifies any relevant additional mitigation measures (i.e. those beyond the embedded mitigation) necessary to avoid, prevent or reduce and, if possible, offset likely significant adverse effects and presents the residual effects; and
- Monitoring Requirements: sets out any proposals for the monitoring of potentially significant effects.

6.5.2 Evidence Based Approach

19. The evidence based approach to EIA involves utilising existing data and information from sufficiently similar or analogous studies to inform baseline understanding and/or impact assessments for a new project. In this way, the evidence based approach does not always require new data to be collected, or new modelling studies to be undertaken, in order to characterise the potential impact with sufficient confidence for the purposes of EIA.

20. The Project boundary is identical to the boundary for the Originally Consented Project. Therefore, the majority of the data and information collected for the purposes of conducting the Original EIA, as set out in the Original ES (NnGOWL, 2012), remain a valuable source of evidence to inform the assessment of likely significant environmental effects associated with the Project and, where relevant to the scope of this EIA Report, have been used to inform the EIA process. Where the original data was considered inadequate, or required updating as indicated by the Scottish Ministers in the Scoping Opinion, further baseline data has been used as the basis of the assessment. The available information has been used to:

    - Characterise the baseline environment to inform the EIA;
    - Scope out impacts where there is clear evidence to do so (see Chapter 5: Scoping and Consultation); and
    - Where impacts have been scoped into this EIA Report, to draw upon the existing evidence base and previous impact assessment work as a basis for conducting the EIA as set out in this EIA Report.

21. The use of existing data is encouraged as part of the offshore wind industry's response to government drivers to reduce the cost of offshore wind energy.

6.5.3 The Design Envelope Approach

22. The nature of offshore wind farm projects, where consent is applied for several years before construction can commence, has the potential to leave the developer unable to use the up-to-date technology or installation methods that were not available at the time of assessment. In addition, since the EIA process and EIA Report are completed before the full, detailed technical engineering assessment of the site has been undertaken, uncertainty inevitably remains with regard to the optimal

engineering solutions such as, for example, installation techniques, foundation types and specification of turbines.

23. To minimise unnecessary constraints on the design and construction methods which can be ultimately utilised, often with environmental benefits, it has become common practice to define a 'Design Envelope'.

24. The adoption of a Design Envelope approach allows a meaningful EIA to be completed based on design parameters that are not finalised at the time of writing, but are indicated within a range of potential values. As long as the final technical and engineering parameters for the Project fall within the limits of this envelope, such that the final scheme gives rise to environmental effects that are no greater than those predicted within the EIA, then these parameters are considered to fall within the scope of the consent granted.

25. For each of the impacts assessed within the topic chapters (Chapters 7 to 15), the most likely (or realistic) worst-case scenario is identified from the range of potential options for each parameter as set out in Chapter 4: Project Description. The most likely worst-case scenario selected, described and assessed in each topic chapter is therefore the most realistic scenario which would give rise to the greatest potential impact. If, after undertaking the impact assessment, it is shown that no significant effect is anticipated, it can be assumed that any design parameter values equal to or less than those assessed in this most likely worst-case scenario will have environmental effects of the same level or less than those described by the EIA. Often, the application of a Design Envelope results in a precautionary approach being applied to the assessments due to the various unknowns at different stages (e.g. precautionary noise contours applied along with precautionary approach using generalised fish spawning grounds resulting in a precautionary level of effect being determined).

26. By employing the design envelope approach, NnGOWL seeks to undertake a robust EIA while retaining a reasonable level of flexibility in the final design of the Project, within certain maximum extents and ranges, all of which are fully assessed in this EIA Report. This approach ensures that the Scottish Ministers can be confident that the maximum environmental impacts that could arise from the Project are described and that any scheme subsequently brought forward will give rise to environmental effects that are no greater than (and probably less than) those set out in this EIA Report.

6.5.4 Measures Envisaged to Avoid, Prevent, Reduce and Where Possible Offset Significant Adverse Effects (Mitigation)

27. The EIA Regulations require that where significant effects are identified, then a description of the measures envisaged to avoid, prevent or reduce and, if possible, offset likely significant adverse effects, should be included in the EIA Report.

28. The iterative approach to EIA employed in this EIA Report has involved a feedback loop during the impact assessment process. A specific impact has initially been assessed for its significance of effect, and if this is deemed significant and adverse in EIA terms, measures are considered, where possible, that could act to reduce the level of effect. The assessment is then repeated until:

- The effect has been reduced to a level that is not significant in EIA terms; or
- No further changes may be made in order to reduce the significance of the effect. In such cases, an overall effect that is still significant in EIA terms may be presented.

6.5.4.1 Embedded Mitigation

29. Through the iterative EIA process and in light of the findings of the Original EIA and subsequent consent determination process, NnGOWL has identified a variety of measures that have been 'embedded' into the Project design and have been termed 'embedded mitigation'. This embedded mitigation is included within the Project design and therefore is considered as being in place when undertaking the EIA process and assigning the significance to a given effect through the assessment

process. A list of relevant embedded mitigation measures is included in each of the topic chapters (Chapters 7 to 15).

30. In addition, embedded mitigation measures that were included for topics that were scoped out of the EIA Report, as listed in the Scoping Report (NnGOWL, 2017), are set out in Chapter 5; Scoping and Consultation.

6.5.4.2 Anticipated Consent Condition Commitments

31. Various conditions were applied to the Originally Consented Project. NnGOWL recognises that MS-LOT may wish to apply similar conditions to new consents and expects these to reflect the main requirements of the conditions applied to the Originally Consented Project.

32. NnGOWL anticipates a condition requiring the Project to be constructed and operated in accordance with the Project EIA Report and the requirement for the following plans to be submitted for approval, which act to limit the final design of the Project to that detailed within the design envelope:

- Construction Programme (CoP) to confirm the timing and programming of construction;
- Design Specification and Layout Plan (DSLP) detailing the final specification and layout of the wind turbine array and cable routes;
- Construction Method Statement (CMS) to confirm the installation methods and management of construction taking into account any required mitigation measures;
- Piling Strategy (PS) setting out the key pile parameters, installation method and mitigation to be applied during construction;
- Cable Plan (CaP) setting out the installation methods taking into consideration all environmental and navigational issues; and,
- Operation and Maintenance Programme (OMP) setting out the requirements and programme of ongoing operation and maintenance activities.

33. Where relevant, there are discussed further within the relevant topic chapters (Chapters 7-15).

6.5.4.3 Additional Mitigation

34. In some instances, the EIA process may identify effects that are considered significant and for which additional mitigation measures are required. Where this is the case, additional mitigation measures are set out under the relevant assessments in each of the topic chapters (Chapters 7 to 15) and the residual significance with the additional mitigation in place is described.

6.5.5 Approach to Impact Assessment

35. The Project has the potential to create a range of 'impacts' and 'effects' with regard to the physical, biological and human environment. For this assessment, the term 'impact' is used to define a change that is caused by an action. For example, piling of turbine foundations (action) during construction, which results in increased levels of subsea noise (impact). Impacts can be classified as direct, indirect, secondary, cumulative and inter-related. They can be either positive or negative, although the relationship between them is not always straightforward. Definitions for each of these terms are provided in Table 6.1.

36. The term 'effect' is used in this assessment to express the consequence of an impact. For example, the piling of turbine foundations (action) results in increased levels of subsea noise (impact), with the potential to disturb, for example, marine mammals (effect).

37. The 'significance of effect' is determined by considering the magnitude of the impact alongside the importance, or sensitivity, of the receptor or resource, in accordance with defined significance criteria, which are set out in the following sections below.

Table 6.1: Definition of direct, indirect, secondary, cumulative, inter-related, positive and negative impacts (derived from IEEM, 2006)

Term	Definition
Direct impact	Occurs as a result of activities undertaken in direct connection with the project.
Indirect impact	Occurs as a consequence of a direct impact (sometimes as part of a chain of events) and may be experienced at a point in space or time that is removed from the direct impact.
Secondary impact	Socioeconomic and cultural changes which may be experienced at a point in space or time that is removed from both direct and indirect impacts.
Cumulative impact	Impacts that result from incremental changes caused by other reasonably foreseeable actions alongside the project in question. This includes the impact of all other developments that were not present at the time of data collection (surveys etc.).
Inter-related effects	The impacts resulting from the inter-relationship of different topic-specific impacts upon the same receptor (e.g. where the impacts from noise and impacts from air quality affect a single receptor such as fauna).
Positive or negative impacts	Positive impacts merit just as much consideration as negative ones, for example as international, national and local policies increasingly press for projects to deliver positive biodiversity outcomes. Positive impacts can be considered for all the definitions above.

38. The impact assessment process considers the following:

- The magnitude of the impact;
- The sensitivity of the receptor to the impact;
- The probability that the impact will result in a given effect;
- The significance of the resulting likely environmental effect; and
- The level of certainty inherent within the assessment.

6.5.5.1 Determining Magnitude of Impacts

39. Predicting the physical impacts of wind farm construction, operation[1] and decommissioning activities on the environment is a critical step in the assessment process. It involves determining the magnitude of the potential physical changes and comparing it to baseline conditions. In this way, inferences can be made on future potential changes to the sensitive receptors.

40. The magnitude of impacts is quantified, where possible, and based on the characteristics set out in Table 6.2.

Table 6.2: Definition of the spatial extent, duration, frequency and reversibility when defining the magnitude of an impact (from IEEM, 2006)

Term	Definition (after IEEM, 2006)
Spatial extent of the impact	Geographical area over which the impact may occur.
Probability	The chance of occurrence of an impact can be described as unlikely, possible, probably or definite.
Duration of the impact	The time over which an impact occurs. An impact may be described as short, medium or long-term and permanent or temporary.
Frequency of the impact	The number of times an impact occurs across the lifetime of a project.

[1] For the avoidance of doubt, the term 'operation' is used throughout this EIA Report and includes any maintenance activities undertaken during the operational phase.

Term	Definition (after IEEM, 2006)
Reversibility of the impact	An irreversible (permanent) impact may occur when recovery is not possible within a reasonable timescale, or there is no reasonable chance of action being taken to reverse it. By contrast, a reversible (temporary) impact is one where recovery is possible naturally, in a relatively short time period, or where mitigation measures can be effective at reversing the impact. It is possible for the same activity to cause both irreversible and reversible impacts.

41. Consideration of these various characteristics allow the assessment of magnitude to take into account aspects such as whether a change as a result of the Project is localised or widespread, one-off or continuous, the scale of the change and whether or not it is reversible (i.e. temporary or permanent). It also takes account of the probability of an impact having an effect on a given receptor.

42. Based on the above criteria, the magnitude of impact is assessed as being within one of four impact severity groups, and can be either beneficial or adverse:

- Negligible;
- Low;
- Medium; or
- High.

43. Example definitions for each of these categories is set out in Table 6.3 below, derived from the Design Manual for Roads and Bridges (DMRB) (Highways Agency et al., 2008). However, in this EIA Report, topic specific definitions for each of these categories are provided in each of the topic chapters (Chapters 7 to 15), the topic-specific definitions drawing upon relevant guidance and other material, including specialist knowledge, relevant to each specific topic.

Table 6.3: Definition of terms relating to the magnitude of impacts (adapted from Highways Agency et al., 2008)

Magnitude of impact	Description (adverse)	Description (beneficial)
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements.	Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality.
Medium	Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements.	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
Low	Some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring.
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements.	Very minor benefit to, or positive addition of one or more characteristics, features or elements.
No change	No loss or alteration or characteristics, features or elements; no observable impact in either direction.	

6.5.5.2 Determining Receptor Sensitivity (or Vulnerability)

44. Sensitivity, or vulnerability, is used to describe the susceptibility of a given receptor to a change in baseline conditions brought about by an impact and the response of that receptor to the change. The sensitivity of a receptor is determined by consideration of a number of factors, which can include:

- Adaptability – the degree to which a receptor can avoid or adapt to an impact. Higher adaptability results in lower sensitivity;
- Tolerance – the ability of a receptor to accommodate temporary or permanent change. Higher tolerance results in lower sensitivity;
- Recoverability – the ability of a receptor to recover following exposure to an impact. Higher recoverability results in lower sensitivity; and
- Value – a measure of the importance of the receptor in terms of ecological, social/community and/or economic value. Higher value results in higher sensitivity.

45. The exact determination of sensitivity for any given receptor will vary according to the receptor in question, and as such will be defined on a receptor by receptor basis. Expert judgement may be applied to determine overall receptor sensitivity, taking into account relevant guidance, knowledge, legislation and protected status. Within the EIA Report, vulnerability is therefore attributed on a topic by topic basis within each of the Chapters 7 to 15.

46. The sensitivity of a receptor is defined within each topic on the following scale:

- Negligible;
- Low;
- Medium; or
- High.

47. Example definitions for each of these categories is set out in Table 6.4 below, derived from the DMRB (Highways Agency et al., 2008). However, in this EIA Report, topic specific definitions for each of these categories are provided in each of the topic chapters (Chapters 7 to 15), the topic-specific definitions draw upon relevant guidance and other material, including specialist knowledge, relevant to each specific topic.

Table 6.4: Definition of terms relating to the environmental value (sensitivity of the receptor) (adapted from Highways Agency et al., 2008)

Value (sensitivity of the receptor)	Description
High	Very High or high importance and rarity, international or national scale and limited potential for substitution.
Medium	Medium importance and rarity, regional scale, limited potential for substitution.
Low	Low importance and rarity, local scale.
Negligible	Very low importance and rarity, local scale.

6.5.5.3 Evaluating the Significance of Effects

48. The significance of an effect, either adverse or beneficial, is determined using a combination of the magnitude of the impact and the sensitivity of the receptor and with due regard to any degree of uncertainty encountered in the assessment and the probability of an effect occurring. A matrix approach will normally be applied (see Table 6.5) unless otherwise described in the topic specific EIA methodology.

Table 6.5: Significance of potential effects

		Magnitude			
		High	Medium	Low	Negligible
Sensitivity	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

49. For the purposes of this EIA Report, and unless otherwise stated in the topic specific chapters (7 to 15), effects rated as being of either Moderate or Major significance are considered to be potentially significant in EIA terms and therefore may require further consideration and/or mitigation.

50. The definitions of significance are set out in each of the topic chapters, but, as an example, definitions for each of these categories is set out in Table 6.6 below, derived from the DMRB (Highways Agency et al., 2008).

Table 6.6: Definition of significance levels (adapted from Highways Agency et al., 2008)

Significance Term	Definition
Negligible	No effects or those that are beneath levels of perception.
Minor	These beneficial or adverse effects are generally, but not exclusively, raised as local factors. They are unlikely to be critical in the decision-making process, but are important in enhancing the subsequent design of the project.
Moderate	These beneficial or adverse effects may be important, but are not likely to be key decision-making factors. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse or beneficial effect on a particular resource or receptor.
Major	These beneficial or adverse effects are considered very important considerations and are likely to be material in the decision-making process.

6.5.5.4 Evaluating Uncertainty

51. When predicting the significance of an effect and understanding the significance judgment, it is important to establish any significant uncertainty encountered in the assessment process. This may arise from the data used within the assessment, the identification of activities and impacts, the confidence in determining impact magnitude and receptor sensitivity and ultimately in assigning significance levels of predicted resulting effects. Therefore, uncertainty is indicated within each topic chapter in relation to the assessment process.

6.6 Assessment of Cumulative Impacts

52. The EIA Directive requires the consideration of the potential impacts of a project not only in isolation but also how it might act cumulatively with other plans or projects to create a cumulative impact greater than or different to that of each individual project.

53. The term cumulative assessment is used in this EIA Report to describe the assessment of incremental changes caused by other reasonably foreseeable actions alongside the Project. The term 'in-combination' is reserved for use in the context of the separate Habitats Regulations Assessment (HRA) requirements and therefore, to avoid confusion, is not used in this EIA Report.

54. The following sections set out the approach to Cumulative Impact Assessment (CIA) in this EIA Report, and as set out in detail in each of the topic specific chapters (Chapters 7 to 15). It sets out the following:

- Cumulative impact assessment legislation and guidance;

- The role of the Forth and Tay Offshore Wind Developers Group (FTOWDG); and
- The approach to cumulative impact assessment.

6.6.1 Cumulative Impact Assessment Legislation and Guidance

55. The current EIA Regulations require that a description of the likely significant cumulative effects of a project should be considered. This requirement is also set out within the SNH EIA Handbook (SNH, 2013) (with further topic-specific guidance, for example in relation to cumulative landscape and seascape visual impact assessment, also available). Other relevant guidance includes:
    - IEEM (2010) Guidelines for Ecological Impact Assessment in Britain and Ireland. Marine and Coastal. Final Version 5. August 2010;
    - European Commission (1999). Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions;
    - SNH (2005) *Cumulative Effects of Wind Farms. Version 2 Revised 13.04.05;*
    - SNH (2012). Assessing the Cumulative Impact of Onshore Wind Energy Developments;
    - Renewable UK (2013). Cumulative Impact Assessment Guidelines. Guiding Principles for Cumulative Impacts Assessment in Offshore Wind Farms. June 2013;
    - BSI (2015). PD 6900:2015. Environmental impact assessment for offshore renewable energy projects – Guide; and
    - 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.

56. The approach to CIA undertaken for the Project takes into account some of the principles outlined in the Renewable UK guidelines (Renewable UK, 2013) in addition to the requirements set out in the legislation and statutory guidance documents together with the commentary provided on cumulative impact assessment in BSI guidance (BSI, 2015).

6.6.2 The Forth and Tay Offshore Wind Developers Group

57. The developers of the major offshore wind farm projects in the outer Forth and Tay (NnG, Inch Cape and Seagreen) cooperated prior to submitting their respective applications for the original consents through the FTOWDG, formed specifically to assist collaboration and cooperative working to inform cumulative assessments.

58. FTOWDG developed a guidance document setting out the proposed approach for assessing the cumulative impacts and to guide some aspects of the individual project EIAs. The document *Scottish Territorial Waters Offshore Wind Farms – East Coast. Discussion Document – Cumulative Effects Assessment* was produced in 2009 and a second version was produced in 2010. These documents defined areas where the developers could work collaboratively in developing an approach to considering cumulative (and in-combination) impacts. The approach was followed in undertaking the cumulative assessments for the Original ES.

59. Where appropriate, the approaches developed through FTOWDG, and applied in the Original ES, have equally been applied to the cumulative assessment for this EIA Report.

6.6.3 Approach to the Cumulative Impact Assessment

60. The following section sets out the approach taken to the CIA for the EIA Report including details relating to the:
    - Approach to assessing the other Forth and Tay offshore wind farm projects;
    - Screening of the CIA (including identification of other offshore and onshore plans or projects that may have CIA); and

- The approach to conducting the CIA.

6.6.3.1 The Firth of Forth and Tay Offshore Wind Farms

61. There are currently several major offshore wind farm proposals in the Firths of Forth and Tay: Inch Cape, Seagreen and NnG as shown in Figure 4-4, Volume 2.

62. The original consents issued by Scottish Ministers in 2014 in relation to the Inch Cape and Seagreen Alpha and Bravo Offshore Wind Farms, along with NnG, were subject to lengthy Judicial Review proceedings. In parallel with the Judicial Review proceedings, NnG, Inch Cape and Seagreen all submitted requests for scoping opinions, accompanied by Scoping Reports, seeking an opinion on the matters to be addressed in an EIA Report to accompany new consent applications. It is the current understanding that these new applications are likely to be submitted to Scottish Ministers in the coming months.

63. Based on information set out in the respective Scoping Reports, NnGOWL understands that these applications will be for revised project design envelopes (when compared to the originally consented projects) (a summary of the project details for Inch Cape and Seagreen is presented in Chapter 4: Project Description).

64. The potential for cumulative impacts with these projects is considered in this EIA Report and it is it is understood that each developer only intends to progress either the original consented project or the revised project design.

65. In order to address this in the CIA, NnGOWL has for most topics presented the worst case scenario i.e. the new applications or the existing consents. In some topics, two CIA scenarios are presented, based on the Project with:
    - Inch Cape and Seagreen as consented in 2014; and
    - Inch Cape and Seagreen revised designs for their forthcoming applications.

66. NnGOWL, by presenting the full range of cumulative scenarios with the other offshore wind farms in the Firths of Forth and Tay, has set out the full information on the theoretically possible worst-case cumulative impacts that could arise for each of the topics considered (the specific CIA scenarios being set out in each topic chapter).

67. However, it is equally important to understand what represents the theoretical worst-case and what is in fact the more realistic scenario. In most (but not necessarily all) cases, the worst case will be represented by the originally consented parameters (the original projects having a design envelope allowing for a substantially greater number of turbines. However the other Forth and Tay projects will be seeking the lowest cost design solution in order to be competitive in seeking a CfD from the UK Government. This can be achieved most effectively by the use of the most up-to-date offshore wind technology, which is represented by the revised designs set out in the currently proposed projects rather than the worst-case designs defined by the original consents. It is therefore considered extremely unlikely that a scenario where the projects are built to the extent of their 2014 consents will occur. Nevertheless, as those consents do currently stand, they are considered and assessed in this EIA Report.

68. To aid the interpretation of the CIA scenarios with regard to the Forth and Tay projects, each topic assessment, where necessary, provides additional commentary on the cumulative impacts in this regard, highlighting the likelihood of the maximum theoretical worst-case occurring compared to the more realistic worst-case.

6.6.3.2 Screening of Other Plans and Projects

69. In addition to the Firth of Forth and Tay offshore wind projects, other major developments (both onshore and offshore) in the area should be taken into account, including those which are:

- Under construction;
- Consented application(s), but not yet under construction;
- Submitted application(s) not yet determined;
- Projects identified in a relevant development plan (and emerging development plans - with appropriate weight being given as they move closer to adoption) recognising that much information on any relevant proposals will be limited; and
- Identified in other plans and programmes (as appropriate) which set the framework for future development consents/approvals, where such development is reasonably likely to come forward.

70. A 'long list' of other plans and projects with which the Project may interact to produce a cumulative impact during any of the construction, operation or decommissioning phases was presented in the Scoping Report (NnGOWL, 2017) and has been amended, where relevant, in light of the Scoping Opinion (MS-LOT, 2017).

71. For each project included on the long list, the following information has been compiled (where it is publicly available): project name, information source, confidence in project data, scale / capacity, status of the development, known planned construction programme, and distance to the Project.

72. These plans and projects have been considered for inclusion within the CIA presented in each topic chapter based on the potential for cumulative impacts to occur with the Project when considering the potential interaction, the physical overlap and the temporal overlap (as well as the level of detail available for any given plan or project).

73. In relation to the potential interaction, for a cumulative effect to occur it must be established that a cumulative impact has the potential to directly or indirectly affect the receptor(s) in question i.e. there must be an impact-receptor-pathway. Each project, plan and activity on the 'long list' has been considered on a topic by topic basis in order to evaluate the potential for a relevant receptor-impact pathway in screening that plan or project into a particular topic specific cumulative assessment.

74. In many cases, for a cumulative impact to arise there must be a physical overlap in the extents of the impact from each particular project in relation to the effect on any given receptor. Where such a physical overlap cannot occur, a particular plan or project can be screened out of the topic specific cumulative assessment (note that exceptions to this can occur for certain mobile species such as marine mammals that may move between areas impacted by separate projects).

75. Temporal overlap relates to the overlap in time of a given impact arising on a particular receptor. For example, impacts arising from construction (such as piling noise) will only result in direct cumulative effects with projects producing underwater noise at the same time, but might produce indirect cumulative effects where sequential piling from different projects affects the same receptor over an extended period. By contrast, collision risk for birds occur over a longer operational period and the likely temporal overlap with other potential plans or projects must be screened and assessed accordingly.

6.6.3.3 The Cumulative Impact Assessment Methodology

76. In relation to each topic chapter, screening of projects on the long list is undertaken to identify those plans or projects that are considered relevant to the topic specific CIA; these topic specific lists are presented in each of the topic chapters. The list in each topic chapter also includes a summary of each of the screened in projects, plans and activities.

77. In general, the CIA methodology follows the outline of the stand-alone assessment methodology. This approach is employed in order to maintain consistency throughout the chapter and to allow relevant comparisons to be made. This approach, however, differs between topic chapters according to several factors, such as the nature of the topic, the cumulative projects, plans and activities included for that

topic, the data available for each project, plan and activity, and the specific practicalities around undertaking CIA for each particular topic.

78. Importantly, as part of the CIA process, the temporal status of the other projects, plans and activities has been considered in order to identify those that may have construction and/or operational periods that overlap the respective periods of NnG (again based on the publicly available information on the proposed timing of the other plans or projects). Such a consideration is particularly important for certain receptors (for example marine mammals), where the overlap of impacts during construction, such as noise from the piling activities of several large offshore developments, tends to be considered important. The details provided on the timing of other plans and projects represent the current understanding of programmes of development, though it is recognised that these programmes may be subject to change.

6.7 Inter-related effects

6.7.1 Approach to the assessment of inter-related effects

79. The EIA Regulations require consideration of the inter-relationships between topics that may lead to environmental effects. The Project EIA has therefore considered the inter-related effects resulting from the Project. Inter-related effects have been assessed through the consideration of the scope of all effects on a given receptor to interact, whether that be spatially or temporally, to result in an inter-related effect on that receptor. Such effects may be short-term, temporary or transient effects or incorporate longer term effects over the lifetime of the Project.

80. The approach adopted includes consideration of inter-dependencies for each topic, where one topic draws upon the findings of another assessment. To illustrate, the assessment of effects on commercial fisheries draws upon information from the shipping and navigation assessment in terms of navigation risk to fishing vessels and from the fish and shellfish ecology chapter in relation to ecological effects on target species. In this way, many of the inter-related effects are intrinsic to the assessments undertaken. Where relevant, this aspect is covered within each chapter, with specific attention drawn to other topic assessments upon which it relies. If there are additional effects from separately considered impacts acting together, these are considered qualitatively using professional judgement.

81. The approach to the inter-related assessment process can be summarised by the following key steps:

- Identification of relevant receptors from the individual impact assessments;
- Identification of potential inter-related effects on these receptor groups through a review of relevant assessment sections; and
- Presentation of an inter-related effects assessment identifying all potential effects on a given receptor during the construction, operation and decommissioning phases.

6.7.2 Assessment of the Onshore Components of the Project

82. As noted in Section 6.1, the onshore aspects of the Project (the OnTW) received planning permission from ELC in 2013 with an amended planning permission granted in 2015. The planning permission was implemented in 2016. The application for the planning permission for the OnTW was accompanied by a separate EIA. Consequently, the OnTW works are not considered as part of the EIA process presented in this EIA Report, which focuses on the offshore works as the subject of the application for S36 Consent and Marine Licences.

83. However, the requirement to consider the potential inter-related effects arising from the offshore works and the OnTW works is noted (and was scoped into the assessment in the Project Scoping Report). This reflects the requirements of the UK MPS (2011) which sets out the inter-relationship between marine and terrestrial planning regimes and requires that when the Scottish Ministers make

decisions that affect, or might affect, the marine area they must do so in accordance with the Statement.

84. This EIA has therefore considered the potential for inter-related effects to occur on onshore receptors as a result of effects arising from the offshore proposals and the OnTW on the same receptor. Specifically, this has been considered in respect of the following receptors:

- The visual impacts arising from the offshore works (i.e. the turbines and OSPs) on onshore receptors alongside the visual impacts of the OnTW works on those same receptors; and
- The visual impacts on the setting of cultural heritage assets at the coast arising from the offshore works (i.e. the turbines and OSPs) alongside the visual impacts of the OnTW works on those same receptors.

85. The spatial overlap of the separate consenting regime (the intertidal area between mean high-water springs and mean low water springs) is also addressed by a presentation of the effects on the intertidal area resulting from the offshore works (i.e. cable landfall) where relevant to the topics scoped into the EIA.

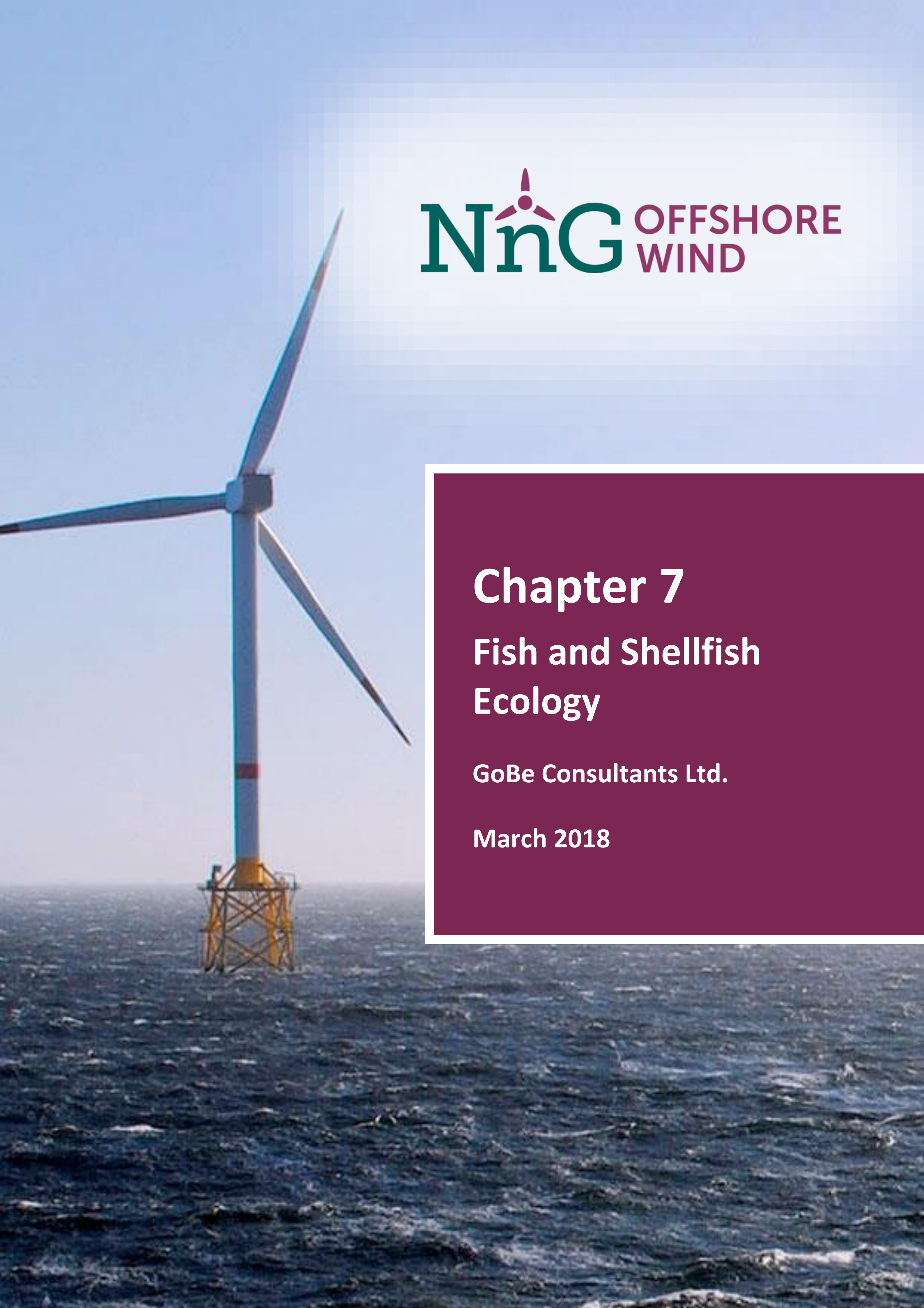
6.8 Transboundary Effects

86. The Scoping Report (NnGOWL, 2017) proposed that, given the location of the Project and the likely key receptors, potential transboundary effects would not be considered likely to occur and as such, no specific transboundary assessment would be presented. Therefore, no further specific transboundary assessments are presented in this EIA Report.

6.9 References

- BSI (2015) *Environmental impact assessment for offshore renewable energy projects – Guide.* Report Number PD 6900:2015
- Cefas (2012*) Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects (Final). Cefas.* Report reference: ME5403 – Module 15. Issue date: 2 May 2012
- EC (2017) *Environmental Impact Assessment of Projects Guidance on the preparation of the Environmental Impact Assessment Report* (Directive 2011/92/EU as amended by 2014/52/EU).
- EC (1999) *Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions*. Available from https://tethys.pnnl.gov/sites/default/files/publications/European-Commission-1999.pdf
- Highways Agency Scottish Government, Welsh Assembly Government and the Department for Regional Development Northern Ireland (2008) *Design Manual for Roads and Bridges (DMRB) Volume 11: Environmental Assessment*
- IEEM, (2010) *Guidelines for Ecological Impact in Britain and Ireland. Marine and Coastal.* (Council of the Institute of Ecology and Environmental Management).
- IEEM (2006) *Guidelines for ecological impact assessment in the United Kingdom* (Institute of Ecology and Environmental Management: Winchester, Hampshire).
- IEMA (2004) *Guidelines for Environmental Impact Assessment* (Institute of Environmental Management and Assessment St Nicholas House, 70 Newport, Lincoln).
- 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., Wright L.J., Showler D.A. and Rehfisch M.M. (2009) *A Review of Assessment Methodologies for Offshore Wind farms (COWRIE METH-08-08)* (Report commissioned by COWRIE Ltd., COWRIE, CIBIRD, London.)

- Marine Scotland (2015) *Guidance for Marine Licence applicants – Version 2.* Available from http://www.gov.scot/Resource/0052/00524064.pdf
- MMO (2014) *A Strategic Framework for Scoping Cumulative Effects. MMO Project No: 1055*. Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/389876/MMO1055_Report_Final.pdf
- NnGOWL (2012) *Neart na Gaoithe Offshore Wind Farm Environmental Statement. July 2012*; Doc Ref: 12/J/1/06/1664/1354. Available from http://marine.gov.scot/datafiles/lot/nng/Application/
- NnGOWL (2017) *Neart na Gaoithe Offshore Wind Farm Scoping Report. Dated May 2017.* Report ref: UK02-0504-0673-MRP-NNG SCOPING REPORT 2017-RPT-A1. Available from http://www.gov.scot/Topics/marine/Licensing/marine/scoping/NnGRev2017/NnG-ScopingReport-May2017
- RenewableUK (2013) *Cumulative Impact Assessment Guidelines – Guiding Principles for Cumulative Impacts Assessment in Offshore Wind Farms* (RenewableUK)
- Scottish Ministers (2017) *Scoping Opinion for the Proposed Section 36 Consent and Associated Marine Licence Application for the Revised Neart Na Gaoithe Cape Offshore Wind Farm and Revised Neart Na Gaoithe Offshore Transmission Works. Dated September 2017.* Available from http://www.gov.scot/Topics/marine/Licensing/marine/scoping/NnGRev2017/SO-092017
- SNH (2005) *Cumulative Effects of Wind Farms. Version 2 Revised 13.04.05*. Available from http://www.snh.org.uk/pdfs/strategy/cumulativeeffectsonwindfarms.pdf ;
- SNH (2013) *A Handbook on Environmental Assessment. Guidance for competent authorities, consultees and others involved in the Environmental Assessment Process in Scotland, 3rd ed.*



NnG OFFSHORE WIND

Chapter 7

Fish and Shellfish Ecology

GoBe Consultants Ltd.

March 2018

Table of Contents

Table of Figures

Table of Tables

7 Fish and Shellfish Ecology

7.1 Introduction

1. This chapter of the EIA Report presents an assessment of the potential impacts upon Fish and Shellfish Ecology arising from the construction, operation and decommissioning of the Project, as detailed in Chapter 4: Project Description.

2. This chapter is comprised of the following elements:

- A summary of relevant policy and guidance;
- Details of the data sources used to characterise the study area;
- A summary of the relevant consultations with stakeholders;
- A description of the methodology for assessing the impacts of the Project, including details of the study area and approach to the assessment of potential effects;
- A review of the baseline conditions;
- A description of the most likely worst-case design scenario relevant to fish and shellfish ecology;
- An assessment of the likely effects arising from the construction, operation and decommissioning phases of the Project, including cumulative effects;
- Identification of any further mitigation measures or monitoring requirements in respect of any significant effects; and
- A summary of the residual impact assessment determinations taking account of any additional mitigation measures identified.

3. This chapter is supported by two technical appendices which are contained within Volume 4 of this EIA Report:

- Appendix 7.1: Benthic Ecology Characterisation Report; and
- Appendix 7.2: Atlantic Salmon – Appraisal of Original EIA

7.2 Legislation, Policy and Guidance

4. There is no policy or guidance directly relevant to the assessment of potential impacts on fish and shellfish ecology arising from offshore wind farm development. However, a number of the general guidance documents set out in Chapter 6: EIA Methodology include guidance on the matters to be considered in relation to the potential impacts of offshore wind farm development on fish and shellfish ecology, or otherwise provide guidance on data acquisition and data sources to be applied in describing the baseline conditions.

5. In legislative terms, a number of fish species relevant to the Project are protected under various Acts of legislation; for example, Atlantic salmon (*Salmo salar*) and sea lamprey (*Petromyzon marinus*) are listed as Annex II species under the Habitats Directive (and within the Habitats Regulations) as animal species of community interest whose conservation requires the designation of special areas of conservation. Salmon and sea trout (*Salmo trutta*) are also protected under the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 (as amended) which, amongst other things, gives protection to spawning gravels and eggs. European eel (*Anguilla anguilla*) is protected under a European Commission eel recovery plan (Council Regulation No. 1100/2007), with an Eel Management Plan being in place for Scotland. Other species including Atlantic herring (*Clupea harengus*), Atlantic cod (*Gadus morhua*), whiting (*Merlangius merlangus*) and plaice (*Pleuronectes platessa)* are listed as Scottish Biodiversity List (SBL) species. Relevant species are described further under Section 7.6.

6. The UK Marine Policy Statement (HM Government, 2011) and Scotland's National Marine Plan (Marine Scotland, 2015) contain relevant policy provision related generally to biodiversity and, in some cases identify issues specific to fish, such as outlining policies to protect commercially sensitive fish spawning grounds and spawning adults such as herring and cod. The policy statement also identifies the potential for adverse effects on marine fish (and other species) primarily through construction noise. Scotland's National Marine Plan identifies a list of priority marine features (PMFs) that must be considered when planning decisions are being made, taking account of the advice of Statutory Advisors. Several fish species are listed as PMFs and these are discussed further in Section 7.6. Further information on the Marine Policy Statement and Scotland's National Marine Plan is provided in Chapter 2: Policy and Legislation.

7. Both these national policy documents make reference to the EU Marine Strategy Framework Directive (MSFD) and the role of that Directive in protecting and enhancing the marine environment. The UK government has published its Marine Strategy Part Three in response to the requirements of the Habitats Directive (Defra, 2015) which sets out the UKs programme of measures, which are designed to achieve or maintain Good Environmental Status (GES) for the UK marine waters.

8. Measures are set out specifically for fish (Descriptors 1 and 4) identifying the requirement to maintain or enhance (or to avoid any human actions leading to an impact on) fish populations; measures are predominantly aimed at the management of commercial fisheries and the maintenance or development of protected areas.

9. Descriptor 11 relates to underwater noise and identifies the requirement to establish a noise registry to record, assess and manage the distribution and timing of anthropogenic sound sources exceeding 186 decibels (dB) re 1 10^{-6} Pascal squared, per metre, per second ($\mu Pa^2 m^2 \cdot s$) (a measure of sound exposure level) and for noise (and the requirement for any mitigation) to be a consideration in the marine licensing process for sensitive species including some fish.

7.3 Data Sources

10. The assessment considers the potential interaction between the Project, as described in Chapter 4: Project Description, and Fish and Shellfish receptors within the study area and in regard to those issues scoped into this EIA Report (See Section 7.4).

11. The study area includes the Wind Farm Area. In addition, a wider area has been used to provide the appropriate ecological context for mobile fish and shellfish species. It is dependent upon the species in question and the nature of the impact being assessed, but generally extends across the Forth and Tay area in a manner sufficient to characterise the baseline, and to provide a basis for the assessment process.

12. Baseline characterisation data has been collated combining a thorough desk-based study of extant data supplemented by site-specific surveys. Site-specific geophysical and geotechnical surveys have been completed for the Development Area, including sediment particle size analysis (PSA) and contaminant analysis using grab samples. In addition, benthic faunal analysis was undertaken based on samples collected during benthic grab and beam trawl surveys. These data have been reviewed to consider the presence of source-receptor pathways when assessing the potential for fish and shellfish receptors to be affected by the impacts arising from the Project.

13. Table 7.1 details the key data sources used to inform the baseline characterisation within the study area (other data sources are referenced within the baseline description – Section 7.6).

Table 7.1 Data sources used to inform the baseline description.

Data Source	Study/Data Name	Overview
NnGOWL	Neart na Gaoithe Proposed Offshore Wind Farm Benthic Ecology Characterisation (EMU, 2010a)	EMU Ltd was commissioned to undertake a series of benthic ecology sampling surveys of the Wind Farm Area, the Offshore Export Cable route options and associated intertidal area options where the Offshore Export Cable was proposed to make landfall. Fish and shellfish resources were sampled using a scientific beam trawl to provide a primary description of the site-specific communities, within, and peripheral to, the Wind Farm Area. A total of 19 stations were trawled. Grab samples were also taken. Ten species of fish were caught within the Development Area. Four species are of commercial importance. No rare or protected species were found. The report of the characterisation is included as Appendix 7.1.
NnGOWL	Neart Na Gaoithe Proposed Offshore Wind Farm and Cable Routes Geophysical Survey (EMU 2010b)	Geophysical survey of the Wind Farm Area and the Offshore Export Cable Corridor, including side scan sonar, AGDS and swath bathymetry.
Fisheries Research Services and Cefas	Fisheries Sensitivity Maps in British Waters, Coull et al. (1998)	Distribution of Spawning and Nursery Grounds in the vicinity of the Wind Farm Area
Cefas	Spawning and Nursery Grounds of Selected Fish Species in UK waters, Ellis et al. (2012)	Distribution of Spawning and Nursery Grounds in the vicinity of the Wind Farm Area
IHLS	International Herring Larvae Survey	Data derived from herring larval surveys conducted by the IHLS in the North Sea; early stage herring larvae are used as an indicator of herring spawning grounds.

7.4 Relevant Consultations

14. As part of the EIA process, NnGOWL has consulted with various statutory and non-statutory stakeholders. A formal scoping opinion was requested from MS-LOT following submission of the Scoping Report on 15 May 2017.

15. Following submission of the Scoping Report MS-LOT hosted a consultation meeting to discuss any issues relating to fish and shellfish with NnGOWL and key stakeholders on 13 June 2017. Key items raised are summarised in Table 7.2.

16. In response to NnGOWL's request, MS-LOT issued a Scoping Opinion on 8 September 2017 which included a number of issues that could not be scoped out of the assessment of potential impacts on fish and shellfish ecology. The key items raised for further consideration in respect of fish and shellfish are summarised in Table 7.2.

Table 7.2: Summary of consultation relating to Fish and Shellfish

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
13/06/2017, MS-LOT Pre-application scoping meeting	Marine Scotland Science (MSS) requested that the EIA Report should include consideration of recent publications on the distribution and migratory patterns of Atlantic salmon based on recent Atlantic salmon tagging studies. MSS also advised that recent publications on the role of electromagnetic fields on Atlantic salmon navigation should be considered.	For a review of recent publications regarding Atlantic salmon see Appendix 7.2
	MSS advised that it may be necessary to scope in impacts related to particle motion (whilst acknowledging that there is no satisfactory quantitative assessment method available); a qualitative assessment to address the potential effects of particle motion on fish and shellfish species was requested. MSS confirmed that effects on herring from pile driving noise was not a concern for the Project alone (whilst noting the increase in hammer energy proposed at the Inch Cape site).	For impacts related to particle motion see Section 7.8. Effects on herring are scoped out.
	SNH advised that it would be acceptable to SNH to scope the assessment of potential impacts on diadromous fish out of the EIA and HRA from their perspective.	On the advice of MSS, diadromous fish have been considered further in respect of updating the baseline information. See Appendix 7.2.
08/09/2017, Scoping Opinion – Scottish Ministers	The Scottish Ministers note the point raised by SFF in relation to the possible negative impacts of suspended sediment and smothering, but as gravity base structures are not going to be used for NnGOWL they consider this does not need further assessment. The Scottish Ministers agree with SFF that the information regarding the presence of scallop populations and associated catching grounds should be clarified.	Potential effects from suspended sediment and smothering are scoped out. Information on scallops and their catching grounds is presented in Chapter 10: Commercial Fisheries.
	The 2017 EIA Regulations require that the Scottish Ministers come to a reasoned conclusion, based on up to date information, on the significant effects of the Project. As the information noted above [references relating to diadromous fish ecology provided by MSS] has been published since the previous assessment, the Scottish Ministers advised NnGOWL to consider whether it changes the outcome of the Original ES and, if so, carry out a further assessment. If NnGOWL consider no further assessment is required, they must provide justification of their reasons.	For a justification for scoping out diadromous fish from the EIA, see Appendix 7.2
	The Scottish Ministers have considered the concerns raised by the River Tweed Commission (RTC) and taken into account the advice provided by MSS in relation to the behaviour of seals, and advise that this issue can be scoped out. This is based on the advice from MSS that, if salmon are present, they will be actively migrating through the site and less at risk of being predated.	Effects upon the behaviour of seals have been scoped out.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	The Scottish Ministers agree, with the exception of diadromous fish and clarification of information regarding scallop populations and catching grounds, that the existing fish and shellfish baseline and proposed updates are appropriate to the potential level of impact from the Project.	Diadromous fish are addressed within Appendix 7.2. Scallop population and catching ground information is provided in Chapter 10: Commercial Fisheries.
	The Scottish Ministers are satisfied with the embedded mitigation but note that further mitigation may be required if any concerns are raised following the outcome of the assessment on diadromous fish and particle motion.	See Chapter 17 for details of embedded mitigation. See Appendix 7.2 regarding diadromous fish.
	The Scottish Ministers agree that the potential impact of particle motion should be assessed and suggests that NnGOWL follows the approach outlined by MSS.	See Section 7.8 for the assessment of particle motion.
	The Scottish Ministers note the comments of RTC and the Forth District Salmon Fishery Board (FDSFB) and advise NnGOWL to take account of the new information available and include it in the EIA as noted above.	The new information available is detailed in Appendix 7.2.
	The Scottish Ministers agree that, with the exception of diadromous fish and particle motion, the assessment of fish and shellfish ecology receptors should be scoped out of the EIA.	For diadromous fish, see Appendix 7.2. For particle motion assessment, see Section 7.8.
	The Scottish Ministers advise NnGOWL to review the cumulative impact assessment for the Original Application to take account of the points raised in relation to particle motion and diadromous fish. If, after this review, NnGOWL considers that there is no need to update the cumulative impact assessment, they should provide justification for this decision. The Scottish Ministers note the comments of RTC and FDSFB and advise NnGOWL to take account of the new information available and include it in the EIA as noted above.	Cumulative effects are discussed in Section 7.8.4. The new information available is detailed in Appendix 7.2.
08/09/2017, Scoping – Scottish Natural Heritage	SNH confirmed that the Scoping Report provides full consideration and justification for scoping out diadromous fish species (and other qualifying interests of SAC rivers) from further assessment.	On advice of MSS, diadromous fish have been considered further in respect of updating the baseline information - See Appendix 7.2.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
08/09/2017, Scoping – Marine Scotland Science	MSS is content with regards to scoping out marine fish on the basis of the project design envelope being reduced and with the application of embedded mitigation.	The consideration of the impact of the project on marine fish species has been scoped out (with the exception of particle motion effects).
	Consideration should be given to potential changes to the Inch Cape or Seagreen design envelopes in regards to need for and scope of the CIA.	See Section 7.8.4 for the cumulative impact assessment.
	MSS provided a list of references in relation to diadromous fish and effects of particle motion on fish species to inform the assessment for the Project.	See Section 7.8 for the assessment of particle motion See Appendix 7.2 for information of diadromous fish.
08/09/2017, Scoping – East Lothian Council	ELC requested that fisheries baseline information include the species and location of fish being caught within the study area.	The commercial fisheries baseline is presented in Chapter 10: Commercial Fisheries.
	East Lothian Council have highlighted the need to consider any areas where the onshore works might contribute towards cumulative impacts.	The scope of this part of the EIA focuses on potential impacts from particle motion associated with construction and operation of the Project as agreed through Scoping, see Section 7.4. Given the distance of the onshore works to the Wind Farm Area there is no likelihood of cumulative effects from the Project affecting fish and shellfish species.
08/09/2017, Scoping – Forth District Salmon Fishery Board	FDSFB consider the information presented in the Scoping Report to be insufficient to scope out diadromous fish species. FDSFB suggested use of the Harding *et al*. (2016); Knudsen *et al*. (1996) and Malcolm *et al*. (2010).	See Appendix 7.2 for further information in relation to diadromous fish.
	FDSFB also proposed that a piling strategy informed by further assessment be considered to mitigate the risk to effects on salmonids.	See Section 0; embedded mitigation

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	Expressed concern over use of wind farms by seals and effects on salmon of increased seal predation.	The Scottish Ministers concluded in the Scoping Opinion, based on advice from MSS, that Atlantic salmon present within the Wind Farm area are likely to be actively migrating through the site and less at risk of being predated. This is scoped out of the Project EIA.
08/09/2017, Scoping – River Tweed Commission	Highlighted information relating to salmon tagging studies in Norway and records of fish returning to the east coast of Scotland indicating migrating salmon may pass through the project area.	See Appendix 7.2 for discussion of Atlantic salmon.
	The RTC concludes that diadromous fish should be scoped in to the EIA.	See Appendix 7.2 for further information regarding diadromous fish.
08/09/2017, Scoping – Scottish Fishermen's Federation	SFF believes that in areas identified as scallop and Nephrops grounds, more attention needs to be given to any possible negative impacts on these species by operations that produce suspended sediment and the potential to smother the animals or interfere with their feeding or breeding.	The Scottish Ministers agree with SFF that the information regarding the presence of scallop populations and associated catching grounds should be clarified. See Chapter 10: Commercial Fisheries. The Scottish Ministers confirmed that as the Project design envelope does not include gravity base foundations they were content with the conclusions of the Scoping Report that impacts resulting from increased suspended sediment be scoped out of the Project EIA.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	The SFF contend that habitat disturbance, suspended sediment concentration (SSC) and sediment settlement in the wind farm area must be properly defined as there is little scientific evidence to back up the claim of minor significance. Similarly, these effects also need to be assessed for the export cable, and both the windfarm and cable route need to be included in a proper assessment of the cumulative impacts with other projects.	The Scottish Ministers confirmed they were content with the conclusions of the Scoping Report that impacts resulting from increased suspended sediment should be scoped out of the Project EIA. The worst case in the Original EIA comprised gravity base foundations and impacts were assessed informed by a sediment dispersal model, with impacts found to be not significant. Gravity bases are not part of the Project and therefore impacts are considered to be lower and therefore not significant and are scoped out.

17. In summary and as set out in Table 7.2, the Scoping Opinion and justification set out in Appendix 7.2 has confirmed that (based on the scheme design as set out in the Scoping Report, and on the assumption that the embedded mitigation will be applied) that only the following matters should be scoped in to the EIA of impacts on fish and shellfish ecology:

- Particle motion resulting from increased sound pressure (noise) from pile driving activity and the construction and operation of turbines, foundations and Offshore Substation Platforms (OSPs) and sheet piling of interlocking sheets around the HDD exit point. Potential effects to be assessed for all fish and shellfish species.

18. In addition, the Scottish Ministers advised that the location of scallop populations and catching grounds should be clarified; this information is presented in Chapter 10: Commercial Fisheries.

19. The Scottish Ministers (along with SNH) have advised NnGOWL to review the updated published information relating to the behaviour of diadromous fish to ensure that the conclusions of the previous Original ES provide a robust basis for the scoping out of impacts on those species from this EIA (for the Project alone and cumulatively). This review is provided as Appendix 7.2 where justification is provided to confirm that the assessment provided in the Original ES remains valid and this aspect can be scoped out.

20. All other potential impacts on marine and diadromous fish have been scoped out of this assessment, for the Project alone and for the cumulative impact assessment, and are not considered further in this chapter.

7.5 Impact Assessment Methodology

21. This assessment considers the potential impacts associated with the construction, operation and maintenance and decommissioning of the Project and those effects on Fish and Shellfish that have been scoped into the EIA. The impact assessment process and methodology follows the principles and approach outlined in Chapter 6: EIA Methodology. For decommissioning, it is anticipated that the potential effects will be less than those for the construction due to potential for no pile driving activity

and for subsea structures / cables to be left in situ, but for the purposes of this assessment the precautionary principle is applied and the potential effects are considered to be the same as for the construction stages.

7.5.1 Assessment and Assignment of Significance

22. The sensitivities of Fish and Shellfish receptors are defined by both their potential vulnerability to an impact from the Project, their recoverability, and the value or importance of the receptor. The definitions of terms relating to Fish and Shellfish are detailed in Table 7.3.

Table 7.3: Sensitivity / importance of the environment

Receptor sensitivity / importance	Description / justification
High	Nationally and internationally important receptors with high vulnerability and no ability for recovery.
Medium	Regionally important receptors with high vulnerability and no ability for recovery. Nationally and internationally important receptors with medium to high vulnerability and low to medium recoverability.
Low	Locally important receptors with medium to high vulnerability and low recoverability. Regionally important receptors with low vulnerability and medium recoverability. Nationally and internationally important receptors with low vulnerability and medium to high recoverability.
Negligible	Receptor is not vulnerable to impacts regardless of value/ importance. Locally important receptors with low vulnerability and medium to high recoverability.

23. The magnitude of impact is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact. The definitions of the levels of magnitude used in this assessment in respect of Fish and Shellfish are described in Table 7.4.

Table 7.4: Magnitude of the impact

Magnitude of impact	Description (adverse effects)
High	The impact would affect the conservation status of the site or feature, with loss of ecological functionality. Major negative shift away from baseline conditions.
Medium	The feature’s conservation status would not be affected, but the impact is likely to be significant in terms of ecological objectives or populations. Fundamental negative shift away from baseline conditions.
Low	Minor shift away from baseline but the impact is of limited temporal or physical extent.
Negligible	Very slight change from the baseline condition.
No change	No loss or alteration or characteristics, features or elements; no observable impact in either direction.

24. The magnitude of the impact is correlated against the sensitivity of the receptor to provide a level of significance. For the purposes of this assessment, any effect that is moderate or major is considered significant in EIA terms, and would potentially require additional mitigation.

Table 7.5: Significance of potential effects

		Magnitude			
		High	Medium	Low	Negligible
Sensitivity	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

7.5.2 Uncertainty and Technical Difficulties Encountered

25. The description of spawning and nursery grounds is primarily based on the information presented in Ellis et al. (2012) and Coull et al. (1998). The limitations of these sources of information should, however, be recognised. These publications provide an indication of the general location of spawning and nursery grounds, particularly in the context of the relatively small footprint of the Wind Farm Area, based on historical data, and do not necessarily represent the location of current spawning activity.

26. Similarly, the spawning times given in these publications represent the maximum duration of spawning on a species / stock basis. In some cases, the duration of spawning may be much more contracted, on a site-specific basis, than reported in Ellis et al. (2012) and Coull et al. (1998). Therefore, where available, additional research publications have also been reviewed to provide site specific information.

27. It is also the case that mobile species, such as fish (and to some extent shellfish), exhibit varying spatial and temporal patterns.

28. In relation to the assessment process, the use of particle motion in fish and shellfish species and, particularly, the response of individual species to a given level of acoustic particle motion, as may arise from, for example, pile driving operations, is an area of incomplete knowledge. Measurement of acoustic particle motion at sea is an area of emerging science and there is yet to be a means of modelling the acoustic particle motion arising from offshore wind farm construction or operation in the way that can be done for the sound pressure component of underwater noise. This is acknowledged in the Scoping Opinion by Marine Scotland *"… understanding of the effects from particle motion, and extent of these effects, is currently an area for further development, and there are various initiatives being progressed."*

29. As a result, MSS advised that the following approach be taken to the assessment of acoustic particle motion:

- Provide an overview of currently available information on particle motion within the vicinity of noise producing construction and operational activities – both within the water column and the seabed. This should include consideration of the likely distances at which elevated levels of particle motion may be detected;
- Provide an overview of the published information on sensitive species and potential physiological and behavioural effects of particle motion;
- Consider the potential effects of particle motion on species known to occur around the Wind Farm Area, making use of information on species distribution from the Original ES and information which has become available since then. Particular attention should be given to potential effects on species of commercial or conservation concern; and

- Provide information on opportunities that the Project may present to investigate effects of particle motion on fish and invertebrates.

7.6 Baseline Description

7.6.1 Uncertainty and Technical Difficulties Encountered

30. The following sections present a description of the baseline characteristics that are relevant to those issues scoped into the EIA, which comprise an assessment of particle motion in relation to construction and operation within the Wind Farm Area for all fish and shellfish species (see Section 7.4). The baseline information presented here identifies these key species, their sensitivities.

31. A review of recently published information regarding the ecology of diadromous fish species and the most up to date position on migration routes, behaviour at sea and responses to noise and EMF is provided separately in Appendix 7.2 in response to the requirements set out in the Scoping Opinion (see Section 7.4).

7.6.2 Overview

32. The following section presents an overview of the main fish and shellfish species that are characteristic of the central North Sea, with particular regard to the southeast Scotland region, as described by Barne et al. (1997). This region encompasses the Wind Farm Area and the Firth of Forth, the seaward boundary of which falls between Fife Ness and Dunbar (Eleftheriou et al., 2004).

33. The North Sea comprises two main fish assemblages located above and below the 50 metre (m) depth contour, respectively. A third, minor assemblage occurs in the far north around the 200 m depth line (Calloway et al., 2002). The sea around the southeast Scotland region is considered part of the Central North Sea (ICES Division IVb) (Cefas, 2001). This region comprises fish assemblages that are strongly depth and temperature related, made up of shallower pelagic (50 - 100 m water depth) and deeper demersal (100 - 200 m water depth) species groups.

34. The southeast Scotland region hosts important inshore populations of shellfish, the distribution of which is highly influenced by the substratum type, as these highly sedentary organisms have habitat specific requirements. Shellfish (as with fish species) are of considerable ecological value as prey species for a number of marine mammals and birds. In addition, they represent a source of revenue for the commercial fishing industry (see Chapter 10: Commercial Fisheries).

35. The water depth across the Wind Farm Area ranges between 40 m and 58 m relative to Lowest Astronomical Tide (LAT), with the deeper water in the north and west of the site. Geophysical and geotechnical surveys at the Wind Farm Area indicate that seabed conditions are similar to much of the surrounding North Sea region and are generally characterised by slightly gravelly sand sediments with small amounts of silt, characterised by typical mud and sand fauna with prominent mounds and burrows produced by megafauna. The seabed within the Wind Farm Area includes a series of interspersed mounds, each approximately 1 km across and up to 6 m higher than the surrounding sea bed, comprised of areas of mixed coarse sediment cobbles and boulders representing exposed Wee Bankie formation.

36. Similar fish and shellfish communities exist within the Wind Farm Area and surrounding Firth of Forth (EMU, 2010). The shrimp species *Crangon allmani* and *Pandalus montagui* dominate the catch composition across this area with American plaice, gobies and dab accounting for the most common fish species. No particular distributional trends have been observed. The mobile epibenthic assemblages recorded during the beam trawl sampling (EMU, 2010) were found to be more characteristic of the Southern North Sea but concur with the findings of historic surveys in the area (Calloway et al., 2002 & Jennings et al., 1999).

37. A number of species (Table 7.6) are potentially present within the Wind Farm Area and surrounding areas as informed through review of the Original ES, a literature review (including data from Ellis et al. (2012), Greenwood and Hill (2003), Greenwood et al. (2002) and Coull et al. (1998)), site-specific surveys and through consultation with local fishery stakeholders (refer to Chapter 10: Commercial Fisheries).

Table 7.6: Species potentially present within the Wind Farm Area

Group / Species	
Pelagic	
Mackerel (*Scomber scombrus*) [2] **Sprat (*Sprattus sprattus*)** Blue whiting (*Micromesistius poutassou*) [2 3] **Herring (*Clupea harengus*)** [2 3]	Atlantic salmon (*Salmo salar*) [1 2 3] Sea trout (*Salmo trutta*) [2 3] Shad (*Alosa spp.*) [1 3] Basking shark (*Cetorhinus maximus*) [2 3]
Inshore / Coastal Species	
Catfish (Anarhichas lupus) Gobies (Gobidae) [2 (only sand goby)] Greater pipefish (Syngnathus acus)	Scaldfish (*Arnoglossus laterna*) Four-bearded rockling (*Rhinonemus cimbrus*) Wrasses (*Labrus spp.*)
Demersal	
Whiting (*Merlnagius merlangus*) [2 3] **Lemon Sole (*Microstomus kitt*)** **Plaice (*Pleuronectes platessa*)** [3] **Turbot (*Scophthalmus maximus*)** **Halibut (*Hippoglossus hippoglossus*)** [2 3] **Dab (*Limanda limanda*)** **American plaice (*Hippoglossoides platessoides*)** **Megrim (*Lepidorhombus whiffiagonis*)** **Witch (*Glyptocephalus cynoglossus*)** **Sole (*Solea solea*)** [3] **Brill (*Scophthalmus rhombus*)** Haddock (*Melangrammus aeglefinus*) Hake (*Merluccius merluccius*) [3] Saithe (*Pollachius virens*) [2] Ling (*Molva molva*) [2 3]	**Sandeels (*Ammodytes spp.*)** [2 3] Gurnards – Red (*Aspitrigla cuculus*) Gurnards – Grey (*Eutrigla gurnardus*) Red Mullet (*Mullus barbatus*) Monks or Anglers (*Lophius spp.*) [2 3] Dogfish (*Scyliorhinus canicular*) Tope (*Galeorhinus galeus*) [3] Thornback Ray (*Raja clavata*) [3] Blonde Ray (*Raja brachyura*) Cuckoo Ray (*Raja naevus*) Pollack (*Pollachius pollachius*) Cod (*Gadhus morhua*) [2 3] Bass (*Dicentrarchus labrax*) Conger Eels (*Conger spp*) Long rough dab (*Hippoglossoides platessoides*)
Shellfish	
Norwegian Lobster (*Nephrops norvegicus*)	Queen Scallops (*Aequipecten opercularis*)

Lobster (*Homarus gammarus*)	Razor Clam (*Ensis spp*.)
Brown crab (*Cancer pagurus*)	Clams (*Mya arenaria*)
Green Crab (*Carcinus maenus*)	Whelks (*Buccinum undatum)*
Squat Lobster (*Munida rugosa*)	Shrimp species (*Crangon spp., Pandalus montagui*)
Velvet swimming crab (*Necora puber*)	Squid (*Loligo spp*.)
King scallops (*Pecten Maximus*)	
Key to Conservation Status	
1. Habitats Regulations and Offshore Habitats Regulations Schedule 3 Species. 2. Scottish PMF's. 3. SBL species.	

7.6.3 Pelagic Species

38. Pelagic fish inhabit the water column including the near surface. Their distribution and abundance is strongly affected by hydrographic conditions and can vary significantly from year to year. The principal pelagic species found in the region are typical of the wider North Sea and include herring, sprat, mackerel and whiting.

39. These species are commercially exploited in the wider region (see Chapter 10: Commercial Fisheries) and sprat and herring can also play an important ecological role as principal prey items for several larger fish species, marine birds and mammals.

7.6.3.1 Spawning Areas

40. Data from Ellis et al. (2012) and Coull et al. (1998) indicate that sprat and herring spawn in the southeast Scotland region (Figure 7.1 (Volume 2). The Wind Farm Area does not coincide directly with the sprat or herring spawning areas but they are located to the east (for sprat) and to the north and south (for herring). Adult spawning herring are highly sensitive due to their specialist hearing capabilities, but are also susceptible to particle motion due to the presence of their swim bladder and its connection to the hearing system. Consideration of the more contemporary and detailed information provided by the ICES International Herring Larvae Survey (IHLS) data, conducted over the last ten years (Figure 7.2 (Volume 2)) confirms that herring spawning activity has been centred to the north of the Wind Farm Site off the Aberdeenshire coast and shows no evidence of spawning activity in the vicinity of the Wind Farm Area. MS-LOT has advised during scoping that there will be no potential effects upon these spawning areas or on the Buchan or Orkney / Shetland herring stocks. Some data (Ellis et al, 2012) suggests that whiting spawning grounds may occur near to the Wind Farm Area and although not affected directly by the Project, it is possible that larval draft may result in the presence of eggs / larvae within the Wind Farm Site (whiting eggs in the pelagic stage are of conservation interest (Table 7.7) are protected).

7.6.3.2 Nursery Areas

41. Data from Ellis et al. (2012) and Coull et al. (1998) further indicate that herring, sprat and mackerel nursery areas overlap with the Wind Farm Area as shown (Figure 7.1 (Volume 2) and Figure 7.3 (Volume 2)). Whiting nursery areas are present to the east of the Wind Farm Area (Figure 7.3 (Volume 2)).

42. Coull et al. (1998) found sprat to be ubiquitous across the region and around the UK during nursery periods. It also noted that data for specific nursery periods are not readily available as *"nursery grounds for most fish species are dynamic features of life history"* (Cefas, 2001).

7.6.3.3 Vulnerabilities and Seasonal Sensitivities

43. Sensitivity data for the specific pelagic species considered here are relatively sparse as is an understanding of how individual fish actually respond to underwater noise in terms of reaction and behavioural responses. However, research shows that the main issues for pelagic fish species are noise and SSC levels (in turn affecting water quality). The relative mobility of pelagic fish may allow localised avoidance of some impacts such as suspended sediments (Birklund and Wijsman, 2005), however suspended sediments can settle and smother habitats or spawn / eggs and affect recruitment to a fish population (e.g. herring have very specific spawning bed requirements). For other pelagic species, such as mackerel or herring, raised sediment levels may also cause avoidance behaviour or communication issues (e.g. affect shoaling behaviour). Man-made noise introduced to the marine environment causes sound pressure waves which can affect the hearing capabilities of fish species with swim bladders, but sound waves can also cause particle waves (or particle motion) which can be detected by a wider range of fish and invertebrates.

44. Effects such as sound pressure changes can be detected at relatively long distances. Herring, unlike most other fish, have specialised adaptations connecting the swim bladder and oesophagus to the inner ear, which classifies them as ‘hearing specialists’. These morphological adaptations make them one of the most sensitive fish species to sound pressure (ICES, 2006a). They are also however, susceptible to particle motion.

45. Table 7.7 details the key pelagic species, their conservation status and seasonality of spawning activity. A brief summary of herring biology with regard to the North Sea population is presented below, with a view to identifying species key life stages likely to be particularly sensitive to sound pressure and particle motion.

Table 7.7 Seasonal sensitivities and conservation importance for key pelagic species

	Seasonal Spawning Activity												
Name	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Notes on conservation importance**
Mackerel *S.scombrus*					spawning	spawning	spawning	spawning					Scottish Priority Marine Feature (PMF) and UK BAP species
Herring *C.harengus*								spawning	spawning				PMF (juveniles and spawning adults); and Scottish Biodiversity list; and UK BAP species
Sprat *S.sprattus*					spawning	spawning	spawning	spawning					PMF; and UK BAP species
Whiting *M.merlangus* (NB. pelagic at egg stage only)	spawning	spawning	spawning	peak spawning	peak spawning	spawning	spawning	spawning					Scottish Nature Conservation Marine Protected Area (MPA) search feature (juvenile); and Scottish Biodiversity List; and PMF (juveniles); and UK BAP species

(dark)	peak spawning
(medium)	spawning

46. Herring is a pelagic species, which is abundant in the summer and autumn throughout the southeast Scotland region (Robson, 1997). Breeding takes place on the seabed within specific habitat types, where there is a low proportion of fine sediment and in well oxygenated water (Ellis et al., 2012). Their eggs, which have adhesive qualities, sink through the water column and onto the seabed. Herring have historically been reported to exhibit natal spawning site fidelity that results in predictable patterns of migration to and from spawning grounds (McPherson et al., 2001). This spawning fidelity, together with the predictable nature of spawning, has been shown to take place in discrete groups (McPherson et al., 2001).

47. Most authors distinguish four major spawning groups within the North Sea defined by distinct spawning times and sites (Payne, 2010). Those that spawn off the east of Scotland are known as the Orkney/Shetland and Buchan components. The Orkney-Shetland component spawns in August/September between the Islands that give it its name; the Buchan component to the east of Scotland in September/October. Some authors consider Buchan/Shetland as one component (Ellis et al., 2012; Cefas, 2001), spawning between August and September (Cefas, 2001).

48. In the context of the current study, the spawning period has been considered to extend from August to October with peak activity in September (Table 7.7). Natural variability in the timing of spawning is to be expected (Payne, 2010), owing to year to year changes of environmental conditions at the time of egg development and larval hatch, as well as changes in the timing of emergence of eggs and larvae or a combination of both (Wieland et al., 2000).

7.6.4 Demersal Species

49. Demersal fish are bottom feeders that live on or near the seabed. In coastal waters, they are found on or near the continental shelf whereas in deep waters they are more associated with the continental slope or continental rise. Their distribution is related to abiotic factors such as sediment type (which is usually important as a refuge in predation avoidance or for cryptic behaviour), hydrography, biotic processes (e.g. predator-prey interactions) and competition for space. Demersal species found in the region include gadoids (soft finned fish species of the family Gadidae), flatfish, sandeel and elasmobranchs.

7.6.4.1 Spawning Areas

50. Data from Ellis et al. (2012) and Coull et al. (1998) indicate that several demersal round and flatfish species spawn in the region surrounding the Wind Farm Area. Figure 7.3 (Volume 2) shows spawning grounds for whiting, Figure 7.4 (Volume 2) for cod and Figure 7.5 (Volume 2) for lemon sole and plaice, all of which spawn in the region.

51. Many demersal species, such as plaice, have buoyant eggs that are released into the water column where they remain for several weeks until the pelagic larvae emerges (van Damme et al., 2011).

52. There are five species of sandeel in the North Sea, though the majority of commercial landings are of *Ammodytes marinus* (Cefas, 2001). Sandeel occur in the southeast Scotland region and are abundant on the series of sandbanks that lie at about 30 - 50 kilometres (km) offshore of the coast, including the Berwick Bank, Scalp Bank, Montrose Bank and Wee Bankie (Robson, 1997). Ellis et al 2012 fish sensitivity maps show that there are high intensity sandeel spawning areas present within the Wind Farm Area.

53. Sandeel generally inhabit shallow turbulent sandy areas with a high percentage of medium to coarse grained sand (particle size 0.25 - 2 millimetres (mm)) (Greenstreet et al., 2010). Sandeel are considered to have highly specific habitat requirements, requiring well flushed tidally active areas (Wright et al., 2000) with current flows greater than 0.6 m s^{-1} (Jensen et al., 2011).

54. Results of site-specific surveying and analysis using recommendations outlined in Greenstreet et al. (2010) indicated that due to the relatively high mud content, the habitats within the Wind Farm Area are unlikely to support a substantial sandeel spawning population. Results of the faunal analyses showed that the total number of sandeel recorded was very low (five individuals were captured across the entire survey area) (See Appendix 7.1).

55. Elasmobranch species produce relatively small numbers of live young (10 - 100 per year) or lay eggs on the seabed close to their nursery areas (Robson, 1997). Several species of elasmobranchs have been reported in the region, namely spurdog, lesser spotted dogfish, thornback ray, cuckoo ray and tope (Ellis et al., 2010; Robson, 1997). Basking sharks have also been reported. Several elasmobranchs are recognised as of conservation importance (particularly basking shark) and some are targeted by commercial or recreational fishermen.

56. The distribution of elasmobranch breeding grounds, in relation to the Wind Farm Area is presented in Figure 7.7 (Volume 2). The breeding grounds of both spotted ray and skate occur outside the Wind Farm Area. With respect to the spurdog and the tope, both species' breeding grounds coincide with the Wind Farm Area.

57. The seasonality of elasmobranch breeding is summarised in Table 7.9.

7.6.4.2 Nursery Areas

58. Data indicate that high intensity nursery areas for cod (Figure 7.4 (Volume 2)) and low intensity nursery areas for lemon sole and plaice (Figure 7.5 (Volume 2)) and blue whiting and ling (Figure 7.6 (Volume 2)) overlap with the Wind Farm Area. There are also low intensity nursery areas for sandeel recorded within the fish sensitivity maps (Ellis et al, 2012).

59. Table 7.8 summarises the spawning seasonality of some of the key demersal species.

7.6.4.3 Vulnerabilities and Seasonal Sensitivities

60. Adult spawning demersal fish and shellfish are susceptible to particle waves that are created from sound pressure waves (noise), as even fish and shellfish that do not possess swim bladders can detect these potential effects. Such sound and particle waves can result in adults avoiding or being driven away from their regular spawning areas, resulting in failed spawning or reduced survival of eggs that are laid within unsuitable habitat conditions due to displacement and disturbance of usual spawning activity. This type of sensitivity is restricted to certain times of the year however, during key spawning periods.

61. Juvenile fish are also susceptible to particle motion and their behaviour may also be affected within their key nursery grounds and as a result, their survival rates may potentially be affected. The level of these types of effect are not however currently fully understood.

Table 7.8: Seasonal sensitivities and conservation importance for key demersal species

	Seasonal Spawning Activity												
Name	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Notes on conservation importance**
Cod *G.morhua*													Scottish Nature Conservation Marine Protected Area (MPA) search feature; Scottish Biodiversity list; Scottish Priority Marine Feature (PMF) and UK BAP species; listed as vulnerable on the IUCN red list; and OSPAR species.
Whiting *M.merlangus*													Scottish Nature Conservation Marine Protected Area (MPA) search feature (juvenile); Scottish Biodiversity List; PMF (juveniles); and UK BAP species.
Ling *M.molva*													Scottish Biodiversity List; PMF; and UK BAP species.
Plaice *P.platessa*													UK BAP species
Lemon sole *M.kitt*													
Blue whiting *M.potassou*													UK BAP species
Sandeels *Ammodytes spp.*													Scottish Nature Conservation Marine Protected Area (MPA) search feature; and PMF.
	peak spawning												

	Seasonal Spawning Activity												
Name	J	F	M	A	M	J	J	A	S	O	N	D	Notes on conservation importance
	spawning												

Table 7.9: Seasonal sensitivities and conservation importance for key elasmobranch species

	Seasonal Spawning Activity												
Name	J	F	M	A	M	J	J	A	S	O	N	D	Notes on conservation importance
Spurdog (or spiny dogfish) *S.acanthius*													Scottish Nature Conservation Marine Protected Area (MPA) search feature; OSPAR species; listed as critically endangered on the IUCN red list.
Basking shark *C.maximus*													Listed under several international conventions as of conservation importance including: EC Habitats Directive Annex V species; listed as vulnerable on the IUCN red list; Barcelona convention listed species (Annex II); Bern convention listed species (Appendix IIb); and Convention on migratory species/Bonn convention list species (Appendix I and IId)
Tope *G.galeus*													Listed as vulnerable on the IUCN red list; and UK BAP species.
	spawning												

7.6.5 Diadromous Fish

62. Diadromous species are migratory fish moving between the sea and freshwater (or vice versa) for breeding/spawning purposes. They spend a significant period of their life cycle in both freshwater and seawater habitats. There are two types of diadromous fish: anadromous and catadromous. Anadromous fish are those that spend the majority of their lives at sea, but specifically move upstream to freshwater to breed and spawn e.g. Atlantic salmon. Conversely catadromous fish are those that move from freshwater to the sea to spawn e.g. the European eel.

7.6.5.1 Spawning Areas

63. There are no spawning areas within, or immediately surrounding the Wind Farm Area. The nearest Atlantic salmon and sea trout spawning areas are within the network of rivers that feed into the Firth of Forth.

7.6.5.2 Nursery Areas

64. Similar to spawning areas, there are no nursery areas within, or immediately surrounding the Wind Farm Area.

65. Although no diadromous species have nursery or breeding areas directly in the vicinity of the Wind Farm Area, they are known to travel through the Forth and Tay area en route to and from their natal rivers. Anadromous species may spawn or have nursery areas in the lower estuary (e.g. shad) or in fully freshwater rivers (e.g. salmon and sea trout), whereas catadromous species (e.g. eel) will pass through the Firth of Forth on their way to their oceanic spawning grounds.

66. The following diadromous species are known to be present in the Firth of Forth region, although in small numbers (Greenwood et al., 2002) and may therefore be present in and around the Wind Farm Area:

- Atlantic salmon;
- Sea trout;

- European eel;
- Smelt / sparling;
- River lamprey;
- Sea lamprey;
- Allis shad; and
- Twaite shad.

67. A review of the migratory habits of Atlantic salmon is provided in Appendix 7.2. In summary, Atlantic salmon may be present within the Development Area at certain times of the year. Atlantic salmon spawn in Scottish east coast rivers before migrating to remote feeding grounds. Adult Atlantic salmon return to natal rivers to spawn after one or more winters at sea. Atlantic salmon's use of the Development Area is thought to be transitory in nature with individuals migrating predominately in surface waters although studies have observed individuals using the full water column (Godfrey et al., 2015). Returning adults have been observed migrating along coastal waters in a northerly direction when migrating to Scottish east coast rivers although evidence is limited (Malcolm et al., 2010). Smolts have been observed to undergo rapid and active migration towards open marine areas within the uppermost surface waters (Finstad, et al., 2005; Lothian, et al., 2017; Thorstad et al., 2007). A full review of the current understanding of Scottish salmon migratory behaviour is presented in Appendix 7.2.

7.6.5.3 Vulnerabilities and Seasonal Sensitivities

68. The migratory behaviour of diadromous species means that they have the potential to be sensitive to certain impacts arising from the construction of the Project, specifically pile driving noise. During operation they may be sensitive to EMF generated by subsea cables where the migration occurs in close proximity to the Project, or in such a way that the migratory behaviour might be disturbed. This might have secondary impacts in relation to the success of individuals migrating to or from their spawning sites (for example, by interfering with the migration of returning adult salmon to their natal rivers such that their spawning success is somehow reduced).

69. Table 7.10 summarises the key seasonal sensitivities (related to migratory periods) and the conservation status of the named diadromous species.

Table 7.10: Seasonal sensitivities and conservation importance of diadromous species

	Timing of migration to and from natal rivers												
Name	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Notes on conservation importance**
Atlantic salmon *Salmo salar*[1]													EC Habitat Directive Annex II and V (and transposed regulations) species; Qualifying feature of the River South Esk, River Tay and River Teith Special Areas of conservation (SACs) with varying conservation objectives and statuses as part of these sites (see SNH, 2012); Scottish Nature Conservation MPA search feature (marine life stages); Priority Marine Feature Scottish Waters (Marine part of life cycle).UK BAP species; Bern Convention Appendix 3; OSPAR species; Scottish Biodiversity List;
Sea trout *Salmo trutta*													Scottish Nature Conservation MPA search feature (marine life stages); and UK BAP species.
European eel *Anguilla anguilla*													IUCN Red List critically endangered; OSPAR species; and PMF (marine part of life cycle).
Smelt/sparling *O.eperlanus*													UK BAP species; Scottish Biodiversity List species; and PMF (marine part of life cycle).
River lamprey *Lampetra fluviatilis*													EC Habitat Directive Annex II and V (and transposed regulations) species; Qualifying feature for River Tay SAC; Bern Convention, Appendix 3; Habitat Regulations, Schedule 3; Scottish Biodiversity List species; and PMF (marine part of life cycle).
Sea lamprey *Petramyzon marinus*													EC Habitat Directive Annex II and V (and transposed regulations) species; Qualifying feature of River Tay SAC; UK BAP species; OSPAR species; Scottish Biodiversity List species; and PMF (marine part of life cycle).
Allis shad *Alosa alosa*													EC Habitat Directive Annex II and V (and transposed regulations) species; Qualifying feature of a number of Special Areas of Conservation (SACs) in the region; UK BAP species; Bern Convention, Appendix 3; Habitat Regulations, Schedule 3; and Scottish Biodiversity List species.
Twaite shad *Alosa fallax*													Conservation information as per Allis shad.
	Main migratory period												

[1] The peak timing of migrations reflects periods of peak post-smolt emigration and periods of peak returning MSW salmon, however, the Scottish salmon stock is known to enter natal rivers over a broader period and may therefore be present within the Development Area throughout the year, the impact assessment has been undertaken on this basis.

7.6.6 Shellfish

70. A number of commercially important shellfish species have been recorded within the Wind Farm Area. The commercial species most commonly targeted within the Wind Farm Area are Nephrops, lobster and brown crab, which accounts for over 90% of commercial landings by value. All of these shellfish species are potentially affected by particle motion resulting from increased noise (sound pressure waves).

71. The southeast Scotland region hosts important inshore populations of European lobster *Homarus gammarus*, edible crab *Cancer pagurus*, common mussel *Mytilus edulis*, and large offshore populations of Norway lobster *Nephrops norvegicus* (commonly referred to as Nephrops) and king scallops *Pecten maximus*. Queen scallops *Aequipecten opercularis* are present in a large area off the coast of the region and around the Isle of May, but not in exploitable quantities (Robson, 1997).

7.6.6.1 Spawning and Nursery Areas

72. Female lobsters reach sexual maturity when they are 75-85 mm (5-7 years old), whereas males mature at a slightly smaller size (Beard and McGregor, 2004). Mating occurs in the summer and berried females (those carrying the eggs) begin to appear from September to December in all areas where lobsters are present (Pawson, 1995). The eggs can be carried up to 12 months depending on the water temperature (Beard and McGregor, 2004), before hatching in spring and early summer (Pawson, 1995). Hatching occurs at night and larvae swim to the surface where they drift with the currents. This stage lasts for 15 to 35 days and involves three moults. After the third moult, the juveniles take on a form close to that of the adults and adopt a benthic lifestyle (Beard and McGregor, 2004). The main lobster nurseries are found on rocky grounds in coastal waters (Beard and McGregor, 2004).

73. Female crabs move inshore in late spring to moult and shortly afterwards they mate. After mating, the females move offshore in late summer or autumn, against the prevailing current to ensure that after spawning the larvae can drift back to the coastal nursery area. The berried females rarely feed or move; instead, they lay in pits dug in the sediments or under rocks. In late spring/early summer, the larvae are released into the water column where they remain in pelagic form for two months before settling as juveniles in the intertidal zone in late summer/early autumn (Pawson, 1995).

74. Nephrops do not travel far from their burrows and as a result, the distribution of spawning and nursery grounds coincide with the adult population. Females mature at about three years old and from then on carry eggs each year from September to April or May. After hatching, the larval stage lasts 6 to 8 weeks, before settlement to the seabed (Cefas, 2001). The distribution of Nephrops spawning and nursery grounds in relation to the Wind Farm Area and the North Sea is shown in Figure 7.8 (Volume 2). Marine Scotland (2017) has reported an increase in Nephrops stock abundance within the Firth of Forth functional unit between 2013 and 2015 with the stock being harvested above the maximum sustainable yield.

75. Scallops are sedentary for most of their life cycle; hence, their spawning areas correspond with the areas of adult distribution (Pawson, 1995). There is considerable regional variation in the time of spawning; in Scottish waters, spawning occurs in the spring and in the autumn (Cefas, 2001). It is speculated that a minimum density of spawning adults may be necessary to ensure good recruitment of juvenile scallops; consequently, productive spawning areas may be more restricted than the overall distribution of the species (Pawson, 1995). Scallop landings in the vicinity of the Wind Farm Area are limited with the scallop fleet focusing effort to the north and east of the Wind Farm Area (See Chapter 10: Commercial Fisheries).

76. Concentrations of squid *Loligo forbesi* occur seasonally along the southeast coast of Scotland, particularly within the kelp aggregations around the Isle of May, which also offer shelter to fish and crabs. Squid reach sexual maturity at about one year of age. They mainly reproduce only once during their limited lifespan of one to two years although they occasionally live up to three years. Breeding

occurs yearly from autumn through to spring. At night, females lay up to 100,000 eggs in colourless capsules attached to the seafloor (Taylor, 2002). Winter breeding cohorts spawn in inshore waters and some evidence suggests that spawning grounds of the summer breeders may also be inshore (Viana et al., 2009). The embryonic development stage lasts approximately 30 days after which the young squid hatch. The young maintain a vertical body structure for a period of time, floating and drifting passively. Growth occurs rapidly during the summer and the species reaches sexual maturity between June and October (Taylor, 2002).

77. Razor shells (*Ensis spp*.) occur in the inshore areas of the Firth of Forth where the seabed is clean sand (Robson, 1997). The presence of potentially exploitable burrowing bivalve molluscs such as razor shells has been reported to occur at various sites around the southeast coast of Scotland (Robson, 1997).

78. Two resident shrimp species, brown shrimp *Crangon crangon* and pink shrimp *P. montagui*, and a migrant species, *C. allmani*, have been identified as the main three species of shrimp in the Firth of Forth (Jayamanne, 1995), whereas crawfish *Palinurus elehas* are reported as being uncommon (Robson, 1997). *C. crangon* has been recorded throughout the estuary, while the pink shrimp occurred in the lower reaches of the estuary (Jayamanne, 1995). This is reflected in the site-specific surveys with brown and pink shrimp dominating the beam trawl catch data within the study area.

79. Inshore bedrock and rocky habitats also support velvet swimming crab *Necora puber*. In northwest Scotland, the main spawning period is reported to start in March with all berried females recorded in June carrying eggs at the hatching stage. No berried females are reported to occur between July and January (Bakir and Healy, 1995).

80. Mussels are found around most of the east coast of Scotland, from the mid shore to the subtidal zone (Robson, 1997). Important areas for mussels around this region include the Montrose Basin, the south shores of the Firth of Tay at Tayport, the Eden Estuary and the south shore of the Firth of Forth (Robson, 1997). Intertidal rocky habitats support the winkle *Littorina littorea*.

81. Ocean quahog *Arctica islandica*, the bivalve mollusc *Devonia perrieri* and the gastropod *Simnia patula* are also known to occur in the North Sea within Scottish waters (SNH, 2011).

7.6.6.2 Vulnerabilities and Seasonal Sensitivities

82. Although shellfish do not possess swim bladders, a literature review suggests that marine shellfish are potentially affected by particle motion, particularly as they are not as mobile as fish species and cannot alter their behaviour to avoid particle motion (e.g. by fleeing behaviour). The effects of particle motion on shellfish is not yet fully understood and therefore shellfish are considered vulnerable at all life stages.

7.6.7 Summary of Sensitive Fish Species

83. As outlined above, many species of fish and shellfish are known to value the seabed habitats in relatively close proximity to, or potentially overlapping with the Wind Farm Area for the purposes of spawning or for use as nursery areas for juvenile life stages (Coull et al., 1998; Ellis et al., 2012). Adult spawning fish could potentially be affected by particle motion, which could influence behaviour and affect spawning activity and success.

84. Spawning activity is summarised as follows:

- Three species have spawning areas that directly overlap the Wind Farm Area; these are plaice, lemon sole and Nephrops (Coull et al., 1998);
- Ellis et al., (2012) report low intensity spawning areas overlapping the Wind Farm Area for plaice, lemon sole, mackerel, blue whiting and ling;
- Coull et al. (1998) reports spawning areas overlapping the Wind Farm Area for Nephrops, spurdog and tope (undetermined intensity); and

- High intensity nursery areas are reported to overlap the Wind Farm Area for whiting, cod and herring (Ellis et al., 2012).

7.6.8 Development of Baseline Conditions without the Project

85. Mobile species, such as fish and some shellfish species, exhibit varying spatial and temporal patterns. Short term trends often exhibit fluctuations in fish and shellfish stock abundance often in response to abiotic factors and / or fishing pressure. It is anticipated that in the absence of the Project, fish and shellfish abundance in the region would be anticipated to fluctuate within its natural range unless affected by changes in fishing behaviour. There are unlikely to be any major changes in seabed habitats and therefore the species present within the study area are unlikely to experience any fundamental shift in species composition.

86. Recent research has suggested that there have been substantial changes in the fish communities in the northeast Atlantic over several decades as a result of a number of factors including climate change and fishing activities (DECC, 2016).

87. Climate change may influence fish distribution and abundance, affecting growth rates, recruitment, behaviour, survival and response to changes of other trophic levels. Within the North Sea, increased sea surface temperatures may lead to an increase in the relative abundance of species associated with more southerly areas, whilst other fish species will extend their distribution into deeper, colder waters where habitat exists to allow them to do so. Climate change may also affect key life history stages of fish and shellfish species, including the timing of spawning and migrations. However, climate change effects on marine fish populations are difficult to predict, and the evidence is not easy to interpret and therefore it is difficult to make accurate estimations of the future baseline scenario for the entire lifetime of Project.

88. Overfishing subjects many fish species to considerable pressure, reducing the biomass of commercially valuable species, and non-target species. Overfishing can reduce the resilience of fish and shellfish populations to other pressures, including climate change and other anthropogenic impacts. There are indications that overfishing in UK waters is reducing to some degree, with declines in fishing mortality estimates in recent years and ICES advice suggesting that some of the stocks are recovering, with increased quotas for several species in 2016. However, OSPAR's Quality Status Report (OSPAR, 2010) concluded that many fish stocks are still outside safe biological limits, although there have been some improvements in some stocks. Should these improvements continue, this may not result in significant changes in the species assemblage in the vicinity of the Project, although may result in increased abundances of the characterising species present in the area.

89. The fish and shellfish baseline characterisation described in the preceding sections represents a 'snapshot' of the fish and shellfish assemblages in the area, within a gradual and continuously changing environment. Any changes that may occur during the lifetime of the Project (i.e. construction, operation and decommissioning) should be considered in the context of the natural variability and anthropogenic effects, including climate change, overfishing and other environmental impacts.

7.7 Design Envelope – Worst Case Design Scenario

90. The Project application is for the construction, operation and decommissioning of an offshore wind farm with an output of up to 450 MW, comprising of up to 54 turbines.

91. The assessment scenarios identified in respect of Fish and Shellfish Ecology have been selected as those having the potential to represent the greatest effect on an identified receptor based on the design envelope described in Chapter 4: Project Description. The worst-case design scenarios are set out in Table 7.11 and in relation to those issues scoped into this EIA.

Table 7.11: Design envelope scenario assessed

Potential Impact	Worst Case Design Scenario	Justification
Construction (and Decommissioning)		
Disturbance or injury as a result of particle motion arising from pile driving	Installation of 54 turbine jackets comprising of up to 6 piles per jacket and 2 OSP jackets comprising of up to 8 piles per jacket and one met mast comprising of up to 4 piles per jacket. Total number of piles: up to 344 Driven only piles: 0 – 10% Drill-drive-drill / drill only pile: 90 – 100% Absolute maximum hammer energy of 1,635 kJ Pile Driving time for 6 piles: 6 – 21 hours. Pile driving to occur over a 15 month (maximum). If concurrent piling takes place, piling will be completed within a maximum of 9 months.	The maximum worst case design scenario equates to the greatest likely effect from particle motion with respect to both spatial and temporal coverage, i.e. maximum hammer energy for the greatest period of time.
Disturbance from noise and particle motion arising from the HDD pipe site works	Installation of interlocking steel sheets being lifted in to place by an excavator and being sheet piled – with the potential for noise generated by this installation operation.	The worst-case scenario considers the piling element of installation taking place over a number of days at the HDD exit point relatively close to shore.
Operation		
Disturbance resulting from particle motion arising from turbine operation	Operation of up to 54 turbines	It is assumed that the greatest operational noise will result from the maximum number of turbines.

7.7.1 Embedded Mitigation

92. A number of mitigation options, both embedded and for implementation, were identified within the design envelope for the Originally Consented Project, during the consultation phase of the Original Application and during the on-going liaison with stakeholders and MS-LOT. As set out in the Scoping Report (and as summarised in Chapter 5: Scoping and Consultation) these have been adopted into the Project design as the design envelope has evolved.

93. Those embedded mitigation measures that are relevant to the potential impacts on Fish and Shellfish that have been captured within the design envelope for the Project are:

- Inter-array, interconnector and Offshore Export Cables will be suitably buried or will be protected by other means when burial is not practicable. This will reduce the potential for effect and exposure of electromagnetically sensitive species to the strongest electromagnetic fields (EMF);
- To minimise the extent of any unnecessary habitat disturbance, material displaced as a result of cable burial activities will be back filled, where necessary, in order to promote recovery; and
- Cable specifications will be used that reduce EMF emissions as per industry standards and best practice such as the relevant IEC (International Electrotechnical Commission) specifications.

7.7.2 Anticipated Consent Conditions Commitments

94. A number of consent conditions were attached to the Consents to manage the environmental risk associated with the Originally Consented Project. NnGOWL anticipates that any future consents issued to the Project may incorporate similar conditions to manage the risk to fish and shellfish receptors commensurate with the Project design envelope, where it remains necessary to do so. Table 7.12 sets out the conditions attached to the Consents which have some relevance to the management of effects on Fish and Shellfish Ecology.

Table 7.12: Original Consent Requirements relating to Fish and Shellfish

Mitigation Measure	Deliverable
Piling Strategy	Setting out, for approval, the pile driving methods, in accordance with the Application and detailing associated mitigation incorporating data collected as part of pre-construction survey work to demonstrate how the risk to species will be managed.
Cable Plan	Setting out, for approval, in accordance with the application and detailing routing considerations, including environmental sensitivities based on pre-construction survey data, and any relevant mitigation to ensure all relevant environmental risks associated with cable installation and operation are managed in respect of fish receptors.
Environmental Management Plan	Setting out, for approval, the over-arching environmental management procedures that will be implemented across the Project to minimise the risk to environmental receptors from, for example, potential pollution, introduction of non-native species, and dropped objects.
Project Environmental Monitoring Programme	Setting out, for approval, the proposed environmental monitoring programme, to include as relevant and necessary the monitoring of sandeels, marine fish and diadromous fish.
Participation in the Forth and Tay Regional Advisory Group (FTRAG)	Participate in the monitoring requirements as laid out in the 'National Research and Monitoring Strategy for Diadromous Fish' so far as they apply at a local level (the Forth and Tay).
Participation in the Scottish Marine Environment Group (SSMEG)	Participation in the SSMEG with respect to monitoring and mitigation of diadromous and commercial fish.

Mitigation Measure	Deliverable
Participation in the 'National Research and Monitoring Strategy' for Diadromous Fish	Engage with and participate in the delivery of the strategic salmon and trout monitoring strategy at a local level (the Forth and Tay).

7.8 Impact Assessment

95. As identified in Section 7.4, the Scoping Opinion only required potential impacts arising from acoustic particle motion as a result of construction activities and operation of the turbines, foundations and OSPs to be assessed for fish and shellfish receptors (all other potential impacts being scoped out of this EIA). An assessment of decommissioning activity is not required at this time due to no requirement for pile driving to take place.

96. As noted in Section 7.5.2, the understanding of acoustic particle motion and its effects on fish and shellfish is acknowledged as an area of uncertainty and subject to ongoing research. MSS identified an approach for the following assessments, set out under Section 7.5.2; that approach has been followed in so far as the knowledge base allows. The following assessment sections therefore present the following:

- An overview of currently available information on particle motion (including within the vicinity of noise producing construction and operational activities and both within the water column and the sea bed), combined with an overview of the published information on sensitive species and potential physiological and behavioural effects of particle motion;
- Impact assessment of the potential effects arising as a result of particle motion arising from construction activities (pile driving) on key fish species known to occur in the vicinity of the Wind Farm Area; and
- Impact assessment of the potential effects arising as a result of particle motion arising from the operation of the Project (operational turbines) on key fish species known to occur in the vicinity of the Wind Farm Area.

97. Cumulative impacts are subsequently considered and any requirements for mitigation or monitoring are set out under Sections 7.7.1 and 7.7.2 above and 7.9 respectively.

7.8.1 Overview of available information on particle motion and the sensitivity of fish and shellfish to particle motion

98. Published literature acknowledges the relative paucity of information surrounding the effects of the particle motion element of noise on fish and shellfish species (Hawkins et al., 2014b). Nonetheless, it is widely reported that the majority of species are likely to detect the particle motion component of noise rather than the sound pressure level component, which is more commonly considered within EIA.

99. Particle motion is the displacement or movement of fluid particles within a sound field. Most fish respond to particle motion as it is detected by the lateral line of fishes (a visible line along the side of a fish consisting of a series of sense organs which detect pressure and vibration), which contain hundreds of flow sensors and neuromasts (hair cell sensors) and also by the otolithic organs (small oval calcareous structures in the inner ear of vertebrates, involved in sensing gravity and movement) which contain sensory epithelium and sensory hair cells which cause otoliths to vibrate, which the fish then detect. It is the otolithic organs of fish that respond to particle motion of the surrounding fluid. The receptors of the lateral line system in fish also respond to the particle motion but over a very

short range (one or two body lengths away from the source) (Popper et al, 2014). Directional hearing in fishes is based on the detection of particle motion.

100. Different species of fish respond differently to the particle motion and pressure components of noise. Fish species lacking a gas-filled cavity primarily detect particle motion and do not detect sound pressure. Fish that have a functional connection between the swim bladder and the inner ear are likely to predominately detect sound pressure. However, they are still likely to have a capacity of the detection of particle motion similar to non-hearing specialists. Herring are considered more sensitive to sound pressure; cod and eel sensitive to both components of sound and the species such as dab, plaice and Atlantic salmon are predominately sensitive to particle motion (Popper et al, 2014).

101. Particle motion attenuation is known to deviate significantly from the attenuation of sound pressure (except under very specific conditions) and will also be highly site specific, especially in shallow coastal areas (Nedelec et al., 2016) (so that it cannot be assumed that the measurement or modelling of sound pressure levels provides a proxy for particle motion). Popper et al. (2014) note that the three-dimensional particle motion field is quite complex near boundaries that include the air/water interface and the seabed, as well as in shallow water. In these instances, the particle motion may be unpredictable. For example, there can also be instances where transient sound waves in the sediment are transmitted from the sediment into the water column resulting in localised areas of high and low particle motion. In this way it is has been postulated that it would be possible for higher measurements of particle motion to be detected at distance from the sound source (Caltrans, 2001; Hawkins, 2009).

102. The development of modelling techniques for particle motion has been inhibited by the limited availability of any field measurements of particle motion at varying distance from a noise source (Farcas et al., 2016; Hawkins and Popper, 2016). This absence of field measurements during, for example, pile driving means that few studies have been able to model predicted impact ranges in respect of particle motion that could be applied in the EIA process to predict a range of effects on any given species and at any given level of noise.

103. However, Miller et al. (2016) used a novel modelling technique to estimate impact ranges on two species and compared the model outputs with measured data for the driving of a 1.2 m pile in up to 30 m of water. Extant information on species sensitivity was then used to estimate impact ranges for flounder and American lobster. Miller et al. (2016) concluded that flounder and American Lobster may be able to detect particle motion at a distance of 250 m and 500 m from the sound source, respectively.

104. Bass and Clark (2003) report that the particle motion component of sound is likely to decrease more rapidly than the sound pressure component.

105. Studies of very low frequency sound have indicated that consistent deterrence from the source is only likely to occur at particle accelerations equivalent to a free-field SPL of 160 dB re 1 μPa^2 (RMS) (Sand et al., 2001). Particle acceleration resulting from an operational wind turbine has also been measured by Sigray et al. (2011) with the resultant levels being considered too low to be of concern for behavioural reactions from fish. Furthermore, the particle acceleration levels measured at 10 m from an operational wind turbine were comparable with hearing thresholds. Whilst limited, the available data provides an indicator that operational wind turbines are unlikely to result in disturbance of fish except within very close proximity of the turbine structure, as postulated by Wahlberg and Westerberg (2005).

106. Similarly, although there is general acknowledgment that fish and shellfish species will detect the particle motion component of anthropogenic noise, there has been little progress in identifying hearing or response thresholds that could be used to determine the response of any given species to a given level of impact (i.e. a pile driving event). Studies that have observed responses to sound have generally failed to distinguish whether observed responses are as a result of sound pressure or particle motion (Mueller-Blenke et al., 2010; Harding et al., 2016). Radford et al. (2012) isolated the

particle motion component of sound and exposed three species of teleost fish with different sound pressure hearing capabilities. It was observed that the three species exhibited a similar capacity to detect particle motion despite large difference in their ability to detect sound pressure, although the author notes that further investigations into other species are required to draw any firm conclusions.

107. However, more general classifications of 'particle motion sensitivity' have been attempted. Popper et al. (2014) report that, where species of fish have a mechanical connection between the swim bladder and the inner ear, such as those present in clupeids, they are more likely to respond to the sound pressure component of a stimuli (although these species are likely to also detect particle motion). Species without specialised connections between the inner ear and swim bladder, or with no swim bladder at all, are more likely to respond to the particle motion component of sound. Demersal fish that live on or in the Wind Farm Area are also likely to be more sensitive to sediment-borne vibrations resulting from pile driving. A range of behavioural responses have been reported in response to pile driving noise exposure. Cod and sole were observed to change swimming behaviour, although again the study did not distinguish between sound pressure and particle motion (Mueller-Blenkle et al., 2010).

108. Invertebrates are considered unlikely to detect sound pressure levels but are known to detect particle motion via other anatomical adaptions such as superficial surface receptors, internal statocyst receptors and the chordotonal organs (Thomsen et al., 2015; Roberts and Elliot, 2017). Particle motion detection has been demonstrated in bivalves with responses including closing their siphon, burrowing deeper and increased clearance rate (Roberts et al., 2015; Solan et al., 2016; Spiga et al, 2016 Roberts et al., 2017). A number of crustacean species have been reported to respond to anthropogenic noise including hermit crab (*Pagurus bernhardus;) Roberts* et al., 2016), Nephrops (Goodall et al., 1990), American lobster (*Homarus americanus*) (Payne et al., 2007) the shore crab *Carcinus maenus* (Wale et al., 2013a; 2013b) and the two shrimp species *Crangon crangon* and *Pandulus borealis* (Roberts *et al.,* 2017). Roberts et al. (2015) and Roberts et al. (2016) concluded that both the mussel (*Mytilus edulis)* and *hermit crab* responded to noise from blasting within 300 m of the source.

109. The sensitivity of the receptor systems in crustaceans appears to be much less compared to fish - up to 105 times lower in terms of particle velocity (Fay and Simmons, 1998). This suggests that any impacts resulting from particle motion would only be detectable at relatively close range to the sound source.

110. It is important to note that, to date, there has been no indication that high levels of particle motion can cause tissue damage, although research into this area is limited (Popper et al., 2014). There is, currently, therefore an assumption that sensitivity to particle motion in fish (and invertebrates) is most likely to result in behavioural responses rather than injury (Hawkins, 2009; Mueller-Blenkle et al., 2010; Hawkins et al., 2014a).

111. As noted above, Popper et al. (2014) categorised fish species into four distinct groups with regard to their likely sensitivity to noise (sound pressure and particle motion components):

- **Group 1**: Fishes lacking swim bladders that are sensitive only to sound particle motion and show sensitivity to a narrow band of frequencies (includes flatfishes and elasmobranchs);
- **Group 2**: Fishes with a swim bladder where the organ does not appear to play a role in hearing. These fish are considered sensitive only to particle motion and show sensitivity to a narrow band of frequencies (including salmonids and some tuna);
- **Group 3**: Fishes with swim bladders that are close, but not intimately connected to the ear. These fishes are considered sensitive to both particle motion and sound pressure and show a more extended frequency range than groups 1 and 2, extending to about 500 Hz (includes gadoids and eels); and

- **Group 4**: Fishes that have special structures mechanically linking the swim bladder to the ear. These fishes are considered sensitive primarily to sound pressure, although they also detect particle motion. These species have a wider frequency range extending to several kHz and generally show higher sensitivity to sound pressure than fishes in Groups 1, 2 and 3 (includes clupeids such as herring, sprat and shads).

112. For the purposes of assessing the potential impacts of particle motion arising from construction and operation, these four groupings have been considered in relation to the potential for adverse effects to fish.

7.8.2 Construction Phase Impacts

7.8.2.1 Disturbance or injury as a result of particle motion arising from pile driving

113. The greatest levels of noise, and specifically particle motion, will result from the pile driving of foundation piles for the wind turbine and OSP jackets. The following describes the likely effects on each of the four fish groups, and for shellfish, in relation to the worst case design envelope scenario. Note that the assessment focuses on the behavioural effects resulting from particle motion since the current knowledge base indicates that physical trauma from particle motion is not currently thought likely to occur.

114. Popper et al (2014) set out qualitative behavioural criteria for fish from a range of noise sources. These categorise the risks of effects in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. tens of metres), “intermediate” (i.e. hundreds of metres) or “far” (i.e. thousands of metres). These behavioural criteria (for pile driving operations) are summarised in Table 7.13.

Table 7.13: Criteria for onset of behavioural effects in fish from pile driving operations considered within this assessment (Popper et al., 2014)

Type of fish	Masking	Behaviour
Group 1 Fish: no swim bladder (particle motion detection)	N: Moderate risk I: Low risk F: Low risk	N: High risk I: Moderate risk F: Low risk
Group 2 Fish: swim bladder is not involved in hearing (particle motion detection)	N: Moderate risk I: Low risk F: Low risk	N: High risk I: Moderate risk F: Low risk
Group 3 and 4 Fish: swim bladder involved in hearing (pressure and particle motion detection	N: High risk I: High risk F: Moderate risk	N: High risk I: High risk F: Moderate risk

Group 1 and 2 Species

115. Group 1 and 2 fish species are reported to be insensitive to sound pressure and most likely to detect the particle motion component of sound.

116. Group 1 species found within the Wind Farm Area will include flat fish such as dab and plaice and elasmobranch species such as tope and ray species. These are species that predominantly live in close proximity to the sea bed (or within sediments i.e. sandeels) and are therefore more likely to be susceptible to particle motion and vibration effects than pelagic species. Although spawning and nursery habitats are present within the Wind Farm Area and surroundings, these nursery and spawning habitats also extend over a wider area.

117. Group 2 species would include salmonids such Atlantic salmon and sea trout. Atlantic salmon and sea trout are likely to pass through the Wind Farm Area and surroundings both as smolts, leaving their

natal rivers and entering the marine environment heading, and as adults returning to natal rivers to spawn (and in the case of some sea trout as residents of coastal waters).

118. The Popper et al. (2014) criteria suggest that particle motion effects on these species will be limited to within hundreds of metres of the source, with a low risk of disturbance at greater distances (kilometres). This being the case, and given the small area of effect that would arise against the broader distribution of key spawning and nursery habitats, the sensitivity of these species to particle motion effects arising from pile driving is considered to be low for all Group 1 species. Group 2 species include salmonids which have a higher conservation status, however, their use of the site is considered to be transitory in nature with individuals passing through the Development Area on migrations to remote feeding grounds or on return migrations to natal rivers (See Appendix 7.2). Therefore, the sensitivity of these species to particle motion effects arising from pile driving is also considered to be low.

119. The magnitude of the effect will be limited so that the proportion of key habitat will be small, and the effect will be short term, intermittent and reversible. The magnitude of effect for all Group 1 and 2 species is therefore considered to be low.

120. The impact of construction related particle motion on Group 1 and 2 species is therefore considered to be of minor significance and not significant in EIA terms for all Group 1 and 2 species.

Group 3 and 4 Species

121. Group 3 and 4 fish species are considered to be 'hearing specialists', being more likely to respond to the sound pressure component of noise rather than the particle motion component. Therefore, whilst the Popper et al 2014 criteria suggest these species are at higher risk of disturbance over a considerably greater range, this response will be predominantly in relation to the sound pressure component of the pile driving noise rather than the particle motion component. As a result, the sensitivity of these species to particle motion is considered to be low.

122. The exposure will be short term, intermittent and reversible. The magnitude of the impact is therefore considered to be low for Group 3 and 4 species.

123. The significance of effect on Group 3 and 4 species arising from the particle motion component of noise generated by pile driving is therefore considered to be minor and not significant in EIA terms.

Shellfish

124. Shellfish species present in the survey area include the commercially important crustacean species Norwegian lobster, European lobster and brown crab and velvet swimming grab. There are both spawning and nursery grounds for Nephrops overlapping the Wind Farm Area, and commercial fishing data and site specific survey data indicates that this species is common in the area. The reported Nephrops nursery and spawning grounds extend over a wide area, and the relative proportion of these habitats affected by pile driving operations at any one time will therefore be small in the context of the wider habitat available.

125. Mollusc species potentially found within the study area include kind scallops, queen scallops, blue mussels, razor clams and squid. Site specific survey work and commercial fisheries data suggests that these species are not found in large numbers within the study area.

126. As noted under Section 7.8.1 above, although any invertebrates are likely to be able to detect particle motion they are likely to be much less sensitive than fish species so that noticeable behavioural effects are only likely to occur within relatively close proximity to the source. Therefore, sensitivity is considered to be low for all shellfish species.

127. Construction related particle motion will represent a temporary, short term and intermittent source of disturbance and will be reversible. The magnitude of the impact on all invertebrate species is therefore considered to be low.

128. The significance of particle motion effects on invertebrates is therefore, considered to be minor and not significant in EIA terms for all species.

7.8.2.2 Disturbance from noise and particle motion arising from the HDD pipe site works

129. In addition to the main wind turbine and substation foundation pile driving works, installation of a temporary circular or rectangular steel casing is proposed in the shallow subtidal area to facilitate the excavation of a dry area within which a second receiving pit would be constructed for the emergence of the Horizontal Directional Drill (HDD) (as described in Chapter 4: Project Description). This would involve interlocking steel sheets being lifted in to place by an excavator – with the potential for noise generated by this installation operation. Here, the cable will emerge and, if required, be joined with the Offshore Export Cable. The cable will then be buried, the disturbed area reinstated and the casing removed.

130. The installation of the steel casing, which may require sheet piling, has the potential to give rise to underwater noise – both particle motion and sound pressure, which may lead to the disturbance of marine and diadromous fish species. The installation of the sheet piling will take place in relatively shallow water close to shore with installation taking a relatively short period (e.g. a number of days at most). Given this, the noise generated will attenuate over a relatively short distance (given the shallow water depths) so that effects on fish will be limited spatially and temporally – given the short period for installation and the effects are considered temporary and reversible. The magnitude is therefore considered to be low.

131. Sensitivity is judged to be greatest in diadromous fish species such as salmon which may be present in nearshore waters during their migratory periods (as smolt on outward migration or as adults returning to their natal rivers). Salmon are considered to be relatively low sensitivity to noise (Group 2 species as defined by Popper et al, 2014); the sensitivity of these species therefore is considered to be low. The significance of the effect on fish species arising from the impact of sheet piling works at the landfall is therefore considered to be minor, which is not considered significant in EIA terms.

7.8.3 Operational Phase Impacts

7.8.3.1 Disturbance resulting from vibration / particle motion arising from turbine operation

132. The available studies on particle motion effects arising from operational wind turbines (see Section 7.8.1) suggest that any behavioural response in fish or shellfish would be limited to within very close proximity of the source.

133. The sensitivity of fish and shellfish species to the low level of particle motion arising from operational turbines is considered to be low for all species.

134. The magnitude of the effect will be continual (during turbine operation), and over a long period, but will affect a very small area, and is therefore considered to be low for all species.

135. The significance of particle motion effects arising from the operational wind turbines is therefore considered to be minor and not significant in EIA terms for all species.

7.8.4 Cumulative Impacts

136. Cumulative effects refer to effects upon receptors arising from the Project when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals. In this context, the term 'projects' is considered to refer to any project with comparable effects and is not limited to offshore wind projects.

137. Project and activities considered within the cumulative impact assessment are set out in Table 7.14. There may be an element of uncertainty associated with the design envelope of proposed projects;

therefore, a judgement is made on the confidence associated with the latest available design envelope.

138. As the impacts of particle motion are localised, not impacting receptors beyond a regional scale, only the Inch Cape and Seagreen projects are considered in this cumulative assessment.

139. In assessing the cumulative impacts for the Project, two scenarios are considered to take into account the consented design envelopes of the Inch Cape Offshore Wind Farm and the Seagreen Phase 1 Wind Farm Project. Scenario one incorporates the design envelopes for the proposed Inch Cape and Seagreen projects as detailed in the Scoping Reports submitted to MS-LOT (ICOL, 2017; Seagreen, 2017). Scenario two incorporates the consented design envelopes as detailed in the respective project consents.

Table 7.14: Projects for cumulative assessment – fish and shellfish

Development Type	Project	Status	Data Confidence Assessment / Phase
Offshore Wind Farm	Inch Cape Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Inch Cape Offshore Wind Farm	Proposed	High – Scoping report publicly available.
Offshore Wind Farm	Seagreen Alpha	Consented	High – Consented project details available.
Offshore Wind Farm	Seagreen Bravo	Consented	High – Consented project details available.
Offshore Wind Farm	Seagreen Phase 1	Proposed	High – Scoping report publicly available.

140. Table 7.15 sets out the potential cumulative impacts and the worst case cumulative design envelope scenario considered within the cumulative impact assessment.

Table 7.15: Cumulative worst-case design envelope scenarios – fish and shellfish

Impact	Worst Case Design Scenario	Justification
Construction		
Disturbance or injury as a result of particle motion arising from pile driving	Scenario 1: ▪ Seagreen Phase 1: Installation of up to 120 turbines on monopiled foundations. 2400 kJ hammer (maximum hammer energy limited to 2300kJ) is assumed for the proposed Seagreen project. ▪ Inch Cape Offshore Wind Farm: Installation of up to 72	The maximum cumulative impact is considered to be the project scenarios that generate the greatest noise. Therefore, the scenarios consider the greatest number of turbines and installation of the largest piled foundations. This will generate the greatest spatial footprint in terms of propagation of the particle motion component of noise.

Impact	Worst Case Design Scenario	Justification
	turbines on piled 4 leg jacket foundations using a 2400 kJ hammer. Scenario 2: ▪ Seagreen Alpha and Bravo Offshore Wind Farms: Installation of up to 150 turbines on piled 4 leg jacket foundations using 3 m piles with a 1800 kJ hammer (maximum hammer energy limited to 1500kJ). Driving duration will be 0.5 hrs per pile; ▪ Inch Cape Offshore Wind Farm: Installation of up to 110 turbines on piled 4 leg jacket foundations using 2.43 m piles with a maximum hammer energy of 1200 kJ. Driving duration will be 4.2 hrs per pile.	
Operation		
Disturbance as a result of particle motion arising from turbine operation	Scenario 1: ▪ Seagreen Phase 1: Operation of up to 120 turbines. ▪ Inch Cape Offshore Wind Farm: Operation of up to 72. Scenario 2: ▪ Seagreen Alpha and Bravo Offshore Wind Farms: Operation of up to 150 turbines; ▪ Inch Cape Offshore Wind Farm: Operation of up to 110 turbines.	The maximum cumulative impact is considered to be the project scenarios that generate the greatest noise. Therefore, the scenarios consider the greatest number of turbines in operation at the largest capacity. This will generate the greatest footprint in terms of the propagation of the particle motion component of noise.

7.8.4.1 Cumulative Construction Phase Impacts

141. There is the potential for cumulative effects of particle motion arising from construction noise (pile driving) to occur. The only projects within the wider Forth and Tay region that could theoretically be under construction at the same time as the Project are the Inch Cape Offshore Wind Farm (either consented or proposed) and Seagreen Alpha and Bravo projects (or the proposed Phase 1 project) (Table 7.14). It is however considered to be highly unlikely that there would be overlap between the construction of any of those projects with NnG's construction programme. As is the case for the Project alone assessment (Section 7.8.2), since there are currently no reported injurious effects on fish and shellfish resulting from particle motion, only the potential behavioural effects are assessed.

142. As noted for the Project alone assessment (Section 7.8.2), the criteria for disturbance developed by Popper et al. (2014) suggests that for all hearing sensitive groups, the particle motion component of pile driving noise is likely to give rise to a disturbance response that would be limited to within hundreds of metres of the source, with a low risk of disturbance at greater distances (kilometres) (noting that the sound pressure component may give rise to disturbance at greater ranges for species sensitive to sound pressure). This being the case for all of the Forth and Tay projects there would be no spatial overlap in the particle motion impact even under the Scenario that all three projects were pile driving simultaneously. Even considered additively, the spatial area of key fish and shellfish habitats (i.e. spawning or nursery grounds) affected would be minimal when considered as a proportion of the whole.

143. Sequential and / or spatially-separated concurrent pile driving could give rise to individual fish encountering particle motion from the different projects as they move around the Forth and Tay region (i.e. an individual could successively over time encounter particle motion generated by pile driving events at the various Projects) leading to a potential dative effect. This could, theoretically, increase the magnitude of effect for a given individual, although the sensitivity would be unchanged. Similarly, sequential pile driving would mean that a proportion of a sensitive habitat (spawning or nursery habitat for example) could be affected over a longer period of time even if the spatial footprint remained the same at any given time; again, this could lead to a somewhat greater magnitude of effect although again the sensitivity would remain unchanged.

144. The Scenario 1 cumulative impact considers the installation of 246 foundations within the Forth and Tay region. The assessment considers that the 192 foundations associated with the Inch Cape and Seagreen projects will all be pile driven. As detailed in Table 7.11 it is assumed 10% of foundations will be piled for the Project; therefore, the cumulative assessment considers 198 pile driven foundations with the remaining 48 installed using a drill-drive-drill, or drive-only method. The construction period for the Inch Cape and Seagreen project is not currently known. Construction periods could vary and taking a worst case of sequential pile driving over a 5 year period, this would represent a medium term impact, that will have a localised spatial extent but in a regional context. The magnitude of the impact for Scenario 1 is therefore considered to be medium.

145. As detailed above in the Project alone assessment all Group 1, 2, 3 and 4 fish species and all shellfish species are considered to have a low sensitivity to the impact of particle motion from pile-driving.

146. In the case of Scenario 2, the worst-case scenario would be in the installation of 314 foundations within the Forth and Tay region. It is assumed that the 260 foundations associated with the Inch Cape and Seagreen projects and 6 foundations associated with the Project will all be pile driven with the remaining 48 installed using a drill-drive-drill, or drive-only method. Construction might, therefore, be expected to occur more frequently but it is assumed would still be completed over the same duration as Scenario 1, i.e. 5 years of sequential, but intermittent, pile driving. Again, this would be localised in a regional context, temporary and reversible and would remain as a medium magnitude impact.

147. The cumulative effect arising from particle motion for all species will therefore be minor and not significant in EIA terms.

7.8.4.2 Cumulative Operational Phase Impacts

148. As noted in the project alone assessment (Section 7.8.3), particle motion arising from offshore wind turbine operation will be detectable only in close proximity to the turbines and will therefore give rise, for each project, to a highly localised effect. As such, there will be no additive effect arising from the Forth and Tay projects in the operational phase (i.e. the noise footprints will not overlap); although fish or shellfish species that move between the projects may be exposed to several sources of low level particle motion as they pass in close proximity to the operational turbines of each project. This conclusion would be the same for both Scenario 1 and Scenario 2 as defined in Table 7.15.

149. The sensitivity of fish and shellfish species to the low level of particle motion arising from operational turbines is considered to be low for all species.

150. The magnitude of the effect will be continual (during turbine operation at each project) and over a long period but will be affect a very small area in each case and with no overlap between the separate wind farms and is therefore considered to be low for all species.

151. The significance of cumulative particle motion effects arising from the operational phase is therefore considered to be Minor and not significant in EIA terms for all species.

7.8.5 Inter-relationships

152. Inter-relationships considers the impacts and associated effects of different aspects of the proposal on the same receptor. These are considered to be:

- **Project lifetime effects:** Assessment of the scope for effects that occur throughout more than one phase of the project (construction, operation, decommissioning) to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three key project phases (e.g. subsea noise effects from pile driving, operational turbines, vessels and decommissioning);
- **Receptor led effects:** Assessment of the scope for all effects to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on a given receptor such as fish and shellfish – direct habitat loss or disturbance, sediment plumes, underwater noise and EMF etc. may interact to produce a different or greater effect on this receptor than when the effects are considered in isolation. Receptor led effects might be short term, temporary or transient effects, or incorporate longer term effects.

153. The greatest disturbance from particle motion is predicted to result from pile driving during the construction phase with minor effects predicted. Noise produced during the operation of the turbines was assessed to result in effects of minor significance being highly localised. Therefore, across the Project lifetime, the effects on fish and shellfish receptors are not anticipated to interact in such a way as to result in combined effects (in relation to particle motion) of greater significance than the assessments presented for each individual phase.

154. The potential exists for spatial and temporal interactions between habitat loss / disturbance / alteration, increased SSC, sediment deposition, underwater noise (both sound pressure and particle motion), EMF and contamination effects during the lifetime of the Project. All of these individual impacts, with the exception particle motion, were scoped out of the EIA, as the effects were deemed to be not significant as standalone impacts. As a result, and given the minor level of significance attributed to the potential effects arising from particle motion, significant inter-related effects are not predicted.

7.9 Mitigation and Monitoring

155. The assessment of impacts, both in isolation and cumulatively, on Fish and Shellfish receptors as a result of the construction, operation and decommissioning of the Project are predicted to be of minor significance and therefore not significant in EIA terms. Based on the predicted effects it is concluded that no additional mitigation is required beyond the embedded mitigation set out in Chapter 17.

156. As noted in Section 7.5.2, there are a number of acknowledged uncertainties in the general knowledge base relating to the particle motion component of underwater noise and the effects of particle motion arising from activities such as pile driving on fish and shellfish species. Whilst the assessments presented within this EIA Report are considered to represent a reasonable consideration of the issue using the best available information, the lack of e.g. modelling techniques or clear thresholds of effects for key species inevitably means that uncertainties remain.

157. Many of these uncertainties relate to the fundamental understanding of particle motion and the effects on fish and shellfish, which require ongoing academic research initiatives and which would lie beyond the normal scope of project-specific monitoring. No monitoring related to particle motion is proposed at this stage, but this will be discussed further during the post-consent phase. Final monitoring proposals will be discussed with the FTRAG as part of the approval process for the Project Environmental Monitoring Plan (PEMP).

7.10 Summary of the Residual Effects

158. This chapter has assessed the potential effects on Fish and Shellfish of the construction, operation and decommissioning of the Project, both in isolation and cumulatively. Where significant effects were identified, additional mitigation has been considered and incorporated into the assessment. Table 7.16 summarises the impact determinations discussed in this chapter and presents the post-mitigation residual significance.

Table 7.16: Summary of predicted impacts of the Project

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Construction			
Disturbance or injury as a result of particle motion arising from pile driving	Minor adverse for all Group 1, 2, 3 and 4 species. Minor adverse for all shellfish species,	n/a	Minor adverse for all Group 1, 2, 3 and 4 species. Minor adverse for all shellfish species
Operation			
Disturbance resulting from particle motion arising from turbine operation	Minor adverse for all species	n/a	Minor adverse for all species
Cumulative Effects			
Disturbance or injury as a result of particle motion arising from pile driving	Minor adverse for all fish and shellfish species	n/a	Minor adverse for all fish and shellfish species
Disturbance resulting from particle motion arising from turbine operation	Minor adverse	n/a	Minor adverse

7.11 References

- Bass AH, Clark CW (2003) *The Physical Acoustics of Underwater Sound Communication.* In: Simmons AM, Popper AN, Fay RR (eds*) Acoustic Communication.* (Springer Verlag New York) p 404
- Barne, J.H., Robson, C.F., Kaznowska, S.S., Doody J.P., Davidson N.C. and Buck, A.L. (1997) *Coasts and Seas of the United Kingdom Region 4 South-east Scotland: Montrose to Eyemouth* (JNCC Peterborough) (Coastal Directories Series).

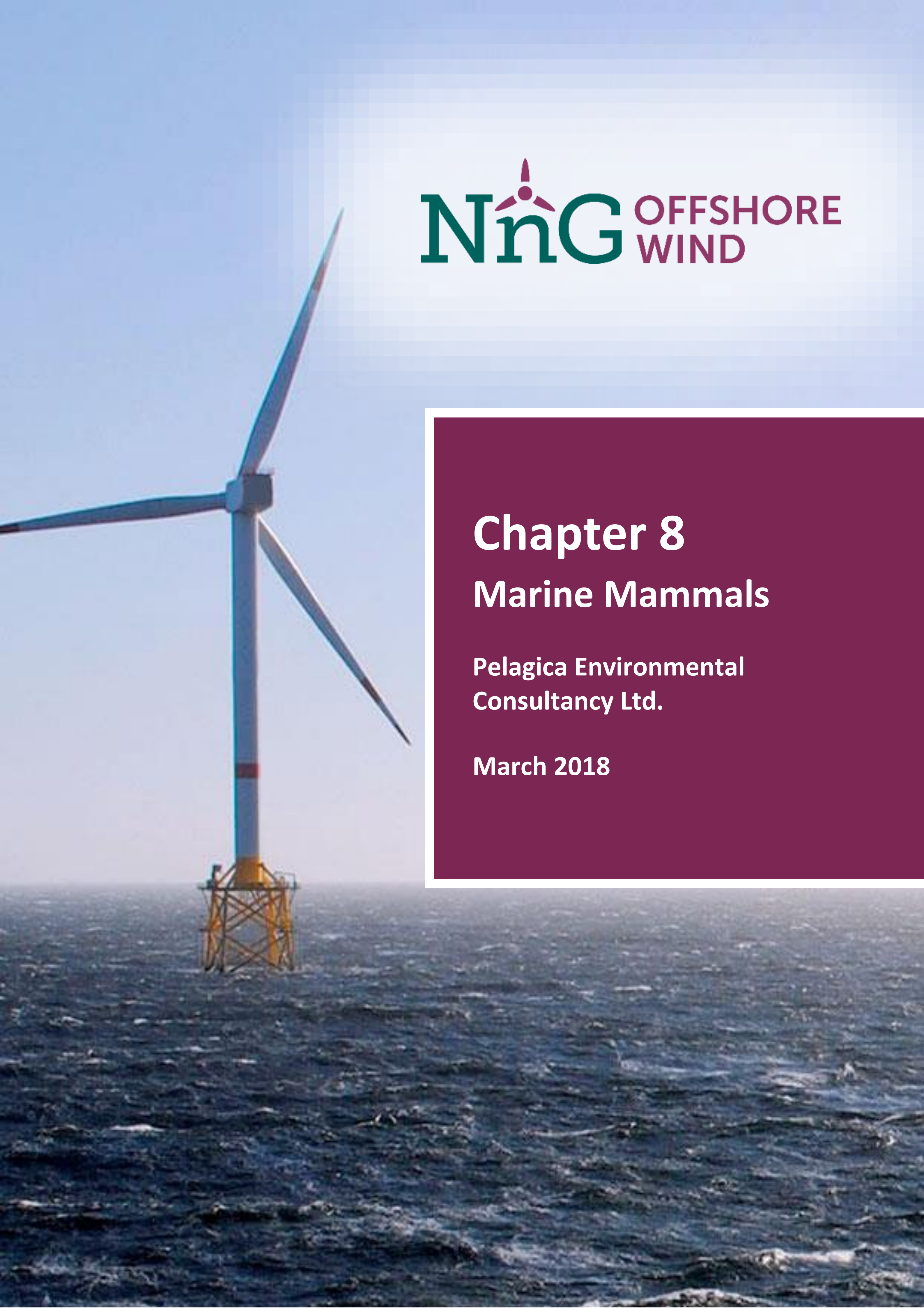
- Bakir, W.M.A. and Healy, B., (1995) *Reproductive cycle of the velvet swimming crab Necora puber (L.) (Decaoda, Brachyura, ortunidae) on the east coast of Ireland*. (Irish Fisheries Investigations Series B (Marine) No. 43. The Stationary Office.)
- Beard, T.W. and McGregor, D., (2004) *Storage and care of live lobsters*. (Laboratory Leaflet Number 66 (Revised) Cefas, Lowestoft) 004
- Birklund, J. and Wijsman, J.W.M., (2005) *Aggregate extraction: A review on the effects on ecological functions.* (Report Z3297/10 SAWDPIT Fith Framework Project no EVK3-CT-2001-00056. Calloway et al., 2002).
- Caltrans (2001). *Pile Installation Demonstration Project, Fisheries Impact Assessment*. (PIDP EA012081, Caltrans Contract 04A0148. San Francisco - Oakland Bay Bridge East Span Seismic Safety Project)
- Cefas (2001). *North Sea Fish and Fisheries Technical Report TR_003* (Produced for Strategic Environmental Assessment (SEA) 2 Department of Trade and Industry)
- Coull, K.A., Johnstone, R and Rogers, S.I., (1998) *Fishery sensitivity Maps in British Waters.* (Published and distributed by UKOOA Ltd)
- DECC, (2016) *UK Offshore Strategic Environmental Assessment 3 Environmental Report*. URN 16D/033
- Defra (2015). *Marine Strategy Part Three: UK programme of measures.* Available from: https://www.gov.uk/government/publications/marine-strategy-part-three-uk-programme-of-measures [Accessed on 04/12/2017]
- Eleftheriou, A., Basford, D. and Moore D.C. (2004) *Synthesis of Information on the Benthos of Area SEA5*. (Report for the Department of Trade and Industry. Final Draft May 2004.)
- Ellis, J.R., Milligan, S. P., Readdy, L., Taylor, N. and Brown, M.J., (2012) *Spawning and nursery grounds of selected fish species in UK waters. Sci. Ser. Tech. Rep.*, (Cefas, Lowestoft) 147: 56 pp.
- EMU, (2010a) *Neart Na Gaoithe Proposed Offshore Wind Farm Benthic Ecology Characterisation Survey, Final Report*. Report No: 09/J/1/03/1483/0943.
- EMU, (2010b) *Neart Na Gaoithe Proposed Offshore Wind Farm and Cable Routes Geophysical Survey*. Report No.09/J/1/02/1447/0917
- Finstad, B. Økland, F. Thorstad, E. B. Bjørn, P. A. M. and McKinley, R. S., 2005. Migration of hatchery-reared Atlantic salmon and wild anadromous brown trout post-smolts in a Norwegian fjord system. Journal of Fish Biology, 66 (1), 86-96.
- Farcas, A., Thompson, P. M., & Merchant, N. D. (2016). *Underwater noise modelling for environmental impact assessment.* (Environmental Impact Assessment Review, 57, 114-122.)
- Godfrey, JD Stewart, DC Middlemas, SJ and Armstrong, JD (2015) Depth use and migratory behaviour of homing Atlantic salmon (Salmo salar) in Scottish coastal waters. ICES Journal of Marine Science, 72: 568–575
- Greenwood, M.F. D. and Hill, A.S., (2003) *Temporal, spatial and tidal influences on benthic and demersal fish abundance in the Forth estuary*. (Estuarine, Coastal and Shelf Science, 58: 211-225)
- Greenwood, M.F. D., Hill, A.S. and McLusky, D.S. , (2002) *Trends in abundance of benthic and demersal fish population of the lower Forth Estuary, east Scotland, from 1982-2001*. (Journal of Fish Biology, 61(A),90-94)
- Greenstreet, P.R., Holland,G. J., Guirey, E. R. J., Armstrong, E., Fraser, H. M. and Gibb, I.M., (2010) *Combining hydroacoustic seabed survey and grab samling techniques to assess "local" sandeel population abundance.* (ICES Journal of Marine Science, 67(5), 971-984).
- Harding, H, Bruintjes, R, Radford AN Simpson SD (2016) *Measurement of Hearing in the Atlantic salmon (Salmo salar) using Auditory Evoked Potentials, and effects of Pile*

Driving Playback on Salmon Behaviour and Physiology. (Scottish Marine and Freshwater Science Report Vol 7 No 11).

- Hawkins, A. (2009) *The impact of pile driving upon fish.* (Proc. Inst. Acoustics, vol.31. pt.1, pp. 72-79).
- Hawkins, A. D., Roberts L., and S. Cheesman (2014a) *Responses of free-living coastal pelagic fish to impulsive sounds.* (J. Acoust. Soc. Am., 135, PP3101-3116)
- Hawkins, A. D., Pembroke, A. E., Popper, A. N. (2014b) *Information gaps in understanding the effects of noise on fishes and invertebrates*. (Rev. Fish. Biol. Fisheries, 25: 39 – 64).
- Hawkins, A. and Popper, A. (2016). *A Sound Approach to Assessing the Impact of Underwater Noise on Marine Fishes and Invertebrates*. (ICES Journal of Marine Science, 74(3), 635-651).
- ICES, (2006a) *ICES CIEM ICES Fish Map –Herring*
- ICOL, (2017) *Inch Cape Offshore Wind Farm. Offshore Scoping Report.* Available from: http://www.gov.scot/Topics/marine/Licensing/marine/scoping/InchCape/InchCapeScoping2017 [Accessed on 4/12/2017].
- Jayamanne, S.C., (1995) *Population dynamics, biology and ecology of the caridean shrimps Crangon crangon Linneaus, Crangon allmanni Kinahan and Pandalus montagui Leach in the estuary and Firth of forth, Scotland.* (PhD Thesis, University of Stirling).
- Jennings, S., Lancaster, J., Woolmer, A., and Cotter, J. (1999) *Distribution, diversity and abundance of epibenthic fauna in the North Sea.* (Journal of the Marine Biological Association U.K., 79: 385–399).
- Jensen, H., Rindorf, A., Wright, P.J. and Mosegaard, H., (2011*) Inferring the location and scale of mixing between habitat areas of lesser sandeel through information from the fishery.* (ICES Journal of Marine Science, 68(1),43–51).
- Lothian AJ, Newton M, Barry, J, Walters M, Miller RC and Adams CE (2017) Migration pathways, speed and mortality of Atlantic salmon (Salmo salar) smolts in a Scottish river and the near-shore coastal marine environment. Ecology of Freshwater Fish.
- MS-LOT (2017) *Scoping Opinion for the proposed Section 36 consent and associated marine licence application for the revised Neart na Gaoithe Offshore Wind Farm and revised Offshore Wind Farm Offshore Transmission Works*. Issued on the 08th September 2017. Available from: http://www.gov.scot/Topics/marine/Licensing/marine/scoping/NnGRev2017/SO-092017 [Accessed on the 08/09/2017]
- Malcolm, I.A., Godfrey, J. and Youngson, A.F., (2010) *Review of migratory routes and behaviour of Atlantic Salmon, sea trout and European eel in Scotland's coastal environment: implications for the development of marine renewables.* (Scottish Marine and Freshwater Science,1, 14)
- Malcolm, IA, Millar CP and Millidine KJ (2015) *Spatio-temporal variability in Scottish smolt emigration times and sizes*. (Scottish Marine and Freshwater Science. Volume 6 Number 2) Available from: http://www.gov.scot/Resource/0047/00472202.pdf. [Accessed 10/10/2017]
- Marine Scotland, (2014) *Status of Scottish salmon stocks*. (Marine Scotland Science Report 02/14).
- Marine Scotland (2017) *Annual Fish and Shellfish Stock* Available from: http://www.gov.scot/Topics/marine/Publications/publicationslatest/farmedfish/fishandshellfishstocks/2017 [Accessed 01/10/2017]
- Marine Scotland (2015) *Scotland's National Marine Plan A Single Framework for Managing Our Seas* [Accessed 01/10/2017]

- McPherson, A.A., Stephenson, R.L., O'Reilly, P. T., Jones, M.W. and Taggart, C.T., (2001) *Genetic diversity of coastal Northwest Atlantic herring populations: implications for management.* (Journal of Fish Biology (2001) 59 (A): 356–370).
- Miller, J.H., Potty, G.R., Hui-Kwan, K.,(2016*) Pile-driving pressure and particle velocity at the seabed: quantifying effects on crustaceans and groundfish.* In: Popper, A.N., Hawkins, A.D. (Eds.), *The Effects of Noise on AQUATIC Life II.* (Springer, New York, NY, pp. 705–712).
- Mueller-Blenkle, C., McGregor,P. K., Gill, A.B., Andersson, M.H., Metcalfe, J., Bendall, V., Sigray, P., Wood, D.T. and Thomsen, F., (2010) *Effects of Pile-driving Noise on the Behaviour of Marine Fish.* (COWRIE Ref: Fish 06-08, Technical Report.)
- Nedelec, S. L., Campbell, J., Radford, A. N., Simpson, S. D., and Merchant, N. D. (2016) *Particle motion: the missing link in underwater acoustic ecology*. (Methods in Ecology and Evolution, 7, 836–842).
- NnGOWL (2017) *Neart na Gaoithe Offshore Wind Farm Scoping report.* Report Reference: UK02-0504-0673-MRP-NNG SCOPING REPORT 2017-RPT-A1. Available from: http://www.gov.scot/Topics/marine/Licensing/marine/scoping/NnGRev2017/NnG-ScopingReport-May2017 [Accessed on 18 August 2017]
- OSPAR, (2010) Quality Status Report 2010. OSPAR Commission. London. 176 pp.
- Pawson, M.G., (1995) *Biogeographical identification of English Channel fish and shellfish stocks.* (Fisheries Research Technical Report Number 99).
- Payne, M.R., (2010) *Mind the gaps: a state-space model for analysing the dynamics of North Sea herring spawning components.* (ICES Publications).
- Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D. A., Bartol, S., Carlson, T. J., Coombs, S., et al. (2014) *Sound Exposure Guidelines*. In ASA S3/SC1. 4 TR-2014 *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report* (prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI, pp. 33–51. Springer, New York).
- Putman,NF, Lohmann, KJ, Putman, EM, Quinn,TP, Klimley, AP and Noakes, DLG (2013) *Evidence for Geomagnetic Imprinting as a Homing Mechanism in Pacific Salmon*. (Current Biology 23, 312–316) http://www.cell.com/current-biology/pdf/S0960-9822(13)00003-1.pdf [Accessed 22/10/2017]
- Radford, CA, Montgomery, JC, Caiger P and Higgs DM (2012) *Pressure and particle motion detection thresholds in fish: a re-examination of salient auditory cues in teleosts*. (The Journal of Experimental Biology 215, 3429-3435).
- Roberts L and Elliott M (2017) *Good or bad vibrations? Impacts of anthropogenic vibration on the marine epibenthos*. (Science of the Total Environment 595:255-268).
- Roberts, L., Harry, R., Harding, R., Voellmy, I., Bruintjes, R., Simpson, S. D., Radford, A. N., Breithaupt, T., Elliot, M. (2017) *Exposure of benthic invertebrates to sediment vibration: From laboratory experiments to outdoor simulated pile-driving*. (Acoustical Society of America, 27, 010029 (2016); doi: 10.1121/2.0000324).
- Roberts, L. (2015). *Behavioural responses by marine fishes and macroinvertebrates to underwater noise* (Doctoral dissertation, University of Hull).
- Robson, C. F., (1997) *Chapter 5 -Important Species* in: Barne, J. H., Robson, C. F., Kaznowska, S. S., Doody, J. P., Davidson, N. C. and Buck, A. L., eds. *Coasts and Seas of the United Kingdom. Region 4: South-east Scotland: Montrose to Eyemouth*.(JNCC Peterborough (Coastal Directories Series).
- Sand, O., Enger P. S., KaRLen H. E., Knudesen, F. R. (2001) *Detection of infrasound in fish and behavioural responses to intense infrasound in juvenile salmonids and European silver eels: a mini review*. (Am. Fish Soc. Symp., 26, pp. 183 – 193).
- Seagreen (2017) *Seagreen Phase 1 Offshore Project. Scoping Report, Round 3: Firth of Forth.* Report Reference: A4MR/DEAG-AB-DEV230-SPR-311. Available from: http://www.gov.scot/Topics/marine/Licensing/marine/scoping/SeagreenPhase1-2017/SeagreenPhase1-ScopingReport [Accessed on 4/12/2017]

- Sigray, P. and Andersson, M.H. , (2011) *Particle motion measured at an operational wind turbine in relation to hearing sensitivity in fish*. (Journal of the Acoustic Society of America, 130(1),200-207).
- Solan, M., Hauton, C., Godbold, J.A., Wood, C.L., Leighton, T.G., White, P., (2016) *Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties*. (Sci. Rep. 6, 1–9).
- Spiga I, Caldwell GS and Bruintjes R. (2016) *Influence of Pile Driving on the Clearance Rate of the Blue Mussel, Mytilus edulis (L.)*. In: *Fourth International Conference on the Effects of Noise on Aquatic Life.* (2016) (Dublin, Ireland: Acoustical Society of America).
- SNH, (2011) *Ocean Quahog aggregations*
- Taylor, R. (2002) *Loligo forbesii.* (Animal Diversity Web).
- Thomsen, F., Gill, A., Kosecka, M., Andersson, M. H., Andre, M., Degraer, S., & Norro, A. (2015). *MaRVEN–Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewable Energy*. (Final study report, Brussels, Belgium).
- Thorstad, E. B., Okland, F., Finstad, B., Silvertsgard, R., Plantalech Manel-la, N., Bjorn, P. A. and McKinley, R. S., 2007. Fjord migration and survival of wild and hatchery reared Atlantic salmon and wild brown trout post-smolts. Hydrobiologia, 582, 99-107.
- Turrell W R (2006) *Fisheries Research Services Collaborative Report No 12/06* (Climate Change and Scottish Fisheries August 2006)
- Wale, M.A., Simpson, S.D., Radford, A.N., 2013a. Noise negatively affects foraging and antipredator behaviour in shore crabs. Anim. Behav. 86, 111–118.
- Wale, M.A., Simpson, S.D., Radford, A.N., 2013b. Size-dependent physiological responses of shore crabs to single and repeated playback of ship noise. Biol. Lett. 9, 20121103.
- Wahlberg, M. & Westerberg, H. (2005) *Hearing in fish and reactions to sound from offshore wind farms.* (Mar. Ecol. Prog. Ser., Vol. 288: 295 – 309).
- Wieland, K., Jarre-Teichmann, A., and Horbowa, K., (2000) *Changes in the timing of spawning of Baltic cod: possible causes and implications for recruitment*. (ICES Journal of Marine Science, 57: 452–464).
- Wright PJ, Jensen H, Tuck I (2000) *The influence of sediment type on the distribution of the lesser sandeel, Ammodytes marinus*. (J Sea Res 44: 243−256).
- HM Government (2011) *UK Marine Policy Statement*, (ISBN: 978 0 10 851043 4)



Chapter 8

Marine Mammals

Pelagica Environmental Consultancy Ltd.

March 2018

Table of Contents

Table of Figures

Table of Tables

8 Marine Mammals

8.1 Introduction

1. This chapter of the Environmental Impact Assessment Report (EIA Report) presents an assessment of the potential impacts upon marine mammals arising from the construction, operation and decommissioning of the Project, as detailed in Chapter 4: Project Description. This chapter has been drafted by Pelagica Environmental Consultancy Ltd. (Pelagica) with underwater noise (Genesis 2017a) and interim PCoD modelling undertaken by Genesis Oil and Gas Consultants Ltd. (Genesis 2017b).

2. The assessment is based upon a combination of the understanding of the Project in terms of the potential for impact and the resultant effects on receptors that were identified as present within the study area along with the results from project specific noise modelling as detailed within Appendix 8.1

3. This chapter is comprised of the following elements:

- A summary of relevant guidance, policy and legislation;
- Details of the data sources used to characterise the study area;
- A summary of the relevant consultations with stakeholders;
- A description of the methodology for assessing the impacts of the Project, including details of the study area and approach to the assessment of potential effects;
- A review of the baseline conditions;
- A description of the worst-case design scenario relevant to marine mammals;
- An assessment of the likely effects for the construction, operation and decommissioning phases of the Project, including cumulative effects;
- Identification of any further mitigation measures or monitoring requirements in respect of any likely significant effects;
- A summary of the residual impact assessment determinations taking account of any additional mitigation measures identified.

4. It should be noted that there have been no significant changes to the marine mammal baseline since the original application was made, although new information has become available and has been used within this assessment. There have also not been any changes made to the Project that would likely affect the magnitude of impacts on marine mammals predicted in the original application. In particular, the maximum hammer energy of 1,635 kJ being used to install piles has remained the same and the overall number of piles to be installed has been reduced. Consequently, the level of impact from construction noise on marine mammals from the Project is predicted not to be no greater than has previously been assessed and consented. However, the potential cumulative impacts may have changed with increased hammer energies being considered by other wind farm developments in the Firths of Forth and Tay. Following advice received in the Scoping Opinion the approach to undertaking the assessment of impacts from noise on marine mammals has changed since the original application was made (Marine Scotland 2017a).

8.2 Guidance and Legislation

5. Marine mammals are protected under a range of national and international legislation, details of which are presented below and listed in Table 8.1.

European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora.

6. Known as the Habitats Directive, the main objectives of the Directive are:

"...to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies" (Article 2.1); and

"...to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest" (Article 2.2)

7. The Directive requires Member States to identify sites collectively known as Natura 2000 sites, which includes Special Areas of Conservation (SAC) that host particular habitats or species as listed in Annexes I and II of the Directive. Four species of marine mammal: harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*) are listed in Annex II of the Directive.

8. The Directive also requires Member States to provide strict protection to all species listed in Annex IV of the Directive, this includes all species of cetacean.

***Conservation (Natural Habitats, &c.) Regulations 1994 (as amended), Conservation of Habitats and Species Regulations 2017* and Conservation of Offshore Marine Habitats and Species Regulations 2017 (together the "Habitats Regulations")**

9. In Scotland, the Habitats Directive has been transposed into domestic law by the Habitats Regulations. The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) apply in relation to the terrestrial environment and in territorial waters out to 12 nautical miles (nm), with the exception of certain matters, such as the consideration of Section 36 consent applications, in relation to which the Conservation of Habitats and Species Regulations 2017 apply. The Conservation of Offshore Marine Habitats and Species Regulations 2017 apply to UK territorial waters outside 12 nm.

10. The Habitats Regulations require:

(1) A competent authority, before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which–

(a) is likely to have a significant effect on a European site or a European offshore marine site (either alone or in combination with other plans or projects), and

(b) is not directly connected with or necessary to the management of the site,

must make an appropriate assessment of the implications of the plan or project for that site in view of that site's conservation objectives.

(2) A person applying for any such consent, permission or other authorisation must provide such information as the competent authority may reasonably require for the purposes of the assessment or to enable it to determine whether an appropriate assessment is required.

11. The information to inform an appropriate assessment is presented separately in the HRA Report, which accompanies the Application.

12. Animals and plants listed in Annex IV of the Habitats Directive, whose natural range includes any area in Great Britain, are referred to within the Habitats Regulations as European protected species (EPS) of animals and plants. They are species of European Community Interest in need of strict protection (SNH 2015).

13. Species listed in Annex IV of the Directive include porpoises and all species of dolphin and whale and are protected under the Habitats Regulations. In Scotland, it is an offence, with certain exceptions, to

- Deliberately or recklessly:
- Capture, injure or kill any wild animal of a European protected species;
- Harass such an animal or group of animals;
- Disturb such an animal while it is rearing or otherwise caring for its young;

- Obstruct access to a breeding site or resting place, or otherwise deny the animal use of the breeding site or resting place;
- Disturb such an animal while it is occupying a structure or place used for shelter or protection;
- Disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs;
- Disturb such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young; or
- Disturb such an animal whilst migrating or hibernating.

14. These offences apply to all stages of the animal's life, and all stages of the biological cycle of the plants (SNH 2015).

Deliberate Injury Offence

15. The term "deliberate" has been interpreted as including indirect but foreseeable actions and the deliberate injury offence has been interpreted as occurring if a cetacean receives a sound exposure level, which may cause permanent threshold shift in hearing (JNCC 2010a).

Disturbance Offence

16. A disturbance offence may occur if the level of disturbance is likely to:

- Impair the ability to survive, to breed or reproduce, or to rear or nurture their young, or migrate,
- Affect significantly the local distribution or abundance.

17. The risk of a disturbance offence in respect of marine mammals will exist if there is sustained noise in an area and/or chronic noise exposure, as a result of an activity (JNCC 2010a).

18. The Habitats Regulations provide a licensing regime for certain activities that might otherwise constitute an offence in respect of EPS. The information to inform possible future EPS licence applications is presented in Appendix 8.3.

Marine Strategy Framework Directive

19. The main aim of the Marine Strategy Framework Directive is to achieve Good Environmental Status of EU marine waters by 2020. It requires EU Member States to develop marine strategies that apply an ecosystem approach to the management of human activities while enabling sustainable use of marine goods and services. It applies to all human activities that have an impact on the marine environment.

20. In order to determine Good Environmental Status a number of high level descriptors are specified within the Directive, one of which is the '*Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment*'. The initial purpose of this descriptor is to assess the overall pressure from manmade noise on the marine environment and the UK has produced a marine noise register, which requires noise, particularly impulsive noise, to be reported.

Marine (Scotland) Act 2010

21. The Marine (Scotland) Act 2010 re-enacts the Conservation of Seals Act 1970. Under Section 117 of the Marine (Scotland) Act specific seal haul out sites have been designated to provide additional protection for seals from intentional or reckless harassment. It is an offence under the Act to intentionally or recklessly harass seals at these sites. Within the Firths of Forth and Tay areas three haul out sites have been designated under the Act. Haul out sites within the Isle of May SAC and the Berwickshire and Northumberland Coast SAC are designated for grey seal and the haul out sites in the Firth of Tay and Eden Estuary SAC are protected for harbour seal.

Nature Conservation (Scotland) Act 2004.

22. The Nature Conservation (Scotland) Act 2004 sets out a series of measures, which are designed to conserve biodiversity and to protect and enhance the biological and geological natural heritage of Scotland. The Act makes amendments to the Wildlife and Countryside Act 1981 in Scottish waters, including the addition of 'reckless' acts to species protection, which make it an offence to intentionally or recklessly disturb a cetacean. The Act also implements the requirements of the Bern Convention 1979.

Wildlife and Countryside Act 1981

23. Section 9(4A) of the Act makes it an offence to intentionally or recklessly disturb or harass a wild animal listed in Schedule 5 and both whales and dolphins are listed in Schedule 5 of the Act.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1973.

24. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has been implemented at a European level through a set of Regulations known as the EU Wildlife Trade Regulations, which includes Council Regulation 338/97 on the protection of species of wild fauna and flora by regulating trade therein, and in the UK (in respect of enforcement) through the Control of Trade in Endangered Species (Enforcement) Regulations 1997 (COTES. It aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival in the wild. Species covered under CITES are listed in three appendices according to the level of protection required. Appendix I includes species threatened with extinction, Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled and Appendix III contains species protected in at least one country. The minke whale appears on Appendix I with white-beaked dolphin and harbour porpoise appearing on Appendix II. All cetaceans are listed in Annex A of Council Regulation 338/97.

Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) 1979.

25. The Bern Convention is intended to promote cooperation between Contracting Parties in order to conserve wild flora and fauna and their natural habitats and to protect endangered and vulnerable species (including endangered and vulnerable migratory species). The Convention is largely implemented through the EU Habitats Directive (92/43/EEC). The obligations of the Convention are transposed into national law by means of the Wildlife and Countryside Act 1981 (as amended) and Nature Conservation (Scotland) Act 2004 (as amended). The Convention prohibits the deliberate killing and significant disturbance of species listed in Appendix II and requires that any exploitation of species listed in Appendix III is regulated. Most cetaceans (including harbour porpoise, minke whale, orca, white-beaked dolphin and bottlenose dolphin) are listed in Appendix II and seals (including grey seal and harbour seal) are listed in Appendix III.

Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention) 1979.

26. The Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention) aims to conserve migratory species throughout their range, with species that need, or would benefit from, international co-operation. Appendix II of the Convention covers migratory species that have an unfavourable conservation status and that require international agreements for their conservation and management. Species listed in Appendix II includes bottlenose dolphin, white-beaked dolphin (*Lagenorhynchus albirostris*) and harbour porpoise. Under the Bonn Convention, the UK ratified the Agreement on the Conservation of Small Cetaceans in the Baltic, North-East Atlantic, Irish and North Seas (ASCOBANS).

Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) 1994 – amended in 2008 to the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas.

27. The Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) implements the requirements of the Bonn Convention and aims to promote close cooperation amongst Parties with a view to achieving and maintaining a favourable conservation status for small cetaceans, including the bottlenose dolphin, white-beaked dolphin and harbour porpoise.

Convention for the Protection of the Marine Environment of the North-East Atlantic 1998 (OSPAR Convention)

28. The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) aims to provide a comprehensive and simplified approach to addressing issues associated with maritime pollution. Additionally, OSPAR also provides for the '*protection and conservation of the ecosystem and biological diversity of the maritime area*', which includes criteria for identifying human activities and work on Marine Protected Areas (MPAs). There is an agreed list of threatened and declining species that includes harbour porpoise. Although not legally binding the purpose of the list is to strengthen the protection of the harbour porpoise at all life stages in order to recover its population, to improve its status and to ensure that the population is effectively conserved. Contracting Parties should consider establishing measures to reduce or avoid disturbing and/or harmful acoustic effects to harbour porpoises especially from seismic surveys, pile driving, shipping traffic, military activities and underwater explosions.

Table 8.1: Legislation and relevant species

Legislation / Conventions	Relevant Species
Habitats Directive	Cetaceans, grey and harbour seal
Habitats Regulations	Cetaceans, grey and harbour seal
Marine Strategy Framework Directive	Cetaceans and seals
Marine (Scotland) Act 2010	Seals
Wildlife and Countryside Act 1981 (as amended)	Cetaceans
Nature Conservation (Scotland) Act 2004	Cetaceans
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1973	Cetaceans
Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) 1979	Cetaceans, grey and harbour seal
Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention) 1979	Cetaceans
Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) 1994 – amended in 2008 to the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas.	Small cetaceans regularly occurring in the Baltic, North East Atlantic, Irish and North Seas
OSPAR Convention (Convention for the Protection of the Marine Environment of the North-East Atlantic) 1998	Harbour porpoise

29. There are also a number of published guidance documents providing information on impact assessments that have been used to inform the marine mammal chapter including:

- European Guidance on wind energy development in accordance with the European Union (EU) nature legislation (EC 2010),
- Oslo Paris Convention (OSPAR) Guidance on Environmental Considerations for Offshore Wind Farm Development (OSPAR 2008),
- Natura 2000 Conservation Guidelines on Offshore Wind Farm Development (Defra 2005).
- Scottish Natural Heritage (SNH) guidance on Habitats Regulation Appraisal (Tyldesley and Associates 2015,
- Chartered Institute for Ecology and Environmental Management (IEEM) Guidelines for Ecological Impact Assessment in Britain and Ireland (Marine and Coastal) (IEEM 2010).

8.3 Favourable Conservation Status

30. Favourable conservation status (FCS) is defined in Article 1 (i) of the Habitats Directive as follows:

- "Conservation status of a species means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the territory referred to in Article 2. The conservation status will be taken as 'favourable' when:
  - Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats;
  - The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and
  - There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis."

31. The Favourable Conservation Status for the relevant marine mammals and the regional Management Unit populations are presented in Table 8.2.

Table 8.2: Favourable Conservation Status of marine mammals considered in this assessment

Species	FCS assessment	Regional Management Unit population
Harbour porpoise	Favourable	227,298 (95% CI 176,360 - 292,948) **333,808**
Bottlenose dolphin	Unfavourable	195 (95% HDPI 162 – 253)
White-beaked dolphin	Favourable	15,895 (95% CI 9,107 – 27,743) **35,908**
Orca	Unknown	Unknown 1,000's
Minke whale	Favourable	23,528 (95% CI=13,989-39,572) **11,819**
Grey seal	Favourable	9,607 (95% CI 8,028 – 11,958)
Harbour seal	Unfavourable	311 (95% CI 254 - 415)

Regional Management Unit population is based on IAMMWG (2015). Bottlenose dolphin population is based on the Coastal East Scotland population from Cheney *et al*. (2013).
Figures in bold are the latest management unit population estimates (JNCC 2017)
Grey and Harbour seal population estimates are the adjusted total for the East Coast Management Area.
Note: Seals are not listed under Annex IV of the Habitats Directive but are listed in Annex II and Annex V.

32. The status of a population becomes unfavourable should it decline by more than 1% per year or if there is an overall decrease in the population by more than 25% (European Commission, 2005).

8.4 Designated Sites

33. Four SACs along the east coast of Scotland and northern England have qualifying marine mammal species whose populations may make use of the Offshore Wind Farm Area (Figure 8-1). These SACs 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).

34. Given the potential connectivity of the proposed Project with these SACs, there is a requirement to consider the effects arising from the development of the Project in terms of the potential impacts on the integrity of these SACs. This is known as a Habitats Regulation Appraisal (HRA) and is required by the Habitats Directive (and transposing regulations). Further detailed information on HRA, including the legislative background and presentation of relevant information to inform an Appropriate Assessment, is provided separately in support of the consent applications (Habitats Regulations Appraisal Report, Document Ref. UK02-0504-0742-MRP-HRA_REPORT-RPT-A2).

35. The Southern North Sea cSAC, for which harbour porpoise is a qualifying species, is in excess of 100 km from the Project and therefore there is no potential for connectivity between impacts arising from planned activities relating to the proposed Project and the qualifying species within the site.

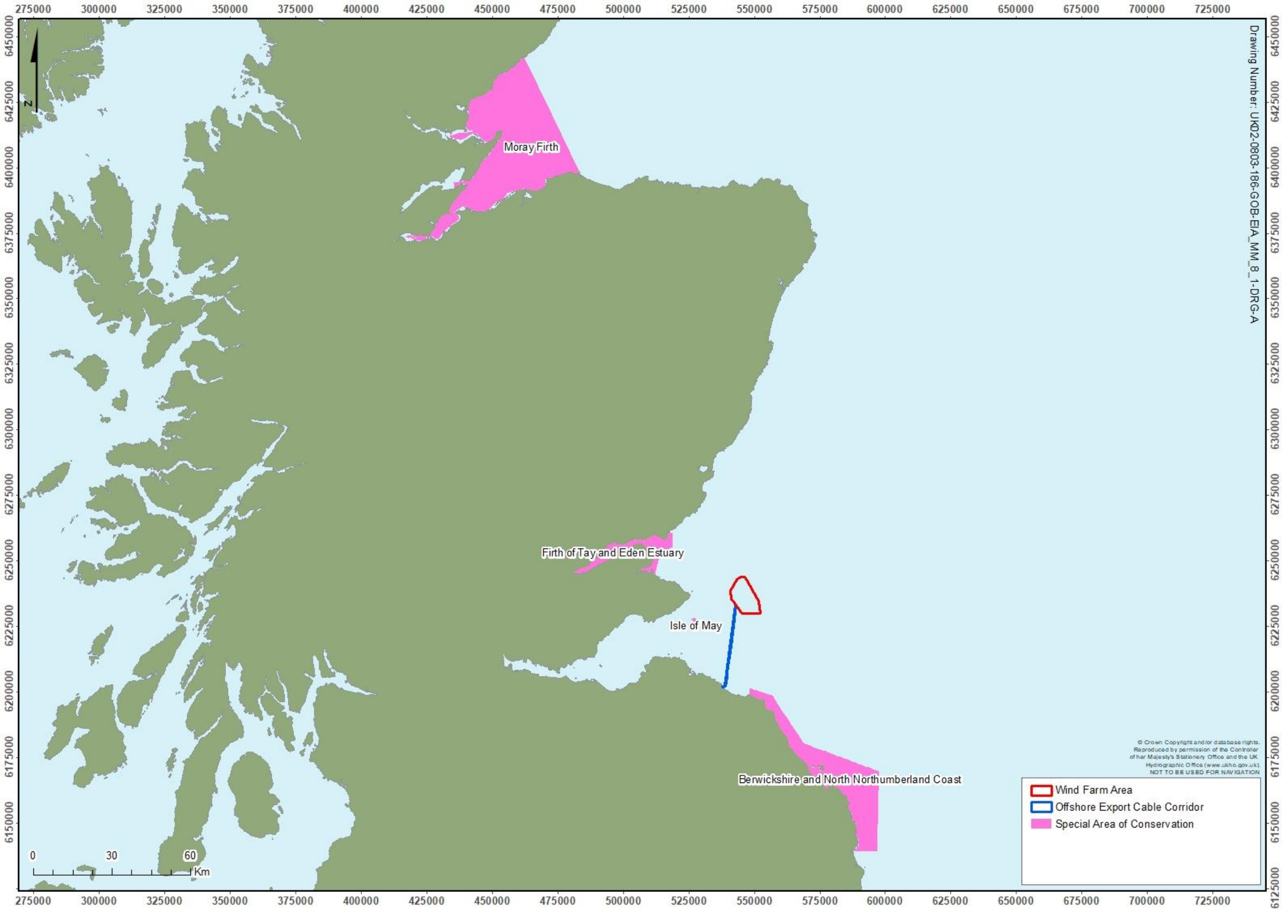


Figure 8-1: SACs identified as having qualifying species at risk of being impacted by the proposed Project

8.5 Data Sources

36. The assessment conducted considers the potential interaction between the Project, as described in Chapter 4: Project Description, and the marine mammal receptors, including their prey, that may be present within the study area.

37. Baseline characterisation data has been collated combining a thorough desk-based study of extant data supplemented with a series of site-specific surveys. Table 8.3 details the data sources used to inform the baseline characterisation within the study area.

Table 8.3: Data sources used to inform the baseline characterisation within the study area

Data Source	Study/Data Name	Overview
NnGOWL	Site specific marine mammal survey data 2009 – 2012. (NnGOWL, 2012; 2013).	Site specific marine mammal survey data collected monthly from between November 2009 and October 2012. The surveys covered the wind farm area and surrounding waters out to 8 km from the Wind Farm Area boundary.
SMRU	*Cetacean baseline characterisation for the Firth of Tay based on existing data: Bottlenose dolphins* (Quick and Cheney, 2011).	The report provides background information on bottlenose dolphins to inform site assessments. It presents the spatial and temporal extent of bottlenose dolphins in the region and their abundance. The report also assesses the connectivity of bottlenose dolphins between the Tay and the Moray Firth SAC.

Data Source	Study/Data Name	Overview
SMRU	*Assessment of The Crown Estate aerial survey marine mammal data for the Firth of Forth development areas* (Macleod and Sparling, 2011)	The report provides an overview of the marine mammal data collected from aerial surveys commissioned by The Crown Estate during 2009 and 2010.
SMRU	*Analysis of The Crown Estate aerial survey data for marine mammals for the FTOWDG*. (Grellier and Lacey, 2011)	The report presents the results of analysis undertaken on the marine mammals recorded from aerial surveys undertaken during 2009 and 2010. It presents estimates of abundance and densities for harbour porpoise, white-beaked dolphin and 'all seals'.
NnGOWL	*Marine Ecological Research, Marine Mammal Acoustic and Visual Surveys - Analysis of Neart Na Gaoithe data* (Gordon, 2012)	By using site specific acoustic and visual data collected over two years between November 2009 and October 2011, estimated densities of harbour porpoise and grey seal within the offshore wind farm area were calculated.
Forth and Tay Offshore Wind Developers Group (FTOWDG)	*Baseline seal information for the Forth and Tay area* (Sparling *et al.* 2012)	The report presents an analysis of existing satellite telemetry and aerial survey data to describe the abundance and distribution of harbour and grey seals in the Firths of Forth and Tay, specifically to inform site specific and cumulative assessments of the likely nature and extent of potential impacts from the development of offshore wind farms in the region.
DMP Statistical Solutions Ltd	*Forth and Tay Offshore Wind Developers Group: Cetacean surveys data analysis report* (Mackenzie *et al*. 2012).	The document presents the results of the statistical analyses of marine mammal survey data for the FTOWDG. The report presents spatial surfaces and associated estimates of abundance for harbour porpoise, white-beaked dolphin and minke whale.
University of Aberdeen	*Integrating multiple data sources to assess the distribution and abundance of bottlenose dolphins Tursiops truncatus in Scottish waters* (Cheney *et al*. 2013).	Using multiple sources of data, the report presents a comprehensive assessment of the abundance of bottlenose dolphins in the inshore waters of Scotland.
JNCC	*Management Units for cetaceans in UK waters* (January 2015) (IAMMWG 2015).	The report sets out the final agreed Management Units (MUs) for the seven most common cetacean species in UK waters. Details of each MU are provided, including boundaries and estimated abundance figures.
University of St Andrews	*Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys* (Hammond *et al*. 2017).	This report presents the initial results from the latest SCANS III surveys. It provides the latest cetacean population estimates.
University of St Andrews and Marine Scotland	*Categorizing click trains to increase taxonomic precision in echolocation click loggers* (Palmer *et al*. 2017).	Paper presents the findings from C-PODs deployed to detect dolphins in the Moray Firth and along the east coast of Scotland during 2013. Using newly developed statistical techniques to separate bottlenose and white-beaked dolphin vocalisations the relative encounter rates of both species within the region are presented.

Data Source	Study/Data Name	Overview
ECOMMAS	*The East Coast Marine Mammal Acoustic Study data. doi: 10.7489/1969-1* (Brookes, K. 2017).	Data from C-PODS deployed at ten locations in the Moray Firth and along the east coast of Scotland between 2013 and 2016.

8.6 Relevant Consultations

38. As part of the EIA process, NnGOWL has consulted with various statutory and non-statutory stakeholders. A formal scoping opinion was requested from MS-LOT following submission of the Scoping Report. Ongoing consultation with stakeholders continued post-scoping and responses have been used to develop an appropriate methodology and parameters for assessment.

39. In response to the scoping request, MS-LOT issued a Scoping Opinion identifying the impacts to be scoped into the assessment. A summary of the main issues raised during scoping and through other consultations are summarised in Table 8.4.

Table 8.4: Summary of consultation relating to marine mammals

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
3 April 2017. **NnGOWL Pre-Scoping Discussion, Seabirds and Marine Mammals with SNH**	SNH advised that it was not necessarily essential to update the noise modelling if it could be shown that the magnitude of any potential impacts had not increased since the application was made.	Due to the revised approach to modelling and changes in the thresholds at which noise may impact upon marine mammals, Revised noise modelling has been undertaken.
	It was agreed that the use of dBht, as previously used, was not now considered the most appropriate approach to use.	The use of dBht as a metric to assess impacts from noise on marine mammals has not been used in this assessment (See Appendix 8.1: Noise modelling).
	NnGOWL advised that the information required for an EPS licence application would be presented within the future application.	See Appendix 8.3: EPS Licence Assessment.
13 June 2017 **NnGOWL Scoping Meeting with MS-LOT, Marine Scotland Science (MSS) and SNH**	It was confirmed by MS and SNH that no new baseline survey data would be required for the application.	Information on the baseline data used can be found in Section 8.8.1 (Baseline surveys).
	As per the scoping document, the focus of the assessment is to be on construction noise, i.e. piling noise and potential impacts on marine mammals from other activities and noise sources could be scoped out of the EIA. No concerns were raised during the meeting about the approach taken in the scoping document.	Information on the scope of the EIA is presented in Table 8.23.
	Noise modelling presenting results based on both the Southall and NOAA thresholds should be presented within the application.	Both are presented, see Appendix 8.1: Noise modelling

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	SNH advised that an assessment of potential impacts from Acoustic Deterrent Devices (ADD) should be included in the EIA.	The use of ADDs are addressed in Section 8.11.
	Population Viability Analysis (PVA) modelling would be used to help determine possible population level effects from disturbance on bottlenose dolphins. MSS advised that the use of the interim PCoD model should be considered within the EIA.	The interim PCoD model has been used in this assessment (See Appendix 8.2: Interim PCoD modelling and Sections 8.10.6 and 8.10.12).
27 June 2017-10-11 **NnGOWL marine mammal meeting with Whale and Dolphin Conservation (WDC)**	WDC advised that impacts from helicopters should be addressed in the new application.	See Section 8.10.9.1.
	WDC advised that if ADDs were to be used then these would need to be assessed in the EIA.	See Section 8.11.
8 September 2017 Scoping Opinion – Scottish Ministers	The Scottish Ministers agree that the baseline detailed in the Original ES is still valid and note that the other data now available that can be used to ensure the information is the most up to date.	Section 8.8 includes an updated baseline description and uses latest published information.
	The Scottish Ministers agree that bottlenose dolphin, harbour seal, grey seal, harbour porpoise, minke whale and white-beaked dolphin should be included in the EIA.	Section 8.8 and 8.10 consider the potential impacts on these species.
	MSS agree with the developer and SNH that the assessment will need to cover the impact of increasing the energy of the hammer used to install the piled foundations. MSS also agree that since the other potential impacts to marine mammals are the same, or reduced, compared with the original ES, that this is the only area that requires consideration in the Project EIA.	Since the Scoping Opinion was issued, there was some discussion regarding a potential increase to hammer energy, compared with that presented in the Scoping Report. It was subsequently established this would not be required and that maximum hammer energy would remain the same as the Original Application. See Chapter 4: Project description.
	The Scottish Ministers agree that the IAMMWG 2015 figures for the cetacean reference populations and the additional references suggested by SNH should be used. The Scottish Ministers confirm that the approach agreed at the Inch Cape workshop on 27 July 2017, and described above, with regard to bottlenose dolphin distribution should be used.	IAMMWG reference populations have been used but also more up to date SCANS III survey abundances have been used. (See species accounts in Section 8.8)
	The Scottish Ministers agree that: • The management units based on the IAMMWG (2015) guidance should be used. • If available, the SCANS-III surveys should be used for abundance estimates as these are the most up to date, if not available	The Management Units as described in the IAMMWG (2015) are recognised with the exception of bottlenose dolphin, which is based on

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	then the IAMMWG (2015) guidance should be used. • The most up to date SCANS-III survey results for Block R should be used to provide a regional abundance estimate for use within the assessment. • Distribution data for these species can be taken from the Original ES, unless other more recently published data are available.	advice received in the Scoping Opinion. Management Units based on SCAN III data has been used for abundance estimates. SCANS III survey data from Block R have been used in the assessment for regional abundances. Distribution data has been updated to include a third year of survey results that were obtained following the submission of the Original Development ES. (See species accounts in Section 8.8)
	The Scottish Ministers agree that the Special Committee of Seals (SCOS) seal management units and population estimates are used and advise that the seal usage maps produced by [the] Sea Mammal Research Unit (SMRU) are used for distribution data on both species.	The SCOS seal management units are included and figures produced by SMRU are presented for both species of seal in in Section 8.8.
	Both instantaneous and cumulative permanent threshold shift (PTS) should be presented, modelled for each of the species. The total number of individuals from each species that may suffer PTS and the number that may be displaced through disturbance should be presented.	Detailed noise modelling has been undertaken in support of this assessment. The methods and results are presented in Appendix 8.1: Noise modelling
	Swim speeds as outlined by SNH in the guidance note should be used along with information provided by SMRU in relation to bottlenose dolphin swim speeds (which can be used as a proxy for white-beaked dolphin).	These have been used in the noise modelling (Appendix 8.1: Noise modelling).
	Fleeing should be considered to begin from the start of ADD use.	The use of ADD by the Project has not been confirmed yet and is discussed as possible mitigation (Section 8.11).
	PTS thresholds from both Southall *et al.* (2007) and the NOAA (2016) should be presented.	Outputs from noise modelling based on both Southall and NOAA thresholds are presented in Appendix 8.1: Noise Modelling. The assessment is based on the NOAA thresholds. These are the latest published information on marine mammal hearing thresholds and present the worst-case scenario.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	A dose response curve should be used to determine the proportion of animals likely to be disturbed sufficiently to displace them by piling noise. NnGOWL should take into account the concerns noted above about the use of the Horns Rev II and make use of other relevant data as noted above, in particular the data from the Beatrice Offshore Wind Farm in relation to piling if available.	Presented in Appendix 8.1: Noise Modelling.
	The Scottish Ministers advise that, for bottlenose dolphin, an assessment of the impacts of the Revised Development alone on the East Scotland management unit population as well as cumulatively with other developments that may impact on the same population is required. NnGOWL should ensure that the information provided can be used for an Appropriate Assessment in relation to the Moray Firth SAC.	The relevant information can be found in Appendix 8.1: Noise Modelling, and the Habitats Regulations Assessment
	The Scottish Ministers advise for harbour porpoise, minke whale, white-beaked dolphin, harbour seal and grey seal that further assessment is only carried out if the effects of the Revised Development are found to be greater than those assessed for the Original Development.	Due to the revised noise modelling undertaken and the latest thresholds at which the onset of physical injury is predicted to occur, further assessment has been undertaken on all marine mammals identified as being at risk of a significant impact from noise during the construction phase. (Section 8.10)
	The Scottish Ministers request that, where necessary, the information is provided in a form that means it can be used for the EPS process or, where needed, to inform the Appropriate Assessment as part of an HRA.	Appendix 8.3 presents the information in a form that means it can used for the EPS application process should an EPS licence be required.
	The Scottish Ministers advise that the interim PCoD framework is used for species where population level impact assessments are undertaken. The Scottish Ministers request that a comprehensive list of the parameters input and other relevant information to allow MSS to be able to replicate the analysis is provided. As a minimum this must include: • The piling schedule, • The demographic parameters, • Starting population size, • Copy of the code used to run the model, • Any quality assurance/quality control outputs that the software produces, • The Scottish Ministers advise that the results of the assessment using interim PCoD should be presented using the	Appendix 8.2: Interim PCoD modelling presents the information relating to the interim PCoD.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	metrics provided in the MSS guidance note.	
	The Scottish Ministers consider the following projects should be considered for inclusion in the cumulative impact assessment: • Worst case scenario of Neart na Gaoithe (2014 as consented) or Neart na Gaoithe (2017 scoping report) • Worst case scenario of Seagreen Alpha and Bravo (2014 as consented) or Seagreen (2017 scoping report) • Worst case scenario of Moray Offshore East Development or Moray East Offshore Wind Farm – Alternative Design • Beatrice Offshore Wind Farm • Moray West Offshore Wind Farm • Aberdeen Harbour Expansion project The Cumulative Impact Assessment is likely to benefit from discussion once the initial results of the noise modelling are available, therefore the list of projects to be included may be refined following this.	The projects advised to be considered for potential cumulative impacts have been included in the assessment (See Section 8.10.9). Including those for Inch Cape (2014 as consented and Inch Cape (2017 scoping report)
22/09/17 **NnGOWL Noise Modelling meeting with MS-LOT, MSS and SNH**	MS advised that the assessment can only use information that is available and it should be based on published information.	The assessment is based on the available information including those presented in Section 8.5.
	SNH confirmed that they were content with the algorithms being used for the noise modelling.	See Appendix 8.1: Noise modelling for details of noise modelling undertaken.
	SNH advised that outputs should be based on M-weighted cumulative SEL metric.	See Appendix 8.1: Noise Modelling for details of noise modelling undertaken.
	SNH confirmed that they were content with the use of interim PCoD as part of the assessment process.	The interim PCoD model has been used based on published available information. See Appendix 8.2: Interim PCoD modelling for details of the population modelling undertaken.
27/09/17 **Email MS to NnGOWL**	MS advise that the worst-case in-combination impact will arise if all projects undertake construction sequentially as opposed to concurrently, therefore this should be the basis for the cumulative assessment.	Cumulative impacts are based on sequential construction scenario (Appendix 8.1 Noise modelling and Section 8.10.10)

40. In summary, the results of the scoping exercise identified the impacts arising from the installation of the foundation piles as having potential to cause a significant impact on marine mammals. This was due to the noise produced by the hammer used for driving the foundation piles into the seabed.

41. All other sources of potential impacts on marine mammals arising during the construction, operation and decommissioning phases of the project were assessed as not causing a significant impact on marine mammals and were scoped out of requiring further assessment within the EIA Report (NnGOWL, 2017). This was agreed with Marine Scotland and their advisors in their response to the scoping document (Marine Scotland, 2017a).

8.7 Impact Assessment Methodology

42. This assessment considers the potential impacts associated with the construction, operation and decommissioning of the Project and the effects on marine mammals. The impact assessment process and methodology follows the principles and general approach outlined in Chapter 6: EIA Methodology. The methodology and parameters assessed have also taken into account issues identified through consultation with stakeholders as detailed in (Section 8.6) and the understanding of baseline conditions informed by the data sources referenced in (Section 8.5).

43. The Project Description (Chapter 4) and the project activities for all stages of the project life cycle (construction, operation and decommissioning) have been assessed against the environmental baseline to identify the potential interactions between the Project and the environment. These are known as the potential impacts and are then assessed to determine a level of significance of effect upon the receiving environment.

8.7.1 Assessment and Assignment of Significance

44. The sensitivities of marine mammals are defined by both their potential vulnerability to an impact from the Project, their recoverability and value or importance of the receptor. The definitions of terms relating to marine mammals are detailed in Table 8.5.

45. The magnitude of impact is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact. The definitions of the levels of magnitude used in this assessment in respect of marine mammals are described in Table 8.6.

Table 8.5: Sensitivity / importance of the environment

Receptor sensitivity / importance	Description / justification
High	High or very importance and rarity, international or national scale and limited potential for substitution. Receptor population has very limited tolerance of effect i.e. likely to have limited capacity to absorb change, so a population level effect is likely to occur. Likely to be limited to populations with poor existing conservation status.
Medium	High or medium importance and rarity, regional scale, limited potential for substitution. Receptor population has limited tolerance of effect, i.e. a very minor capacity to absorb change so a population level effect is possible. Likely to include but not be limited to populations with poor existing conservation status.
Low	Low or medium importance and rarity, local scale. Receptor population has some tolerance of effect i.e. likely to have minor capacity to absorb additional mortality or a reduction in productivity, or habitat loss, so a population level effect unlikely.

Receptor sensitivity / importance	Description / justification
Negligible	Very low importance and rarity, local scale. Receptor population generally tolerant of effect i.e. likely to have moderate capacity to absorb additional mortality or a reduction in productivity, or habitat loss, so a population level effect very unlikely.

Table 8.6: Magnitude of the impact

Magnitude of impact	Description (adverse)	Description (beneficial)
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements.	Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality.
Medium	Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements.	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
Low	Some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring.
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements.	Very minor benefit to, or positive addition of one or more characteristics, features or elements.
No change	No loss or alteration or characteristics, features or elements; no observable impact in either direction.	

46. The magnitude of the impact is correlated against the sensitivity of the receptor to provide a level of significance. For the purposes of this assessment any effect that is considered to be of moderate or major significance in Table 8.7, is considered to be significant in EIA terms. Any effect that is considered to be minor or negligible is considered to be not significant.

Table 8.7: Significance of potential effects

		Magnitude of Impact			
		High	Medium	Low	Negligible
Sensitivity	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

8.7.2 Uncertainty and Technical Difficulties Encountered

8.7.2.1 Baseline Data

47. The assessment is based on the best information available at the time of undertaking the Project EIA. The assessment uses site-specific baseline survey data collected by trained and experienced observers each month for over a period of three years (See Chapter 9: Ornithology for details). These three years of marine mammal data along with supporting information on marine mammals over the wider area (See Table 8 3) provides a robust baseline on which to undertake an assessment.

8.7.2.2 Noise Modelling

48. The noise modelling used to help determine the extent and magnitude of any potential impact uses recognised published algorithms recommended for assessing impacts from sound arising from pile driving (Jensen et al. 2011; Porter and Liu, 1994). The model accounts for the effects of varying bathymetry, variations in sound speed through the water column and the differences that geo-acoustic properties of the seabed have on sound propagation. The noise model used for this assessment therefore reflects best practice as described by Farcas et al. (2016). There is an inherent degree of uncertainty associated with pile driving source levels, since the source frequency spectrum and source sound level are typically derived from back propagation of measurements made at distance from the sound source (Lepper et al. 2012a). To minimise such uncertainties, the noise model only utilises verifiable frequency spectra and source levels derived from peer reviewed published measurements.

49. There is however, uncertainty on the relationship between the levels of noise received and the impacts it may have upon a receptor. Published studies indicate that marine mammals with a relatively high frequency auditory range, e.g. harbour porpoise along with those with relatively low frequency auditory range, e.g. minke whale (Balaenoptera acutorostrata), may be more sensitive to sound than had previously been considered. The auditory weightings and the thresholds at which hearing damage are predicted to occur have therefore been revised. Currently there are two published thresholds at which hearing damage are predicted to occur: Southall et al. (2007) and NMFS (2016). The thresholds published in NMFS (2016), known as the NOAA thresholds, are based on more recent published research on marine mammal hearing than those published in Southall et al. (2007) and some of the authors of the NMFS (2016) paper were also authors of the Southall et al. (2007) paper. Noise modelling presented in Appendix 8.1: Noise Modelling, presents outputs based on both sets of thresholds. However, for the purposes of this assessment those based on the latest NOAA thresholds have been used.

50. It should be noted that the outputs from the noise modelling are based on there being no mitigation measures in place, specifically the use of Acoustic Deterrent Devices (ADDs). The use of ADDs significantly reduce the risk of any marine mammals occurring within the area in which the onset of PTS is predicted to occur and therefore effectively reduces the predicted number of marine mammals at risk of the onset of PTS to zero. Therefore, the noise and population modelling undertaken is considered worst-case if it is determined that ADDs are to be used (see Section 8.11.2: Acoustic Deterrent Devices).

51. Outputs from the noise model presented in Appendix 8.1 Noise modelling, include unweighted peak SPL and cumulative SEL metrics. Both metrics are considered suitable for assessing pulsed sound sources but it is recommended that the worst case should be used when undertaking assessments (e.g. Southall *et al*. 2007; NMFS, 2017). The differences in the estimated area of impact between the two metrics are often large, with cumulative SEL indicating a significantly larger area of impact compared with unweighted peak SPL and consequently producing potentially greater predicted impacts. This assessment has been based on the recommended approach of assessing based on the worst-case model outputs.

52. Different noise models are also available and these are also considered to be good industry practice. Results from these models may produce differing results that indicate less of an impact from pile driving. Given that NnG has applied a noise model that may produce results showing potentially larger areas of impact and consequently a greater number of marine mammals at risk of injury and disturbance the results from the noise modelling, which feed into NnG's iPCoD and marine mammal assessments, are very precautionary.

8.7.2.3 Interim Population Consequences of Disturbance Framework (iPCoD)

53. There is good evidence that marine mammals can be displaced or disturbed from an area while pile driving is being undertaken, e.g. Carstensen et al. 2006, Thompson et al. 2010 and Dähne et al. 2013.

However, there is uncertainty with regard to the effect the displacement from an area may have on a marine mammal. To address this uncertainty, the assessment is based on an assumption that displacement from an area will cause a negative effect on the ability of the individual to survive or breed; the consequences of which may be a population level effect. Version 3 of Interim Population Consequences of Disturbance Framework (iPCoD) population model has been used in this assessment to estimate the population level effects that displacement and disturbance may have (See Appendix 8.2: Interim PCoD modelling). The iPCoD was developed to evaluate the potential effects from the construction and operation of offshore renewable energy projects on marine mammal populations (King et al. 2015). Recognising the lack of empirical evidence for the effects disturbance may have on the survival and fecundity of marine mammals, the iPCoD framework relies on expert elicitation to estimate these effects. Although there is a level of uncertainty associated with this, the iPCoD framework has been previously used to assess potential population level effects from pile driving on harbour porpoises within SACs, e.g. Booth et al. (2017). However, the metrics used for these assessments have been based on the risk (or the additional risk) of an impact occurring. The outputs from the model and the metrics presented in this assessment are based on the recommendations from studies undertaken reviewing the robustness of population models and the metrics used (Cook and Robinson, 2017; Jitlal et al 2017) and the advice received in the Scoping Opinion (Marine Scotland 2017a).

54. It is recognised that the model is an interim model and is subject to ongoing development and refinement. It has had limited, if any use, in assessments on cetaceans other than harbour porpoise and it is understood that outputs have to date not been used to inform consent decisions in Scotland. The Marine Scotland website notes that 'We emphasise the interim nature of this approach, which was developed to deal with the current situation, where there is limited data on the way in which changes in behaviour and hearing sensitivity may affect the ability of individual marine mammals to survive and to reproduce.'

55. The SNCBs acknowledge that there are a number of gaps in understanding in respect of the influences disturbance can have on life-history parameters of marine mammals. Advances in the understanding of these effects will be used to replace parameters in the model as they become available and reduce uncertainty in the model outputs.

56. Key messages from SNCBs regarding iPCoD include the following:

57. 'Whilst SNCBs do not anticipate a need for the Interim PCoD to be used in the EIA/HRA processes for every single development, this tool may form a useful reference in standardising the type of data submitted in impact assessments which will help when assessing cumulative effects. For large-scale developments and clusters of developments the tool may also help standardise the process for population level assessments. Decisions on when PCoD might be a useful tool should be made on a case-by-case basis in discussion with the relevant SNCBs and Regulators.

58. One of the main strengths of the Interim PCoD may be at assessing the cumulative effect of several developments and SNCBs advise that this is better achieved at the strategic level (e.g. SEA, and/or as a result of a joint effort between regulators, their advisers and developers [e.g. regional monitoring groups]). We will be working to encourage this approach in the future.'

59. The results of iPCoD have been surprising, with predicted population increases due to piling in one instance, an error for another species and unexpectedly high long-term impacts for others. Given the interim nature of the model and the surprising results, outputs should be interpreted with caution.

8.7.2.4 Cumulative Construction Schedule

60. There is limited information available on other offshore wind farm developments considered within the cumulative assessment. Although information on the installation methods are presented in the applications for the consented Inch Cape Offshore Wind Farm and Seagreen Alpha and Bravo Offshore Wind Farms it is recognised that the revised projects, Inch Cape and Seagreen Phase I, will have

different design envelopes from those that were originally consented. Where available, information presented within the scoping document for each revised project has been used. However, where the relevant information is not available the assessment has been based on information published within the original applications.

61. There is considerable uncertainty over the potential construction schedule of other future offshore wind farms. Only offshore wind farms with a (Contract for Difference) CfD can progress to construction and at present, in Scotland only Beatrice, Moray East and NnG have CfDs. If all developments included in the cumulative impact assessment were to obtain CfDs, it is almost certain that there would be gaps between construction phases and potentially some overlap. This would therefore have a lower population level impact. However in the absence of certainty regarding certain projects (Moray West, Inch Cape and Seagreen) progressing or certainty regarding their construction programmes, a very much worst case scenario was adopted for the assessment.

62. This has potentially significant influence on the assessment when a population model is used to assess the population level effects arising from cumulative impacts. The worst-case scenario is predicted to arise when construction across the projects occurs sequentially over a period of years with no gaps in the construction activities between projects. For the purpose of this assessment this highly precautionary assumption has been made, with no breaks in pile driving noise between 2020 and 2028. This is extremely unlikely to occur. Cumulative impact results should therefore be viewed as highly precautionary.

8.7.2.5 Other Factors

63. The cumulative impacts from developments within the Moray Firth are based on published information presented within the applications. It is recognised that since these studies have been published that the noise models used and the output metrics have changed. Consequently, the number of individual marine mammals estimated to be impacted from the wind farms in the Moray Firth are based on different approaches than those used in the assessment of projects within the Firths of Forth and Tay.

64. The dose response curve used to assess the impacts from disturbance within this assessment is from published sources (Brandt et al. 2016). A dose response curve has been developed based on studies undertaken in the Moray Firth. However, it was not available at the time assessments for NnG were undertaken.

65. This assessment is based on the best available information and follows the assessment methods as required from the Scoping Opinion. Although there are areas of uncertainty these are recognised within the approaches used for this marine mammal impact assessment and a highly precautionary approach has been taken.

8.8 Baseline Description

66. The following section presents the baseline information on marine mammals that are known to occur regularly within the Firths of Forth and Tay and the wider area of eastern Scotland and north-east England. It draws upon existing information including studies undertaken to support the original application and the results from three years of site specific surveys.

67. A total of four species of cetacean: harbour porpoise, white-beaked dolphin, orca (*Orcinus orca*) and minke whale were recorded during site specific surveys undertaken between 2010 and 2012. In addition to the four species of cetacean recorded, existing information indicates that bottlenose dolphin occur regularly in nearshore waters of the Firths of Forth and Tay and along the east coast of Scotland. Although no bottlenose dolphins were recorded during site specific surveys, their potential proximity to the proposed Project suggests that there is potential for Project to impact on them. Therefore, bottlenose dolphin is also considered as part of this assessment.

68. Two species of seal: harbour seal and grey seal were recorded during the site specific surveys.

8.8.1 Site Specific Surveys

69. Much of the available site-specific information on marine mammals was obtained from three years of boat-based surveys undertaken each month between November 2009 and October 2012. In addition to boat-based surveys, monthly acoustic surveys were undertaken between December 2010 and August 2011. Data from aerial surveys undertaken across the Firth of Forth and Firth of Tay area during 2009 and 2010 are also available to inform the marine mammal baseline information. Based on advice received in the Scoping Opinion these data have been used to support this assessment (Marine Scotland 2017).

8.8.1.1 Survey Methods

Boat-Based Surveys

70. Three years of boat-based surveys were undertaken across the Wind Farm Area and an 8 km 'buffer' area surrounding the site. A series of transects running in a north-west to south-easterly direction across the study area and spaced 2 km apart was surveyed each month and an average of 52.4 km of line transect were collected each month, with the exception of November 2010 and December 2011 when no data were collected due to poor weather making it unsuitable for marine mammal surveys.

71. Marine mammals were counted ahead of the ship and out to one side of the survey vessel in a 90º arc, with a 300 m transect width and using two surveyors, as per Camphuysen *et al.* (2004). Three European Seabirds at Sea (ESAS) accredited surveyors were on board for the majority of surveys. At any one time, one surveyor was acting as the primary observer, with a second acting as scribe and secondary observer, while the third surveyor was on a break.

72. Marine mammals (seals and cetaceans) were recorded concurrently with seabirds. Sightings were recorded using the same methodology as for birds on the water. Species, number of animals, direction of travel and behaviour were recorded. Binoculars were used to confirm identifications as well as to scan ahead for species. Animals were assigned to distance bands (A = <50 m, B = 51-100 m, C = 101-200 m, D = 201-300 m, E = >300 m), according to their perpendicular distance from the ship's track. The count interval for surveys was 1 minute intervals, and synchronised GPS recorders were used to record the vessel position every minute.

73. In addition, the angle of the sighting was estimated using an angle board and the radial distance was estimated either using a range finder or a visual estimate in metres, if no horizon was visible. Any marine mammals seen on the 'non-survey' side of the vessel were also recorded. Other species that were visible from the vessel, such as basking sharks, were noted regardless of the distance from the vessel.

74. Environmental conditions such as wind direction and force, sea state, swell height and visibility were recorded every 15 minutes throughout survey days. Surveys were carried out in good weather where possible, to maximise detection rates of marine mammals on the water. Surveys were halted if conditions exceeded sea state 4, as recommended in Camphuysen *et al.* (2004).

Acoustic Survey

75. Monthly acoustic surveys using a stereo towed hydrophone system capable of detecting small odontocetes (porpoises and dolphins) were undertaken within the Wind Farm Area between 2010 and 2011. A total of 2,579 km of line transects were surveyed using a passive acoustic detection system covering a total area of 2,140 km^2. During this period, a total of 263 harbour porpoises were detected (Gordon, 2012).

76. The acoustic surveys provide additional means of collecting cetacean data which are less affected by weather conditions and sea state. For harbour porpoise acoustic surveys provide a higher detection

rate under most field conditions and provide an independent method for detecting odontocete cetaceans and therefore offered the possibility of determining the proportion of available animals missed by either visual or acoustic teams, allowing g(0) (the proportion of animals detected on the trackline) to be calculated. With a reliable estimate of g(0) absolute abundance estimates could be calculated.

Aerial Surveys

77. Aerial surveys, commissioned by The Crown Estate (TCE), were undertaken across the Firths of Forth and Tay area during 2009 and 2010. The surveys were undertaken using visual observers and standard survey techniques along a series of fixed transects. Data were collected monthly with the exception of April, September and October.

8.8.2 Harbour Porpoise Baseline Data

78. The following presents a summary of the existing information on harbour porpoise.

8.8.2.1 Existing baseline

79. The harbour porpoise (*Phocoena phocoena*) is the most abundant cetacean species in UK waters with an estimated total North Sea population of 345,373 (95% CL 246,526 – 495,752) individuals (Hammond *et al*. 2017). The North Sea Management Unit population (based largely on previous Small Cetaceans in the European Atlantic and North Sea (SCANS II) surveys) is estimated to be 227,298 (95% CI 176,360 - 292,948) (IAMMWG, 2015). However, more recent estimates based on the latest SCANS III survey results indicate a total of 333,808 harbour porpoise within the North Sea Management Unit (JNCC, 2017). Within the SCANS III Block R, the area in which the proposed development is located, the estimated population of harbour porpoise is 38,646 individuals (95% CL 20,584 – 66,524) (Table 8.8). The abundance of harbour porpoise across the North Sea has not changed significantly since the initial SCANS surveys were undertaken in 1994 (Hammond *et al*. 2017). However, it is recognised that population estimates derived from SCANS surveys are each based on data from a single survey collected during a single month and that densities of harbour porpoise across the North Sea vary both temporally and spatially.

80. Densities of harbour porpoise across the North Sea as a whole are estimated to be 0.52 ind./km^2 with a density of 0.599 ind./km^2 within SCANS III Block R (Hammond *et al*. 2017) (Table 8.9).

Table 8.8: Harbour porpoise abundance estimates

Abundance	SCANS III [1]	SCANS III Block R [1]	SCANS III North Sea MU [2]	North Sea MU [3]	Firths of Forth and Tay [4]
Harbour porpoise	345,373 (246,526 – 495,752)	38,646 (CL 20,584 – 66,524)	333,808	227,298	582 (CI 581 – 1,235)
Source: 1. Hammond *et al*. 2017; 2. JNCC, 2017; 3. IAMMWG, 2015; 4. Mackenzie *et al.* 2012.					

Table 8.9: Estimated harbour porpoise densities

Density Ind./Km²	SCANS III North Sea [1]	SCANS III Block R [1]	Firths of Forth and Tay [2]	Firths of Forth and Tay [3]	Firths of Forth and Tay [4]	NnG [4]	NnG [5]
Harbour porpoise	0.52	0.599	0 - 0.4	0.048 – 0.099	0.5	0 – 0.1	0.38
Source: 1. Hammond *et al*. 2017; 2. Mackenzie *et al.* 2012; 3 Grellier and Lacey, 2011; 4. King and Sparling 2012; 5. Gordon, 2012.							

81. Data from ESAS and other databases indicate harbour porpoise are widespread across the continental shelf with relatively higher densities occurring in the Southern North Sea, Moray Firth and the west coast of Scotland (Reid *et al*. 2003; Paxton, *et al.* 2016; NMPI, 2017) . Evidence from the SCANS surveys undertaken in 1994, 2005 and 2016 indicates that there may have been a southward shift in the distribution of harbour porpoise from occurring predominantly around eastern Scotland and the northern North Sea to the central and southern North Sea since the early 1990's (Hammond *et al*. 2013, 2017) (Figure 8-2).

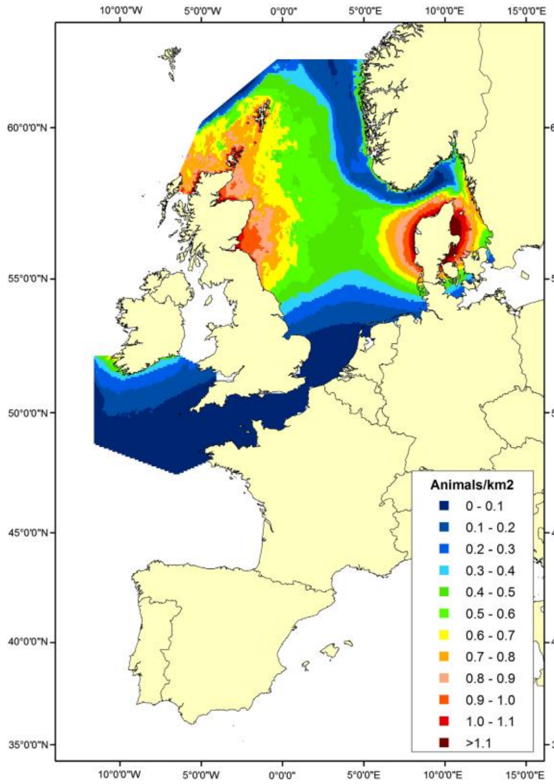


Figure a.

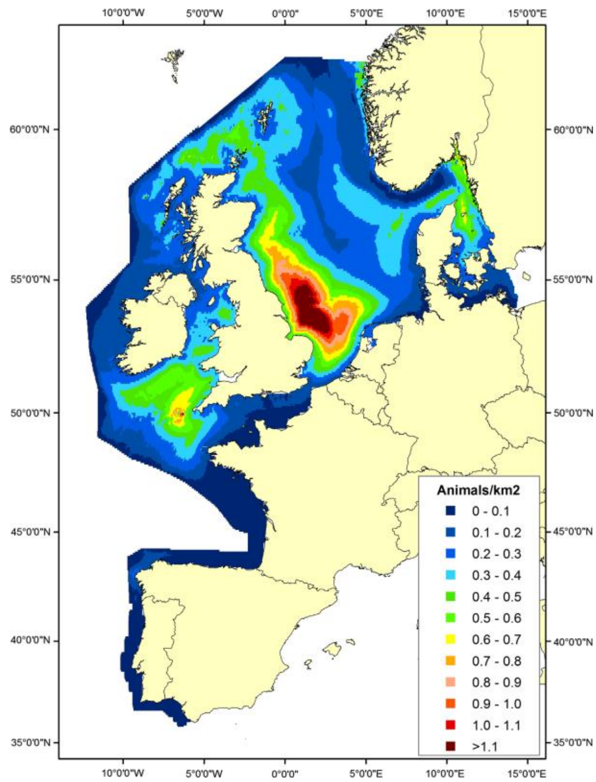


Figure b.

Figure 8-2: a) Predicted surface density for harbour porpoise in 1994. b) Predicted surface density for harbour porpoise in 2005 (Source Hammond *et al.* 2013)

82. Harbour porpoise occur widely across shelf waters, predominantly either individually or in small groups but larger aggregations have been reported (Defra, 2015); with group sizes varying with season (Clark, 2005). Although harbour porpoise has a very broad distribution across the United Kingdom Continental Shelf (UKCS), higher densities occur in areas of up-wellings and strong tidal currents and in water depths of predominantly between 20 and 40 m (Clark, 2005; Whaley, 2004). Their distribution

may also be strongly correlated with seabed type, with areas of sandy gravel being preferred and this may be linked to prey availability (Clark, 2005).

83. Tagging studies undertaken in Denmark indicate that harbour porpoises are highly mobile and range widely in the North Sea, with individuals tagged in the Skagerrak travelling up to 100 km per day and occurring off the east coasts of England and Scotland (Sveegaard, 2011).

84. Swimming speeds vary with the highest recorded swimming speeds being 4.3 m/s (Otani *et al.* 2000). Mean recorded speeds are typically around 1 m/s, although the average descent and ascent speeds reported as being 1.4 m s^{-1} (Otani *et al.* 2000; SNH, 2016, Kastelein *et al.* 2018). When disturbed harbour porpoise can increase swimming speeds with increasing sound levels. Studies using playback experiments of pile-driving sounds have reported increases in swimming speed from an average of 1.2 m/s to 2.0 m/s at sound levels of 154 dB re 1 µPa that were sustained for at least 30 minutes (Kastelein *et al*. 2018).

85. Although harbour porpoises may dive to depths of up to 226 m and remain submerged for up to five minutes, they more frequently undertake relatively shallow dives of a short duration, with a mean depth of 14 m and duration of 44 seconds (Santos and Pierce 2003; Otani *et al*. 1998; 2000). Studies undertaken on tagged 14 harbour porpoise in Danish and adjacent waters reported that on average harbour porpoise spend 55% of the time in the upper 2 m of the surface waters. The most frequent dive depths were between 14 m and 32 m, with the maximum depth dived of 132 m. The number of dives per hour increased from an average of 29 dives hr^{-1} between April and August to 43 dives hr^{-1} in October and November when it was presumed that higher levels of foraging activity occurred to compensate for the higher energy requirements required during the cooler winter period (Teilmann *et al*. 2007).

86. Harbour porpoise live for a maximum of between 15 – 20 years. Females become sexually mature at around three to four years old (Lockyer, 2003). Breeding is thought to occur primarily during the summer months between May and September, particularly in August, with calving 10 months later. Calves are nursed for eight to ten months but may remain with the mother until a new calf is born (Defra, 2015; Lockyer, 2003; Weir *et al*. 2007).

87. Harbour porpoise use echolocation to detect and track individual prey and are opportunistic feeders, foraging close to the seabed or near the sea surface, preying on a wide range of fish species including, herring (*Clupea harengus*), cod (*Gadus morhua*), whiting (*Merlangius merlangus*) and sandeels (*Ammodytidae* Spp.). Their prey will vary during and between seasons (Santos and Pierce, 2003). Studies undertaken in Denmark indicate that their local distribution may be correlated with prey availability (Sveegaard, 2011). The prey of harbour porpoise may change over time with a reported long-term shift in prey from clupeid species to sandeels and gadoid species (IAMMWG *et al.* 2015).

88. Their prey preferences within the proposed development area are not well known. However, species known to occur within the region include herring, cod, whiting, sandeels and sprats (*Sprattus sprattus*), all of which may be prey for harbour porpoise.

89. There nearest Special Areas of Conservation (SAC) for which harbour porpoise is a qualifying species is the Southern North Sea candidate SAC (cSAC), which is located in excess of 100 km from the Wind Farm Area and the conservation status of the population is in a Favourable condition (Table 8.2).

8.8.2.2 Site Specific Data

90. During three years of boat-based surveys harbour porpoise were the most frequently recorded species of cetacean with between 86 and 107 individuals recorded each year and accounted for 88% of all cetacean sightings (Table 8.10). The distribution of harbour porpoise across the surveyed area was uneven with few sightings within the Wind Farm Area but widely scattered sightings across the 8 km buffer zone (Figure 8-3). The majority of sightings were recorded outwith the Wind Farm Area, with a total of 19 harbour porpoise recorded during all three years of surveys in the Wind Farm Area compared with 263 individuals recorded within the Buffer area.

91. Harbour porpoise occurred within the surveyed area throughout the year and showed both inter-annual and seasonal variations. However, peak number of sightings were typically between February and April and there were relatively few sightings between May and July (Figure 8-4).

Table 8.10: Number of harbour porpoise recorded within the Wind Farm Area and 8 km buffer during boat-based surveys undertaken between November 2010 and October 2013

Year	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Year 1 (Nov 2010 – Oct 2011)													
WFA	0	10	0	0	0	0	0	0	0	1	0	0	11
Buffer	15	27	2	1	7	7	0	0	0	7	1	11	78
Total	**15**	**37**	**2**	**1**	**7**	**7**	**0**	**0**	**0**	**8**	**1**	**11**	**89**
Year 2 (Nov 2011 – Oct 2012)													
WFA	n/c	0	0	0	2	0	0	0	0	2	0	0	4
Buffer	n/c	1	0	6	13	15	0	0	7	20	11	9	82
Total	**n/c**	**1**	**0**	**6**	**15**	**15**	**0**	**0**	**7**	**22**	**11**	**9**	**86**
Year 3 (Nov 2012 – Oct 2013)													
WFA	0	0	0	4	0	0	0	0	0	0	0	0	4
Buffer	7	0	4	47	14	16	2	0	0	4	2	7	103
Total	**7**	**0**	**4**	**51**	**14**	**16**	**2**	**0**	**0**	**4**	**2**	**7**	**107**

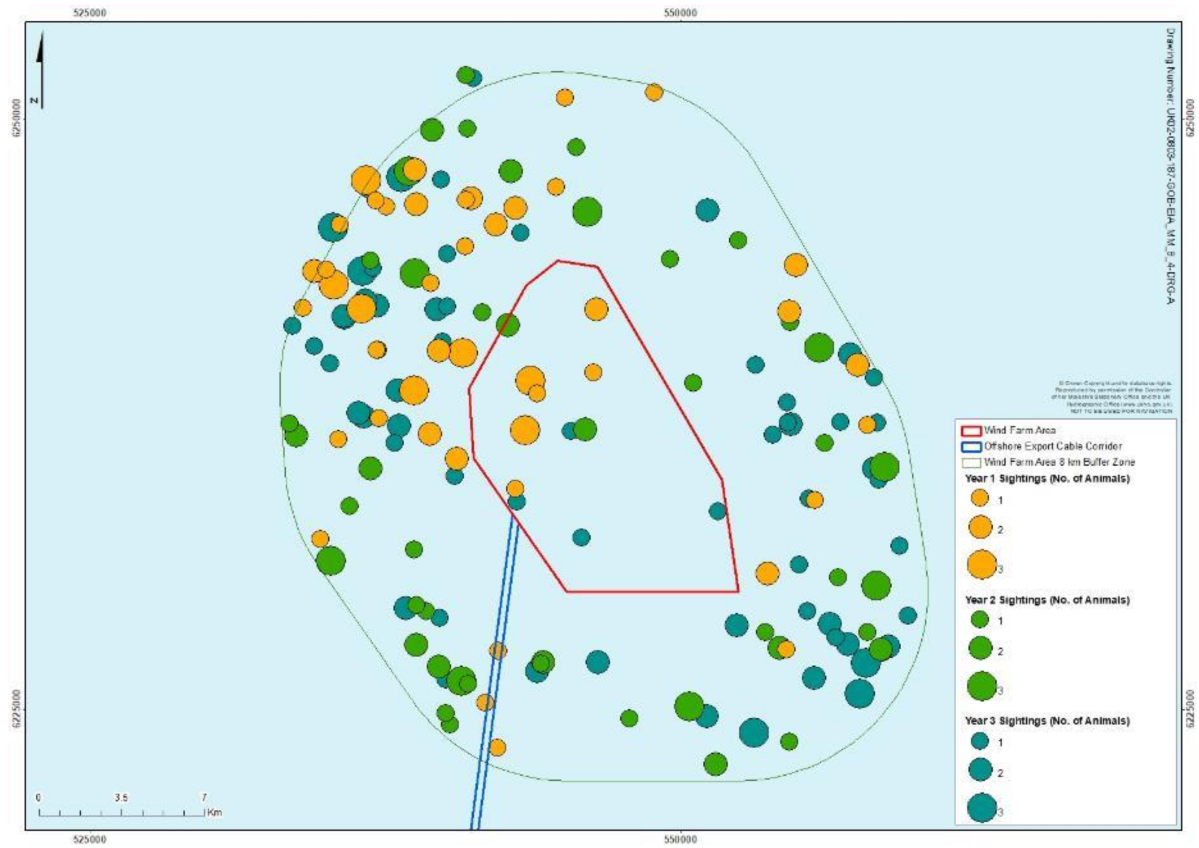


Figure 8-3: Distribution of harbour porpoise recorded within the study area during boat-based surveys undertaken between November 2010 and October 2013

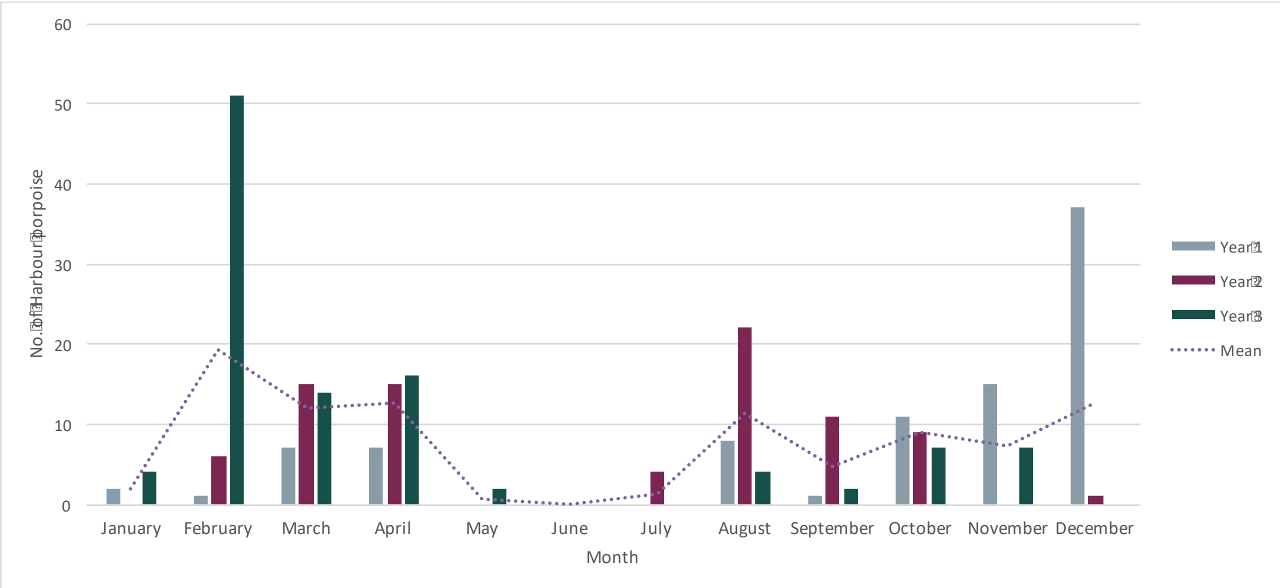


Figure 8-4: Monthly number of harbour porpoise recorded within the study area during boat-based surveys undertaken between November 2010 and October 2013

92. Within the local region harbour porpoise are recorded widely. Between 2013 and 2016 C-PODs have been deployed between Cromarty and St Abb's Head, including at five locations between Cruden Bay and St Abb's Head (Brookes, 2017). Porpoises were recorded most days with daily detection rates from all C-PODs of 97% or more. The exception being at a C-POD located within 5 km of St Andrews, where porpoises were only detected between 52% and 67% of the days that it was deployed over a period of four years (Figure 8-5 and Figure 8-6).

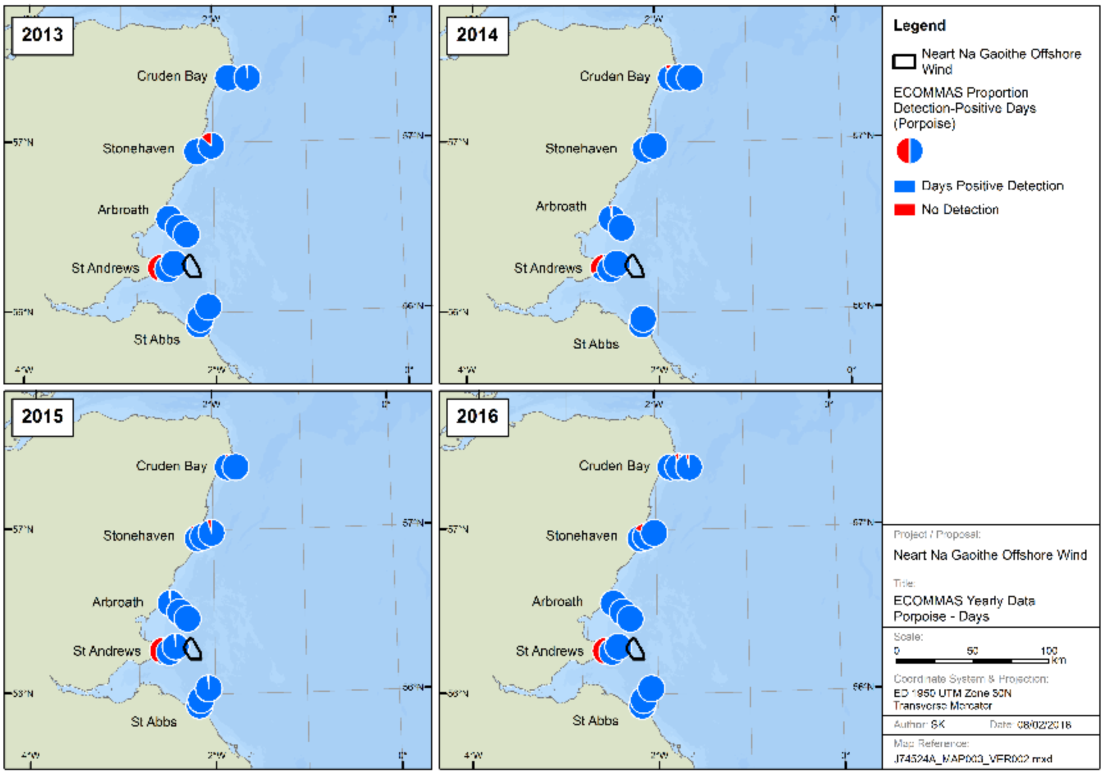


Figure 8-5: Harbour porpoise positive detection days at C-PODs located between Cruden Bay and St Abb's Head from 2013 to 2016 (Source Brookes, 2017)

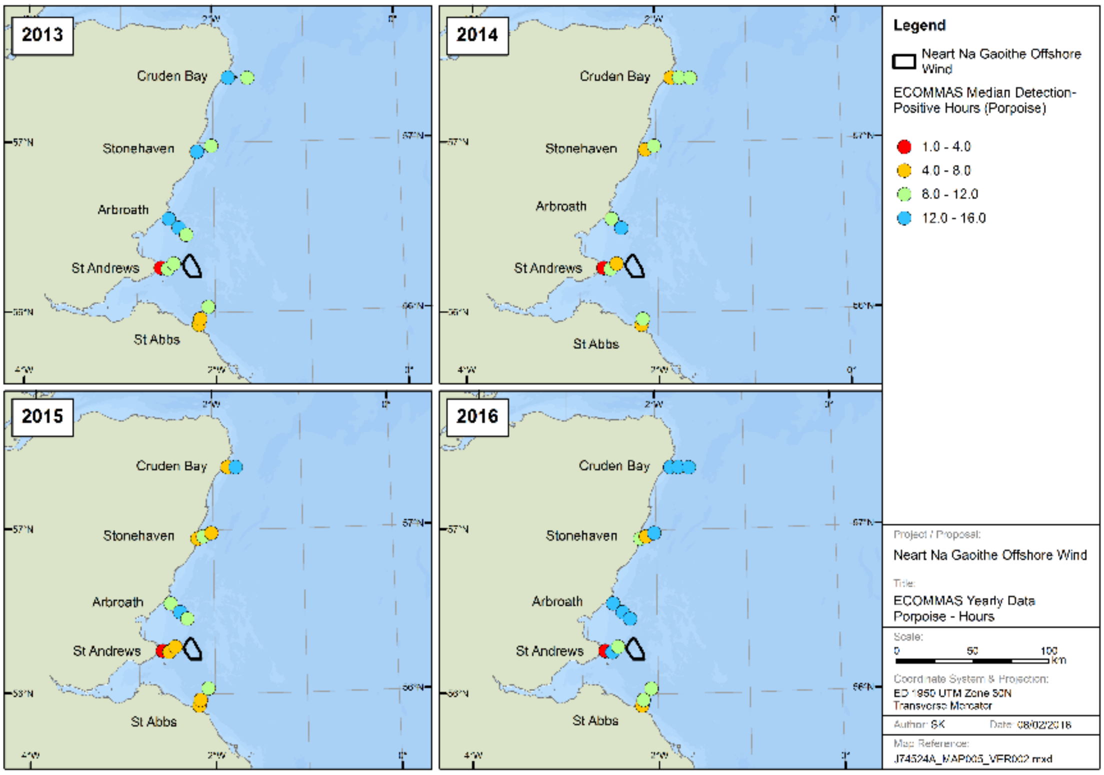


Figure 8-6: Harbour porpoise positive detection hours at C-PODs located between Cruden Bay and St Abb's Head from 2013 to 2016 (Source Brooks, 2017)

Harbour porpoise density estimates

93. Using acoustic data collected from 8,272 minutes of survey effort and covering an area of 2,140 km^2 during which 263 harbour porpoises were detected, a density of 0.27 porpoises per km^2 is estimated to occur across the Wind Farm Area (Gordon 2012).

94. Using visual data collected over the same period an estimated density of 0.28 harbour porpoise occur across the study area. However, based on all visual data covering a period of 22,754 minutes a density of 0.38 porpoises per km^2 has been calculated (Gordon, 2012).

95. Integrated analysis of all the Forth and Tay developer's marine mammal data and incorporating aerial survey data estimates, an average absolute abundance of 582 harbour porpoise across the Firths of Forth and Tay area, which is 0.25% of the North Sea management unit population (Mackenzie *et al*. 2012). This indicates that the Firth of Forth and Tay area is not an important area for harbour porpoise.

96. Densities of harbour porpoise vary across the Firths of Forth and Tay area with highest densities of 0.4 ind/km^2 occurring further offshore and to the north of Neart na Gaoithe (Mackenzie *et al*. 2012). Based on both visual and acoustic surveys undertaken across the Wind Farm Area the mean density of harbour porpoise across the year is 0.38 ind/km^2 (Table 8.10) (Gordon, 2012).

97. For the purposes of this assessment a SCANS III North Sea Management Unit population of 333,808 individuals and a regional density of 0.599 ind/km^2, based on SCANS III Block R, have been used. These are based on the most recent population estimates (JNCC, 2017; Hammond, *et al*. 2017).

8.8.3 Bottlenose Dolphin Baseline Data

98. The following presents a summary of the existing information on bottlenose dolphin.

8.8.3.1 Existing baseline

99. Bottlenose dolphin (*Tursiops truncatus*) occur widely in nearshore waters along the Moray Firth and the east coast Scotland. Elsewhere in the UK they occur regularly in Cardigan Bay with smaller numbers recorded elsewhere particularly around South-west England and North Uist (Reid *et al*. 2003; Paxton, *et al.* 2016; NMPI, 2017).

100. In Scotland, bottlenose dolphins occur widely along the east coast between the Moray Firth and the Firth of Forth with recognised areas of regular usage in the Moray Firth, Aberdeen Bay and the Firth of Tay (Figure 8-7 and Figure 8-8) (Anderwald and Evans, 2010; Quick *et al.* 2014). They are less frequently recorded between Montrose and Aberdeen or within the Firth of Forth (Quick *et al*. 2014).

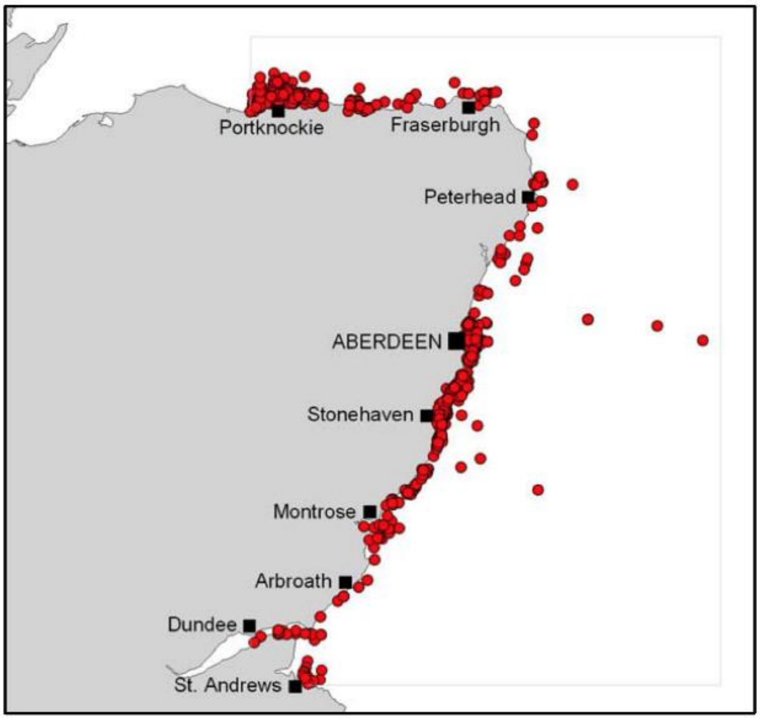


Figure 8-7: Bottlenose dolphin distribution in north-east Scotland (Anderwald and Evans 2010)

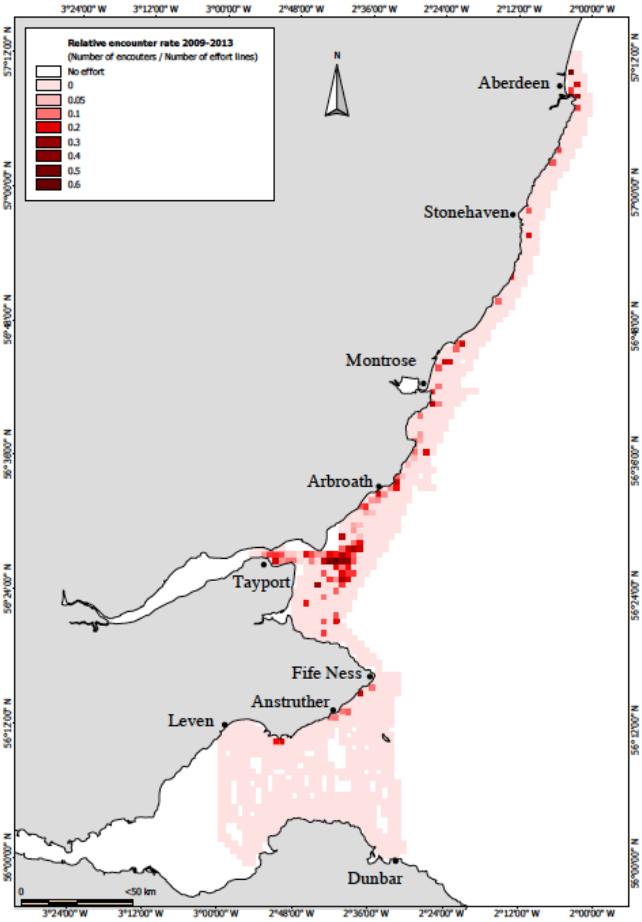


Figure 8-8: Bottlenose dolphin relative encounter rates between Aberdeen and the Firth of Forth between 2009 and 2013 (Quick *et al*. 2014).

101. Data from SCANS III, within Block R, estimated a population of 1,924 (95% CL 0 – 5,948) bottlenose dolphins (Hammond *et al*. 2017). The estimated population of bottlenose dolphins in the Moray Firth and the east coast of Scotland is 195 individuals (range 162 - 253) of which, based on surveys undertaken in 2003, between 81 and 142 bottlenose dolphins might occur in the Tay area (Cheney *et al*. 2013; Quick and Cheney, 2011; Thompson *et al.* 2011) (Table 8.11). The proportion of the east coast bottlenose dolphin population estimated to occur within the Firth of Forth and Firth of Tay area varies across years with between 71 (95% CI 63 - 81) and 91 (95% CI 82 - 100) individuals occurring within the area between 2009 and 2013 and between 35% and 55% of the east coast population (Arso Civil, 2014; Quick *et al*. 2014).

Table 8.11: Bottlenose dolphin abundance estimates

Abundance Ind./Km^2	SCANS III Block R [1]	Coastal East Scotland Management Unit [2]	Moray Firth and Firth of Tay [3]	East Coast Scotland [4]
Bottlenose dolphin	1,924 (0 – 5,048)	195 (95% HDPI 162 – 253)	195 (95% HDPI 162 – 253)	98
Source: 1. Hammond *et al.* 2017; 2. IAMMWG, 2015; 3. Cheney *et al.* 2013; 4. MS, 2017.				

Table 8.12: Estimated Bottlenose dolphin densities

Density Ind./Km^2	SCANS III Block R [1]	East Coast Scotland [2]	Firths of Forth and Tay [3]
Bottlenose dolphin	0.03	0.07 km^2	0.28 – 0.35
Source: 1. Hammond *et al.* 2017; 2. Derived from MS (2017); 3. Quick and Cheney, 2011.			

102. Bottlenose dolphins regularly move within the area between the Moray Firth and St Andrews Bay and the east coast population of bottlenose dolphin cannot be sub-divided on area alone and should be considered as a single management unit (Cheney *et al*. 2013; Thompson *et al.* 2011).

103. Sightings of bottlenose dolphin obtained from SCANS III data within Block R indicate a density across the wider region of 0.030 ind./km^2. Within the coastal waters of the Firths of Forth and Tay region densities of between 0.28 and 0.35 ind./km^2 have been estimated (Quick and Cheney 2011) (Table 8.12).

104. Based on advice received during Scoping the density of bottlenose dolphins has been estimated on an assumption that of the reference population of 195 bottlenose dolphins, 98 of them will be present along the east coast of Scotland at the time pile driving activities are undertaken (Marine Scotland 2017a). All bottlenose dolphins will be within the 20 m contour depth and that they are distributed evenly across their range (Figure 8-9). Areas within the Forth and Inner Tay were excluded, as per the advice received. Following this approach, a bottlenose dolphin density of 0.07 ind./km^2 is derived.

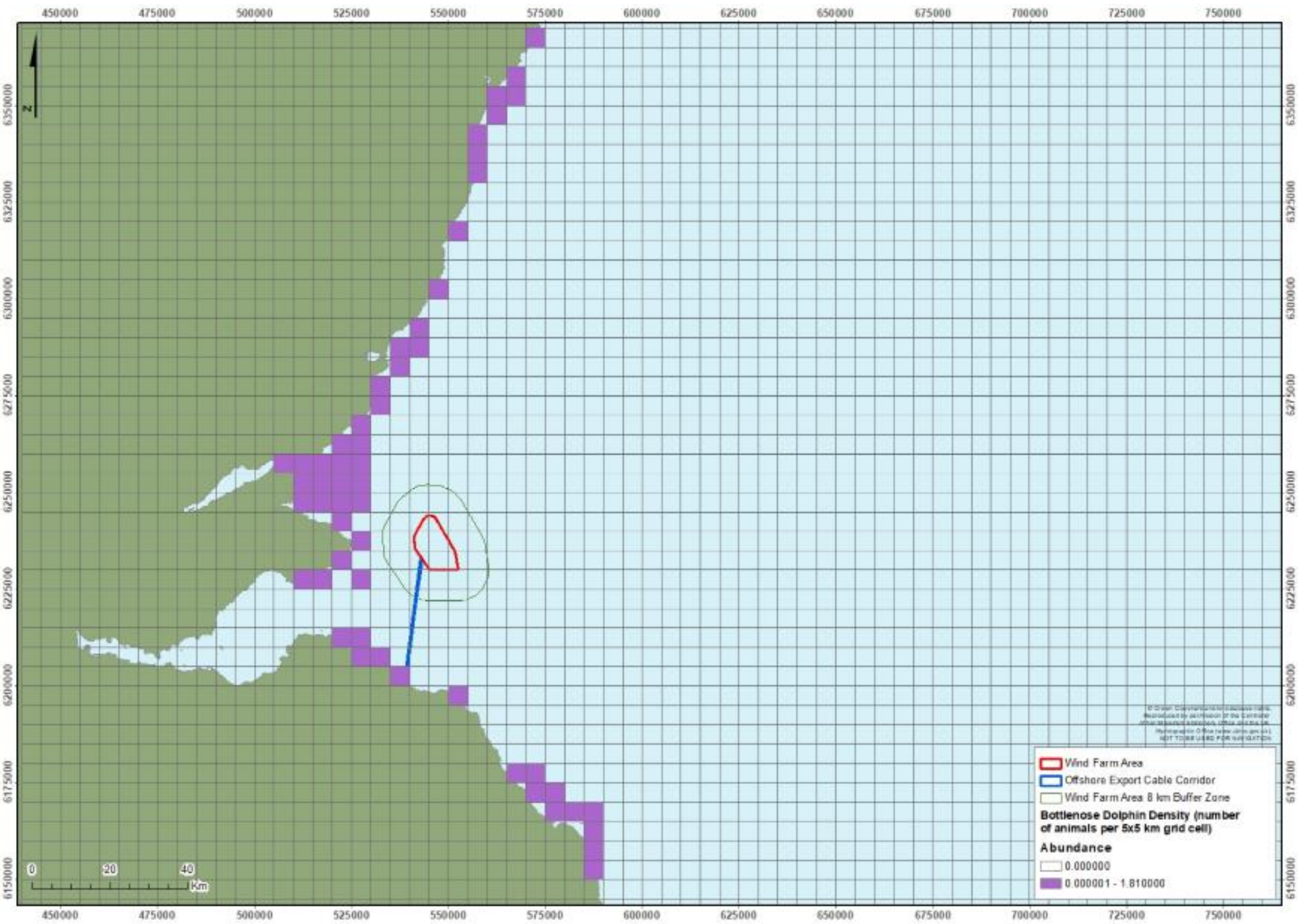


Figure 8-9: Distribution of coastal east Scotland bottlenose dolphins (Source: ICOL, 2017)

105. Along the east coast of Scotland, bottlenose dolphins occur predominantly within 2 km of the coast and in water depths of less than 20 m. There are relatively very few records of bottlenose dolphins in waters beyond 2 km and in water depths of greater than 20 m (Figure 8-8) (Quick *et al*. 2014).

106. Between 2013 and 2016 C-PODs that are able to detect bottlenose dolphins have been deployed between Cromarty and St Abb's Head, including at five locations between Cruden Bay and St Abb's Head (Brookes, 2017). Bottlenose dolphins were recorded most frequently within 5 km of Cromarty, in the Moray Firth, with detections recorded on more than 89% of the days that C-PODs were present. Daily detection rates at C-PODS located within 5 km of St Andrews were no greater than 18%. Further offshore daily detection rates were lower with detections on less than 10% of the days at distances of between 10 km and 15 km (Figure 8-10).

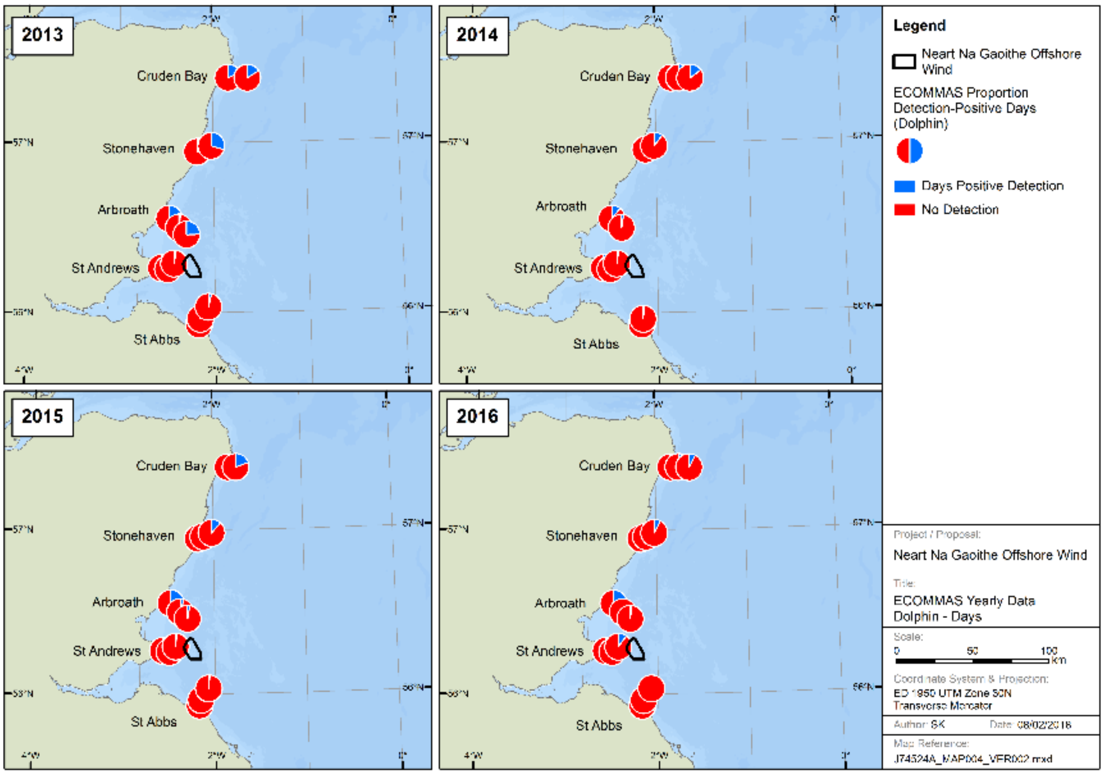


Figure 8-10: Bottlenose dolphin positive detection days at C-PODs located between Cruden Bay and St Abb's Head from 2013 to 2016 (Source Brookes, 2017)

107. The use of C-PODS to detect dolphins at five locations between Cruden Bay and St Abb's, including at Arbroath and St Andrews supports the evidence that the majority of dolphin activity along the east coast of Scotland occurs within 5 km of the coast (Brookes 2017, Palmer *et al.* 2017).

108. Acoustic surveys undertaken at two locations between Arbroath and Fife Ness using T-Pods between 2006 and 2009 indicated that dolphins occur in the coastal waters throughout the year, although there may be seasonal variation with an increase in the number of detections at Fife Ness between May and October compared with the rest of the year. However, a similar seasonal variation was not observed at Arbroath where the number of detections across the year are relatively similar (Figure 8-11) (Quick and Cheney; 2011).

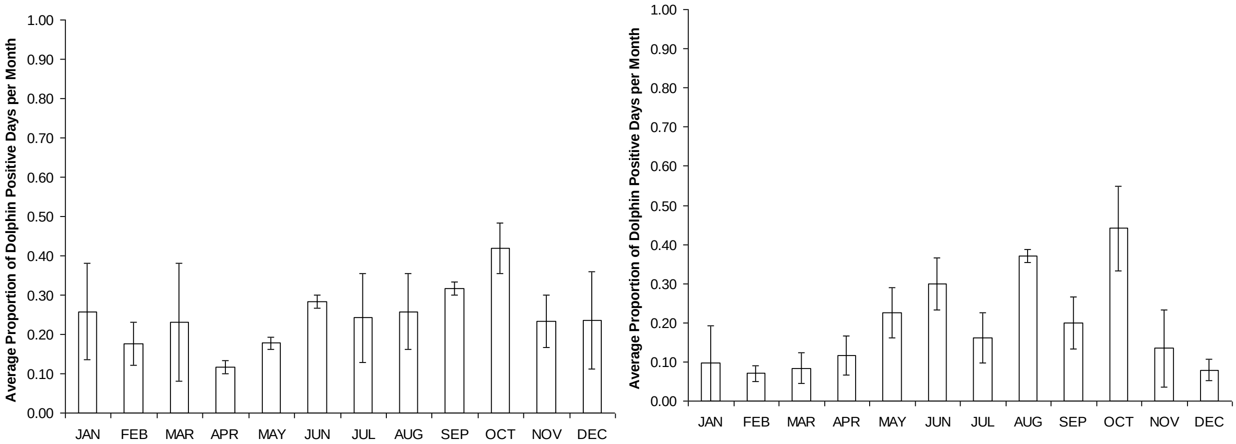


Figure 8-11: The average proportion of dolphin positive days in each month (+/- SE) for T-pod sites at a) Arbroath and b) Fife Ness, for the entire T-pod deployment period (Source: Quick and Cheney 2011)

109. Within the Firths of Forth and Tay area bottlenose dolphin occur predominantly in nearshore waters within 10 km of the coast and in water depths of less than 20 m (Figure 8-12). Within the Firth of Tay bottlenose dolphin have been most frequently recorded along the north side of a sand bar to the south of a shipping lane (Quick and Cheney, 2011). However, complete survey coverage across the whole of the Firths of Forth and Tay has not been undertaken and therefore their distribution across the wider area is unclear.

110. Using photo identification techniques, it is recognised that many, if not all, the bottlenose dolphins occurring in the Firth of Tay area are associated with those that occur to the north, along the east coast of Scotland and the Moray Firth including within the Moray Firth SAC. There is a relatively high level of movement of bottlenose dolphins between those in the Firth of Tay and elsewhere along the east coast of Scotland and, to a lesser extent, along the coasts of North-east England (Quick and Cheney, 2011).

111. Bottlenose dolphins first breed from the age of between 5 and 13 years of age and produce a single offspring which will remain with its mother from between 3 and 8 years. Inter-birth years, the time between calves, range from between 2 and 9 years, although 3 years is most frequent. Mortality rates in the first year vary from between 19 and 29%. Adult survival within the east coast of Scotland population is 94.7% (Quick *et al*. 2014).

112. Bottlenose dolphins feed on a wide range of prey species with main prey items for bottlenose dolphins in the Moray Firth reported to be cod, saithe (*Pollachius virens*) and whiting with some salmon (*Salmo salar*), haddock (*Melanogrammus aeglefinus*) and cephalopods (Santos *et al*. 2001).

113. The bottlenose dolphin is a qualifying species for the Moray Firth SAC, which is located approximately 165 km from the Wind Farm Area.

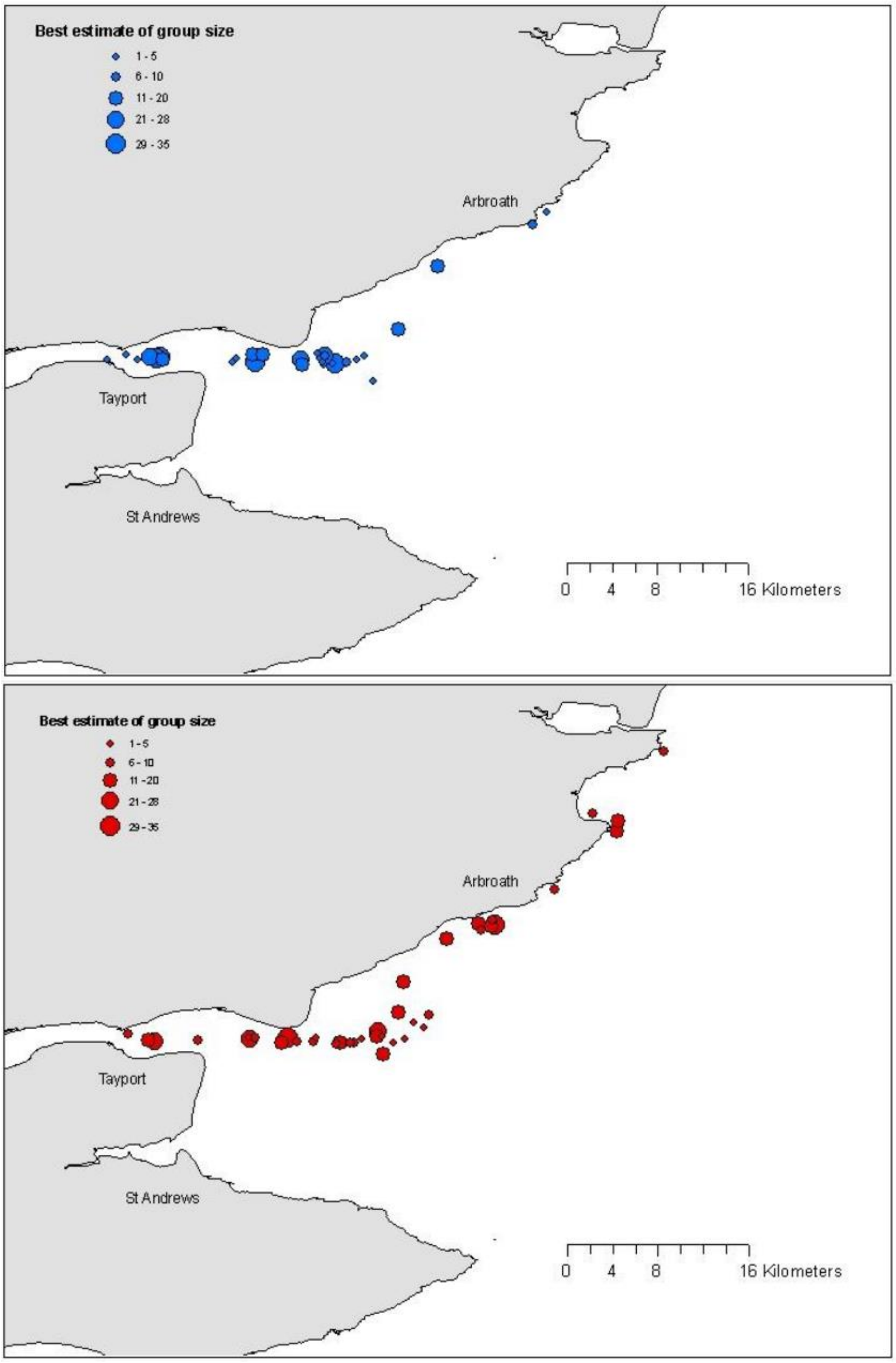


Figure 8-12: Bottlenose dolphin encounter locations in Firth of Tay during 2009 (top) and 2010 (bottom) (Source: Quick and Cheney 2011)

8.8.3.2 Site Specific Data

114. No bottlenose dolphins were recorded during three years of boat-based surveys within the Offshore Wind Farm Area and the 8 km buffer surrounding the site, i.e. no bottlenose dolphins have been recorded within 8 km of the Wind Farm Area.

115. The most recent estimate of the Moray Firth and east coast bottlenose dolphin population is 195 individuals. Published abundance estimates for the Firth of Tay area based on photo identification studies undertaken during the summers of 2003 and 2004 indicate a population of between 81 and 142 individuals (Quick and Cheney, 2011). Advice received during scoping is that half the bottlenose dolphin population, i.e. 98 individuals, may occur along the east coast of Scotland and are at risk of being impacted by the proposed Project (Marine Scotland 2017a).

116. The only estimated densities of bottlenose dolphin within the Firth of Forth and Tay area are between 0.28 and 0.35 ind/km^2 (Quick and Cheney, 2011). However, using the approach advised during scoping and assuming that bottlenose dolphins are evenly distributed along the east coast of Scotland out to the 20 m water depth, a density of 0.07 ind/km^2 has been estimated (Table 8.12).

117. For the purposes of this assessment a Coastal East Scotland Management Unit population of 195 individuals has been used and it is assumed that the population is split 50:50 between the Moray Firth and the east coast of Scotland. A regional density of 0.07 ind/km^2 has been calculated following the approach advised in the Scoping Opinion (Marine Scotland 2017a).

8.8.4 White-beaked Dolphin Baseline Data

118. The following presents a summary of the existing information on white-beaked dolphin.

8.8.4.1 Existing baseline

119. The white-beaked dolphin (*Lagenorhynchus albirostris*) occurs across the North Sea, although predominantly the central North Sea in waters of between 50 – 100 m deep and in waters at temperatures below 14^{o}C. They are largely absent in waters greater than 200 m and where water temperatures exceed 18^{o}C (Reid *et al*. 2003; MacLeod *et al*. 2008; Parsons *et al*. 2012; OSPAR, 2017).

120. Scottish waters are recognised to be a regionally important for white-beaked dolphin particularly in the Minch, to the north of the Outer Hebrides, in the outer Moray Firth and off the coast of Aberdeenshire (Lancaster *et al*. 2014a).

121. The species occurs throughout the year, with evidence of localised seasonal movements to nearshore waters during the summer months. In northeast Scotland, there is an increase in sightings of white-beaked dolphins in nearshore waters between June and August and off northeast England peak numbers occur in inshore waters during July and August (Weir *et al*. 2007; Brereton *et al*. 2013).

122. The estimated white-beaked dolphin population within Block R of the SCANS III survey area is 15,694 (95% CL 3,022– 33,340) individuals (Hammond *et al*. 2017). The Management Unit population comprising Celtic and Greater North Seas (CGNS) is estimated to be between 15,895 individuals and 36, 287 depending on the source of the data (Table 8.13) (IAMMWG, 2015; JNCC, 2017; Hammond *et al.* 2017). The CGNS Management Unit population of 15,895 individuals is largely based on the results from the SCANS II surveys which have subsequently been revised from a previous population estimate of 16,536 individuals to 37,689 individuals for the whole SCANS II surveyed area (Hammond *et al.* 2017). Consequently, white-beaked dolphin population within the CGNS Management Unit area may be higher than previously thought. For the purposes of this assessment the SCANS III CGNS Management Unit population of 35,908 has been used (JNCC, 2017).

123. Within the Firth of Forth and Firth of Tay area the white-beaked dolphin population is estimated to be 293 individuals (95% CI 266 – 1,055) (see Table 8.13) (Grellier and Lacey, 2011).

124. SCANS III survey data indicate densities within Block R of 0.24 ind/km^2 occur (Hammond *et al*. 2017). Densities of between 0.3 and 0.4 ind/km^2 are estimated to occur along the east coast of Scotland, with higher densities of up to 0.7 ind/km^2 occurring further offshore in the Central North Sea. Across the Forth and Tay estuaries peak white-beaked dolphin densities of 0.052 ind./km^2 have been estimated to occur during the summer and 0.024 ind./km^2 during winter period (Grellier and Lacey, 2011) (Table 8.14). This suggest that densities of white-beaked dolphin in the waters around the Firths of Forth and Tay are relatively low compared with adjacent areas.

Table 8.13: White-beaked dolphin abundance estimates

Abundance Ind./Km^2	SCANS III [1]	SCANS III CGNS Management Unit [2]	SCANS III Block R [1]	CGNS Management Unit [3]	Firths of Forth and Tay [4]
White-beaked dolphin	36,287 (CL 18,694 – 61,869)	35,908	15,694 (CL 3,022– 33,340)	15,895 (CI 9,107 – 27,743)	91 (CI 32 – 384)
Source: 1. Hammond *et al.* 2017; 2. JNCC, 2017; 3. IAMMWG, 2015; 4. King and Sparling, 2012.					

Table 8.14: Estimated white-beaked dolphin densities

Density Ind./km^2	SCANS III -1	SCANS III Block R [1]	Firths of Forth and Tay [2]	Firths of Forth and Tay [3]	NnG [3]
White-beaked dolphin	0.03	0.24	0.024 - 0.052	0.016	0 – 0.005
Source: 1. Hammond *et al*. 2017; 2. Grellier and Lacey 2011; 3. King and Sparling, 2012.					

125. Analysis of the sightings along the Aberdeenshire coast indicate that seabed depth and slope influence the distribution of white-beaked dolphins in this area and this is thought to be related to prey distribution. Sea temperature has been found to influence white-beaked dolphin group size, with smaller groups being recorded in waters at higher temperatures (Canning, 2008).

126. White-beaked dolphin breed mainly between July and August, with gestation lasting approximately 11 months (Culik, 2010). The high number of calves observed during the boat surveys off Aberdeenshire and in the stranding data during the summer suggests the inshore movement of this species at this time of year may be related to calving (Canning, 2008).

127. White-beaked dolphins have a broad range of prey, feeding on mackerel (*Scomber scombrus*), herring, cod, poor-cod (*Trisopterus minutus*), sandeels, whiting, haddock, and hake (*Merluccius merluccius*), as well as squid (*Loligo vulgaris*), octopus Sp. and benthic crustaceans (Anderwald and Evans, 2010).

128. There are no European designated sites for white-beaked dolphin in the UK. However, their range is thought to be contracting, possibly due to increasing sea temperatures (Lancaster *et al*. 2014a).

8.8.4.2 Site Specific Data

129. During three years of boat-based surveys white-beaked dolphins were recorded infrequently within the wind farm and buffer area. A total of 18 white-beaked dolphins were recorded during all surveys with no sightings during Year 1. Peak numbers occurred during May and June, with all but one sighting being recorded during this period. The only other sighting was of an individual observed in January 2012 (Table 8.15 and Figure 8-13). Possibly due to there being relatively few sightings from surveys, no clear pattern in the distribution of white-beaked dolphins has been identified with recorded sightings scattered across the surveyed area (Figure 8-14).

Table 8.15: Number of white-beaked dolphin recorded within the Wind Farm area and 8 km buffer during boat-based surveys undertaken between November 2010 and October 2013

Year	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Year 1 (Nov 2010 – Oct 2011)													
WFA	0	0	0	0	0	0	0	0	0	0	0	0	0
Buffer	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Year 2 (Nov 2011 – Oct 2012)													
WFA	n/c	0	0	0	0	0	3	3	0	0	0	0	6
Buffer	n/c	0	1	0	0	0	9	0	0	0	0	0	10
Total	**n/c**	**0**	**1**	**0**	**0**	**0**	**12**	**3**	**0**	**0**	**0**	**0**	**16**
Year 3 (Nov 2012 – Oct 2013)													
WFA	0	0	0	0	0	0	0	0	0	0	0	0	0
Buffer	0	0	0	0	0	0	0	2	0	0	0	0	2
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**2**

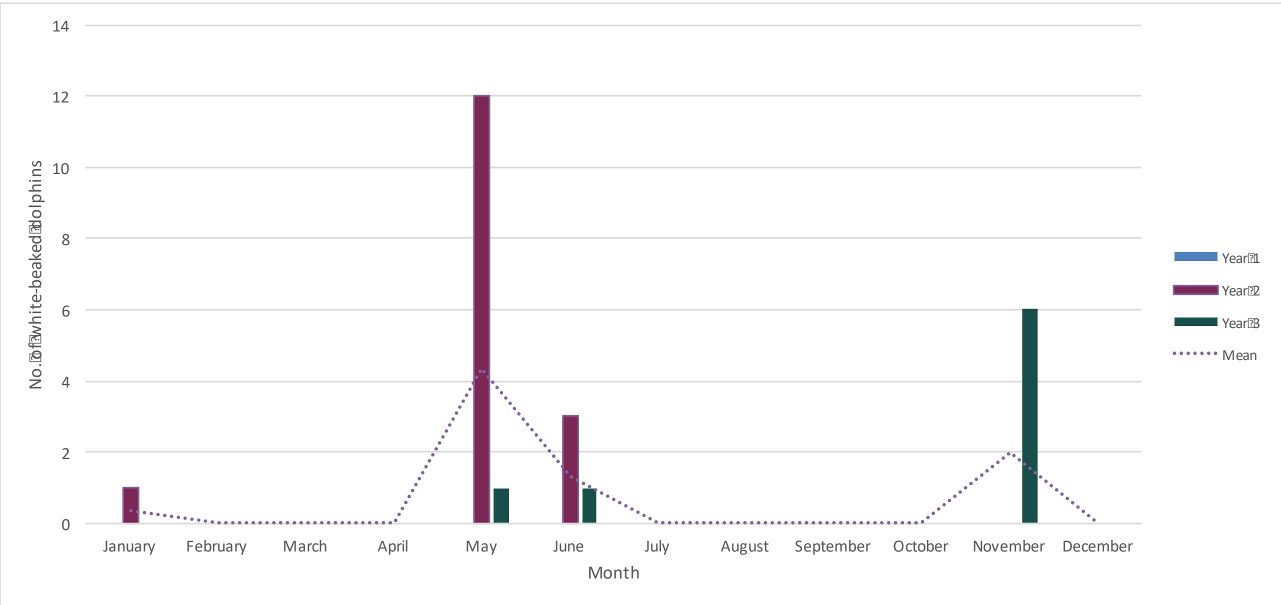


Figure 8-13: Monthly number of white-beaked dolphins recorded within the study area during boat-based surveys undertaken between November 2010 and October 2013

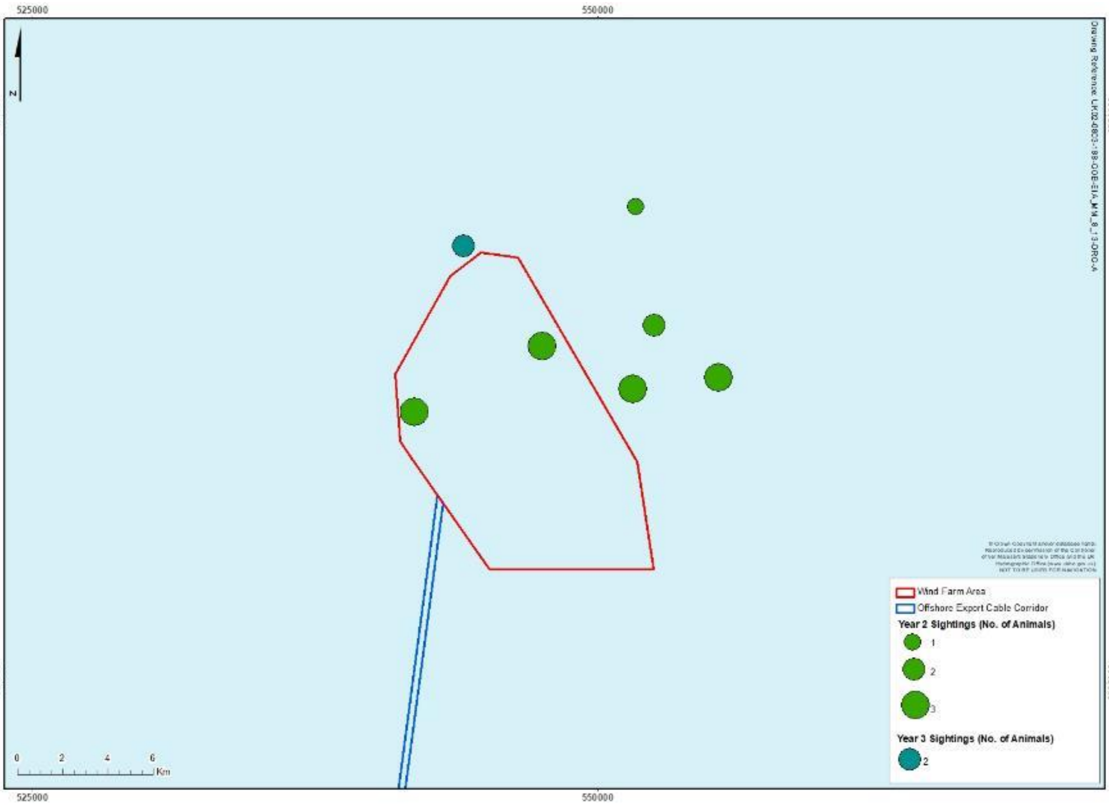


Figure 8-14: Distribution of white-beaked dolphin recorded within the study area during boat-based surveys undertaken between November 2010 and October 2013

130. Within the Wind Farm Area densities of between zero and 0.005 ind/km^2 have been estimated (Table 8.14) (King and Sparling, 2012). These densities are lower than reported over the wider area, therefore indicating that the Wind Farm Area is relatively less important to white-beaked dolphins than elsewhere.

131. For the purposes of this assessment a SCANS III based CGNS Management Unit population of 35,908 individuals and a regional density of 0.24 ind/km^2 have been used. These are based on the most recent population estimates and regional specific densities.

8.8.5 Orca Baseline Data

132. The following presents a summary of the existing information on orca.

8.8.5.1 Existing baseline

133. Orcas occur predominantly in waters to the north and west of the UK and are very scarce in the North Sea with few records south of the Moray Firth (Reid *et al.*, 2003).

8.8.5.2 Study Area

134. A single orca was recorded in October 2011 within the buffer area. Due to the scarcity of this species in the area no further assessment has been made.

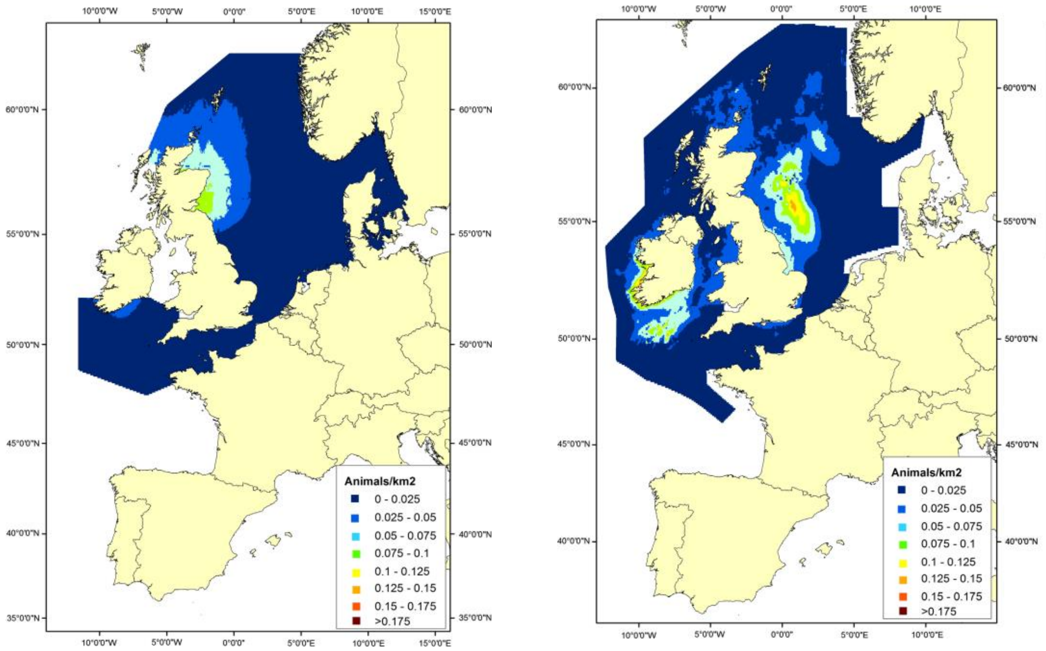
8.8.6 Minke Whale Baseline Data

135. The following presents a summary of the existing information on minke whale.

8.8.6.1 Existing baseline

136. The Minke whale (*Balaenoptera acutorostrata*) is the most abundant baleen whale in the region, occurring widely across the North Sea during the summer months (**Error! Reference source not found.**). They are predominantly a summer visitor to the waters off the east coast of Scotland, with animals distributed in both coastal waters and offshore throughout the central and northern North Sea during the summer months, particularly during July and August. There are few sightings of minke whale in the region between October and April (Anderwald and Evans, 2010; Reid *et al.* 2003). Off the east coast of Scotland minke whales appear to be more frequent in offshore waters between the Moray Firth and the borders of England (Lancaster *et al*. 2014b; NMPI, 2017) to the north of the Firth of Forth and Firth of Tay area, with highest numbers occurring off the coasts of Aberdeenshire (Anderwald and Evans, 2010).

137. The distribution of minke whales appears to have shifted southward over the last 20 years from a core area off North-east Scotland to the Central North Sea (Figure 8-15) (Hammond *et al.* 2013).



a) b)

Figure 8-15: a) Predicted density surface for minke whale in 1994. b) Predicted density surface for minke whale in 2005 (Source Hammond *et al.* 2013)

138. The estimated minke whale population within the SCANS III CGNS Management Unit is 11,819 individuals. Within Block R of the SCANS III survey area the estimated minke whale population is 2,498 (95% CL 604 – 6,791) individuals (Hammond *et al*. 2017). SCANS III survey data indicate densities of minke whale within Block R of 0.039 ind/km^2 occur (Table 8.17) (Hammond *et al*. 2017); these were the highest densities for any area recorded during the SCANS III surveys.

139. The estimated number of minke whales within the North Sea varies across years and this may be due to the presence of seasonal or inter-annual variations in water temperature, with higher numbers being recorded in areas of warm water where there may be increased productivity (Tetley *et al*. 2008).

Table 8.16: Minke whale abundance estimates

Abundance	SCANS III CGNS Management Unit [1]	SCANS III Block R [1]	CGNS Management Unit [2]	Firths of Forth and Tay [3]	Firths of Forth and Tay [4]
Minke whale	11,819	2,498 (604 – 6,791)	23,528 (95% CI=13,989-39,572)	594 (CI 483 – 2,695)	269 (CI 86 – 1,711)
Source: 1. JNCC 2017; 2. IAMMWG ,2015; 3. Mackenzie *et al.* 2012; 4. King and Sparling, 2012.					

Table 8.17: Estimated minke whale densities

Density Ind./km^2	SCANS III Block R [1]	Firths of Forth and Tay [2]	Firths of Forth and Tay [3]	NnG [3]
Minke whale	0.039	0 – 0.25	0.047	0.02 – 0.10
Source: 1. Hammond *et al*. 2017; 2. Mackenzie *et al.* 2012; 3. King and Sparling.				

140. Minke whales feed on both invertebrates and a variety of fish species, particularly herring, sandeel, cod, haddock and saithe (Anderwald and Evans, 2010).

141. Studies undertaken in the Moray Firth have identified strong correlations in the distribution of minke whales and water depth and sediment type, with minke whales occurring most frequently in water depths of between 20 m and 50 m and over areas with sandy gravel sediments. These habitats are known to be areas used by sandeels and it is thought that the distribution of minke whales during the summer months is associated with the distribution and availability of sandeels that make up between 62% and 87% of their diet by weight. From July onwards, they disperse to pre-spawning area for herring (Lancaster *et al*. 2014b). Another strong influencing factor in their distribution is the seabed bathymetry with more frequent occurrence in areas of relatively steep slopes and, in the Moray Firth, north facing slopes were preferred (Robinson *et al*. 2009). The presence of relatively steep seabed is thought to provide up-wellings where increased concentrations of prey may occur.

142. There are no European Protected Sites for minke whale in UK waters.

8.8.6.2 Site Specific Data

143. Minke whale were recorded in relatively low numbers during three years of boat-based surveys with a total of 18 individuals recorded, of which, one was in the proposed Wind Farm Area (Table 8.18 and Figure 8-16). All sightings were made between May and November, with peak numbers observed during November followed by June and August. However, the numbers were low across the year (Figure 8-17).

Table 8.18: Number of minke whales recorded within the Wind Farm and Buffer areas during boat-based surveys undertaken between November 2010 and October 2013

Year	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Year 1 (Nov 2010 – Oct 2011)													
WFA	0	0	0	0	0	0	0	0	0	0	0	1	1
Buffer	0	0	0	0	0	0	0	0	0	0	0	1	1

Year	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**
Year 2 (Nov 2011 – Oct 2012)													
WFA	n/c	0	0	0	0	0	0	0	0	0	0	0	0
Buffer	n/c	0	0	0	0	0	0	3	0	4	1	0	8
Total	**n/c**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**4**	**1**	**0**	**8**
Year 3 (Nov 2012 – Oct 2013)													
WFA	0	0	0	0	0	0	0	0	0	0	0	0	0
Buffer	6	0	0	0	0	0	0	2	0	0	0	0	8
Total	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**8**

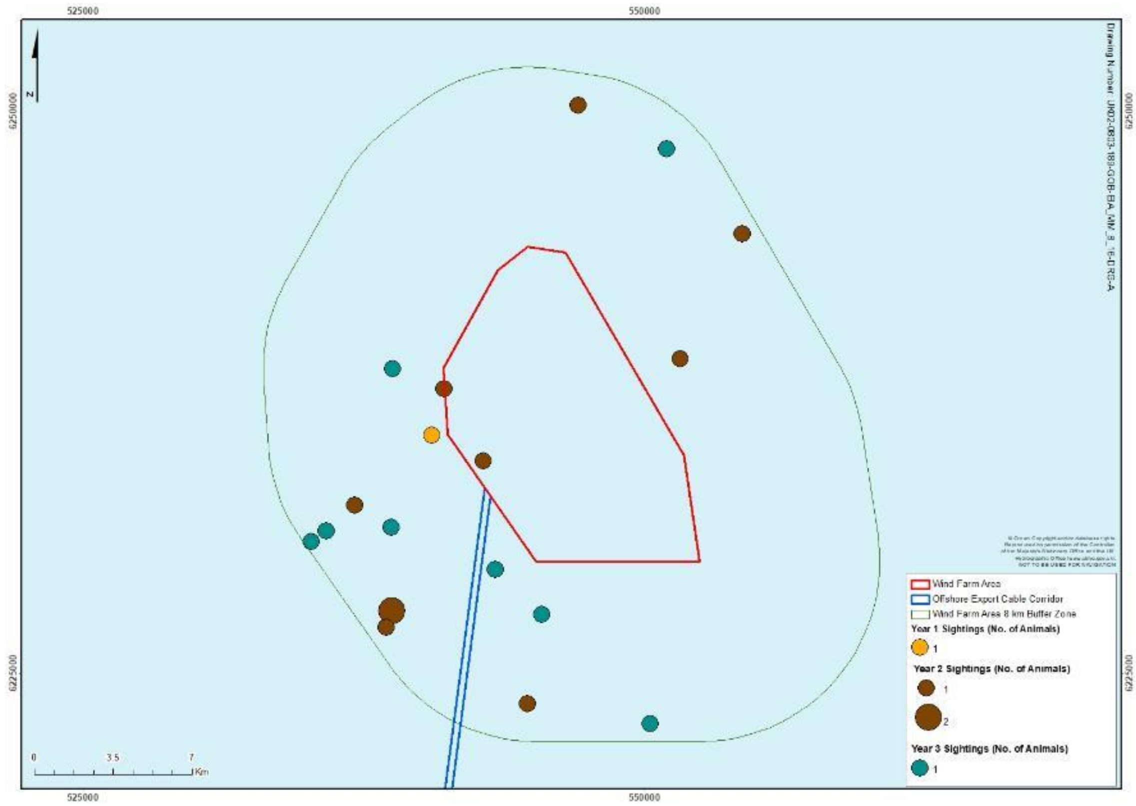


Figure 8-16: Distribution of minke whale recorded within the study area during boat-based surveys undertaken between November 2010 and October 2013

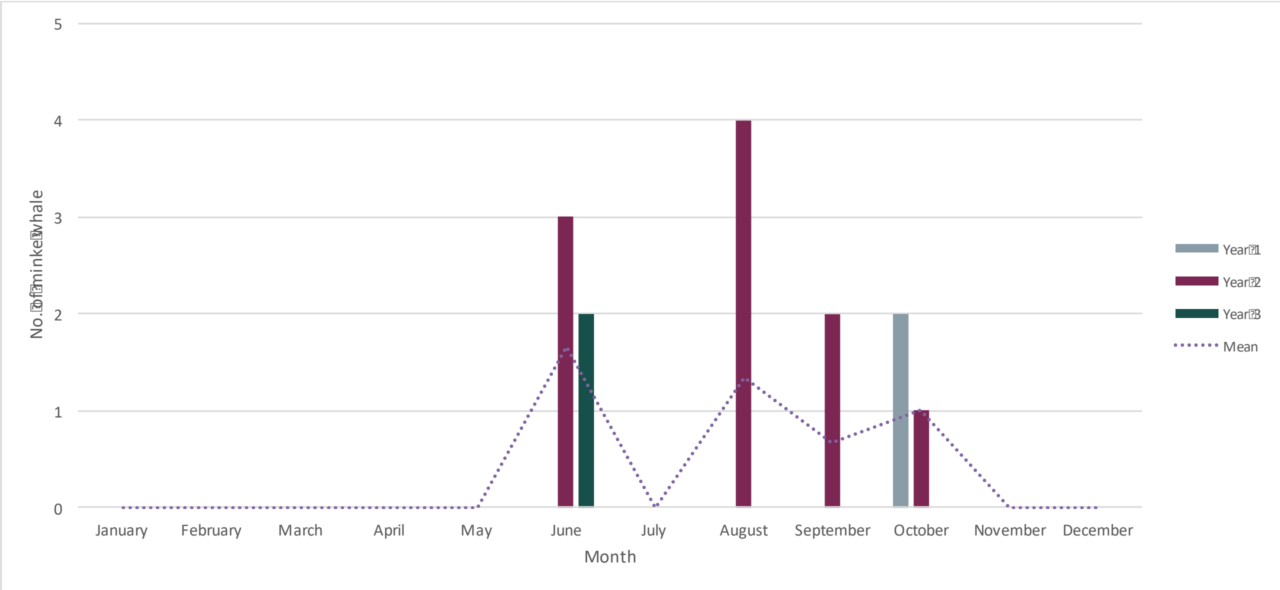


Figure 8-17: Monthly number of minke whales recorded within the study area during boat-based surveys undertaken between November 2010 and October 2013

144. Due to the low numbers of minke whales recorded in the area it is not possible to calculate population estimates or densities within the Wind Farm Area. However, within the Firths of Forth and Tay population estimates of between 269 (95% CI 86 – 1,711) and 594 (95% CI 483 – 2,695) minke whales has been estimated at densities of between zero and 0.25 ind./km^2 (Table 8.16 and Table 8.17) (King and Sparling, 2012; Mackenzie *et al*. 2012).

145. For the purposes of this assessment a SCANS III CGNS Management Unit population of 11,819 individuals and a regional density of 0.039 ind/km^2 have been used. These are based on the most recent population estimates and SCANS III Block R regional specific density.

8.8.7 Grey Seal Baseline Data

146. The following presents a summary of the existing information on grey seal.

8.8.7.1 Existing baseline

147. The grey seal (*Halichoerus grypus*) is the more abundant of the two species of seal that breed around the coast of the British Isles with a UK population of 139,800 (95% CI 116,500 - 167,100) individuals (SCOS, 2016). Approximately 88% of British grey seals breed in Scotland, mostly in the Outer Hebrides and Orkney. Elsewhere, they occur in Shetland and along the north and east coasts of the UK and in the southwest (SCOS, 2016).

148. Total counts of grey seals hauled out within the East Scotland and North-east England Management Areas are presented in Figure 8-18 (Duck *et al.* 2016). However, as not all grey seals are at haul-out sites at the same time the actual population will be greater than this. To account for this, the number of grey seals recorded at haul out sites is adjusted using a scalar multiplier of 2.39 (Russell *et al*. 2016a). By doing so this provides a population estimate based on the most recent available survey counts of grey seals in the East Coast Management Area (ECMA) of 9,607 (95% CI 8,028 – 11,958) individuals and a North-East England population of 29,046 (95% CI 24,272 – 36,156) individuals (Figure 8-18).

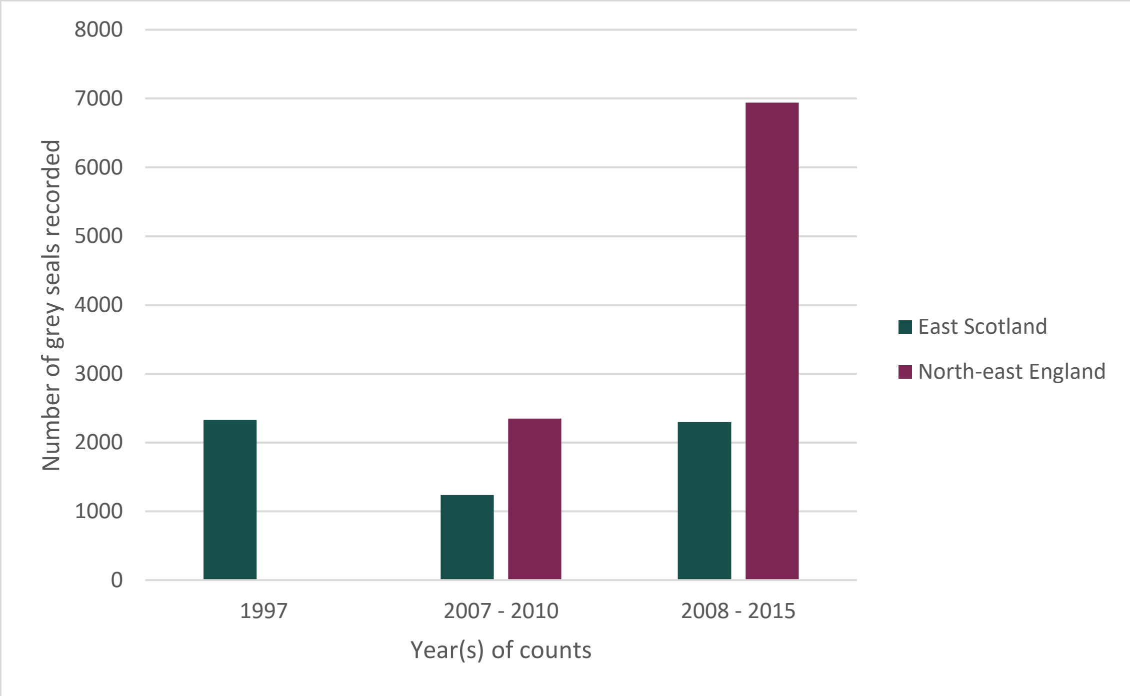


Figure 8-18: Estimated unadjusted number of grey seals hauled out within East Scotland and North-east England Seal Management Areas (Source: Duck *et al.* 2016)

149. Major grey seal colonies on the east coast of Scotland and northeast England include the Isle of May, Fast Castle and the Farne Islands. Fast Castle is the largest colony in the North Sea and between the three sites they hold 12% of the UK grey seal population (Figure 8-19) (Duck and Morris, 2012). Based on the numbers hauled out and the number of pups, the grey seal population in the region from Northeast Scotland to the Farne Islands is between 9,000 and 20,000 grey seals depending on time of year (Sparling *et al.* 2012).

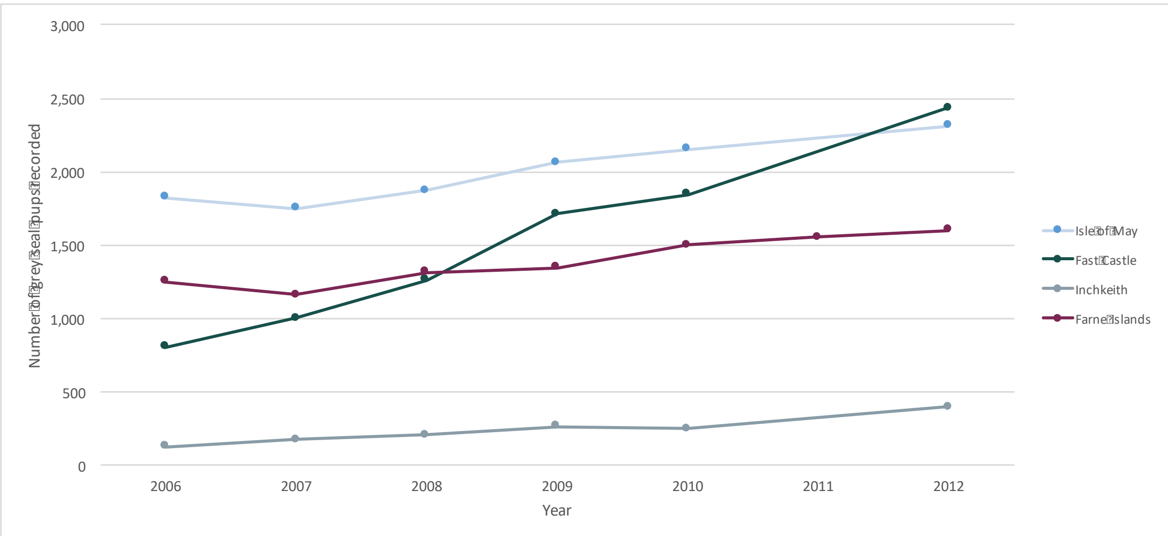


Figure 8-19: Grey seal pup production estimates for breeding colonies on the northeast coast of England and southeast coast of Scotland between 1999 and 2009

150. Tagging studies undertaken in the East Scotland Management Area indicate that grey seals occur throughout the Firths of Forth and Tay area with relatively higher occurrence in St Andrews Bay and around the Farne Islands and off North-east Scotland (Figure 8-20) (Marine Scotland 2017d).

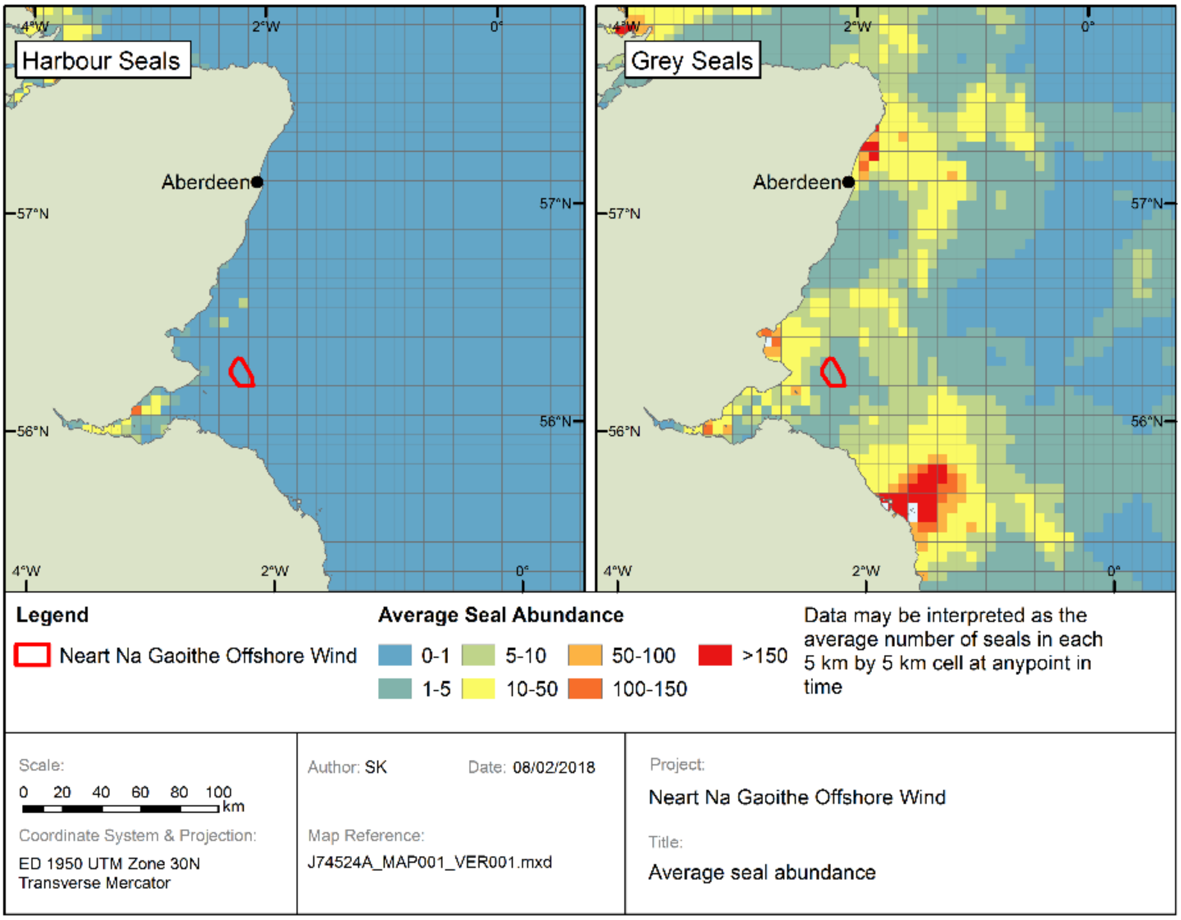


Figure 8-20: Estimated at sea distribution of grey and harbour seals off eastern Scotland (Source Marine Scotland 2017d)

151. Prior to pupping there is a gradual increase in the numbers of grey seals occurring in nearshore waters adjacent to the haul-out beaches (SNH, 2006). Pupping occurs late October and late November and the pup is weaned after approximately 2 weeks, after which mating takes place (Duck, 2010). During this period grey seals remain largely onshore or in nearshore waters; outwith this period grey seals are more widespread occurring more frequently in offshore foraging areas. Following breeding, grey seals undergo a moult in January and February (SNH, 2006).

152. Grey seals forage in areas that are up to at least 100 m deep and that tend to have gravel/sand seabed sediments, which are 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 occur regularly in the waters around the Wind Farm Area (Hammond *et al* 2004).

153. Grey seals are qualifying species for the Isle of May SAC and the Berwickshire and North Northumberland Coast SAC. Their haul out sites within these SACs are protected under the Marine Scotland Act (2010).

8.8.7.2 Site Specific Data

154. During three years of boat-based surveys grey seals were occasionally recorded within the Offshore Wind Farm and buffer area. The majority of sightings were outwith the wind farm area with 125 of the 140 sightings occurring in the buffer area (Figure 8-21). Across years the total number of grey seals recorded was relatively constant with 43 in year 1, 58 in year 2 and 39 in Year 3 (Table 8.19).

155. Peak numbers occurred during March and October with a maximum of 16 grey seals recorded across the whole survey area in October 2011 (Figure 8-22). Outwith these periods, grey seals were recorded infrequently.

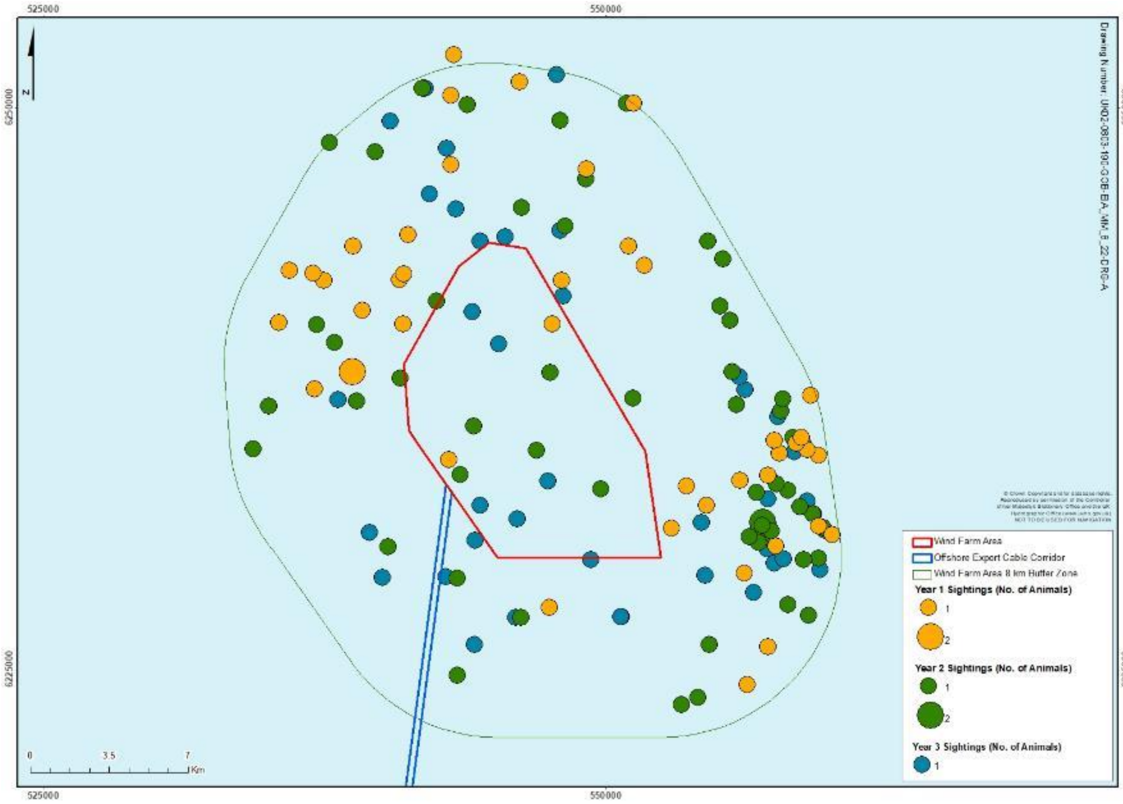


Figure 8-21: Distribution of grey seals recorded within the study area during boat-based surveys undertaken between November 2010 and October 2013

Table 8.19: Number of grey seals recorded within the Wind Farm and Buffer areas during boat-based surveys undertaken between November 2010 and October 2013

Year	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Year 1 (Nov 2010 – Oct 2011)													
WFA	0	0	0	0	1	0	0	0	0	1	0	0	2
Buffer	3	2	0	0	13	4	1	1	0	1	0	16	41
Total	**3**	**3**	**0**	**0**	**14**	**4**	**1**	**1**	**0**	**2**	**0**	**16**	**43**
Year 2 (Nov 2011 – Oct 2012)													
WFA	n/c	0	0	1	0	0	0	0	3	1	0	1	6
Buffer	n/c	3	1	6	6	0	7	1	4	9	7	8	52
Total	**n/c**	**4**	**1**	**7**	**6**	**0**	**7**	**1**	**7**	**10**	**7**	**9**	**58**
Year 3 (Nov 2012 – Oct 2013)													
WFA	0	0	2	1	3	0	0	0	0	0	1	0	7
Buffer	4	0	4	3	8	9	0	0	2	0	1	1	32
Total	**4**	**0**	**6**	**4**	**11**	**9**	**0**	**0**	**2**	**0**	**2**	**1**	**39**

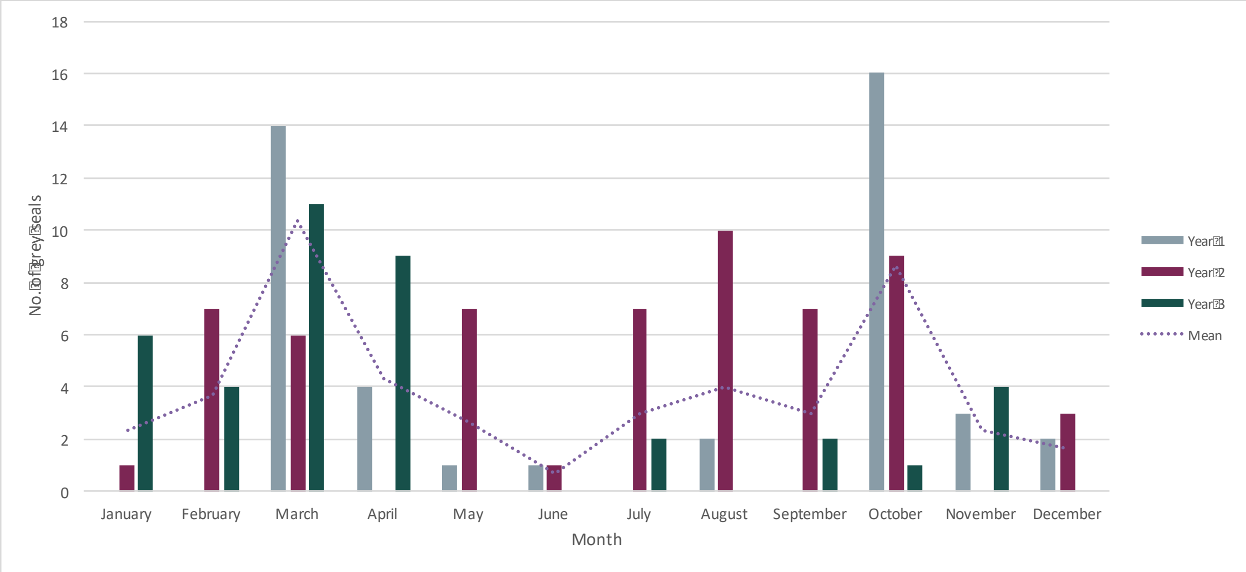


Figure 8-22: Monthly number of grey seals observed during three years of boat-based surveys

156. The abundance of grey seals within the study area varies with higher numbers occurring in nearshore waters, particularly adjacent to haul-out sites (Figure 8-18). Within the Offshore Wind Farm Area between one and five grey seals occurs within each 5 km^2. Site specific grey seal densities have been estimated based on two years of site specific studies on grey seal usage of the site. The results of the studies estimated a density of grey seals within the study area of 0.14 ind./km^2 with highest densities occurring to the south-east of the Offshore Wind Farm Area (Figure 8-23) (Gordon, 2012).

157. For the purposes of this assessment the adjusted East Coast Management Area of 9,607 individuals has been used. A regional specific density is not required as the number of individuals predicted to be impacted is estimated from the at sea distributions (See Appendix 8.2: interim PCoD Population Modelling for further details).

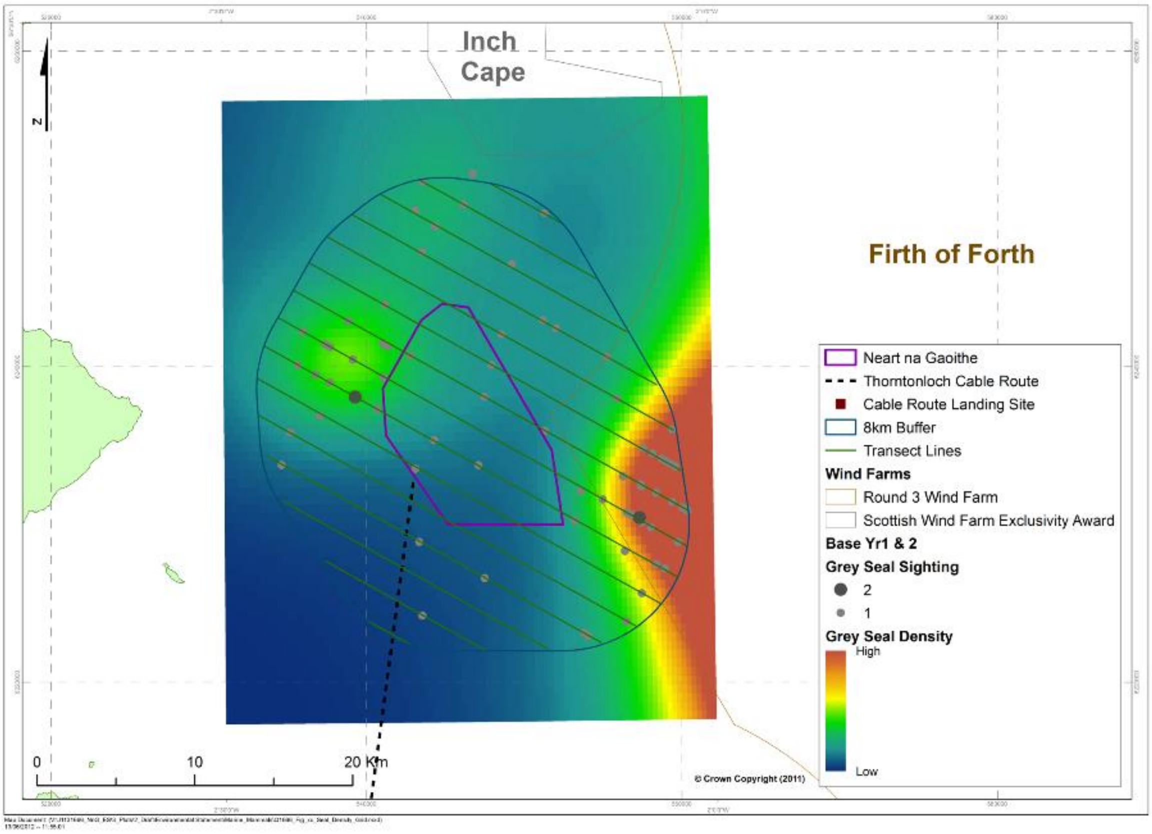


Figure 8-23: Estimated densities of grey seals in the Wind Farm Area and adjacent waters (Source: Gordon, 2012)

8.8.8 Harbour Seal Baseline Data

158. The following presents a summary of the existing information on harbour seal (*Phoca vitulina*).

8.8.8.1 Harbour Seal

159. The UK population of harbour seal is estimated to be 43,300 individuals (95% CI: 35,500 - 59,000) of which 224 individuals occur within the ECMA, which extends from Fraserburgh to the border with England (Duck *et al.* 2016).

160. Total counts of harbour seals hauled out within the East Coast and Moray Firth Management Areas are presented in Figure 8-24. However, as not all harbour seals are at haul-out sites at the same time, the actual population will be greater than the number of seals counted. To account for this, the number of harbours seals recorded at haul out sites is adjusted using a scalar of 1.39 (Sparling *et al.* 2012). By doing so this provides a population estimate of harbour seals in the ECMA of 311 (95% CI 254 - 415) individuals and a Moray Firth population of 1,034 (95% CI 846 – 1,379) individuals, based on the latest available survey data.

161. Since 1997 there has been a wide-scale decline in the number of harbour seals across much of the UK with significant reductions at most haul out sites along the east coast of Scotland. The Firth of Tay and Eden Estuary SAC lies approximately 30 km from the proposed development and like most other east coast harbour seal sites has recorded a decrease in the number of harbour seals present, with a 90% decline in the harbour seal population since 2002 (SCOS, 2016). The latest harbour seal population estimate based on counts undertaken in 2015 is 60 individuals (Duck *et al*. 2016).

162. The cause of the decline in harbour seals is unknown but if the trend continues, based on the current rate of decline, the population of harbour seals within the Firth of Tay and Eden Estuary SAC may become effectively extinct by approximately 2030 (Figure 8-25).

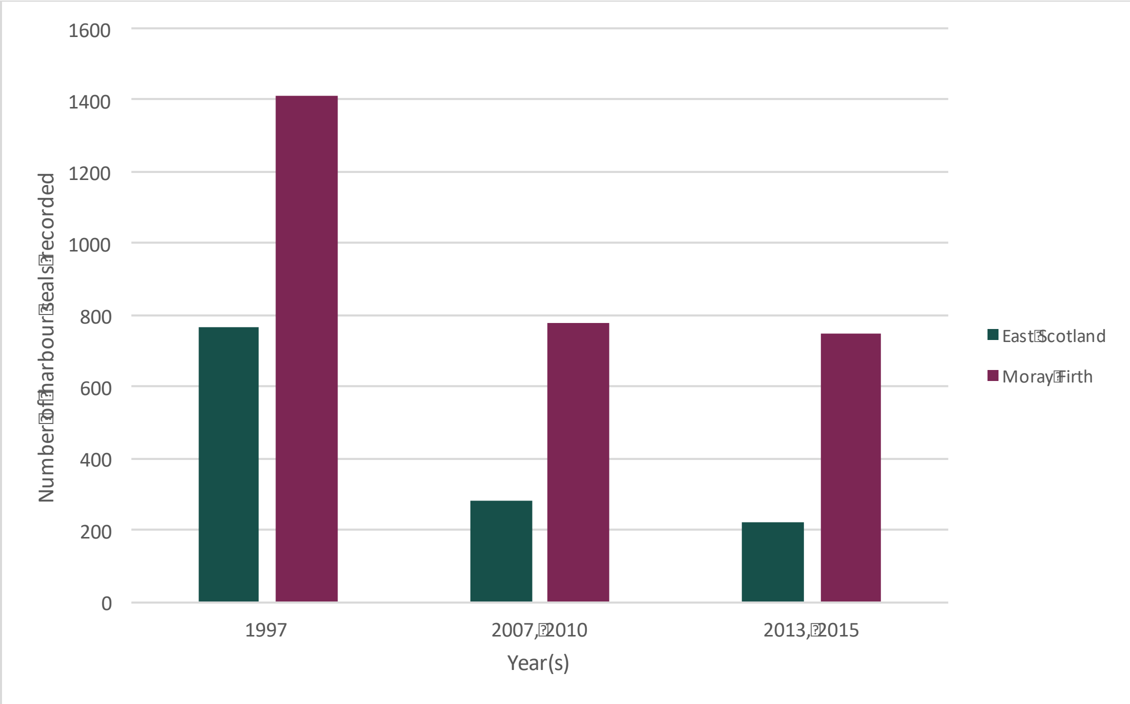


Figure 8-24: Estimated number of harbour seals hauled out within the East Coast and Moray Firth Seal Management Areas (Source: Duck *et al.* 2016)

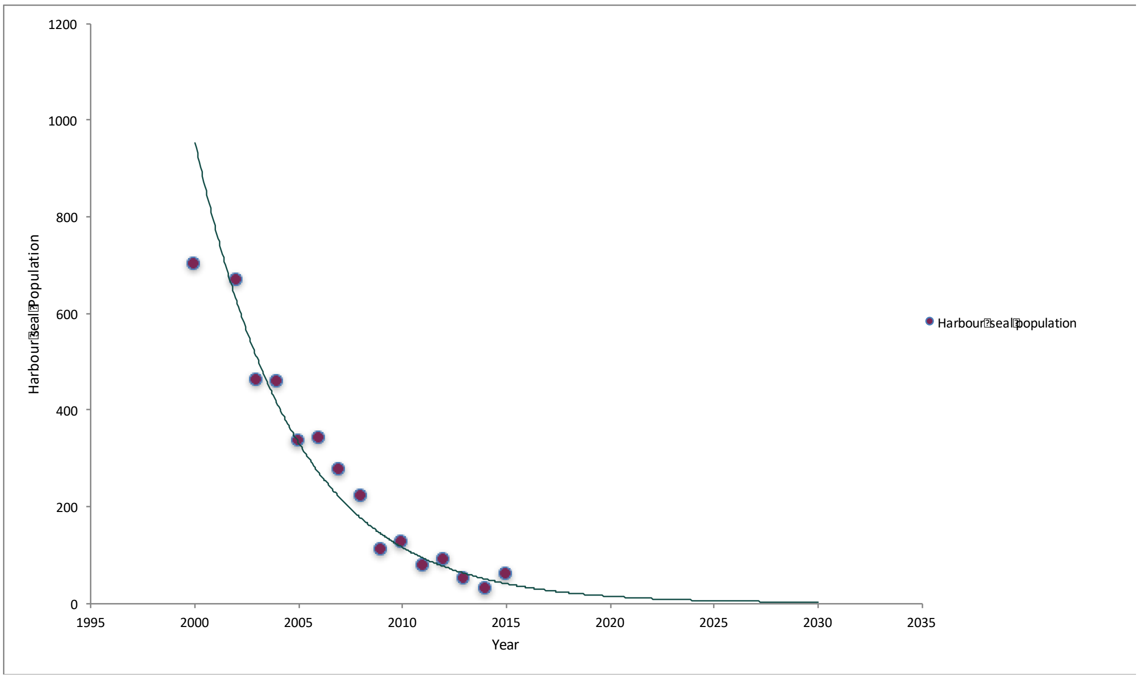


Figure 8-25: Harbour seal population in the Firth of Tay and Eden Estuary SAC from 2000 to 2015

163. Tagging studies of harbour seals indicate that they remain largely in nearshore waters with only infrequent occurrences further offshore (Marine Scotland, 2017d; Sparling *et al*. 2012). Tagging results indicate a very low abundance offshore with relatively higher numbers occurring the Firth of Forth and St Andrews bay area (Figure 8-20).

164. Pupping occurs during June and July followed by moulting during August. Mating also occurs during this period when males will hold underwater territories using vocalisation to help maintain their territories that are close to their haul-out sites. During this period harbour seals remain closer to their haul-out sites. Studies have shown that they spend on average 43% of their time within 10 km of haul out sites (McConnell *et al.* 1999).

165. Breeding in the region takes place between June and July and pups are nursed for a few weeks. Harbour seals undergo a moult during August during which time they spend a greater proportion of their time on shore (Brown and Pierce, 1997; SCOS, 2016).

166. Harbour seals are opportunistic feeders, preying on a wide range of fish species including sandeels, herring, whiting and gadoids, although there is seasonal and geographical variation with for example Gadoid fish being a dominant prey item for harbour seals on Mousa (Brown and Pierce, 1997; Hall and Kershaw, 2012).

167. Harbour seals normally feed within 40-50 km around their haul out sites, and take a wide variety of prey including sandeels, cod, haddock, whiting, ling (*Molva molva*), herring and sprat, flatfish species, octopus and squid, with some seasonal and regional variation with sandeels, octopus, whiting, flounder (*Platichthys flesus*) and cod being eaten by harbour seals in North-east Scotland and sandeels and salmonids being significant prey items for harbour seals in the Tay Estuary (Sparling *et al.* 2012; SCOS, 2005; Tollit and Thompson, 1996).

168. The harbour seal is a qualifying species for the Forth and Tay and Eden estuary SAC and their haul out site within the SAC is protected under the Marine Scotland Act (2010).

8.8.8.2 Site Specific Data

169. During three years of boat-based surveys harbour seals were infrequently recorded within the wind farm and buffer area. A total of 41 harbour seals were recorded over the three years of surveys, of which five were within the Wind Farm Area. Although the number of sightings was low across all three years, the number of harbour seals recorded in Year 1 was relatively lower than the number recorded in Years 2 and 3 (Table 8.20). The majority of sightings were outwith the Wind Farm Area with most observations to the south-east of the site (Figure 8-26).

170. The number of harbour seals recorded within the surveyed areas fluctuated each month with no distinct seasonal variation in the numbers recorded. However, the average number of harbour seal recorded tended to be lower between June and October. Although with relatively few sightings it is difficult to draw a firm conclusion on this (Figure 8-27).

Table 8.20: Number of harbour seals recorded within the Wind Farm and Buffer areas during boat-based surveys undertaken between November 2010 and October 2013

Year	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Year 1 (Nov 2010 – Oct 2011)													
WFA	1	1	0	0	0	0	0	0	0	0	0	0	2
Buffer	1	2	0	1	0	0	0	0	0	0	0	0	4
Total	**2**	**3**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**
Year 2 (Nov 2011 – Oct 2012)													
WFA	n/c	0	0	0	0	0	0	0	0	0	0	0	0
Buffer	n/c	0	2	1	1	3	4	2	0	2	0	2	17
Total	**n/c**	**0**	**2**	**1**	**1**	**3**	**4**	**2**	**0**	**2**	**0**	**2**	**17**

Year 3 (Nov 2012 – Oct 2013)													
WFA	0	2	0	0	0	0	1	0	0	0	0	0	3
Buffer	2	0	1	4	0	3	2	0	1	1	1	0	15
Total	**2**	**2**	**1**	**4**	**0**	**3**	**3**	**0**	**1**	**1**	**1**	**0**	**18**

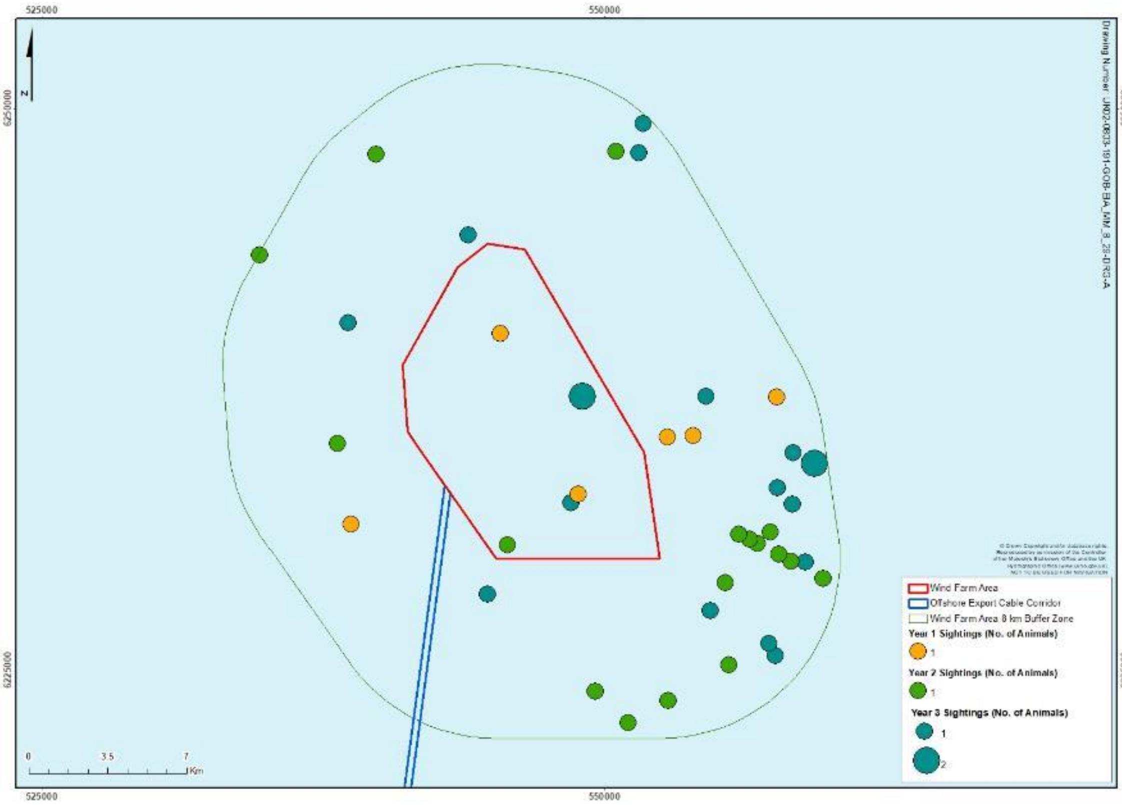


Figure 8-26: Distribution of harbour seals recorded within the study area during boat-based surveys undertaken between November 2010 and October 2013

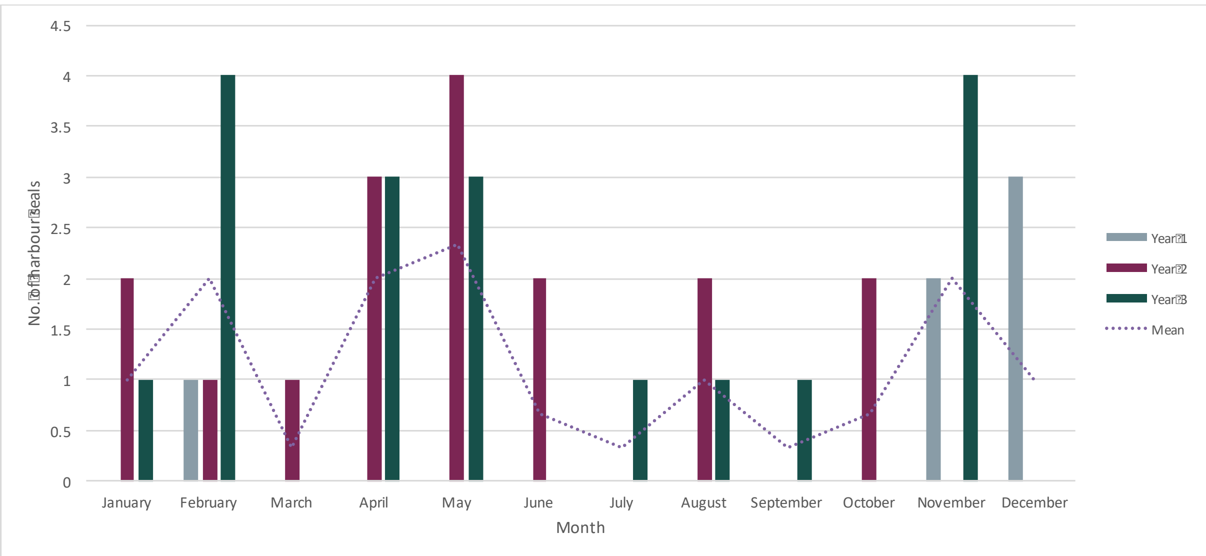


Figure 8-27: Monthly number of harbour seals observed during three years of boat-based surveys

171. Densities of harbour seals within the study area have been estimated based on the offshore usage presented in Figure 8-20. Based on the offshore usage within the Wind Farm Area a density of less than 0.04 ind/km^2 occur within the Wind Farm Area.

172. For the purposes of this assessment the adjusted ECMA population has been used; a total regional population of 311 individuals. A regional specific density is not required as the number of individuals predicted to be impacted is estimated from the at sea distributions (See Appendix 8.2: Interim PCoD modelling for further details).

8.8.9 Development of Baseline Conditions without the Project

173. In the event of the Project not being developed, there would be no change in the baseline conditions in the Offshore Wind Farm Area beyond those resulting from drivers such as climate change, natural variations in temporal and spatial distributions or impacts from other human activities.

174. Population modelling undertaken for this assessment indicate that, with the exception of harbour seal, populations of marine mammals are predicted to remain relatively stable with small fluctuations in populations over the next 24 years (see Appendix 8.2: Interim PCoD modelling).

8.9 Design Envelope – Worst Case Design Scenario

175. The Project application is for the construction, operation and decommissioning of an offshore wind farm with a maximum output of up to 450 MW, comprising of up to 54 turbines and with two OSPs. The assessment scenarios identified in respect of marine mammals have been selected as those having potential to represent the greatest effect based on the design envelope described in Chapter 4: Project Description. The worst-case design scenarios are set out in Table 8.21.

Table 8.21: Design envelope scenario assessed

Potential Impact	Worst Case Design Scenario	Justification
Construction		
Pile driving construction noise	'Drive-only' scenario. It is estimated that between 0% and 10% (max) of piles can be installed by driving without assistance from use of a drill (i.e. driven only piling). Pile driving will occur for up to 18 hrs in total at each wind turbine location with a maximum hammer energy of 1,635 kJ.	The 'Drive-only' scenario will require the highest hammer energy which causes the greatest extent of noise propagation. Noise modelling previously undertaken for both the 'Drive-only' and 'Drive-Drill-Drive' scenarios indicated that the worst-case scenario was 'Drive-only' (Nedwell and Mason, 2012).
Noise from pre-construction geophysical survey work	Sound arising from a range of geophysical survey equipment has potential to cause disturbance to marine mammals. The location and duration of surveys are not known at this stage. The assessment considers the use of multi-beam sonar, sidescan sonar and sub-bottom profilers.	NnGOWL have already completed a number of geophysical survey campaigns within the Development Area. Survey requirements will be determined following review of the already collected data, all potential geophysical survey equipment has therefore been considered within the EIA.
Disturbance from noise and particle motion	Sheet piling of interlocking steel sheets to create a dry area around the receiving pit at the HDD exit in shallow water close to the landfall	Installation of a dry area may be required to assist with export cable pull in and joining the OfTW and OnTW components of the export cable.

from the HDD site pipe works	location. The casing will be removed following export cable installation. The installation duration for the dry area is unknown but it is anticipated that it would be of short duration taking a number of days.	
Operation and Maintenance		
Disturbance from helicopter noise and physical presence	Up to 80 helicopter flights per year between a helicopter base likely situated on the east coast of Scotland and the Wind Farm Area.	Access to vessels and structures may utilise helicopter transfers during operation and maintenance for personnel transfer and transfer of equipment.

8.9.1 Embedded Mitigation

176. Embedded Mitigation measures to minimise the potential effects on marine mammals, are captured within the Project design envelope. The scoping of the assessment of effects on marine mammals has taken account of the following:

- Pile driving will be undertaken using the lowest possible hammer energy to allow satisfactory pile installation. This will reduce the area of potential impact from noise on marine mammals and their prey. Pile driving will commence by using a lower hammer energy and slowly, over a period of time, ramp-up to a maximum hammer energy. This reduces the duration at which marine mammals will be impacted by potentially significant levels of noise and provides time for them to leave the area in order to avoid possible risk of physical injury.

8.9.2 Anticipated Consent Condition Commitments

177. A number of conditions were attached to the Original Consents to manage the environmental risk associated with the Originally Consented Project. NnGOWL anticipates that any future consents issued to the Project may incorporate similar conditions to manage the risk to marine mammals commensurate with the Project design envelope where it remains necessary to do so. Table 8.22 sets out the conditions attached to the Consents which have relevance to the management of effects on marine mammals.

Table 8.22: Consent conditions for the Originally Consented Project relevant to marine mammals

Original Consent Requirement	Relevance to Marine Mammals
Piling Strategy	Setting out, for approval, the piling methods, in accordance with the Application and detailing associated mitigation incorporating data collected as part of pre-construction survey work to demonstrate how effects on bottlenose dolphin, harbour seal and grey seal will be adequately mitigated.
Noise registry	Prior to the commencement of piling activities the proposed date(s), location(s) and nature of the piling activities undertaken must be reported. In the event piling is to be carried out for more than 10 consecutive days, submit quarterly noise registry reports.
Construction Method Statement	Setting out, for approval, details of the finalised construction methods and set out the construction procedures and god working practices to be used. The CMS will be submitted for approval at least six months prior to the commencement of works.

Original Consent Requirement	Relevance to Marine Mammals
Vessel Management Plan	Requires details of the vessels to be used and working practices to reduce the use of ducted propellers.
Environmental Management Plan	Setting out, for approval, relevant environmental management and mitigation measures to be applied during the construction and operation of the Project.
Project Environmental Monitoring Plan	Setting out, for approval, the proposed environmental monitoring programme, to include the participation in surveys to be carried out in relation to marine mammals as set out in the Marine Mammal Monitoring Programme
Participation in the Scottish Strategic Marine Environmental Group (SSMEG)	Requires participation in the SSMEG with respect to research, monitoring and mitigation programmes for marine mammals.
Participation in the Forth and Tay Regional Advisory Group (FTRAG)	Participation in the FTRAG with respect to monitoring and mitigation for marine mammals.

8.10 Impact Assessment

178. The following section addresses the potential impacts on marine mammals from the construction, operation and decommissioning of an offshore wind farm. The assessment is based on:

- Knowledge of the marine mammals at risk of being impacted, as presented in Section 8.8;
- The potential magnitude of any impact, in particular impacts from sound arising during construction, based on the results of the noise modelling presented in Appendix 8.1: Noise modelling; and
- Our understanding of the effects any potential impacts may have on the marine mammals, in particular the population level effects, based on the results from population modelling (as presented in Appendix 8.2: Interim PCoD modellinginterim PCoD).

179. A summary of the potential impacts on marine mammals arising during the construction, operation and decommissioning phases of the Project is presented in Table 8.23. The potential impacts were identified during formal scoping and the subsequent formal and informal consultation (see Section 8.6 Impacts to be assessed).

180. The activities identified as having the potential to cause an impact on marine mammals and whether they were requiring assessment are summarised in Table 8.23 below.

Table 8.23: Activities recognised as having the potential to impact on marine mammals and the determination of whether they are assessed in the EIA

Activity	Scoped in/out of EIA
Disturbance resulting from vessel noise during construction, operation and decommissioning.	It is anticipated that the type and number of vessels operating during the construction period will be broadly similar to the Original Project design envelope; however, each vessel type will be present on site for a shorter duration. There is no change in the construction vessels required. However, duration on site of construction vessels associated with foundation and turbines installation and commissioning is likely to be reduced due to reduced scale of the Project.

Activity	Scoped in/out of EIA
	The potential impacts from vessel noise on marine mammals were assessed in the Original EIA as being not significant and were identified as not requiring further assessment in the NnGOWL Scoping document and agreed with MS in the Scoping Opinion (Marine Scotland 2017a).
Disturbance resulting from vessel presence during construction, operation and decommissioning.	The potential impacts from the presence of vessels on marine mammals were assessed in the Original EIA as being not significant and were identified as not requiring further assessment in the NnGOWL Scoping document and agreed with MS in the Scoping Opinion (Marine Scotland 2017a).
Hammer noise during construction.	The Project is for the installation of up to 54 turbines with a maximum of 6 piles per foundation. Up to 10% of piles can be installed by driving without assistance from use of a drill (i.e. driven only piling). Between 90 and 100% of piles can be installed using one or either of drive-drill-drive method or the drill only method. Where drill only is adopted, the sacrificial casing is expected to be driven to an average length of 30% of the pile length. The installation methods are similar to those assessed in the Original EIA and described in Chapter 4: Project description. The Original EIA concluded that the potential impacts were of minor significance. However, changes in the approach to assessing impacts from noise on marine mammals since the Original EIA indicate further assessment is required for the Revised Project. The potential impact from driving was identified in the Scoping Opinion (Marine Scotland 2017a) as requiring further assessment.
Drilling noise during construction	There is no significant change in the proportion of piles that will require drilling from the Originally Consented Project. The Original EIA concluded that impacts from drilling were not significant and were identified as not requiring further assessment in the Project Scoping document and agreed with MS in the Scoping Opinion (Marine Scotland 2017). However, as drilling will be an integral component of the installation of foundations, an assessment of the potential impacts from drilling noise on marine mammals has been undertaken.
Indirect effects resulting from impacts on prey species	Potential impacts on prey species considered in the Original EIA were identified as not requiring further assessment in the NnGOWL Scoping document and agreed with MS in the Scoping Opinion (Marine Scotland 2017). MS did request that consideration of the potential impacts of particle motion effects were considered on all fish and shellfish species. The impacts of particle motion arising from pile driving activity was considered to be of minor significance and not significant in EIA terms (See Chapter 7: Fish and Shellfish).
Suspended sediment concentrations during construction and decommissioning	Increased suspended sediment concentrations may arise during the installation (or possible removal) of inter-array and export cables. The design envelope relating to the inter-array cables remains unchanged compared to the Original Application although there has been an increase in Offshore Export Cable length. The Original EIA determined that the potential impacts were not significant and this is considered to remain valid. These impacts were identified as not requiring further assessment in the NnGOWL Scoping document and agreed with MS in the Scoping Opinion (Marine Scotland 2017).
Increased noise associated with cable installation (inter-	There is no change in the vessels required to install cables.

Activity	Scoped in/out of EIA
array and export cabling) during construction.	The Original EIA determined that the potential impacts were not significant and this is considered to remain valid. These impacts were identified as not requiring further assessment in the NnGOWL Scoping document and agreed with MS in the Scoping Opinion (Marine Scotland 2017).
Operational noise	No change in the level of noise from individual operating turbines but an overall reduction in the total number of turbines since the Original Project Application. The Original EIA determined that the potential impacts were not significant and this is considered to remain valid. These impacts were identified as not requiring further assessment in the NnGOWL Scoping document and agreed with MS in the Scoping Opinion (Marine Scotland 2017).
Electromagnetic fields from cables during operation	As per the Original Project Application the Offshore Export Cables will be high voltage alternating current (HVAC) and will be trenched and buried. The Original EIA determined that the potential impacts were not significant and this is considered to remain valid. These impacts were identified as not requiring further assessment in the NnGOWL Scoping document and agreed with MS in the Scoping Opinion (Marine Scotland 2017).
Geophysical and geotechnical surveys during construction, operation and decommissioning.	It is recognised that there is the potential for geophysical and geotechnical surveys to be undertaken within the NnG Development Area. Although they will be subject to their own applications as and when required, SNH have advised that they should be considered within the Project EIA.
Operation and Maintenance activities from helicopters	The potential impact on marine mammals from helicopters during operation and maintenance activities was raised during consultation. This had not previously been assessed in the Original Application and therefore potential impacts by helicopter on marine mammals are assessed in ES for the Project.

181. Based on the assessment undertaken during scoping and responses received during formal and informal consultation it has been determined that the activities arising from the construction, operation and decommissioning of the Neart na Gaoithe offshore wind farm that may cause a significant environmental impact on marine mammals are:

- The installation of foundation piles for the wind turbines, offshore substation platform and meteorological (met) mast.

182. In addition, two further activities have been identified as being appropriate for inclusion in the EIA. The activities are:

- Geophysical surveys required in order to determine seabed conditions. Sound arising from a range of geophysical survey equipment has potential to cause disturbance to marine mammals.
- The use of helicopters during the operational life-time of the project. The sound and physical presence could cause disturbance to marine mammals.

8.10.1 Marine Mammals and Noise

183. Sound arising from proposed construction activities has the potential to impact on marine mammals within or adjacent to the Offshore Wind Farm Area.

184. There is a substantial volume of literature describing the potential effects of sound on marine mammals, and summarised in e.g. Thomsen *et al.* (2006), Southall *et al.* (2007) and OSPAR (2009).

185. There are four main types of potential effect from noise that are recognised within the marine environment:

- *Fatal effects* caused by significant levels of noise in close proximity to the receptor.
- *Physical injury*, specifically hearing impairment, which can be permanent or temporary. These effects can impact on the ability of marine mammals to communicate, forage or avoid predators.
- *Behavioural effects* such as avoidance, resulting in displacement from suitable feeding or breeding areas, and changes in travelling routes.
- *Secondary impacts* caused by the direct effects of noise on potential prey causing a reduction in prey availability

186. The range at which marine mammals may be able to detect sound arising from offshore activities depends on the hearing ability of the species and the frequency of the sound. Pinnipeds (seals) are potentially more sensitive to low frequency sounds than bottlenose dolphin or harbour porpoise. Other factors potentially affecting the potential impact of sound on marine mammals includes ambient background noise, which can vary depending on water depth, seabed topography and sediment type. Natural conditions such as weather and sea state and other existing sources of human produced sound, e.g. shipping, can also reduce the auditory range.

Fatal effects

187. If source peak pressure levels from the proposed operations are high enough there is the potential for a lethal effect on marine mammals. Studies suggest that potentially lethal effects can occur to marine mammals when the peak pressure level is greater than 246 or 252 dB re. 1 µPa (Parvin, Nedwell and Harland, 2007). Damage to soft organs and tissues can occur when the peak pressure level is greater than 220 dB re. 1 µPa.

Physical injury

188. Underwater sound has the potential to cause hearing damage in marine mammals, either permanently or temporarily. The potential for either of these conditions to occur is dependent on the hearing bandwidth of the animal, the duty cycle of the sound source and duration of the exposure (Southall *et al*. 2007, OSPAR 2009).

189. Physical injury is described as either a permanent loss of hearing range (permanent threshold shift (PTS)) or temporary loss of hearing range (temporary threshold shift (TTS)). Sound exposure levels considered capable of causing the onset of either PTS or TTS do not mean that such physical impacts will always occur. The probability of developing PTS or TTS will follow a dose response curve, with increasing risk of physical injury as exposure increases. Studies undertaken on bottlenose dolphin indicate that only between 18% and 19% of bottlenose dolphins exposed to sound exposure levels of 195 dB re 1 μPa^2.s, actually resulted in the onset of TTS (Finneran *et al*. 2005).

190. Although PTS is a permanent physical injury impairing the marine mammal's ability to hear, TTS is not and impacts are relatively short-lived. Studies undertaken on harbour porpoise indicate that, depending on the exposure level and duration, hearing ability returns between 4 and 96 minutes after the sound causing the impact has ceased (Kastelein *et al*. 2012).

Behavioural Change

191. Potential changes in behaviour may occur depending on the sound source levels and the species' and individuals' sensitivities. Behavioural changes can vary from changes in swimming direction, diving duration, avoidance of an area and reduced communication from masking. The displacement of marine mammals could cause them to relocate to sub-optimal locations where there is lower prey availability or increased inter and intra-specific competition. If permanent or over a long period, this could cause lower fecundity or increased mortality.

192. Changes in behaviour arising from noise impacts may be easily detectable, e.g. a significant displacement from an area. Other effects caused by changes in behaviour, e.g. energetic stress, may be more difficult to detect and go unnoticed (OSPAR 2009).

193. Masking effects may also cause changes in the behaviour as the level of sound may impair the detection of echolocation clicks and other sounds that species use to communicate or detect prey thus causing them to alter their behaviour (David 2006).

Secondary Effects

194. There is potential for impacts on prey species to affect marine mammals and seabirds, in particular possible impacts of noise on fish species. The impacts from noise on fish are assessed in Chapter 7: Fish and Shellfish Ecology.

8.10.1.1 Harbour porpoise

195. Porpoises are generally considered to be 'high frequency' specialists with a relatively poor ability to detect lower frequency sounds (Southall *et al.* 2007). Studies undertaken on captive harbour porpoises indicate that porpoises have a functional hearing range of between 250 Hz and 180 kHz with their best hearing between 16 to 140 kHz and their maximum sensitivity between 100 and 140 kHz. This is within the frequency range of 130 to 140 kHz that harbour porpoise echolocate (Miller and Wahlberg 2013).

196. Their ability to detect sound below 16 kHz or above 140 kHz falls sharply (Kastelein *et al.* 2012, 2015, Southall *et al*. 2007). Harbour porpoise are therefore most sensitive to relatively high sound frequencies between 16 to 140 kHz and, although audible, they are unlikely to be sensitive to sound either above or below those frequencies.

197. Harbour porpoise use echolocation to communicate and detect prey. Reported sound levels produced range from between 166 to 194 dB re 1 µPa @ 1 m $_{(rms)}$ and 178 and 205 dB re. 1 µPa $_{(peak-peak)}$, with a mean level of 191 dB re. 1 µPa $_{(peak-peak)}$ and within the peak frequency range of 110 to 150 kHz (Villadsgaard, *et al*. 2007; Miller and Wahlberg, 2013; MMO, 2015).

8.10.1.2 Bottlenose dolphin and white-beaked dolphin

198. The frequencies at which bottlenose dolphins communicate through whistles and clicks is typically between 5 kHz and 10 kHz (Janik, 2000), However, lower frequency sounds of below 1 kHz have been reported (Simard *et al*. 2011). Bottlenose dolphins echolocate between 50 kHz and 115 kHz (Richardson *et al*. 1995, Jensen 2011). Sound levels produced by free-swimming bottlenose dolphins range from 196 to 228 dB re. 1 µPa $_{(peak-peak}$ and white-beaked dolphin of between 194 and 211 dB re. 1 µPa $_{(peak-peak)}$ (Rasmussen *et* al. 2004; Wahlberg *et al*. 2011).

8.10.1.3 Minke whale

199. Minke whales are generally considered to be 'low-frequency specialists' with a functional hearing range of between 7 Hz and 22 kHz (Southall *et al*. 2007). This suggests that they are more sensitive to low frequency sounds than other species of marine mammal. Low frequencies propagate further in the water column than higher frequencies and therefore the extent of impacts from low frequency sound are greater for baleen whales, including minke whales, than they are for other species of marine mammal.

200. Minke whales vocalise between 50 Hz and 9.4 kHz at broad band source levels of between 150 and 165 dB re. 1 µPa@1m (Gedamke *et al*. 2001).

8.10.1.4 Harbour and grey seal

201. Seals are thought to have a relatively broad hearing range of between 75 Hz and 70 kHz (Southall *et al*. 2007). Studies undertaken on captive harbour seals indicate their optimal hearing range is between 500 Hz and 40 kHz with relatively poor hearing ability of sound below or above these levels.

202. Measured underwater recordings indicate that grey seals vocalise at relatively low frequencies of between 100 Hz and 3.0 kHz (Asselin *et al.* 1993). During the mating season, male harbour seals hold territories underwater. They maintain their territories through vocalisation at relatively low frequencies of between 250 Hz and 1.4 kHz (van Parijs *et al* 2000). Anthropogenic sound produced at these frequencies during the mating season could impact on the ability of male harbour seals to hold territories.

8.10.2 Sound Modelling

203. In order to undertake an assessment of the potential impacts on marine mammals and their prey by proposed pile driving activities during the construction of the Project, modelling has been commissioned to assess the potential impacts from noise arising from pile driving activities. Details of the modelling undertaken are presented in Appendix 8.1: Noise modelling. A summary of the modelling undertaken is presented in this section.

204. Noise modelling has been undertaken at two locations within the Wind Farm Area and, to allow potential cumulative impacts to be assessed, modelling has also been undertaken at the Inch Cape Offshore Wind Farm and at a further four locations at Seagreen Phase 1 (Seagreen Alpha and Bravo) offshore wind farms. When considering potential cumulative impacts, the location within each of the wind farm areas that produced the worst-case scenario, i.e. greatest area of sound propagation, was selected.

205. Noise modelling results based on both peak Sound Pressure Level (SPL) and weighted Sound Exposure Level (SEL) are presented using both Southall *et al.* (2007) and NOAA (2016) thresholds and their auditory weightings for each species. The sound thresholds at which the onset of PTS and TTS are predicted to occur based on the Southall and NOAA thresholds are presented in Table 8.24 (Southall *et al.* 2007; NMFS, 2016).

Table 8.24: Sound thresholds at which the onset of PTS and TSS are predicted to occur

Sound Thresholds	PTS		TTS	
	Unweighted peak SPL (dB re 1 µPa)	Weighted SEL (dB re 1 µPa)	Unweighted peak SPL (dB re 1 µPa)	Weighted SEL (dB re 1 µPa)
SOUTHALL THRESHOLDS				
All Cetaceans (Harbour porpoise, Bottlenose dolphin, White-beaked dolphin, Minke whale)	230	198	224	183
Phocid Pinnipeds (Grey seal, Harbour seal)	218	186	212	171
NOAA THRESHOLDS				
High Frequency Hearing specialist, (Harbour porpoise)	202	155	196	140

Sound Thresholds	PTS		TTS	
	Unweighted peak SPL (dB re 1 µPa)	Weighted SEL (dB re 1 µPa)	Unweighted peak SPL (dB re 1 µPa)	Weighted SEL (dB re 1 µPa)
Mid Frequency Hearing Specialist (Bottlenose dolphin, White-beaked dolphin)	230	185	224	170
Low Frequency Hearing Specialist (Minke whale)	219	183	213	168
Phocid Pinnipeds (Grey seal, Harbour seal)	218	185	212	170

206. The potential magnitude of any impact on a marine mammal is dependent on whether the individual avoids the area by swimming away from the sound source. The speed and direction it swims has a significant effect on the extent of the potential impact. An increase in swimming speed from 1.5 m s-1 to 3.0 m s-1 decreases the area within which the onset of PTS is predicted to occur in harbour porpoise by approximately 60%. A similar reduction in the area of predicted effect occurs when a minke whale increases its swimming speed from 2.1 m s-1 to 3 m s-1 (See Section 6 in Appendix 8.1: Noise Modelling). For the purposes of this assessment the modelling assumes that marine mammals will swim away from the sound source at differing speeds, depending on the species. The swimming speeds for each of the marine mammals for which modelling has been undertaken are presented in Table 8.25 and are based on the advice received in the Scoping Opinion (Marine Scotland 2017a). However, evidence shows that animals will significantly increase swimming speeds when avoiding underwater noise, e.g. Otani *et al*. (2000), Sivle *et al*. (2015), McGarry *et al*. (2017), Kastelein *et al*. (2018). Consequently, the results from the noise modelling are considered to be precautionary.

Table 8.25: Swimming speeds of marine mammals used in the noise modelling (SNH 2016, Marine Scotland 2017a)

Species	Swimming speed (m s^{-1})
Harbour porpoise	1.4
Bottlenose dolphin	1.52
White-beaked dolphin	1.52
Minke whale	2.1
Grey seal	1.8
Harbour seal	1.8

207. The direction a marine mammal moves away from the sound will be variable and depends on a number of factors including the propagation of sound in the environment and the individual's tolerance to the noise. The noise modelling has been conducted for all possible directions that an individual may swim away from the sound source. Results are presented showing minimum, average and maximum impact distances. The minimum impact distance corresponds to the scenario where a marine mammal swims away from the sound source along the route where the lowest sound levels from the sound source exists, whilst the maximum impact distance corresponds to the scenario where a marine mammal swims away from the sound source along the direction of the sound source, where

sound levels are highest. It is considered unlikely that a marine mammal would swim away from the source along the route of maximum sound levels since it is conjectured that they would seek a route away from the sound source where they are not exposed to such high levels of sound. The average impact distance has been calculated by averaging the impact distances over all possible directions that a marine mammal may swim away from the sound source. For the purposes of this assessment the average impact distance has been used since it is based on all possible directions a marine mammal may move away from the sound source. This is considered suitably precautionary as an individual is likely to select a route along lower noise levels but also accounts for the variability in the behaviour of the individual. Furthermore, the modelling assumes that the marine mammal swims at a depth where there is greatest sound propagation within the water column. Evidence from studies indicate that marine mammals will rise to the surface and swim away from the area of disturbance at the sea surface (e.g. Sivle *et al*. 2015). Typically, this part of the water column has lower sound levels than other depths

208. There are three possible scenarios for the installation of piles: pile driving only ('Drive-only'), pile driving followed by a period of drilling and completed with additional pile driving ('Drive-Drill-Drive') and Drilling only. Details of the installation methods are presented in Chapter 4: Project description. Previous modelling undertaken as part of the original application indicated that potential impacts on marine mammals were greatest from the Drive-only scenario (NnGOWL, 2012). Consequently, for the purposes of this assessment noise modelling has been based on the Drive-only scenario as this is predicted to be the worst-case scenario with respect to noise impacts on marine mammals or their prey, but noting that only a relatively small proportion of piles will be drive only installations (up to approximately 10% or up to approximately 41 piles out of a total of up to 344 piles for the wind turbines, OSPs and met mast).

8.10.2.1 Pile driving

209. The noise modelling is based on the pile driving of 4 x 50 m long piles sequentially over a period of approximately 20 hours. The Project design envelope also includes a 6 pile jacket option at each wind turbine foundation. However, noise modelling has considered the installation of 4 pile jackets as this is considered the worst case scenario. Installing 4 piles takes approximately the same length of time as it does to install six. However, when installing four piles a greater proportion of overall installation time is spent pile driving at the maximum hammer energy due to the longer pile length, than compared with installing six piles, i.e. there is, proportionally, less overall time at the lower hammer energies used during soft-start and ramp-up. Consequently, the predicted area of potential impact is greater when installing four piles.

210. The maximum SPL used in the model is 244 dB *re* 1 $\mu Pa^2 s_{(0\text{-peak})}$. Modelled outputs are presented for the installation of a pile hammer operating at full energy and assuming a ramp-up scenario. The installation of a pile requires the hammer energy to be increased over a period of time until it reaches maximum energy and hammer blows maintained at this energy level until full pile penetration is achieved. This allows time for individuals to swim away from the sound source as the sound level increases. Ramp-up scenarios vary depending on the pile size and the seabed conditions and will therefore vary from site to site. However, there is limited information on the ramp-up scenarios to be used during pile driving by other projects. For the purposes of this assessment all the modelling is based on the most likely ramp-up scenario for the proposed Project (Table 8.26).

Table 8.26: Pile driving scenarios used for noise modelling at Neart na Gaoithe, Inch Cape and Seagreen A and B offshore wind farms

Abundance	Neart na Gaoithe	Inch Cape	Seagreen A and B
Hammer capacity (kJ)	1,800	2,400	2,400
No. of piles	4	4	4

Abundance	Neart na Gaoithe	Inch Cape	Seagreen A and B
Ramp-up duration	30 minutes at 360 kJ (approx. 20% capacity) 85 minutes at 1,026 kJ (approx. 57% capacity) 180 minutes at 1,635 kJ (approx. 91% capacity)	20 minutes at 264 kJ (approx. 11% capacity) 20 minutes at 480 kJ (approx. 20% capacity) 10 minutes at 720 kJ (approx. 30% capacity) 106 minutes at 2,160 kJ (approx. 90% capacity)	20 minutes at 264 kJ (approx. 11% capacity) 20 minutes at 480 kJ (approx. 20% capacity) 10 minutes at 720 kJ (approx. 30% capacity) 106 minutes at 2,160 kJ (approx. 90% capacity)

8.10.3 Sound Modelling Results for PTS and TTS on Marine Mammals

211. The following presents a summary of the results from the modelling that are used in the assessment of impacts from noise on marine mammals and their prey from the proposed Project on its own. The modelling results presented are based on the application of thresholds based on the latest studies on marine mammal hearing sensitivities published in NMFS (2016), i.e. they are based on the NOAA thresholds. The worst-case scenarios are presented, i.e. the modelling location where the greatest distance at which thresholds are exceeded based on the cumulative weighted results have been selected.

212. Further details of all the noise modelling undertaken in support of this assessment, including results based on the Southall thresholds, are presented in Appendix 8.1 Noise Modelling.

8.10.3.1 Harbour porpoise

213. The predicted extent that sound from pile driving could cause the onset of PTS and TTS on harbour porpoise, based on the cumulative weighted SEL, is presented in Figure 8-28.

214. The results from the noise modelling indicate that the average distances at which the onset of instantaneous PTS (un-weighted SPL) is predicted to occur on harbour porpoise from a 1,635 kJ hammer strike is 247 m from the pile driving and the onset of cumulative PTS occurs out to 6,357 m (Table 8.27).

215. The onset of TTS (un-weighted SPL) is predicted to occur on average within 823 m from the pile driving and the onset of cumulative TTS to occur within 25,112 m (Table 8.28).

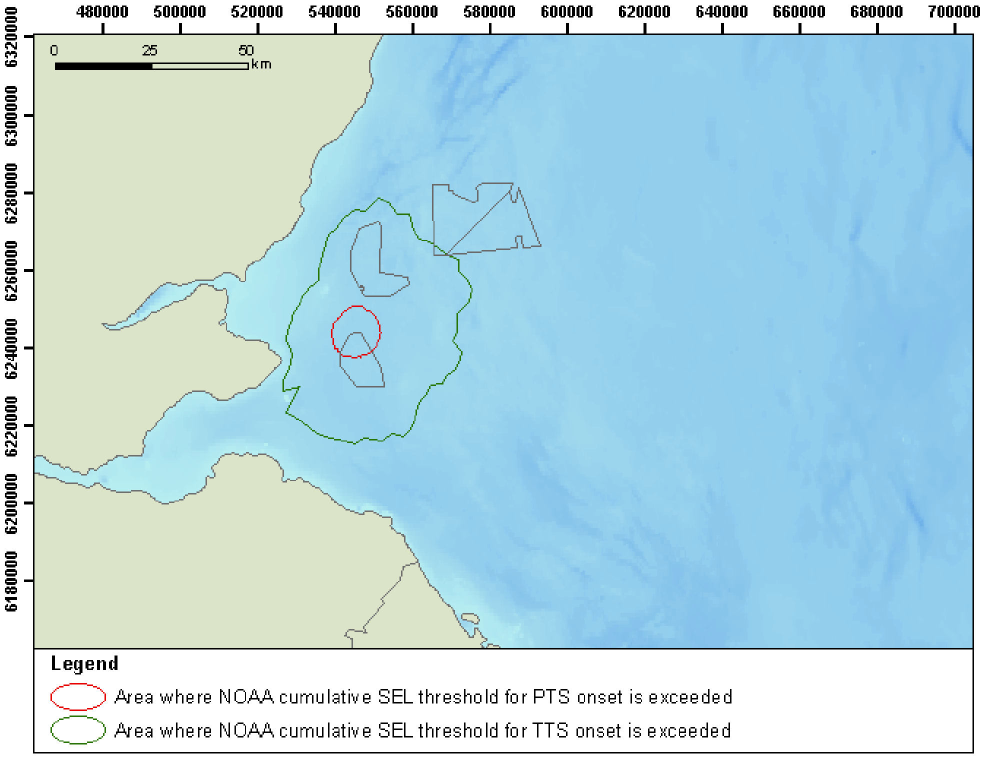


Figure 8-28: Predicted areas where NOAA cumulative SEL thresholds for high-frequency cetaceans are during pile driving at Neart na Gaoithe modelling location 1

Table 8.27: Predicted distances and areas where NOAA thresholds for PTS in high-frequency cetaceans are exceeded during pile driving at Neart na Gaoithe model location 1

Harbour Porpoise PTS	Distance to threshold exceedance (m)			Area (km²)
	Minimum	Average	Maximum	
Unweighted single pulse peak SPL of 202 dB re 1 µPa	238	247	255	0.204
Weighted cumulative SEL of 155 dB re 1 µPa²s	5,424	6,357	6,876	127.3

Table 8.28: Predicted distances and areas where NOAA thresholds for TTS in high-frequency cetaceans are exceeded during pile driving at Neart na Gaoithe model location 1

Harbour Porpoise TTS	Distance to threshold exceedance (m)			Area (km²)
	Minimum	Average	Maximum	
Unweighted single pulse peak SPL of 196 dB re 1 µPa	796	823	885	2.46
Weighted cumulative SEL of 140 dB re 1 µPa²s	15,897	25,112	35,141	2,074.9

8.10.3.2 Bottlenose dolphin and white-beaked dolphin

216. The results from the noise modelling indicate that the average distances at which the onset of instantaneous PTS (un-weighted SPL) is predicted to occur on dolphins from a single 1,635 kJ hammer

strike is within 3 m from the pile driving and the onset of cumulative PTS occurs within 1 m (Table 8.29).

217. The onset of TTS (un-weighted SPL) is predicted to occur on average within 8 m from the pile driving and the onset of cumulative TTS to occur within 493 m (Table 8.30).

Table 8.29: Predicted distances and areas where NOAA thresholds for PTS in mid-frequency cetaceans are exceeded during pile driving at Neart na Gaoithe model location 2

Bottlenose dolphin and White-beaked dolphin PTS	Distance to threshold exceedance (m)			Area (km²)
	Minimum	Average	Maximum	
Unweighted single pulse peak SPL of 230 dB re 1 µPa	3	3	3	<0.001
Weighted cumulative SEL of 185 dB re 1 µPa²s	1	1	1	<0.001

Table 8.30: Predicted distances and areas where NOAA thresholds for TTS in mid-frequency cetaceans are exceeded during pile driving at Neart na Gaoithe model location 2

Bottlenose dolphin and White-beaked dolphin TTS	Distance to threshold exceedance (m)			Area (km²)
	Minimum	Average	Maximum	
Unweighted single pulse peak SPL of 224 dB re 1 µPa	8	8	8	<0.001
Weighted cumulative SEL of 170 dB re 1 µPa²s	482	493	508	0.76

8.10.3.3 Minke whale

218. The predicted extent that sound from pile driving could cause the onset of PTS and TTS on minke whale, based on the cumulative weighted SEL, is presented in Figure 8-29.

219. The results from the noise modelling indicate that the average distances at which the onset of instantaneous PTS (un-weighted SPL) is predicted to occur from a 1,635 kJ hammer strike on minke whale is within 15 m from the pile driving and the onset of cumulative PTS occurs within 10,224 m (Table 8.31).

220. The onset of instantaneous TTS (un-weighted SPL) is predicted to occur on average within 37 m from the pile driving and the onset of cumulative TTS to occur within 44,889 m (Table 8.32).

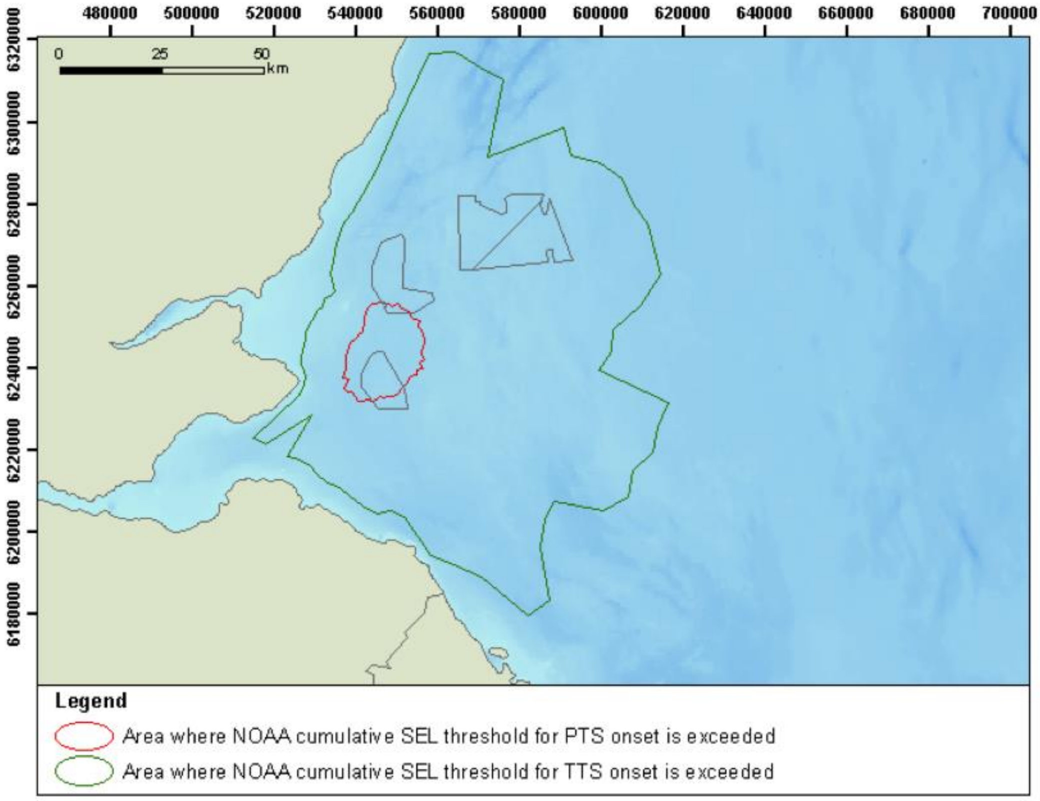


Figure 8-29: Predicted areas where NOAA cumulative SEL thresholds for low-frequency cetaceans are during pile driving at Neart na Gaoithe modelling location 1

Table 8.31: Predicted distances and areas where NOAA thresholds for PTS in low-frequency cetaceans are exceeded during pile driving at Neart na Gaoithe model location 1

Minke whale PTS	Distance to threshold exceedance (m)			Area (km²)
	Minimum	Average	Maximum	
Unweighted single pulse peak SPL of 219 dB re 1 µPa	15	15	15	<0.001
Weighted cumulative SEL of 183 dB re 1 µPa²s	5,693	10,224	13,115	344.4

Table 8.32: Predicted distances and areas where NOAA thresholds for TTS in low-frequency cetaceans are exceeded during pile driving at Neart na Gaoithe model location 1

Minke whale TTS	Distance to threshold exceedance (m)			Area (km²)
	Minimum	Average	Maximum	
Unweighted single pulse peak SPL of 213 dB re 1 µPa	37	37	37	<0.001
Weighted cumulative SEL of 168 dB re 1 µPa²s	17,035	44,889	75,421	7,724

8.10.3.4 Grey seal and harbour seal

221. The predicted extent that sound from pile driving could cause the onset of PTS and TTS on seals, based on the cumulative weighted SEL, is presented in Figure 8-30.

222. The results from the noise modelling indicate that the average distances at which the onset of instantaneous PTS is predicted (un-weighted SPL) to occur from a 1,635 kJ hammer on seals is within 18 m from the pile driving and the onset of cumulative PTS occurs within 472 m (Table 8.33).

223. The onset of TTS (un-weighted SPL) is predicted to occur on average within 47 m from the pile driving and the onset of cumulative TTS to occur within 20,312 m (Table 8.34).

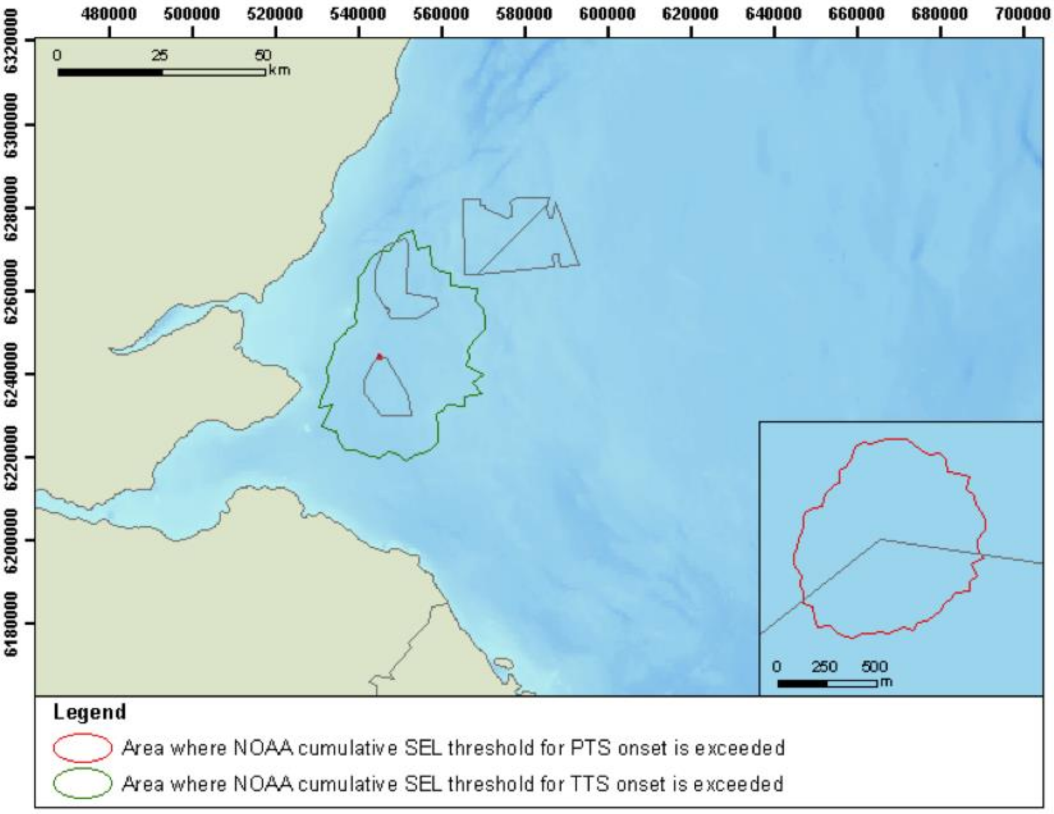


Figure 8-30: Predicted distances and areas where NOAA thresholds for TTS in phocid pinniped are exceeded during pile driving at Neart na Gaoithe model location 1

Table 8.33: Predicted distances and areas where NOAA thresholds for PTS in phocid pinnipeds are exceeded during pile driving at Neart na Gaoithe model location 1

Grey seal and Harbour seal PTS	Distance to threshold exceedance (m)			Area (km²)
	Minimum	Average	Maximum	
Unweighted single pulse peak SPL of 218 dB re 1 µPa	18	18	18	0.001
Weighted cumulative SEL of 183 dB re 1 µPa²s	337	472	553	0.706

Table 8.34: Predicted distances and areas where NOAA thresholds for TTS in phocid pinnipeds are exceeded during pile driving at Neart na Gaoithe model location 1

Grey seal and Harbour seal TTS	Distance to threshold exceedance (m)			Area (km^2)
	Minimum	Average	Maximum	
Unweighted single pulse peak SPL of 213 dB re 1 µPa	47	47	48	<0.007
Weighted cumulative SEL of 168 dB re 1 µPa²s	9,846	20,312	31,668	1,409

224. The estimated number of individuals at risk of the onset of PTS from single pile driving is presented in Section 8.10.8.1**Error! Reference source not found.**.

8.10.4Sound Modelling Results for Potential Disturbance to Marine Mammals

225. The area within which a marine mammal may be displaced or disturbed will vary depending on a number of factors including the level of sound received, the sensitivity of the species and individuals to noise and whether there are suitable areas to which they may move.

226. When considering the extent at which disturbance occurs, Southall *et al*. (2007) were not able to define thresholds for multiple-pulse and non-pulse sounds as empirical studies revealed no clear relationship between the received sound level and behavioural response. Similarly, NMFS (2016) did not present any thresholds at which disturbance to marine mammals may occur. Consequently, there are no defined published sound thresholds at which displacement or disturbance effects are predicted to occur.

227. Studies on marine mammals during pile driving activities have demonstrated that higher levels of displacement or disturbance occur at higher received sound levels. The received sound level decreases with increasing distance from the sound source and there is a corresponding reduction in displacement or disturbance.

228. Studies undertaken at eight offshore wind farms in German waters have estimated the proportion of harbour porpoise displaced within a range of SEL (Brandt *et al*. 2016). Based on these findings a dose-response curve has been developed from which it can be estimated the proportion of individuals displaced at any given received sound level (Figure 8-31). Details of the dose response curve are presented in Appendix 8.1: Noise Modelling.

229. It is recognised that further data have been obtained from pile-driving activities being undertaken within the Moray Firth, from which a dose response curve could be obtained (Marine Scotland 2017a). Requests were made for the data in order to produce a dose response curve. However, the data were not made available at the time of undertaking this assessment. In the absence of data from the Moray Firth the use of Brandt *et al*. (2016) data to produce a dose response curve is considered the most appropriate published data available.

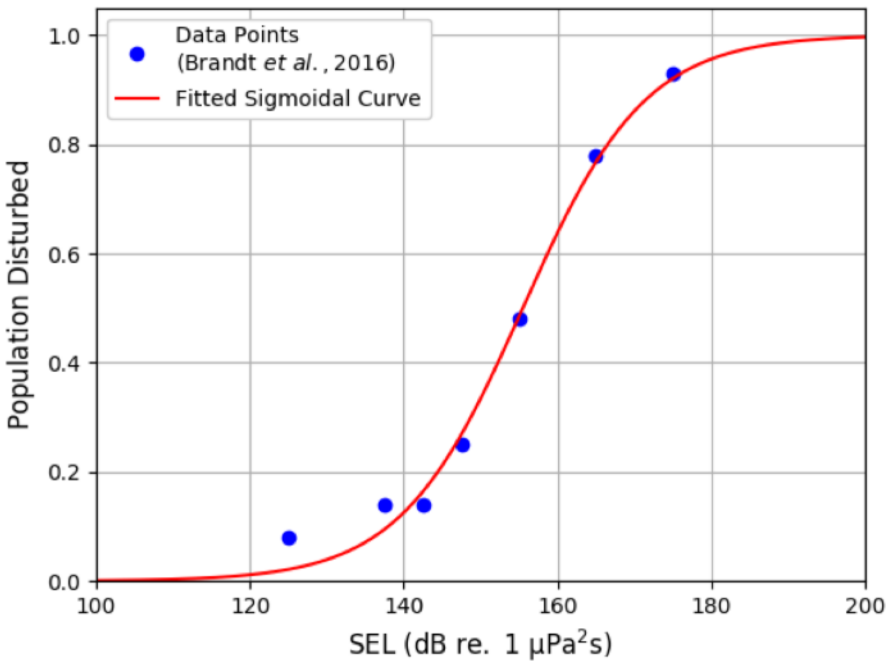


Figure 8-31: Behavioural response curve used for assessing potential behavioural disturbance to marine mammals

230. Noise modelling undertaken at two locations within the Offshore Wind Farm Area predicts the extent sound from pile driving will propagate (Figure 8-32 and Figure 8-33). From these figures, it is possible to estimate the area of impact at a range of SEL and the proportion of marine mammals that will be displaced (Table 8.35).

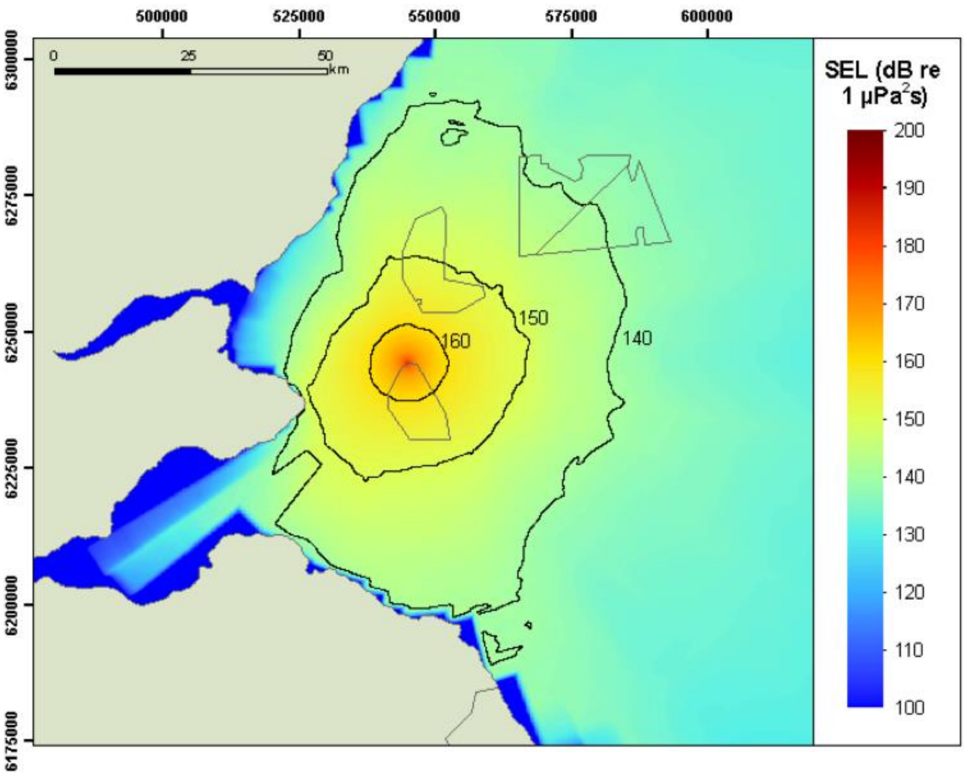


Figure 8-32: Predicted unweighted SEL during pile driving at Neart na Gaoithe modelling location 1 with hammer operating at maximum energy

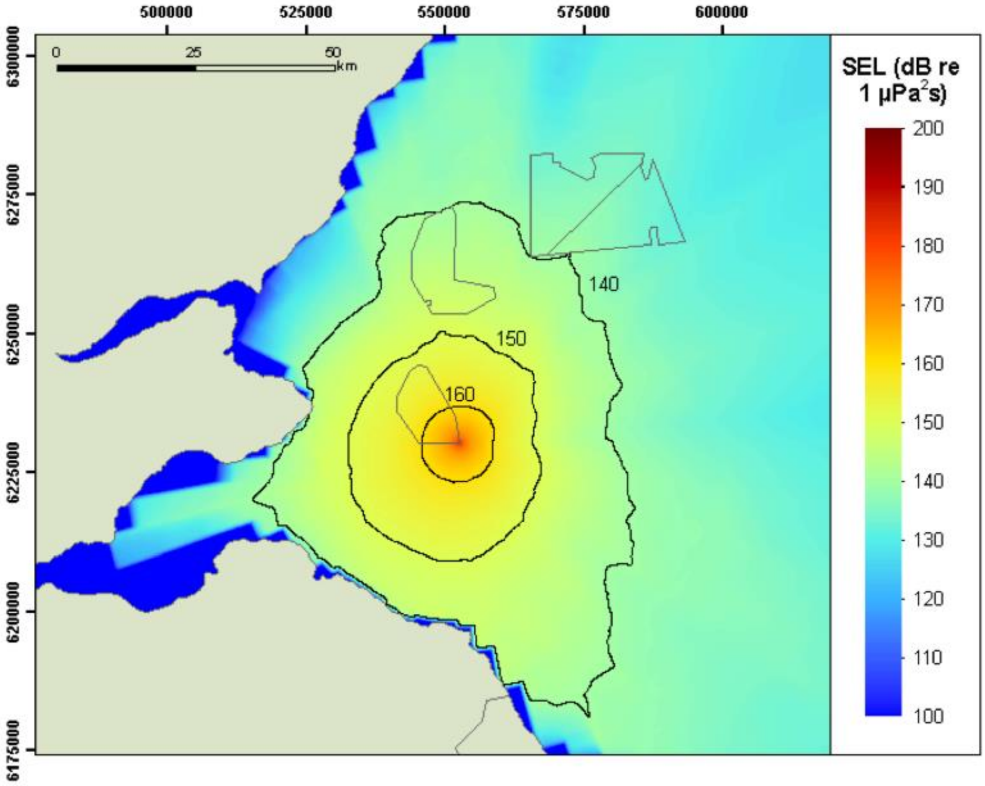


Figure 8-33: Predicted unweighted SEL during pile driving at Neart na Gaoithe modelling location 2 with hammer operating at maximum energy

Table 8.35: Predicted disturbance areas and probability of disturbance to marine mammals during pile driving at Neart na Gaoithe at modelled locations 1 and 2

SEL sound level (dB re 1 µPa²s)	Area encompassed by SEL band (km²)		Probability of disturbance (%)
	Location 1	Location 2	
>200	0.000	0.000	99.89
195 - 200	0.001	0.002	99.49
190 - 195	0.008	0.010	99.05
185 – 190	0.061	0.060	98.23
180 – 185	0.265	0.372	96.74
175 – 180	2.105	2.223	94.06
170 - 175	8.568	7.719	89.42
165 - 170	32.51	31.38	81.86
160 – 175	111.3	101.9	70.68
155 – 160	318.7	262.5	56.28
150 – 155	671.2	689.2	40.73

SEL sound level (dB re 1 µPa²s)	Area encompassed by SEL band (km²)		Probability of disturbance (%)
	Location 1	Location 2	
145 - 150	1,103	1,236	26.85
140 - 145	1,921	1,533	16.39
135 – 140	2,970	2,979	9.47
130 - 145	7,406	5,908	5.29

231. The results indicate that the areas encompassed by each SEL band are similar for Location 1 and Location 2, suggesting that there are no significant differences in the extent noise impacts will occur across the site.

232. The estimated number of marine mammals at risk of PTS and disturbance from single pile driving at Neart na Gaoithe based on the NOAA thresholds are presented in Table 8.36**Error! Reference source not found.** (See Appendix 8.2 Interim PCoD modelling).

Table 8.36: Estimated number of marine mammals at risk of the onset of PTS and disturbance from single pile driving activities at Neart Na Gaoithe

Species	Density (ind./km²)	PTS		Disturbed
		Area of PTS (km²)	Number of animals	Number of animals
Harbour Porpoise	0.599	127.276	77	1,177
Bottlenose Dolphin	0.070	0.00001	0	2
White-Beaked Dolphin	0.24	0.00003	<1	478
Minke Whale	0.039	344.357	14	77
Grey Seal	Variable	1.30591	1	821
Harbour Seal	Variable	1.30591	1	8

8.10.5Concurrent Pile driving

233. There is the potential for pile driving to occur simultaneously at two locations within the Offshore Wind Farm Area. The areas within which the onset of PTS and TTS are predicted to occur, should concurrent pile driving be undertaken, are presented in Table 8.37 and Table 8.38.

234. The results indicate that if concurrent pile driving is undertaken, the area within which PTS and TTS are predicted to occur, is greater than if only one pile driving activity takes place, although the area of impact is overall lower than if two temporally and spatially separate pile driving activities were undertaken (Table 8.39). The overall duration of any impacts are predicted to be shorter if concurrent pile driving occurs, as the installation of turbine foundations will be undertaken more quickly and therefore completed sooner. It is predicted that in the event concurrent pile driving is undertaken, all pile driving and drilling will be completed within nine months as opposed to potentially occurring over 15 months should pile driving occur at only one location at a time. The potential impacts this may have on marine mammals have been assessed and are discussed in Section 8.10.8: Construction Phase Impacts.

235. The areas of potential disturbance from concurrent pile driving and the probability of it occurring across a range of SELs are presented in Figure 8-34 and Table 8.40.

Table 8.37: Predicted area where NOAA thresholds for PTS in marine mammals are exceeded during concurrent pile driving at Neart na Gaoithe

Species	Area of PTS threshold exceedance (km^2) Concurrent Pile driving within NnG	
	Un-weighted SPL	Cumulative weighted SEL
Harbour porpoise	0.641	240.3
Bottlenose dolphin and white-beaked dolphin	<0.001	<0.001
Minke whale	<0.001	564.5
Grey seal and harbour seal	<0.002	1.306

Table 8.38: Predicted area where NOAA thresholds for TTS in marine mammals are exceeded during concurrent pile driving at Neart na Gaoithe

Species	Area of TTS threshold exceedance (km^2) Concurrent Pile driving within NnG	
	Un-weighted SPL	Cumulative weighted SEL
Harbour porpoise	5.509	2,582
Bottlenose dolphin and white-beaked dolphin	<0.001	1.035
Minke whale	0.01	9,039
Grey seal and harbour seal	0.015	1,785

Table 8.39: Areas within which the onset of PTS and TTS to marine mammals are predicted to occur from single and concurrent pile driving

Species	Area of PTS (km^2)			Area of TTS (km^2)		
	Single piling	Concurrent piling	% Difference	Single piling	Concurrent piling	% Difference
Harbour porpoise	127.3	240.3	89	2,075	2,582	24
Dolphin Sp.	<0.001	<0.001	0	0.760	1.035	36
Minke whale	344.4	564.5	64	7,724	9,039	17
Seal Sp.	0.706	1.306	85	1,409	1,785	27

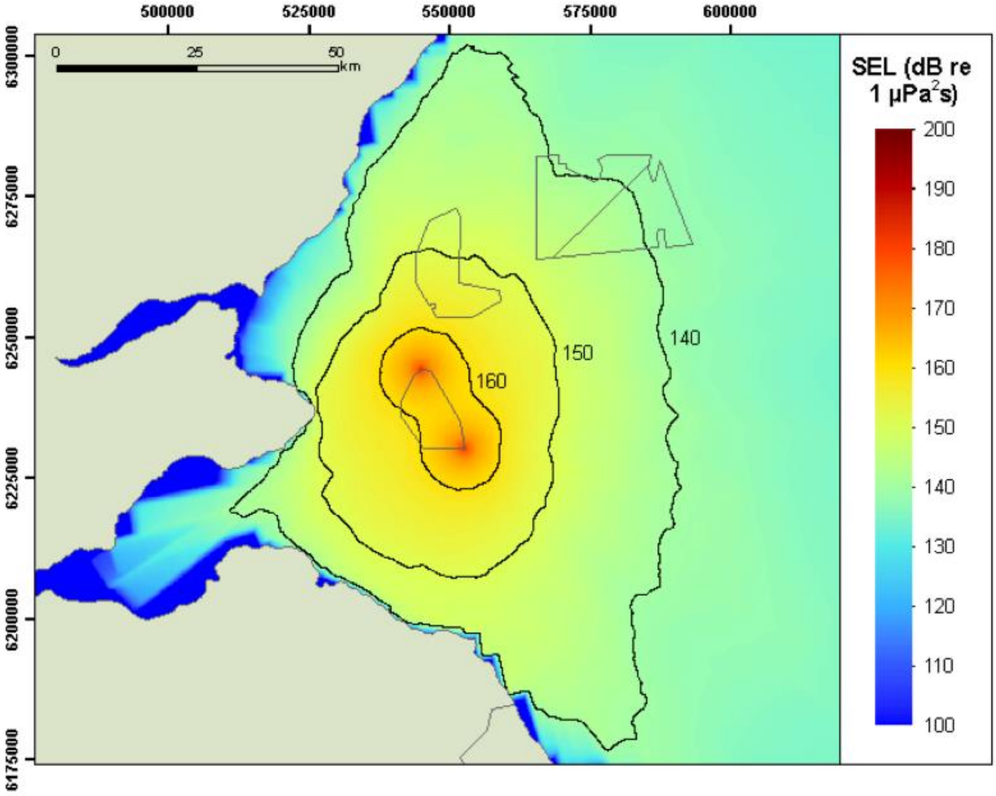


Figure 8-34: Predicted unweighted SEL during concurrent pile driving at Neart na Gaoithe with hammers operating at maximum energy

Table 8.40: Predicted disturbance areas and probability of disturbance to marine mammals during concurrent pile driving at Neart na Gaoithe

SEL sound level (dB re 1 µPa²s)	Area encompassed by SEL band (km²)	Probability of disturbance (%)
	Concurrent Piling	
>200	0.000	99.89%
195 – 200	0.001	99.49%
190 – 195	0.008	99.05%
185 – 190	0.148	98.23%
180 – 185	0.494	96.74%
175 – 180	4.069	94.06%
170 – 175	17.17	89.42%
165 – 170	70.21	81.86%
160 – 175	283.7	70.68%
155 – 160	566.3	56.28%
150 – 155	991.2	40.73%

SEL sound level (dB re 1 µPa²s)	Area encompassed by SEL band (km²)	Probability of disturbance (%)
	Concurrent Piling	
145 – 150	1,520	26.85%
140 – 145	2,280	16.39%
135 - 140	5,072	9.47%
130 - 135	16,551	5.29%

236. The estimated number of marine mammals at risk of PTS and disturbance from concurrent pile driving at Neart na Gaoithe based on the NOAA thresholds are presented in Tables 8-41**Error! Reference source not found.**.

Table 8.41: Estimated number of marine mammals at risk of the potential onset of PTS and disturbance from concurrent pile driving at Neart na Gaoithe

Species	Density (Ind./Km²)	PTS		Disturbed
		Area of PTS (km²)	Number of animals	Number of animals
Harbour Porpoise	0.599	240.251	144	1,880
Bottlenose Dolphin	0.070	0.00001	0	2
White-Beaked Dolphin	0.240	0.00001	<1	763
Minke Whale	0.039	564.483	23	123
Grey Seal	Variable	1.30591	1	1,357
Harbour Seal	Variable	1.30591	1	10

8.10.6Population Modelling

237. In order to determine the potential population level effects from noise on marine mammals, population modelling has been undertaken using the interim Population Consequences of Disturbance (interim PCoD) model. The interim PCoD model used for this assessment (version 3) was issued in October 2017. Details of the population modelling undertaken and the results are presented in Appendix 8.2: Interim PCoD Modelling.

238. In order to estimate the population level impact of PTS and disturbance, the model uses the outputs from the noise modelling undertaken and the timing of the planned activities, along with the proportion of the population predicted to be impacted. The model assumes that there is a level of mortality associated with the impacts from which the future growth of the impacted population is predicted (Sparling *et al*. 2017).

239. The number of individuals estimated to be impacted is based on the outputs from the noise modelling undertaken , presented above and in Appendix 8.1: Noise modelling. For harbour porpoise, white-beaked dolphin and minke whale the regional densities in SCANS III Block R have been used. For

bottlenose dolphin a density is estimated based on the approach described in Para. 104. For pinnipeds their abundances from the at sea distribution have been calculated across the impacted area based on the SEL contours (Figure 8-35).

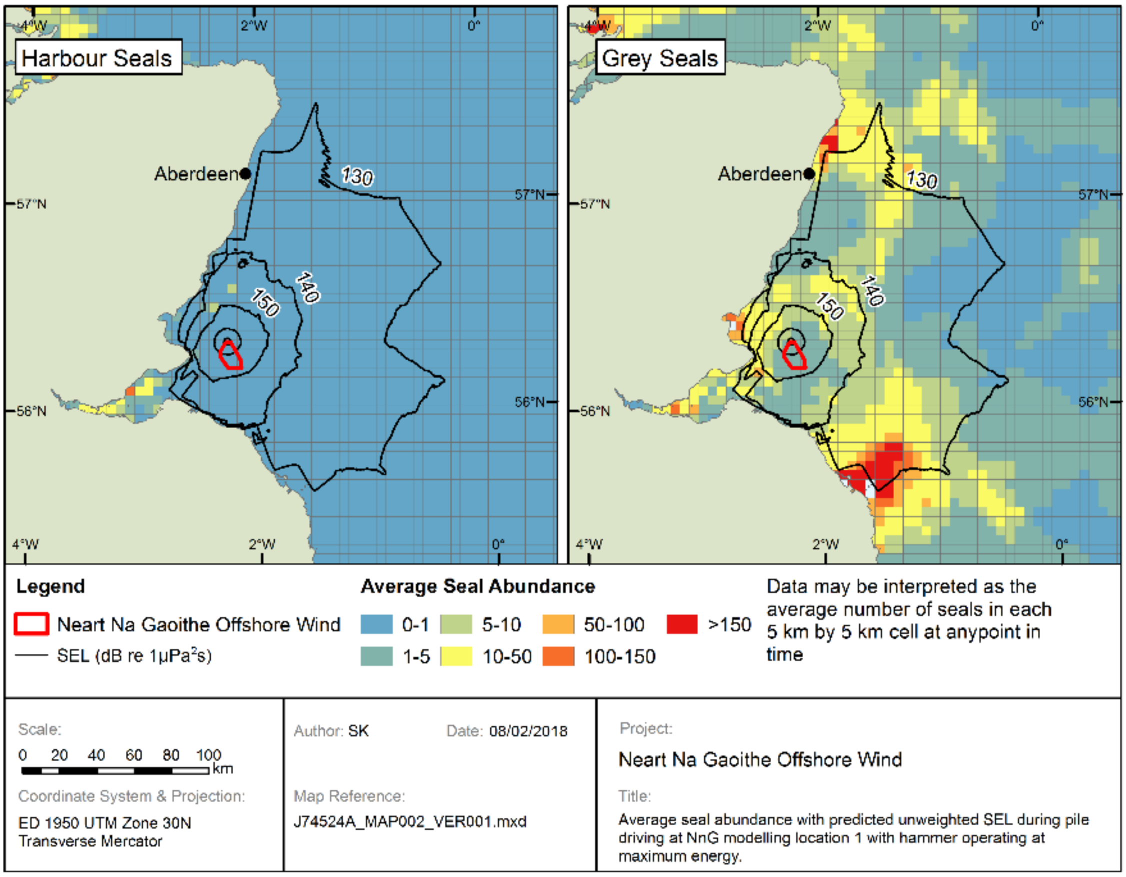


Figure 8-35: Harbour and grey seal offshore distributions in the Firths of Forth and Tay with overlapping SEL contours.

240. The relevant populations of marine mammal potentially affected are the Management Unit populations based on the results from the SCANS III surveys (JNCC, 2017) and for seals the adjusted East Coast Management Area populations from Duck *et al*. (2016) (See Para: 148 and 160).

241. The interim nature of the model is recognised and that the model relies on some assumptions and expert opinion. As further evidence on the behaviour of marine mammals to noise and its consequences become available the model will be revised. However, it is a tool that does allow the assessment of potential population level effects to be standardised, in particular when assessing cumulative impacts (Marine Scotland 2017b). Furthermore, the population model does not include any density dependence that would allow an impacted population to recover following cessation of activities (King *et al*, 2015, Booth *et al*. 2016). If there is density dependence in the marine mammal populations, a population may be predicted to recover more rapidly due a greater availability of resources. This is particularly important when considering what a population level might be after 24 years, many years after impacts from the proposed project alone or cumulatively with other know developments will have ceased. Therefore, the estimated population sizes after 24 years may be overly precautionary.

242. The model allows the population consequences of disturbance to be predicted for five species of marine mammal: Harbour porpoise, bottlenose dolphin, minke whale, grey seal and harbour seal. It does not have the biological parameters required to input into the model for white-beaked dolphin. Therefore, it is not possible to undertake population modelling for this species.

243. Recent reviews of population viability analysis (PVA) metrics have considered and tested the sensitivity of PVA models to a range of potential metrics (Cook and Robinson, 2017; Jitlal *et al*. 2017). The studies identify two metrics that are least sensitive to the quality of the input data, the ratio of the impacted to un-impacted annual growth rate and the ratio of impacted to un-impacted population size. With the first of these two ratio metrics being considerably better than the latter (Jitlal *et al*. 2017). These two counterfactual metrics estimate the difference in predicted numbers between impacted an unimpacted populations.

244. Metrics based on the probability of a change in the growth rate or population were identified as being sensitive to the data used to populate the model, e.g. survival rates and productivity. However, the report identified that the metric representing the centile from un-impacted population size equal to the 50th centile of the impacted population size after a set period of time was less sensitive than other metrics based on probability outputs. The recommendations of the Jitlal *et al* (2017) report and advice received in the Scoping Opinion have been used for this assessment (Marine Scotland 2017a).

245. The metrics used are:

- The median of the ratio of the impacted to un-impacted annual growth rate (the counterfactual of the annual growth rate),
- The median of the ratio of the impacted to un-impacted annual population size (the counterfactual of the population size),
- The difference in median impacted and median un-impacted annual growth rates after 24 years,
- The difference in median impacted and median un-impacted population size after 24 years,
- Centile for un-impacted population which matches the 50th centile for the impacted population after 24 years (i.e. the probability of an unimpacted population being below the median population size of the impacted population).

246. Results from the population model are summarised below for each species and further details of the model and the parameters used to undertake the modelling are presented in Appendix 8.2: Interim PCoD modelling.

8.10.6.1 Harbour porpoise

247. The results from the population modelling indicate that pile driving could cause a decrease in the annual growth rate and population size of harbour porpoise, with a potentially marginally greater effect occurring in the event concurrent pile-driving is undertaken (Table 8.42).

248. The median ratio of the impacted to unimpacted annual growth rate for both single and concurrent pile driving scenarios is 0.998 after 24 years (a counterfactual of growth rate of 99.8%). The difference between the median impacted and unimpacted growth rates after 24 years is -0.002.

249. The median ratio of the impacted to unimpacted population for a single pile driving scenario is 0.959 after 24 years and 0.954 for concurrent pile driving (a counterfactual of population size of 95.9% and 95.4%).

250. Based on the results from the interim PCoD model, the harbour porpoise population within the North Sea Management Unit is predicted to decrease over the next 24 years without any potential impacts from disturbance (Table 8.43 and Figure 8-36 and Table 8.45 and Figure 8-37). In the event that pile driving occurs over a period of 15 months or nine months it is estimated that after 24 years the harbour porpoise population may be between 4.20% and 4.68% lower compared with the unimpacted baseline population (Table 8.44 and Table 8.46). The difference between the median impacted and unimpacted growth rates after 24 years is -0.002.

251. Comparing the distributions of population sizes after 24 years for the unimpacted and impacted populations shows that at least 39% of the runs do not end lower than the median population size of the unimpacted population for single pile driving (Table 8.42).

Table 8.42: Harbour porpoise population model outputs for single and concurrent pile driving at NnG

Harbour Porpoise						
	Median of the ratio of impacted to unimpacted annual growth rate		Median of the ratio of impacted to unimpacted population size		Centile for impacted population that matches the 50th centile for unimpacted population	
Year	Single pile driving	Concurrent pile driving	Single pile driving	Concurrent pile driving	Single pile driving	Concurrent pile driving
1	1.000	1.000	1.000	1.000	0.50	0.51
6	0.997	0.996	0.987	0.982	0.42	0.39
12	0.997	0.996	0.969	0.964	0.37	0.34
18	0.998	0.997	0.962	0.958	0.36	0.36
24	0.998	0.998	0.959	0.954	0.39	0.39

Table 8.43: Estimated population size for harbour porpoise North Sea Management Unit with pile driving undertaken over 15 months

Harbour Porpoise						
NnG single pile driving over fifteen months						
	5th percentile		50th percentile		95th percentile	
Year	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	309,250	309,244	333,535	333,532	351,491	351,491
6	285,561	282,201	324,113	318,648	367,716	361,308
12	263,940	252,630	314,675	303,414	369,895	355,153
18	250,609	240,727	305,878	293,048	372,304	356,897
24	234,112	223,548	296,184	283,733	373,476	359,889

Table 8.44: Estimated difference in median disturbed and median undisturbed harbour porpoise growth rates and population sizes with pile driving undertaken over 15 months

Harbour porpoise	Difference in median disturbed and median undisturbed annual growth rates over 24 years(%)	Difference in median disturbed and median undisturbed population size over 24 years	
Years		No. of individuals	% change in population size
1	±0.000	-3	±0.00
6	-0.003	-5,465	-1.69
12	-0.003	-11,261	-3.58
18	-0.002	-12,830	-4.19
24	-0.002	-12,451	-4.20

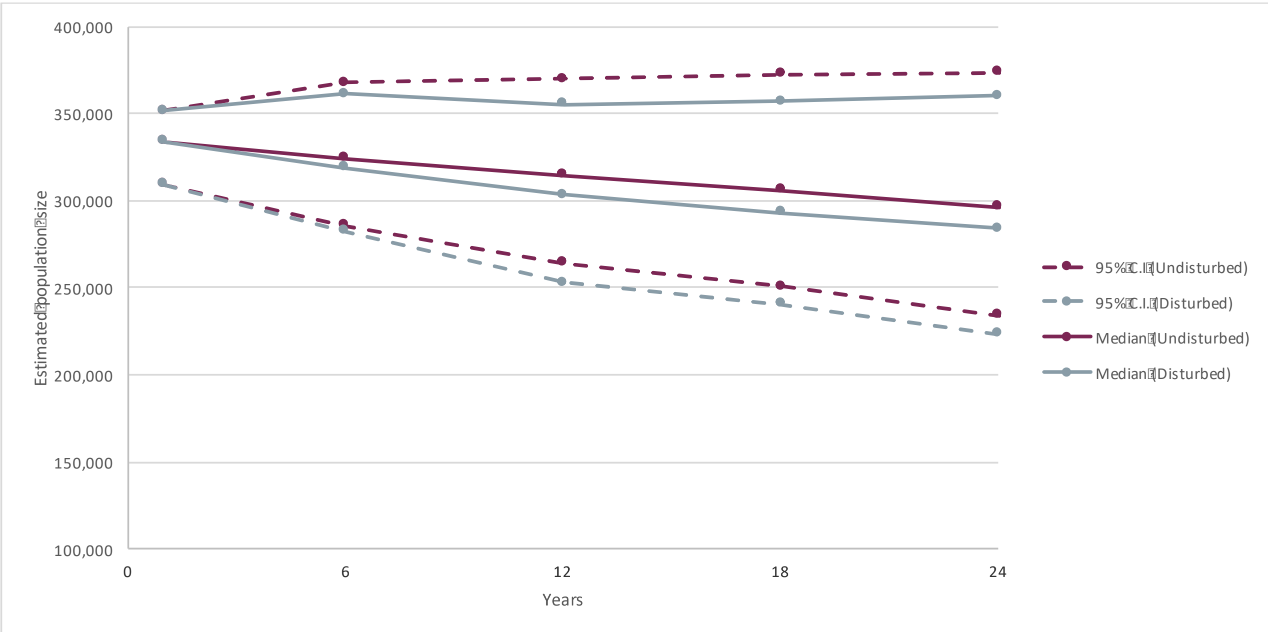


Figure 8-36: Estimated median (50th centile) and 95% C.I. for harbour porpoise North Sea Management Unit population with (disturbed) and without (undisturbed) single pile driving over a period of 15 months

Table 8.45: Estimated population size for harbour porpoise North Sea Management Unit with pile driving undertaken over 9 months

Harbour Porpoise						
NnG concurrent pile driving over nine months						
	5th percentile		50th percentile		95th percentile	
Year	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	309,695	309,691	333,046	333,049	351,408	351,404
6	283,720	278,118	325,595	318,214	366,019	358,502
12	259,965	249,226	313,944	300,651	374,337	360,510
18	245,088	234,162	307,767	294,123	382,220	363,072
24	230,827	217,632	299,137	285,131	373,213	359,564

Table 8.46: Estimated difference in median disturbed and median undisturbed harbour porpoise growth rates and population sizes with concurrent pile driving undertaken over 9 months

Harbour porpoise	Difference in median disturbed and median undisturbed annual growth rates over 24 years(%)	Difference in median disturbed and median undisturbed population size over 24 years	
Years		No. of individuals	% change in population size
1	±0.000	+3	±0.00
6	-0.004	-7,381	-2.27
12	-0.004	-13,293	-4.23
18	-0.003	-13,644	-4.43
24	-0.002	-14,006	-4.68

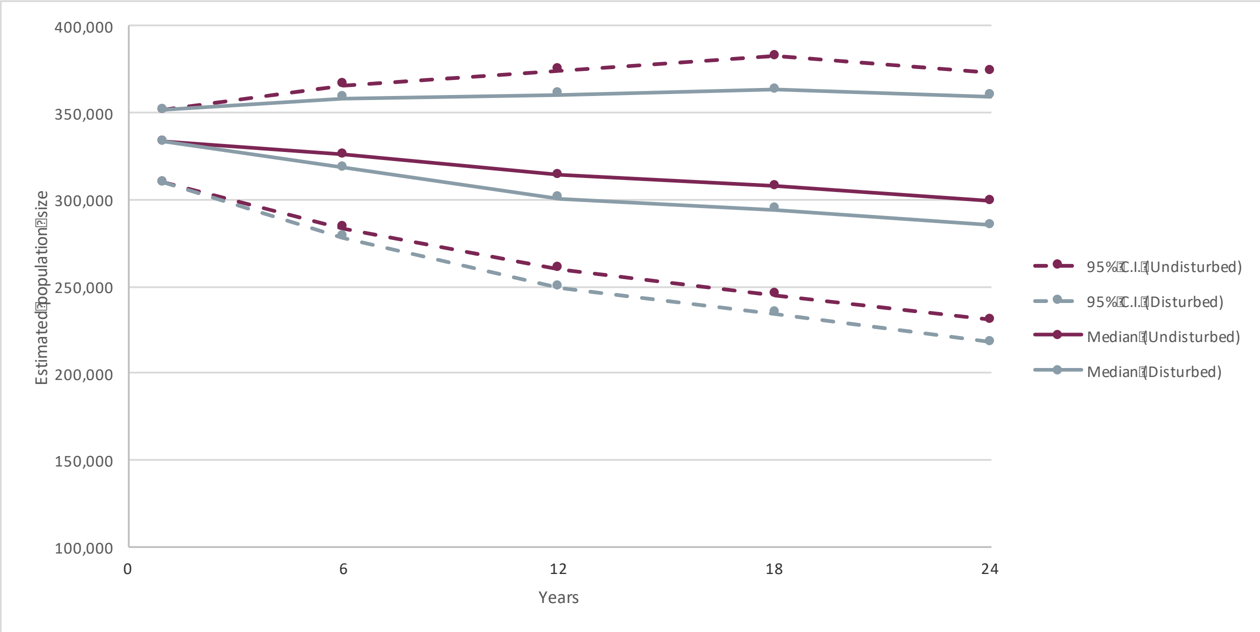


Figure 8-37: Estimated median (50th centile) and 95% C.I. for harbour porpoise North Sea Management Unit population with (disturbed) and without (undisturbed) concurrent pile driving over a period of 9 months

8.10.6.2 Bottlenose dolphin

252. The results from the population modelling indicate that disturbance to bottlenose dolphins from pile driving will not cause a decline in the bottlenose dolphin population with the median of the ratio of impacted to unimpacted growth rate and population size being greater than one (Table 8.47).

253. Based on the results from the interim PCoD model, the bottlenose dolphin population within the Coastal East Scotland Management Unit is predicted to increase over the next 24 years (Table 8.48 and Table 8.38) and Table 8.49 and Figure 8-39). The unimpacted bottlenose dolphin population in 24 years time is estimated to be 288 (204 – 388) individuals compared with 306 (216 - 420) in the event that pile driving occurs over a period of 15 months or 294 (202 - 408) individuals if concurrent pile driving occurs over a period of nine months (Table 8.48 and Table 8.50). Compared with the predicted baseline population the impacted population is predicted to increase by between 5.76% and 6.25% (Table 8.49 and Table 8.51). This counterintuitive result from the interim PCoD model was consistent over many modelling runs.

254. Comparing the distributions of population sizes after 24 years for the unimpacted and impacted populations shows that at least 62% of the runs do not end lower than the median population size of the unimpacted population for single pile driving and 60% of the runs for concurrent pile driving (Table 8.48).

Table 8.47: Bottlenose dolphin population model outputs for single and concurrent pile driving at NnG

Bottlenose dolphin						
	Median of the ratio of impacted to unimpacted annual growth rate		Median of the ratio of impacted to unimpacted population size		Centile for impacted population that matches the 50th centile for unimpacted population	
Year	Single pile driving	Concurrent pile driving	Single pile driving	Concurrent pile driving	Single pile driving	Concurrent pile driving
1	1.000	1.000	1.000	1.000	0.45	0.53
6	1.003	1.002	1.016	1.010	0.54	0.53
12	1.003	1.003	1.033	1.027	0.57	0.58
18	1.003	1.002	1.048	1.043	0.60	0.60
24	1.003	1.002	1.063	1.058	0.62	0.60

Table 8.48: Estimated population size for bottlenose dolphin East Scotland Management Unit with pile driving undertaken over 15 months

Bottlenose dolphin NnG single pile driving over fifteen months						
	5th percentile		50th percentile		95th percentile	
Year	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	182	180	200	200	216	220
6	178	174	216	220	256	268
12	186	184	240	246	302	318
18	196	198	262	276	346	370
24	204	216	288	306	388	420

Table 8.49: Estimated difference in median disturbed and median undisturbed bottlenose dolphin growth rates and population sizes with pile driving undertaken over 15 months

Bottlenose dolphin	Difference in median disturbed and median undisturbed annual growth rates over 24 years	Difference in median disturbed and median undisturbed population size over 24 years	
Years		No. of individuals	% change in population size
1	±0.000	+0	±0.00
6	+0.003	+4	+1.85
12	+0.002	+6	+2.50
18	+0.003	+14	+5.34
24	+0.003	+18	+6.25

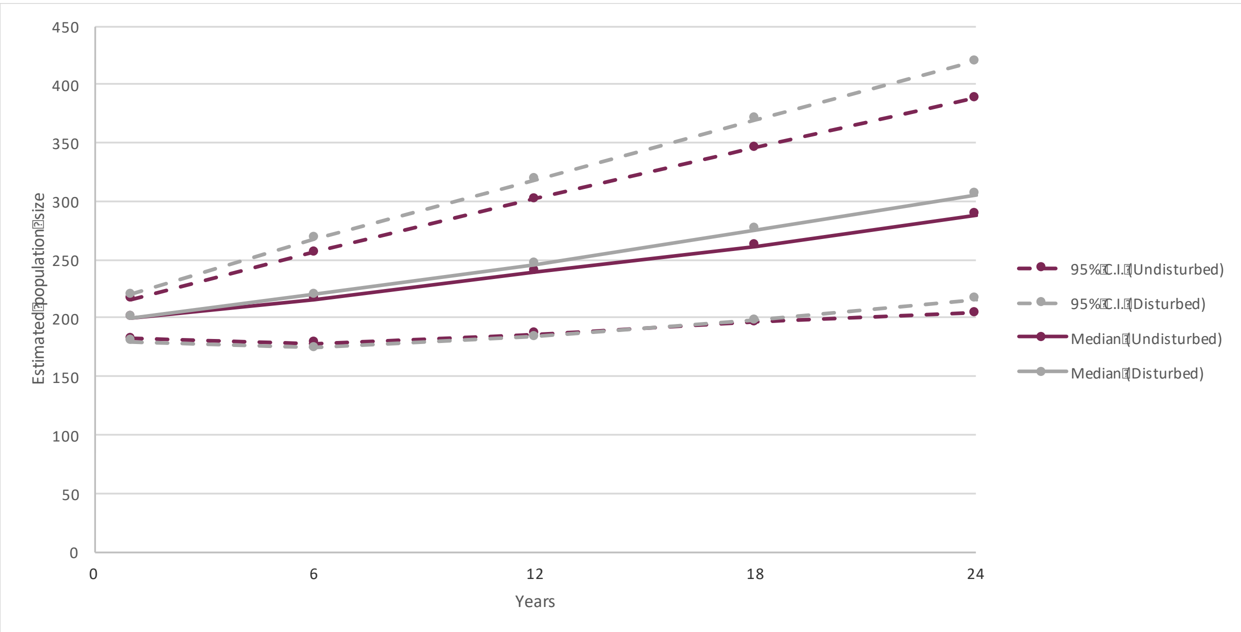


Figure 8-38: Estimated median (50th centile) and 95% C.I. for bottlenose dolphin Coastal East Scotland Management Unit population with (disturbed) and without (undisturbed) single pile driving over a period of 15 months

Table 8.50: Estimated population size for bottlenose dolphin East Scotland Management Unit with concurrent pile driving undertaken over 9 months

Bottlenose dolphin						
NnG concurrent pile driving over nine months						
	5th percentile		50th percentile		95th percentile	
Year	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	182	180	198	200	216	220
6	172	166	213	216	250	260
12	184	182	232	240	294	308
18	184	188	256	268	332	358
24	192	202	278	294	374	408

Table 8.51: Estimated difference in median disturbed and median undisturbed bottlenose dolphin growth rates and population sizes with concurrent pile driving undertaken over 9 months

Bottlenose dolphin	Difference in median disturbed and median undisturbed annual growth rates over 24 years	Difference in median disturbed and median undisturbed population size over 24 years	
Years		No. of individuals	% change in population size
1	+0.010	+2	+1.01
6	+0.002	+3	+1.41
12	+0.003	+8	+3.45
18	+0.003	+12	+4.69
24	+0.002	+16	+5.76

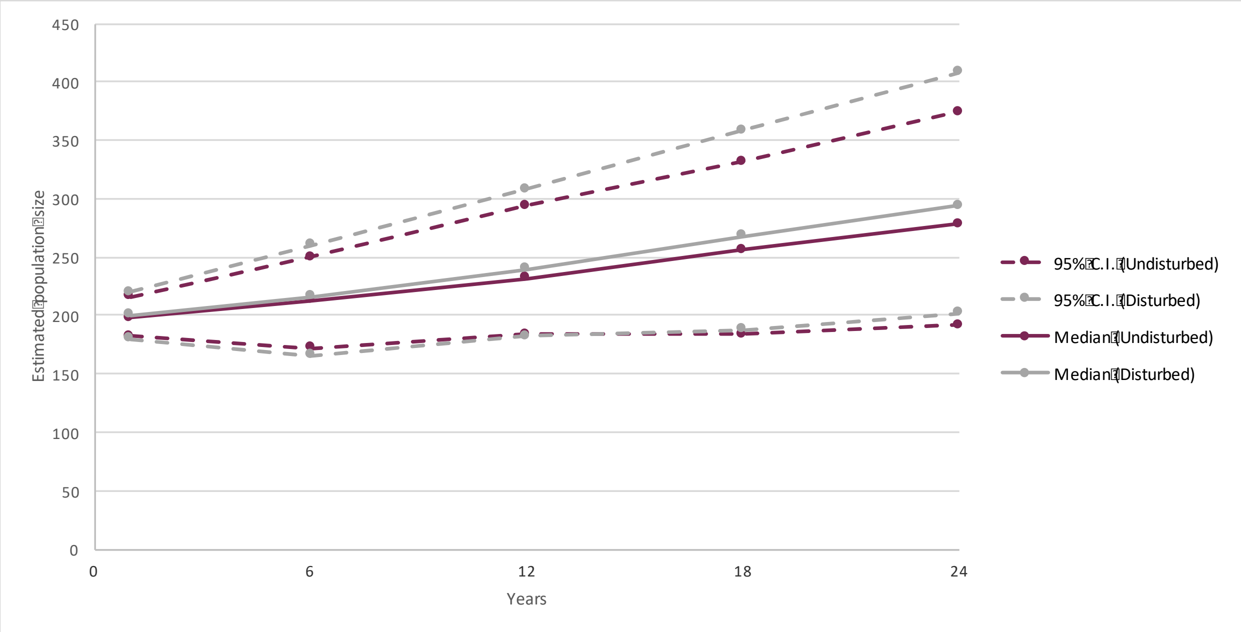


Figure 8-39: Estimated median (50th centile) and 95% C.I. for bottlenose dolphin Coastal East Scotland Management Unit population with (disturbed) and without (undisturbed) concurrent pile driving over a period of 9 months

8.10.6.3 Minke whale

255. The results from the population modelling indicate that pile driving could cause a decrease in the annual growth rate and population size of minke whale, with a potentially marginally greater effect occurring in the event concurrent pile driving is undertaken (Table 8.52).

256. The median ratio of the impacted to unimpacted annual growth rate for a single and concurrent pile driving scenarios is 0.993 after 24 years (a counterfactual of growth rate of 99.3%). The difference between the median impacted and unimpacted growth rates after 24 years is -0.007.

257. The median ratio of the impacted to unimpacted population for a single pile driving scenario is 0.839 after 24 years and 0.845 for concurrent pile driving (a counterfactual of population size of 83.9% and 84.5%).

258. Based on the results from the interim PCoD model, the minke whale population within the CGNS Management Unit is predicted to remain stable over the next 24 years without any potential impacts from disturbance (Table 8.53 and Figure 8-40 and Table 8.55 and Figure 8-41). In the event that pile driving occurs over a period of 15 months or nine months it is estimated that after 24 years the minke whale population may be between 14.8% and 14.6% lower compared with the unimpacted baseline population (Table 8.54 and Table 8.56).

259. Comparing the distributions of population sizes after 24 years for the unimpacted and impacted populations shows that at least 8% of the runs do not end lower than the median population size of the unimpacted population for single pile driving and 7% of the runs for concurrent pile driving (Table 8.52).

Table 8.52: Minke whale population model outputs for single and concurrent pile driving at NnG

Minke whale						
	Median of the ratio of impacted to unimpacted annual growth rate		Median of the ratio of impacted to unimpacted population size		Centile for impacted population that matches the 50th centile for unimpacted population	
Year	Single pile driving	Concurrent pile driving	Single pile driving	Concurrent pile driving	Single pile driving	Concurrent pile driving
1	1.000	1.000	1.000	1.000	0.51	0.50
6	0.992	0.991	0.957	0.954	0.25	0.23
12	0.989	0.990	0.878	0.883	0.06	0.05
18	0.991	0.992	0.850	0.856	0.05	0.05
24	0.993	0.993	0.839	0.845	0.08	0.07

Table 8.53: Estimated population size for Minke whale within the CGNS Management Unit with pile driving undertaken over 15 months

Minke whale						
NnG single pile driving over fifteen months						
	5th percentile		50th percentile		95th percentile	
Year	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	11,076	11,076	11,842	11,843	12,443	12,448
6	10,530	9,956	11,765	11,218	13,028	12,546
12	10,254	8,658	11,718	10,258	13,446	12,183
18	9,932	8,254	11,547	9,898	13,724	12,050
24	9,564	8,014	11,523	9,814	13,721	11,940

Table 8.54: Estimated difference in median disturbed and median undisturbed minke whale growth rates and population sizes with pile driving undertaken over 15 months

Minke whale	Difference in median disturbed and median undisturbed annual growth rates over 24 years	Difference in median disturbed and median undisturbed population size over 24 years	
Years		No. of individuals	% change in population size
1	±0.000	+1	+0.01
6	-0.008	-547	-4.65
12	-0.011	-1,460	-12.46
18	-0.009	-1,649	-14.28
24	-0.007	-1,709	-14.83

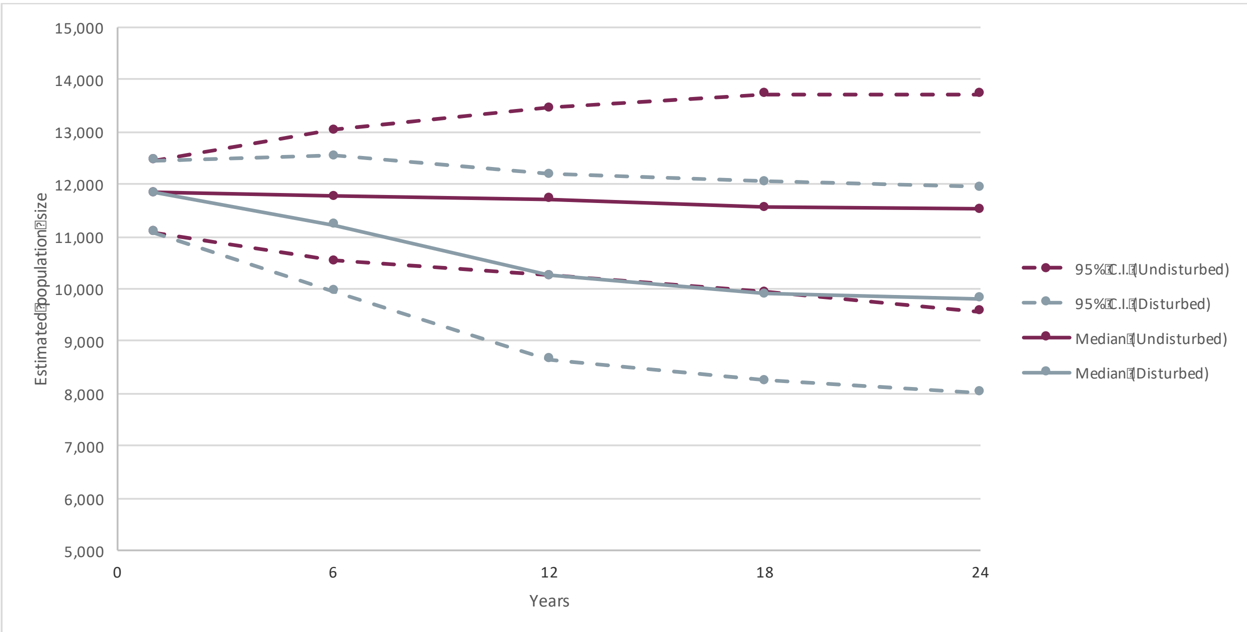


Figure 8-40: Estimated median (50th centile) and 95% C.I. for minke whale CGNS Management Unit population with (disturbed) and without (undisturbed) single pile driving over a period of 15 months

Table 8.55: Estimated population size for minke whale CGNS Management Unit with concurrent pile driving undertaken over 9 months

Minke whale						
NnG concurrent pile driving over nine months						
	5th percentile		50th percentile		95th percentile	
Year	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	11,074	11,070	11,836	11,835	12,436	12,432
6	10,498	9,834	11,690	11,092	12,978	12,430
12	10,282	8,707	11,605	10,236	13,349	12,026
18	9,944	8,332	11,602	9,939	13,664	12,050
24	9,664	8,098	11,432	9,767	13,861	12,128

Table 8.56: Estimated difference in median disturbed and median undisturbed minke whale growth rates and population sizes with concurrent pile driving undertaken over 9 months

Minke whale	Difference in median disturbed and median undisturbed annual growth rates over 24 years	difference in median disturbed and median undisturbed population size over 24 years	
Years		No. of individuals	% change in population size
1	±0.000	-1	-0.01
6	-0.009	-598	-5.12
12	-0.010	-1,369	-11.80
18	-0.009	-1,663	-14.33
24	-0.007	-1,665	-14.56

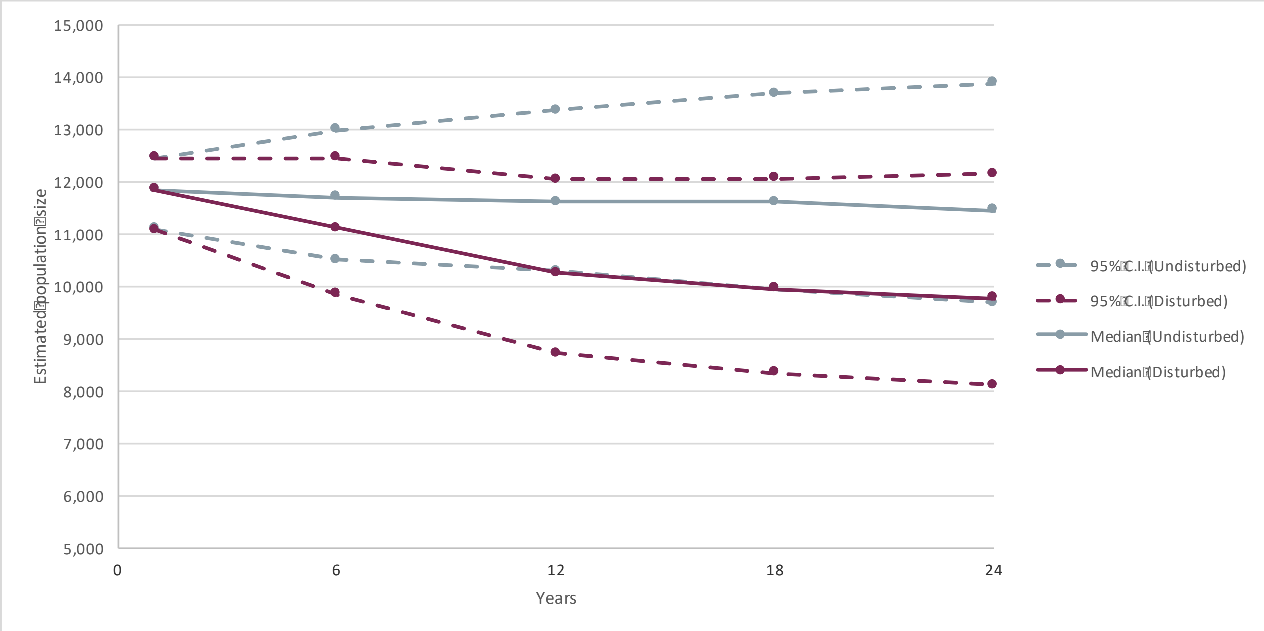


Figure 8-41: Estimated median (50th centile) and 95% C.I. for minke whale CGNS Management Unit population with (disturbed) and without (undisturbed) concurrent pile driving over a period of 9 months

Grey seal

260. The results from the population modelling indicate that impacts from pile driving could cause a decrease in the annual growth rate and population size of grey seals within the East Coast Management Area, with a potentially marginally greater effect occurring in the event single pile-driving is undertaken over a period of fifteen months (Table 8.57). However, the population is still predicted to increase from its current level.

261. The median ratio of the impacted to unimpacted annual growth rate for a single pile driving scenario is 0.997 after 24 years and 0.998 for concurrent pile driving (a counterfactual of growth rate of 99.7% and 99.8%). The difference between the median impacted and unimpacted growth rates after 24 years is -0.003 and 0.002 respectively.

262. The median ratio of the impacted to unimpacted population for a single pile driving scenario is 0.950 after 24 years and 0.973 for concurrent pile driving (a counterfactual of population size of 95.0% and 97.3%).

263. Based on the results from the interim PCoD model, the grey seal population within the East Coast Management Area is predicted to increase over the next 24 years without any potential impacts from disturbance (Table 8.58 and Figure 8-42 and Table 8.60 and Figure 8-43). In the event that pile driving occurs over a period of 15 months or nine months it is estimated that after 24 years the grey seal population will still have increased from its current level but may be between 7.72% and 5.67% lower compared with the unimpacted baseline population (Table 8.59 and Table 8.61).

264. Comparing the distributions of population sizes after 24 years for the unimpacted and impacted populations shows that at least 32% of the runs do not end lower than the median population size of the unimpacted population for single pile driving and 38% of the runs for concurrent pile driving (Table 8.57).

Table 8.57: Grey seal population model outputs for single and concurrent pile driving at NnG

Grey seal						
	Median of the ratio of impacted to unimpacted annual growth rate		Median of the ratio of impacted to unimpacted population size		Centile for impacted population that matches the 50th centile for unimpacted population	
Year	Single pile driving	Concurrent pile driving	Single pile driving	Concurrent pile driving	Single pile driving	Concurrent pile driving
1	1.000	1.000	1.000	1.000	0.50	0.50
6	0.987	0.992	0.945	0.976	0.16	0.28
12	0.994	0.996	0.953	0.975	0.28	0.35
18	0.996	0.997	0.951	0.974	0.31	0.36
24	0.997	0.998	0.950	0.973	0.32	0.38

Table 8.58: Estimated population size for grey seal within the ECMA with pile driving undertaken over 15 months

Grey seal						
NnG single pile driving over fifteen months						
	5th percentile		50th percentile		95th percentile	
Year	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	9,040	9,040	9,667	9,667	10,220	10,220
6	8,706	7,399	9,992	9,237	11,338	10,773
12	8,442	7,662	10,393	9,713	12,589	11,885
18	8,524	7,731	10,751	9,978	13,555	12,630
24	8,602	7,768	11,224	10,357	14,676	13,692

Table 8.59: Estimated difference in median disturbed and median undisturbed grey seal growth rates and population sizes with pile driving undertaken over 15 months

Grey seal	Difference in median disturbed and median undisturbed annual growth rates over 24 years	Difference in median disturbed and median undisturbed population size over 24 years	
Years		No. of individuals	% change in population size
1	±0.000	±0.00	±0.00
6	-0.013	-755	-7.56
12	-0.006	-680	-6.54
18	-0.004	-773	-7.19
24	-0.003	-867	-7.72

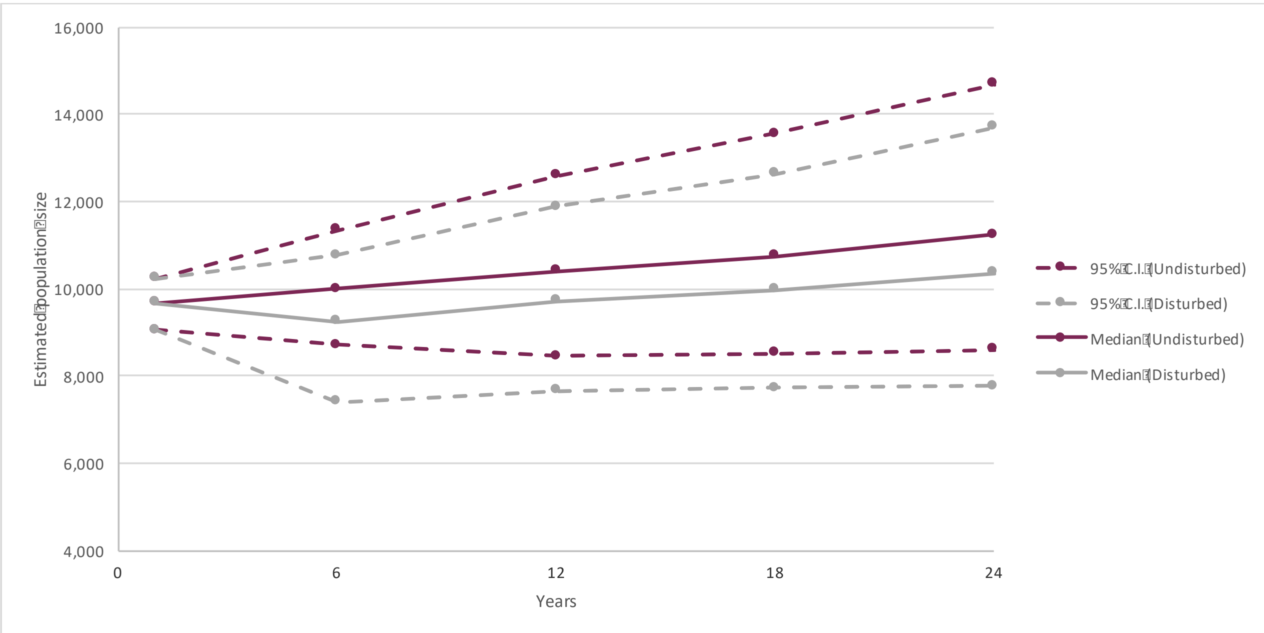


Figure 8-42: Estimated median (50th centile) and 95% C.I. for grey seal ECMA population with (disturbed) and without (undisturbed) single pile driving over a period of 15 months

Table 8.60: Estimated population size for grey seal ECMA with concurrent pile driving undertaken over 9 months

Grey seal						
NnG concurrent pile driving over nine months						
	5th percentile		50th percentile		95th percentile	
Year	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	9,100	9,100	9,694	9,694	10,256	10,256
6	8,670	7,683	9,979	9,511	11,314	10,908
12	8,426	7,698	10,365	9,868	12,619	12,121
18	8,342	7,702	10,826	10,270	13,716	13,193
24	8,333	7,691	11,206	10,571	14,718	14,152

Table 8.61: Estimated difference in median disturbed and median undisturbed grey seal growth rates and population sizes with concurrent pile driving undertaken over 9 months

Grey seal	Difference in median disturbed and median undisturbed annual growth rates over 24 years	difference in median disturbed and median undisturbed population size over 24 years	
Years		No. of individuals	% change in population size
1	±0.000	±0	±0.00
6	-0.008	-468	-4.69
12	-0.004	-497	-4.79
18	-0.003	-556	-5.14
24	-0.002	-635	-5.67

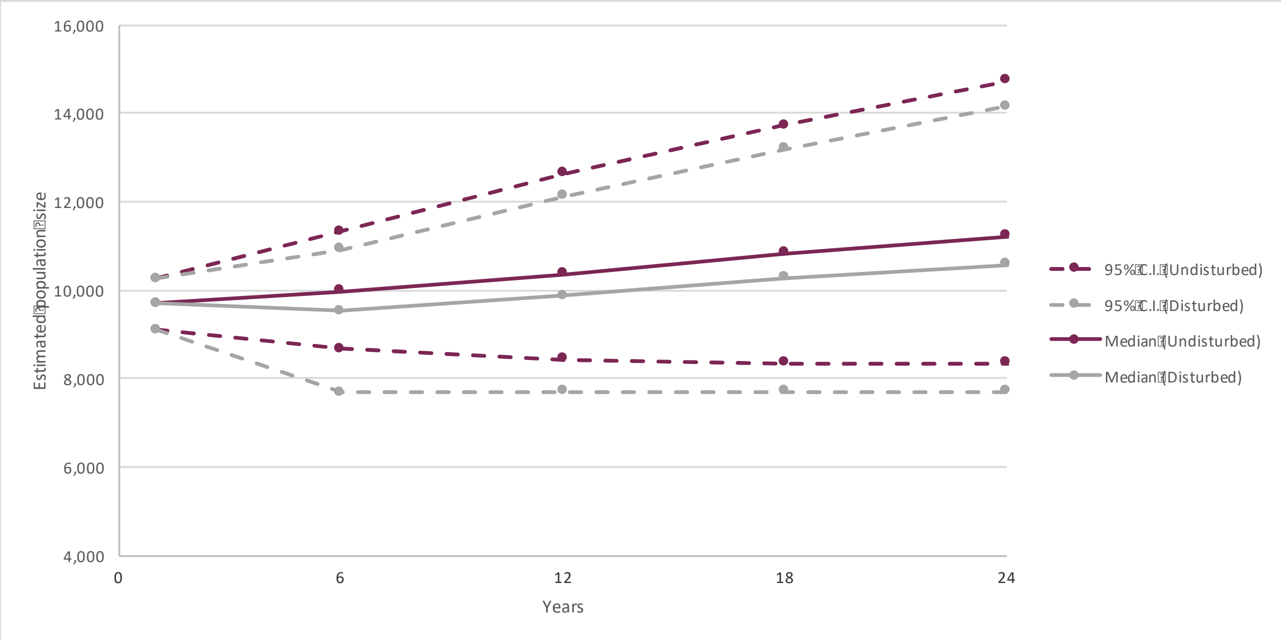


Figure 8-43: Estimated median (50th centile) and 95% C.I. for grey seal ECMA population with (disturbed) and without (undisturbed) concurrent pile driving over a period of 9 months

Harbour seal

265. The results from the population modelling indicate that the harbour seal population within the East Coast Management area will decrease and become effectively zero within 18 to 24 years. Impacts from pile driving could cause a decrease in the annual growth rate and population size of harbour seals (Table 8.62). However, it makes no effective difference as to when the population declines to zero irrespective if the pile driving is undertaken over 15 months or concurrently over nine months (Table 8.63, Table 8.64, Figure 8-44 and Table 8.65, Table 8.66 and Figure 8-45).

Table 8.62: Harbour seal population model outputs for single and concurrent pile driving at NnG

Harbour seal						
	Median of the ratio of impacted to unimpacted annual growth rate		Median of the ratio of impacted to unimpacted population size		Centile for impacted population that matches the 50th centile for unimpacted population	
Year	Single pile driving	Concurrent pile driving	Single pile driving	Concurrent pile driving	Single pile driving	Concurrent pile driving
1	1.085	0.660	1.083	1.083	0.82	0.83
6	1.004	N/A	1.038	1.037	0.54	0.52
12	0.982	N/A	0.778	0.923	0.27	0.40
18	N/A	N/A	1.000	1.000	0.37	0.33
24	N/A	N/A	1.000	1.000	0.01	0.01

Table 8.63: Estimated population size for harbour seal within the ECMA with pile driving undertaken over 15 months

Harbour seal						
NnG single pile driving over fifteen months						
	5th percentile		50th percentile		95th percentile	
Year	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	218	238	250	270	284	302
6	56	52	82	84	116	126
12	6	4	20	16	40	40
18	0	0	4	4	16	16
24	0	0	0	0	8	8

Table 8.64: Estimated difference in median disturbed and median undisturbed harbour seal growth rates and population sizes with pile driving undertaken over 15 months

Harbour seal	Difference in median disturbed and median undisturbed annual growth rates over 24 years	Difference in median disturbed and median undisturbed population size over 24 years	
Years		No. of individuals	% change in population size
1	-0.065	+20	+8.00
6	-0.008	+2	+2.44
12	+0.004	-4	-20.00
18	-0.785	±0	±0.00
24	±0.000	±0	±0.00

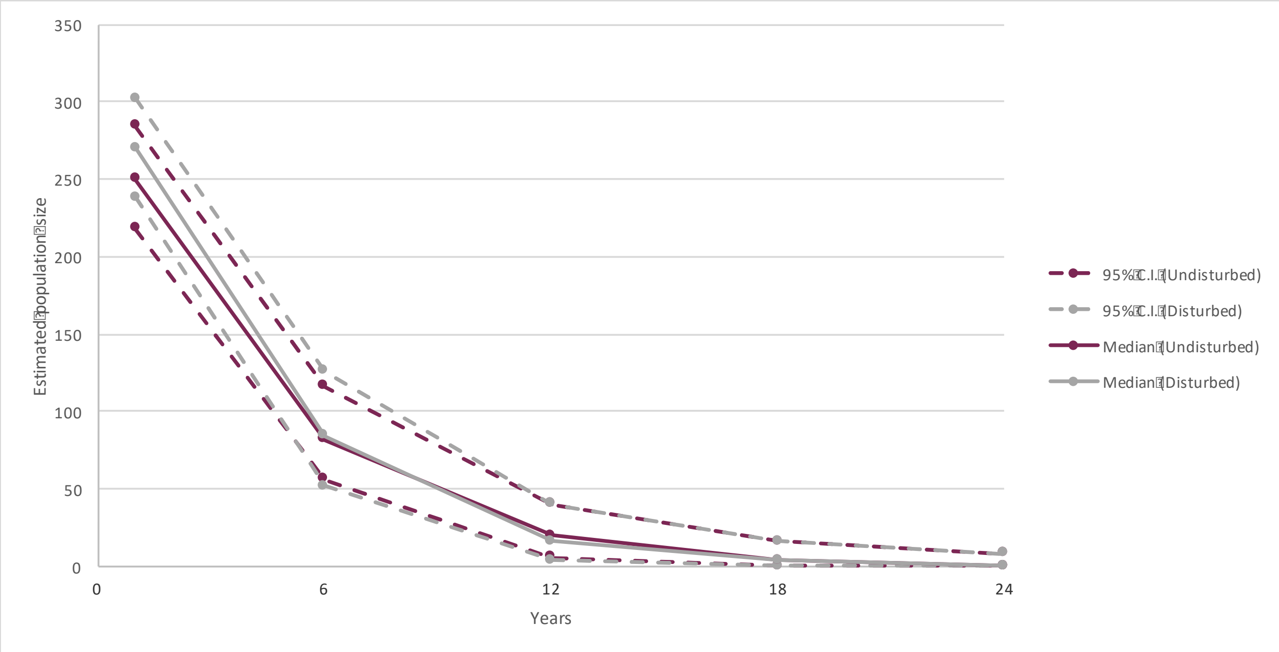


Figure 8-44: Estimated median (50th centile) and 95% C.I. for harbour seal ECMA population with (disturbed) and without (undisturbed) single pile driving over a period of 15 months

Table 8.65: Estimated population size for harbour seal ECMA with concurrent pile driving undertaken over 9 months

Harbour seal						
NnG concurrent pile driving over nine months						
	5th percentile		50th percentile		95th percentile	
Year	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	214	236	250	270	282	302
6	56	52	82	84	114	124
12	6	6	22	20	40	42
18	0	0	6	4	18	18
24	0	0	0	0	8	8

Table 8.66: Estimated difference in median disturbed and median undisturbed harbour seal growth rates and population sizes with concurrent pile driving undertaken over 9 months

Harbour seal	Difference in median disturbed and median undisturbed annual growth rates over 24 years	Difference in median disturbed and median undisturbed population size over 24 years	
Years		No. of individuals	% change in population size
1	-0.064	+20	+8.00
6	-0.003	+2	+2.44
12	+0.006	-2	-9.09
18	+0.018	-2	-33.33
24	±0.000	±0	±0.00

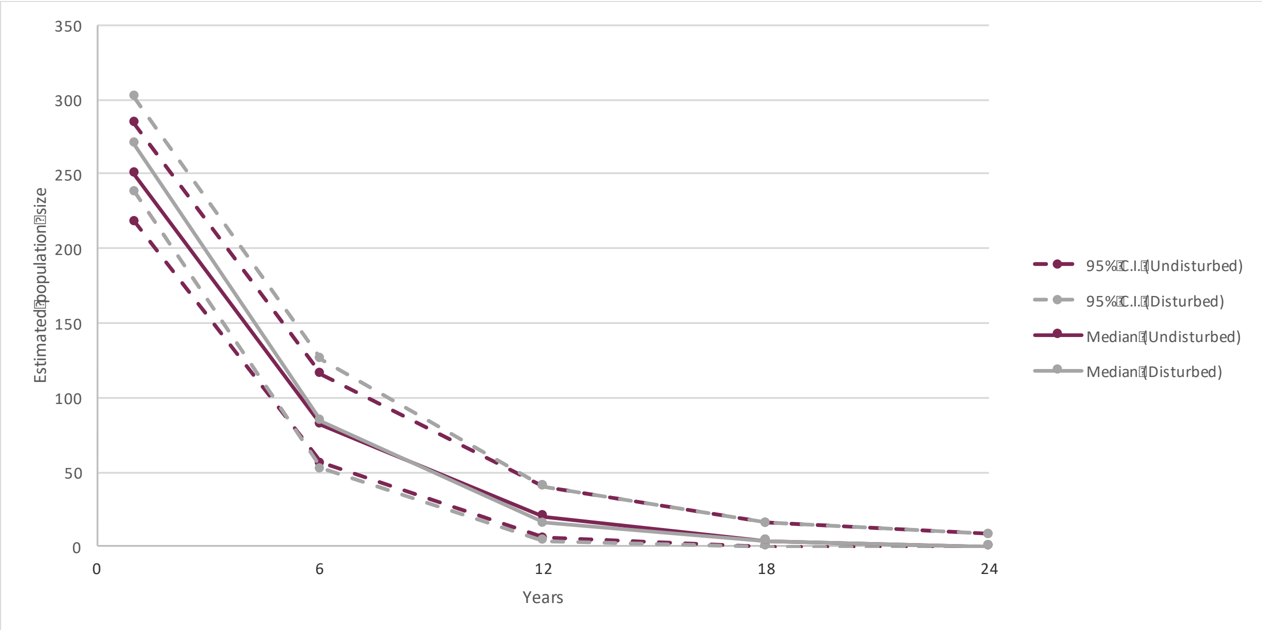


Figure 8-45: Estimated median (50th centile) and 95% C.I. for harbour seal ECMA population with (disturbed) and without (undisturbed) concurrent pile driving over a period of 9 months

8.10.7 Impacts on prey species

266. Based on the advice received in the Scoping Opinion the impacts from particle motion arising from pile driving on fish have been considered in Chapter 7: Fish and Shellfish. As significant effects on fish are not predicted it is reasonable to assume that secondary effects on marine mammal predators would also not occur. However, it is recognised that they are important prey items to marine mammals and for completeness a qualitative assessment has been undertaken.

267. The main prey items for the majority of the marine mammals recorded within the study area are fish, although some non-fish prey items such as cephalopods may also be taken. The main prey items recorded for marine mammals in the region are presented in Table 8.67. However, it is recognised that many marine mammals are opportunistic feeders and will prey on a wide variety of species if available.

Table 8.67: Main prey items for marine mammals recorded within the study area

Species	Main prey
Harbour porpoise	sandeel, whiting
White-beaked dolphin	haddock, whiting, cod
Bottlenose dolphin	cod, saithe, whiting, salmon and haddock
Minke whale	herring, sandeel, cod, haddock and saithe
Grey seal	sandeel, cod and haddock
Harbour seal	sandeel, whiting, flounder and cod

268. Sandeels are one of the main prey items for many of the marine mammals recorded in the area. They are also an important prey species for predatory fish such as whiting, cod and haddock, all of which are also prey to marine mammals (Greenstreet *et al*. 2006). Sandeels are not considered to have sensitive hearing (Popper *et al.* 2014). Studies undertaken using airguns indicate that sandeels have distinct but weak reactions to seismic airguns with initial startle responses reducing in frequency with on-going noise and no increased mortality detected (Hassel *et al.* 2004).

269. Results from studies on cod and sole indicate that pile driving may cause fish to increase swimming speed and move away from the pile driving noise (Mueller-Blenkle *et al.* 2010). Studies undertaken during 35 days of pile driving in a wharf on two species of fish which possess swim-bladders: grey snapper (*Lutjanus griseus*) and sheepshead (*Archosargus probatocephalus*), indicated little displacement effects at received SPL of between 152±157 dB re 1 µPa (peak) (Lafrate *et al*. 2016).

270. Similarly, studies undertaken during seismic surveys have reported localised and temporary changes in behaviour, with fish swimming away from the area or into deeper water but fish populations returning to pre-survey levels shortly after the seismic surveys has stopped (e.g. Wardle *et al*. 2001; Slotte *et al*. 2004; Løkkeborg *et al.,* 2010; Peña *et al*. 2013).

271. Construction surveys from existing wind farms have indicated that fish numbers present within operating wind farms are at least similar to those prior to construction and may be higher (e.g. Jensen *et al.* 2006; Leonhard and Pederson, 2006; Lindeboom *et al.* 2011, Leonhard *et al*., 2011). Consequently, no long-term impacts on fish on which marine mammals prey are predicted following cessation of construction activities.

272. Sound arising from pile driving may have an effect on some prey species for marine mammals. Although the level of impact is dependent on the level of the sound source and the species of fish, the results from the noise modelling indicate that there is a very low risk of injury to any fish species. Although there is potential for a wider area of displacement or disturbance published studies indicate that the impacts will be localised and temporary, with fish populations returning to background levels following cessation of the noise.

273. It is concluded that based on the low risk of injury and localised displacement / disturbance, the sensitivity of the fish population is low and the magnitude of any impacts will be low. The significance of any impacts is therefore assessed to be **minor** and the potential effect from pile driving noise on fish populations is not significant.

8.10.8 Construction Phase Impacts

274. The impact resulting from the construction of the Project alone are predicted to be no greater than those predicted by the assessment undertaken for the consented original application. However, the

methods used to assess the predicted impacts have changed and the results from these revised methods are discussed in this section.

8.10.8.1 Pile driving noise

275. The only impact identified from the scoping process that may have the potential to cause a likely significant impact on marine mammals during construction was noise arising from pile driving (NnGOWL 2017, Marine Scotland 2017a).

276. Pile driving and drilling within the Wind Farm Area is required to support jacket foundations for the wind turbines, the offshore substation(s) and the met mast. The overall piling duration is expected to lie within a period of nine or fifteen months depending on whether concurrent piling is undertaken.

277. Owing to the nature of the seabed sediments at the site and the presence of shallow bedrock, there are three main installation methods that could be used for the installation of the piles:

- Driven only pile - driving with a hydraulic hammer;
- Driven and drilled pile - the 'drive–drill-drive' method where successive driving and drilling phases are used; and
- Drill only pile - drilling out the entire hole for the pile and subsequently grouting the pile into the drilled socket in the bedrock. In this method, a sacrificial casing may be installed by driving to bedrock level ahead of the drilling operation. This is to prevent the sediment layer collapsing in to the drilled hole prior to pile installation.

278. Although the highest levels of noise will arise during pile driving, noise from drilling is predicted to occur over the longest period of time.

Harbour porpoise

279. The harbour porpoise North Sea Management Unit population based on the SCANS III data is estimated to be 333,808 individuals and the population is assessed as being in Favourable condition. The regional population based on SCANS III Block R is 38,646 (CL 20,584 – 66,254) individuals (Table 8.8) (Hammond *et al*. 2017; JNCC, 2017).

280. The results from the noise modelling indicate that during a single pile driving operation within the Wind Farm Area the average distance within which the onset of PTS in harbour porpoise will occur is 247 m from a single pulse (peak SPL) and 6,357 m from cumulative multiple pulses (Table 8.27). There is the potential for the onset of TTS to occur within 823 m from a single pulse and 25,112 m from cumulative multiple pulses (Table 8.28).

281. The number of individuals at risk of the onset of PTS is estimated to be 77 individuals and therefore an estimated 0.02% of the Management Unit population and 0.29% of the regional population may be impacted (Table 8.36). It is estimated that the number of harbour porpoise that may be disturbed during a single pile driving event is 1,177 individuals, equivalent to 0.35% of the Management Unit population and 3.0% of the regional population (Table 8.36). Consequently, the noise modelling undertaken indicates that a very small proportion of the harbour porpoise Management Unit population are predicted to be at risk of the onset of PTS irrespective of whether single pile driving or concurrent pile driving is undertaken.

282. The results from population modelling indicate that should pile driving be undertaken over a period of 15 months the median of the ratio of impacted to unimpacted annual growth rate will be 0.998. the difference in median growth rates is very small at -0.002. The median of the ratio of impacted to unimpacted population size may be 0.959 (Table 8.42). The potential difference in the population size between the impacted and unimpacted harbour porpoise populations in 24 years is estimated to be 4.2% (Table 8.44).

283. In the event that concurrent pile driving is undertaken, the pile installation across the Wind Farm Area could be completed within a single year. The number of harbour porpoise estimated to be at risk of PTS is 144 individuals, equivalent to 0.04% of the North Sea Management Unit population and 0.37% of the regional population. The estimated number of harbour porpoise predicted to be disturbed is 1,880 individuals; equivalent to 0.56% of the North Sea Management Unit population and 4.9% of the regional population (Table 8.41).

284. The population modelling undertaken indicates that should concurrent pile driving be undertaken within the Wind Farm Area this could result in a 4.6% difference in the harbour porpoise population in 24 years (Table 8.46).

285. Studies undertaken on harbour porpoise indicate that the impacts from TTS are temporary and, depending on the exposure level and duration, hearing ability returns between 4 and 96 minutes after the sound causing the impact has ceased (Kastelein *et al.* 2012; Kastelein *et al*. 2014). Consequently, the impacts from TTS are predicted to be of short duration and unlikely to have an effect on harbour porpoise.

286. Studies undertaken at existing offshore wind farms with regard to behavioural effects from pile driving, suggest that harbour porpoise return to areas from which they have been displaced relatively shortly after the cessation of pile driving activities. Results from Horns Rev offshore wind farm indicated that harbour porpoises were present in an area within 48 hrs of pile driving operations having stopped (Tougaard *et al.* 2006). Similarly, in the Moray Firth, harbour porpoise returned within 2 to 3 days following the installation of piles for two jacket based wind turbines (Thompson *et al*. 2010). At the Greater Gabbard offshore wind farm porpoises returned within four weeks following cessation of pile driving (GWFL, 2011). Studies undertaken during the construction of eight offshore wind farms in Germany indicate that there may be a level of displacement out to 20 km or more from the pile driving activities. However, the duration of any impacts were short with harbour porpoise returning, following the cessation of pile driving, within 20 to 31 hrs (Brandt *et al*. 2016).

287. Similar studies undertaken in the Moray Firth during 10 days of 2D seismic surveys using a 470 cu in airgun with peak-to-peak source levels estimated to be 242-253 dB re 1 µPa @ 1 m, reported a decrease in the relative densities of harbour porpoises within 10 km of the airgun and an increase in densities at greater distances. However, porpoises continued to occur at sites within the impacted area during the seismic survey and there was a decline in the level of displacement over the ten day period that surveys were undertaken; indicating an increasing level of acclimation during the surveys. Once the surveys had ceased the number of detections returned to baseline levels within a day (Thompson *et al.* 2013; Pirotta *et al.* 2014).

288. Displaced harbour porpoise will relocate elsewhere. The species occurs widely across the North Sea and is therefore not constrained by specific habitat preferences. Harbour porpoise are known to forage widely and prey on a wide selection of fish species (Sveegaard, 2011); they are therefore adaptable and capable of relocating to new areas. However, the impacts on their prey are predicted to be limited to when pile driving is being undertaken and fish populations are predicted to return to baseline level following the cessation of pile driving.

289. It is concluded that any displacement or disturbance impacts on harbour porpoise from pile driving will be temporary and not have a significant population level effect. The sensitivity of harbour porpoise population is assessed to be low and the magnitude of any effects are also low. The significance of any effect is therefore assessed to be **minor** and the potential impact from pile driving noise on harbour porpoise is not significant.

White-beaked dolphin

290. The white-beaked dolphin Management Unit population based on SCANS III survey results is estimated to be 35,908 individuals and the population is assessed as being in Favourable condition (IAMMWG,

2015; JNCC, 2017). The regional population based on SCANS III Block R is 15,694 (CL 3,022– 33,340) individuals (Table 8.13) (Hammond *et al*. 2017).

291. The results from the noise modelling indicate during a single pile driving operation undertaken over a period of fifteen months within the Offshore Wind Farm Area, the average distance within which the onset of PTS in white-beaked dolphin will occur is within 3 m from a single pulse (peak SPL) and 1 m from cumulative multiple pulses (Table 8.29). There is potential for the onset of TTS to occur within 8 m from a single pulse and 493 m from cumulative multiple pulses (Table 8.30). The number of individuals at risk of the onset of PTS is estimated to less than one individual and therefore less than 0.003% of the SCANS III based Management Unit population and 0.006% of the regional population may be impacted (Table 8.36).

292. The SCANS III surveys did not record any white-beaked dolphins in the in the Firths of Forth and Tay area and the regional densities for the SCANS III Block R are derived from sightings beyond the area potential impacted by pile driving activities (Hammond *et al*. 2017). Consequently, the estimated density of 0.24 ind. km^2 for SCANS III Block R may not reflect the densities of white-beaked dolphin within the area of potential impact. Three years of site specific surveys recorded a total of 18 white-beaked dolphins and for eight months of the year there were no sightings. Similarly, although data from aerial surveys did recorded white-beaked dolphins in the Firths of Forth and Tay area, the majority of sightings were further offshore with none within the Wind Farm Area (Grellier and Lacey, 2011). Densities based on data obtained from boat based and aerial surveys undertaken across Firths of Forth and Tay area indicate densities of white-beaked dolphin within the Wind Farm Area are between 0.00 and 0.005 ind/km^2 and the highest densities further offshore are between 0.1 and 0.2 ind/km^2. A density of 0.016 ind/km^2 has been calculated based on boat based and aerial survey data obtained across the Firths of Forth and Tay and the total number of white-beaked dolphins estimated to be in the area is 91 (95% CI 32 – 384) (King and Sparling 2012).

293. Based on the SCANS III regional density of 0.24 ind/km^2 it is estimated that the number of white-beaked dolphin that may be disturbed during a single pile driving event is 478 individuals and 763 individuals if concurrent pile driving occurs. The number of individuals estimated to be disturbed is therefore higher than the total population of white-beaked dolphins thought to occur in the Firths of Forth and Tay area. The use of the relatively high density of 0.24 ind/km^2 is therefore not considered appropriate for this assessment

294. Based on the densities of white-beaked dolphins within the Firths of Forth and Tay of 0.016 ind/km^2, it is estimated that up to 30 white-beaked dolphins could be affected from single pile driving, 0.08% of the Management Unit population and 0.19% of the regional population. In the event concurrent pile driving is undertaken an estimated 50 individuals may be affected, 0.13% of the Management Unit population and 0.32% of the regional population.

295. No studies on the potential impacts arising from the construction of offshore wind farms on white-beaked dolphins have been published. However, studies on other marine mammals have demonstrated that once activities causing the displacement cease, marine mammals will return to the area. It is predicted that white-beaked dolphins will also show similar behaviour as other marine mammals, with individuals returning shortly have activities have ceased.

296. White-beaked dolphin feed on a broad range of prey and therefore will be able to feed opportunistically in alternative areas should they be displaced. However, the impacts on their prey are predicted to be limited to when pile driving is being undertaken and fish populations are predicted to return to baseline levels following the cessation of pile driving.

297. The proportion of the white-beaked dolphin population predicted to be displaced or disturbed is relatively very low and any impacts from pile driving will be temporary. It is concluded that based on the relatively low numbers impacted and the temporary nature of any potential impacts that the sensitivity of white-beaked dolphins population is low and the magnitude of any impacts will be

negligible. The significance of any effect is therefore assessed to be **negligible** and the potential impact from pile driving noise on white-beaked dolphin is not significant.

Bottlenose dolphin

298. The bottlenose dolphin Management Unit population is estimated to be 195 individuals and the population is assessed as being in unfavourable condition.

299. Bottlenose dolphins do not occur within the Wind Farm Area and there were no sightings of bottlenose dolphin during the three years of surveys undertaken across the study area.

300. The results from the noise modelling indicate that during both single and concurrent pile driving operations within the Offshore Wind Farm Area the average distance within which the onset of PTS in bottlenose dolphin will occur is limited to within 3 m of the pile driving activities (Table 8.29). There is potential for the onset of TTS to occur within 8 m from a single pulse and 493 m from cumulative multiple pulses (Table 8.30). The number of individuals at risk of the onset of PTS and TTS is estimated to less than one individual.

301. It is estimated that the number of bottlenose dolphins that may be disturbed during a single pile driving event is two individuals, equivalent to 1.0% of the Management Unit population.

302. In the event that concurrent pile driving occurs within the Wind Farm Area, the area within which physical injury could occur remains at less than 0.001 km^2, although the onset of TSS could occur over a wider area of 1.035 km^2 (Table 8.37 and Table 8.38). The number of bottlenose dolphins estimated to be at risk of PTS and TTS is less than one individual and the number at risk of disturbance is two individuals; equivalent to 1.0% of the Management Unit population.

303. The very low numbers of bottlenose dolphin at risk of physical injury or disturbance indicates that there is a very low risk of any effect on the bottlenose dolphin population. This is supported by the results from the population modelling that indicates that the impacts from the pile driving will not cause a population level effect after 24 years (See Section 8.10.6.2)

304. Bottlenose dolphin feed on a broad range of prey and the few individuals that may be disturbed will, if dispalced, be able to feed opportunistically in alternative areas. The impacts on their prey are predicted to be limited to when pile driving is being undertaken and fish populations will return to baseline levels following the cessation of pile driving.

305. It is concluded that the impacts from pile driving at NnG will have no effect on the population of bottlenose dolphins. The sensitivity of the bottlenose dolphin population is assessed as high and the magnitude of any impacts will be negligible. The significance of any effect is therefore assessed to be **minor** and the potential effect from pile driving noise on bottlenose dolphin is not significant.

Minke whale

306. The Minke whale CGNS Management Unit population based on the SCANS III data is estimated to be 11,819 individuals and the population is assessed as being in Favourable condition. The regional population based on SCANS III Block R is 2,498 (CL 604 – 6,791) individuals(Table 8.16) (JNCC, 2017; Hammond *et al*. 2017).

307. The results from the noise modelling indicate that during a single pile driving operation within the Wind Farm Area the average distance within which the onset of PTS in Minke whale will occur is 15 m from a single pulse and 10,224 m from cumulative multiple pulses (Table 8.31). There is potential for the onset of TTS to occur within 37 m from a single pulse and 44,889 m from cumulative multiple pulses (Table 8.32).

308. The number of individuals at risk of the onset of PTS from cumulative multiple pulses is estimated to 14 individuals and therefore 0.11% of the Management Unit population and 0.56% of the regional population may be impacted.

309. It is estimated that the number of minke whales that may be disturbed during a single pile driving event is 77 individuals, equivalent to 0.65% of the Management Unit population and 3.1% of the regional population (Table 8.36). In the event that concurrent pile driving occurs within the Wind Farm Area, the duration of impacts from pile driving will be reduced to within nine months. The number of minke whales estimated to be at risk of PTS from concurrent pile driving increases to 23 individuals, equivalent to 0.19% of the Management Unit population and 0.92% of the regional population. The number at risk of disturbance increases to 123 individuals, equivalent to 1.0% of the management unit population and 4.9% of the regional population (Table 8.41).

310. The results from population modelling indicate that should pile driving be undertaken over a period of 15 months the median of the ratio of impacted to unimpacted annual growth rate will be 0.993 and the median of the ratio of impacted to unimpacted population size will be 0.839 (Table 8.52). The potential difference in the median impacted and unimpacted growth rates after 24 years is -0.007 and population size of 4.2% (Table 8.54).

311. The population modelling undertaken indicates that should concurrent pile driving be undertaken the median of the ratio of impacted to unimpacted annual growth rate will be 0.845 and the median of the ratio of impacted to unimpacted population size will be 0.950 (Table 8.52). Based on the modelling outputs this could result in a 14.8% difference in the minke whale population in 24 years (Table 8.54).

312. The low percentage of modelling runs where the estimated impacted population size is not lower than the estimated unimpacted population (Table 8.52) indicates that there is a relatively high probability that after 24 years impacted population will be lower than the unimpacted population due to the impacts from pile driving.

313. There are few studies on the potential effects of underwater noise on minke whales. Studies undertaken using naval sonar found that a minke whale started avoiding the source at a received SPL of 146 dB re 1 μPa and at a received cumulative SEL of 155 dB re 1 μPa^2s it increased swimming speed and the whale moved away from the sound source. At a cumulative SEL of 171 dB re 1 μPa^2s swimming speed increased up to more than 4 m s^{-1} and the animal remained near the sea surface. Within ten minutes of the noise stopping the swimming speed and diving behaviour returned to normal (Sivle *et al.* 2015; Kvadsheim *et al*. 2015). Studies undertaken on minke whales have shown that when ADD's are operating they increase swimming speeds to an average of 7.4 kmh^{-1} and swim away from the sound source (McGarry *et al.* 2017). It is predicted that minke whales impacted by pile driving noise will behave similarly and increase swimming speeds to move quickly away from the area.

314. There is a low risk of physical injury to minke whales with no more than 0.19% of the Management Unit population at risk of the onset of PTS. Displaced minke whales will swim rapidly away from the sound source and relocate to other areas. Within the study area only 18 minke whales were recorded during three years of monthly surveys and therefore the area is not considered to be important for minke whales (Table 8.18). The broad distribution of minke whales across the North Sea indicates that they are not restricted to specific habitats within their range and displaced individuals will be able to relocate elsewhere.

315. Minke whale feed on a broad range of fish species (Table 8.67) and will therefore will be able to feed opportunistically in alternative areas should they be displaced. The impacts on their prey are predicted to be limited to when pile driving is being undertaken and fish populations are predicted to return to baseline levels following the cessation of pile driving. Advice received in the Scoping Opinion is that the impacts on diadromous fish are not significant (Marine Scotland 2017a)

316. It is concluded that impacts on minke whale from pile driving will be temporary and not have a significant population level effect. The sensitivity of minke whale population is assessed to be low and the magnitude of any effects is Medium. The significance of any effect is therefore assessed to be **minor** and the potential effect from pile driving noise on minke whale is not significant.

Grey seal

317. The adjusted grey seal population in the ECMA is estimated to be 9,607 (CI 8,028 – 11,958) individuals and the NEEMA is 29,046 (95% CI 24,272 – 36,156) (See Para: 148). A combined regional population of 38,653 (CI 32,300 – 48,114) individuals. It is known from tagging studies that seals from the NEEMA occur with the Firths of Forth and Tay.

318. The results from the noise modelling indicate that during a single pile driving operation within the Wind Farm Area the average distance within which the onset of PTS in grey seals will occur is 18 m from a single pulse (peak SPL) and 472 m from cumulative multiple pulses (Table 8.33). There is potential for the onset of TTS to occur within 47 m from a single pulse and 20,312 m from cumulative multiple pulses (Table 8.34). The number of individuals at risk of the onset of PTS from cumulative multiple pulses is estimated to be one individual (Table 8.36) and therefore 0.01% of the ECMA population and <0.001% of the regional population (comprising East Coast and North-East England Management Areas) may be affected. It is estimated that during a single pile driving event 821 grey seals, 8.5% of the ECMA population and 2.1% of the regional population may be disturbed (Table 8.36).

319. In the event that concurrent pile driving occurs within the Wind Farm Area the number of grey seals estimated to be at risk of PTS is individual; 0.01% of the ECMA population. The number at risk of disturbance is 1,357 individuals; equivalent to 14.1% of the ECMA population and 3.5% of the regional population (Table 8.41).

320. The population modelling are based on the ECMA population only. The results indicate that the ECMA grey seal population will continue to increase over the next 24 years with or without impacts from proposed pile driving (Figure 8-42 and Figure 8-43).

321. Should pile driving be undertaken over a period of 15 months the median of the ratio of impacted to unimpacted annual growth rate will be 0.997 and the median of the ratio of impacted to unimpacted population size will be 0.950 (Table 8.57). The potential difference in the growth rate between the impacted and unimpacted grey seal population in 24 years is very small at -0.003 and the difference in population size may be 7.7% (Table 8.59).

322. Should concurrent pile driving be undertaken the median of the ratio of impacted to unimpacted annual growth rate will be 0.998 and the median of the ratio of impacted to unimpacted population size will be 0.973 (Table 8.57). Based on the modelling outputs this could result in a 5.7% difference in the grey seal population after 24 years (Table 8.61).

323. Studies undertaken at other offshore wind farms have not detected any declines in the population of grey seals following construction. At Scroby Sands Offshore wind farm the population of grey seals continued to increase following the construction of the wind farm (Skeate *et al* 2012). Similarly, following construction of the Nysted offshore wind farm in Denmark, no long term effects on the number grey seals hauled at Rødsand as close as 4 km away were recorded (Edrén, *et al*., 2010). Consequently, it is predicted that there will not be any decrease in the number of grey seals within the ECMA or wider regional population and the population may continue to increase.

324. Grey seals feed on a broad range of fish species and forage widely from their haul out sites (Figure 8-20) and will therefore will be able to feed opportunistically in alternative areas should they be displaced. The impacts on their prey are predicted to be limited to when pile driving is being undertaken and fish populations are predicted to return to baseline levels following the cessation of pile driving.

325. The potential impacts on individual grey seals will vary, depending on individuals' sensitivities and habituation to noise. Furthermore, studies suggest that the response to noise may depend on whether the sound is sudden and causes a startle response or is more gradual and allows habituation to occur and therefore avoids a startle response. Where sound levels are increased more gradually, i.e. by ramp-up, a reduced level of displacement may occur (Götz and Janik, 2011).

326. It is concluded that any displacement or disturbance impacts on grey seals from pile driving will be temporary. The sensitivity of grey seal population is assessed to be medium and the magnitude of any effects will be low. The significance of any effects is therefore assessed to be **minor** and the potential impact from pile driving noise on grey seal is not significant.

Harbour seal

327. The population of harbour seals within the ECMA has declined significantly over the last 20 years (Figure 8-24 and Figure 8-25) and the adjusted population is estimated to be 311 (95% CI 254 - 415) individuals (See Para: 160. The cause of the decline is unknown.

328. Results from noise modelling indicates that there is potential for the onset of PTS to occur within 472 m from the pile driving, and for the onset of TTS to occur within 20,312 m (Table 8.33).

329. Population modelling predicts that the ECMA harbour seal population will become extinct within 24 years with or without any impacts from pile driving. Although the decrease in the population may be marginally greater over the initial ten to fifteen years with pile driving (Figure 8-44 and Figure 8-45).

330. Tagging data obtained during the construction of the Lincs Offshore wind farm indicated that displacement effects could occur out to 25 km from the sound source with a predicted maximum SPL of 235 dB re 1 $\mu Pa_{(p\text{-}p)}$ @ 1 m and a maximum SEL of 211 dB re 1 $\mu Pa^2 s^{-1}$. However, following cessation of pile driving the distribution of harbour seals returned to the pre-pile driving scenarios (Russell *et al.* 2016b). Consequently, any potential displacement effects arising from pile driving are predicted to be temporary.

331. Studies undertaken at other offshore wind farms indicate that there is a low risk of any population level effect to harbour seals from construction activities. Following construction at Horns Rev offshore wind farm no changes in the abundance of harbour seals were recorded at haul-out sites (Teilmann *et al*. 2006) and at the Dutch Egmond aan Zee wind farm harbour seals avoided the wind farm area during construction but were recorded within the wind farm following the cessation of construction activities. However, due to the limited data it was not possible to conclusively conclude that there were no population effects (Brasseur *et al*. 2012).

332. Harbour seals prey on a wide variety of species including sandeels, whiting, flounder, cod and other fish species (SCOS, 2005; Tollit and Thompson, 1996). The main prey species for harbour seals in the Tay Estuary area are sandeels and salmonids (Sparling *et al*. 2012) neither of which are particularly sensitive to sound (Popper *et al*. 2014) and both have a relatively localised potential area of impact. Consequently, it is predicted that there will be potential prey available in the area during the period of construction.

333. Although there will be an impact on harbour seals arising from pile driving noise the results from the population modelling indicate that the additive effect on the harbour seal population from the pile driving is negligible.

334. It is concluded that any displacement or disturbance impacts on harbour seals from pile driving will be temporary and not have a significant population level effect. The sensitivity of harbour seal population is assessed to be high but the magnitude of any effects on the population will be negligible. The significance of any effects is therefore assessed to be **minor** and the potential impact from pile driving noise on harbour seal is not significant.

8.10.8.2 Drilling noise

335. It is anticipated that the majority of the foundations will require drilling to be undertaken in the 'drive-drill-drive' and 'drill only' scenarios and is predicted to be the most continuous sound source occurring during the installation of the foundations. Consequently, the potential impacts from drilling noise on marine mammals have been assessed.

336. Sound associated with drilling operations will propagate from rotating equipment such as generators, pumps and the drill string. In general, sound from drilling has been found to be predominantly low frequency (<1kHz) with relatively low source levels. Source levels have been found to be less than 195 dB (rms) re 1µPa-m for a drill ship (Nedwell and Edwards 2004). A study by Greene (1987) found that the sound generated by drilling activities from a semi-submersible did not exceed local ambient levels beyond 1 km, although weak tones were detectable up to 18 km away. Studies have shown that during drilling, other underwater sound levels increase when compared to periods of non-drilling, which has been related to the use of additional machinery and power demands (McCauley 1998). Drilling sounds, although of a relatively low level, will be continuously generated throughout the drilling activity.

337. Noise from drilling activities is largely dependent on the type of drilling platform being used. Jack-up rigs are the most frequently used drilling platform and produce the lowest levels of sound. Studies in Danish waters reported sound source levels of 148 re 1µ Pa-m $_{(rms)}$ from drilling activities undertaken from a fixed platform (Bach *et al.* 2010). The level of sound arising from drilling is relatively low and occurs predominantly at a low frequency and is a continuous sound source (Greene, 1986; McCauley, 1998; Nedwell and Edwards, 2004).

338. Sorensen *et al.* (1984) (cited in Hammond *et al.* 2003) reported that, although there were little data on the reactions of marine mammals to drilling noise, there was no clear evidence of avoidance behaviour by small odontocetes. Bottlenose dolphins, Risso's dolphins and common dolphins were all recorded close to platforms and sighting rates were similar in areas with and without drilling rigs.

339. Studies using Passive Acoustic Monitoring (PAM) at platforms located on the Dogger Bank did not record any decrease in harbour porpoise activity at the platforms when drilling was being undertaken, compared to when there was no drilling and indicated that porpoises appeared to use oil and gas platforms as feeding refuges (Todd *et al.* 2007; Todd *et al*. 2009). Similar results have been reported from studies undertaken at two platforms in Danish waters (Bach *et al.* 2010).

340. The levels of sound reported from drilling are below that which would be predicted to cause either PTS or TTS and although audible to marine mammals, studies indicate no adverse behavioural response to drilling noise.

341. The sensitivity of marine mammal populations to drilling noise is considered to be low and the magnitude of impacts is negligible. Consequently, effects arising from drilling are assessed to be **negligible** and not significant.

8.10.8.3 Geophysical surveys

342. Geophysical surveys are likely to be required, although precise details e.g. durations, are not currently known. If required, they will be subject to relevant applications and associated impact assessment. However, in line with the advice received during scoping, the following section provides an assessment of the potential impacts that may arise in the event that geophysical surveys are undertaken in the future.

343. The specific details of the geophysical equipment that may be used in any future geophysical survey are unknown and will depend on the survey requirements at the time. However, although there are many different types of equipment that could be used depending on the data required, the potential impacts on marine mammals are similar in nature for each type of equipment.

Sidescan Sonar

344. Sidescan sonar provides high resolution acoustic images of the seabed. It involves the use of an acoustic beam to obtain an accurate image over a narrow area of seabed to either side of the instrument. Maximum source levels can be up to 228 dB re 1 µPa-m $_{(0-p)}$ (SCAR 2002). However, the frequencies used by sidescan sonar are relatively very high (100-600 kHz), with higher frequency

systems providing higher resolution but shorter range measurements. The high frequencies emitted by sidescan sonar are predominantly outside of the hearing range of all marine mammals (JNCC 2010).

Multi-beam Echosounders

345. Multi-beam echosounders measure water depth and can determine the nature of the seabed. They use multiple (>100) transducers to send out a relatively broad swath of sound covering a large, fan-shaped area of the seabed beneath the vessel. The sound source level, firing rate and pulse duration can be varied depending on the depth of the area under investigation. In relatively shallow water depths multi-beam echosounders operate at a relatively lower sound source and at higher frequencies of between 200 to 500 kHz, that are outwith the hearing range of most marine species (SCAR 2002, Danson 2005, IHO 2005). Previous geophysical surveys undertaken within the Development Area operated band widths of between 200 and 400 kHz and 100 and 900 kHz.

Sub-bottom profilers

346. Sub-bottom profiling is used to determine the stratification of soils beneath the sea floor. Various types of instrument may be used, such as pingers, boomers, sparkers and chirpers, depending on the required resolution and seabed penetration. They produce sound source levels of between 196 and 225 dB re 1 µPa @ 1 m and at a broad range of frequencies ranging from between 0.5 and 300 kHz (King 2013, Danson 2005).

347. The majority of sound energy from sub-bottom profilers is directed vertically downwards and the pulse duration is short (tens to hundreds of milliseconds). The actual source levels generated by a sub-bottom profiler depends on the type of equipment used and its operating specification.

348. Pingers emit relatively high frequency sound between 2 and 12 kHz and Sound Exposure Levels (SEL) higher than those from sparkers with maximum source levels up to 214-225 dB re 1 µPa @ 1 m $_{(rms)}$. Sparkers operate at a lower frequency between 200 Hz and 800 Hz and also at source levels up to 222 dB re 1 µPa @ 1 m $_{(rms)}$. Maximum source SELs for pingers and chirpers are higher than those of the sparkers and boomers, primarily due to the much longer signals that they can produce. Chirpers are frequency modulated sub-bottom profilers capable of providing high penetration and high resolution data. They produce sound levels of between 189 and 214 dB re 1 µPa @ 1 m $_{(rms)}$ and at frequencies of between 2 and 24 kHz.

349. All types of sub-bottom profiling equipment may make sound that will be audible to cetaceans. However, sound from the higher frequency pingers will attenuate rapidly within the water column and the directionality of the sound source arising from pingers and chirpers reduces the amount of sound travelling horizontally (Danson 2005, Duncan & Salgado-Kent 2011, King 2013).

Magnetometers

350. Magnetometers are used to detect metallic objects on or near the surface of the seabed. They are frequently used during unexploded ordnance surveys. No noise is emitted from magnetometers.

8.10.8.3.1 Potential impacts on marine mammals from geophysical survey.

351. Figure 8-46 below presents a summary of the frequencies emitted from sidescan sonar, multi-beam echosounders and sub-bottom profilers that could potentially be used in any possible future geophysical surveys along with the hearing range of marine mammals that may be in the survey area. It is predicted that marine mammals will not be able to detect sound from multi-beam echo sounders or sidescan sonar but will be able to detect sound from sub-bottom profilers.

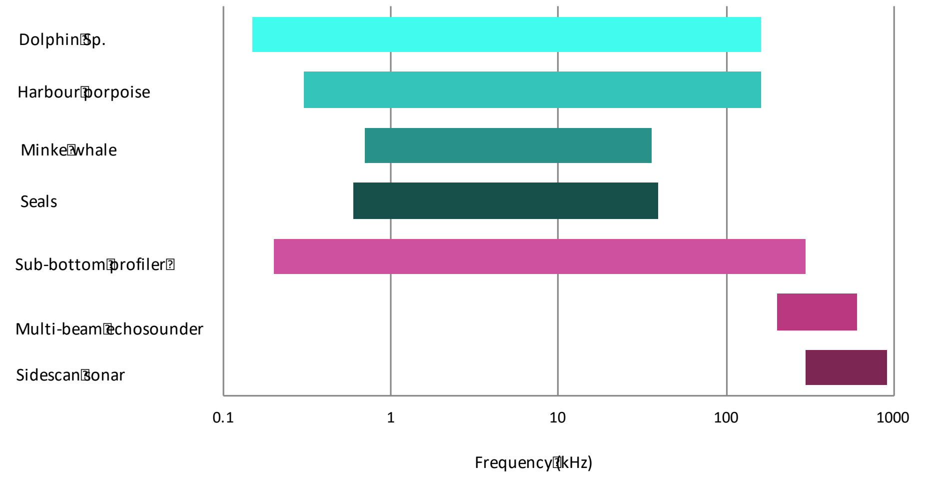


Figure 8-46: Frequency ranges of geophysical and the marine mammals

352. Sub-bottom profilers operate at frequencies of between 0.5 kHz and 300 kHz depending on the type of profiler and are audible to marine mammals (Figure 8-46).

353. No specific noise modelling for the use of a sub-bottom profiler has been undertaken for this assessment. However, studies from elsewhere indicate sound emitted from sparkers, with a source level of between 116 and 222 dB re 1 µPa @ 1 m $_{(0\text{-}p)}$, will be below levels at which the onset of TTS might occur within 5 m of the sound source and below 160 dB re 1 $\mu Pa^2 s$ within 40 m from the sound source. This occurs in all water depths from between 3 m and 30 m (Duncan & Salgado-Kent, 2011). Based on maximum operating source levels King (2013) concluded that all types of sub-bottom profiler have the potential to exceed the marine mammal injury and disturbance thresholds. However, this was based on the maximum source levels from sub-bottom profilers and did not take into consideration the marine mammal hearing weightings nor that the sound from sub-bottom profilers is focussed downwards and therefore limits the horizontal propagation of sound and consequently the area of potential disturbance.

354. JNCC acknowledges that sound from sub-bottom profilers is within the hearing frequency range of marine mammals and could cause a localised behavioural response such as avoidance, but considers that it is unlikely to cause injury or disturbance due to the small area of ensonification (JNCC, 2010).

355. It is concluded that sidescan sonar and multi-beam echosounder emit sound at frequencies that are above the hearing thresholds of marine mammals predicted to occur within the Wind Farm Area (Figure 8-46). Consequently, sound from this equipment will not cause any impact on marine mammals that may be present in the area.

356. There is a very low risk of physical injury to any marine mammals from the potential use of sub-bottom profilers. There is potential for a relatively localised area of disturbance. The extent of disturbance will depend on the type of sub-bottom profiling equipment to be used. However, should it occur it is predicted that any displacement or disturbance impacts would be temporary with marine mammals returning to the area once the activity has ceased.

357. The sensitivity of marine mammal populations to noise from geophysical surveys is considered to be low and the magnitude of impacts is negligible. Consequently, the significance of any effects arising from geophysical surveys are **negligible** and not significant.

8.10.8.4 Disturbance from noise and particle motion arising from the HDD pipe site works

358. In addition to the main wind turbine and substation foundation pile driving works, installation of a temporary circular or rectangular steel casing is proposed in the shallow subtidal area to facilitate the excavation of a dry area within which a second receiving pit would be constructed for the emergence of the HDD drill (as described in Chapter 4: Project Description). This would involve interlocking steel sheets being lifted in to place by an excavator – with the potential for noise generated by this installation operation. Here, the cable will emerge and, if required, be joined with the Offshore Export Cable. The cable will then be buried, the disturbed area reinstated and the casing removed.

359. The installation of the steel casing, which may require sheet piling, has the potential to give rise to underwater noise which may lead to the disturbance of marine mammal species. The installation of the sheet piling will take place in relatively shallow water close to shore with installation taking a relatively short period (e.g. a number of days at most). Given this, the noise generated will attenuate over a relatively short distance (given the shallow water depths) so that effects on marine mammals will be limited spatially and temporally – given the short period for installation, and the effects are considered temporary and reversible. As such the effects on marine mammals arising from the sheet piling impacts are predicted to be **minor**, which is not considered significant in EIA terms.

8.10.9 Operational Phase Impacts

8.10.9.1 Aircraft and helicopter disturbance

360. It is envisaged that approximately 80 round trips by helicopter could occur each year. There is limited information on the impacts noise from helicopters may have on marine mammals although they have been reported to react to overflights by diving or changing in swimming direction (Richardson *et al*. 2005). The dominant sound from helicopters is below 500 Hz and therefore typically outwith the main hearing frequencies of marine mammals (Richardson *et al*. 2005). However, low-frequency hearing specialists such as minke whales may be impacted.

361. Studies on bowhead whale (*Balaena mysticetus*) and beluga whales (*Delphinapterus leucas*) in the Beaufort sea recorded most behavioural responses when the helicopter was less then 150 m above the sea surface and 250 m laterally from them (Patenaude *et al*. 2002). Studies on ringed seals (*Phoca hispida*) hauled out have shown that a helicopter flying at 150 m can cause behavioural disturbance at 1,250 m (Hoang 2013). Consequently, there is potential for low flying helicopters to cause localised disturbance. However, the duration of impacts are predicted to short, with behaviour returning to normal within a few minutes of the helicopter passing.

362. The effects of any helicopter noise are predicted to be localised and be of a long duration enduring for the operational lifecycle of the Project. However, it is considered that is it unlikely to cause a significant disturbance (JNCC 2008). The sensitivity of marine mammal populations to noise from helicopters is considered to be low and the magnitude of impacts is negligible. Consequently, the significance of any effects arising from helicopter flights are **negligible** and not significant.

8.10.10 Cumulative Impacts

363. Cumulative effects refer to effects upon receptors arising from the Project when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals. In this context, the term 'projects' is considered to refer to any project, plan or programme with comparable effects and is not necessarily limited to offshore wind projects. Impacts from other projects identified as being most likely to have the potential to have a cumulative effect, in the context of the issues scoped into this EIA, are from other underwater sound sources.

364. Project and activities considered within the cumulative impact assessment are set out in Table 8.68 and are based on, and incorporate, the advice received during the formal consultation (Marine Scotland, 2017a) (see Section 8.6). It is recognised that there may be plans or projects for which there

is limited information and yet may be being undertaken at the same time as the planned construction period of NnG. It is also possible that activities arising from current projects that have been identified as having the potential to cause a cumulative impact may be completed prior to works commencing at NnG. There is, in some cases, also an element of uncertainty associated with the design envelope of certain of the other proposed projects. Therefore, a judgement is made on the confidence associated with the latest available design envelope.

Table 8.68: Projects for cumulative assessment

Development Type	Project	Status	Data Confidence Assessment / Phase
Offshore Wind Farm	Inch Cape Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Inch Cape Offshore Wind Farm	Proposed	High – Scoping report publicly available.
Offshore Wind Farm	Seagreen Alpha Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Seagreen Bravo Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Seagreen Phase 1 Wind Farm Project	Proposed	High – Scoping report publicly available.
Offshore Wind Farm	Beatrice Offshore Wind Farm	Consented	High – Consented project details available
Offshore Wind Farm	Moray East Offshore Wind Farm	Consented	High – Consented project details available
Offshore Wind Farm	Moray East Offshore Wind Farm – Alternative design	Proposed	High – Scoping report publicly available.
Offshore Wind Farm	Moray West Offshore Wind Farm	Proposed	High – Scoping report publicly available.
Harbour Expansion	Aberdeen Harbour Expansion Project	Consented	High – Consented project details available

365. Current timelines for other offshore wind farms are uncertain and likely to change. However, based on currently known schedules as available from publicly available information, there is potential for overlapping periods of construction activity with the Moray West Offshore Wind Farm.

366. It is anticipated that work arising from the Beatrice Offshore Wind Farm and the Aberdeen Harbour Expansion Project that could cause a potential cumulative impact on marine mammals will have been completed prior to any construction activities associated with the Project. However, it is recognised that impacts from these projects could cause population level effects that may continue beyond the end of the construction and therefore there is potential for an on-going cumulative impact.

367. The construction schedules for the other offshore wind farms located within the Firths of Forth and Tay, i.e. Inch Cape and Seagreen, are known, based on the publicly available information but must be considered subject to change at this stage. It is considered highly unlikely that there will be any construction being undertaken at other planned wind farms within the Firths of Forth and Tay area at the same time as NnG is being constructed. In addition, the worst-case scenario for marine mammals

would be unbroken sequential piling (as agreed with MS and SNH). Existing modelled outputs have been used to compare the potential for cumulative impacts with consented projects, the results of which are discussed in Section 8.10.11.

368. Table 8.69 sets out the potential cumulative impacts and the worst case cumulative design envelope scenario considered within the cumulative impact assessment.

Table 8.69: Cumulative worst-case design envelope scenarios

Impact	Project	Worst Case Design Scenario
Noise arising from hammering	Inch Cape Offshore Wind Farm (proposed)	Pile diameter - unknown Maximum hammer size 2400 kJ Total pile driving duration –unknown
	Inch Cape Offshore Wind Farm (consented)	Pile diameter - 2.43 m Maximum hammer size - 1200 kJ Total pile driving duration – 4.2 hrs
	Seagreen Alpha Offshore Wind Farm (consented)	Pile diameter – 3.0 m Maximum hammer size - 1800 kJ Total pile driving duration – 0.5 hrs
	Seagreen Bravo Offshore Wind Farm (consented)	Pile diameter – 3.0 m Maximum hammer size - 1800 kJ Total pile driving duration – 0.5 hrs
	Seagreen Phase 1 Wind Farm Project (proposed)	Monopiles now included as a potential foundation option. Maximum hammer size 2400 kJ Total pile driving duration – unknown
	Beatrice Offshore Wind Farm	Pile diameter – 2.4 m Maximum hammer size - 2300 kJ Total pile driving duration – 5 hrs
	Moray East Offshore Wind Farm (consented)	Pile diameter – 2.5 m Maximum hammer size - 1200 kJ Total pile driving duration – 1.2 hrs
	Moray East Offshore Wind Farm (proposed)	Potential use of suction bucket foundations eliminating the requirement to pile. Pile driving as previously consented still an option.
	Moray West Offshore Wind Farm	Pile diameter – 4 - 12 m (depending on foundation type) Maximum hammer size - Unknown Total pile driving duration – Unknown
Noise arising from blasting	Aberdeen Harbour Expansion Project	Blasting – maximum of two blasts per day.

369. No other projects or plans have been identified as having the potential to cause a cumulative impact on marine mammals with respect to noise arising from construction (Marine Scotland 2017a).

8.10.11 Cumulative Sound Modelling Results on Marine Mammals

370. The following section presents a summary of the results from the noise modelling undertaken for potential cumulative impacts. There is potential for cumulative impacts to arise from the proposed Project and a number of other planned offshore wind farms should construction occur either simultaneously as NnG or sequentially, i.e. each development is constructed in succession. There are three other consented offshore wind farms within the Firths of Forth and Tay: Inch Cape, Seagreen A and Seagreen B. Noise modelling has previously been undertaken to assess the potential impacts from these developments (Nedwell and Mason, 2012). The modelling undertaken used the Impulsive Noise Sound Propagation and Impact Range Estimator (INSPIRE) model, a proprietary software that produced outputs primarily based on the dBht metric developed by Subacoustech. This is a species specific weighting metric that takes into account the varying hearing abilities of marine species. Although the approach is similar to the weighted SEL metrics proposed by Southall *et al*. (2007) and NOAA (2016) and used in this assessment, the metrics are not comparable.

371. To ensure a consistent approach is taken across all projects when identifying potential cumulative impacts and to allow a direct comparison to be made, modelling has been undertaken for all consented and planned offshore wind farms within the Firths of Forth and Tay. The modelling is based on the design envelopes presented in Table 8.69.

372. Table 8.70 presents the predicted areas within which the onset of PTS is predicted to occur for all consented or planned offshore wind farms in the Firths of Forth and Tay area, based on the NOAA thresholds.

Table 8.70: Area within which the onset of PTS is estimated to occur from pile driving activities at consented wind farm developments in the Firths of Forth and Tay based on NOAA cumulative weighted thresholds

Scenario	Cumulative weighted SEL Area of auditory injury (PTS) km^2			
	Low-frequency cetacean	Mid-frequency cetacean	High-frequency cetacean	Pinnipeds
NnG (2017)	344.4	<0.001	127.3	0.706
NnG at 2 locations (2017)	564.5	<0.001	240.3	1.306
Inch Cape (consented)	192.5	<0.001	85.15	0.030
Seagreen Alpha (consented)	354.9	<0.001	152.6	2.459
Seagreen Bravo (consented)	252.6	<0.001	137.9	2.212
Inch Cape (new application)	376.1	<0.001	142.2	0.458
Seagreen Phase 1 Location 1 (formerly Seagreen Alpha) (new application)	586.7	<0.001	161.3	0.495
Seagreen Phase 1 Location 2 (formerly Seagreen Bravo) (new application)	333.1	<0.001	125.0	0.339

373. The modelling indicates that the revised Inch Cape and the two Seagreen Phase 1 developments will have greater impacts on marine mammals than the previously consented projects. This is likely due to the proposed increases in hammer energies used to install the piles. Hammer energy has an important effect on the level of sound produced, with pile driving using higher hammer energies typically creating higher noise levels (Lepper *et al*. 2012b). Other factors that could have an effect on the

propagation of noise include water depth and seabed type. However, these are the same for the consented developments and new applications. Consequently, it is predicted that as one of the main factors that affects the level of noise produced, i.e. hammer energy, has increased in the new applications the cumulative impacts will be greatest with the revised Inch Cape and Seagreen Phase 1 developments.

374. It is concluded that the worst-case cumulative effect with respect to the potential impacts from noise on marine mammals will arise from the proposed Inch Cape and Seagreen Phase 1 developments and the impacts from existing consented Inch Cape, Seagreen A and Seagreen B developments will be lower due to the assumed lower hammer energies.

The estimated number of marine mammals predicted to be at risk from the onset of PTS across all developments considered in the cumulative impact assessment is presented in Table 8.71 and for disturbance in

375. . The estimates for developments in the Firths of Forth and Tay are from noise modelling undertaken based on the revised design parameters available at the time modelling was undertaken. Data for other developments have been obtained from their applications.

Table 8.71: Estimated number of marine mammals at risk of the onset of PTS from developments considered in the cumulative impacts

Wind farm	Harbour porpoise	White-beaked dolphin	Bottlenose dolphin [1]	Minke whale	Grey seal [2,3]	Harbour seal [2,3]
Neart na Gaoithe	77	<1	<1	14	1	1
Inch Cape (revised project)	86	<1	<1	15	1	1
Seagreen Phase 1 (Location 1)	97	<1	<1	23	1	1
Seagreen Phase 1 (Location 2)	75	<1	<1	13	1	1
Beatrice	9	N/A	1	36	-	-
Aberdeen Harbour Expansion Project	1	<1	1	1	1	1
Moray East	7	N/A	1	13	-	-
Moray West [4]	7	N/A	1	13	-	

1 = The predicted area of PTS for wind farms in the Firths of Forth and Tay area did not overlap with the bottlenose dolphin management unit area.

2 = Number of seals that could potentially experience the onset of PTS has been estimated using seal distribution maps (SMRU and Marine Scotland, 2017). The number of seals that could experience PTS onset has been calculated by estimating the number of seals within the predicted PTS area using the latest seal distribution maps.

3 = It has been assumed that the Moray Firth projects will not impact the East Coast Scotland seal management unit area and therefore not applicable for this assessment.

4 = In the absence of any published information it is assumed that the number of individuals impacted by the Moray West development is the same as Moray East.

N/A = Not available.

Table 8.72: Estimated number of marine mammals at risk of disturbance from developments considered in the cumulative impacts

Wind farm	Harbour porpoise	White-beaked dolphin [2]	Bottlenose dolphin	Minke whale	Grey seal [2,3]	Harbour seal [2,3]
Neart na Gaoithe [1]	1,177	50	2	77	821	8
Inch Cape (revised project)	1,691	37	1	111	925	10
Seagreen Phase 1 (Location 1)	2,207	45	1	144	1,103	11
Seagreen Phase 1 (Location 2)	2,490	45	1	163	1,087	4
Beatrice	3,191	N/A	19	177	-	-
Aberdeen Harbour Expansion Project	30	N/A	15	2	N/A	N/A
Moray East	2,933	N/A	17	168	-	-
Moray West [4]	2,933	N/A	17	168	-	-

1 = For assessing potential cumulative impacts it is assumed that single pile driving will be undertaken at the time as this provides the greatest period of sequential pile driving.

2 = Number of seals that could potentially experience the onset of PTS has been estimated using seal distribution maps (SMRU and Marine Scotland, 2017). The number of seals that could experience PTS onset has been calculated by estimating the number of seals within the predicted PTS area using the seal distribution maps.

3 = It has been assumed that the Moray Firth projects will not impact the East Coast Scotland seal management unit area and is therefore zero.

4 = In the absence of any published information it is assumed that the number of individuals impacted by the Moray West development is the same as Moray East.

N/A = Not available.

8.10.12 Cumulative Population Modelling

376. Advice received during consultation is to use the interim PCoD population model to predict potential population level effects from cumulative pile driving activities. The worst case cumulative scenario is predicted to arise when construction across all proposed wind farms occur sequentially (Marine Scotland, 2017c).

377. The timing and duration of construction by the projects included within the cumulative impact assessment are known with a high degree of certainty for projects that have commenced construction. However, for projects that have not started construction or received consent there is a high degree of uncertainty as to when construction may occur. For those projects which have been awarded Contracts for Difference (CfDs), i.e. NnG and Moray East, broad timescales can be estimated. For those without CfDs there is no certainty regarding timescales and a highly precautionary worst-case scenario has been applied for the cumulative assessment. This assumes that all construction activities occur sequentially and that there are no breaks in the cumulative construction period between 2020

and 2028 (Figure 8-47). This scenario will almost certainly not occur, therefore cumulative assessment outputs are considered to be very conservative.

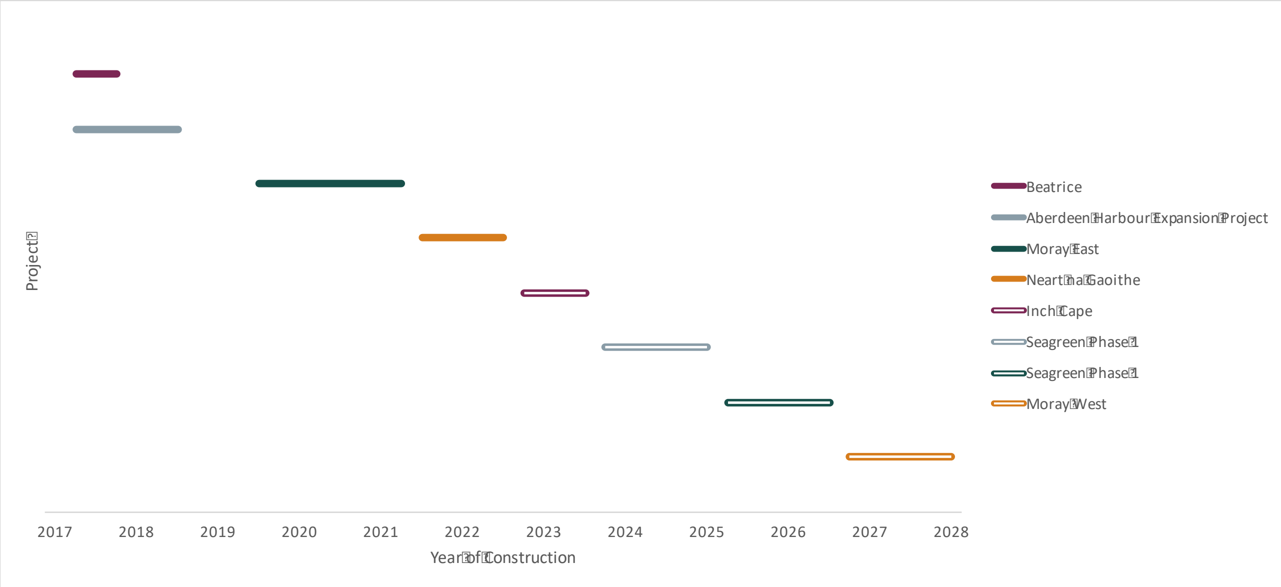


Figure 8-47: Estimated construction schedule used for cumulative population modelling

378. The following assesses the potential population level impacts on marine mammals from cumulative impacts arising from the construction of:

- Beatrice Offshore Wind Farm;
- Aberdeen Harbour Expansion Project;
- Moray East Offshore Wind Farm;
- Neart na Gaoithe Offshore Wind Farm;
- Inch Cape Offshore Wind Farm;
- Seagreen Phase 1 Alpha;
- Seagreen Phase 1 Bravo;
- Moray West Offshore Wind Farm.

8.10.12.1 Harbour porpoise

379. The results from the population modelling indicate that cumulative impacts from pile driving could cause a decrease in the annual growth rate and population size of harbour porpoise (Table 8.73).

380. The median ratio of the impacted to unimpacted annual growth rate for a cumulative sequential pile driving scenario is 0.996 after 24 years (a counterfactual of growth rate of 99.6%). The difference in the median growth rates between impacted and unimpacted populations is -0.004 (Table 8.75).

381. The median ratio of the impacted to unimpacted population for cumulative sequential pile driving is 0.904 after 24 years (a counterfactual of population size of 90.4%).

382. Based on the results from the interim PCoD model, the harbour porpoise population within the North Sea Management Unit is predicted to decrease over the next 24 years without any potential impacts from disturbance (Table 8.74, Table 8.75 and Figure 8-48). In the event that sequential pile driving occurs over a period of 11 years it is estimated that after 24 years the harbour porpoise population may be 9.7% lower compared with an unimpacted baseline population (Table 8.75).

383. Comparing the distributions of population sizes after 24 years for the unimpacted and impacted populations shows that at least 26% of the runs do not end lower than the median population size of the unimpacted population (Table 8.74).

Table 8.73: Harbour porpoise population model outputs for cumulative pile driving scenario

Harbour Porpoise			
Year	Median of the ratio of impacted to unimpacted annual growth rate	Median of the ratio of impacted to unimpacted population size	Centile for impacted population that matches the 50th centile for unimpacted population
1	0.998	0.999	0.48
6	0.995	0.975	0.37
12	0.993	0.921	0.22
18	0.994	0.910	0.25
24	0.996	0.904	0.26

Table 8.74: Estimated population size for harbour porpoise North Sea Management Unit with cumulative sequential pile driving undertaken over 11 years

Harbour Porpoise						
Cumulative sequential pile driving over 11 years						
	5th percentile		50th percentile		95th percentile	
Year	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	310,263	309,821	332,722	332,082	352,841	352,381
6	285,452	275,933	324,423	315,211	364,692	358,063
12	260,864	238,263	314,854	288,611	371,177	343,225
18	242,521	217,219	305,720	276,636	374,931	343,793
24	229,815	206,772	294,888	266,251	372,956	341,717

Table 8.75: Estimated difference in median disturbed and median undisturbed harbour porpoise growth rates and population sizes with cumulative sequential pile driving undertaken over 11 years

Harbour porpoise	Difference in median disturbed and median undisturbed annual growth rates over 24 years	Difference in median disturbed and median undisturbed population size over 24 years	
Years		No. of individuals	% change in population size
1	-0.002	-640	-0.19
6	-0.005	-9,212	-2.84
12	-0.007	-26,243	-8.33
18	-0.006	-29,084	-9.51
24	-0.004	-28,637	-9.71

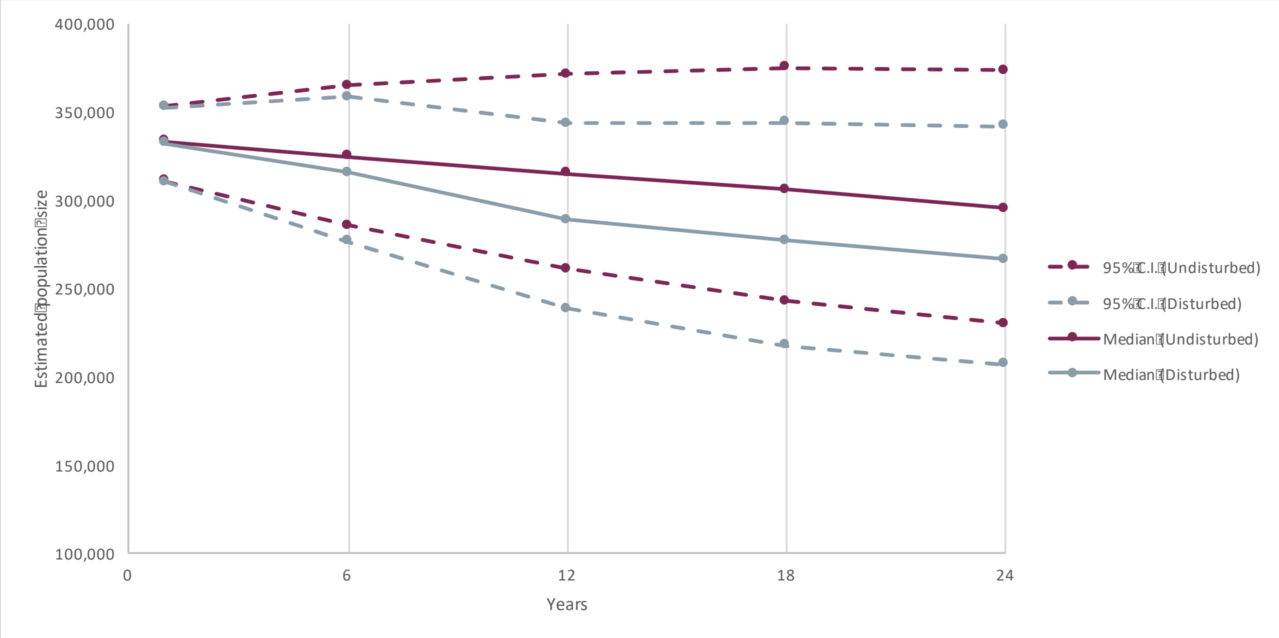


Figure 8-48: Estimated median (50th centile) and 95% C.I. for harbour porpoise North Sea Management Unit population with (disturbed) and without (undisturbed) sequential pile driving over a period of 11 years

8.10.12.2 Bottlenose dolphin

384. The results from the population modelling indicate that cumulative impacts from pile driving could cause a decrease in the annual growth rate and population size of bottlenose dolphin (Table 8.76).

385. The median ratio of the impacted to unimpacted annual growth rate for a cumulative sequential pile driving scenario is 0.973 after 24 years (a counterfactual of growth rate of 97.3%). The difference in the median growth rates between impacted and unimpacted populations is -0.027 (Table 8.78).

386. The median ratio of the impacted to unimpacted population for cumulative sequential pile driving is 0.535 after 24 years (a counterfactual of population size of 53.5%).

387. Based on the results from the interim PCoD model, the bottlenose dolphin population within the Coastal East Scotland Management Unit is predicted to increase over the next 24 years without any potential impacts from disturbance (Table 8.77 and Figure 8-49). In the event that sequential pile driving occurs over a period of 11 years it is estimated that after 24 years the bottlenose dolphin population may decrease and be 47.7% lower compared with an unimpacted baseline population (Table 8.78).

388. Comparing the distributions of population sizes after 24 years for the unimpacted and impacted populations shows that at least 1% of the runs do not end lower than the median population size of the unimpacted population (Table 8.76).

Table 8.76: Bottlenose dolphin population model outputs for cumulative pile driving scenario

Bottlenose dolphin			
Years	**Median of the ratio of impacted to unimpacted annual growth rate**	**Median of the ratio of impacted to unimpacted population size**	**Centile for impacted population that matches the 50th centile for unimpacted population**
1	0.960	0.970	0.18
6	0.966	0.828	0.04
12	0.965	0.679	0.01
18	0.968	0.588	0.01
24	0.973	0.535	0.01

Table 8.77: Estimated population size for bottlenose dolphin Coastal East Scotland Management Unit with cumulative sequential pile driving undertaken over 11 years

Bottlenose dolphin						
Cumulative sequential pile driving over 11 years						
	5th percentile		**50th percentile**		**95th percentile**	
Years	**Undisturbed**	**Disturbed**	**Undisturbed**	**Disturbed**	**Undisturbed**	**Disturbed**
1	182	156	200	192	216	224
6	176	84	212	172	252	270
12	178	46	228	149	284	278
18	180	38	244	136	320	296
24	180	36	256	134	354	304

Table 8.78: Estimated difference in median disturbed and median undisturbed bottlenose dolphin growth rates and population sizes with cumulative sequential pile driving undertaken over 11 years

Bottlenose dolphin	**Difference in median disturbed and median undisturbed annual growth rates over 24 years**	**Difference in median disturbed and median undisturbed population size over 24 years**	
Years		**No. of individuals**	**% change in population size**
1	-0.041	-8	-4.0%
6	-0.035	-40	-18.9
12	-0.035	-79	-34.6
18	-0.032	-108	-44.3
24	-0.027	-122	-47.7

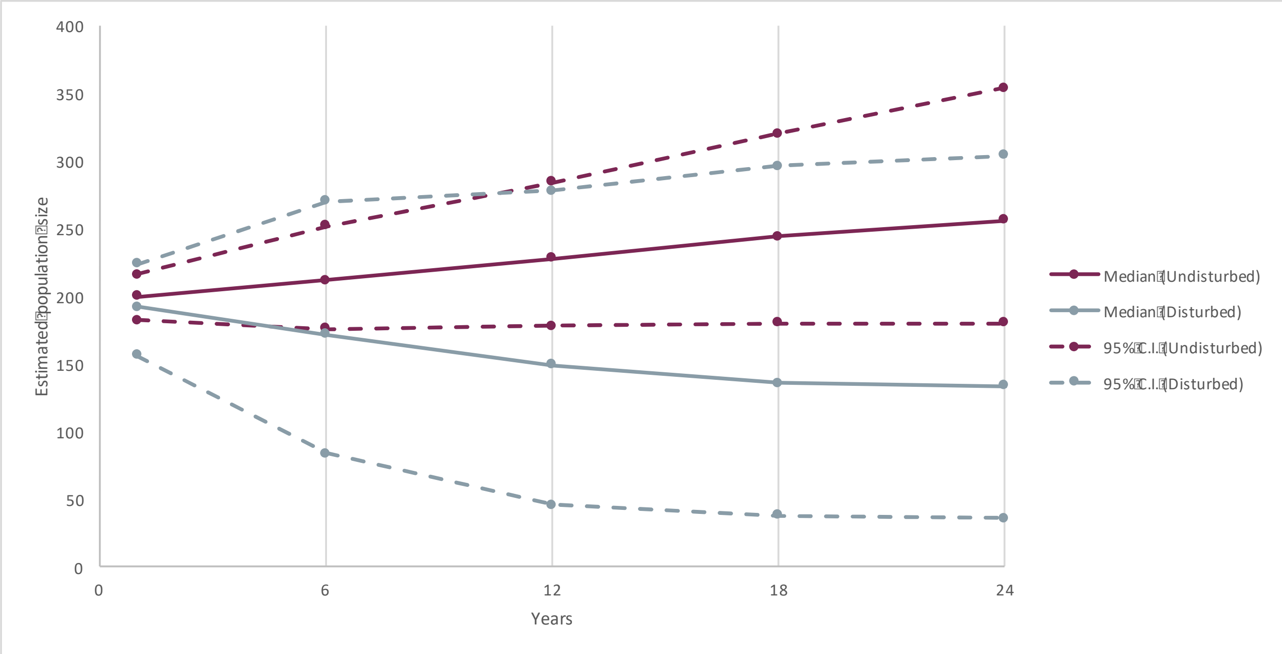


Figure 8-49: Estimated median (50th centile) and 95% C.I. for bottlenose dolphin Coastal East Scotland Management Unit population with (disturbed) and without (undisturbed) sequential pile driving over a period of 11 years

8.10.12.3 Minke whale

389. The results from the population modelling indicate that cumulative impacts from pile driving could cause a decrease in the annual growth rate and population size of minke whale (Table 8.79).

390. The median ratio of the impacted to unimpacted annual growth rate for a cumulative sequential pile driving scenario is 0.991 after 24 years (a counterfactual of growth rate of 99.1%). The difference in the median growth rates between impacted and unimpacted populations is -0.009 (Table 8.81).

391. The median ratio of the impacted to unimpacted population for cumulative sequential pile driving is 0.802 after 24 years (a counterfactual of population size of 80.2%).

392. Based on the results from the interim PCoD model, the minke whale population within the North Sea Management Unit is predicted to remain relatively stable over the next 24 years without any potential impacts from disturbance. However, disturbance impacts arising from potential cumulative sequential pile driving over a period of 11 years could cause a decrease in the minke whale CGNS Management Unit population (Table 8.80 and Figure 8-50). In the event that sequential pile driving occurs over a period of 11 years it is estimated that after 24 years the minke whale population may be 19% lower compared with the unimpacted baseline population (Table 8.81).

393. Comparing the distributions of population sizes after 24 years for the unimpacted and impacted populations shows that at least 2% of the runs do not end lower than the median population size of the unimpacted population (Table 8.79).

Table 8.79: Minke whale population model outputs for cumulative pile driving scenario

Minke whale			
	Median of the ratio of impacted to unimpacted annual growth rate	Median of the ratio of impacted to unimpacted population size	Centile for impacted population that matches the 50th centile for unimpacted population
Years	Single pile driving	Single pile driving	Single pile driving
1	0.993	0.994	0.43
6	0.987	0.929	0.12
12	0.986	0.845	0.02
18	0.989	0.819	0.02
24	0.991	0.802	0.02

Table 8.80: Estimated population size for minke whale CGNS Management Unit with cumulative sequential pile driving undertaken over 11 years

Minke whale						
Cumulative sequential pile driving over 11 years						
	5th percentile		50th percentile		95th percentile	
Years	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	11,066	11,002	11,843	11,764	12,482	12,410
6	10,540	9,582	11,738	10,828	12,945	12,174
12	10,245	8,296	11,671	9,804	13,308	11,694
18	9,918	7,917	11,612	9,542	13,308	11,401
24	9,672	7,598	11,500	9,319	13,733	11,515

Table 8.81: Estimated difference in median disturbed and median undisturbed minke whale growth rates and population sizes with cumulative sequential pile driving undertaken over 11 years

Minke whale	Difference in median disturbed and median undisturbed annual growth rates over 24 years	Difference in median disturbed and median undisturbed population size over 24 years	
Years		**No. of individuals**	**% change in population size**
1	-0.007	-79	-0.7
6	-0.013	-910	-7.8
12	-0.014	-1,867	-16.0
18	-0.011	-2,070	-17.8
24	-0.009	-2,181	-19.0

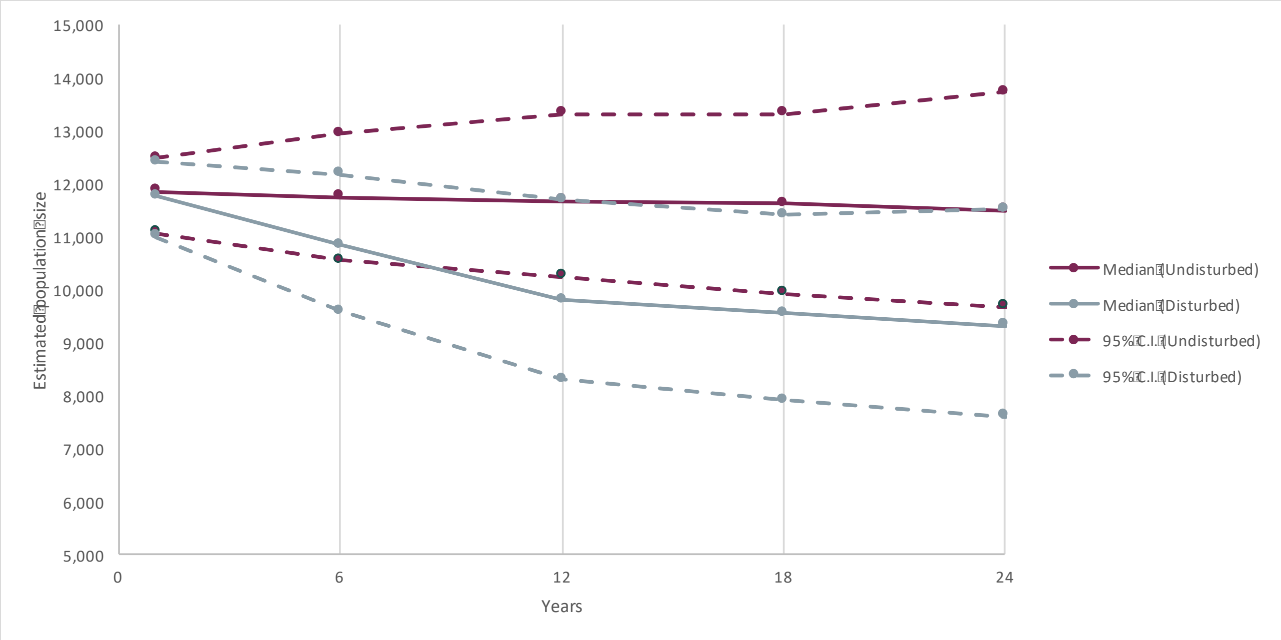


Figure 8-50: Probability of a decline in the population of minke whales within the CGNS Management unit over 24 years with and without cumulative pile driving events

8.10.12.4 Grey seal

394. The results from the population modelling indicate that cumulative impacts from pile driving could cause a decrease in the annual growth rate and population size of grey seal (Table 8.82).

395. The median ratio of the impacted to unimpacted annual growth rate for a cumulative sequential pile driving scenario is 0.985 after 24 years (a counterfactual of growth rate of 98.5%). The difference in the median growth rates between impacted and unimpacted populations is -0.015 (Table 8.84).

396. The median ratio of the impacted to unimpacted population for cumulative sequential pile driving is 0.707 after 24 years (a counterfactual of population size of 70.7%).

397. Based on the results from the interim PCoD model, the grey seal population within the East Coast Management Area is predicted to increase over the next 24 years without any potential impacts from disturbance. However, disturbance impacts arising from potential cumulative sequential pile driving over a period of 11 years could cause a decrease in the grey seal ECMA population (Table 8.83 and Figure 8-51). In the event that sequential pile driving occurs over a period of 11 years it is estimated

that after 24 years the grey seal population may be 30.8% lower compared with the unimpacted baseline population (Table 8.84).

398. Comparing the distributions of population sizes after 24 years for the unimpacted and impacted populations shows that at least 3% of the runs do not end lower than the median population size of the unimpacted population (Table 8.82).

Table 8.82: Grey seal population model outputs for cumulative pile driving scenario

Grey seal			
	Median of the ratio of impacted to unimpacted annual growth rate	Median of the ratio of impacted to unimpacted population size	Centile for impacted population that matches the 50th centile for unimpacted population
Years	Single pile driving	Single pile driving	Single pile driving
1	0.995	0.996	0.45
6	0.981	0.908	0.09
12	0.973	0.739	0.01
18	0.980	0.715	0.01
24	0.985	0.707	0.03

Table 8.83: Estimated population size for Grey seal ECMA with cumulative sequential pile driving undertaken over 11 years

Grey seal						
Cumulative sequential pile driving over 11 years						
	5th percentile		50th percentile		95th percentile	
Years	Undisturbed	Disturbed	Undisturbed	Disturbed	Undisturbed	Disturbed
1	9,118	9,068	9,692	9,635	10,284	10,222
6	8,772	7,300	10,042	8,953	11,360	10,532
12	8,624	5,215	10,427	7,519	12,557	9,963
18	8,524	5,135	10,876	7,577	13,652	10,329
24	8,567	5,059	11,260	7,793	14,902	11,100

Table 8.84: Estimated difference in median disturbed and median undisturbed grey seal growth rates and population sizes with cumulative sequential pile driving undertaken over 11 years

Grey seal	Difference in median disturbed and median undisturbed annual growth rates over 24 years	difference in median disturbed and median undisturbed population size over 24 years	
Years		No. of individuals	% change in population size
1	-0.006	-57	-0.6
6	-0.019	-1,089	-10.8
12	-0.027	-2,908	-27.9
18	-0.020	-3,299	-30.3
24	-0.015	-3,467	-30.8

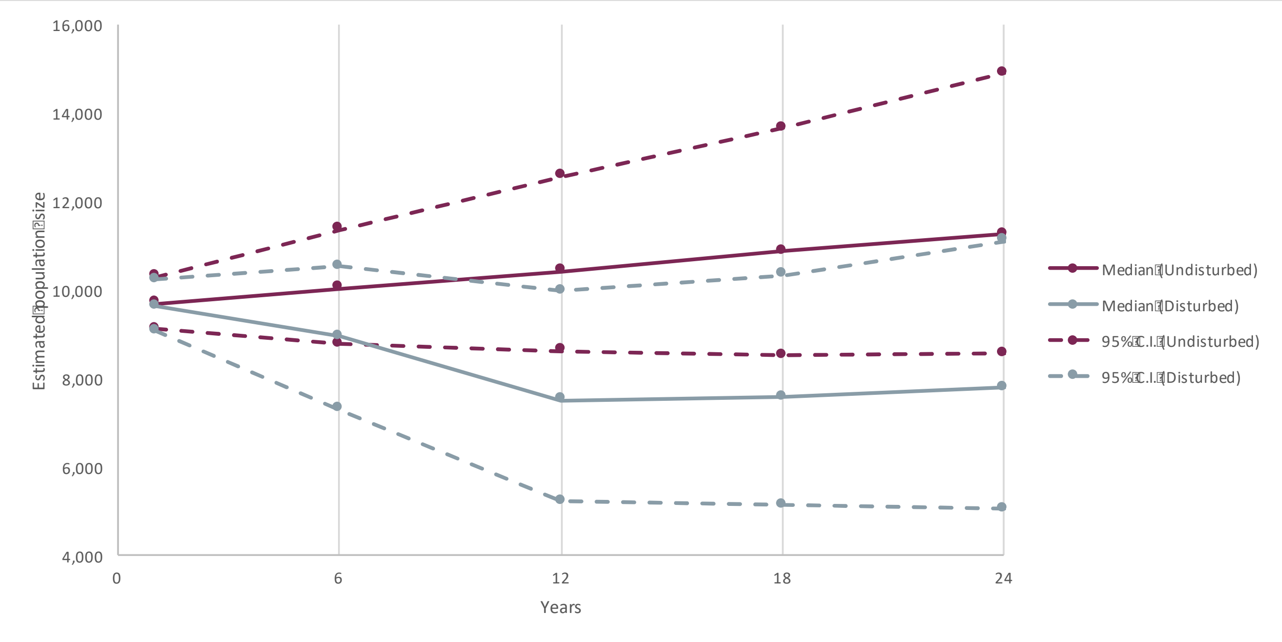


Figure 8-51: Probability of a decline in the population of grey seals within the East Coast and North-east England Management Areas over 24 years with and without cumulative pile driving events

8.10.12.5 Harbour seal

399. The interim PCoD model for harbour seals would not run successfully without reporting an error. The reasons for this error are unclear. It is possible that this is due to a combination of factors, including the number of animals predicted to experience PTS and behavioural disturbance, the small starting size of the management unit population, and the demographic parameters for the species which mean that the population goes to extinction within 24 years even without additional impact from piling at east coast wind farm and infrastructure projects. Consequently, population modelling was not able to be used to assess potential cumulative impacts on harbour seal. However, the population modelling undertaken for the Project alone predicted a significant decline in the harbour seal population without any possible impacts from pile driving (e.g. Table 8.62 and Figure 8-44). It is predicted that similar reductions in the harbour seal population will occur with potential cumulative impacts and that the impacts will not affect this decline to a significant extent.

8.10.13 Cumulative Construction Phase Impacts

400. The following section assesses the potential cumulative impacts on marine mammals from pile driving activities. The assessment is based on a number of precautionary assumptions including the noise modelling outputs based on cumulative sound exposure levels (which predicts the greatest area of impact) and population modelling assuming worst-case sequential pile driving schedules, with uninterrupted continuous pile driving over 11 years. The results are therefore considered to be precautionary.

8.10.13.1 Harbour porpoise

401. The results from the noise modelling indicate that the number of harbour porpoise at risk of the onset of PTS over a period of 11 years is 359 individuals and therefore an estimated 0.1% of the Management Unit population may be impacted (Table 8.71). It is estimated that the number of harbour porpoise that may be disturbed by any one wind farm project ranges from 1,177 and 3,191 individuals (Table 8.72). At most, at any one time, no more than 0.9% of the Management Unit population may be disturbed. Consequently, the noise modelling undertaken indicates that a relatively small proportion of the harbour porpoise Management Unit population may be at risk of the onset of PTS or disturbance.

402. The results from the population modelling indicate that cumulative impacts will have a relatively very small impact on the annual growth rate of harbour porpoise with difference of -0.004 after 24 years. However, the population modelling also indicates that should cumulative pile driving be undertaken sequentially over a period of 11 years that this could result in a 9.7% difference in the harbour porpoise population after 24 years (Table 8.75).

403. The population of harbour porpoises across the North Sea has remained largely stable since the first SCANS surveys, with 289,000 in 1994, 355,000 in 2005 and 345,000 in 2016 (Hammond *et al*. 2017). The predicted impacts on the population from cumulative pile driving indicate that the population, if undisturbed, will decline over the next 24 years to an estimated population size of 294,888 (229,815 – 372,956) individuals compared with 266,251 (206,772 – 341,717) individuals if there is cumulative pile driving; a potential difference of 28,637 (23,043 – 31,239) individuals (Table 8.74).

404. Although the effects on the annual growth rate are small, the potential cumulative impacts may be measurable and the results from the population modelling indicate a potential decline in the harbour porpoise population. The precautionary assumptions made and the uncertainties within model, particularly when predicting changes in populations over a 24 year period suggest that the future population may not be as impacted as indicated.

405. Based on the estimated differences in the harbour porpoise population after 24 years in the event sequential pile driving occurs, it is concluded that the sensitivity of harbour porpoise population is low, the magnitude of the impacts are medium and the significance of effect is **Minor**. Consequently, the impacts from cumulative pile driving are not significant.

8.10.13.2 White-beaked dolphin

406. It is not possible to undertake population modelling on white-beaked dolphin using interim PCoD as data on white-beaked dolphin required to run a population model are not available. Therefore, it is not possible to estimate population level effects on this species from sequential pile driving over a period of 11 years. However, the extent of any impacts that could cause the onset of PTS from pile driving at any of the proposed developments within the Firths of Forth and Tay are estimated to be very small and all less than 0.001 km^2 (Table 8.70) and the total number of individuals at risk of PTS across all developments is estimated to be less than eight individuals (Table 8.71) Similarly, the number of individuals predicted to be disturbed by each of the four developments within the Firths of Forth and Tay are broadly similar and relatively low, impacting on an estimated 177 individuals across a period of six years (Figure 8-47 and Table 8.72). Over any one year an estimated 0.2% of the CGNS Management Unit population and 0.3% of the regional population may be impacted.

407. The population is in favourable condition and it is predicted that the relatively low impact on the population will not affect its status.

408. It is concluded that the sensitivity of white-beaked dolphin population is low, the magnitude of the impacts are low and the significance of effect is **Minor**. Consequently, the impacts from cumulative pile driving are not significant.

8.10.13.3 Bottlenose dolphin

409. The results from the noise modelling indicate that the number of bottlenose dolphins at risk of the onset of PTS over a period of 11 years is no more than eight individuals and therefore an estimated 4% of the Management Unit population may be impacted (Table 8.71). It is estimated that the number of bottlenose dolphins that may be disturbed by any one wind farm development ranges from between 1 and 19 individuals (Table 8.72). At most, at any one time, no more than 1.0% of the Management Unit population may be disturbed by developments within the Firths of Forth and Tay. A higher proportion of the Management Unit population may be affected by developments within the Moray Firth with up to 9.7% of the population disturbed.

410. The results from the population modelling indicate that cumulative impacts will have a relatively small impact on the annual growth rate of bottlenose dolphin with a difference of -0.027after 24 years. However, the population modelling also indicates that should cumulative pile driving be undertaken sequentially over a period of 11 years that this could result in a 47.7% difference in the bottlenose dolphin population after 24 years (Table 8.78). The potential difference in the bottlenose dolphin population size of 47.7% after 24 years would be significant if it were to occur.

411. Based on the results from the population modelling, NnG on its own will not have a population level effect on bottlenose dolphin (See Table 8.48 and Table 8.50) and therefore the Project will not have a measurable, if any, cumulative impact on the bottlenose dolphin population. Although there is predicted to be a reduction in the population from cumulative impacts the Project does not significantly contribute to this predicted impact.

412. Based on the estimated decrease in the bottlenose dolphin population from potential cumulative impacts, it is concluded that the sensitivity of bottlenose dolphin population is high, and the magnitude of any cumulative impacts from construction noise impacts will be high. The significance of any effect is therefore assessed to be **major** and the potential effect from cumulative pile driving noise on bottlenose dolphin is significant. However, the Project does not have an impact on the population on its own and therefore does not have a cumulative impact on bottlenose dolphin Management Unit population.

8.10.13.4 Minke whale

413. The results from the noise modelling indicate that the number of minke whales at risk of the onset of PTS over a period of 11 years is 128 individuals and therefore an estimated 1.1% of the CGNS Management Unit population may be impacted (Table 8.71). It is estimated that the number of minke whales that may be disturbed by any one wind farm project ranges from between 77 and 177 individuals (Table 8.72). At most, at any one time, no more than 1.5% of the Management Unit population may be disturbed. Consequently, the noise modelling undertaken indicates that a relatively small proportion of the minke whale Management Unit population may be at risk of the onset of PTS or disturbance.

414. The results from the population modelling indicate that cumulative impacts will have a relatively very small impact on the annual growth rate of minke whale with a difference of -0.009 after 24 years. However, the population modelling also indicates that should cumulative pile driving be undertaken sequentially over a period of 11 years that this could result in a 19% difference in the minke whale population after 24 years (Table 8.81).

415. The predicted impacts on the minke whale population from cumulative pile driving indicate that CGNS Management Unit population may, if undisturbed, remain relatively stable over the next 24 years with

an estimated population size of 11,500 (9,672 – 13,733) individuals compared with 9,319 (7,598 – 11,513) individuals if there is cumulative pile driving; a potential difference of 2,181 (2,074 – 2,220) individuals (Table 8.80).

416. Although the effects on the annual growth rate are small, the potential cumulative impacts may be measurable and the results from the population modelling indicate a potential decline in the minke whale population.

417. Minke whales do not breed in UK waters and therefore potential impacts from pile driving are unlikely to affect survival. However, they are capital breeders and rely on stored energy reserves obtained during the summer to breed in their wintering grounds south of 30ºN. Displacement or disturbance during the breeding season could affect the rate at which energy reserves are accumulated, with a subsequent impact on individual fertility (Harwood and King, 2014). The relatively low number of sightings recorded during baseline surveys, with only 18 sightings from three years of surveys, indicates that the Wind Farm Area is a relatively unimportant area for minke whales. Their broad distribution across the North Sea indicates that displaced minke whales will be able to relocate to other areas to feed and the impacts from displacement will be limited. In the event that an ADD is used this will reduce the risk of physical injury occurring to minke whales (See Section 8.11.2)

418. Based on the estimated differences in the minke whale population after 24 years in the event sequential pile driving occurs, it is concluded that the sensitivity of minke whale population is low, the magnitude of the impacts is high and the significance of the effect is **Moderate**. Consequently, the impacts from cumulative pile driving are significant.

8.10.13.5 Grey seal

419. The results from the noise modelling indicate that the number of grey seals at risk of the onset of PTS over a period of 11 years is five individuals and therefore an estimated 0.05% of the ECMA population may be impacted (Table 8.71). It is estimated that the number of grey seals that may be disturbed by any one wind farm project ranges from between 821 and 1,087 individuals (Table 8.72). At most, at any one time, no more than 11.3% of the Management Unit population may be disturbed.

420. The results from the population modelling indicate that cumulative impacts will have a relatively very small impact on the annual growth rate of grey seal with a difference of -0.015 after 24 years. However, the population modelling also indicates that should cumulative pile driving be undertaken sequentially over a period of 11 years that this could result in a 30.8% difference in the grey seal population after 24 years (Table 8.84).

421. The predicted impacts on the grey seal population from cumulative pile driving indicate that the ECMA grey seal population may, if undisturbed, increase over the next 24 years with an estimated population size of 11,260 (8,567 – 14,902) individuals compared with 7,793 (5,059 – 11,100) individuals if there is cumulative pile driving; a potential difference of 3,467 (3,508 – 3,802) individuals (Table 8.83).

422. Although the effects on the annual growth rate are small, the potential cumulative impacts may be measurable and the results from the population modelling indicate a potential decline in the grey seal population.

423. Based on the estimated differences in the grey seal population after 24 years in the event sequential pile driving occurs, it is concluded that the sensitivity of grey seal population is medium, the magnitude of the impacts is high and the significance of the effect is **Major**. Consequently, the impacts from cumulative pile driving are significant.

8.10.13.6 Harbour seal

424. The harbour seal population within the ECMA has declined significantly in recent years (see Figure 8-25) and at its current trajectory the population is predicted to become extinct within 24 years. The cumulative impacts from pile driving will not significantly alter the predicted on-going population decline. It is therefore concluded that the sensitivity of the harbour seal population is high, although

the magnitude of the impacts on the population are negligible and the significance of the effect is **Minor**. Consequently, the impacts from cumulative pile driving are not significant.

8.11 Mitigation and Monitoring

425. As outlined in Section 8.9.1, embedded mitigation has been incorporated in to the Project design. No later than six months prior to the start of construction a PEMP, CMS and Pile Driving Strategy will be submitted to the Scottish Ministers. The submissions will contain details of the pile driving locations, the maximum hammer energy to be used and details of any soft-start procedures to be implemented. They will also include agreed mitigation measures. Approval of these submissions is required prior to the commencement of any construction works.

426. No likely significant effects have been identified that require defined mitigation measures, however potential mitigation that could be included to reduce not significant, potential effects further and their likely effectiveness are described below:

8.11.1 Marine Mammal Observers and Passive Acoustic Monitoring

427. The use of a Marine Mammal Observer (MMOb) and Passive Acoustic Monitoring (PAM) are recognised to be effective means of minimising the risk of a marine mammal within 500 m of the pile at the commencement of pile driving and are therefore recognised to be suitable mitigation in ensuring marine mammals are not present in an area where they could be at risk of traumatic physical injury and, in the case of dolphins, PTS.

8.11.2 Acoustic Deterrent Devices (ADD)

428. The use of ADD has the potential to reduce the risk of marine mammals from being within the area within which physical injury could occur at the start of pile driving activities and may be an alternative approach to using MMOb and PAM. ADDs produce relatively high levels of sound in the water column with the aim of causing an avoidance behaviour in marine mammals and discouraging them from a particular area. The extent and duration of any displacement varies across devices and the behaviour of the individual species, with ADDs having less of an effect where marine mammals may be attracted to a site, e.g. seals and fish farms. However, in areas where there is less of an attraction, the use of ADDs have been found to be effective at temporarily displacing marine mammals from an area.

429. The Lofitech seal scarer ADD operates at a frequency of between 13.5 and 15 kHz with a signal duration of 0.5 seconds repeated randomly between <1 and 40 seconds. The sound source level is 189 dB re 1m Pa @ 1 m.

430. Two studies have been undertaken on the effectiveness of using the Lofitech ADD to displace harbour porpoise (Brandt *et al.* 2012 and 2013). Although the studies showed slightly differing results with one recording a harbour porpoise as close 798 m of an active ADD and the other showing that all harbour porpoise avoided the area within 1.9 km and for half the time between 2.1 and 2.4 km. They both reported a strong avoidance behaviour by harbour porpoise to the ADDs with an effective range of between 1.3 km and 1.9 km. The effects of avoidance lasted approximately six hours. It is recognised that the effects of ADD on harbour porpoise may be site specific but the results from these studies indicate that an ADD may effectively mitigate against the risk of harbour porpoise occurring in the area of risk of PTS at the onset of and during pile driving.

431. Studies undertaken on minke whales indicate that ADD's are effective at reducing the risk of minke whales being within an area at which the onset of PTS could occur. The studies showed that when an ADD was operating minke whales increased swimming speeds to of 7.4 kmh^{-1} and moved directly away from the sound source (McGarry *et al*. 2017).

432. The effectiveness of ADDs in causing avoidance behaviour in dolphins and minke whales is less well understood. However, recent studies on the effectiveness of ADD's on minke whale indicate that the

use of ADD on these species is predicted to have a similar deterrent effect. Furthermore, the physical impacts on dolphins are not predicted to occur beyond a few metres and therefore the use of a MMOb and PAM would be effective mitigation. Baseline surveys recorded relatively few minke whales and therefore there is less risk of an impact on minke whales.

433. Should an ADD be used it will be operated at the pile driving location for a period of time, typically approximately 20 minutes prior to the start of pile driving. It will be turned off once pile driving has started. In the event that the use of an ADD is planned, discussions with the Marine Scotland and SNH would be held.

8.11.3Soft-start procedures

434. Soft-start procedures for pile driving are considered to be embedded mitigation (See Section 8.9.1). The hammer energy used to install each pile will be increased slowly over a period of time. The initial hammer energy used at the start of each pile driving activity will be approximately 20% of the maximum possible hammer energy and will last for an estimated 53% of the total pile driving duration. Following this, the hammer will increase to 57% of the maximum hammer capacity for 40% of the total pile duration. This soft-start will allow marine mammals and their prey time to move away from the pile driving and reduce the risk of physical injury occurring.

8.11.4 Monitoring

435. A detailed monitoring programme will be developed through consultation with Marine Scotland and SNH. NnGOWL will also participate in regional and national fora such as the Forth and Tay Regional Advisory Groups (FTRAG) and the Scottish Strategic Marine Environment Group (SSMEG), through which a strategic monitoring plan will be developed.

436. At least six months prior to the start of the development a Project Environmental Management Plan (PEMP) will be submitted to the Scottish Ministers within which details of the planned monitoring to be undertaken will be presented. A Marine Mammal Monitoring Plan (MMMP) will be developed and agreed with Marine Scotland and SNH prior to the start of construction activities.

437. Details of the monitoring that could be undertaken are yet to be confirmed. However, potential monitoring could include:

- Measuring sound levels during pile driving activities. This would help improve our understanding of the sound levels produced from pile driving.
- Monitoring the responses of marine mammals to pile driving noise. The species that effective monitoring could be undertaken and the methods to be used will be agreed with Marine Scotland and SNH. However, it is envisaged that monitoring the responses to pile driving on bottlenose dolphins and harbour porpoise could be undertaken through the use of passive acoustic monitoring. This could improve our understanding of the potential impacts on marine mammals and confirm the predictions made within the Environmental Statement.

8.12 Summary of Residual Effects

438. This chapter has assessed the potential effects on marine mammals of the construction, operation and decommissioning of the Project, both in isolation and cumulatively. Where significant effects were identified, additional mitigation has been considered and incorporated into the assessment. Table 8.85 summarises the impact determinations discussed in this chapter and presents the post-mitigation residual significance.

Table 8.85: Summary of predicted impacts of the Project

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Construction			
Pile driving construction noise	Harbour Porpoise: Minor, adverse White-beaked dolphin: Negligible, adverse Bottlenose Dolphin: Minor, adverse Minke Whale: Minor, adverse Grey Seal: Negligible, adverse Harbour Seal: Minor, adverse	Use of MMOs, PAM systems, ADDs and soft-start procedures will be considered and agreed with MS-LOT, to further mitigate any risk of residual effect.	Harbour Porpoise: Minor, adverse White-beaked dolphin: Negligible, adverse Bottlenose Dolphin: Minor, adverse Minke Whale: Minor, adverse Grey Seal: Negligible, adverse Harbour Seal: Minor, adverse
Drilling construction noise	All species: negligible	n/a	All species: negligible
Noise from pre-construction geophysical survey work	All species: negligible, adverse	n/a	All species: negligible, adverse
Disturbance from noise and particle motion from the HDD site pipe works	All species: Minor, adverse	n/a	All species: Minor, adverse
Operation			
Aircraft and helicopter disturbance	All species: Negligible, adverse	n/a	All species: Negligible, adverse
Cumulative Effects			
Pile driving construction noise	Harbour Porpoise: Minor, adverse White-beaked dolphin: Minor, adverse Bottlenose Dolphin: Major, adverse Minke Whale: Moderate, adverse Grey Seal: Major, adverse Harbour Seal: Minor, adverse	Use of MMOs, PAM systems, ADDs and soft-start procedures will be considered and agreed with MS-LOT, to further mitigate any risk of residual effect.	Harbour Porpoise: Minor, adverse White-beaked dolphin: Minor, adverse Bottlenose Dolphin: Major, adverse Minke Whale: Moderate, adverse Grey Seal: Major, adverse Harbour Seal: Minor, adverse

8.13 References

- Anderwald, P., and Evans, P.G.H. (2010). *Cetaceans of the East Grampian Region. (*Sea Watch Foundation, August 2010).
- Arso Civil, M. (2014). *Population Ecology of Bottlenose Dolphins (Tursiops truncatus) off the East Coast of Scotland.* (PhD Thesis. University of St Andrews).
- Asselin, S., Hammill, M.O. and Barrette, C. (1993). *Underwater vocalisations of ice breeding grey seals*, (Canadian Journal of Zoology, 71: 2211-2219).
- Bach, S.S. Skov, H. and Piper, W. (2010). *Acoustic Monitoring of Marine Mammals around Offshore Platforms in the North Sea and Impact Assessment of Noise from Drilling Activities*. (Society of Petroleum Engineers SPE 126651-PP).
- Booth, C.G., Harwood, J., Plunkett, R, Mendes, S. and Walker, R. (2017). *Using the Interim PCoD framework to assess the potential impacts of offshore wind developments in Eastern English Waters on harbour porpoises in the North Sea.* (Natural England Joint Report, Number 024 York).
- Brandt, M. J., Höschle, C., Diederichs, A., Betke, K., Matuschek, R., Witte, S. and Nehls, G. (2012). *Far-reaching effects of a seal scarer on harbour porpoises, Phocoena phocoena.* (Aquatic Conservation: Marine and Freshwater Ecosystems 23(2): 222-232).
- Brandt, M.J., Höschle, C., Diederichs. A., Betke, K., Matuschek, R. and Nehls, G. (2013). *Seal scarers as a tool to deter harbour porpoises from offshore construction sites.* (Marine Ecology Progress Series 475:291-302).
- Brandt, M.J., Dragon, A., Diederichs, A., Schubert, A,. Kosarev, V., Nehls, G., Wahl, V., Michalik, A., Braasch, C., Hinz, C., Katzer, D., Todeskino, D., Gauger, M., Laczny, M.,and Piper W. (2016). *Effects of offshore pile driving on harbour porpoise abundance in the German Bight*. (Report prepared for Prepared for Offshore Forum Windenergie).
- Brasseur, S., Aarts, G., Meesters, E., van Polanen-Petel, T., Dijkman, E., Cremer, J. and Reijnders, P. (2010). *Habitat preferences of harbour seals in the Dutch coastal area: analyses and estimate of effects of offshore wind farms* (Report number: OWEZ R 252 T1 20100929 p 55).
- Brereton, T., Kitching, M., Browne, A. and Scott, C. (2013). *Recent surveys to evaluate the Importance of the Farne Deeps and surrounding waters off the Northumberland coast for white-beaked dolphin and other cetaceans and seabirds of Conservation Concern.* (MarineLife).
- Brookes, K. (2017). The East Coast Marine Mammal Acoustic Study data. doi: 10.7489/1969-1. https://data.marine.gov.scot/dataset/east-coast-marine-mammal-acoustic-study.
- Brown, E.G. and Pierce G.J. (1997). *Diet of harbour seals at Mousa, Shetland during the third quarter of 1994.* (Journal of Marine Biological Association 77: 539-555).
- Camphuysen, C.J., Fox, T., Leopold, M.F. and 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).
- Canning, S.J., Santos, M.B., Reid, R.J., Evans, P.G.H., Sabin, R.C., Bailey, N., and Pierce, G.J. (2008). *Seasonal distribution of white beaked dolphins (Lagenorhynchus albirostris) in UK waters with new information on diet and habitat use*. (Journal of the Marine Biological Association of the UK, 88(6): 1159 – 1166)
- Carstensen, J., Henriksen, O.D. & Teilmann, J. (2006). *Impacts of offshore wind farm construction on harbour porpoises: acoustic monitoring of echolocation activity using porpoise detectors (T-PODs). (*Marine Ecology-Progress Series, 321: 295-308).
- Culik, B. (2010). *Odontocetes: The toothed whales: Lagenorhynchus albirostris.* (UNEP/CMS Secretariat, Bonn, Germany.) http://www.cms.int/sites/default/files/publication/Odontocete_poster_3_0_0.pdf

- Cheney, B., Thompson, P.M., Ingram, S.N., Hammond, P.S., Stevick, P.T., Durban, J.W., Culloch, R.M., Elwen, S.H., Mandleberg, l., Janik, V.M., Quick, N.J., Islas-Villanueva, V., Robinson, K.P., Costa, M., Eisfeld, S.M., Walters, A., Phillips, C., Weir, C.R., Evans, P.G.H., Anderwald, P., Reid, R.J., Reid, J.B. and Wilson, B. (2013). *Integrating multiple data sources to assess the distribution and abundance of bottlenose dolphins Tursiops truncatus in Scottish waters.* (Mammal Review, 43: 71-88).
- Clark, N. (2005). *The Spatial and Temporal Distribution of the Harbour Porpoise (P. phocoena) in the Southern Outer Moray Firth, NE Scotland*. (Unpublished Master of Science Thesis. University of Bangor).
- Cook, A.S.C.P. and Robinson, R.A. (2017). Towards a framework for quantifying the population-level consequences of anthropogenic pressures on the environment: The case of seabirds and windfarms. *Journal of Environmental Management* 190: 113 – 121.
- Dähne, M., Gilles, A. and Lucke K. (2013*). Effects of pile driving on harbour porpoises (Phocoena phocoena) at the first offshore wind farm in Germany*. (Environmental Research Letters 8:025002. doi: 10.1088/1748-9326/8/2/ 025002).
- David, J.A. (2006). *Likely sensitivity of bottlenose dolphins to pile driving noise*. (Water and Environment Journal 20: 48–54)
- Defra (2005). *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, Department for Environment, Food and Rural Affairs).
- Defra (2015). *An analysis of potential broad-scale impacts on harbour porpoise from proposed pile driving activities in the North Sea*. (Report of an expert group convened under the Habitats and Wild Birds Directives – Marine Evidence Group).
- Duck, C. (2010). *Charting Progress 2 Healthy and Biological Diverse Seas Feeder Report: Section 3.5: Seals.* In Frost, M & Hawkridge, J (eds) UKMMAS (2010) *Charting Progress 2 Healthy and Biological Diverse Seas Feeder Report.* (Published by Department for Environment Food and Rural Affairs (DEFRA) on behalf of UKMMAS. p506-539).
- Duck, C., and Morris, C. D. (2012). *Grey seal pup production in Britain in 2012: First use of a digital system*. In: (Scientific Advice on Matters Related to the Management of Seal Populations: 2013. SCOS (Special Committee on Seals)).
- Duck, C., Morris C. and Thompson, D. (2016). *The status of UK harbour seal populations in 2015, including summer counts of grey seals*. (Briefing Papers for SCOS 16/04. In: Scientific Advice on Matters Related to the Management of Seal Populations: 2015. SCOS (Special Committee on Seals)).
- EC (2010). *Wind Energy Developments and Natura 2000 sites*. (Guidance Document. European Commission, 2010).
- European Commission (2005). *Note to the Habitats Committee: Assessment, monitoring and reporting of conservation status – Preparing the 2001-2007 report under Article 17 of the Habitats Directive. Annex C: Assessing conservation status of a species*. (European Commission DocHab-04-03/03 rev.3).
- Edrén, S., Andersen, S., Teilmann, J., Carstensen, J., Hardes, P.B., Dietz, R. and Millar, L.A. (2010). *The effect of a large Danish Offshore wind farm on harbor and grey seal haul-out behavior. (*Marine Mammal Science, 26(3), 614-634).
- Farcas, A., Thompson, P. M. and Merchant. N. D. (2016). *Underwater noise modelling for environmental impact assessment.* (Environmental Impact Assessment Review 57:114–122).
- Finneran, J.J., Carder, D.A., Schlundt, C.E. and Ridgway, S.H. (2005). *Temporary threshold shift in bottlenose dolphins (Tursiops truncatus) exposed to mid-frequency tones. (*J. Acoust. Soc. Am. 2005 Oct; 118(4): 2696-705).

- Gedamke, J., Costa, D.P., and Dunstan, A. (2001). *Localization and visual verification of a complex minke whale vocalization.* (J. Acoust. Soc. Am. 109(6), 3038–304710.1121/1.1371763).
- Genesis (2017a). Neart na Gaoithe Offshore Wind Farm Noise Modelling. Technical Report for Neart na Gaoithe Offshore Wind Limited. J74524A-A-TN-00001.
- Genesis (2017b) interim PCoD nose modelling results
- Gordon, J. (2012). *Marine Ecological Research, Marine Mammal Acoustic and Visual Surveys - Analysis of Neart Na Gaoithe data.* (Unpublished Report for Mainstream Ltd).
- Götz, T. and Janik V.M. (2011). *Repeated elicitation of the acoustic startle reflex leads to sensitisation in subsequent avoidance behaviour and induces fear conditioning*. (Neuroscience 2011, 12:30).
- Greene, C.R. (1986). *Underwater sounds from the semi-submersible drill rig SEDCO 708 drilling in the Aleutian Islands, Section 1*. (American Petroleum Institute 4438, 1986: 69pp).
- Greene, R. (1987). *Characteristics of oil industry dredge and drilling sounds in the Beaufort Sea*. (Journal of the Acoustical Society of America 82:1315-1324).
- Greenstreet, S., Robertson, M., Fraser, H., Holland, G., Doyle K. and Li, R., (2006). *Variation in the abundance, distribution, diet and food consumption rates of gadoid predators in the Wee Bankie/Marr Bank region of the northwestern North Sea, and consequences for predator population dynamics*. (IMPRESS Final Report Appendix 8. 65pp).
- Grellier, K. and Lacey C. (2011). *Analysis of The Crown Estate aerial survey data for marine mammals for the Forth and Tay Offshore Wind Developers Group region. SMRUL-SGW-2012-015.* (Unpublished report to The FTOWDG)
- GWFL. (2011). *Galloper Wind Farm Project. Environmental Statement - Chapter 14: Marine Mammals. Document Reference – 5.2.14.* (Galloper Wind Farm Limited RWE, SSE and Royal Haskoning).
- Hammond, P. S., MacLeod, K., Northridge, S. P., Thompson, D. and Matthiopoulos, J. (2003). *Background information on marine mammals relevant to Strategic Environmental Assessment 4*, (Sea Mammal Research Unit).
- 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., Macleod, K., Berggren, P., Borchers, D.L., Burt, M.L., Cañadas, A., Desportes, G., Donovan, G.P., Gilles, A., Gillespie, D., Gordon, J., Hiby, L., Kuklik, I., Leaper, R., Lehnert, K., Leopold, M., Lovell, P., Øien, N., Paxton, C.G.M., Ridoux, V., Rogan, E., Samarra, F., Scheidat, M., Sequeira, M., Siebert, U., Skov, H., Swift, R., Tasker, M.L., Teilmann, J., Van Canneyt, O. & Vázquez, J.A. (2013). *Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management*. (Biological Conservation 164: 107-122).
- Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vingada, J. and Øien, N. (2017). *Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys*. (University of St Andrews. https://synergy.st-andrews.ac.uk/scans3/category/researchoutput/ (Accessed August 2017)).
- Harwood, J. and King, SL. (2014). *The Sensitivity of UK Marine Mammal Populations to Marine Renewables Developments.* (Report number SMRUL-NER-2012-027. Submitted to the Natural Environment Research Council (NERC) (unpublished)).
- Hassel, A., Knutsen, T., Dalen, J., Skaar, K., Løkkeborg, S., Misund, O. A., Østensen, Ø., Fonn, M., and Haugland, E. K., (2004). *Influence of seismic shooting on the lesser sandeel (Ammodytes marinus).* (ICES Journal of Marine Science, 61: 1165e1173).

- Hoang, T. (2013). *A literature review of the effects of aircraft disturbances 0n seabirds, shorebirds and marine mammals*. (NOAA. Greater Farallones National Marine Sanctuary and the Seabird Protection Network).
- IAMMWG (2015). *Management Units for cetaceans in UK waters (January 2015).* JNCC Report No. 547, JNCC, Peterborough.
- IAMMWG, Camphuysen, C.J. and Siemensma, M.L. (2015). *A Conservation Literature Review for the Harbour Porpoise (Phocoena phocoena).* (JNCC Report No. 566, Peterborough. 96pp).
- ICOL (2017). Inch Cape Marine Mammal Workshop 1. Minutes of Meeting. 27 July 2017. Apex Hotel, Edinburgh. Inch Cape Offshore Limited.
- IEEM (2010). *Guidelines for Ecological Impact Assessment in Britain and Ireland: Marine and Coastal.* (Institute for Ecology and Environmental Management (IEEM), Winchester).
- Janik, V.M. (2000). *Source levels and the estimated active space of bottlenose dolphin (Tursiops truncatus) whistles in the Moray Firth, Scotland*. (J. Comp. Physiol. A, 186, 673–680).
- Jensen BS, Klaustrup M, and Skov H. (2006). *EIA Report Fish - Horns Rev 2 Offshore Wind Farm*, (BioConsult A/S).
- Jensen, F. B., Kuperman, W. A., Porter, M. B. and Schmidt, H. (2011). *Computational ocean acoustics*. (Second edition. Springer. Modern Acoustics and Signal Processing. 794 pp).
- Jitlal, M., Burthe, S., Freeman, S. and Daunt, F. (2017). *Testing and validating metrics of change produced by population viability analysis*. Scottish Marine and Freshwater Science Vol 8 No. 23. Scottish Government
- JNCC (2008). The deliberate disturbance of marine European Protected Species. Guidance for English and Welsh territorial waters and the UK offshore marine area By JNCC. March 2008. Available from http://jncc.defra.gov.uk/PDF/consultation_epsGuidanceDisturbance_all.pdf
- JNCC (2010a). *The protection of European Protected Species from injury and disturbance. Guidance for the marine area in England Wales and UK offshore marine area.* (Joint Nature Conservation Committee, Natural England and Countryside Council for Wales).
- JNCC (2017). *Species abbreviations and Management Units (MU) abundance values, in "Instructions.doc".* Available from: http://jncc.defra.gov.uk/page-7201. Accessed: November 2017.
- Kastelein, R. A., Gransier, R., Hoek, L. and Olthuis, J. (2012). *Temporary threshold shifts and recovery in a harbor porpoise (Phocoena phocoena) after octave-band noise at 4 kHz.* (Journal of the Acoustical Society of America. 132(5): 3525–3537).
- Kastelein, R. A., Gransier, R., Schop, J., and Hoek, L. (2014). *Effect of intermittent and continuous 6-7 kHz sonar sweep exposures on harbor porpoise (Phocoena phocoena) hearing," (*J. Acoust. Soc. Am. 137 (4), April 2015).
- Kastelein, R.A., Schop, J., Hoek, L. and Covi, J. (2015*). Hearing thresholds of a harbor porpoise (Phocoena phocoena) for narrow-band sweeps (0.125-150 kHz)* (SEAMARCO final report 2015-02).
- Kastelein, R.A., Van de Voorde, S. and Jennings, N. (2018). Swimming Speed of a Harbor Porpoise (*Phocoena phocoena*) During Playbacks of Offshore Pile Driving Sounds. *Aquatic Mammals* 2018, *44*(1), 92-99, DOI 10.1578/AM.44.1.2018.92.
- King, S. and Sparling, C. (2012). *FTOWDG Cetacean Density Modelling* – (Non Technical summary. Report number SMRUL-SGW-029 to FTOWDG, October, 2012).
- King, S.L., Schick, R.S., Donovan, C., Booth, C.G., Burgman, M., Thomas, L. and Harwood, J. (2015). An interim framework for assessing the population consequences of disturbance. *Methods in Ecology and Evolution* doi:10.1111/2041-210X.12411.

- Kvadsheim, P.H., Lam, F-P., Miller, P., Sivle, L.D., Wensveen, P., Roos, M., Tyack, P., Kleivine L., Visser, F., Curé, C., Ijsselmuide, S-v., Isojunno, S., Beckmann, S-v., Nordland, N and Deckiling René. (2015). *The 3S2 experiments – Studying the behavioural effects of naval sonar on northern bottlenose whales, humpback whales and minke whales* (FFI-rapport 2015/01001).
- Lafrate, J.D., Watwood, S.L., Reyier, E.A., Scheidt, D.M., Dossot, G.A. and Crocker, S.E. (2016) *Effects of Pile Driving on the Residency and Movement of Tagged Reef Fish*. (PLoS ONE11(11): e0163638. https://doi.org/10.1371/journal.pone.0163638.).
- Lancaster, J. (Ed.), McCallum, S., Lowe A.C., Taylor, E., Chapman A. & Pomfret, J. (2014a). *Development of detailed ecological guidance to support the application of the Scottish MPA selection guidelines in Scotland's seas*. (Scottish Natural Heritage Commissioned Report No.491. White-Beaked Dolphin. Supplementary document).
- Lancaster, J. (Ed.), McCallum, S., Lowe A.C., Taylor, E., Chapman A. & Pomfret, J. (2014b). *Development of detailed ecological guidance to support the application of the Scottish MPA selection guidelines in Scotland's seas*. (Scottish Natural Heritage Commissioned Report No.491. Minke Whale. Supplementary document).
- Leonhard, S.B. and Pedersen, J. (2006). *Benthic communities at Horns Rev before, during and after Construction of Horns Rev Offshore Wind Farm*. (Vattenfall Report number: Final Report/Annual report 2005, p 134).
- Leonhard, S.B., Stenberg, C. and Støttrup, J. (2011). *Effect of the Horns Rev 1 Offshore Wind Farm on Fish Communities Follow-up Seven Years after Construction DTU Aqua* (Report No 246-2011).
- Lepper, P.A., Ainslie, M.A., de Jong, C.A.F. and Robinson, S.P. (2012a). *What is the source level of pile-driving noise in water*? In: Popper, A.N and Hopkins, A. (eds). The effects of Noise on Aquatic Life: Advances in Experimental Medicine and Biology, 730(VII), pp. 445 – 448.
- Lepper P.A., Robinson S.P., Ainslie M.A., Theobald P.D., de Jong C.A.F. (2012b). *Assessment of Cumulative Sound Exposure Levels for Marine Piling Events.* In: Popper A.N., Hawkins A. (eds) *The Effects of Noise on Aquatic Life. (*Advances in Experimental Medicine and Biology, vol 730. Springer, New York, NY).
- Lindeboom, H. J., Kouwenhoven, H. J., Bergman, M. J. N., Bouma, S., Brasseur, S., Daan, R., Fijn, R. C., de Haan, Dirksen S.D., van Hal, R., Hille Ris Lambers, R., ter Hofstede, R., Krijgsveld, K.L., Leopold, M., and Scheidat. M. (2011). *Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation*. (Environ. Res. Lett. 6 035101).
- Løkkeborg, S., Ona, E., Vold, A., Pena, H., Salthaug, A, Totland, B., Øvredal, J.T., Dalen, J. and Handegard, N.O. (2010). *Effects of seismic surveys on fish distribution and catch rates of gillnets and longlines in Vesterålen in summer 2009*. (Institute of Marine Research. Bergen. Norway).
- Lockyer C. (2003). *Harbour porpoises (Phocoena phocoena) in the North Atlantic: biological parameters*. (*NAMMCO Scientific Publications*, 5: 71–89).
- MacLeod, C.D Weir, C.R., Santos, M.B. and Dunn, T.E. (2008). *Temperature-based summer habitat partitioning between white-beaked and common dolphins around the United Kingdom and Republic of Ireland. (*Journal of the Marine Biological Association of the UK, 88: 1193-1198).
- Marine Scotland (2017a). *Marine Scotland – Licensing Operations Team Scoping Opinion. Scoping opinion for the proposed Section 36 consent and associated marine licence application for the revised Neart na Gaoithe offshore wind farm and revised Neart na Gaoithe offshore transmission works*. (Marine Scotland 8 September 2017).
- Marine Scotland (2017b). *Interim Population Consequences of Disturbance Model (PCOD).* http://marine.gov.scot/information/interim-population-consequences-disturbance-model-pcod. (Accessed October 2017).

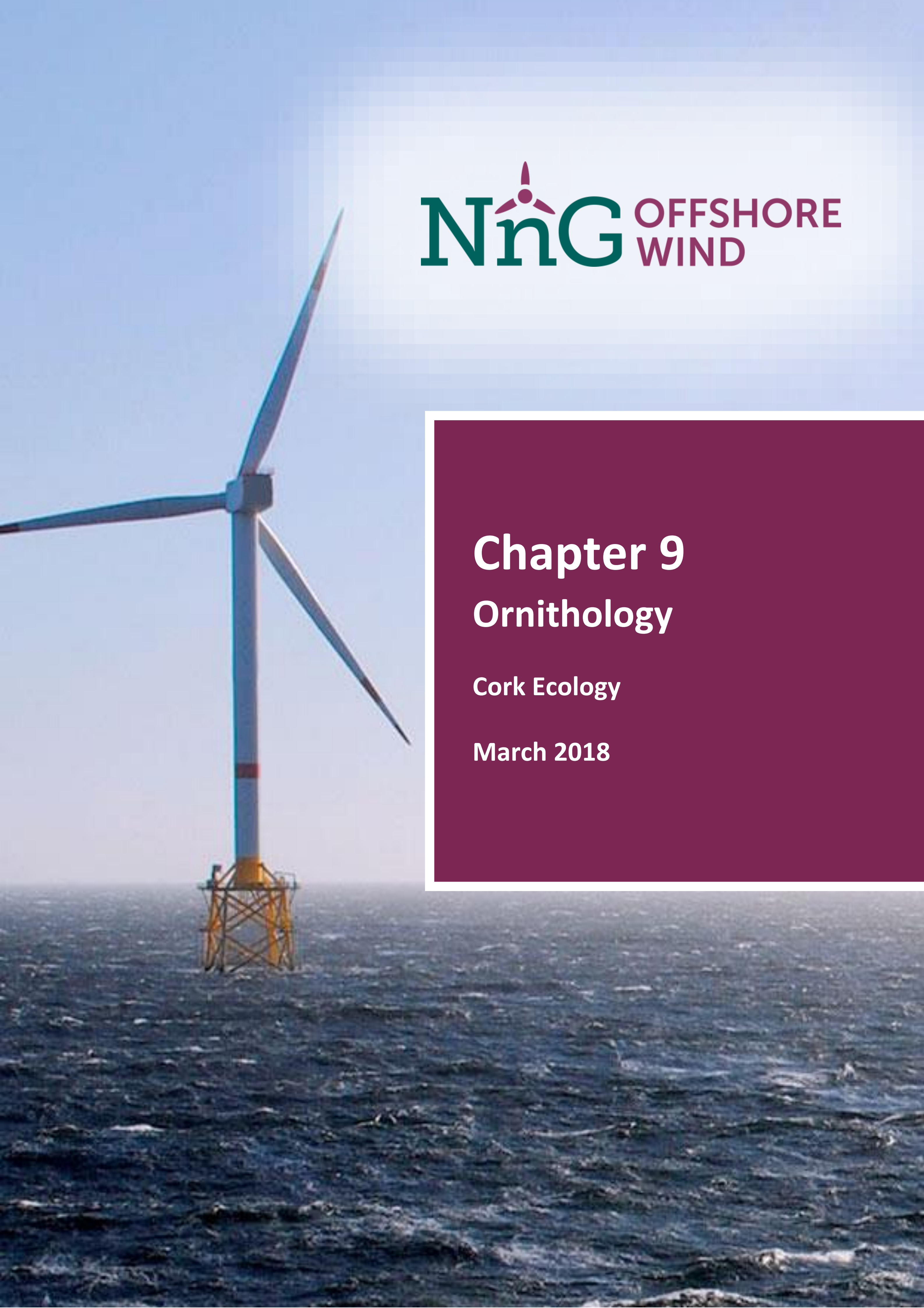
- Marine Scotland (2017c). *Marine Mammal Assessment.* (Email from Marine Scotland to NnGOWL dated 4 October 2017).
- Marine Scotland (2017d). *Estimated at-sea distribution of grey and harbour seals. Updated maps 2017*. Marine Scotland. https://data.marine.gov.scot/dataset/estimated-sea-distribution-grey-and-harbour-seals-updated-maps-2017. (accessed January 2018).
- McGarry, T., Boisseau, O., Stephenson, S. and Compton, R. (2017). *Understanding the Effectiveness of Acoustic Deterrent Devices (ADDs) on Minke Whale (Balaenoptera acutorostrata), a Low Frequency Cetacean.* (ORJIP Project 4, Phase 2. RPS Report EOR0692. Prepared on behalf of The Carbon Trust. November 2017).
- Mueller-Blenkle, C., McGregor, P. K., Gill, A. B., Andersson, M. H., Metcalfe, J., Bendall, V., Sigray, P., Wood, D. T. and Thomsen, F. (2010). *Effects of Pile driving Noise on the Behaviour of Marine Fish*. (COWRIE Ref: Fish 06-08, Technical Report).
- McCauley, R.D. (1998). *Radiated Underwater noise measured from the drilling rig Ocean General, rig tenders Pacific Ariki and Pacific Frontier, Fishing vessel Reef Venture and natural sources in the Timor Sea, Northern Australia*. (Shell Australia, 1998).
- McConnell, B.J., Fedak, M.A., Lovell, P. and Hammond, P.S. (1999). *Movements and foraging areas of grey seals in the North Sea.* (Journal of Applied Ecology 36: 573-590).
- Miller, L. A., and Wahlberg, M. (2013). *Echolocation by the harbour porpoise: life in coastal waters. (*Frontiers in Physiology, 4, 52. http://doi.org/10.3389/fphys.2013.00052).
- MMO (2015). *Modelled mapping of continuous underwater noise generated by activities.* (A report produced for the Marine Management Organisation, pp50. MMO Project No. 1097. ISBN 978-1-909452-87-9).
- Nedwell, J.R. and Edwards, B. (2004). *A review of underwater man-made noise.* (Subacoustech Report 534R0109).
- Nedwell, J.R, and Mason, T.I. (2012). *Modelling of Noise during Impact Piling Operations at the Neart na Gaoithe Offshore Wind Farm in the Firth of Forth*. (Subacoustech Environmental Report No. E297R0106).
- NMFS (2016). *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. (U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 p. National Marine Fisheries Service).
- NMPI (2017). *National Marine Plan Interactive*. http://marine.gov.scot/marine-atlas/chapter-4-cetaceans (Accessed August 2017).
- NnGOWL (2012). *Neart na Gaoithe Offshore Wind Farm Environmental Statement*. (Neart an Gaoithe Offshore Wind Farm).
- NnGOWL (2013). *Addendum of Supplementary Environmental Information Neart an Gaoithe Offshore Wind Farm, June 2013*. (Neart an Gaoithe Offshore Wind Farm).
- NnGOWL (2017). *Neart na Gaoithe Offshore Wind Farm Scoping Report - May 2017.* (UK02-0504-0673-MRP-NNG SCOPING REPORT 2017-RPT-A1).
- OSPAR (2008). *Guidance on Environmental considerations for Offshore Wind Farm Development 2008-3.* (OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic. Reference No. 2008-3).
- OSPAR (2009). *Guidance on Environmental considerations for Offshore Wind Farm Development 2008-3. Overview of the impacts of anthropogenic underwater sound in the marine environment.* (OSPAR Biodiversity Series).
- OSPAR (2017). *Intermediate Assessment 2017*. https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/. (Accessed August 2017).
- Otani S., Naito Y., Kawamura A., Kawasaki M., Nishiwaki S., and Kato A. (1998*) Diving behavior and performance of harbor porpoises, Phocoena phocoena, in Funka Bay, Hokkaido, Japan. (*Marine Mammal Science, 14: 209–220).

- Otani S., Naito Y., Kato A. and Kawamura A. (2000). *Diving behaviour and swimming speed of a free ranging harbor porpoise, Phocoena phocoena*. (Marine Mammal Science, 16: 811– 814).
- Palmer, K.J., Brookes, K. and Rendell, L. (2017). *Categorizing click trains to increase taxonomic precision in echolocation click loggers. (Acoustical Society of America* 142: 863). http://asa.scitation.org/doi/full/10.1121/1.4996000.
- Parsons, E.C.M. (2012). *Delphinidae: The Oceanic Dolphins: Chapter 12 in: An introduction to marine mammal biology and conservation*. (Published by Jones and Bartett Learning, MA).
- Parvin, S.J, Nedwell, J.R. and Harland. E. (2007). *Lethal and physical injury of marine mammals and requirements for Passive Acoustic Monitoring*. (Subacoustech Report).
- Patenaude, N. J., Richardson, W. J., Smultea, M. A., Koski, W. R., Miller, G. W., Wursig, B. and Greene, C. R. (2002). *Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea*. (Marine Mammal Science, 18, pp. 309-335).
- Paxton C.G.M. Scott-Hayward, L., Mackenzie, M., Rexstad, E. and Thomas, L. (2016). *Revised Phase III Data Analysis of Joint Cetacean Protocol Data Resources with Advisory Note*, JNCC Report 517, ISSN 0963-8091.
- Peña, H., Handegard, N.O. and Ona, E. (2013). *Feeding herring schools do not react to seismic air gun surveys.* (ICES Journal of Marine Science).
- Pirotta, E., Brookes, K.L., Graham, I.M. and Thompson, P.M. (2014). *Variation in harbour porpoise activity in response to seismic survey noise. (*Biological. Letters. 10: 20131090. http://dx.doi.org/10.1098/rsbl.2013.1090).
- Popper, A. N. Hawkins, A. D., Fay, R. F., Mann, D. A., Bartol, S., Carlson, T. J., Coombs, S., Ellison, W.T., Gentry, R.L., Halvorsen, M.B., Løkkeborg, S., Rogers, P.H., Southall, B.L., Zeddies, D.G., and Tavolga, W.N. (2014). *Sound Exposure Guidelines for Fishes and Sea Turtles*: (A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014).
- Porter, M. B. and Liu, Y-C. (1994). *Finite-element ray tracing*. (Theoretical and Computational Acoustics, Vol. 2, World Scientific Publishing Co).
- Quick, N., and Cheney, B., (2011). *Cetacean baseline characterisation for the Firth of Tay based on existing data: bottlenose dolphins*. (Report for Forth Tay Offshore Windfarm Developers Group (FTOWDG)).
- Quick, N. J., Arso Civil, M., Cheney, B., Islas Villanueva, V., Janik, V., Thompson, P. and Hammond, P. S. (2014). *The east coast of Scotland bottlenose dolphin population: improving understanding of ecology outside the Moray Firth SAC*. (OESEA2 Supporting documents; No. 14D/086). Department of Energy and Climate Change).
- Rasmussen, M. H., Wahlberg, M., and Miller, L. A. (2004). *Estimated transmission beam pattern of clicks recorded from free ranging white-beaked dolphins (Lagenorhynchus albirostris).* (J. Acoust. Soc. Am. 116(3), 1826–1831).
- Reid, J.B., Evans, P.G.H. and Northridge, S.P. (2003). *Atlas of Cetacean distribution in northwest European waters*. (Joint Nature Conservation Committee, Peterborough).
- Richardson, W.J., Greene, C.R., Malme, C.I. and Thomson D.H. (1995). *Marine Mammals and Noise*. (Academic Press, San Diego, 576pp).
- Robinson K.P., Tetley M.J. and Mitchelson-Jacob E.G. (2009). *The distribution and habitat preference of coastally occurring minke whales (B. acutorostrata) in northeast Scotland. (*Journal of Coastal Conservation 13(1): 39-48).
- Russell, D., Duck, D., Morris, C. and Thompson, D. (2016a). *Independent estimates of grey seal population size: 2008 and 2014. Briefing Papers for SCOS 16/03*. In: *Scientific Advice on Matters Related to the Management of Seal Populations: 2015.* (SCOS (Special Committee on Seals))

- Russell, D. J.F., Hastie, G. D., Thompson, D., Janik, V. M., Hammond, P. S., Scott-Hayward, L. A.S., Matthiopoulos, J., Jones, E. L. and McConnell, B. J. (2016b). *Avoidance of wind farms by harbour seals is limited to pile driving activities.* (Journal of Applied Ecology pp 1365-2664).
- Santos, M.B., Pierce, G.J., Reid, R.J., Patterson, I.A.P., Ross, H.M. and Mente, E. (2001). *Stomach contents of bottlenose dolphins (T. truncatus) in Scottish waters.(* Journal of the Marine Biological Association of the United Kingdom, 81: 873-878).
- Santos, M.B. and Pierce, G.J. (2003). *The diet of harbor porpoise (P. phocoena) in the Northeast Atlantic. (*Oceanography and Marine Biology: an Annual Review 2003, 41: 355–390).
- SCOS (2005). *Scientific Advice on Matters Related to the Management of Seal Populations: 2005*. (Special Committee on Seals).
- SCOS (2016). *Scientific Advice on Matters Related to the Management of Seal Populations: 2016*. (Special Committee on Seals) http://www.smru.st-andrews.ac.uk/files/2017/04/SCOS-2016.pdf. (Accessed August 2017).
- Seagreen (2017). *Seagreen Phase 1 Offshore Project. Scoping document. Round 3: Firth of Forth*. (A4MR/SEAG-AB-DEV230-SPR-311. Seagreen Wind Energy Limited).
- Sivle, L.D., Kvadsheim, P.H., Cure, C., Isojunno, S., Wensveen, P.J., Lam, F-PA., Visser, F., Kleivane, L., Tyack, P. L., Harris, C.M. and Miller, P. (2015). *Severity of expert-identified behavioural responses of humpback whale, minke whale, and northern bottlenose whale to naval sonar Aquatic Mammals,* (Vol 41, no. 4, pp. 469-502).
- Simard, P., Lace, N., Gowans, S., Quintana-Rizzo, E., Kuczaj, II, S.A., Wells, R.S. and Mann D.A. (2011). *Low frequency narrow-band calls in bottlenose dolphins (Tursiops truncatus): signal properties, function, and conservation implications*. (J Acoust Soc Am. 130(5): 3068–3076. doi:10.1121/1. 3641442).
- Skeate, E. R., Perrow, M.R. and Gilroy, J.J. (2012). *Likely effects of construction of Scroby Sands offshore wind farm on a mixed population of harbour Phoca vitulina and grey Halichoerus grypus seals. (*Marine pollution bulletin 64(4): 872-81).
- Slotte, A., Hansen, K., Dalen, J. and One, E. (2004). *Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast.* (Fish. Res. 67: 143-150).
- SNH (2006). *Isle of May Special Area of Conservation. Advice under Regulation 33(2) of The Conservation* (Natural Habitats, &c.) Regulations 1994 (as amended). Available online from: http://www.ukmpas.org.uk/pdf/Sitebasedreports%5CIsle_of_May.pdf
- SNH (2015). *Species Licensing Guidance Notes. Guidance Notes for 'Application for a licence for European protected species'*. (Scottish Natural Heritage).
- SNH (2016). *Assessing collision risk between underwater turbines and marine wildlife. Scottish Natural Heritage guidance note*. Available from https://www.nature.scot/sites/default/files/2017-09/Guidance%20Note%20-%20Assessing%20collision%20risk%20between%20underwater%20turbines%20and%20marine%20wildlife.pdf
- Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, Ro., Greene Jr., C., Kastak, D., Ketten, D., Miller, J., Nachtigall, P., Richardson, W., Thomas, J. and Tyack, P. (2007). *Marine Mammal Noise Exposure Criteria: Initial Scientific recommendations*. (Aquatic Mammals. 33(4): 411-521).
- Sparling, C.E., Russell, D.F., Lane, E., Grellier, K., Lonergan, M.E., McConnell, B.J., Matthiopoulous, J. and Thompson, D. (2012). *Baseline seal information for the FTWODG area*. (SMRUL-FDG-2012-0 to FTOWDG. May 2012 (unpublished)).
- Sparling, C.E., Thompson, D. and Booth, C.G. (2017). *Guide to population models used in marine mammal impact assessment*. (Report Number SMRUC-JNC-2017-004).
- Sveegaard, I. (2011). *Spatial and temporal distribution of harbour porpoises in relation to their prey*. (Unpublished PhD Thesis, Aarhus University).

- Teilmann, J., Tougaard, J., Carstensen, J., Dietz, R., Tougaard, S. (2006). *Summary on seal monitoring 1999-2005 around Nysted and Horns Rev Offshore Wind Farms*. (Technical report to Energi E2 A/S and Vattenfall A/S).
- Teilmann, J., Larsen, F. and Desportes, G. (2007). Time allocation and diving behaviour of harbour porpoises (*Phocoena phocoena*) in Danish and adjacent waters. *J. Cetacean Res. Manage*. 9(3):201–210, 2007.
- Tetley M.J., Mitchelson-Jacob, E.G. and Robinson K.P. (2008). *The summer distribution of coastal minke whales (B. acutorostrata) in the southern Moray Firth, northeast Scotland, in relation to co-occurring mesoscale oceanographic features. (*Remote Sensing of Environment 112(8): 3449-3454).
- Thomsen, F., Ludemann, K., Kafemann, R. and Piper, W. (2006). *Effects of offshore wind farm noise on marine mammals and fish*. (Biola, Hamburg, Germany on behalf of Cowrie Ltd).
- Thompson, P.M., Lusseau, D., Barton, T., Simmons, D., Rusin, J. & Bailey, H. (2010). *Assessing the responses of coastal cetaceans to the construction of offshore wind turbines*.(Mar. Pollut. Bull. 60: 1200 – 1208).
- Thompson, P.M., Cheney, B., Ingram, S., Stvick, P., Wilson, B., and Hammond, P.S. (Eds). (2011). *Distribution, abundance and population structure of bottlenose dolphins in Scottish waters. (*Scottish Natural Heritage Commissioned report).
- Thompson, P.M., Brookes, K.L., Graham, I.M., Barton, T.R., Needham, K., Bradbury, G. and Merchant, N.D. (2013). *Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises*. (Proc R Soc Lond. B. Biol Sci. 2013, 280:20132001).
- Todd V.L.G., Lepper P.A. and Todd I.B. (2007). *Do harbour porpoises target offshore installations as feeding stations?* (IADC Environmental Conference & Exhibition, 3rd April 2007, Amsterdam, Netherlands, 62pp).
- Todd, V. L. G., Pearse, W. D., Tregenza, N. C., Lepper, P. A., and Todd, I. B. (2009). *Diel echolocation activity of harbour porpoises (Phocoena phocoena) around North Sea offshore gas installations.* (ICES Journal of Marine Science, 66: 734–745).
- Tollit, D.J., and Thompson, P.M. (1996). *Seasonal and between year variations in the diet of harbour seals in the inner Moray Firth, N.E. Scotland*. (Canadian Journal of Zoology 74: 1110-1121).
- Tougaard, J., Carstensen, J., Bech, N.I. and Teilmann, J. (2006). *Final report on the effect of Nysted offshore Wind Farm on harbour porpoises.* (Annual report to EnergiE2. Roskilde, Denmark, NERI).
- Tyldesley, D. and Associates (2015). *Guidance on Habitats Regulation Appraisal. (*Report for Scottish Natural Heritage).
- Van Parijs, S.M., Corkeron, P.J., Harvey, J., Hayes, S.A., Mellinger, D.K., Rouget, P.A., Thompson, P.M., Whalberg, M. and Kovack, K.M. (2000*). Patterns in the vocalizations of male harbour seals.* (J. Acoust. Soc. Am. 113(6): 3403-3410).
- Villadsgaard A., Wahlberg M., Tougaard J. (2007). *Echolocation signals of wild harbour porpoises, Phocoena phocoena* (J. Exp. Biol. 210: 56–64).
- Wahlberg, M., Jensen, F.H., Soto, N.A., Beedholm, K., Bejder, L., Oliveira, C., Simon, M., Villadsgaard, A. and Masden, P.T. (2011). *Source parameters of echolocation clicks from wild bottlenose dolphins (Tursiops aduncus and Tursiops truncatus*). (J. Acoust. Soc. Am. 130 (4), October 2011).
- Wardle, C.S., Carter, T.J., Urquart, G.G., Johnstone, A.D.F., Ziolkowski, A.M., Hampson, G. and Mackie, D. (2001). *Effects of seismic airguns on marine fish*. (Continental shelf research 21: 1005 – 1027).
- Weir, C.R., Stokin, K.A., and Pierce, G.J. (2007). *Spatial and Temporal Trends in the Distribution of Harbour Porpoises, White-Beaked Dolphins and Minke Whales Off Aberdeenshire (UK)*, J. Mar. Biol. Assoc. UK 87: 327-338).

- Whaley, A.R. (2004). *The distribution and relative abundance of the harbour porpoise (P. phocoena L.) in the southern outer Moray Firth, NE Scotland*. (Unpublished bachelor of Science thesis. School of Geography, Birkbeck College).



OFFSHORE WIND

Chapter 9
Ornithology

Cork Ecology

March 2018

Table of Contents

Table of Figures

Table of Tables

9 Ornithology

9.1 Introduction

1. This chapter of the EIA Report presents an assessment of the potential impacts upon ornithology arising from the construction, operation and decommissioning of the Project, as detailed in Chapter 4: Project Description. This chapter has been prepared on behalf of NnGOWL by Cork Ecology with input from Bureau Waardenburg (BW). Acknowledgement is also made to Francis Daunt of the Centre for Ecology and Hydrology (CEH) and Keith Hamer of the University of Leeds for kindly providing tracking data for various species based on tagging studies on the Isle of May, St Abb's Head and the Bass Rock.

2. This chapter is comprised of the following elements:

- A summary of relevant guidance, policy and legislation;
- Details of the data sources used to characterise the study area;
- A summary of the relevant consultations with stakeholders;
- A description of the methodology for assessing the impacts of the Project, including details of the study area and approach to the assessment of potential effects;
- A review of the baseline conditions;
- A description of the worst-case design scenario relevant to ornithology;
- An assessment of the likely effects for the construction, operation and decommissioning phases of the Project, including cumulative and in-combination effects;
- Identification of any further mitigation measures or monitoring requirements in respect of any significant effects;
- A summary of the residual impact assessment determinations taking account of any additional mitigation measures identified.

9.2 Guidance, Policy and Legislation

3. The key legislation in relation to birds includes:

- The Council Directive on the Conservation of Wild Birds 2009/147/EC (EU Birds Directive).
- The Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora 1992/43/EEC (EU Habitats Directive).
- The Nature Conservation (Scotland) Act 2004 (as amended).
- The Wildlife and Countryside Act 1981 (as amended).
- Conservation (Natural Habitats, etc.) Regulations 1994 (as amended).
- The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017.
- The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017.
- Conservation of Habitats and Species Regulations 2017.

4. The principal guidance documents and information used to inform the assessment of potential impacts on ornithology are as follows:

- Band, W., M. 2012. Using a collision risk model to assess bird collision risks for offshore windfarms. Final version, August 2012. SOSS, The Crown Estate, http://www.bto.org/science/wetland-and-marine/soss/projects;
- Cook, A.S.C.P., Humphreys, E.M., Masden, E.A. and Burton, N.H.K. (2014). The avoidance rates of collision between birds and offshore turbines. BTO Research Report No. 656;

- Cook, A.S.C.P & Robinson, R.A. 2016. Testing sensitivity of metrics of seabird population response to offshore wind farm effects. JNCC Report No. 553. JNCC, Peterborough.
- Freeman, S., Searle, K., Bogdanova, M., Wanless, S. & Daunt, F. 2014. Population dynamics of Forth and Tay breeding seabirds: Review of available models and modelling of key breeding populations. Ref: MSQ-0006. Final Report to Marine Scotland Science.
- Furness R. W., Wade, H. M. and Masden E.A. (2013) Assessing vulnerability of marine bird populations to offshore wind farms. Journal of Environmental Management 119 pp.56-66;
- Furness, R.W. (2015) Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Report Number 164. 389 pp;
- IEEM 2010. Guidelines for ecological impact assessment in Britain and Ireland. Marine and Coastal.
- JNCC (2015). Seabird Displacement Impacts from Offshore Wind Farms: report of the MROG Workshop, 6- 7th May 2015. JNCC Report No 568. JNCC Peterborough;
- MacArthur Green. 2014. Bass Rock Gannet PVA. Report to Marine Scotland Science.
- MacArthur Green. (2016) Qualifying impact assessments for selected seabird populations: A review of recent literature and understanding. Report commissioned by Vattenfall, Statkraft and Scottish Power Renewables;
- Marine Scotland. (2014a) Application For Consent Under Section 36 Of The Electricity Act 1989 And Applications For Marine Licences Under The Marine (Scotland) Act 2010 For The Construction And Operation Of The NnG Offshore Windfarm. Marine Scotland's Consideration Of A Proposal Affecting Designated Special Areas Of Conservation ("SACs") Or Special Protection Areas ("SPAs");
- Marine Scotland. (2014c) Population consequences of displacement from proposed offshore wind energy developments for seabirds breeding at Scottish SPAs (CR/2012/03);
- Searle, K., Mobbs, D., Butler, A., Bogdanova, M., Freeman, S., Wanless, S. & Daunt, F. 2014. Population consequences of displacement from proposed offshore wind energy developments for seabirds breeding at Scottish SPAs (CR/2012/03). Final Report to Marine Scotland Science.
- SNH. (2014) Interim Guidance On Apportioning Impacts From Marine Renewable Developments To Breeding Seabird Populations In Special Protection Areas. http://www.snh.gov.uk/docs/A1355703.pdf;
- SNH. (2017) Seasonal Periods for Birds in the Scottish Marine Environment. http://www.snh.gov.uk/docs/A2200567.pdf;
- Statutory Nature Conservation Bodies (SNCB). (2017). Interim Displacement Advice Note. Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments http://jncc.defra.gov.uk/pdf/Joint_SNCB_Interim_Displacement_AdviceNote_2017.pdf;
- Thaxter, C.B. Lascelles, B. Sugar, K. Cook, A.S.C.P. Roos, S. Bolton, M. Langston, R.H.W. and Burton, N.H.K. (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. Biological Conservation; and
- Wade H.M., Masden. E.A., Jackson, A.C. and Furness, R.W. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. Marine Policy 70, 108–113. Available online at doi:10.1016/j.marpol.2016.04.045

9.3 Data Sources

5. The assessment considers the potential interaction between the Project (as described in Chapter 4: Project Description) and seabirds.

6. The Project includes the Wind Farm Area, and the Offshore Transmission Works (including the offshore export corridor, up to Mean High Water Springs (MHWS).

7. Baseline characterisation data has been collated combining a thorough desk-based study of extant data supplemented with a series of site-specific surveys. Data was drawn from site surveys, studies commissioned by NnGOWL and existing published datasets.

8. Table 9-1 details the data sources used to inform the baseline characterisation within the study area.

Table 9-1: Data sources used to inform the baseline description.

Data Source	Study/Data Name	Overview
NnGOWL	Baseline seabird surveys	Monthly boat-based seabird surveys Covered NnG Wind Farm Area and buffer extending out to 8km Covered a 3 year period, from November 2009 – October 2012
Forth and Tay Offshore Wind Developers Group (FTOWDG)	Daunt *et al.*, 2011a	GPS tracking of guillemot, razorbill and kittiwake from the Isle of May, Summer 2010
	Daunt *et al.*,2011b	GPS tracking of kittiwake and observations of guillemot trips from Fowlsheugh & St Abb's Head, Summer 2011
Isle of May tracking data 2012 to 2014[1]	Data from Francis Daunt, CEH	GPS tracking of guillemot, razorbill and kittiwake from the Isle of May, in the 2012, 2013 and 2014 breeding seasons.
Gannet tracking data 2010 – 2012[2] **Gannet tracking data 2015** [3]	Data from Keith Hamer, University of Leeds	GPS data collected by tracking breeding adult and immature gannets from Bass Rock
JNCC Seabird Monitoring Programme	Seabird 2000 dataset and more recent colony counts	Online database of breeding numbers of seabirds around UK

[1] Data are owned by NERC Centre for Ecology & Hydrology. Data collection received support from the RSPB, JNCC, SNH and Marine Scotland.

[2] The gannet tagging data from 2010 to 2012 were obtained by Keith Hamer, Ewan Wakefield and Ian Cleasby, funded by NERC Standard Research Grant NE/H007466/1 to Keith Hamer, Stuart Bearhop (University of Exeter) and Stephen Votier (University of Exeter).

[3] The 2015 data were obtained by Keith Hamer, James Grecian and Jude Lane with funding from NERC and DBEIS, with thanks to John Hartley (Hartley Anderson).

9.4 Relevant Consultations

9. As part of the EIA process, NnGOWL has undertaken a number of consultations with various statutory and non-statutory stakeholders.

10. An intitial kick-off meeting was held in Aberdeen on 20th January 2017 between MS-LOT and NnGOWL, regarding the approach to scoping and the EIA process.

11. A pre-scoping meeting was held in Battleby on 3rd April 2017 between MS-LOT, MSS, SNH and NnGOWL regarding the approach to scoping and the EIA process, including modelling.

12. A scoping meeting was held in Aberdeen on 13th June 2017 to discuss the NnGOWL Scoping Report and to agree the approach for the EIA Report. Present at the meeting were MS-LOT, MSS, SNH, RSPB and NnGOWL.

13. A meeting was held in Edinburgh on 24th July 2017 between NnGOWL and RSPB to discuss the NnG Scoping Report, and in particular changes in Collision Risk Modelling outputs over the course of the Project design.

14. A formal scoping opinion was requested from MS-LOT, supported by the NnGOWL Scoping Report. In response to NnGOWL's request, MS-LOT issued a Scoping Opinion on 8th September 2017, identifying a number of issues that could not be scoped out of the assessment at this stage following review of the Scoping Report. The issues to be considered further within this EIA in respect of ornithology are summarised in Table 9-2.

15. Ongoing consultation with stakeholders continued post-scoping and responses have been used to develop an appropriate methodology and parameters for assessment. Additional advice received from Marine Scotland after scoping is also summarised in Table 9-2.

Table 9-2: Summary of consultation relating to ornithology.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
8/9/2017– Scoping Opinion – Scottish Ministers	**Age of survey data** The boat-based survey data for the Original Development EIA remain suitable for providing the baseline survey data for the Revised Development EIA but advise NnG that if their application is delayed this advice may change.	Noted.
	SPAs to be included The following SPAs/pSPA and qualifying features must be included in the assessment: • Forth Islands SPA – gannet, kittiwake, herring gull, puffin, guillemot, razorbill • Fowlsheugh SPA – kittiwake, herring gull, guillemot, razorbill • Buchan Ness to Collieston Coast SPA and St Abb's Head to Fast Castle SPA should be scoped in due to connectivity. PVAs for these SPAs are required unless the cumulative effects from the Forth and Tay projects are estimated to be less than a reduction in annual adult survival of 0.2%. Impacts are to be considered in relation to the existing colony SPA breeding populations. The reference populations provided by SNH are to be used for the SPAs (see Table 9.8).	Section 9.7.4

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	Assessment of Firth of Forth and St Andrews Bay Complex pSPA Seabird species to be considered in the assessment of Firth of Forth and St Andrews Bay Complex pSPA: Gannet, Kittiwake, Herring gull, Puffin, Razorbill, Guillemot. The assessment carried out for these species at the breeding colony SPAs listed above should also be used for the assessment of the pSPA. A qualitative assessment of potential disturbance or displacement, and collision in relation to little gull, common gull and black-headed gull should be carried out if the turbines overlap with the pSPA.	Section 9.9.2.5
	Apportioning The methods that should be used are the SNH apportioning approach and the Apportionment tool being produced for Marine Scotland by CEH (if available). The reference populations provided by SNH are to be used for the SPAs (see Table 9.8). Breeding season: Apportioning impacts between SPA and non-SPA colonies should be done using Seabird 2000 data. Impacts apportioned between SPAs should use most recent colony counts, as provided by SNH. Non-breeding season: The biologically defined minimum population scales (BDMPS) should be used for gannet and kittiwake, using reference populations from Furness (2015). SNH guidance should be used to define the seasons, as follows: Gannet – Autumn (Oct to Nov); Spring (Dec to mid-Mar) Kittiwake – Autumn (Sep to Dec); Spring (Jan to mid-April). For herring gull the updated CRM outputs for the breeding and non-breeding seasons should be presented. If further quantitative assessment is needed, collisions during the non-breeding season should be apportioned across the regional population (a similar method was used previously for Moray Firth wind farms). For guillemot and razorbill, all non-breeding season impacts should be assigned to SPAs as per breeding season. Use of the total SPA population, all ages, and apportioning impacts across age classes based on the PVA stable age structure is recommended.	Sections 9.9.2 and 9.9.4
	Collision Risk CRM is required for gannet, herring gull and kittiwake. The nocturnal activity scores of 2 (25%) should be used for herring gull and kittiwake and 1 (0%) for gannet. The mean monthly value should be used, and density of birds in flight values should also have 95% confidence limits presented. Comparison should be made of the proportion of birds at collision height using site specific flight height data and the generic flight height data (Johnson et al. 2014), and any differences between the two should be discussed.	Section 9.9.2.3

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	For kittiwake and gannet, the assessment should assume Option 2 using Johnson et al. (2014) with corrigendum. If sufficient site-specific flight height data are available, outputs using Option 1 should also be presented. Option 2 (at a 98.9% avoidance rate) should be assumed for the PVA. For herring gull, the assessment should present Options 2 and 3 using Johnson et al. (2014) with corrigendum flight height distributions. However, if sufficient site specific flight height data are available, outputs using Option 1 or 4 should also be presented. Option 2 (at a 99% avoidance rate) should be assumed for the PVA. The following avoidance rates should be used: • Gannet – 98.9% (±0.002) • Kittiwake – 98.9% (±0.002) • Herring gull – 99.5% (±0.001) for Option 2, 99.0% (± 0.002) for Option 3 The breeding season and non-breeding season months are those described in the SNH advice (Table 9-7). Apportioning between SPAs should follow methods presented in SPA section above.	
	Displacement & Barrier effects The species to be included are: puffin, guillemot, razorbill and kittiwake. The breeding season months are those described in the SNH advice (Table 9-7). Density estimates should be mean seasonal peaks and include a 2km buffer and should include all birds, both those in flight and on the water. Breeding season: Estimates of displacement should be presented following the SNCB guidance (SNCB 2017). The updated CEH (SeaBORD) model should also be used if available. Outputs from the previous CEH modelling (2014) should be used for context. In addition, a qualitative assessment of displacement impacts on little gull, common gull and black-headed gull should also be included. Non-breeding season: Qualitative assessments should be presented for puffin and kittiwake in the non-breeding season. For guillemot and razorbill, the approach described in the 2017 SNCB guidance should be used. Non-breeding season effects should be assigned to relevant SPAs as per breeding season. A displacement rate of 60% should be used for auks and 30% for kittiwake. A mortality rate from displacement of 2% for puffin and kittiwake (quantitative assessment is for the breeding season only) and 1% for guillemot and razorbill (same rate across breeding and non-breeding seasons) should be applied. The same rates should be used for immatures as for adult birds.	Section 9.9.2.2

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	Apportioning between SPAs should follow methods presented in SPA section above.	
	Cumulative Impact Assessment Effects should be considered quantitatively for the wind farm in isolation and in combination with the worst case scenario (for each species) from either Scenario 1: • Seagreen Alpha and Bravo (2014 as consented) or Seagreen (2017 scoping report) and • Inch Cape (2014 as consented) or Inch Cape (2017 scoping report). • Breeding season effects from other wind farms should be considered within the CIA qualitatively. Or Scenario 2: Effects should be considered quantitatively for the wind farm in isolation and in combination with: • Inch Cape (2017 scoping report) and • Seagreen (2017 scoping report) and • Breeding season effects from other wind farms should be considered within the CIA qualitatively. For breeding season, the CIA should consider projects within mean max foraging range of the colony SPA under consideration. For guillemot and razorbill, the CIA should incorporate non-breeding season displacement effects from the Forth and Tay wind farms, apportioning effects as to SPA and non-SPA colonies in the same manner as the breeding season. For gannet and kittiwake, the CIA should estimate non-breeding season collision effects from the Forth and Tay wind farms in isolation, and in combination with the other UK wind farms. For herring gull, if further quantitative assessment is needed, collisions during the non-breeding season from NnGOWL in isolation and in combination with the other Forth and Tay windfarms should be apportioned as outlined in Scoping Opinion.	Section 9.9.4
	PVA modelling PVA outputs are required for SPA breeding colonies where the assessed effects exceed a change to the adult annual survival rate of 0.2% and it is considered they are likely to be needed for the following: Forth Islands SPA – gannet, kittiwake, puffin, guillemot, razorbill Fowlsheugh SPA – kittiwake, guillemot, razorbill PVAs should be produced for the estimated effects from the wind farm in isolation, and in combination with the other three Forth & Tay wind farms for: • Guillemot, razorbill, puffin, gannet and kittiwake (effects throughout the year and on all age classes). • For gannet and kittiwake, breeding season effects from the Forth and Tay wind farms combined with the non-breeding season effects from the offshore wind farms in UK waters.	Sections 9.9.2.4 and 9.9.5

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	For kittiwake, PVAs for the following should also be provided: • Collision effects (throughout the year and on all age classes) in isolation. • Collision effects (throughout the year and on all age classes) in combination with displacement effects (during the breeding season and on all age classes). Stochastic, density independent PVA models should be used and they will need to include the specifications outlined in the Scoping Opinion. The existing matrix-based population models for Forth Islands gannet and puffin populations would still be considered suitable for use in the EIA and HRA for the Revised Development.	
8/9/2017– Scoping Opinion – SNH additional comments	**Age of survey data** No further baseline survey is required.	Noted.
	Assessment of Firth of Forth and St Andrews Bay Complex pSPA The following seabird species can be scoped out of the assessment of Firth of Forth and St Andrews Bay Complex pSPA: Common tern, Arctic tern, Shag and Manx shearwater.	Section 9.9.2.5
	Assessment of non-seabird species SNH – Non-seabird species were fully considered and addressed in pre-application dialogue and in final assessments for the previous application. In respect of wildfowl and waders these species have been addressed in the Marine Scotland strategic CRM report (Marine Scotland 2014). We confirm that current offshore wind proposals in Scottish waters do not present significant risk to any other bird interests and we do not require any individual developer to submit further information in this regard.	Noted.
	Collision Risk Annual CRM totals will need to be apportioned between breeding and non-breeding seasons following SNH guidance. For half months the collisions calculated for that month are split equally between breeding and non-breeding period. Collision mortality will need to be apportioned between age classes. We therefore recommend that all adults recorded during survey work are considered as breeding adults. Impacts which occur during the breeding season will need to be apportioned between the breeding colonies (SPA and other) within foraging range of the proposed wind farm, as set out in SNH Guidance (SNH 2014). We advise that assessment of collision mortality in the non-breeding season for herring gull can use the approach agreed for herring gull during the Moray Firth determinations.	Section 9.9.2.3

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	Cumulative Impact Assessment For herring gull, the updated CRM outputs for the breeding and non-breeding seasons should be presented.	Section 9.9.4
8/9/2017– Scoping Opinion – RSPB additional comments	**Age of survey data** Updated survey not requested, however, the survey data may not represent an accurate account of seabird usage. This element of uncertainty will need to be taken into account within the assessment.	Noted.
	Assessment of Firth of Forth and St Andrews Bay Complex pSPA Potential impacts on Firth of Forth and St Andrew's Bay Complex proposed SPA resulting from Cable route requires inclusion in assessment.	Section 9.9.2.5
	Collision Risk Lesser black-backed gull & great black-backed gull should also be included in CRM assessment. CRM output for gannet should be presented for basic Band model and a 98% AR in breeding season and a 98.9% AR in non-breeding season. CRM outputs for herring gull, lesser black-backed gull and great black-backed gull should be presented for basic Band model and a 99.5% AR, and for the extended Band model, a 98.9% AR for lesser black-backed gull and great black-backed gull and 99.0% AR for herring gull. Nocturnal activity values as per SNH 2013/14 guidance should be used.	Section 9.9.2.3
	Displacement & Barrier effects Species to be included in the assessment: Puffin, razorbill, guillemot, kittiwake. Guidance from SNH should be followed.	Section 9.9.2.2
	Cumulative Impact Assessment For the cumulative assessment of non-breeding season collision effects on kittiwake and gannet, a qualitative assessment for non UK sites should also be presented.	Section 9.9.4
	PVA modelling Species to be addressed and model population as per SNH advice. Either deterministic or stochastic model. Demographic rates should follow Horswill & Robinson, (2015). Outputs should be presented as either as formula or table to allow for testing a range of mortality input scenarios. Counterfactuals to be presented as per Cook & Robinson, (2016).	Sections 9.9.2.4 and 9.9.5. Appendix 9.8: Population Viability Analysis (PVA) methods and results
21/09/2017	Email containing a list of offshore wind projects in the North Sea and English Channel for use in the CIA assessment; and also a report and	Section 9.9.4

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
Post-scoping opinion additional advice from Marine Scotland	spreadsheet from The Crown Estate for use in the CIA. Comments from SNH on the use of this information were also included. Comments from RSPB to follow if any received.	
11/10/2017 **Post-scoping opinion additional advice from Marine Scotland**	Email containing Collision Risk Modelling spreadsheets from Seagreen and Inch Cape based on the original project applications	Section 9.9.4 and Appendix 9.3: Collision Rate Modelling methods, inputs and results
1/11/2017 **Post-scoping opinion additional advice from Marine Scotland**	Email outlining non-breeding season illustrative example of calculation of non-breeding season impacts to Forth Islands SPA provided by SNH	Section 9.9.4 and Appendix 9.9: Cumulative Impact Assessment additional calculations
7/11/2017 **Post-scoping opinion additional advice from Marine Scotland**	Email outlining delay in availability of outputs from MS seabird apportioning tool project until 2018. MS-LOT advise that the SNH 2 step approach should be used for apportioning as outlined in the recent scoping opinions as the most appropriate method.	Section 9.9.5
8/11/2017 **Post-scoping opinion additional advice from Marine Scotland**	Email outlining SNH response to Inch Cape queries on the non-breeding season illustrative example provided by SNH and circulated by MS on 1/11/2017	Section 9.9.4
30/11/2017 **Post-scoping opinion additional advice from Marine Scotland**	Email outlining correction to the non-breeding season illustrative example provided by SNH and circulated by MS on 1/11/2017 and Forth & Tay Seabird Population Counts - Updated Appendix A(ii): Most recent population counts for the key seabirds and SPAs of relevance to the Forth and Tay offshore wind farm reassessments – gannet, kittiwake, herring gull, guillemot, razorbill and puffin.	Section 9.9.4
8/12/2017 **Post-scoping opinion additional advice from**	Further correction to Forth & Tay Seabird Population Counts - Updated Appendix A(ii): Most recent population counts for the key seabirds and SPAs of relevance to the Forth and Tay offshore wind farm reassessments – gannet, kittiwake, herring gull, guillemot, razorbill and puffin.	Section 9.9.4

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
Marine Scotland		

9.4.1 Impacts to be Assessed

16. The Scoping Opinion (Marine Scotland, 2017) highlighted the potential impacts on key species resulting from the Project that are required to be considered in this assessment (Table 9-3). In addition, some other species have also been included, based on numbers recorded on baseline surveys, and on whether they are listed as qualifying interest species for relevant SPAs.

Table 9-3: Potential impacts that have been included in the Project Assessment

Potential Impact	Reason for scoping in
Construction	
Impacts of Installation of turbines and Export Cables on the Outer Firth of Forth & St Andrews Bay pSPA	Although most potential impacts on birds arising during the construction phase of the Project have been scoped out of this EIA Report (Marine Scotland, 2017), part of the Wind Farm Area and the offshore export cable corridor are within the Outer Firth of Forth & St Andrews Bay pSPA. Therefore, MS-LOT will need to address turbine and export cable installation in any new appropriate assessment for the pSPA. An assessment of possible impacts on birds resulting from the installation of turbines and the export cables within the Outer Firth of Forth & St Andrews Bay pSPA is therefore included.
Operation	
Displacement and barrier effects on the following species: **Kittiwake, guillemot, razorbill & puffin**	Barrier effects during Operation were concluded to be of Minor significance for puffin in the Original EIA & Addendum. Displacement and barrier effects during Operation were concluded to be not significant for the remaining species in the Original EIA & Addendum. However, these species have been scoped in to the EIA Report for the Project on the basis of numbers of birds recorded within the Development Area in the breeding season, and the presence of SPAs within species mean maximum foraging range of the Project. In addition, kittiwake, guillemot, razorbill and puffin were highlighted as requiring assessment for displacement and barrier effects in the NnG Scoping Opinion (Marine Scotland, 2017).
Collision mortality impacts on the following species: **Gannet, Arctic skua, great skua, little gull, black-headed gull, common gull, lesser black-backed gull, herring gull, great black-backed gull & kittiwake**	Collision effects during Operation were concluded to be not significant for these species in the Original EIA & Addendum. However, these species have been scoped in to the EIA Report for the Project on the basis of flight heights recorded during baseline surveys, where more than 1% of recorded flight height was within the rotor-swept zone in the Original Application. In addition, gannet, kittiwake, herring gull, lesser black-backed gull and great black-backed gull were highlighted as requiring assessment in the NnG Scoping Opinion (Marine Scotland, 2017).

Seabird species to be considered in the assessment of Firth of Forth and St Andrews Bay Complex pSPA: **Gannet, Kittiwake, Herring gull, Puffin, Razorbill, Guillemot, Little gull, black-headed gull and common gull. The remaining qualifying species have been scoped out of the assessment, based on the low numbers recorded within the Project Study Area and on the advice received in the NnG Scoping Opinion (Marine Scotland, 2017)** Impacts to be assessed are displacement and collision impacts on qualifying species pf the pSPA arising from the overlap of the Wind Farm Area with the pSPA.	These species were highlighted as requiring assessment in the NnG Scoping Opinion (Marine Scotland, 2017). Assessment of pSPA also needs to include the offshore export cable corridor, as highlighted by RSPB in the Scoping Opinion (Marine Scotland, 2017).
Combined displacement and collision impacts	Combined displacement and collision impacts were highlighted as requiring assessment in the NnG Scoping Opinion (Marine Scotland, 2017). Kittiwake was the only species assessed for both displacement and collision impacts so was the only species considered for combined displacement and collision impacts.
Disturbance during Operation and Maintenance activities from helicopters **All species**	Helicopter use for O & M activities is scoped into the EIA Report for the Project as it may be utilised in future.
Cumulative Impacts	
Displacement	Cumulative displacement impacts were highlighted as requiring assessment in the NnG Scoping Opinion (Marine Scotland, 2017). Species assessed were kittiwake, guillemot, razorbill and puffin.
Collision	Cumulative collision impacts were highlighted as requiring assessment in the NnG Scoping Opinion (Marine Scotland, 2017). Species assessed were gannet and kittiwake.

17. Other potential impacts and species considered in the Original EIA and Addendum have been scoped out of this assessment, based on the advice received in the recent Scoping Opinion (Marine Scotland, 2017). These potential impacts will therefore not be considered further in this EIA Report.

9.5 Impact Assessment Methodology

18. This assessment considers the potential impacts associated with the construction, operation and decommissioning of the Project and the potential effects on ornithology. The impact assessment process and methodology follows the principles and general approach outlined in Chapter 6: EIA Methodology. The methodology and parameters assessed have also taken into account issues identified through consultation with stakeholders as detailed in Section 9.4 and the understanding of baseline conditions informed by the data sources referenced in Section 9.3.

19. The Project Description (Chapter 4) and the project activities for all stages of the project life cycle (construction, operation and decommissioning) have been assessed against the environmental baseline to identify the potential interactions between the Project and the environment. These are known as the potential impacts and are then assessed to determine a level of significance of effect upon the receiving environment.

9.5.1 Assessment and Assignment of Significance

20. The sensitivities of bird species are defined by both their potential vulnerability to an impact from the Project, their recoverability and value or importance of the bird species involved. The definitions of terms relating to ornithology are detailed in Table 9-4.

Table 9-4: Definition of terms relating to the environmental value (sensitivity of the receptor) (adapted from Highways Agency et al., 2008)

Value (sensitivity of the receptor)	Definition
High	High or very high importance and rarity, international or national scale and limited potential for substitution. Receptor population has very limited tolerance of effect i.e. likely to have limited capacity to absorb change, so a population level effect is likely to occur. Likely to be limited to populations with poor existing conservation status
Medium	High or medium importance and rarity, regional scale, limited potential for substitution. Receptor population has limited tolerance of effect i.e. a very minor capacity to absorb change so a population level effect possible. Likely to include but not be limited to populations with poor existing conservation status
Low	Low or medium importance and rarity, local scale. Receptor population has some tolerance of effect i.e. likely to have minor capacity to absorb additional mortality or a reduction in productivity, or habitat loss, so a population level effect unlikely.
Negligible	Very low importance and rarity, local scale. Receptor population generally tolerant of effect i.e. likely to have moderate capacity to absorb additional mortality or a reduction in productivity, or habitat loss, so a population level effect very unlikely.

21. The magnitude of impact is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact. The definitions of the levels of magnitude used in this assessment in respect of bird populations are described in Table 9-5. Guide percentages used to determine the magnitude of any effect were based on Regini (2000).

Table 9-5: Definition of terms relating to the magnitude of impacts on bird populations (adapted from Highways Agency et al., 2008)

Magnitude of impact	Description (adverse effects)	Description (beneficial effects)
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements. Major reduction in the status or productivity of a bird population due to mortality or displacement or disturbance.	Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality.
	Guide: >21% of population affected, >21% change factor in mortality or productivity rate.	
Medium	Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements. Partial reduction in the status or productivity of a bird population due to mortality or displacement or disturbance.	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
	Guide: 6-20% of population affected, 6-20% change factor in mortality or productivity rate.	
Low	Some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements. Small but discernible reduction in the status or productivity of a bird population due to mortality or displacement or disturbance.	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring.
	Guide: 1-5% of population affected, 1-5% change factor in mortality or productivity rate.	
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements. Very slight reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Reduction not detectable or barely discernible, approximating to the “no change” situation.	Very minor benefit to, or positive addition of one or more characteristics, features or elements.
	Guide: <1% population affected, <1% change factor in mortality or productivity rate.	
No change	No loss or alteration or characteristics, features or elements; no observable impact in either direction.	

22. The magnitude of the impact is correlated against the sensitivity of the receptor to provide a level of significance (Table 9-6). For the purposes of this assessment, effects rated as being of either **Moderate** or **Major** significance are considered **significant** in EIA terms. Any effect that is below moderate is not significant.

Table 9-6: Significance of potential effects

		Magnitude			
		High	Medium	Low	Negligible
Sensitivity	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

9.5.2 Uncertainty and Technical Difficulties Encountered

23. The assessment is based on the best information available at the time of undertaking the Project EIA. The assessment uses site-specific baseline data collected by trained and experienced ESAS observers each month over a period of three years (Section 9.6). The three years of baseline seabird data along with supporting information on the key seabird species over the wider area (e.g. tracking studies and breeding colony counts over a similar time period) provides a robust baseline on which to undertake an assessment.

24. The collision risk modelling that was conducted to help determine the extent and magnitude of any potential collision impact and the associated avoidance rates used in this assessment followed recommended guidance as presented in the Scoping Opinion (Marine Scotland, 2017).

25. Similarly, the displacement assessment followed recommended guidance presented in the Scoping Opinion (Marine Scotland, 2017). Although the revised Marine Scotland displacement model was not available for use at the time of this assessment, the Scoping Opinion recommended the use of the SNCB displacement matrices (SNCB, 2017) as an alternative approach and this was used for the assessment. The use of the three-year peak seasonal mean for the displacement assessment was considered to reduce uncertainty caused by natural variation in bird numbers and distribution between years.

26. There is limited information available on other offshore wind farm developments considered within the cumulative assessment. Where available, information presented within the 2017 scoping document for each project, or information circulated by the developers, has been used. However, where the relevant information is not otherwise available, the assessment is based on information published within the original applications. For Seagreen A and B, there were no population estimates available for the 2 km buffer area around the Wind farm Area.

27. For other, more distant North Sea offshore wind projects, the most conservative published collision estimate was used in the cumulative collision impact assessment, as detailed in Section 9.9.4. This was considered precautionery, as it resulted in a higher number of cumulative collisions being assessed.

28. The assessment used the North Sea BDMPS population estimates for the key SPAs in the vicinity of the Forth and Tay projects as reference populations for the non-breeding season (Furness, 2015), as recommended in the Scoping Opinion (Marine Scotland, 2017). There were some differences between the seasonal breakdowns presented in Furness (2015) and the seasonal breakdowns provided in the Scoping Opinion (Table 9-7), however, the seasonal breakdowns in the Scoping Opinion were followed in this assessment.

29. There is uncertainty over the potential construction schedule of the other, future offshore wind farms. This has a potential effect on the assessment when a population model is used to assess the population level effects arising from cumulative impacts. The worst-case scenario is predicted to arise if all currently planned future projects are included. For the purpose of this assessment this

precautionary assumption has been made. However, there is a high degree of uncertainty that this scenario will occur, as some future projects may not get constructed, or if they do, then the eventual number of turbines used will likely be much lower, due to improvements in turbine technology. It is therefore likely that any cumulative impacts would have a lower population level impact.

30. This assessment is based on the best available information and assessment methods currently available and although there are areas of uncertainty these are recognised within the approaches used for this assessment and a precautionary approach has been taken throughout.

9.6 Baseline Survey Methods

31. The methods used to conduct the three years of baseline seabird surveys between November 2009 and October 2012 followed standard COWRIE approved survey methodology (Camphuysen *et al.* 2004). Seabirds (and marine mammals) were recorded using an adaptation of the standard Joint Nature Conservation Committee (JNCC) Seabirds at Sea survey method, which uses line transect methodology (see Webb & Durinck 1992 for further details).

32. Within the Project study area, there are two components; the Wind Farm Area and the surrounding Buffer area, which extends out to 8 km (Figure 9-1). A series of transects running in a north-west to south-easterly direction across the Wind Farm Area and 8 km buffer area and spaced 2 km apart were surveyed each month.

33. Surveys were conducted on the *M.V. Fleur de Lys* in Years 1 and 2, which has a custom-built surveyor platform with an observer eye-height of greater than 5 m, as recommended for ESAS surveys (Webb & Durinck 1992, Camphuysen *et al.* 2004). In Year 3, surveys were conducted onboard *M.V. Eileen May*, which had a survey platform with a similar observer eye-height to the previous survey vessel.

34. Birds were counted ahead of the ship and out to one side of the survey vessel in a 90° arc, with a 300 m transect width, using two surveyors, as per Camphuysen *et al.,* (2004). Three ESAS accredited surveyors were on board for the majority of surveys, apart from between November and March of Year 1, and February of Year 3 when only two ESAS surveyors were on board. At any one time, one surveyor was acting as the primary observer, with a second acting as scribe and secondary observer, while the third surveyor was on a break.

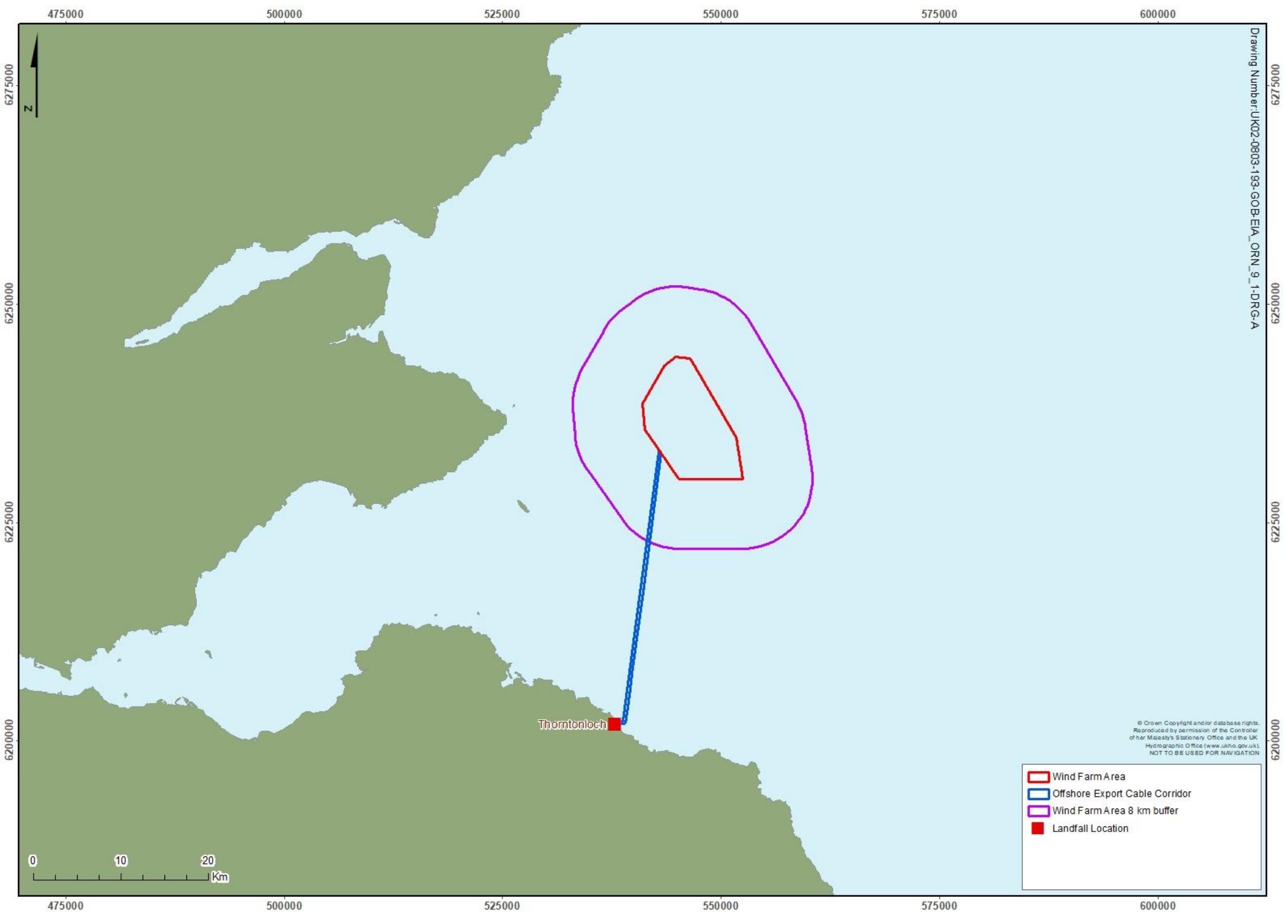


Figure 9-1 Wind Farm Area and 8 km buffer area

35. Binoculars were used to confirm identifications as well as to scan ahead for species such as red-throated divers, which are easily disturbed and take flight at some distance from the approaching vessel. Birds on the water were assigned to distance bands (A = <50 m, B = 51-100 m, C = 101-200 m, D = 201–300 m, E =>300 m), according to their perpendicular distance from the ship's track.

36. A snapshot method was used for flying birds, which considers the ship's speed and prevents overestimation of flying seabird densities. In addition, the estimated height of flying birds was also recorded, to the nearest 5 m. The count interval for surveys was 1 minute intervals, and synchronised GPS recorders were used to record the vessel position every minute. Any marine mammals and uncommon bird species seen on the 'non-survey' side of the vessel were also recorded. All terrestrial bird species seen were also recorded.

37. Environmental conditions such as wind direction and force, sea state, swell height and visibility were recorded every 15 minutes throughout survey days. Surveys were carried out in good weather where possible, to maximise detection rates of birds and marine mammals on the water. Surveys were halted if the sea state exceeded sea state 4, as recommended in Camphuysen (2004).

38. Baseline surveys were conducted by Simon Pinder, Ailsa Reid, Richard Schofield, Caroline Weir, Stuart Murray, Digger Jackson, Ewan Wakefield, Andy Sims, John Clarkson, Tim Sykes, Rachel Coombes, Jon Ford, Paul French, Jonathon Clarke, Bill Aspin, Phil Espin and Chris Rodger. All surveyors were ESAS-accredited.

39. Following completion of each survey, survey datasheets were entered onto a Paradox database using the JNCC Seabirds at Sea Team data-entry program, then printed and manually checked for any errors before the analysis of the data was conducted.

40. These data formed the basis for estimating population sizes and densities of seabirds in the study area. These estimates were derived by applying Distance sampling techniques using Distance 6.0

software. Further details on this technique and associated corrections in relation to the baseline survey data are presented in Appendix 9.1: Population and density estimates of seabirds at Neart na Gaoithe. Distance analysis of ship-based survey data from the period November 2009 to October 2012. Bureau Waardenburg. 2013.

41. The Scottish Ministers, SNH and RSPB concluded in the Scoping Opinion that additional baseline seabird surveys were not required for this application (Marine Scotland, 2017).

9.7 Baseline Description

9.7.1 Definition of Seasons and Reference Populations

9.7.1.1 Definition of Seasons

42. The breakdown of months for the breeding and non-breeding seasons for the key species covered in this assessment followed the Scoping Opinion (Marine Scotland, 2017), and are shown in Table 9-7. Where seasons were split within months e.g. mid-March to September, monthly totals of birds were split 50:50 between each season, as recommended in the Scoping Opinion (Marine Scotland, 2017).

Table 9-7: Definitions of breeding and non-breeding season used in this assessment, as provided in the Scoping Opinion (Marine Scotland, 2017)

Species	Breeding season	Non-breeding season
Gannet	Mid-March to September	Autumn – October and November Spring – December to mid-March
Kittiwake	Mid-April to August	Autumn - September to December Spring – January to mid-April
Herring gull	April to August	September to March
Lesser black-backed gull	Mid-March to August	Not present in significant numbers
Great black-backed gull	April to August	September to March
Puffin	April to mid-August	Mid-August to March
Guillemot	April to mid-August	Mid-August to March
Razorbill	April to mid-August	Mid-August to March

9.7.1.2 Reference Populations

43. Most recent population counts for the key seabirds and breeding colony SPAs of relevance to this assessment have been taken from Appendix A(ii) of SNH guidance, as provided in the Scoping Opinion (Marine Scotland, 2017) (Table 9-8). For the breeding season, those SPAs within mean maximum foraging range (+1 SD) for each species, based on Thaxter *et al.,*(2012) were used in the assessment. For the non-breeding season, all SPAs listed as relevant for each species were used in the assessment, on the basis that individuals from these SPAs may occur in the Wind Farm Area at this time.

Table 9-8: Most recent population counts for the key seabirds and breeding colony SPAs of relevance to this assessment, as provided in Scoping Opinion (Marine Scotland, 2017)

Species	SPAs and distance from NnG	SPA Citation population [4]	Most recent counts & year
Gannet	Forth Islands (16 km)	21,600 pairs	75,259 pairs (2014)
Kittiwake	Buchan Ness/Collieston Coast (113 km) Forth Islands (16 km) Fowlsheugh (62 km) St Abb's Head to Fast Castle (31 km) **Total**	30,452 pairs 8,400 pairs 36,350 pairs 21,170 pairs **96,372 pairs**	11,482 pairs (2016-17) 4,663 pairs (2017) 9,655 pairs (2015) 3,334 pairs (2016) **29,134 pairs**
Herring gull	Buchan Ness/Collieston Coast (113 km) Forth Islands (16 km) Fowlsheugh (62 km) St Abb's Head to Fast Castle (31 km) **Total**	4,292 pairs 6,600 pairs 3,190 pairs 1,160 pairs **15,242 pairs**	3,115 pairs (2016-17) 6,580 pairs (2014-17) 125 pairs (2015) 325 pairs (2016) **10,145 pairs**
Lesser black-backed gull	Forth Islands (16 km)	2,920 pairs [1]	2,571 pairs (2014-16)
Great black-backed gull	No SPA within mean maximum foraging range	-	121 pairs Forth Islands in 2015-16. Not SPA.
Puffin	Forth Islands (16 km)	14,000 pairs	45,005 pairs (2009-17)
Guillemot	Buchan Ness/Collieston Coast (113 km) Forth Islands (16 km) Fowlsheugh (62 km) St Abb's Head to Fast Castle (31 km) **Total**	17,280 birds 8,000 birds 56,450 birds 31,750 birds **113,480 birds**	33,632 birds (2016-17) 28,786 birds (2017) 55,507 birds (2015) 36,206 birds (2016) **154,131 birds**
Razorbill	Forth Islands (16 km) Fowlsheugh (62 km) St Abb's Head to Fast Castle (31km) **Total**	2,800 birds 5,800 birds 2,180 birds **10,780 birds**	5,815 birds (2017) 7,426 birds (2015) 2,067 birds (2016) **15,298 birds**

9.7.2 Wind Farm Area

9.7.2.1 Results from Site Specific Baseline Surveys for Key Species

44. Within the NnG Wind Farm Area, 22 species of seabird were recorded during Year 1 baseline surveys. The three most frequently recorded species in the Wind Farm Area in Year 1 were gannet, puffin and guillemot, which together accounted for 62.3% of all birds recorded. In Year 2, 16 species were recorded in the Wind Farm Area, with gannet, guillemot and puffin again the three most frequently recorded species. These three species accounted for 77.1% of all birds recorded. In Year 3, 17 species were recorded in the Wind Farm Area, with gannet, guillemot and puffin again the three most frequently recorded species. These three species accounted for 72.9% of all birds recorded.

[4] Stroud *et al.*, 2001

45. There were eight species highlighted for assessment in the Scoping Opinion (Marine Scotland, 2017). Raw numbers of these species recorded in the Wind Farm Area and the Project Study Area during baseline surveys are presented in Table 9-9.

Table 9-9: Raw numbers of the eight key species recorded on baseline surveys in the Project study area in Years 1 to 3 (Raw numbers, all sea states)

Species	Year One		Year Two		Year Three	
	Wind Farm Area	Project Study Area	Wind Farm Area	Project Study Area	Wind Farm Area	Project Study Area
Gannet	1,649	13,021	3,122	19,416	2,134	14,825
Kittiwake	801	3,955	719	4,123	838	4,300
Herring gull	50	1,723	58	1,433	54	800
Lesser black-backed gull	10	66	11	195	37	171
Great black-backed gull	25	528	20	434	17	225
Guillemot	1,252	7,898	1,544	11,730	1,769	11,557
Razorbill	596	3,980	350	3,131	278	1,915
Puffin	1,306	11,199	1,110	6,622	1,196	5,983

46. Species accounts summarising the main findings of the baseline surveys for each of these eight species are presented in Appendix 9.2: Summary of results from baseline surveys for key species considered in this assessment. In addition, summary species accounts are also provided for five additional species (Arctic skua, great skua, little gull, black-headed gull and common gull) which were recorded in low numbers on baseline surveys, but which are included in the collision risk modelling assessment. These five species were included in the assessment on the basis of flight heights recorded during baseline surveys, where more than 1% of recorded flight height were above 27.5m in height.

9.7.3 Offshore Export Cable Corridor

47. In addition to the Wind Farm Area, the assessment of the Outer Firth of Forth and St Andrews Bay Complex proposed Special Protection Area (pSPA) should include the Offshore Export Cable Corridor, as highlighted by RSPB in the Scoping Opinion (Marine Scotland, 2017). During construction, the possibility of indirect effects on bird communities resulting from impacts on prey availability may occur.

48. For this reason, a summary of both benthic habitats and fish species likely to occur in the vicinity of the Offshore Export Cable Corridor and the wider area, including the Wind Farm Area is presented below. Further information is available in the Benthic Characterisation Report (Emu Ltd., 2010) (Appendix 7.1).

49. The offshore part of the cable route lies within the 'deep circalittoral mud' habitat indicated as characteristic of the outer Forth Estuary and widely distributed in this area. The southern end of the cable route corresponds to deep 'circalittoral coarse sediment' and 'low energy rock' habitats towards the Thortonloch landfall. All habitats along the cable route option appear to be common throughout the wider region (Emu Ltd., 2010).

50. In conclusion, the subtidal benthic environment was classified as a low energy, deep water (circalittoral) seabed environment within the vicinity of the Project (Emu Ltd., 2010). The dominant sediment type was slightly gravelly sand sediments with small amounts of silt, which was characterised by typical mud and sand fauna comprising infaunal brittlestars, polychaetes and bivalves. Sea bed imagery revealed that this sand habitat was also associated with sea pens and prominent mounds and burrows produced by megafauna. No rare or protected benthic species were recorded from the grab, trawl and video studies (Emu Ltd., 2010).

51. The principal pelagic fish species found in the vicinity of the Wind Farm Area and Offshore Export Cable Corridor are typical of the wider North Sea and include herring *Clupea harengus*, sprat *Sprattus sprattus* and mackerel *Scomber scombrus*. These species are commercially exploited in the wider region (see Chapter 10: Commercial Fisheries for details) and sprat and herring play an important ecological role as principal prey items for several larger fish species, seabirds and marine mammals.

52. Neither the Wind Farm Area nor the Offshore Export Cable Corridor coincide with sprat spawning areas, while herring spawning areas only coincide with the inshore region of the export cable. The Development area does not coincide with spawning areas for mackerel (Ellis *et al.* 2012, Coull *et al.* 1998). Both the Wind Farm Site and Offshore Export Cable Corridor are located in herring, sprat and mackerel nursery areas. The nursey grounds for mackerel in this area are stated as “low intensity”, while the nursey areas for herring are stated as “high intensity.

53. There are also several demersal species found in the vicinity of the Wind Farm Area and Offshore Export Cable Corridor, including sandeels (*Ammodytes* species), which are of particular importance as they occur within the foraging range of many seabirds breeding at colonies in and around the Firth of Forth (Wanless *et al.*, 1998).

9.7.4 Special Protection Areas (SPAs)

9.7.4.1 Terrestrial SPAs

54. There are four terrestrial SPAs for breeding seabirds that are within mean maximum foraging range of the key seabird species considered in this assessment (Table 9-8). The following site summaries are taken from online iSPA descriptions (JNCC, 2001).

55. The Firth of Forth Islands SPA is located in or near to the Firth of Forth on the east coast of central Scotland. The SPA comprises a number of separate islands or island groups, principally Inchmickery (together with the nearby Cow and Calves) off Edinburgh, Fidra, Lamb and Craigleith together with the Bass Rock off North Berwick, and the much larger Isle of May in the outer part of the Firth. The islands support important numbers of a range of breeding seabirds, in particular terns, auks and gulls. During the breeding season, the area regularly supports important numbers of breeding gannets, razorbills, guillemots, kittiwakes, herring gulls, lesser black-backed gulls, cormorants, shags, fulmars, puffins, common terns, Arctic terns and roseate terns. The seabirds feed outside the SPA in nearby waters, as well as more distantly in the North Sea.

56. Fowlsheugh SPA is located on the east coast of Aberdeenshire in north-east Scotland, overlooking the North Sea. The sheer cliffs, between 30-60 m high, are cut mostly in basalt and conglomerate of Old Red Sandstone age. They form a rock face with diverse structure providing ideal nesting sites for seabirds. The cliffs support major numbers of breeding seabirds, especially gulls and auks. During the breeding season, the area regularly supports important numbers of breeding razorbills, guillemots, kittiwakes, herring gulls and fulmars.The seabirds feed outside the SPA in nearby waters, as well as more distantly in the North Sea.

57. Buchan Ness to Collieston Coast SPA is located on the coast of Aberdeenshire in north-east Scotland. It is a 15 km stretch of south-east facing cliff formed of granite, quartzite and other rocks running to the south of Peterhead, interrupted only by the sandy beach of Cruden Bay. The site is of importance as a nesting area for a number of seabird species (gulls and auks). During the breeding season, the

area regularly supports important numbers of breeding guillemots, kittiwakes, herring gulls, shags and fulmars. These birds feed outside the SPA in the nearby waters, as well as more distantly.

58. St Abb's Head to Fast Castle SPA lies on the coast of Berwickshire in south-east Scotland. It is a 10 km stretch of cliffs comprised of Old Red Sandstone and Silurian rocks, in places reaching over 150 m in height. The cliffs are backed by areas of grassland, open water, flushes and splash zone communities. The site is important for large numbers of breeding seabirds, especially auks and gulls, which feed outside the SPA in surrounding marine areas, as well as further away in the North Sea. During the breeding season, the area regularly supports important numbers of breeding razorbills, guillemots, kittiwakes, herring gulls and shags.

9.7.4.2 Outer Firth of Forth & St Andrews Bay pSPA

59. The following information is based on the SPA Site Selection Document produced in support of the pSPA designation (SNH 2016).

60. The Outer Firth of Forth and St Andrews Bay Complex proposed Special Protection Area (SPA) is a large estuarine/marine site with a total area of 2720.68km^2 situated off the south-east coast of Scotland. It consists of the outer sections of the adjacent Firths of Forth and Tay, including St Andrew's Bay, together with adjacent marine waters, to the east of the Isle of May (Table 9-2).

61. The Outer Firth of Forth and St Andrews Bay Complex has been selected to provide protection to important wintering grounds used for feeding, moulting and roosting by eight species of non-breeding inshore waterfowl (divers, grebes and seaduck). This wintering waterfowl assemblage includes the Annex 1 species red-throated diver and Slavonian grebe and over 1% of the biogeographical population of common eiders. Many of these birds migrate to Scotland every year to overwinter or to stop off at as one of their staging posts while on migration. The Firth of Forth is also notable for its concentrations of four species of wintering gulls, including Annex 1 little gulls and large numbers of roosting black-headed, common and herring gulls. In the non-breeding season these together with kittiwakes, guillemots, shags and razorbills contribute to an assemblage of over 40,000 seabirds using the site. The site also encompasses feeding grounds for breeding common terns, Arctic terns and shags nesting at SPA colonies within the site. During the breeding season kittiwakes, gannets, herring gulls, guillemots, puffins, and Manx shearwaters also contribute to a major assemblage of over 100,000 seabirds.

62. The Outer Firth of Forth and St Andrews Bay Complex proposed SPA, lying adjacent to the existing SPAs of the Firth of Forth and the Firth of Tay and Eden Estuary, supports populations of European importance of the following Annex 1 species:

- Red-throated diver;
- Little gull;
- Common tern;
- Arctic tern, and
- Slavonian grebe.

63. It also supports migratory populations of European importance of the following species: eider, Long-tailed duck, common scoter, velvet scoter, goldeneye, red-breasted merganser, gannet, Manx shearwater, shag, kittiwake, guillemot, razorbill puffin, black-headed gull, common gull and herring gull.

64. The area supports a wide variety of both pelagic and demersal fish, including sandeels, and crustaceans, molluscs and marine worms. The abundance of sandeels is of particular importance to colonial seabirds including terns, shags, puffins, razorbills, guillemots and kittiwakes which breed in colonies within and close to the pSPA, including the Isle of May. Gannet also feed on sandeels but are capable of taking a wider range of fish, including larger species such as herring and mackerel. Bass Rock, which is the largest gannet colony in the UK, is also situated in the Firth of Forth. Terns and

kittiwake feed on prey close to the water surface, whereas shags, puffins, razorbills, guillemots and gannet will also pursue prey underwater, in some cases to great depths.

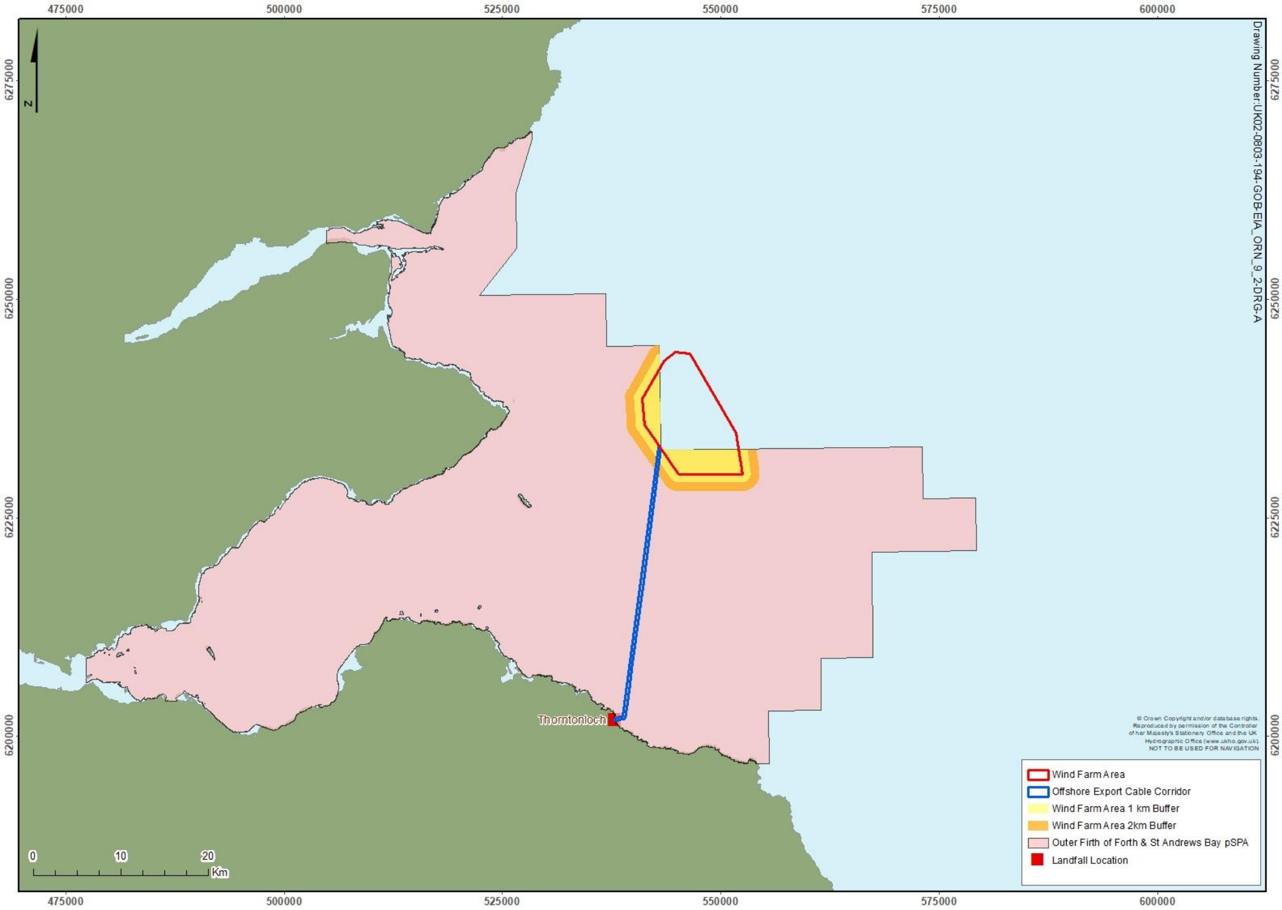


Figure 9-2: Outer Firth of Forth and St Andrews Bay pSPA

9.7.5 Development of Baseline Conditions without the Project

65. In the event of the NnG Project not being developed, there would be no change in the baseline conditions in the Wind Farm Area beyond those resulting from drivers such as climatic factors (such as temperature change and subsequent impacts of species' ranges), or human activities such as changes in fishing activities that indirectly affect seabird communities.

66. The numbers of seabirds using and passing through the Wind Farm Area over the next 50 years (the period when it is assumed the Wind Farm could be operational), would reflect changes in local distribution and populations which are driven by these factors.

9.8 Design Envelope – Worst Case Design Scenario

67. The Project application is for the construction, operation and decommissioning of an offshore wind farm with a maximum capacity of 450 MW, and a maximum of 54 turbines. The assessment scenarios identified in respect of ornithology have been selected as those having potential to represent the greatest effect on birds, based on the design envelope described in Chapter 4: Project Description.

68. The assessment of potential impacts on birds within this chapter is based on this design envelope, with the development methodology and parameters being based upon the worst case scenario.

69. Key parameters for the worst case scenario for each potential impact are detailed in Table 9-10.

Table 9-10: Design envelope scenario assessed

Potential Impact	Worst Case Design Scenario	Justification
Construction		
Disturbance and loss of seabed habitat arising from cable installation	Two export cables approximately 43 km in length. Cable corridor is approximately 33 km long (site boundary to landfall). Burial depth is maximum of 3m. Maximum 300m spacing between cables. 3x water depth but no less than 70m. Burial method currently unconfirmed, but likely plough/cutting/jetting or rock cover. Installation will require one primary vessel with dynamic positioning and up to three support vessels. Likely vessel speed of 2-3km per day. Installation methods under consideration include: Use of high-pressure pump/jets to cut trenches where sandy conditions exist. Having laid the cable, the trenches will close naturally without backfilling; Use of mechanical cutters or cable ploughs; Laying of cable on the seabed and covering with scour protection, either with rock mattress or over placement with unbound graded rock (where bedrock outcrops at seabed level or thin sediment layer is present over the bedrock).	This is the worst case scenario for disturbance. Final methods for cable trenching will be established following final detailed geotechnical surveys therefore at this stage, none of these potential methods can be excluded.
Operation		
Displacement and barrier effects	Wind farm footprint and 2 km buffer.	A single wind farm footprint and 2 km buffer is the worst case. Variations on the potential design e.g. turbine numbers, are not considered as the assessment uses displacement rates recommended by the Scoping Opinion.

Potential Impact	Worst Case Design Scenario	Justification
Collision mortality	Maximum of 54 turbines Minimum air gap of 35m LAT Rotor diameter 167m See Chapter 4: Project Description and Appendix 9.3 for further details of turbine design parameters	The maximum number of modelled collisions occurs due to the maximum number of turbines, therefore this forms the worst case. The air gap will vary across the site and whilst the lowest rotors will be at 35m LAT, it cannot currently be determined how many rotors will be higher. Therefore a precautionary approach has been taken, where it is assumed that all rotors have a minimum air gap of 35m LAT. The maximum rotor diameter under consideration is 167m.
Disturbance during Operation and Maintenance activities from helicopters	80 round trips to site anticipated per annum for a small helicopter	If helicopters are used (which is not certain), 80 is considered to be the maximum number of annual trips therefore this is considered to be the worst case scenario for disturbance.
Cumulative Effects		
Cumulative displacement impacts	For NnG and Inch Cape, worst case scenario taken as birds displaced from Wind Farm Area and 2 km buffer. For Seagreen A & B, no figures available for 2 km buffer, so worst case was birds displaced from Wind Farm Area only.	This was recommended approach in Scoping Opinion (Marine Scotland, 2017).
	Scenario One: NnG with proposed updated designs for Seagreen and Inch Cape **NnG:** 2017 worst-case design scenario (54 turbines) (as above) **Seagreen Phase 1:** 120 turbines Minimum rotor height of 29.8m LAT Rotor diameter 167m **Inch Cape:** 40 turbines Minimum rotor height of 30.5m LAT Rotor diameter 250m See Appendix 9.3 for further details of turbine design parameters.	NnG 2017 worst-case design scenario (54 turbines) (as above). Seagreen 2017 – maximum turbine numbers (120) within Seagreen revised design were used. These are assumed for a scenario with lowest individual turbine capacity. Currently the lowest turbine capacity likely to be used would be an 8MW machine, therefore the parameters of a known 8MW were the basis for the assessment. Minimum air gap was provided by Seagreen. Air gaps will vary and in some cases will be higher, so this is a precautionary approach. Inch Cape – a comparison of CRM outputs was undertaken for turbine numbers/parameters provided by ICOL. The worst case was using a theoretical maximum rotor

Potential Impact	Worst Case Design Scenario	Justification
		diameter of 250m (far larger than anything available or present or in the near future). Such a large generator would use the lowest number of turbines in ICOL's range i.e. 40. Minimum air gap was provided by Inch Cape. Air gaps will vary and in some cases will be higher, so this is a precautionary approach.
	Scenario Two: NnG with consented designs for Inch Cape and Seagreen **NnG:** 2017 worst-case design scenario (54 turbines) (as above) **Seagreen:** Maximum of 75 turbines per project (consented) Minimum rotor height of 29.8m LAT Rotor diameter 167 m **Inch Cape:** Maximum of 110 turbines (consented) Minimum rotor height of 27 m LAT Rotor diameter 172 m See Appendix 9.3 for further details of turbine design parameters.	NnG 2017 worst-case design scenario (54 turbines) (as above). For Inch Cape and Seagreen, 2014 scenarios were assessed as these were the worst case designs for the existing consents. It is considered highly unlikely that these projects will be built to this extent, therefore they are considered to be precautionary and unrealistic.
Collision impacts from other UK OWF projects	For kittiwake collision impacts in the non-breeding season, NnG 2017 & 2014 consents for Inch Cape & Seagreen A & B were considered, along with collision estimates for UK offshore wind farms in North Sea. For gannet collision impacts, projects in the English Channel were also included. In addition, all four 2017 proposed projects, together with UK offshore wind farms in North Sea (and English Channel for gannet) – see Section 9.9.4.	This was recommended approach in Scoping Opinion (Marine Scotland, 2017).

9.8.1 Embedded Mitigation

70. Mitigation measures that have been identified and adopted into the Project design as the design envelope has evolved and that are relevant to ornithology are set out in Table 9-11. In the event that further mitigation is required that cannot be embedded into the Project, this has been included as additional mitigation and is set out in Section 9.10.

Table 9-11: Embedded mitigation relating to ornithology

Design Parameter	Embedded Mitigation
Operation	
Number of turbines	The number of turbines was reduced from a maximum of 125 at the time of the Original Application to a maximum of 90 at the time of the addendum and 75 for the Original Consents. The reduced turbine numbers and increased spacing was anticipated to reduce the risk of collision, displacement and barrier effects on birds. The design evolution of the Project has continued and the number of turbines has been further reduced to a maximum of 54 turbines for the Project EIA Report.
Rotor height	Increasing the turbine rotor height reduces the risk of collision for a number of seabirds, many of which rarely fly above about 25 m but occur regularly at around 20 m. Therefore an increase in turbine height can cause a reduction in the number of predicted collisions. Minimum rotor height was increased from 26m above LAT in the Original Application to 30.5m above LAT in the Addendum. The design evolution of the Project has continued and the minimum rotor height has been further increased to a minimum rotor height of 35m above LAT and the assessments are on this basis.

9.9 Impact Assessment

71. Based on the requirements set out in the Scoping Opinion (Marine Scotland, 2017), the impact assessment focuses only on the operational phase of the Project, with the exception of construction phase impacts on the the Outer Firth of Forth & St Andrews Bay pSPA which are considered in the following section. Currently, impacts on birds resulting from decommissioning activities are expected to be no greater than those during the construction phase. Decommissioning impacts are considered to be covered under Construction Phase Impacts below, with no further assessment required.

9.9.1 Construction Phase Impacts

72. Although most of the potential impacts on birds arising during the construction phase of the Project have been scoped out of this EIA Report (Marine Scotland, 2017), part of the Wind Farm Area and the offshore export cable corridor are within the Outer Firth of Forth & St Andrews Bay pSPA (Table 9-2). Therefore, MS-LOT will need to address turbine and export cable installation in any new appropriate assessment for the pSPA, as highlighted in the Scoping Opinion (Marine Scotland, 2017). An assessment of possible impacts on birds resulting from the installation of turbines and the export cables within the Outer Firth of Forth & St Andrews Bay pSPA is therefore included.

9.9.1.1 Impacts of Installation of Turbines and Export Cables on the Outer Firth of Forth & St Andrews Bay pSPA

73. In their response to the Scoping Opinion (Marine Scotland, 2017), SNH considered that cable installation would not result in any significant amount of permanent habitat loss and were satisfied that the scoping report adequately addressed the potential cable impacts for each of the Forth & Tay wind farms and the liklihood of significant effects arising on ornithological receptors. SNH stated that any habitats or prey disturbed during the cable laying should not take long to recover and that they did not consider that cable installation would give rise to any significant amount of permanent habitat loss.

74. In their response to the scoping process, the RSPB accepted that potential impacts on the pSPA from the export cabling from the Forth & Tay wind farms and NnG turbine array could be small, however they did not agree that this necessarily meant they would be insignificant. RSPB considered it necessary that further information be provided to inform the requirements of the Birds & Habitats Directive. The RSPB suggested that information on the scale and longevity of the potential effect on the supporting habitats needed to be presented as part of the assessment.

75. In conclusion, the Scoping Opinion stated that "In order to inform the appropriate assessment ("AA") for the pSPA, NnGOWL should consider the footprint of the wind turbines and also the cable route in relation to the qualifying interests and conservation objective regarding habitat deterioration."

76. Details of the turbines and Offshore Export Cables and Cable Corridor are presented in Table 9-10. Further details are presented in Chapter 4: Project Description.

77. The export cable installation methods to be adopted will ultimately be dependent on the ground conditions along the export cable route. Final decisions will be made following further detailed geotechnical investigations and engineerign design work. Given the length of the proposed Export Cable Route Corridor a combination of methodologies may be required to bury the cable in different sections of the route. Seabed conditions or protection issues may require the cable to be protected by scour protection instead of, or in addition to, burial. It is estimated that up to 15% of the export cable route could require additional cable protection.

78. As highlighted in the Scoping Opinion (Marine Scotland, 2017), the existing consents, as previously issued for the Originally Consented Project, require the submission, for approval, of a cable installation plan (or cable lay strategy). The cable installation plan will detail how the final cable routing takes account of environmental sensitivities, including pSPA features of interest, and will also include a cable burial risk assessment so will provide details of the location of any required cable protection material. NnGOWL would expect a similar requirement in the consents issued for the Project.

79. The scoping report (NnGOWL, 2017) concluded that there will be no likely adverse significant effects on the benthic communities in the vicinity of the turbines or the Offshore Export Cable Corridor as a result of seabed sediment disturbances and re-deposition during construction. This view was shared by the Scottish Ministers who agreed that impacts on benthic habitats could be scoped out of this EIA Report. Impacts on fish and shellfish habitats arising from construction were also scoped out (with the exception of particle motion effects) on the basis that there would be no likely significant effects.

9.9.1.2 Direct impacts on birds

80. Direct habitat loss impacts during construction on birds are considered to be of negligible magnitude due to the very localised and short-term effects of such habitat loss, effectively representing a very slight change to baseline conditions. Therefore, direct habitat loss during construction on birds during all seasons is evaluated as a negligible impact, with any effects predicted to lie within the limits of natural variation of a dynamic seabed ecosystem.

9.9.1.3 Indirect impacts on birds

81. During construction, there is the potential for indirect effects on bird communities resulting from impacts on prey availability to occur. Within the Wind Farm Area that overlaps with the pSPA site boundary, there is the potential for the loss of habitat arising from the physical presence of the turbines. The possible loss of seabed habitat due to the physical presence of the turbines will occur on the seabed at each of the turbine locations. The scour protection around each turbine is estimated to be up to 1,200m^2. If each turbine foundation impacts an area of 1,200m^2 then there is the potential for a maximum loss of 64,800m^2 (0.064 km^2) of seabed habitat. In addition, there is the possibility that an Offshore Substation Platform will be situated within the pSPA, which would remove

a further 2,400m^2 of seabed habitat. The total potential area of seabed habitat lost would therefore be 67,200m^2 (0.0672 km^2).

82. This assessment is based on the worst-case scenario that all 54 turbines will be within the pSPA. However, approximately 68% of the Wind Farm Area is outwith the pSPA and therefore approximately 68% of the turbines will occur outwith the pSPA boundary and have no physical impact on the pSPA. It is therefore assumed that the potential habitat lost from turbine installation will be 68% less than 67,200m^2, which means that approximately 21,504m^2 (0.021504 km^2) of seabed habitat could be lost. The potential loss of 0.021504 km^2 of seabed habitat out of a total pSPA area of 2,720.68 km^2 is 0.0008% of the physical habitat within the pSPA.

83. It is concluded that the very small area of seabed habitat lost within the pSPA as a result of turbine installation will not cause a significant effect on benthic habitats within the pSPA and therefore will not result in indirect impacts on seabirds. No further assessment on the potential loss of habitat has been undertaken.

84. As summarised in Section 9.7.3, all habitats along the cable route option appear to be common throughout the wider region, indicating that there will be no significant effect on habitat diversity at the regional level as a result of the construction of the wind farm (Emu Ltd., 2010).

85. The assessment considered all birds of all sensitivities in all seasons. Indirect disturbance impacts during turbine installation or export cable installation on birds via impacts on fish prey were considered to be of negligible magnitude. As noted above, any such effects have been identified as not giving rise to likely significant effects at scoping. Any impacts in relation to installation of turbines or the Offshore Export Cables are very small in relation to seabird species foraging ranges, and are short-term and reversible. As a result it is considered highly unlikely that seabird communities would be affected given the absence of any significant effects on benthos or fish species.

86. Any such impact is therefore considered to represent no more than a short-term, slight change from baseline conditions, with any effects to lie within the limits of natural variation. Indirect impacts on seabird populations from the surrounding Outer Forth and St Andrews Bay pSPA arising from turbine or the export cable installation have therefore been evaluated as negligible. The significance of any impacts is therefore assessed to be **minor** at worst, and the potential indirect impact from habitat loss or disturbance during installation of turbines and the Expoprt Cable on seabirds is not significant.

9.9.2 Operational Phase Impacts

87. Impacts predicted to occur during the operational phase of the Project are presented below and based on the requirements set out in the Scoping Opinion (Marine Scotland, 2017).

9.9.2.1 Displacement and barrier effects

88. Displacement and barrier effects have been considered together in this assessment, as recommended by the SNCBs (SNCB 2017). Depending on the season and species involved, different methods have been applied during the assessment; these are outlined further below.

89. Displacement and barrier effects in the breeding and non-breeding seasons have been assessed for the following species, based on numbers of these species recorded in the Wind Farm Area during the baseline surveys and following the recommendations set out in the Scoping Opinion (Marine Scotland, 2017):

- Kittiwake;
- Puffin;
- Guillemot; and
- Razorbill.

90. The definition of breeding season for each species followed advice in the Scoping Opinion (Table 9-7) (Marine Scotland, 2017). The assessment of displacement and barrier effects in the breeding season followed the recent SNCB guidance (2017). In addition, the original CEH displacement modelling (2014) was also used as a basis for running a comparative assessment of breeding season effects for kittiwake, puffin, guillemot and razorbill.

91. The SNCB guidance (2017) states that a proportion of birds recorded within offshore wind farms may be passing through, and are therefore more likely to be affected by barrier effects, rather than displacement from the offshore wind farm, and that this is more likely to be the case for flying birds. However, the guidance concludes that there is currently not enough evidence to separate these impacts out and apportion to the two groups. In accordance with the guidance, this assessment assumes that total numbers of birds on site (flying and on water) are subject to displacement impacts.

92. Displacement impacts were assessed based on the overall mean seasonal peak numbers of birds (averaged over three years of baseline surveys) in the development footprint and 2 km buffer, as specified in the guidance. Mean seasonal peak population estimates were calculated by summing the highest monthly population estimate for the relevant season in years 1 to 3 and dividing by the number of years. Breeding seasons were determined using the seasonal breakdown provided by SNH (Table 9-7). Where a month was split across a season (e.g. mid-April to August), the monthly population estimate was split equally between the breeding and non-breeding season, as recommended in the Scoping Opinion (Marine Scotland, 2017). Where appropriate, the non-breeding season was further broken down into autumn and spring periods to allow comparison with non-breeding season seabird populations calculated in a recent review (Furness, 2015), as recommended in the Scoping Opinion (Marine Scotland, 2017).

93. For kittiwake, the ratio of different age classes recorded on surveys was used to estimate the number of adult birds present in each season. Due to the difficulty in aging guillemots, razorbills and puffins at sea, age ratios were assigned using the proportions from the stable age structure used in the PVA, as recommended in the Scoping Opinion (Marine Scotland, 2017).

94. For each species, a range of potential displacement is presented (in 10% intervals from 0% to 100%), based on the mean seasonal peak estimated numbers from baseline surveys as matrix tables. Values are presented for the Wind Farm Area and the Wind Farm Area plus a 2 km buffer, as recommended in the SNCB guidance (2017).

95. Mortality of adult birds displaced from the development site (plus buffer) was considered in this assessment. Reduction in productivity of breeding birds was not considered in the assessment, as recommended in the SNCB guidance, due to the lack of empirical evidence on the consequence of displacement to seabirds. Mortality of displaced birds was presented in 1% intervals between 1 and 5%, and 10% intervals between 10% and 100%. The rate of displacement and mortality used in the assessment was based on available published evidence and also on the recommendations set out in the Scoping Opinion (Marine Scotland, 2017). Displacement and mortality matrices for species covered in this assessment are presented in Appendix 9.4: Displacemet matrices for NnG and other projects included in the Cumulative Impact Assessment.

96. A comparison of mortality estimates between the SNCB displacement guidance (2017) and the CEH displacement model (Searle et al.2014) is also presented for each species considered in the displacement assessment. Depending on the species, there are differences between the SNCB guidance and the CEH displacement model, for example in terms of the displacement rates used, and the size of the buffer around the Wind Farm Area. These differences are highlighted in the text.

97. A recent review estimated species-specific non-breeding season seabird populations at biologically defined minimum population scales (BDMPS) to enable the apportioning of potential impacts of marine renewable developments during the non-breeding season (Furness, 2015). This review also included estimates of the numbers of adult and immature birds originating from each individual UK

SPA population in the non-breeding season, as required for HRA. Where appropriate, this information has been reproduced here and used to inform the assessment.

98. In the non-breeding season, displacement effects on kittiwake and puffin were considered by using the matrix approach as outlined in the recent SNCB guidance (2017) and non-breeding season seabird populations from Furness (2015). This provides a more informative means to assess potential displacement effects rather than using a purely qualitative approach.

99. For guillemot and razorbill, displacement effects in the non-breeding season were assessed using the recent SNCB guidance (2017) only, as the original CEH displacement modelling (2014) did not include the non-breeding season. Advice received in the Scoping Opinion (Marine Scotland, 2017) stated that for these two species, non-breeding season effects should be compared against relevant breeding season reference SPA populations. Although this was recognised in the Scoping Opinion as being highly precautionary due to the non-breeding season dispersal of these species, it was considered that using reference populations based on BDMPS could underestimate impacts, due to e.g. guillemots returning to their colony during this period (Marine Scotland, 2017). Both reference populations are presented in the assessment text.

9.9.2.2 Displacement and barrier effect results

9.9.2.2.1 Gannet

100. Although it was documented in the Scoping Opinion that both SNH and RSPB agreed that gannet did not need to be considered in the displacement assessment (Marine Scotland, 2017), the potential impact from barrier effects caused by offshore wind farms in the breeding season has been assessed qualitatively here, using evidence from published studies.

101. The potential effect that an offshore wind farm acting as a barrier would have on flight distances and times depends on how far the destination areas lie beyond the barrier. The results from tagging studies on gannets breeding on the Bass Rock show that they forage over a considerable area of the northern North Sea; commonly travelling distances in excess of 150 km from the colony and sometimes up to three times this distance (Appendix 9.7: GPS tracking maps for breeding gannets from Bass Rock). The mean maximum distances recorded from tagged gannets from the Bass Rock varies between years, depending on food availability, but ranges from between 170 km and 363 km (Hamer *et al.,* 2000; Hamer *et al.,* 2011). It is therefore reasonable to assume that likely destinations of gannet flights potentially affected by barrier effects due to the Project will be at a wide range of distances beyond the Wind Farm Area, and commonly many tens of kilometres beyond.

102. Studies on foraging gannets have shown that they are capable of extending foraging distances in response to distribution of prey, suggesting that birds would easily absorb the minor increases in flight distances that a barrier could cause (Hamer *et al.,* 2007; Hamer *et al*., 2011). On this basis, gannets appear to have a low sensitivity to barrier effects. This species was rated as having a low sensitivity to barrier effects by Maclean *et al.* (2009) and Langston (2010). In addition, a review by Furness and Wade (2012) concluded that gannets use a wide range of habitats over a large area, usually with a relatively wide range of prey species, and therefore have a high flexibility of habitat use.

103. Appendix 9.7 presents maps of gannets tracked from the Bass Rock in the breeding season in 2010, 2011, 2012 and 2015. Birds tagged in the 2010 to 2012 breeding seasons were all breeding adults from the Bass Rock colony, while birds tagged in the 2015 breeding season were breeding adults and non-breeding immature birds. This gannet data was made available by Keith Hamer of the University of Leeds.

104. The maps demonstrate that adult birds travel a considerable distance from the Bass Rock colony, and are therefore unlikely to be significantly affected by potential barrier effects arising from the Project.

105. It is concluded that barrier impacts caused by NnG will have no effect on gannets from the breeding SPA population within mean maximum foraging range in the breeding season. The sensitivity of gannets to barrier effects is assessed as negligible and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

9.9.2.2.2 Kittiwake

106. Monthly peak estimated numbers of kittiwakes in the Wind Farm Area and buffers (Appendix 9.2: Table 5) in the breeding season (mid-April to August), autumn (September to December) and spring (January to mid-April) for Years 1 to 3 were averaged to get the three-year mean peak per season (Table 9-12). Where peak numbers occurred in different months within the same season across different years, the peak month was used. This was repeated for 1 km and 2 km buffers around the Wind Farm Area.

Table 9-12: Seasonal three-year mean peak estimated numbers of kittiwakes in the Wind Farm Area (plus 1 km and 2 km buffers)

Year	Wind Farm Area		
	Breeding	Autumn	Spring
Year 1	83	2,211	4
Year 2	1,451	837	152
Year 3	3,783	146	117
3-year mean peak	1,772	1,065	91
	Wind Farm Area + 1 km buffer		
	Breeding	Autumn	Spring
Year 1	407	2,513	10
Year 2	1,641	882	185
Year 3	3,903	191	135
3-year mean peak	1,984	1,195	110
	Wind Farm Area + 2 km buffer		
	Breeding	Autumn	Spring
Year 1	620	4,440	10
Year 2	1,708	936	222
Year 3	4,165	672	185
3-year mean peak	2,164	2,016	139

107. Based on advice in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 30% displacement of kittiwakes from the Wind Farm Area (and buffer areas) in the breeding and non-breeding seasons.

108. Populations at SPAs for breeding kittiwakes of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding kittiwakes is 60.0 ± 23.3 km, based on a sample size of six birds (Thaxter *et al.,* 2012). Based on this, three SPAs for breeding kittiwakes (Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum

foraging range + 1 SD of the Project (Appendix 9.2: Figure 18). These three SPAs have therefore been used as the SPA reference population for this assessment in the breeding season. For the non-breeding season, the Buchan Ness to Collieston Coast SPA was also included.

109. The UK breeding population of kittiwakes has declined over the last 25 years. At the time of designation, Forth Islands SPA held 8,400 pairs of kittiwakes, but in 2017 the breeding population was 4,663 pairs (Table 9-8). Similarly, the breeding population at St Abb's Head to Fast Castle SPA was 21,170 pairs at the time of designation, with 3,334 pairs in 2016. The breeding population at Fowlsheugh SPA has also declined, from 36,650 pairs at the time of designation, to 9,655 pairs in 2015. Based on figures provided by SNH in the Scoping Opinion (Marine Scotland, 2017), the most recent total combined breeding population estimate for these three SPAs is therefore 17,652 pairs (Table 9-8).

110. Kittiwake is also listed as a qualifying interest for the Outer Firth of Forth & St Andrews Bay pSPA in the breeding and non-breeding seasons (SNH 2016).

Breeding season (Mid-April to August)

111. Assuming 30% of all kittiwakes were displaced from the Wind Farm Area during the breeding season (Marine Scotland, 2017), this would affect an estimated 532 birds (Table 9-13), increasing to 595 birds including the 1 km buffer, and 649 birds including the 2 km buffer. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period (mid-April to August), 6.8% of aged kittiwakes were immature birds (Appendix 9.2: Table 5). This percentage was applied to the estimated numbers of displaced kittiwakes in the breeding season to estimate the maximum number of adults potentially displaced (equating to 496 adults in the Wind Farm Area, increasing to 554 adults including the 1 km buffer, and 605 adults including the 2 km buffer) (Table 9-13).

Table 9-13: Summary of kittiwake displacement for the Wind Farm Area and surrounding buffer areas in the breeding season

Displacement	Breeding adults	Immature birds	Total number of birds
Wind Farm Area	496	36	532
Wind Farm Area + 1 km	554	41	595
Wind Farm Area + 2 km	605	44	649

112. Based on advice received on mortality rates in the Scoping Opinion (Marine Scotland, 2017), a mortality rate of 2% of all kittiwakes displaced was assumed during the breeding season (from the Wind Farm Area (10 adults and one immature bird), Wind Farm Area and 1 km buffer (11 adults and one immature bird) and Wind Farm Area and 2 km buffer (12 adults and one immature bird) (Table 9-14). A mortality of 12 adult kittiwakes corresponds to a maximum of 0.03% of the SPA population within mean maximum foraging range (17,652 pairs), for the Wind Farm Area and 2 km buffer (Marine Scotland, 2017).

Table 9-14: Summary of kittiwake displacement mortality for the Wind Farm Area and surrounding buffer areas in the breeding season

Displacement mortality	Breeding adults	Immature birds	Total number of birds	% of SPA population (adults)
Wind Farm Area	10	1	11	0.03
Wind Farm Area + 1 km	11	1	12	0.03
Wind Farm Area + 2 km	12	1	13	0.03

113. In comparison, the CEH displacement model (Searle *et al.*, 2014) estimated that the change in the annual adult kittiwake survival rate for the Forth Islands SPA for NnG alone would be -1.04%, based on the homogeneous prey distribution scenario, and -1.08%, based on the heterogeneous prey distribution scenario (Table 9-15).

114. Similarly, for Fowlsheugh SPA, the change in the annual adult survival rates for the NnG project alone were estimated as -0.12% based on the homogeneous prey distribution scenario, and +0.06%, based on the heterogeneous prey distribution scenario.

115. For the St Abb's Head to Fast Castle SPA, the change in the annual adult survival rates for the NnG project alone were estimated as -0.05% based on the homogeneous prey distribution scenario, and -0.14%, based on the heterogeneous prey distribution scenario.

116. The estimated number of adult birds involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-15). Based on the most recent population counts for these three SPAs (17,652 pairs, or 35,304 individuals), the estimated change in adult survival rates correspond to a mortality of 123 adult kittiwakes based on the homogeneous prey distribution scenario, or 98 adult kittiwakes based on the heterogeneous prey distribution scenario.

Table 9-15: Summary of annual kittiwake displacement mortality for SPAs in foraging range of NnG, as presented in the CEH displacement model (Searle *et al.*, 2014)

SPA	Change in annual adult survival		SPA population	Estimated number of adults	
	Homogeneous [5]	Heterogeneous [5]		Homogeneous	Heterogeneous
Forth Islands	-1.04	-1.08	4,663 pairs	-97	-101
Fowlsheugh	-0.12	+0.06	9,655 pairs	-23	+12
St Abb's Head to Fast Castle	-0.05	-0.14	3,334 pairs	-3	-9
Total	-	-	17,652 pairs	-123 adults	-98 adults

117. A worst-case annual estimated mortality of 123 adult kittiwakes corresponds to a maximum of 0.3% of the SPA breeding population within mean maximum foraging range (17,652 pairs), from displacement effects from NnG and a 1 km buffer. This demonstrates that if adult kittiwake mortality from displacement was to occur at this level, the impact would not be significant at the SPA population level.

118. However, this is an annual estimate, based on the homogeneous prey distribution scenario, which is considered highly unrealistic, an assumed 40% displacement rate, as well as several other

[5] Figures from Table 3.2, Searle *et al.* (2014)

assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model (Searle *et al.*, 2014).

119. Searle *et al.* (2014) also concluded that model outputs are very sensitive to some parameters. The total amount of prey is the most prominent of these, and the report concluded that small changes in this value can have very substantial effects on the model output. The barrier and displacement rates, which were agreed by the Steering Committee, are also important parameters in determining the magnitude of the response to the wind farm (and the exploratory analyses, which used different scenarios for barrier and displacement rates, suggest that this is indeed the case).

120. One of the largest sources of uncertainty in the CEH displacement modelling was the translation of adult body mass into subsequent survival over the remainder of the year (Searle *et al.*, 2014).

121. Available evidence from existing operational projects indicates that kittiwake displacement is not likely to occur and as such, it is considered that a displacement rate of 30% as used in this assessment, (or 40% as used for NnG in the CEH displacement model), represents a highly precautionary assumption.

122. Results from monitoring at operational offshore wind farms indicate that kittiwakes are not likely to be displaced. Typically, studies at existing offshore wind farms show either no significant change or small increases in kittiwake numbers compared to pre-construction numbers. For example, analysis of five years of post-construction monitoring data at the Robin Rigg OWF suggested that there was no change in kittiwake flight behaviour in response to the presence of the turbines. Kittiwakes were recorded in flight within the Robin Rigg OWF during operation (although no kittiwakes were recorded at turbine rotor height (35-125 m) within the site).

123. Although monitoring showed that numbers of kittiwakes on the sea decreased within the Robin Rigg OWF during the construction phase, this reduction was not statistically significant (Walls *et al*., 2013a, 2013b). During operation, modelled kittiwake abundance across the study area was largest within and immediately east and west of the Robin Rigg OWF, providing clear evidence that kittiwakes had not been displaced from the Robin Rigg OWF during operation (Nelson *et al.,* 2015).

124. A review of avoidance behaviour recorded at operational wind farm projects in Denmark, Germany, the Netherlands, Belgium and the UK by Krijgsveld (2014), noted that three out of five studies reported kittiwakes as being indifferent to offshore wind farms, and readily entering them (OWEZ, PAWP, Blighbank). At Thorntonbank (B), results indicated that kittiwakes were positively attracted to the wind farm (Vanermen et al. 2013). Only one project (Alpha Ventus), where kittiwakes were numerous, reported a strong decline in numbers, suggesting possible avoidance (Mendel et al. 2014). However, although these studies are indicative, only results from the OWEZ wind farm reported by Leopold et al. (2011) were significant for this species.

125. Post construction monitoring of kittiwakes at the OWEZ wind farm showed statistically significant attraction to the offshore wind farm during one survey with non-significant results (neither attraction or avoidance) for a further four surveys (Leopold et al., 2011). This study also found no behavioural evidence of gulls (including kittiwake) being displaced, with birds regularly seen flying through and sitting on the sea within the wind farm as well as resting on built infrastructure. The authors concluded that “kittiwakes seemed mostly indifferent to the wind farm” and that there was “hardly any effect of the wind farm on their distribution” (Leopold et al., 2011).

126. At Horns Rev, Denmark, selectivity indices were significantly higher for the wind farm area during operation compared with the baseline period (Diersche and Garthe, 2006). By contrast, the compared selectivity indices for the baseline and construction periods showed that kittiwake numbers were significantly lower during the construction phase both in the wind farm and in a zone that comprised the wind farm plus a 4 km area surrounding the wind farm (Christensen et al., 2003).

127. Post-construction monitoring at Arklow Bank, Ireland reported an increase in kittiwake numbers compared to baseline numbers, concentrated within ca. 10 km of the turbine array (Barton et al., 2009). The overall increase in kittiwake numbers and their proximity to the turbines was positively associated but not significantly so (Barton et al., 2009).

128. Results of radar and visual studies indicate that flying gulls in general are not deflected around or away from offshore wind farms. At Horns Rev, it was noted that "marked behavioural reactions to the wind farm and single turbines were not observed in gull and tern species" (Christensen and Hounisen, 2005), although the proportion of 15-minute time units that kittiwakes were recorded flying between two turbines was slightly lower when one and both were active compared to when both were inactive, indicating that operational turbines may have insignificant barrier effect on kittiwakes (Petersen et al., 2006). Summarising the barrier effect of wind farms on seabird species occurring in German marine areas, kittiwakes were categorised as 'commonly flying through wind farms' (Diersche and Garthe, 2006).

129. A recent study conducted at the operational Westermost Rough Offshore Wind Farm in July 2017, investigated evidence of displacement for kittiwakes and auks within the wind farm (APEM 2017). This report is presented in Appendix 9.5: Westermost Rough Displacement Study.

130. A series of three high resolution digital still aerial surveys of the Westermost Rough Offshore Wind Farm (WROWF) and its surrounding 8 km buffer were carried out in July 2017. Surveys were conducted to compare distributions of kittiwakes and auks inside and outside the wind farm during the breeding season. Westermost Rough is approximately 35 km from the Flamborough Head and Bempton Cliffs SPA, and is therefore within mean maximum foraging range of breeding kittiwakes from this colony. The wind farm covers an area of 35 km^2 with a capacity of approximately 210 MW, and was fully commissioned in 2015. The wind farm comprises 35 turbines spaced approximately 1 km apart, each with a turbine height of 177 m, hub height of 102 m and rotor diameter of 154 m. Westermost Rough therefore has a comparable design to NnG, in terms of the size of turbines and spacing between turbines. Older wind farms have smaller turbines with lower rotors which are considerably closer together.

131. Kittiwake distribution within the Westermost Rough wind farm and surrounding study area in July 2017 is presented in Figure 9-3, Figure 9-4 and Figure 9-5 below.

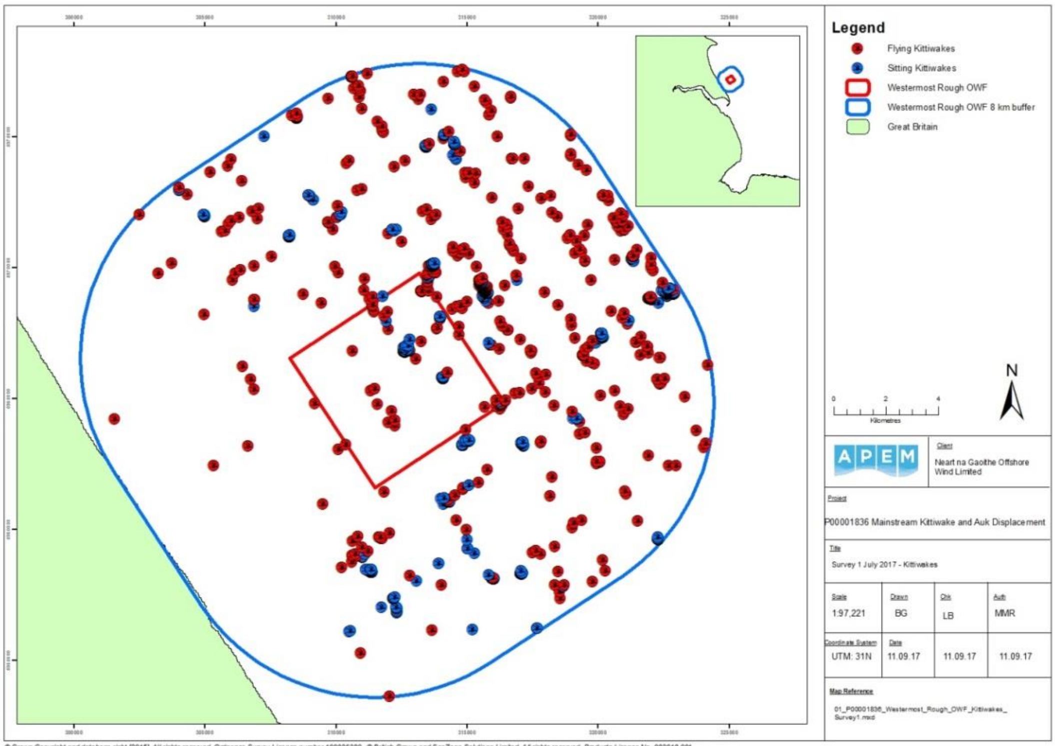


Figure 9-3: Distribution of kittiwakes recorded in the WROWF and 8 km buffer during Survey 1, July 2017

132. On all three surveys, kittiwakes were recorded in flight and on the water within the wind farm, indicating that birds were not displaced by the presence of the operational turbines.

133. While these figures show a lower number of kittiwakes in more inshore waters compared to further offshore, the distribution of kittiwakes within the wind farm compared to the surrounding area is similar on each survey.

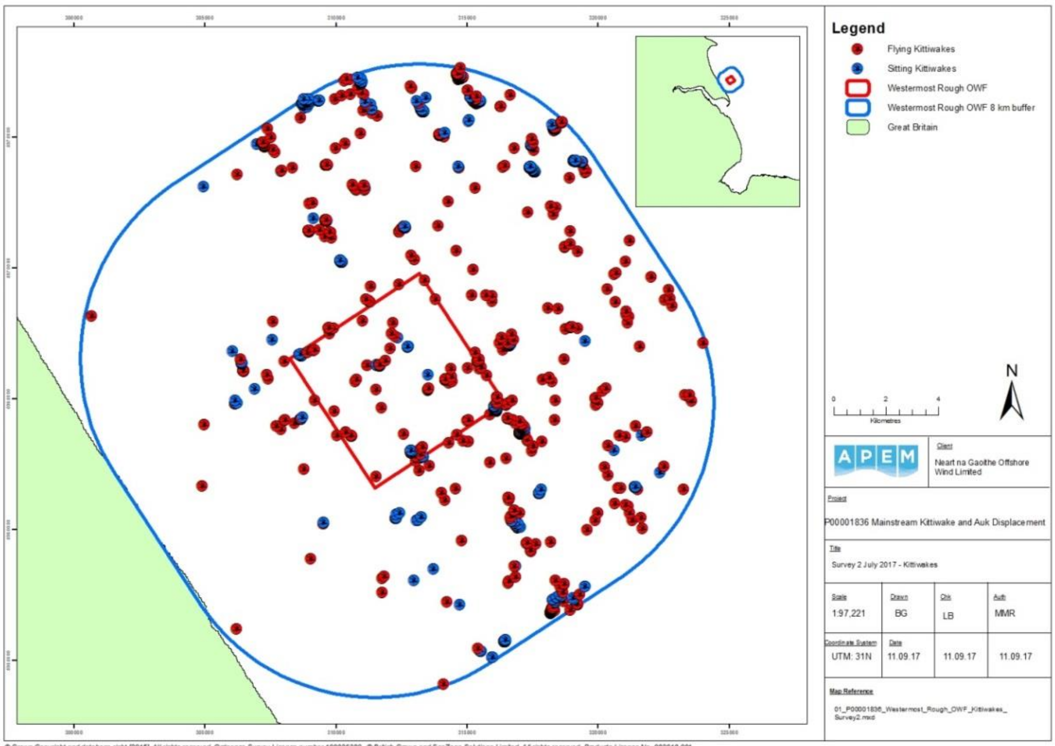


Figure 9-4: Distribution of kittiwakes recorded in the WROWF and 8 km buffer during Survey 2, July 2017

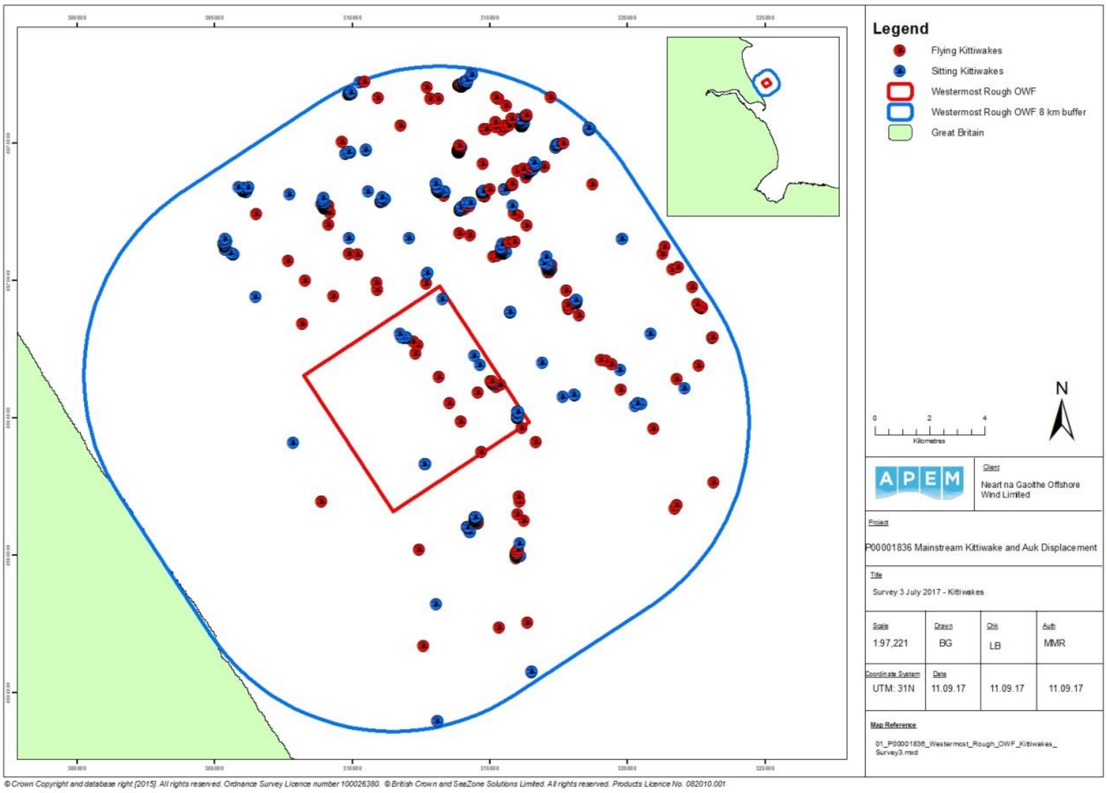


Figure 9-5: Distribution of kittiwakes recorded in the WROWF and 8 km buffer during Survey 3, July 2017

134. The study concluded that there was no evidence of displacement for kittiwakes based on mean densities calculated for the wind farm and compared with mean densities in the surrounding 8km buffer zone. There were variations in kittiwake densities between buffers but this was not statistically significant, potentially due in part to the large between-survey variability in kittiwake densities.

135. The advice provided by SNH in the Scoping Opinion (Marine Scotland, 2017) was that kittiwake did not need to be considered for displacement effects, as the data available from post construction monitoring indicates no significant avoidance behaviour by this species.

136. It was also considered that 2% mortality following displacement was a precautionary estimate, and that the actual mortality rate as a direct result of displacement would be lower than this.

137. There have been a series of tracking studies on kittiwakes breeding on the Isle of May, Fowlsheugh and St Abb's Head in recent years, undertaken by CEH. In the 2010 breeding season, a study conducted for FTOWDG indicated that kittiwakes from the Isle of May use both coastal and offshore areas, with a mean maximum range of 42 ± 31 km and a maximum of 150 km (Daunt *et al*., 2011a). This was based on a sample size of 36 tagged kittiwakes, and a total of 91 trips from the breeding colony. It can be seen from the plot of 2010 activity that the tagged kittiwakes were widespread in the 2010 breeding season, and that while they occurred within the Wind Farm Area, they were also recorded over a wide area north and east of the Isle of May (Appendix 9.6: GPS tracking maps for kittiwake, guillemot and razorbill from CEH tagging studies), with fewer tracks inshore of the Isle of May.

138. Analysis of at-sea distributions of kittiwakes using kernel density estimations found that the Wind Farm Area did not overlap to any great extent with the core area used by foraging kittiwakes from the Isle of May (50% kernels), but was within the overall area used by tagged foraging kittiwakes in 2010 (90% kernels). The core area of use (50% kernels) was estimated to cover an area of 1,947 km^2, while the overall area of active use (90% kernels) was estimated at 3,993 km^2 (Daunt *et al.,* 2011a). For comparison, the total area of the Wind Farm Area is 105 km^2.

139. Similar tracking studies were repeated in May and June 2011 at kittiwake breeding colonies at Fowlsheugh (35 birds, 93 trips) and St Abb's Head (25 birds, 70 trips) (Daunt *et al.,* 2011b). In the 2011 breeding season, foraging trips from Fowlsheugh were concentrated in a north-easterly to south-easterly direction, with a mean maximum foraging range of 35 ± 33 km, and a maximum foraging range of 141 km recorded (excluding one outlier of 415 km) (Appendix 9.6). Foraging range from St Abb's Head was similar (mean maximum range of 32 ± 25 km; maximum 108 km), but overall distribution was more focussed, in a south-easterly direction (Daunt *et al.,* 2011b) (Appendix 9.6). No tagged kittiwakes from the Fowlsheugh or St Abb's Head breeding colonies were recorded within the Wind farm Area during the 2011 breeding season, suggesting that the Wind Farm Area is not a key foraging area for birds from either of these breeding colonies.

140. Similar tracking studies were repeated by CEH in the breeding seasons of 2012 (17 tagged birds), 2013 (22 tagged birds) and 2014 (11 tagged birds). In the 2012 breeding season, the majority of recorded activity was south-west of the Wind Farm Area, to the north and east of the Isle of May, although some birds travelled through and well beyond the Wind Farm Area (Appendix 9.6). Kittiwakes were less widespread in the 2013 breeding season, based on the recorded track data, but again, most tagged birds travelled north and east of the Isle of May colony (Appendix 9.6). Activity within the Wind Farm Area was not higher than elsewhere within the tracking activity. In the 2014 breeding season, fewer tagged birds were recorded in the Wind Farm Area, although the sample size of tagged birds was slightly lower than previous years (11 tagged birds) (Appendix 9.6).

141. The main conclusion that can be drawn from these studies is that kittiwakes are clearly capable of travelling and foraging over considerable distances during the breeding season (Daunt *et al.,* 2011a). It is therefore considered that should kittiwakes be partially displaced from the Wind Farm Area following construction of the wind farm (which is considered unlikely based on available evidence), any impact on breeding success of these displaced birds is not likely to be significant.

142. It is concluded that displacement mortality impacts at NnG will have no effect on the breeding SPA populations of kittiwakes within mean maximum foraging range in the breeding season. The sensitivity of kittiwakes to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Autumn period of non-breeding season (September to December)

143. Assuming 30% of all kittiwakes were displaced from the Wind Farm Area during the autumn period of the non-breeding season, this would affect an estimated 320 birds (Table 9-16), increasing to 359 birds including the 1 km buffer and 605 birds including the 2 km buffer.

144. A total of 43.1% of the kittiwakes aged on baseline surveys undertaken during the autumn period of the non-breeding season (September to December), were immature birds (Appendix 9.2: Table 5). Based on this figure, an estimated 182 adult and 138 immature kittiwakes may be displaced from the Wind Farm Area during the autumn period of the non-breeding season. This would increase to an estimated 204 adults and 155 immature kittiwakes displaced from the Wind Farm Area and 1 km buffer area, and 344 adult and 261 immature kittiwakes displaced from the Wind Farm Area and 2 km buffer area during the autumn period of the non-breeding season (Table 9-16).

Table 9-16: Summary of kittiwake displacement for the Wind Farm Area and surrounding buffer areas in the autumn period of the non-breeding season

Displacement	Adults	Immature birds	Total number of birds
Wind Farm Area	182	138	320
Wind Farm Area + 1 km	204	155	359
Wind Farm Area + 2 km	344	261	605

145. Based on advice in the Scoping Opinion (Marine Scotland, 2017), a mortality rate of 2% was assumed for all kittiwakes displaced from the Wind Farm Area (6 birds), or Wind Farm Area and 1 km buffer (7 birds), or Wind Farm Area and 2 km buffer (12 birds) during the autumn part of the non-breeding season (Table 9-17).

Table 9-17: Summary of kittiwake displacement mortality for the Wind Farm Area and surrounding buffer areas in the autumn period of the non-breeding season

Displacement mortality	Adults	Immature birds	Total number of birds	% of SPA population
Wind Farm Area	3	3	6	0.01
Wind Farm Area + 1 km	4	3	7	0.01
Wind Farm Area + 2 km	7	5	12	0.02

146. This is considered an over-estimate, as outside of the breeding season kittiwakes are no longer limited in their foraging range by having to return to the nest. As birds are free to forage over a wider area, any displacement effects (should they occur) are considerably less likely to have any mortality impact.

147. The total number of kittiwakes (adults and immature birds) estimated to occur in the UK waters of the North Sea in the autumn period (August to December) is 829,937 birds (Furness, 2015). Of this population, an estimated 432,129 kittiwakes (adults and immature birds) are considered to be from UK breeding colonies. If a maximum mortality of 12 kittiwakes resulted from displacement from the Wind Farm Area and 2 km buffer, this would affect 0.003% of the North Sea population from UK breeding colonies (432,129 adults and immature birds) in the autumn period of the non-breeding season.

148. Estimated numbers of adult and immature kittiwakes from the four key SPAs for kittiwakes considered in this assessment (Table 9-8) in the UK waters of the North Sea in the autumn period (August to December) are shown in Table 9-18 (Furness, 2015).

Table 9-18: Estimated numbers of adult and immature kittiwakes from the four key SPAs in the UK waters of the North Sea in the autumn period of the non-breeding season (Furness, 2015)

SPA	Autumn North Sea		
	Adult	Immature	Total
Buchan Ness to Collieston Coast	15,050	8,830	23,880
Fowlsheugh	11,204	6,573	17,778
Forth Islands	3,720	2,182	5,902
St Abb's Head to Fast Castle	4,084	2,396	6,479
Combined total	34,058	19,981	54,039

149. If a mortality of up to 12 kittiwakes occurred as a result of displacement from the Wind Farm Area and 2 km buffer in the autumn period of the non-breeding season, this would affect 0.02% of the North Sea population from the four key SPAs (54,039 adults and immature birds) (Furness, 2015) (Table 9-17).

150. For the surviving displaced birds, there would be minimal impact from displacement, as foraging birds would be able to find food outside of the Wind Farm Area and 2 km buffer. In addition, based on evidence from other operational projects, kittiwakes are not predicted to be susceptible to displacement.

151. It is concluded that displacement mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations in the autumn period of the non-breeding season. The sensitivity of kittiwakes to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Spring part of non-breeding season (January to mid-April)

152. Assuming 30% of all kittiwakes were displaced from the Wind Farm Area during the spring period of the non-breeding season, this would affect an estimated 27 birds (Table 9-19), increasing to 33 birds including the 1 km buffer and 42 birds including the 2 km buffer.

153. A total of 20.8% of the kittiwakes aged on baseline surveys during the spring period of the non-breeding season (January to mid-April), were immature birds (Appendix 9.2: Table 5). Based on this figure, an estimated 21 adult and six immature kittiwakes may be displaced from the Wind Farm Area during the spring period of the non-breeding season. This would increase to an estimated 26 adult and seven immature kittiwakes displaced from the Wind Farm Area and 1 km buffer area, or 33 adult and nine immature kittiwakes displaced from the Wind Farm Area and 2 km buffer area during the spring period of the non-breeding season (Table 9-19). As discussed above, this is considered precautionary.

Table 9-19: Summary of kittiwake displacement for the Wind Farm Area and surrounding buffer areas in the spring period of the non-breeding season

Displacement	Adults	Immature birds	Total number of birds
Wind Farm Area	21	6	27
Wind Farm Area + 1 km	26	7	33
Wind Farm Area + 2 km	33	9	42

154. Based on advice in the Scoping Opinion (Marine Scotland, 2017), assuming a 2% mortality rate of all kittiwakes displaced from the Wind Farm Area (one bird), or Wind Farm Area and 1 km buffer (one bird), or Wind Farm Area and 2 km buffer (one bird) during the spring period of the non-breeding season would result (Table 9-20).

Table 9-20: Summary of kittiwake displacement mortality for the Wind Farm Area and surrounding buffer areas in the spring period of the non-breeding season

Displacement mortality	Adults	Immature birds	Total number of birds	% of SPA population
Wind Farm Area	1	0	1	0.002
Wind Farm Area + 1 km	1	0	1	0.002
Wind Farm Area + 2 km	1	0	1	0.002

155. The total number of kittiwakes (adults and immature birds) estimated to occur in the UK waters of the North Sea in the spring period (January to April) is 627,816 birds (Furness, 2015). Of this population, an estimated 389,392 kittiwakes (adults and immature birds) are considered to be from UK breeding colonies. If one kittiwake was to die as a result of displacement from the Wind Farm Area and 2 km buffer, this would affect 0.0003% of the North Sea population from UK breeding colonies (389,392 adults and immature birds), in the spring period of the non-breeding season.

156. Estimated numbers of adult and immature kittiwakes from the four key SPAs for kittiwakes (Table 9-8) considered in this assessment in the UK waters of the North Sea in the spring period (January to April) are shown in Table 9-21 (Furness, 2015).

Table 9-21: Estimated numbers of adult and immature kittiwakes from the four key SPAs in the UK waters of the North Sea in the spring period of the non-breeding season (Furness, 2015)

SPA	Spring North Sea		
	Adult	Immature	Total
Buchan Ness to Collieston Coast	15,050	6,622	21,673
Fowlsheugh	11,204	4,930	16,134
Forth Islands	3,720	1,637	5,357
St Abb's Head to Fast Castle	4,084	1,797	5,880
Combined total	34,058	14,986	49,044

157. If one adult kittiwake was to suffer mortality as a result of displacement from the Wind Farm Area and 2 km buffer during the spring period of the non-breeding season, this would affect 0.002% of the North Sea population from the four key SPAs (49,044 adults and immature birds) (Furness, 2015).

158. For the surviving displaced birds, there would be minimal impact from displacement, as foraging birds would be able to find food outside of the Wind Farm Area and 2 km buffer. In addition, based on evidence from other operational projects, kittiwakes are not predicted to be susceptible to displacement.

159. It is concluded that displacement mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations in the spring period of the non-breeding season. The sensitivity of kittiwakes

to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Assessment of displacement mortality throughout the year

160. Predicted kittiwake mortality as a result of displacement in the Wind Farm Area and 2 km buffer for all seasons as calculated above, was summed for the whole year (Table 9-22).

Table 9-22: Estimated kittiwake mortality (adult and immature birds) from the Wind Farm Area and 2 km buffer on the key breeding SPAs in the UK waters of the North Sea throughout the year

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of SPA population	No of birds	% of SPA population
Breeding season	10 adults	0.03	12 adults	0.03
Autumn period	6	0.01	12	0.02
Spring period	1	0.002	1	0.002
Total	17 birds	0.04%	25 birds	0.05%

161. Based on the seasonal mortality estimates and an assumed displacement rate of 30%, a total mortality of 17 kittiwakes was estimated based on 2% mortality, if displacement impacts are confined to the Wind Farm Area. This represents an estimated 0.04% of the SPA population, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

162. If displacement impacts occur over the Wind Farm Area and a surrounding 2 km buffer, then an estimated mortality of 25 kittiwakes would occur as a result of displacement impacts. This represents an estimated 0.05% of the SPA population, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

163. However, available evidence from existing wind farm projects as outlined above, indicates that a mortality rate of 2% is precautionary, as is the displacement rate of 30% used in the assessment. Therefore, it is concluded that displacement mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations throughout the year. The sensitivity of kittiwakes to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

9.9.2.2.3 Guillemot

164. Monthly peak estimated numbers of guillemots in the Wind Farm Area (Appendix 9.2: Table 13) in the breeding season (April to mid-August) and non-breeding season (mid-August to March) for Years 1 to 3 were averaged to provide a three-year mean peak per season (Table 9-23). Where peak numbers occurred in different months within the same season across different years, the peak month was used. This was repeated for 1 km and 2 km buffers around the Wind Farm Area.

165. Based on the Scoping Opinion (Marine Scotland, 2017), it was assumed that there would be a 60% displacement of guillemots from the Wind Farm Area (and buffer areas) in the breeding and non-breeding seasons.

Table 9-23: Seasonal three-year mean peak estimated numbers of guillemots in the Wind Farm Area (plus 1 km and 2 km buffers)

Year	Wind Farm Area		Wind Farm Area + 1km buffer		Wind Farm Area + 2km buffer	
	Breeding	Non-breeding	Breeding	Non-breeding	Breeding	Non-breeding
Year 1	387	7,020	542	9,491	924	11,174
Year 2	3,789	2,222	4,100	3,839	4,323	7,140
Year 3	2,429	2,429	3,446	3,446	4,541	4,541
3-year mean peak	2,202	3,890	2,696	5,592	4,894	7,618

166. Populations at SPAs for breeding guillemots of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding guillemots is 84.2 ± 50.1 km, based on a sample size of five birds (Thaxter et al., 2012). Based on this, four SPAs for breeding guillemots (Buchan Ness to Collieston Coast, Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project (Appendix 9.2: Figure 47**).** These four SPAs have therefore been used as the SPA reference population for this assessment in the breeding and non-breeding seasons.

167. Numbers of guillemots at the Buchan Ness to Collieston Coast SPA have increased from 17,820 birds at the time of designation to 33,632 birds in 2016/2017 (Table 9-8). Numbers of guillemots at the Forth Islands SPA have also increased, from 8,000 birds at the time of designation, to 28,786 birds in 2017. Over the same period, the breeding population at Fowlsheugh SPA has declined slightly, from 56,450 birds at the time of designation, to 55,507 birds in 2015. There has been a slight increase at St Abb's Head to Fast Castle SPA, from 31,750 birds at the time of designation, to 36,206 birds in 2016. Based on figures provided by SNH (Table 9-8), the most recent total combined population estimate for these four SPAs is therefore 154,131 birds.

168. In addition, the Project is also within mean maximum foraging range for breeding guillemots from the Farne Islands SPA, which is approximately 72 km from the Project. This population (49,037 birds in 2016) (SMP 2017) is also included in addition to the SPA reference population in the assessment text.

169. Guillemot is also listed as a qualifying interest for the Outer Firth of Forth & St Andrews Bay pSPA in the breeding and non-breeding seasons (SNH 2016).

Breeding season (April to mid-August)

170. Assuming 60% of all guillemots were displaced from the Wind Farm Area during the breeding season, this would affect an estimated 1,321 birds (Table 9-24), increasing to 1,618 birds including the 1 km buffer, and 2,936 birds including the 2 km buffer. However, this estimate includes non-breeding immature birds, as well as breeding adults.

Table 9-24: Summary of guillemot displacement for the Wind Farm Area and surrounding buffer areas in the breeding season

Displacement	Breeding adults	Immature or non-breeding adults	Total number of birds
Wind Farm Area	675	646	1,321
Wind Farm Area + 1 km	791	927	1,618
Wind Farm Area + 2 km	1,436	1,500	2,936

171. Studies have shown that for several seabird species, in addition to breeding birds, colonies are also attended by many immature individuals and a smaller number of non-breeding adults (e.g. Wanless *et al.,* 1998). There is little information on the breakdown of immature and non-breeding adults present at a colony; however, this was estimated using the PVA Stable age structure, as recommended in the Scoping Opinion (Marine Scotland, 2017).

172. Using proportions from the PVA stable age structure, the ratio of adult to immature birds at Forth Islands SPA and Fowlsheugh SPA has been calculated (Table 9-25).

Table 9-25: PVA Stable age structure for guillemots at Forth Islands SPA and Fowlsheugh SPA

Age (years)	Forth Islands SPA	Fowlsheugh SPA	Mean proportion	Mean percentage
1	0.1568	0.1545	0.15565	15.6
2	0.0838	0.085	0.0844	8.4
3	0.0647	0.0662	0.06545	6.5
4	0.0588	0.0597	0.05925	5.9
5	0.0522	0.0545	0.05335	5.3
6	0.0325	0.0349	0.0337	3.4
Total immature birds	0.4488	0.4548	0.4518	45.1
Breeding adults	0.5126	0.507	0.5098	51.0
Non-breeding adults	0.0386	0.0382	0.0384	3.8

173. Assuming that 48.9% of the population present are immature or non-breeding birds, then this would mean that an estimated 646 guillemots displaced from the Wind Farm Area during the breeding season would be immature or non-breeding adults, and that the number of displaced breeding adult birds would be 675 birds (Table 9-24). Similarly, an estimated 791 guillemots displaced from the Wind Farm Area and 1 km buffer during the breeding season would be immature or non-breeding adults, with 827 displaced breeding adult birds. An estimated 1,436 guillemots displaced from the Wind Farm Area and 2 km buffer during the breeding season would be immature or non-breeding adults, with 1,500 displaced breeding adult birds.

174. Using the 1% mortality rate advised by the Scoping Opinion (Marine Scotland, 2017), it was calculated that 13 guillemots (seven adults and six immature or non-breeding birds) displaced from the Wind Farm Area, during the breeding season would suffer mortality as a result (Table 9-26). Similarly, 16 guillemots (eight adults and eight immature or non-breeding birds) would suffer mortality in the Wind Farm Area and 1 km buffer, or 29 guillemots (15 adults and 14 immature or non-breeding birds) in the Wind Farm Area and 2 km buffer, during the breeding season.

Table 9-26: Summary of guillemot displacement mortality for the Wind Farm Area and surrounding buffer areas in the breeding season

Displacement mortality	Breeding adults	Immature or non-breeding adults	Total number of birds	% of SPA population (adults)
Wind Farm Area	7	6	13	0.005
Wind Farm Area + 1 km	8	8	16	0.005
Wind Farm Area + 2 km	15	14	29	0.01

175. Displacement mortality of up to 15 adult guillemots corresponds to up to 0.01% of the SPA adult breeding population within mean maximum foraging range (154,131 birds) (Table 9-8) (Marine Scotland, 2017). If the most recent count from the Farne Islands SPA is included (49,037 birds), then this would correspond to up to 0.007% of the SPA population within mean maximum foraging range (203,168 birds).

176. For the surviving displaced birds (1,308 birds; 668 adults and 640 immature or non-breeding birds from the Wind Farm Area alone, or 1,602 birds; 819 adults and 783 immature or non-breeding birds from the Wind Farm Area plus 1 km buffer, or 2,907 birds; 1,485 adults and 1,422 immature or non-breeding birds from the Wind Farm Area plus 2 km buffer), there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

177. For comparison, the CEH displacement model (Searle *et al.*, 2014) estimated that the change in the annual adult guillemot survival rate for the Forth Islands SPA for NnG alone would be -0.2%, based on the homogeneous prey distribution scenario, and -0.3%, based on the heterogeneous prey distribution scenario (Table 9-27).

178. The estimated number of adult guillemots involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-27). Based on the most recent population counts for the Forth Islands SPA (28,786 individuals), the estimated change in adult survival rates corresponds to a mortality of 58 adult guillemots based on the homogeneous prey distribution scenario, or 86 adult guillemots based on the heterogeneous prey distribution scenario.

Table 9-27: Summary of annual guillemot displacement mortality for the Forth Islands SPA, from NnG alone, as presented in the CEH displacement model (Searle *et al.*, 2014)

SPA	Change in annual adult survival		SPA population	Estimated number of adults	
	Homogeneous [6]	Heterogeneous [6]		Homogeneous	Heterogeneous
Forth Islands	-0.2	-0.3	28,786 birds	-58 adults	-86 adults

179. A worst-case annual estimated mortality of 86 adult guillemots corresponds to a maximum of 0.3% of the Forth Islands SPA breeding population (28,786 birds), from displacement effects from NnG and a 1 km buffer. This demonstrates that if adult guillemot mortality from displacement was to occur at this level, the impact would not be significant at the population level for this SPA.

180. However, this is an annual estimate, based on the heterogeneous prey distribution scenario, an assumed 60% displacement rate, and several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on

[6] Figures from Table 3.2, Searle *et al.* (2014)

subsequent survival, which are detailed in the final report for the displacement model. As previously highlighted, the barrier and displacement rates, which were agreed by the project Steering Committee, are likely to be important parameters in determining the magnitude of the response to the wind farm (Searle *et al.*, 2014). Comparable results for other SPAs within mean maximum foraging range were not presented in the CEH displacement report (Searle *et al.*, 2014).

181. However, evidence from existing operational wind farms indicates that displacement may occur at a lower rate than the 60% rate used in this assessment and recommended by the scoping opinion.

182. A review of avoidance behaviour recorded at operational wind farm projects in Denmark, Germany, the Netherlands, Belgium and the UK by Krijgsveld (2014) reported that strong avoidance by guillemots and razorbills was shown in eight out of 10 studies. Only at Thorntonbank in Belgium, did results suggest that razorbills were attracted to and guillemots were indifferent to or avoided the offshore wind farm, although these results were not statistically significant. It is suggested that the observed results may be the result of foraging birds drifting into the wind farm on the sea surface, rather than birds flying into the wind farm. Wintering guillemots and razorbills occurred in this area in medium densities and results thus reflect a considerable number of observations.

183. At Blighbank, further offshore and in deeper waters, guillemots and razorbills avoided the offshore wind farm. However, this behaviour may have been related to food availability in the area more than the presence of the wind farm (Vanermen et al. 2013).

184. Studies at Horns Rev, Denmark report that although guillemots were recorded in relatively low numbers in the wind farm and buffer compared to the wider monitoring area during the pre-construction surveys, no guillemots occurred within 4 km of the wind farm during the construction period representing a significant decrease. In the operational period, the selectivity index for the wind farm plus a 4 km buffer was significantly lower when compared to the equivalent figure for the pre-construction period suggesting a reduced use of the sea area occupied by, and surrounding the wind farm during the operational phase (Diersche and Garthe 2006).

185. Compared to Horns Rev, the modelled results from OWEZ and the adjacent Princess Amalia wind farm did not conclusively show that guillemots were displaced from either of these offshore wind farms (Leopold *et al.,*2011). Where guillemots were significantly displaced, (2 out of 9 survey visits) this was not total displacement, with birds recorded within both wind farms. However, the authors suggest that higher turbine density probably increased displacement of guillemots. The OWEZ study concluded that the magnitude of the displacement effect for guillemots was less than 50% (Leopold *et al.,* 2011).

186. At OWEZ, despite overall avoidance, foraging guillemots on the water were regularly seen within the wind farm, suggesting that avoidance at OWEZ may be reduced compared to Horns Rev due to the comparatively large spacing between turbines (Krijgsveld et al. 2011, Leopold et al. 2011).

187. One issue that has been highlighted frequently by statutory advisors is that, for operational offshore wind farms in the Netherlands and Germany, species such as guillemot and razorbill predominantly occur in the non-breeding season, and that behaviour in the breeding season, close to colonies may be different.

188. Robin Rigg OWF, in the Solway Firth, is within foraging range of breeding guillemots and razorbills from St Bee’s Head in Cumbria and Mull of Galloway. Evidence from five years of post-construction monitoring at Robin Rigg OWF, suggests that razorbills and guillemots have not been displaced from the Robin Rigg OWF during operation, as razorbills and guillemots were present within the Robin Rigg OWF during all five years of operational monitoring (Nelson *et al.,* 2015a). For guillemot, mean densities of birds on the sea declined during the construction phase, before returning to pre-constructions levels during operation.

189. Although there was an indication of a slight decrease in guillemot and razorbill abundance for birds on the sea across the four operational years, this was not statistically significant, and there were no

significant changes in distribution during operation (Nelson *et al.,* 2015b). It was concluded that changes in guillemot and razorbill abundance and distribution were likely to be due to changes in prey distribution resulting from sedimentary movement, rather than being an effect of the OWF. This explanation is supported by similar patterns in distribution being predicted for both razorbills and guillemots across the five operational years.

190. In other post-construction monitoring studies reviewed, there was no clear evidence showing that guillemots were displaced from the offshore wind farm and the surrounding sea. At the North Hoyle site, located off the coast of North Wales, a highly significant increase in guillemot numbers (estimated at 55%) was reported since the wind farm became operational. However, this finding appears to result from comparing monitoring results from the operational period with those from the construction period, rather than pre-construction (RWE Group, 2007). Post-construction monitoring at Arklow Bank recorded no statistical difference in the number of guillemots recorded between pre and post construction, indicating no displacement of guillemots following construction (Barton *et al.,* 2009).

191. A recent study conducted at the operational Westermost Rough Offshore Wind Farm in July 2017, investigated evidence of displacement for kittiwakes and auks within the wind farm (APEM 2017). This report is presented in Appendix 9.5.

192. Westermost Rough is approximately 35 km from the Flamborough Head and Bempton Cliffs SPA, and is therefore within mean maximum foraging range of breeding guillemots from this colony. The wind farm covers an area of 35 km^2 with a capacity of approximately 210 MW, and was fully commissioned in 2015. The wind farm comprises 35 turbines spaced approximately 1 km apart, each with a turbine height of 177 m, hub height of 102 m and rotor diameter of 154 m. Westermost Rough therefore has a comparable design to NnG, in terms of the size of turbines and spacing between turbines. Older wind farms have smaller turbines with lower rotors which are considerably closer together.

193. Guillemot distribution within the Westermost Rough wind farm and surrounding study area in July 2017 is presented in Figure 9-6, Figure 9-7 and Figure 9-8 below.

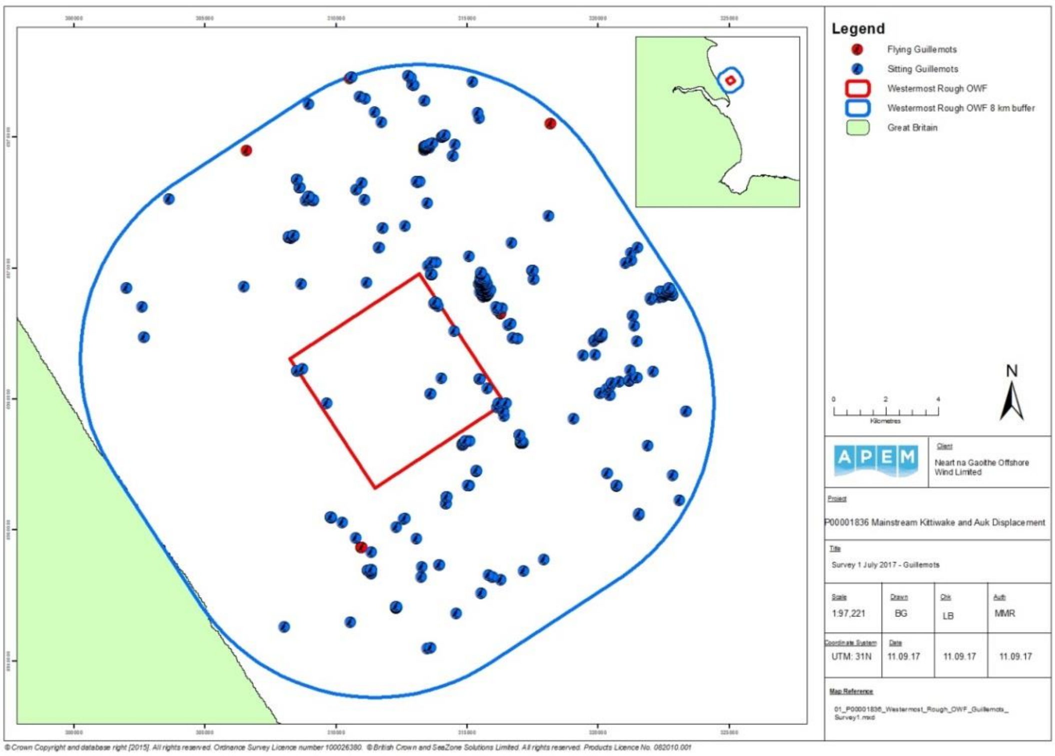


Figure 9-6: Distribution of guillemots recorded in the WROWF and 8 km buffer during Survey 1, July 2017

194. On all three surveys, guillemots were predominantly recorded on the water and occasionally in flight within the wind farm, indicating that birds were not displaced by the presence of the operational turbines.

195. While these figures show a lower number of guillemots in more inshore waters compared to further offshore, the distribution of guillemots within the wind farm compared to the surrounding area is similar on each survey.

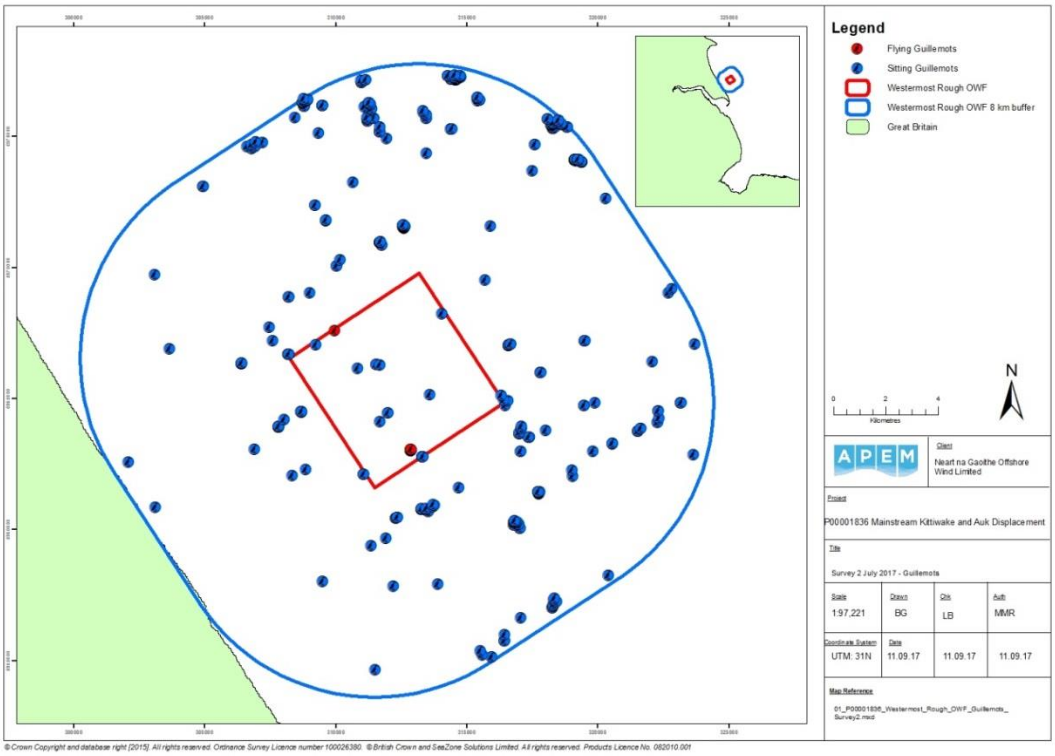


Figure 9-7: Distribution of guillemots recorded in the WROWF and 8 km buffer during Survey 2, July 2017

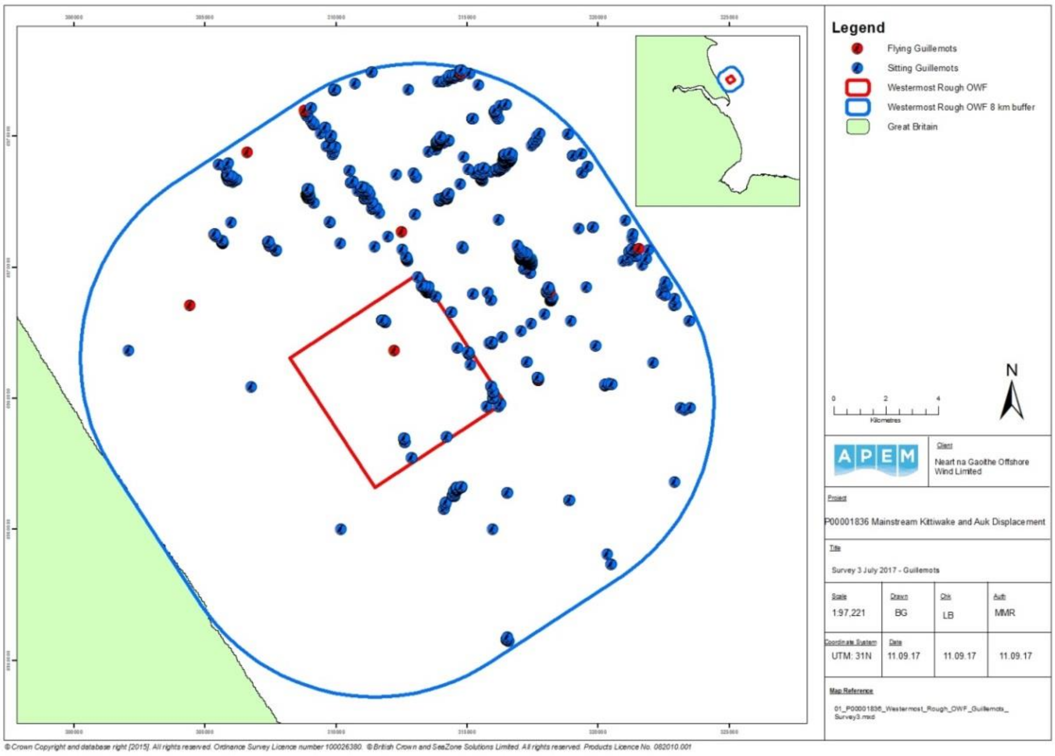


Figure 9-8: Distribution of guillemots recorded in the WROWF and 8 km buffer during Survey 3, July 2017

196. The study recorded a high variability in overall mean densities of auks, including guillemots, calculated for the entire offshore wind farm and the surrounding buffer zone suggesting no evidence of displacement. There were variations in mean densities of auks across the buffer zone but these differences were not statistically significant.

197. In summary, while some studies have shown that partial displacement of guillemots and razorbills has occurred at offshore wind farms, there is evidence to indicate that the proportion of birds displaced is related to spacing distance between turbines. It is noteworthy that, compared with all existing wind farms where monitoring has been undertaken, turbine spacing for the Project (as well as for other Forth and Tay projects) will be considerably greater, at a minimum of 800 metres. Table 9-28 shows the turbine density for NnG, compared with the other Forth and Tay proposals, alongside wind farms referred to above where monitoring has taken place. Of those referred to above, only Westermost Rough is comparable, in terms of height of the turbine rotor above the water and the spacing / density of turbines.

198. Overall, based on the available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%. The estimated mortality from displacement presented in this assessment is therefore considered to be very precautionary.

Table 9-28: Comparison of turbine spacing and density between offshore wind farm projects

Offshore Wind Farm	Number of turbines	Site Area (km^2)	Site Turbine Density (turbines/km^2)
NnG (2017)	54	105	0.5
Seagreen Alpha (2014)	75	197	0.4
Seagreen Bravo (2014)	75	194	0.4
Inch Cape (2014)	110	150	0.7
Seagreen Alpha (2017)	60	197	0.3
Seagreen Bravo (2017)	60	194	0.3
Inch Cape (2017)	72	150	0.5
Inch Cape (2017)	40	150	0.3
Westermost Rough	35	35	1.0
Robin Rigg (Scotland)	58	18	3.2
Arklow Bank (Ireland)	7	2	3.5
Kentish Flats (England)	30	10	3.0
Thanet (England)	100	35	2.9
Greater Gabbard (England)	140	146	1.0
Alpha Ventus (Germany)	12	4	3.0
Egmond aan Zee (Netherlands)	36	24	1.5
Prinses Amalia (Netherlands)	60	17	3.5
Horns Rev 1 (Denmark)	80	21	3.8

Offshore Wind Farm	Number of turbines	Site Area (km²)	Site Turbine Density (turbines/km²)
Horns Rev 2 (Denmark)	49	33	1.5

199. There have been a series of tracking studies on guillemots breeding on the Isle of May in recent years, undertaken by CEH. In the 2010 breeding season, a study conducted for FTOWDG indicated that guillemots from the Isle of May use both coastal and offshore areas, with a mean maximum range of 18 ± 14 km and a maximum of 61 km (Daunt *et al*., 2011a). This was based on a sample size of 33 tagged guillemots, and a total of 112 trips from the breeding colony. It can be seen from the plot of all tagged birds that the majority of guillemot activity at this time occurred outside the Wind Farm Area, to the north and east of the Isle of May (Appendix 9.6), with fewer tracks passing through the Wind Farm Area.

200. Similar tracking studies were repeated by CEH in the breeding seasons of 2012 (20 tagged birds), 2013 (20 tagged birds) and 2014 (11 tagged birds). In the 2012 breeding season, the majority of recorded activity was again west of the Wind Farm Area, to the north and south of the Isle of May (Appendix 9.6). Guillemots were more widespread in the 2013 breeding season, based on the recorded track data (Appendix 9.6). Activity within the Wind Farm Area was not higher than elsewhere within the tracking activity. In the 2014 breeding season, no tagged birds were recorded in the Wind Farm Area, although the sample size of tagged birds was slightly lower (12 tagged birds) (Appendix 9.6).

201. The main conclusion that can be drawn from these studies is that guillemots are clearly capable of travelling and foraging over considerable distances during the breeding season, and are not relying solely on the Wind Farm Area as a foraging area. It is therefore considered that should guillemots be partially displaced from the Wind Farm Area following construction of the wind farm, any impact on the breeding success of these displaced birds is not likely to be significant.

202. It is concluded that displacement mortality impacts at NnG will have no effect on the breeding SPA populations of guillemots within mean maximum foraging range in the breeding season. The sensitivity of guillemots to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Non-breeding season (mid-August to March)

203. The non-breeding season for guillemot was defined in the Scoping Opinion as mid-August to March (Marine Scotland, 2017), and in the BDMPS review as August to February (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

204. Assuming 60% of all guillemots were displaced from the Wind Farm Area during the non-breeding season (mid-August to March), this would affect an estimated 2,334 birds (Table 9-29), increasing to 3,355 birds including the 1 km buffer, and 4,571 birds including the 2 km buffer.

Table 9-29: Summary of guillemot displacement for the Wind Farm Area and surrounding buffer areas in the non-breeding season

Displacement	Adults	Immature birds	Total number of birds
Wind Farm Area	1,281	1,053	2,334
Wind Farm Area + 1 km	1,842	1,513	3,355
Wind Farm Area + 2 km	2,509	2,062	4,571

205. Using proportions from the PVA stable age structure, the ratio of adult to immature guillemots at Forth Islands SPA and Fowlsheugh SPA was calculated (Table 9-25). If it is assumed that 45.1% of the population present in the non-breeding season are immature birds, then this would mean that an estimated 1,053 guillemots displaced from the Wind Farm Area during the non-breeding season would be immature birds, and that the number of displaced adult birds would be 1,281 birds (Table 9-29). Similarly, an estimated 1,513 guillemots displaced from the Wind Farm Area and 1 km buffer during the non-breeding season would be immature birds, with 1,842 displaced adult birds. An estimated 2,062 guillemots displaced from the Wind Farm Area and 2 km buffer during the non-breeding season would be immature birds, with 2,509 displaced adult birds.

206. Using the 1% mortality rate advised by the Scoping Opinion (Marine Scotland, 2017), it was calculated that 23 guillemots (13 adults and 10 immature birds) displaced from the Wind Farm Area, during the non-breeding season would suffer mortality as a result (

207. Table 9-30). Similarly, 34 guillemots (19 adults and 15 immature birds) would suffer mortality in the Wind Farm Area and 1 km buffer, or 46 guillemots (25 adults and 21 immature birds) in the Wind Farm Area and 2 km buffer, during the non-breeding season.

Table 9-30: Summary of guillemot displacement mortality for the Wind Farm Area and surrounding buffer areas in the non-breeding season

Displacement mortality	Adults	Immature birds	Total number of birds	% of SPA population
Wind Farm Area	13	10	23	0.01
Wind Farm Area + 1 km	19	15	34	0.02
Wind Farm Area + 2 km	25	21	46	0.03

208. This is considered an over-estimate, as outside of the breeding season guillemots are no longer limited in their foraging range by having to return to the colony. As birds are free to forage over a wider area, any displacement effects are considerably less likely to have any mortality impact.

209. The total number of guillemots (adults and immature birds) estimated to occur in the UK waters of the North Sea and Channel in the non-breeding period (August to February) is 1,617,306 birds (Furness, 2015). Of this population, an estimated 1,523,146 guillemots (adults and immature birds) are considered to be from UK breeding colonies. If up to 46 guillemots were to suffer mortality as a result of displacement from the Wind Farm Area and 2 km buffer, this would affect up to 0.003% of the North Sea and Channel population from UK breeding colonies (1,523,146 adults and immature birds) in the non-breeding season.

210. Estimated numbers of adult and immature guillemots from the four key SPAs for guillemots considered in this assessment in the UK waters of the North Sea and Channel in the non-breeding season are shown in Table 9-31 (Furness, 2015).

Table 9-31: Estimated numbers of adult and immature guillemots from the four key SPAs in the UK waters of the North Sea in the non-breeding season (Furness, 2015)

SPA	Non-breeding Season North Sea & Channel		
	Adult	Immature	Total
Buchan Ness to Collieston Coast	20,685	13,393	34,078
Fowlsheugh	48,160	31,184	79,344

SPA	Non-breeding Season North Sea & Channel		
	Adult	Immature	Total
Forth Islands	26,413	17,374	43,787
St Abb's Head to Fast Castle	39,785	26,170	65,955
Combined total	135,043	88,121	223,164

211. If up to 46 adult and immature guillemots were to suffer mortality as a result of displacement from the Wind Farm Area and 2km buffer, this would affect 0.02% of the North Sea and Channel population from the four key SPAs (223,164 adults and immature birds) in the non-breeding season (Furness, 2015).

212. In comparison, 46 birds corresponds to 0.03% of the SPA breeding population within mean maximum foraging range (154,131 birds) (Table 9-8). If the most recent count from the Farne Islands SPA is included (49,037 birds), then this would correspond to up to 0.02% of the SPA population within mean maximum foraging range (203,168 birds).

213. For the surviving displaced birds, there would be minimal impact from displacement, as foraging birds are not tied to a breeding colony at this time of year and so would be able to find food outside of the Wind Farm Area and 2 km buffer.

214. It is concluded that displacement mortality impacts at NnG will have no effect on guillemots from the four key SPA populations in the non-breeding season. The sensitivity of guillemots to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Assessment of displacement mortality throughout the year

215. Predicted guillemot mortality from all seasons as calculated above, was summed for the whole year for the Wind Farm Area, and the Wind Farm Area plus 2 km buffer (Table 9-32).

Table 9-32: Estimated guillemot mortality (adult and immature birds) from the Wind Farm Area and 2 km buffer on the key breeding SPAs in the UK waters of the North Sea throughout the year

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of SPA population	No of birds	% of SPA population
Breeding season	7 adults	0.005	15 adults	0.01
Non-breeding season	23 birds	0.01	46 birds	0.02
Total	20 birds	0.015	61 birds	0.03

216. Based on the seasonal mortality estimates and an assumed mortality rate of 1%, a total of 20 guillemots are estimated to suffer mortality as a result of displacement if impacts are confined to the Wind Farm Area. This represents an estimated 0.015% of the population of the four key SPAs (adult and immatures), based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

217. If displacement impacts occur over the Wind Farm Area and a surrounding 2 km buffer, then an estimated 61 guillemots are estimated to suffer mortality as a result of displacement. This represents an estimated 0.03% of the population of the four key SPAs (adult and immatures), based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

218. In comparison, 20 birds corresponds to 0.01% of the SPA breeding population within mean maximum foraging range (154,131 birds) (Table 9-8) (Marine Scotland, 2017), while 61 birds corresponds to 0.04% of the SPA breeding population within mean maximum foraging range. If the most recent count from the Farne Islands SPA (49,037 birds) is included in the SPA total, then this would correspond to 0.001% of the SPA population within mean maximum foraging range (202,713 birds) for 20 birds, and 0.03% of the SPA population within mean maximum foraging range for 61 birds. It should be noted that as highlighted in the Scoping Opinion (Marine Scotland, 2017), using the reference population for the SPA breeding population to assess non-breeding season impacts is likely to be extremely precautionary, due to the non-breeding season dispersal of guillemots.

219. In addition, it is considered that a mortality rate of 1% outside of the breeding season, when birds are no longer tied to their breeding colony, is also precautionary. Overall, based on the available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%. The estimated mortality from displacement presented in this assessment is therefore considered to be very precautionary.

220. Therefore, it is concluded that displacement mortality impacts at NnG will have no effect on guillemots from the four key SPA populations throughout the year. The sensitivity of guillemots to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

9.9.2.2.4 Razorbill

221. Monthly peak estimated numbers of razorbills in the Wind Farm Area and surrounding 1 km and 2 km buffers (Appendix 9.2: Table 14) in the breeding season and non-breeding seasons for Years 1 to 3 were averaged to get the three-year mean peak per season (Table 9-33). Where peak numbers occurred in different months within the same season across different years, the peak month was used.

Table 9-33: Seasonal three-year mean peak estimated numbers of razorbills in the Wind Farm Area (plus 1 km and 2 km buffers)

Year	Wind Farm Area		Wind Farm Area + 1km buffer		Wind Farm Area + 2km buffer	
	Breeding	Non-breeding	Breeding	Non-breeding	Breeding	Non-breeding
Year 1	765	2,655	1,194	3,316	1,460	4,664
Year 2	367	852	419	1,785	590	2,944
Year 3	706	706	1,254	1,254	1,694	1,694
3-year mean peak	613	1,404	956	2,118	1,248	3,101

222. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of razorbills from the Wind Farm Area (and 2 km buffer area) in the breeding and non-breeding seasons.

223. Populations at SPAs for breeding razorbills of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding razorbills is 48.5 ± 35.0 km, based on a sample size of four birds (Thaxter et al., 2012). Based on this, three SPAs for breeding razorbills (Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project (Appendix 9.2: Figure 56). These three SPAs have therefore been used as the SPA reference population for this assessment in the breeding and non-breeding seasons.

224. Numbers of razorbills at the Forth Islands SPA have increased, from 2,800 birds at the time of designation, to 5,815 birds in 2017 (Table 9-8). At Fowlsheugh, numbers have increased from 5,800 at the time of designation to 7,426 birds in 2015. Over the same period, the breeding population at St Abb's Head to Fast Castle SPA SPA has declined slightly, from 2,180 birds at the time of designation, to 2,067 birds in 2016. Based on figures provided by SNH (Table 9-8), the most recent total combined population estimate for these two SPAs is therefore 15,308 birds.

225. Razorbill is also listed as a qualifying interest for the Outer Firth of Forth & St Andrews Bay pSPA in the non-breeding season (SMH 2016).

Breeding season (April to mid-August)

226. The breeding season for razorbill was defined as April to mid-August in the Scoping Opinion (Marine Scotland, 2017).

227. Assuming 60% of all razorbills are displaced from the Wind Farm Area during the breeding season, this would affect an estimated 368 birds (Table 9-34), increasing to 574 birds including the 1 km buffer, and 749 birds including the 2 km buffer. However, this estimate includes non-breeding adults and immature birds, as well as breeding adults.

Table 9-34: Summary of razorbill displacement for the Wind Farm Area and surrounding buffer areas in the breeding season

Displacement	Breeding adults	Immature or non-breeding adults	Total number of birds
Wind Farm Area	208	160	368
Wind Farm Area + 1 km	324	250	574
Wind Farm Area + 2 km	422	327	749

228. Studies have shown that for several seabird species, in addition to breeding birds, colonies are also attended by many immature individuals and a smaller number of non-breeding adults (e.g. Wanless *et al.,* 1998). There is little information on the breakdown of immature and non-breeding adults present at a colony, however, this has been estimated using the PVA stable age structure, as recommended in the Scoping Opinion (Marine Scotland, 2017).

229. Using proportions from the PVA stable age structure, the ratio of adult to immature razorbills at Forth Islands SPA and Fowlsheugh SPA was calculated (Table 9-35).

Table 9-35: PVA Stable age structure for razorbills at Forth Islands SPA and Fowlsheugh SPA

Age (years)	Forth Islands SPA	Fowlsheugh SPA	Mean proportion	Mean percentage
1	0.1724	0.1793	0.17585	17.6
2	0.1238	0.1285	0.12615	12.6
3	0.0889	0.0921	0.0905	9.1
Total immature birds	0.3851	0.3999	0.3925	39.3
Breeding adults	0.5718	0.558	0.5649	56.5
Non-breeding adults	0.043	0.042	0.0425	4.3

230. Assuming that 43.6% of the population present are immature or non-breeding birds, then this would mean that an estimated 160 razorbills displaced from the Wind Farm Area during the breeding season

would be immature or non-breeding adults, and that the number of displaced breeding adult birds would be 208 birds (Table 9-34). Similarly, an estimated 250 razorbills displaced from the Wind Farm Area and 1 km buffer during the breeding season would be immature or non-breeding adults, with 324 displaced breeding adult birds. An estimated 327 razorbills displaced from the Wind Farm Area and 2 km buffer during the breeding season would be immature or non-breeding adults, with 422 displaced breeding adult birds.

231. Using the 1% mortality rate recommended in the Scoping Opinion (Marine Scotland, 2017), it was calculated that four razorbills (two breeding adults and two immature or non-breeding birds) displaced from the Wind Farm Area, during the breeding season would suffer mortality as a result (Table 9-36). Similarly, six razorbills (three breeding adults and three immature or non-breeding birds) would suffer mortality in the Offshore Wind Farm Area and 1 km buffer, or seven razorbills (four breeding adults and three immature or non-breeding birds) in the Wind Farm Area and 2 km buffer, during the breeding season.

Table 9-36: Summary of razorbill displacement mortality for Wind Farm Area and surrounding buffer areas in the breeding season

Displacement mortality	Breeding adults	Immature or non-breeding adults	Total number of birds	% of SPA population (adults)
Wind Farm Area	2	2	4	0.01
Wind Farm Area + 1 km	3	3	6	0.02
Wind Farm Area + 2 km	4	3	7	0.03

232. Displacement mortality of up to four adults corresponds to up to 0.03% of the SPA adult breeding population within mean maximum foraging range (15,308 birds) (Table 9-8) (Marine Scotland, 2017).

233. For the surviving displaced birds (364 birds; 205 adults and 159 immature or non-breeding birds from the Wind Farm Area alone, or 568 birds; 320 adults and 248 immature or non-breeding birds from the Wind Farm Area plus 1 km buffer, or 742 birds; 418 adults and 324 immature or non-breeding birds from the Wind Farm Area plus 2 km buffer), there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

234. In comparison, the CEH Displacement model (Searle et al., 2014) estimated that the change in the annual adult razorbill survival rate for the Forth Islands SPA for NnG alone would be -0.10%, based on the homogeneous prey distribution scenario, and -0.09%, based on the heterogeneous prey distribution scenario (Table 9-37).

235. The estimated number of adult razorbills involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-37). Based on the most recent population counts for the Forth Islands SPA (5,815 birds), the estimated change in adult survival rates corresponds to a mortality of six adult razorbills based on the homogeneous prey distribution scenario, or five adult razorbills based on the heterogeneous prey distribution scenario.

Table 9-37: Summary of annual razorbill displacement mortality for the Forth Islands SPA from NnG alone, as presented in the CEH displacement model (Searle *et al.*, 2014)

SPA	Change in annual adult survival		SPA population	Estimated number of adults	
	Homogeneous [7]	Heterogeneous [7]		Homogeneous	Heterogeneous
Forth Islands	-0.10	-0.09	5,815 birds	-6 adults	-5 adults

[7] Figures from Table 3.2, Searle *et al.* (2014)

236. A worst-case annual estimated mortality of six adult razorbills corresponds to a maximum of 0.1% of the Forth Islands SPA breeding population (5,815 birds), from displacement effects from NnG and a 1 km buffer. This demonstrates that if adult razorbill mortality from displacement was at this level, the impact would not be significant at the population level for this SPA.

237. However, this is an annual estimate, based on the homogeneous prey distribution scenario, an assumed 60% displacement rate, and several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model. As previously highlighted, the barrier and displacement rates, which were agreed by the project Steering Committee, are important parameters in determining the magnitude of the response to the wind farm (Searle et al., 2014). Comparable results for other SPAs within mean maximum foraging range were not presented in the CEH displacement report (Searle *et al.*, 2014).

238. However, evidence from existing operational wind farms indicates that displacement may occur at a lower rate than the predicted 60% rate used in this assessment. The supporting text to this effect in the guillemot section (Section 9.9.2.2.3) also applies for razorbill.

239. A recent study conducted at the operational Westermost Rough Offshore Wind Farm in July 2017, investigated the degree of displacement for auks within the wind farm (APEM 2017). This report is presented in Appendix 9.5.

240. Westermost Rough is approximately 35 km from the Flamborough Head and Bempton Cliffs SPA, and is therefore within mean maximum foraging range of breeding razorbills from this colony. The wind farm comprises 35 turbines spaced approximately 1 km apart, each with a turbine height of 177 m, hub height of 102 m and rotor diameter of 154 m. Westermost Rough therefore has a comparable design to NnG, in terms of the size of turbines and spacing between turbines.

241. Razorbill distribution within the Westermost Rough wind farm and surrounding study area in July 2017 is presented in Figure 9-9, Figure 9-10 and Figure 9-11 below.

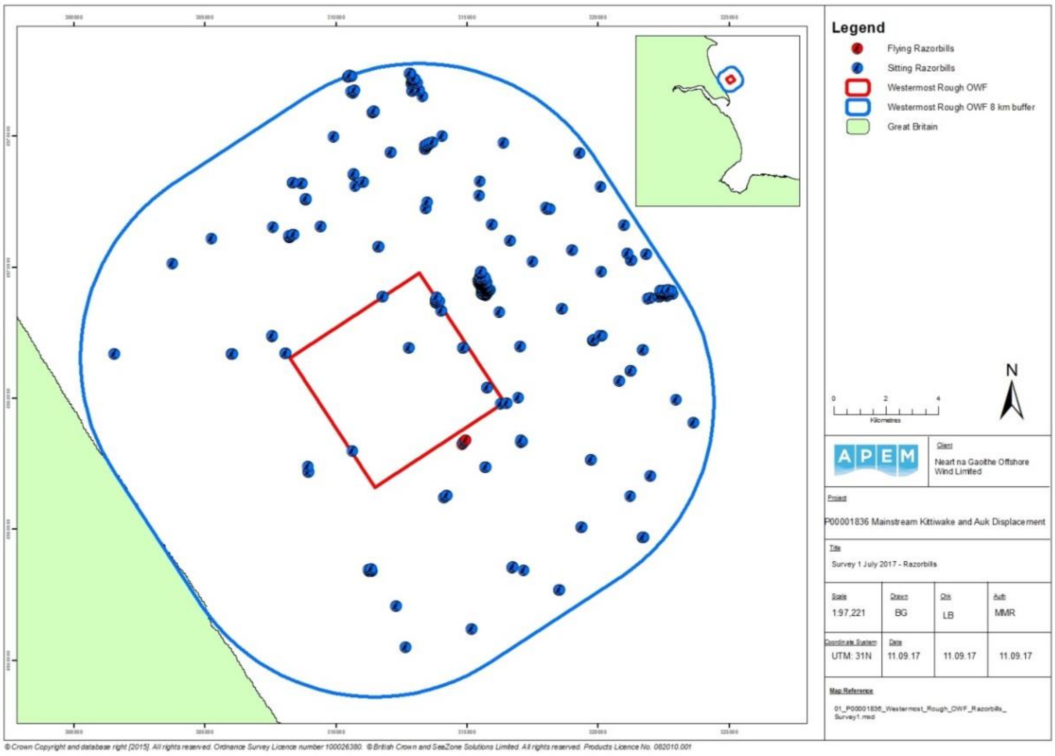


Figure 9-9: Distribution of razorbills recorded in the WROWF and 8 km buffer during Survey 1, July 2017

242. On all three surveys, razorbills were predominantly recorded on the water and occasionally in flight within the wind farm, indicating that birds were not displaced by the presence of the operational turbines.

243. While these figures show a lower number of razorbills in more inshore waters compared to further offshore, the distribution of razorbills within the wind farm compared to the surrounding area is similar on each survey.

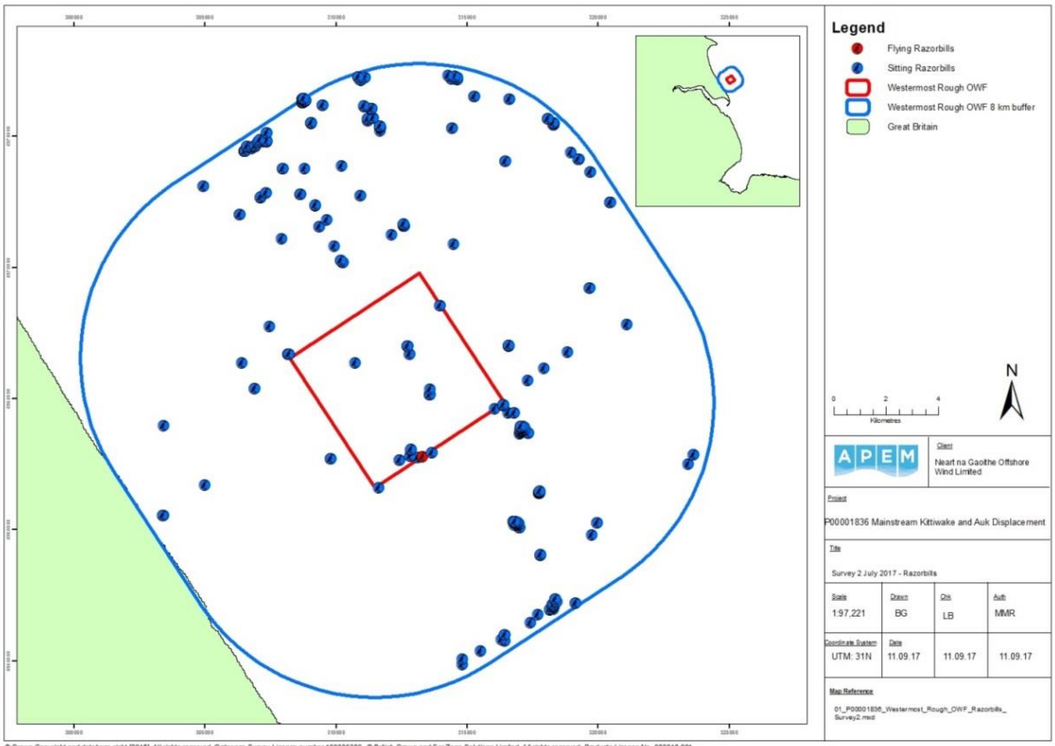


Figure 9-10: Distribution of razorbills recorded in the WROWF and 8 km buffer during Survey 2, July 2017

Figure 9-11: Distribution of razorbills recorded in the WROWF and 8 km buffer during Survey 3, July 2017

244. The study recorded a high variability in overall mean densities of auks, including razorbills, calculated for the entire offshore wind farm and the surrounding buffer zone suggesting no evidence of displacement. There were variations in mean densities of auks across the buffer zone but these differences were not statistically significant.

245. In summary, while studies have shown that partial displacement of guillemots and razorbills has occurred at offshore wind farms, there is evidence to indicate that the proportion of birds displaced is related to spacing distance between turbines. It is noteworthy that, compared with all existing wind farms where monitoring has been undertaken, turbine spacing for the Project (as well as for other Forth and Tay projects) will be considerably greater, at a minimum of 800 metres (Table 9-28).

246. Overall, based on available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%.

247. There have been a series of tracking studies on razorbills breeding on the Isle of May in recent years, undertaken by CEH. In the 2010 breeding season, a study conducted for FTOWDG indicated that razorbills from the Isle of May use both coastal and offshore areas, with a mean maximum range of 14 ± 15 km and a maximum of 69 km, although they avoided the deeper water between the Isle of May and the Wee Bankie (Daunt *et al*., 2011a). This was based on a sample size of 18 tagged razorbills, and a total of 111 trips from the breeding colony. The study also indicated that razorbills did not use the Neart na Gaoithe site for non-flight activities such as foraging or resting. It can be seen from the plot of all tagged birds that the majority of razorbill activity at this time occurred outside the Wind Farm Area, to the north, east and west of the Isle of May (Appendix 9.6), with fewer tracks passing through the Wind Farm Area.

248. Similar tracking studies were repeated by CEH in the breeding seasons of 2012 (16 tagged birds), 2013 (seven tagged birds) and 2014 (five tagged birds). In the 2012 breeding season, the majority of recorded activity was again west of the Wind Farm Area, to the east and west of the Isle of May (Appendix 9.6). In the 2013 breeding season, there was little activity of tagged birds recorded within the Wind Farm Area, although the sample size of tagged birds was smaller than in 2010 or 2012

(Appendix 9.6). Similarly, in the 2014 breeding season, there was little activity of tagged birds recorded in the Wind Farm Area, although the sample size of tagged birds was low (Appendix 9.6).

249. The main conclusion that can be drawn from these studies is that razorbills are clearly capable of travelling and foraging over considerable distances during the breeding season, and are not relying solely on the Wind Farm Area as a foraging area. It is therefore considered that should razorbills be partially displaced from the Wind Farm Area following construction of the wind farm, any impact on the breeding success of these displaced birds is not likely to be significant.

250. It is concluded that displacement mortality impacts at NnG will have no effect on the breeding SPA populations of razorbills within mean maximum foraging range in the breeding season. The sensitivity of razorbills to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Non-breeding season (mid-August to March)

251. The non-breeding season was defined in the Scoping Opinion as mid-August to March (Table 9-7) (Marine Scotland. However, there are three seasons presented in the BDMPS review for the "non-breeding season", defined as follows: Autumn (August to October), Winter (November and December) and Spring (January to March) (Furness 2015). As the population estimates given in the BDMPS report are the same for the Autumn and Spring periods, these populations have been used as SPA reference populations, and the non-breeding season was taken as mid-August to March, as defined in the Scoping Opinion.

252. Assuming 60% of all razorbills were displaced from the Wind Farm Area during the non-breeding season (mid-August to March), this would affect an estimated 842 birds (Table 9-38), increasing to 1,522 birds including the 1 km buffer, and increasing to 1,861 birds including the 2 km buffer.

Table 9-38: Summary of razorbill displacement for the Wind Farm Area and surrounding buffer areas in the non-breeding season

Displacement	Adults	Immature birds	Total number of birds
Wind Farm Area	511	331	842
Wind Farm Area + 1 km	771	500	1,271
Wind Farm Area + 2 km	1,130	731	1,861

253. Using proportions from the PVA stable age structure, the ratio of adult to immature razorbills at Forth Islands SPA and Fowlsheugh SPA was calculated (Table 9-35). If it is assumed that 39.3% of the population present in the non-breeding season are immature birds, then this would mean that an estimated 331 razorbills displaced from the Wind Farm Area during the non-breeding season would be immature birds, and that the number of displaced adult birds would be 511 birds (Table 9-38). Similarly, an estimated 500 razorbills displaced from the Wind Farm Area and 1 km buffer during the non-breeding season would be immature birds, with 771 displaced adult birds. An estimated 731 razorbills displaced from the Wind Farm Area and 2 km buffer during the non-breeding season would be immature birds, with 1,130 displaced adult birds.

254. Using the 1% mortality rate recommended in the Scoping Opinion (Marine Scotland, 2017), it was calculated that eight razorbills (five adults and three immature birds) displaced from the Wind Farm Area, during the non-breeding season would suffer mortality as a result (Table 9-39). Similarly, 13 razorbills (seven adults and six immature birds) would suffer mortality in the Wind Farm Area and 1 km buffer, or 19 razorbills (11 adults and eight immature birds) in the Wind Farm Area and 2 km buffer, during the non-breeding season.

Table 9-39: Summary of razorbill displacement mortality for the Wind Farm Area and surrounding buffer areas in the non-breeding season

Displacement mortality	Adults	Immature birds	Total number of birds	% of SPA population
Wind Farm Area	5	3	8	0.03
Wind Farm Area + 1 km	7	6	13	0.05
Wind Farm Area + 2 km	11	8	19	0.08

255. This is considered an over-estimate, as outside of the breeding season razorbills are no longer limited in their foraging range by having to return to the colony. As birds are free to forage over a wider area, any displacement effects are considerably less likely to have any mortality impact.

256. The total number of razorbills (adults and immature birds) estimated to occur in the UK waters of the North Sea and Channel in the autumn (August to October) and spring (January to March) periods of the non-breeding season (mid-August to October) is 591,874 birds (Furness, 2015). Of this population, an estimated 157,443 razorbills (adults and immature birds) are considered to be from UK breeding colonies. If up to 19 razorbills were to suffer mortality as a result of displacement from the Wind Farm Area and 2 km buffer, this would affect up to 0.01% of the North Sea and Channel population from UK breeding colonies (157,443 adults and immature birds) in the non-breeding season.

257. Estimated numbers of adult and immature razorbills from the three key SPAs for razorbills considered in this assessment in the UK waters of the North Sea and English Channel in the non-breeding season are shown in Table 9-40 (Furness, 2015).

Table 9-40: Estimated numbers of adult and immature razorbills from the three key SPAs in the UK waters of the North Sea and Channel in the autumn and spring periods of the non-breeding season (Furness, 2015)

SPA	Non-breeding season		
	Adult	Immature	Total
Fowlsheugh	7,048	4,757	11,805
Forth Islands	5,250	3,544	8,794
St Abb's Head to Fast Castle	2,438	1,646	4,084
Combined total	14,736	9,947	24,683

258. If up to 19 razorbills were to suffer mortality as a result of displacement from the Wind Farm Area and 2km buffer, this would affect up to 0.08% of the North Sea and Channel population from the three key SPAs (24,683 adults and immature birds) in the autumn period of the non-breeding season, based on the BDMPS review (Furness, 2015). In comparison, 19 birds corresponds to 0.1% of the SPA breeding population within mean maximum foraging range (14,486 birds) (Table 9-8).

259. For the surviving displaced birds, there would be minimal impact from displacement, as foraging birds would be able to find food outside of the Wind Farm Area and 2 km buffer.

260. It is concluded that displacement mortality impacts at NnG will have no effect on razorbills from the three key SPA populations in the non-breeding season. The sensitivity of razorbills to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Assessment of displacement mortality throughout the year

261. Predicted razorbill mortality from all seasons from displacement as calculated above, was summed for the whole year (Table 9-41).

262. Based on the seasonal mortality estimates and an assumed mortality rate of 1%, a total of 10 razorbills are estimated to suffer mortality if displacement impacts are confined to the Wind Farm Area. This represents an estimated 0.04% of the population of the three key SPAs, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

Table 9-41: Estimated razorbill mortality (adult and immature birds) from the Wind Farm Area and 2 km buffer on the three key SPAs in the UK waters of the North Sea throughout the year

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of SPA population	No of birds	% of SPA population
Breeding season	2 adults	0.01	4 adults	0.03
Non-breeding season	8 birds	0.03	19 birds	0.08
Total	10 birds	0.04%	23 birds	0.1%

263. If displacement impacts occur over the Wind Farm Area and a surrounding 2 km buffer, then an estimated 23 razorbills are estimated to suffer mortality as a result of displacement. This represents an estimated 0.1% of the population of the three key SPAs, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

264. In comparison, 10 birds corresponds to 0.07% of the SPA breeding population within mean maximum foraging range (15,308 birds) (Table 9-8), while 23 birds corresponds to 0.2% of the SPA breeding population within mean maximum foraging range. It should be noted that, as highlighted in the Scoping Opinion (Marine Scotland, 2017), using the reference population for the SPA breeding population to assess non-breeding season impacts is likely to be extremely precautionary, due to the non-breeding season dispersal of razorbills.

265. In addition, it is considered that a mortality rate of 1% outside of the breeding season, when birds are no longer tied to their breeding colony, is also precautionary. Overall, based on the available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%. The estimated mortality from displacement presented in this assessment is therefore considered to be very precautionary.

266. It is concluded that displacement mortality impacts at NnG will have no effect on razorbills from the three key SPA populations throughout the year. The sensitivity of razorbills to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

9.9.2.2.5 Puffin

267. Monthly peak estimated numbers of puffins in the Wind Farm Area in the breeding season (April to mid-August) and non-breeding season (mid-August to March) for Years 1 to 3 (Appendix 9.2: Table 15) were averaged to get the three-year mean peak per season (Table 9-42). Where peak numbers occurred in different months within the same season across different years, the peak month was used. This was repeated for the 1 km and 2 km buffers around the Wind Farm Area.

Table 9-42: Seasonal three-year mean peak estimated numbers of puffins in the Wind Farm Area (plus 1 km and 2 km buffer)

Year	Wind Farm Area		Wind Farm Area + 1km buffer		Wind Farm Area + 2km buffer	
	Breeding	Non-breeding	Breeding	Non-breeding	Breeding	Non-breeding
Year 1	1,754	1,881	3,359	3,359	7,508	4,109
Year 2	2,481	1,821	2,831	2,935	3,442	4,994
Year 3	3,812	911	5,474	1,363	7,568	1,864
3-year mean peak	2,682	1,538	3,888	2,552	6,173	3,656

268. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of puffins from the Wind Farm Area (and 2 km buffer area) in the breeding and non-breeding seasons.

269. Populations at SPAs for breeding puffins of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding puffins is 105.4 ± 46.0 km, based on a sample size of eight birds (Thaxter et al., 2012). Based on this, one SPA for breeding puffins (Forth Islands is within mean maximum foraging range ± 1 SD of the Project (Appendix 9.2**:** Figure 65). This SPA has therefore been used as the SPA reference population for this assessment in the breeding and non-breeding seasons.

270. Numbers of puffins at the Forth Islands SPA have increased from 14,000 pairs at the time of designation, to 45,005 pairs between 2009 and 2017 (Table 9-8).

271. In addition, the Project is also within mean maximum foraging range ± 1 SD for breeding puffins from the Farne Islands SPA (72 km from the Project), and Coquet Island SPA (106 km from the Project) (Appendix 9.2**:** Figure 65). These SPA populations (39,962 pairs on Farne Islands in 2013 and 12,344 pairs on Coquet Island in 2013) (SMP 2017) are also included in the assessment text, in addition to the SPA reference population.

272. Puffin is also listed as a qualifying interest for the Outer Firth of Forth & St Andrews Bay pSPA in the breeding season (SNH 2016).

Breeding season (April to mid-August)

273. Assuming 60% of all puffins were displaced from the Wind Farm Area during the breeding season, this would affect an estimated 1,609 birds (Table 9-43), increasing to 2,333 birds including the 1 km buffer, and 3,704 birds including the 2 km buffer. However, this estimate includes non-breeding immature birds, as well as breeding adults.

Table 9-43: Summary of puffin displacement for the Wind Farm Area and surrounding buffer areas in the breeding season

Displacement	Breeding adults	Immature or non-breeding adults	Total number of birds
Wind Farm Area	814	795	1,609
Wind Farm Area + 1 km	1,180	1,153	2,333
Wind Farm Area + 2 km	1,874	1,830	3,704

274. Studies have shown that for several seabird species, in addition to breeding birds, colonies are also attended by many immature individuals and a smaller number of non-breeding adults (e.g. Wanless

et al., 1998). There is little information on the breakdown of immature and non-breeding adults present at a colony, however, this was estimated using the PVA stable age structure, as recommended in the Scoping Opinion (Marine Scotland, 2017). Using proportions from the PVA stable age structure, the ratio of adult to immature birds at the Forth Islands SPA was calculated (Table 9-44).

Table 9-44: PVA Stable age structure for puffins at Forth Islands SPA and Fowlsheugh SPA

Age (years)	Forth Islands SPA	Percentage
1	0.1555	15.6
2	0.125	12.5
3	0.1004	10.0
4	0.0746	7.5
Total immature birds	0.4555	45.6
Breeding adults	0.5064	50.6
Non-breeding adults	0.0381	3.8

275. Assuming that 49.4% of the population present are immature or non-breeding birds, then this would mean that an estimated 795 puffins displaced from the Wind Farm Area during the breeding season would be immature or non-breeding adults, and that the number of displaced breeding adult birds would be 814 birds (Table 9-43). Similarly, an estimated 1,153 puffins displaced from the Wind Farm Area and 1 km buffer during the breeding season would be immature or non-breeding adults, with 1,180 displaced breeding adult birds. An estimated 1,830 puffins displaced from the Wind Farm Area and 2 km buffer during the breeding season would be immature or non-breeding adults, with 1,874 displaced breeding adult birds.

276. Using the 2% mortality rate recommended by the Scoping Opinion (Marine Scotland, 2017), it was calculated that 32 puffins (16 breeding adults and 16 immature or non-breeding birds) displaced from the Wind Farm Area, during the breeding season would suffer mortality as a result (Table 9-45). Similarly, 47 puffins (24 breeding adults and 23 immature or non-breeding birds) would suffer mortality in the Wind Farm Area and 1 km buffer, or 74 puffins (37 breeding adults and 37 immature or non-breeding birds) in the Wind Farm Area and 2 km buffer, during the breeding season.

Table 9-45: Summary of puffin displacement mortality for the Wind Farm Area and surrounding buffer areas in the breeding season

Displacement mortality	Breeding adults	Immature or non-breeding adults	Total number of birds	% of SPA population (adults)
Wind Farm Area	16	16	32	0.02
Wind Farm Area + 1 km	24	23	47	0.03
Wind Farm Area + 2 km	37	37	74	0.04

277. Displacement mortality of 16 adults in the Wind Farm Area corresponds to 0.02% of the Forth Islands SPA adult breeding population (45,005 pairs) (Table 9-8) (Marine Scotland, 2017). Displacement mortality of 24 adults in the Wind Farm Area and 1 km buffer corresponds to 0.03% of the Forth Islands SPA adult breeding population. Displacement mortality of 37 adults in the Wind Farm Area and 2 km buffer corresponds to 0.04% of the Forth Islands SPA adult breeding population.

278. For the surviving displaced adults, there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

279. In comparison, the CEH Displacement model (Searle *et al.*, 2014) estimated that the change in the annual adult puffin survival rate for the Forth Islands SPA for NnG alone would be -0.46%, based on the homogeneous prey distribution scenario, and -0.64%, based on the heterogeneous prey distribution scenario (Table 9-46).

280. The estimated number of adult puffins involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-46). Based on the most recent population counts for the Forth Islands SPA (45,005 pairs, or 90,010 birds), the estimated change in adult survival rates corresponds to a mortality of 414 adult puffins based on the homogeneous prey distribution scenario, or 576 adult puffins based on the heterogeneous prey distribution scenario.

Table 9-46: Summary of annual puffin displacement mortality for the Forth Islands SPA from NnG alone, as presented in the CEH displacement model (Searle *et al.*, 2014)

SPA	Change in annual adult survival		SPA population	Estimated number of adults	
	Homogeneous [8]	Heterogeneous [8]		Homogeneous	Heterogeneous
Forth Islands	-0.46	-0.64	45,005 pairs	-414 adults	-576 adults

281. The worst-case annual estimated mortality of 576 adult puffins corresponds to a maximum of 0.6% of the Forth Islands SPA breeding population (45,005 pairs), from displacement effects from NnG and a 1 km buffer. This demonstrates that if adult puffin mortality from displacement was at this level, the impact would not be significant at the population level for this SPA.

282. However, this is an annual estimate, based on the heterogeneous prey distribution scenario, an assumed 60% displacement rate, and several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model (Searle *et al.*, 2014).

283. Searle *et al.*, (2014) discuss the implications of the assumptions made regarding homogeneous and heterogeneous prey distribution. The report states that both methods rely on assumptions that are unlikely to be realistic in practice, but it is not known which of the two scenarios is likely to be closer to reality. The main assumptions highlighted by Searle *et al.*, (2014) are that:

- The heterogeneous prey results assume that the density of prey can be directly inferred from the density of observed seabird foraging locations (within relatively small datasets), but in reality the GPS data does not give a complete picture of the density of foraging birds, and, further, the density of foraging birds is unlikely to be related solely to the density of prey.
- The homogeneous prey results assume that prey is uniformly distributed across the Forth/Tay area, which is not the case.

284. The report recommends that results from both methods should be considered, although considerable caution should be applied to interpretation of all results. The greatest caution is needed in cases where bird distributions were inferred from GPS data for small numbers of birds, such as puffins, and in these situations the heterogeneous prey distributions are likely to be of particular concern. The modelling for puffins was based on a sample size of seven tagged puffins in 2012, however, it was found that the tagged birds behaved differently from a set of 'control' birds that were not tagged

[8] Figures from Table 3.2, Searle *et al.* (2014)

(Harris *et al*., 2012). As a result, displacement model outputs for puffin were considered unreliable by the SNCBs and MSS (Marine Scotland, 2014a).

285. There is little field-based evidence on the effects on puffins from operational offshore wind farms. This is because existing offshore wind farms for which published results are available are located in areas where puffins are naturally scarce. Occasionally puffins were recorded during Horns Rev, Egmond aan Zee and Arklow Bank post-construction monitoring but not in sufficient numbers to undertake any statistical analysis of effects (Petersen, 2005, Leopold *et al.,* 2011, Barton *et al,* 2010).

286. The extent to which wind farms are likely to act as a barrier to puffins is unknown. However, a recent study looking at the theoretical energy costs of a barrier effect concluded, "If an Atlantic puffin were to travel an additional 10,000 m due to the presence of wind farms then it would expend 103% of its daily energy expenditure on the extended flight activity alone" (Masden *et al.*, 2010).

287. However, a comparison of foraging ranges using satellite tagged breeding adult puffins from two colonies on the Shiant Isles and Hermaness, Shetland, has shown that puffins are capable of flying considerable distances in search of prey during the breeding season. Based on six satellite tagged birds from each colony, preliminary results showed that birds from the Shiant Isles were mostly feeding in the Minch, and travelling approximately 20 km from the colony. In contrast, some of the tagged puffins from the Hermaness colony were travelling much further, with one bird travelling over 400 km to feed (800 km round trip), and another travelling approximately 150 km from the colony. Observations of prey being brought in to the two colonies suggest that birds at the Shiants were bringing larger adult sandeels, whereas the puffins at Hermaness were bringing back small, immature sandeels (RSPB, 2017).

288. While this study demonstrates that different colonies may experience different prey availability conditions, it also demonstrates that puffins are able to fly considerable distances in search of food during the breeding season. On this basis, it is concluded that displacement or barrier effects are unlikely to have an additional significant effect on daily energy expenditure for breeding puffins.

289. A recent study conducted at the operational Westermost Rough Offshore Wind Farm in July 2017, investigated the degree of displacement for auks, including puffins within the wind farm (APEM 2017). This report is presented in Appendix 9.5.

290. Westermost Rough is approximately 35 km from the Flamborough Head and Bempton Cliffs SPA, and is therefore within mean maximum foraging range of breeding puffins from this colony. The wind farm comprises 35 turbines spaced approximately 1 km apart, each with a turbine height of 177 m, hub height of 102 m and rotor diameter of 154 m. Westermost Rough therefore has a comparable design to NnG, in terms of the size of turbines and spacing between turbines.

291. Puffin distribution within the Westermost Rough wind farm and surrounding study area in July 2017 is presented in Figure 9-12, Figure 9-13 and Figure 9-14 below.

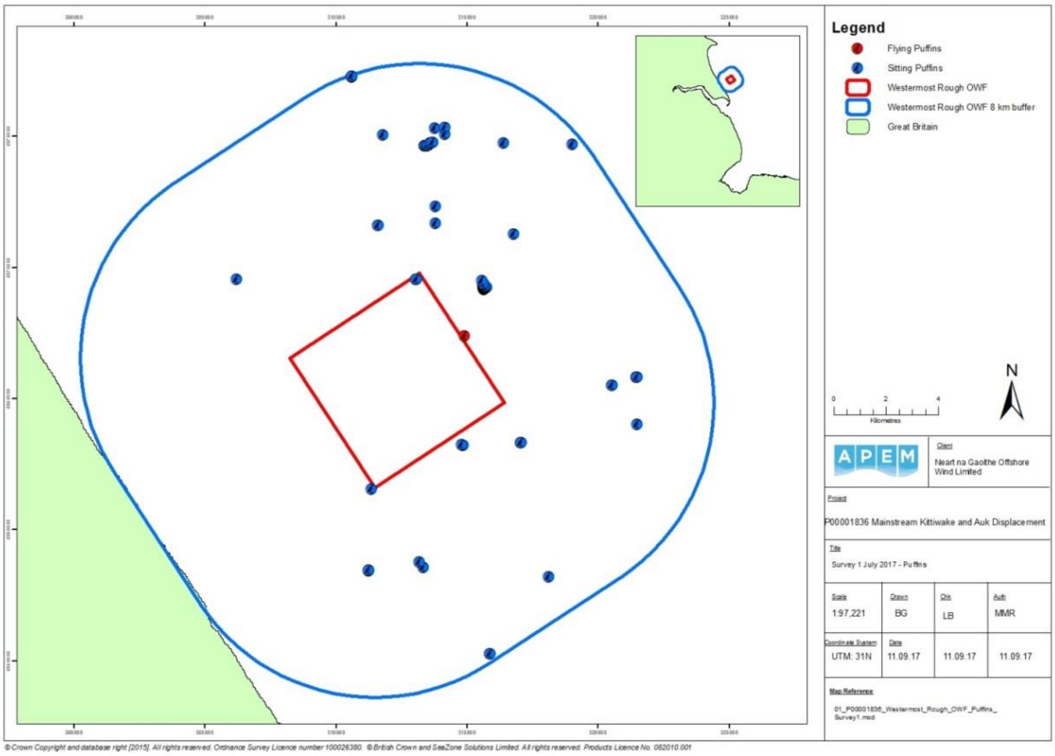


Figure 9-12: Distribution of puffins recorded in the WROWF and 8 km buffer during Survey 1, July 2017

292. On all three surveys, the sample sizes for puffins recorded in the study area were small, and most birds were recorded on the water. However, the survey results showed a similar distribution pattern to the other three species (kittiwake, guillemot and razorbill) in that puffins were recorded in lower numbers in more inshore waters compared to further offshore. However, numbers and distribution within the wind farm compared to the surrounding area is similar on each survey, indicating that birds were not displaced by the presence of the operational turbines.

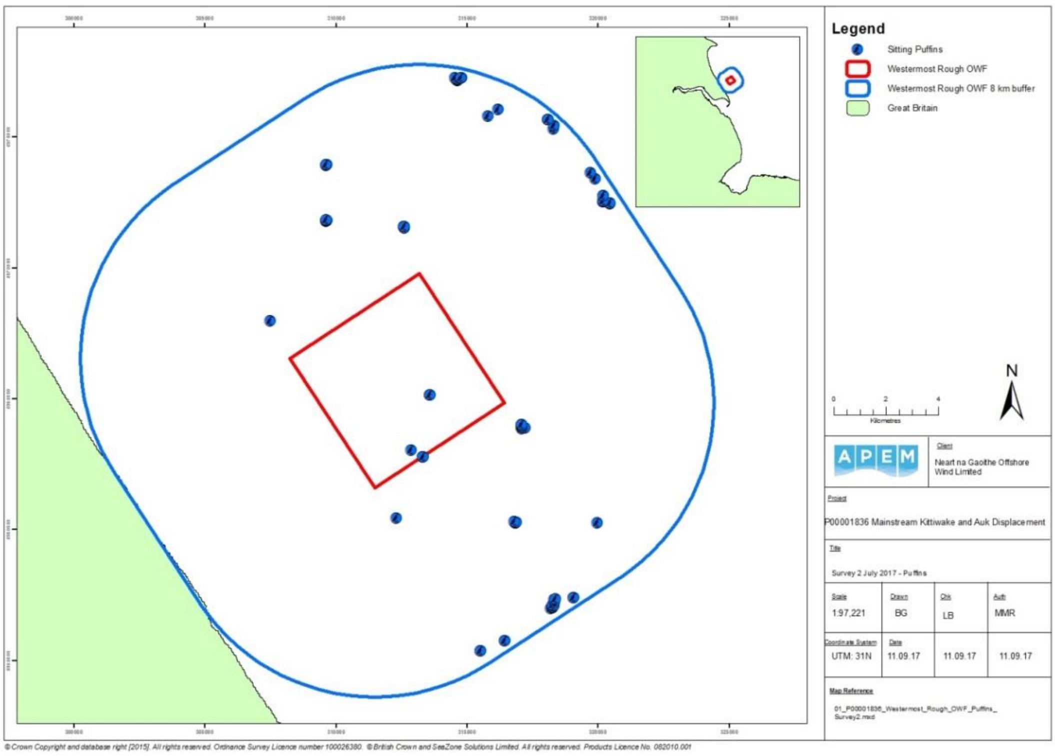


Figure 9-13: Distribution of puffins recorded in the WROWF and 8 km buffer during Survey 2, July 2017

Figure 9-14: Distribution of puffins recorded in the WROWF and 8 km buffer during Survey 3, July 2017

293. The study recorded a high variability in overall mean densities of auks, including puffins, calculated for the entire offshore wind farm and the surrounding buffer zone suggesting no evidence of displacement. There were variations in mean densities of auks across the buffer zone but these differences were not statistically significant.

294. Overall, based on available evidence from other studies and the low predicted mortality arising from displacement, it is concluded that displacement mortality impacts at NnG will have no effect on the breeding SPA populations of puffins within mean maximum foraging range in the breeding season. The sensitivity of puffins to displacement is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Non-breeding season (mid-August to March)

295. The non-breeding season for puffin was defined in the Scoping Opinion and in the BDMPS review as mid-August to March (Marine Scotland, 2017; Furness, 2015).

296. Assuming 60% of all puffins were displaced from the Wind Farm Area during the non-breeding season, this would affect an estimated 923 birds (Table 9-47), increasing to 1,531 birds including the 1 km buffer, and 2,194 birds including the 2 km buffer.

Table 9-47: Summary of puffin displacement for the Wind Farm Area and surrounding buffer areas in the non-breeding season

Displacement	Adults	Immature birds	Total number of birds
Wind Farm Area	502	421	923
Wind Farm Area + 1 km	833	698	1,531
Wind Farm Area + 2 km	1,194	1,000	2,194

297. Using proportions from the PVA stable age structure, the ratio of adult to immature puffins at Forth Islands SPA and Fowlsheugh SPA was calculated (Table 9-44). If it is assumed that 45.6% of the population present in the non-breeding season are immature birds, then this would mean that an estimated 421 puffins displaced from the Wind Farm Area during the non-breeding season would be immature birds, and that the number of displaced adult birds would be 502 birds (Table 9-47). Similarly, an estimated 698 puffins displaced from the Wind Farm Area and 1 km buffer during the non-breeding season would be immature birds, with 833 displaced adult birds. An estimated 1,000 puffins displaced from the Wind Farm Area and 2 km buffer during the non-breeding season would be immature birds, with 1,194 displaced adult birds.

298. Using the 2% mortality rate recommended by the Scoping Opinion (Marine Scotland, 2017), it was calculated that 18 puffins (ten adults and eight immature birds) displaced from the Wind Farm Area, during the non-breeding season would suffer mortality as a result (Table 9-48). Similarly, 31 puffins (17 adults and 14 immature birds) would suffer mortality in the Wind Farm Area and 1 km buffer, or 44 puffins (24 adults and 20 immature birds) in the Wind Farm Area and 2 km buffer, during the non-breeding season.

Table 9-48: Summary of puffin displacement mortality for the Wind Farm Area and surrounding buffer areas in the non-breeding season

Displacement mortality	Adults	Immature birds	Total number of birds	% of SPA population
Wind Farm Area	10	8	18	0.03
Wind Farm Area + 1 km	17	14	31	0.05
Wind Farm Area + 2 km	24	20	44	0.07

299. This is considered an over-estimate, as outside of the breeding season puffins are no longer limited in their foraging range by having to return to the colony. As birds are free to forage over a wider area, any displacement effects are considerably less likely to have any mortality impact.

300. The total number of puffins (adults and immature birds) estimated to occur in the UK waters of the North Sea and Channel in the non-breeding season (mid-August to March) is 231,957 birds (Furness, 2015). Of this population, an estimated 162,061 puffins (adults and immature birds) are considered to be from UK breeding colonies. If up to 44 puffins were to die as a result of displacement from the Wind Farm Area, this would affect 0.03% of the North Sea and Channel population from UK breeding colonies (162,061 adults and immature birds) in the non-breeding season.

301. Estimated numbers of adult and immature puffins from the Forth Islands SPA in the UK waters of the North Sea and Channel in the non-breeding season (mid-August to March) are shown in Table 9-49 (Furness, 2015).

Table 9-49: Estimated numbers of adult and immature puffins from the Forth Islands SPA in the UK waters of the North Sea and Channel in the non-breeding season (Furness, 2015)

SPA	Non-breeding season North Sea		
	Adult	Immature	Total
Forth Islands	62,231	2,589	64,820

302. If up to 44 puffins were to suffer mortality as a result of displacement from the Wind Farm Area and 2 km buffer, this would affect up to 0.07% of the North Sea population from the Forth Islands SPAs (64,820 adults and immature birds) in the non-breeding season (Furness, 2015) (Table 9-48). This is

considered an over-estimate, as outside of the breeding season puffins are no longer limited in their foraging range by having to return to the nest. As birds are free to forage over a wider area, any displacement effects are considerably less likely to have a mortality impact.

303. For the surviving displaced birds, there would be minimal impact from displacement, as foraging birds would be able to find food outside of the Wind Farm Area and 2 km buffer. Therefore, it is concluded that displacement mortality impacts at NnG will have no effect on puffins from the key SPA population in the non-breeding season. The sensitivity of puffins to displacement is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Assessment of displacement mortality throughout the year

304. Predicted puffin mortality from all seasons from displacement as calculated above, was summed for the whole year (Table 9-50).

305. A total of 34 puffins are assumed to suffer mortality if displacement impacts are confined to the Wind Farm Area, based on an assumed mortality rate of 2%. This represents an estimated 0.05% of the population of the key SPA, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

Table 9-50: Estimated puffin mortality (adult and immature birds) from the Wind Farm Area and 2 km buffer on the three key SPAs in the UK waters of the North Sea throughout the year

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of SPA population	No of birds	% of SPA population
Breeding season	16 adults	0.02	37 adults	0.04
Non-breeding season	18 birds	0.03	44 birds	0.07
Total	34 birds	0.05	81 birds	0.1

306. If displacement impacts occur over the Wind Farm Area and a surrounding 2 km buffer, then an estimated 81 puffins are assumed to suffer mortality as a result of displacement. This represents an estimated 0.1% of the population of the key SPA, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

307. However, it is considered that a mortality rate of 2% outside of the breeding season, when birds are not tied to their breeding colony, is precautionary. Therefore, it is concluded that displacement mortality impacts at NnG will have no effect on puffins from the key SPA population throughout the year. The sensitivity of puffins to displacement is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

9.9.2.3 Collision Mortality

308. In the Scoping Opinion, MS-LOT advised that collision rate modelling would be required for gannet, herring gull and kittiwake. The RSPB also recommended that lesser black-backed gull and great black-backed gull should be considered for collision rate modelling (Marine Scotland, 2017). In addition, a further five species (Arctic skua, great skua, little gull, black-headed gull and common gull) have been included in the collision rate modelling, on the basis of flight heights recorded during baseline surveys. Although numbers of these species recorded on baseline surveys were generally low, more than 1% of recorded flight height for these species was above 27.5m in height.

309. Collision rate modelling was carried out using the methods described in Band (2012). For kittiwake and gannet, the assessment presents estimated collisions using Band model Option 1 with site specific flight height data, and Option 2 using generic flight height data from Johnson *et al*. (2014).

310. For gannet, an avoidance rate of 98.9% (± 0.002) has been used in the assessment, with estimates using 98% for summer months also presented, as requested by the RSPB in the Scoping Opinion (Marine Scotland, 2017). For kittiwake, an avoidance rate of 98.9% (± 0.002) has been used, as recommended in the Scoping Opinion (Marine Scotland, 2017). The nocturnal activity scores of 2 (25%) were used for kittiwake and 1 (0%) for gannet, as recommended in the Scoping Opinion (Marine Scotland, 2017).

311. For herring gull, lesser black-backed gull and great black-backed gull, the assessment has presented estimated collisions using the Band model Option 1 with site specific flight height data, and Options 2 and 3 using Johnson *et al*. (2014). For herring gull, the following avoidance rates have been used:

- 99.5% (± 0.001) for Band Option 1;
- 99.5% (± 0.001) for Band Option 2;
- 99.0% (± 0.002) for Band Option 3.

312. For lesser black-backed gull and great black-backed gull, the following avoidance rates have been used, based on the BTO Avoidance Rate review (Cook *et al.,*2014):

- 99.5% (± 0.001) for Band Option 1;
- 99.5% (± 0.001) for Band Option 2;
- 98.9% (± 0.002) for Band Option 3.

313. A nocturnal activity score of 2 (25%) was used for herring gull, and a nocturnal activity score of 3 (50%) was used for lesser black-backed gull and great black-backed gull.

314. Input data for the worst-case design scenario (54 turbines) are presented in Appendix 9.3: Table 1. Information on rotation speed, pitch and the proportion of time in operation was available per month; therefore, collision rate modelling has used monthly figures for these variables along with bird density.

315. Biometric input data for the bird species assessed, such as length, wingspan and recorded monthly densities for the five main bird species are shown in Appendix 9.3: Table 2. Biometric data were obtained from Snow and Perrins (1997) and flight speeds from Alerstam *et al*. (2007), Pennycuick (1987) and Pennycuick (1997). As a precautionary approach, flapping was used for all species to account for the unknown behaviour as birds pass the rotor-swept area.

316. For Band Option 1, densities used in the collision rate modelling were based on mean monthly values from three years of baseline surveys at the Project study site. The proportion of birds at rotor height (PCH in Appendix 9.3: Table 2 and Table 3) was calculated from data recorded during the ship-based surveys and following standardised European Seabirds at Sea (ESAS) protocols in which only flying birds recorded as 'in transect' (thus during the snapshot count) are included (Camphuysen and Garthe 2004, Webb and Durinck 1992). The heights of flying birds recorded as 'in transect' were recorded in categories. To account for observers rounding off, particularly at heights above 30 m, flying birds were pooled into 10 m categories and divided equally across the 1 m bands within these categories. This assumes a precautionary approach as it tends to over-estimate the numbers of birds in the upper limits of each category. The proportion of birds at rotor height (PCH) was then calculated based on the birds at 32 m and above (for a minimum rotor height of 32m above mean sea level, MSL, i.e. 35m above LAT).

317. For Band Options 2 and 3, flight height data accompanying Johnston *et al*. (2014) were used. In Band Option 2, the proportions of birds at rotor height (PCH) were taken as those at 32 m and above. In Band Option 3, the collision model calculation uses these flight height data as input data to calculate the proportions of birds throughout the rotor height.

318. For all species (gannet, kittiwake, herring gull, lesser black-backed gull and great black-backed gull) the proportion of birds at rotor height for site-specific survey data were lower than the data presented in Johnston et al. (2014).

319. The large array correction factor, which takes account of the declining proportion of birds surviving passage through initial rows of turbines and thus exposed to collision risk in later rows, was not applied in this assessment, as this has little effect on the results and is only of relevance for very large wind farms of hundreds of turbines.

320. In addition, collision rate modelling was carried out for five passage species (great skua, Arctic skua, little gull, black-headed gull and common gull) (Appendix 9.3: Table 3). Due to the low number of these species recorded during baseline surveys, modelling was based on an assumption that 1,000 individuals of each species passed through the Wind Farm Area in a south-north direction in April and again in a north-south direction in September, using the 'migrant collision risk' option in the Band Model, and Band Model Option 2. The width of the development area was taken as 8.22km.

321. Turbine parameters for the Original Project and the current Project are shown in Table 9-51.

Table 9-51: Number of turbines, diameter and blade tip height for 2014 and 2017 projects

	NnG	
	2014 consented	**2017 Worst-case**
No. of turbines	75	54
Rotor diameter	Up to 154m	Up to 167m
Air Gap	30.5m above LAT	35m above LAT
Maximum height to blade tip (LAT)	197m	Up to 208m

322. A comparison of the proportion of birds at collision height (PCH) for Option 1 and Option 2 for the five key species assessed here is presented in Table 9-52. Differences in PCH for the two Band Model options are discussed in the relevant species text.

Table 9-52: Proportion of birds at collision height (PCH) for Option 1 and Option 2 for the five key species included in the collision assessment

54 turbines **98.9% AR (± 2 SD)**	**Band Option 1** 32m upwards	**Band Option 2** **32 – 300m**
Gannet	0.018	0.036
Kittiwake	0.019	0.047
Herring Gull	0.120	0.160
Lesser black-backed Gull	0.041	0.131
Great black-backed Gull	0.119	0.167

9.9.2.3.1 Collision estimates for gannet

323. The CRM assessment estimated the number of potential gannet collisions per season based on the worst-case design scenario (54 turbines). The minimum height for the turbine blades above the sea surface for this design is 32.0 m at mean sea level (MSL) (35 m LAT).

Breeding season

324. Estimated gannet collisions for the worst-case design scenario (54 turbines) using an avoidance rate of 98.9% (± 0.002), as recommended in the Scoping Opinion (Marine Scotland, 2017), are shown in Table 9-53. Two sets of figures are presented: Band Model Option 1 and Band Model Option 2, for the breeding and non-breeding seasons. In addition, estimated collisions based on an avoidance rate of 98% (± 0.002) for the breeding season (mid-March to September) are presented in Table 9-54.

325. The proportion of gannets at collision height (PCH) for the different Band Model options used in the assessment are shown in Table 9-52. The proportion at collision height was lowest for the Band Option 1 dataset (0.018) and highest for the Band Model Option 2 dataset (0.036).

326. For the purposes of this assessment, all gannets in the breeding season were assumed to be from the Forth Islands SPA, as recommended in the Scoping Opinion (Marine Scotland, 2017). This SPA has therefore been used as the SPA reference population for this assessment in the breeding season (75,259 pairs).

327. Baseline surveys recorded the age of gannets where possible, with 877 immature (non-breeding) birds (2.5%) and 34,208 adults (97.5%) aged on surveys between mid-March and September, and 193 immature (non-breeding) birds (3.6%) and 5,222 adults (96.4%) aged on surveys between October and mid-March (Appendix 9.2: Table 3). These age ratios were applied to the estimated number of collisions for the breeding and non-breeding seasons to give the estimated number of collisions for adult and immature gannets.

328. For the worst case design scenario (54 turbines), a total of 93 gannet collisions (91 adults and two immature birds) were estimated for the breeding season, using an avoidance rate of 98.9% and Band Option 2 (Table 9-53). This corresponds to 0.06% of the Forth Islands SPA breeding population (75,259 pairs) (Table 9-8). Based on an avoidance rate of 98.9% and using Band Option 2, a total of 14 gannet collisions (13 adults and one immature bird) were estimated for the non-breeding season (October to mid-March), for the worst case design scenario.

Table 9-53: Estimated number of gannet collisions based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98.9% ± 2 SD

54 turbines 98.9% AR (± 2 SD)	Band Option 1	Band Option 2
Collisions in breeding season, all ages	46 ± 8.3	93 ± 16.9
Collisions in breeding season, adults birds	45	91
Collisions in breeding season, immature birds	1	2
Collisions in non-breeding season, all ages	7 ± 1.3	15 ± 2.7
Collisions in non-breeding season, adults birds	7	14
Collisions in non-breeding season, immature birds	0	1
Total collisions per year, all ages	53 ± 9.6	108 ± 19.6

329. For comparison, the estimated number of gannet collisions using Band Model Option 1 & 2 and an avoidance rate of 98% for the breeding season, as requested by RSPB in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-54.

Table 9-54: Estimated number of gannet collisions in the breeding season, based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98%

54 turbines 98% AR	Band Option 1	Band Option 2
Collisions in breeding season, all ages	83	169
Collisions in breeding season, adults birds	81	165
Collisions in breeding season, immature birds	2	4

330. For the worst case design scenario (54 turbines), a total of 169 gannet collisions (165 adults and four immature birds) were estimated for the breeding season, using an avoidance rate of 98% and Band Option 2 (Table 9-54). This corresponds to 0.1% of the Forth Islands SPA breeding population (75,259 pairs) (Table 9-8).

331. As expected, using an avoidance rate of 98% and Band Option 2 gives a higher estimated number of adult gannet collisions in the breeding season (165 birds), compared to 91 adults estimated using an avoidance rate of 98.9% and Band Option 2. However, a study of avoidance rates by the BTO recommended that for gannet, an avoidance rate of 98.9% should be used with the basic Band Model, (which includes Option 2, as used here) (Cook *et al.,* 2014). This was also the avoidance rate recommended for gannet in the Scoping Opinion (Marine Scotland, 2017). Based on these recommendations, an avoidance rate of 98.9% has been used in this assessment.

332. The figure of 91 adult gannet collisions is also considered highly precautionary. Post-construction monitoring at operational wind farms indicate that the majority of gannets are likely to avoid the footprint of the proposed wind farm (PMSS, 2006; Christensen *et al*, 2004; Leopold *et al*, 2011; Diersche and Garthe, 2006). No records of gannets colliding with wind turbines were reported by Diersche and Garthe (2006) in a literature review on the effects of offshore wind farms on seabirds.

333. Gannets observed entering the Egmond aan Zee wind farm in the Netherlands always stopped foraging, decreased flight height to <10 m (i.e. well below rotor height) and flew out of the wind farm (Leopold *et al*, 2011).

334. Although most post-construction studies of gannets have occurred outside the breeding season and away from breeding colonies, some post-construction studies have been carried out at offshore wind farms within foraging range of breeding gannets. Post-construction monitoring at Robin Rigg Offshore Wind Farm in the Solway Firth, recorded no gannets flying within the operating wind farm over a five year period. This study also found that gannets largely flew below turbine swept-rotor height (35-125 m) throughout the entire study area, with less than 2% of all gannets in flight recorded at rotor height (Nelson *et al*, 2015). Robin Rigg is within mean maximum foraging distance of the gannet breeding colony on Ailsa Craig (33,226 pairs in 2014), and also Scar Rocks in Dumfries and Galloway (2,376 pairs in 2014) (SMP 2017).

335. Appendix 9.7 presents maps of gannets tracked from the Bass Rock in the breeding season in 2010, 2011, 2012 and 2015. Birds tagged in the 2010 to 2012 breeding seasons were all breeding adults from the Bass Rock colony, while birds tagged in the 2015 breeding season were breeding adults and non-breeding immature birds. This gannet data was made available by Keith Hamer of the University of Leeds.

336. The maps demonstrate that adult birds travel a considerable distance from the Bass Rock colony, and that the Wind Farm Area is not a key foraging area for gannets in the breeding season. A paper on gannet flight height using pressure tags concluded that foraging gannets were more likely to fly at rotor height than gannets that were travelling or commuting from one place to another, e.g. returning to the Bass Rock after a foraging trip (Cleasby *et al.*, 2015). A comparison of flight direction and flight height of adult gannets recorded on baseline surveys between March and September within the Wind Farm Area and 2 km buffer is presented in Appendix 9.2: Table 2. The majority of adult gannets recorded flying in the direction of the Bass Rock (recorded as flying west, south-west or south) were flying below 7.5m in height (90.7%) (n=18,900 birds). In comparison, just under three quarters of adult gannets recorded flying away from the Bass Rock (recorded as flying north, north-east or east) were flying below 7.5m in height (73.6%%) (n=12,119 birds). Although a relatively crude assessment, these results indicate that the majority of adult gannets flying within the Wind Farm Area and 2 km buffer are well below the rotor swept area.

337. The proportion of gannets at collision height (PCH) for the different Band Model options used in the assessment are shown in Table 9-52. The proportion at collision height was lowest for the Band Option 1 dataset (0.018) and highest for the Band Model Option 2 dataset (0.036). This assessment was based on Band Option 2 (the generic dataset, with a higher proportion of birds at collision height), therefore it is considered precautionary. It is considered that using the Band Option 1 dataset is more representative of gannet flight behaviour at NnG than using the generic dataset with Band Option 2, and that the overall number of collisions in the breeding season will be lower than the number assessed here.

338. In addition, the consistent reports of high avoidance of gannets from offshore wind farms in a variety of different study situations in European marine areas indicates that it is likely that this is how breeding birds from the Bass Rock colony will respond to the Project. Correspondingly, the estimated number of gannet collisions (91 adults) presented here is therefore considered an over-estimate.

339. It is concluded that collision mortality impacts at NnG will have no effect on the breeding SPA population of gannets within mean maximum foraging range in the breeding season. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Autumn period of the non-breeding season

340. The autumn period of the non-breeding season for gannet was defined in the Scoping Opinion as October and November (Marine Scotland, 2017), and in the BDMPS review as September to November (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

341. Estimated gannet collisions between October and November for the worst-case design scenario (54 turbines) using an avoidance rate of 98.9% (+- 0.002), as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-55. Two sets of figures are presented: Band Model Option 1 and Band Model Option 2.

342. Baseline surveys recorded 147 immature (non-breeding) birds (5.5%) and 2,549 adults (94.5%) on surveys between October and November (Appendix 9.2: Table 3). These age ratios were applied to the estimated number of collisions for the autumn period of the non-breeding season to give the estimated number of collisions for adult and immature gannets.

Table 9-55: Estimated number of gannet collisions in the autumn period of the non-breeding season (September to November), based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98.9% ± 2 SD

54 turbines 98.9% AR (± 2 SD)	Band Option 1	Band Option 2
Collisions in autumn period of non-breeding season, all ages	4 ± 0.7	7 ± 1.3
Collisions in autumn period of non-breeding season, adults birds	4	7
Collisions in autumn period of non-breeding season, immature birds	0	0

343. For the worst-case design scenario (54 turbines), a total of seven gannet collisions (all adults) were estimated for the autumn period of the non-breeding season (October and November), using an avoidance rate of 98.9% and Band Option 2 (Table 9-55).

344. The total number of gannets (adults and immature birds) estimated to occur in the UK waters of the North Sea and Channel in the autumn period of the non-breeding period (September to November) is 456,298 birds (Furness, 2015). Of this population, an estimated 411,125 gannets (adults and immature birds) are considered to be from UK breeding colonies. If seven gannets were to suffer mortality in the autumn period of the non-breeding season as a result of turbine collision, this would affect 0.002% of the North Sea and Channel population from UK breeding colonies (411,125 adults and immature birds).

345. Estimated numbers of adult and immature gannets from the key SPA for gannets considered in this assessment in the UK waters of the North Sea and Channel in the autumn period of the non-breeding season are shown in Table 9-56 (Furness, 2015).

Table 9-56: Estimated numbers of adult and immature gannets from the Forth Islands SPA in the UK waters of the North Sea and Channel in the autumn period of the non-breeding season (Furness, 2015)

SPA	Autumn North Sea		
	Adult	Immature	Total
Forth Islands	110,964	80,893	191,857

346. If seven gannets (worst case) were to suffer mortality in the autumn period of the non-breeding season as a result of turbine collision, this would affect 0.004% of the North Sea and Channel population from the key SPA (191,857 adults and immature birds)(Furness, 2015).

347. It is concluded that collision mortality impacts at NnG will have no effect on gannets from the SPA population in the autumn period of the non-breeding season. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Spring period of the non-breeding season

348. The spring period of the non-breeding season for gannet was defined in the Scoping Opinion as December to mid-March (Marine Scotland, 2017), and in the BDMPS review as December to March (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

349. Estimated gannet collisions between December and mid-March for the worst-case design scenario (54 turbines) and an avoidance rate of 98.9% (+- 0.002), as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-57. Two sets of figures are presented: Band Model Option 1 and Band Model Option 2.

350. Baseline surveys recorded 46 immature (non-breeding) birds (1.7%) and 2,673 adults (98.3%) on surveys between December and mid-March (Appendix 9.2 Table 3). These age ratios were applied to the estimated number of collisions for the spring period of the non-breeding season to give the estimated number of collisions for adult and immature gannets.

Table 9-57: Estimated number of gannet collisions in the spring period of the non-breeding season (December to mid-March), based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98.9% ± 2 SD

54 turbines 98.9% AR (± 2 SD)	Band Option 1	Band Option 2
Collisions in spring period of non-breeding season, all ages	4 ± 0.6	7 ± 1.3
Collisions in spring period of non-breeding season, adults birds	4	7
Collisions in spring period of non-breeding season, immature birds	0	0

351. For the worst-case design scenario (54 turbines), a total of seven gannet collisions (all adults) were estimated for the spring period of the non-breeding season (December to mid-March), based on Band Option 2 (Table 9-57).

352. The total number of gannets (adults and immature birds) estimated to occur in the UK waters of the North Sea and Channel in the spring period of the non-breeding period (December to March) is 248,385 birds (Furness, 2015). Of this population, an estimated 226,482 gannets (adults and immature birds) are considered to be from UK breeding colonies. If seven gannets (worst case) were to suffer mortality in the spring period of the non-breeding season as a result of turbine collision, this would affect 0.003% of the North Sea and Channel population from UK breeding colonies (226,482 adults and immature birds).

353. Estimated numbers of adult and immature gannets from the key SPA for gannets considered in this assessment in the UK waters of the North Sea and Channel in the spring period of the non-breeding season are shown in Table 9-58 (Furness, 2015).

Table 9-58: Estimated numbers of adult and immature gannets from the Forth Islands SPA in the UK waters of the North Sea and Channel in the spring period of the non-breeding season (Furness, 2015)

SPA	Spring North Sea		
	Adult	Immature	Total
Forth Islands	77,675	35,952	113,627

354. If seven gannets (worst case) were to suffer mortality in the spring period of the non-breeding season as a result of turbine collision, this would affect 0.006% of the North Sea and Channel population from the key SPA (113,627 adults and immature birds) (Furness, 2015).

355. It is concluded that collision mortality impacts at NnG will have no effect on gannets from the SPA population in the spring period of the non-breeding season. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Assessment of collision mortality throughout the year

356. Predicted gannet mortality from all seasons from collision as calculated above, was summed for the whole year for the worst-case scenario (54 turbines) (Table 9-59).

Table 9-59: Estimated number of gannet collisions per year, based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9% ± 2 SD

54 turbines 98.9% AR (± 2 SD)	Band Option 2	% of SPA population
Collisions in breeding season, all ages	93 ± 16.9	0.06%
Collisions in autumn period of non-breeding season, all ages	7 ± 1.3	0.004%
Collisions in spring period of non-breeding season, all ages	7 ± 1.3	0.003%
Total	107 ± 19.5	0.07%

357. For the worst case design scenario (54 turbines), a total of 107 gannets (adult and immatures) are estimated to suffer mortality each year from collision impacts, based on Band Model Option 2 and an avoidance rate of 98.9%. This represents an estimated 0.07% of the population (adult and immatures) of the key SPA, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

358. This is considered precautionary, as it is based on Band Option 2, which used the generic dataset from Johnston *et al.* 2014, rather than the site-specific flight height data collected on baseline surveys. It is considered that using the Band Option 1 dataset would more representative of gannet flight behaviour at NnG than using the generic dataset with Band Option 2, and that the number of collisions in the breeding season will be lower than the number assessed here.

359. It is concluded that collision mortality impacts at NnG will have no effect on gannets from the SPA population throughout the year. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

9.9.2.3.2 Collision estimates for kittiwake

Breeding season

360. The CRM assessment has estimated the number of potential kittiwake collisions per season for the worst-case design scenario (54 turbines). The minimum height for the turbine blades above the sea surface for this scenario is 32.0 m at mean sea level (MSL) (35 m LAT).

361. The proportion of kittiwakes at collision height for the different Band Model options used in the assessment are shown in Table 9-52. The proportion at collision height was lowest for the Band Option 1 dataset (0.019) and highest for the Band Model Option 2 dataset (0.047).

362. Baseline surveys recorded the age of kittiwakes where possible, with 222 immature (non-breeding) birds (6.8%) and 3,033 adults (93.2%) aged on surveys in the breeding season as defined in the Scoping Opinion (Table 9-7) (mid-April to August), and 1,041 immature (non-breeding) birds (39.5%) and 1,597 adults (60.5%) aged on surveys in the non-breeding season (September to mid-April) (Appendix 9.2: Table 5). These age ratios were applied to the estimated number of collisions for the breeding and non-breeding seasons to give the estimated number of collisions for adult and immature kittiwakes.

363. Populations at SPAs for breeding kittiwakes of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding kittiwakes is 60.0 ± 23.3 km, based on a sample size of six birds (Thaxter *et al.,* 2012). Based on this, three SPAs for breeding kittiwakes (Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project. These three SPAs have therefore been used as the SPA reference population for this assessment in the breeding season (17,652 pairs). For the non-breeding season, the Buchan Ness to Collieston Coast SPA was also included.

364. Estimated kittiwake collisions for the worst-case design scenario (54 turbines) based on an avoidance rate of 98.9% (+- 0.002), as recommended in the Scoping Opinion (Marine Scotland, 2017), are shown in Table 9-60. Two sets of figures are presented: Band Model Option 1 and Band Model Option 2, for the breeding and non-breeding seasons.

Table 9-60: Estimated number of kittiwake collisions based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98.9% ± 2 SD

54 turbines 98.9% AR (± 2 SD)	Band Option 1	Band Option 2
Collisions in breeding season, all ages	3 ± 0.6	9 ± 1.6
Collisions in breeding season, adults birds	3	8
Collisions in breeding season, immature birds	0	1
Collisions in non-breeding season, all ages	8 ± 1.4	19 ± 3.5
Collisions in non-breeding season, adults birds	5	12
Collisions in non-breeding season, immature birds	3	7
Total collisions per year, all ages	11 ± 2.0	28 ± 5.0

365. For the worst-case design scenario (54 turbines), a total of eight adult kittiwake collisions were estimated for the breeding season, using an avoidance rate of 98.9% and Band Option 2 (Table 9-60). This corresponds to 0.02% of the breeding population for the three key SPAs (17,652 pairs) (Table 9-8). A total of 19 kittiwake collisions (12 adults and seven immature bird) were estimated for the non-breeding season (October to mid-March), for the worst-case design scenario.

366. It is concluded that collision mortality impacts at NnG will have no effect on the breeding SPA populations of kittiwakes within mean maximum foraging range in the breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Autumn period of the non-breeding season

367. The autumn period of the non-breeding season for kittiwake was defined in the Scoping Opinion as September to December (Marine Scotland, 2017), and in the BDMPS review as August to December (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

368. Estimated kittiwake collisions between September and December for the worst-case design scenario (54 turbines) based on an avoidance rate of 98.9% (+- 0.002), as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-61. Two sets of figures are presented: Band Model Option 1 and Band Model Option 2.

369. A total of 43.1% of kittiwakes aged during baseline surveys between September and December were immature birds (Appendix 9.2: Table 5). This percentage was applied to the estimated number of collisions for the autumn period of the non-breeding season to give the estimated number of collisions for adult and immature kittiwakes.

Table 9-61: Estimated number of kittiwake collisions in the autumn period of the non-breeding season (September to December), based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98.9% ± 2 SD

54 turbines 98.9% AR (± 2 SD)	Band Option 1	Band Option 2
Collisions in autumn period of non-breeding season, all ages	7 ± 1.3	17 ± 3.1
Collisions in autumn period of non-breeding season, adult birds	4	10
Collisions in autumn period of non-breeding season, immature birds	3	7

370. For the worst-case design scenario (54 turbines), a total of 17 kittiwake collisions (10 adults and seven immature birds) for the autumn period of the non-breeding season (September to December) were estimated, using an avoidance rate of 98.9% and Band Option 2 (Table 9-61).

371. The total number of kittiwakes (adults and immature birds) estimated to occur in the UK waters of the North Sea in the autumn period (August to December) is 829,937 birds (Furness, 2015). Of this population, an estimated 432,129 kittiwakes (adults and immature birds) are considered to be from UK breeding colonies. If 17 kittiwakes were to die as a result of collision impacts from the Project in the autumn period of the non-breeding season, this would affect 0.004% of the North Sea population from UK breeding colonies (432,129 adults and immature birds).

372. Estimated numbers of adult and immature kittiwakes from the four key SPAs for kittiwakes considered in this assessment (Table 9-8) in the UK waters of the North Sea in the autumn period (August to December) are shown in Table 9-18 (Furness, 2015).

373. If 17 kittiwakes were to suffer mortality as a result of collision impacts from the Project in the autumn period of the non-breeding season, this would affect 0.03% of the North Sea population from the four key SPAs (54,039 adults and immature birds) (Furness, 2015).

374. It is concluded that collision mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations in the autumn period of the non-breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Spring period of the non-breeding season

375. The spring period of the non-breeding season for kittiwake was defined in the Scoping Opinion as January to mid-April (Marine Scotland, 2017), and in the BDMPS review as January to April (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

376. Estimated kittiwake collisions between January and mid-April for the worst-case design scenario (54 turbines) based on an avoidance rate of 98.9% (+- 0.002), as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-62. Two sets of figures are presented: Band Model Option 1 and Band Model Option 2.

377. A total of 20.8% of kittiwakes aged during baseline surveys between January and mid-April were immature birds (Appendix 9.2). This percentage was applied to the estimated number of collisions for the spring period of the non-breeding season to give the estimated number of collisions for adult and immature kittiwakes.

Table 9-62: Estimated number of kittiwake collisions in the spring period of the non-breeding season (January to mid-April), based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98.9% ± 2 SD

54 turbines 98.9% AR (± 2 SD)	Band Option 1	Band Option 2
Collisions in spring period of non-breeding season, all ages	1 ± 0.1	2 ± 0.3
Collisions in spring period of non-breeding season, adults birds	1	2
Collisions in spring period of non-breeding season, immature birds	0	0

378. For the worst-case design scenario (54 turbines), a total of two kittiwake collisions (both adults) were estimated for the spring period of the non-breeding season (January to mid-April), using an avoidance rate of 98.9% and Band Option 2 (Table 9-62).

379. The total number of kittiwakes (adults and immature birds) estimated to occur in the UK waters of the North Sea in the spring period of the non-breeding period (January to April) is 627,816 birds (Furness, 2015). Of this population, an estimated 389,392 kittiwakes (adults and immature birds) are considered to be from UK breeding colonies. If two kittiwakes were to die as a result of turbine collision in the spring period of the non-breeding season, this would affect 0.0005% of the North Sea population from UK breeding colonies (389,392 adults and immature birds).

380. Estimated numbers of adult and immature kittiwakes from the four key SPAs for kittiwakes considered in this assessment in the UK waters of the North Sea in the spring period of the non-breeding season are shown in (Table 9-21).

381. If two kittiwakes were to suffer mortality as a result of turbine collision in the spring period of the non-breeding season, this would affect 0.004% of the North Sea population from the four key SPAs (49,044 adults and immature birds) (Furness, 2015).

382. It is concluded that collision mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations in the spring period of the non-breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Assessment of collision mortality throughout the year

383. Predicted kittiwake mortality from all seasons from collision as calculated above, was summed for the whole year for the worst-case scenario (54 turbines) (Table 9-63).

Table 9-63: Estimated number of kittiwake collisions per year, based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9% ± 2 SD

54 turbines 98.9% AR (± 2 SD)	Band Option 2	% of SPA population
Collisions in breeding season, all ages	9 ± 1.6	0.03%
Collisions in autumn period of non-breeding season, all ages	17 ± 3.1	0.03%
Collisions in spring period of non-breeding season, all ages	2 ± 0.3	0.004%
Total	28 ± 5.0	0.06%

384. For the worst-case design scenario (54 turbines), a total of 28 kittiwakes (adult and immatures) are estimated to suffer mortality each year from collision impacts, based on Band Model Option 2 and an avoidance rate of 98.9%. This represents an estimated 0.06% of the population (adult and immatures) of the key SPAs, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

385. Based on this annual figure, it is concluded that collision mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations throughout the year. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

9.9.2.3.3 Collision estimates for herring gull

Breeding season

386. The CRM assessment estimated the number of potential herring gull collisions per season for the worst-case design scenario (54 turbines). The minimum height for the turbine blades above the sea surface for this scenario is 32.0 m at mean sea level (MSL) (35 m LAT).

387. The proportion of herring gulls at collision height (PCH) for the different Band Model options used in the assessment are shown in Table 9-52. The proportion at collision height was lowest for the Band Model Option 2 dataset (0.16) and highest for the Band Option 1 dataset (0.321).

388. Estimated herring gull collisions for the worst-case design scenario (54 turbines) using an avoidance rate of 99.5% (± 0.001) with Band Option 1 and 2, and 99.0% (± 0.002) with Band Option 3, as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-64. Three sets of figures are presented: Band Model Option 1, Band Model Option 2 and Band Model Option 3, for the breeding and non-breeding seasons.

389. Baseline surveys recorded the age of herring gulls where possible, with 138 immature (non-breeding) birds (22.6%) and 472 adults (77.4%) aged on surveys in the breeding season (April to August), and 367 immature (non-breeding) birds (33.7%) and 723 adults (66.3%) aged on surveys in the non-breeding season (September to March) (Appendix 9.2: Table 7). This age ratio was applied to the estimated number of collisions for the breeding period to give the estimated number of collisions for adult and immature herring gulls.

390. Populations at SPAs for breeding herring gulls of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding herring gulls is 61.1 ± 44 km, based on a sample size of two birds (Thaxter *et al.,* 2012). Based on this, three SPAs for breeding herring gulls (Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project. These three SPAs have therefore been used as the SPA

reference population for this assessment in the breeding season (7,030 pairs) (Table 9-8). For the non-breeding season, the Buchan Ness to Collieston Coast SPA was also included.

391. For the worst-case design scenario (54 turbines), a total of two herring gull collisions (both adults) were estimated for the breeding season, using an avoidance rate of 99.5% and Band Option 2 (Table 9-64). This corresponds to 0.01% of the breeding population for the three key SPAs (7,030 pairs) (Table 9-8). A total of four herring gull collisions (three adults and one immature bird) were estimated for the non-breeding season (September to March), for the worst case design scenario.

Table 9-64: Estimated number of herring gull collisions based on 54 turbines, an avoidance rate of 99.5% (± 1SD) with Band Option 1 and 2, and 99.0% (± 2SD) with Band Option 3

54 turbines	Band Option 1 99.5% AR ± 1 SD	Band Option 2 99.5% AR ± 1 SD	Band Option 3 99.0% AR ± 2SD
Collisions in breeding season, all ages	1 ± 0.3	2 ± 0.4	1 ± 0.3
Collisions in breeding season, adults birds	1	2	1
Collisions in breeding season, immature birds	0	0	0
Collisions in non-breeding season, all ages	3 ± 0.5	4 ± 0.7	3 ± 0.6
Collisions in non-breeding season, adults birds	2	3	2
Collisions in non-breeding season, immature birds	1	1	1
Total collisions per year, all ages	4 ± 0.8	6 ± 1.1	4 ± 0.8

392. It is concluded that collision mortality impacts at NnG will have no effect on the breeding SPA populations of herring gulls within mean maximum foraging range in the breeding season. The sensitivity of herring gulls to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Non-breeding season

393. The herring gull non-breeding season was defined in the Scoping Opinion as September to March (Table 9-7), while the BDMPS review defined the non-breeding season for herring gull as consisting of September to February (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

394. Estimated herring gull collisions for the worst-case design scenario (54 turbines) based on an avoidance rate of 99.5% (± 0.001) with Band Option 1 and 2, and 99.0% (± 0.002) with Band Option 3, as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-64. Three sets of figures are presented: Band Model Option 1, Band Model Option 2 and Band Model Option 3, for the non-breeding season.

395. A total of 33.7% of herring gulls aged during baseline surveys between September and March were immature birds (Appendix 9.2: Table 7). This percentage rate was applied to the estimated number of collisions for the BDMPS non-breeding season to give the estimated number of collisions for adult and immature herring gulls.

396. For the worst-case design scenario (54 turbines), a total of four herring gull collisions (three adults and one immature bird) were estimated for the non-breeding season (September to March), using an avoidance rate of 99.5% and Band Option 2 (Table 9-64).

397. The total number of herring gulls (adults and immature birds) estimated to occur in the UK waters of the North Sea and Channel in the non-breeding period (September to February) is 466,511 birds (Furness, 2015). Of this population, an estimated 331,381 herring gulls (adults and immature birds) are considered to be from UK breeding colonies. If four herring gulls were to die as a result of turbine collision from the Project in the non-breeding season, this would affect 0.001% of the North Sea and Channel population from UK breeding colonies (331,381 adults and immature birds).

398. Estimated numbers of adult and immature herring gulls from the four key SPAs for herring gulls considered in this assessment in the UK waters of the North Sea in the non-breeding season (September to March) are shown in Table 9-65 (Furness, 2015).

Table 9-65: Estimated numbers of adult and immature herring gulls from the four key SPAs in the UK waters of the North Sea and Channel in the non-breeding season (Furness, 2015)

SPA	Non-breeding season North Sea		
	Adult	Immature	Total
Buchan Ness to Collieston Coast	6,166	6,449	12,615
Fowlsheugh	513	536	1,049
Forth Islands	5,597	5,855	11,452
St Abb's Head to Fast Castle	473	495	968
Combined total	12,749	13,335	26,084

399. If four herring gulls were to suffer mortality as a result of turbine collision in the non-breeding season, this would affect 0.02% of the North Sea and Channel population from the four key SPAs (26,084 adults and immature birds (Furness, 2015).

400. It is concluded that collision mortality impacts at NnG will have no effect on herring gulls from the four key SPA populations in the non-breeding season. The sensitivity of herring gulls to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Assessment of collision mortality throughout the year

401. Predicted herring gull mortality from all seasons from collision as calculated above, was summed for the whole year for the worst case design scenario (54 turbines) (Table 9-66).

Table 9-66: Estimated number of herring gull collisions per year, based on 54 turbines, an avoidance rate of 99.5% (± 1SD) and Band Option 2

54 turbines 98.9% AR (± 2 SD)	Band Option 2	% of SPA population
Collisions in breeding season, all ages	2 ± 0.4	0.01%
Collisions in non-breeding season, all ages	4 ± 0.7	0.02%
Total	6 ± 1.1	0.03%

402. For the worst-case design scenario (54 turbines), six herring gulls (adult and immature birds) are estimated to suffer mortality each year from collision impacts, based on Band Model Option 2 and an avoidance rate of 99.5%. This represents an estimated 0.03% of the population (adult and

immatures) of the key SPAs, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

403. Based on this annual figure, it is concluded that collision mortality impacts at NnG will have no effect on herring gulls from the four key SPA populations throughout the year. The sensitivity of herring gulls to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

9.9.2.3.4 Collision estimates for lesser black-backed gull

Breeding season

404. The CRM assessment estimated the number of potential lesser black-backed gull collisions per season for the worst-case design scenario (54 turbines). The minimum height for the turbine blades above the sea surface for this scenario is 32.0 m at mean sea level (MSL) (35 m LAT).

405. The proportion of lesser black-backed gulls at collision height for the different Band Model options used in the assessment are shown in Table 9-52. The proportion at collision height was lowest for the Band Option 1 dataset (0.079) and highest for the Band Model Option 2 dataset (0.131).

406. Estimated lesser black-backed gull collisions for the worst-case design scenario (54 turbines) based on an avoidance rate of 99.5% (± 0.001) with Band Option 1 and 2, and 98.9% (± 0.002) with Band Option 3, based on the BTO Avoidance Rate review (Cook *et al.,*2014) are shown in Table 9-67. Three sets of figures are presented: Band Model Option 1, Band Model Option 2 and Band Model Option 3, for the breeding and non-breeding seasons.

407. Baseline surveys recorded the age of lesser black-backed gulls where possible, with 20 immature (non-breeding) birds (15.0%) and 113 adults (85.0%) aged on surveys in the breeding season (April to August), and eight immature (non-breeding) birds (16.7%) and 40 adults (83.3%) aged on surveys in the non-breeding season (September to March) (Appendix 9.2: Table 9). This age ratio was applied to the estimated number of collisions for the breeding and non-breeding seasons to give the estimated number of collisions for adult and immature lesser black-backed gulls.

408. Populations at SPAs for breeding lesser black-backed gulls of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding lesser black-backed gulls is 141.0 ± 50.8 km, based on a sample size of three birds (Thaxter *et al.,* 2012). Based on this, one SPA for breeding lesser black-backed gulls (Forth Islands) is within mean maximum foraging range + 1 SD of the Project (Appendix 9.2: Figure 31). This SPA has therefore been used as the SPA reference population for this assessment in the breeding season (2,571 pairs) (Table 9-8).

Table 9-67: Estimated number of lesser black-backed gull collisions based on 54 turbines, an avoidance rate of 99.5% (± 1SD) with Band Option 1 and 2, and 98.9% (± 2SD) with Band Option 3

54 turbines	Band Option 1 99.5% AR ± 1 SD	Band Option 2 99.5% AR ± 1 SD	Band Option 3 98.9% AR ± 2SD
Collisions in breeding season, all ages	0 ± 0.04	1 ± 0.1	1 ± 0.1
Collisions in breeding season, adults birds	0	1	1
Collisions in breeding season, immature birds	0	0	0
Collisions in non-breeding season, all ages	0	0	0
Collisions in non-breeding season, adults birds	0	0	0
Collisions in non-breeding season, immature birds	0	0	0
Total collisions per year, all ages	0 ± 0.04	1 ± 0.1	1 ± 0.1

409. For the worst-case design scenario (54 turbines), a total of one adult lesser black-backed gull collision was estimated for the breeding season, using an avoidance rate of 99.5% and Band Option 2 (Table 9-67). This corresponds to 0.02% of the breeding population for the key SPA (2,571 pairs) (Table 9-8). Based on an avoidance rate of 99.5% and using Band Option 2,there were zero lesser black-backed gull collisions estimated for the non-breeding season (September to March), for the worst case design scenario.

410. It is concluded that collision mortality impacts at NnG will have no effect on the breeding SPA populations of lesser black-backed gulls within mean maximum foraging range in the breeding season. The sensitivity of lesser black-backed gulls to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Autumn, winter and spring periods of the non-breeding season

411. There are three periods presented in the BDMPS review for the "non-breeding season" for lesser black-backed gull, defined as follows: Autumn migration (August to October), Winter (November to February) and Spring migration (March to April) (Furness 2015).

412. Based on the Collision Rate Modelling undertaken for this assessment, there were no lesser black-backed gull collisions estimated between August and March. Therefore, no additional assessment based on the BDMPS review has been undertaken for this species.

Assessment of collision mortality throughout the year

413. Based on the seasonal mortality estimates for the 54 turbine design, a total of one lesser black-backed gull is estimated to die each year from collision impacts, based on Band Model Option 2 and an avoidance rate of 99.5% (Table 9-67). This represents an estimated 0.02% of the population of the key SPA, based on breeding colony counts (Table 9-8).

414. Based on this annual figure, it is concluded that collision mortality impacts at NnG will have no effect on lesser black-backed gulls from the key SPA population throughout the year. The sensitivity of lesser black-backed gulls to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

9.9.2.3.5 Collision estimates for great black-backed gull

Breeding season

415. The CRM assessment estimated the number of potential great black-backed gull collisions per season for the worst-case design scenario (54 turbines). The minimum height for the turbine blades above the sea surface for this scenario is 32.0 m at mean sea level (MSL) (35 m LAT).

416. The proportion of great black-backed gulls at collision height for the different Band Model options used in the assessment are shown in Table 9-52. The proportion at collision height was lowest for the Band Model Option 2 dataset (0.167) and highest for the Band Option 1 dataset (0.181).

417. Estimated great black-backed gull collisions for the worst-case design scenario (54 turbines) based on an avoidance rate of 99.5% (± 0.001) with Band Option 1 and 2, and 98.9% (± 0.002) with Band Option 3, based on the BTO Avoidance Rate review (Cook *et al.,*2014) are shown in Table 9-68. Three sets of figures are presented: Band Model Option 1, Band Model Option 2 and Band Model Option 3, for the breeding and non-breeding seasons.

418. Baseline surveys recorded the age of great black-backed gulls where possible, with 40 immature (non-breeding) birds (57.1%) and 30 adults (42.9%) aged on surveys between April to August (Appendix 9.2: Table 11). This age ratio was applied to the estimated number of collisions for the breeding season to give the estimated number of collisions for adult and immature great black-backed gulls.

419. Great black-backed gull is not listed as a qualifying interest species in the breeding season for any SPAs on the Scottish east coast south of Peterhead (JNCC, 2017). The nearest SPA for breeding great blacked-gulls is Copinsay SPA, approximately 297 km from the Project. In the breeding season, the estimated maximum foraging distance for this species is less than 10 km (Furness & Tasker, 2000).

420. Using an avoidance rate of 99.5% and Band Option 2, zero great black-backed gull collisions were estimated for the breeding season (April to August), for the worst-case design scenario (54 turbines) (Table 9-68).

Table 9-68: Estimated number of great black-backed gull collisions in the breeding and non-breeding seasons, based on 54 turbines, an avoidance rate of 99.5% (± 1SD) with Band Option 1 and 2, and 98.9% (± 2SD) with Band Option 3

54 turbines	Band Option 1 99.5% AR ± 1 SD	Band Option 2 99.5% AR ± 1 SD	Band Option 3 98.9% AR ± 2SD
Collisions in breeding season, all ages	0 ± 0.03	0 ± 0.04	0 ± 0.03
Collisions in breeding season, adults birds	0	0	0
Collisions in breeding season, immature birds	0	0	0
Collisions in non-breeding season, all ages	2 ± 0.4	3 ± 0.6	3 ± 0.5
Collisions in non-breeding season, adults birds	1	1	1
Collisions in non-breeding season, immature birds	1	2	2
Total collisions per year, all ages	2 ± 0.4	3 ± 0.6	3 ± 0.5

421. Results from the Collision Risk Modelling demonstrate that there will be no adverse effects on great black-backed gulls in the breeding season caused by collision impacts arising from the Project.

Non-breeding season

422. In the BDMPS review, the "non-breeding season" for great black backed gull is defined as September to March (Furness 2015), and this definition was applied for this assessment.

423. Baseline surveys recorded the age of great black-backed gulls where possible, with 266 immature (non-breeding) birds (53.8%) and 228 adults (46.2%) aged on surveys in the non-breeding season (September to March) (Appendix 9.2: Table 11). This age ratio was applied to the estimated number of collisions for the non-breeding season to give the estimated number of collisions for adult and immature great black-backed gulls.

424. Using an avoidance rate of 99.5% and Band Option 2, there were three great black-backed gull collisions (one adult and two immature birds) estimated for the non-breeding season (September to March), for the worst-case design scenario (54 turbines) (Table 9-68).

425. The total number of great black-backed gulls (adults and immature birds) estimated to occur in the UK waters of the North Sea in the non-breeding season (September to March) is 91,399 birds (Furness, 2015). Of this population, an estimated 28,663 great black-backed gulls (adults and immature birds) are considered to be from UK breeding colonies. If three great black-backed gulls were to die as a result of turbine collision in the non-breeding season, this would affect 0.01% of the North Sea population from UK breeding colonies (28,663 adults and immature birds).

426. Great blacked-backed gulls are not a qualifying species at any of the key SPAs used in this assessment. The nearest SPA for great black-backed gulls to the Project is is Copinsay SPA, approximately 297 km away.

427. Estimated numbers of adult and immature great black-backed gulls from Copinsay SPA for great black-backed gulls in the UK waters of the North Sea in the non-breeding season (September to March) are shown in Table 9-69 (Furness, 2015).

Table 9-69: Estimated numbers of adult and immature great black-backed gulls from Copinsay SPA in the UK waters of the North Sea in the non-breeding season (Furness, 2015)

SPA	Non-breeding season North Sea		
	Adult	Immature	Total
Copinsay	436	549	985

428. If three great black-backed gulls were to suffer mortality as a result of turbine collision in the non-breeding season, this would affect 0.3% of the North Sea population from Copinsay SPA (985 adults and immature birds (Furness, 2015). However, given the distances involved, it is considered highly unlikely that all collisions would involve birds from one SPA.

Assessment of collision mortality throughout the year

429. For the worst-case design scenario (54 turbines), a total of three great black-backed gulls are estimated to suffer mortality each year from collision impacts, using Band Model Option 2 and an avoidance rate of 99.5% (Table 9-68). This represents an estimated 0.3% of the population of the Copinsay SPA (Furness 2015).

430. This is precautionary, as given the distances involved, it is considered highly unlikely that all collisions would involve birds from the Copinsay SPA.

431. Based on this annual figure, it is concluded that collision mortality impacts at NnG will have no effect on great black-backed gulls from any UK SPA throughout the year. The sensitivity of great black-backed gulls to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

9.9.2.3.6 Collision estimates for additional species

432. For the five additional species (black-headed gull, common gull, little gull, Arctic skua and great skua), collision risk modelling based on 1,000 birds passing through the development area in a north-south/south-north direction two times a year predicted that there would be no collisions in the breeding and non-breeding seasons for any of these species for the worst-case design scenario (54 turbines) (Table 9-70).

Table 9-70: Estimated number of collisions for five less regular species, based on 54 turbines, the recommended BTO avoidance rate, with Band Option 2

Species	Breeding season	Non-breeding season	Annual collisions
Black-headed gull	0	0	0
Common gull	0	0	0
Little gull	0	0	0
Great skua	0	0	0
Arctic skua	0	0	0

433. Based on this annual figure, it is concluded that collision mortality impacts at NnG will have no effect on these five species throughout the year. The sensitivity of these species to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

9.9.2.3.7 Displacement and collision impacts combined

434. Kittiwake was considered for both displacement and collision impacts, and therefore these assessments were combined, using the worst-case results from the seasonal assessments (Table 9-71).

Table 9-71: Estimated kittiwake mortality from displacement and collision impacts throughout the year

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of SPA population	No of birds	% of SPA population
Total displacement	17	0.04%	25	0.05%
Total collisions	28 ± 5.0	0.06%	28 ± 5.0	0.06%
Total	45	0.1	53	0.1

435. For the worst-case design scenario (54 turbines), a total of 45 kittiwakes (adult and immatures) are estimated to die each year from displacement and collision impacts combined. This represents an estimated 0.1% of the population (adult and immatures) of the key SPAs, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

436. If displacement impacts affect kittiwakes out to a distance of 2 km from the Wind Farm Area, then a total of 53 kittiwakes (adult and immatures) are estimated to die each year from displacement and collision impacts combined, based on Band Model Option 2 and an avoidance rate of 98.9%. This represents an estimated 0.1% of the population (adult and immatures) of the key SPAs, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

437. However, this assessment is considered precautionary, based on the displacement and mortality rates used. As highlighted by SNH in the Scoping Opinion (Marine Scotland, 2017), for kittiwake, collision risk and displacement are currently considered to be mutually exclusive impacts, and therefore combining mortality estimates for kittiwake displacement and collision should be considered extremely precautionary.

438. In addition, it is considered that the use of a mortality rate of 2% for displacement impacts outside of the breeding season, when birds are no longer tied to their breeding colony, is also precautionary. It is concluded that displacement and collision mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations throughout the year. The sensitivity of kittiwake to collision is assessed as high, while sensitivity to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

9.9.2.4 Population Viability Analysis (PVA) for the Project

439. Population models were developed for breeding populations of gannet, kittiwake, guillemot, razorbill and puffin, as recommended in the Scoping Opinion (Marine Scotland, 2017). The calculated numbers of collisions, along with the estimated effects of displacement were applied to these population models for relevant breeding colonies. These effects were assessed for the Project alone, and cumulatively with the Inch Cape and SeaGreen A and B projects, as well as with other offshore wind farm projects in the UK North Sea and England Channel (See Section 9.9.5).

440. Methods for the PVA are presented in Appendix 9.8. MSS recently commissioned a research project undertaken by CEH to review the use of Population Viability Analysis (PVA) metrics in the context of assessing effects of offshore renewable developments on seabirds and to test PVA metric sensitivity to mis-specification of input parameters (Jitlal *et al.*, 2017). This work identified three metrics that

were subsequently highlighted in the Scoping Opinion as being required in an assessment (Marine Scotland, 2017):

- Median of the ratio of impacted to unimpacted annual growth rate;
- Median of the ratio of impacted to unimpacted population size; and
- Centile for unimpacted population that matches the 50th centile for impacted population.

441. These metrics are presented for each species included in the PVA assessment for the project alone and for the cumulative PVA assessment.

Scenarios

442. In order to assess the potential effects of proposed and constructed wind farms on the modelled bird populations, a number of scenarios were run. This involved applying additional mortality to the population based on outputs from collision rate modelling using Band Option 2, displacement or both (Table 9-72). In each scenario, this additional mortality was applied to the relevant season, age-classes and populations, based on advice from SNH (Marine Scotland, 2017).

443. Due to limitations in consequently assigning ages of birds from the survey data, the population viability analysis stable age structure was used to assign effects across age classes for gannet, kittiwake, guillemot and razorbill throughout the year. For puffin, effects were applied on adult birds and during the breeding season only, as recommended in the Scoping Opinion (Marine Scotland).

444. Effects from collisions and displacement were apportioned to the relevant SPA populations based on the scenarios outlined in Table 9-72. Further details on these scenarios are presented in Appendix 9.8.

Table 9-72: Scenarios applied to the population models (F&T = NnG, Inch Cape and Seagreen A & B, UK = OWF projects in North Sea and English Channel for gannet and North Sea for Kittiwake) and following SNH advice (Marine Scotland, 2017)

Species	SPA Population	Collisions	Displacement	Collisions and displacement
Gannet	Forth Islands	NnG, F&T, UK	-	
Kittiwake	Forth Islands	NnG, F&T, UK	-	NnG, F&T, UK
Kittiwake	Fowlsheugh	NnG, F&T, UK	-	NnG, F&T, UK
Guillemot	Forth Islands	-	NnG, F&T	-
Guillemot	Fowlsheugh	-	NnG, F&T	-
Razorbill	Forth Islands	-	NnG, F&T	-
Razorbill	Fowlsheugh	-	NnG, F&T	-
Puffin	Forth Islands	-	NnG, F&T	-

445. Effects were based on collision rate modelling using Band Option 2 and displacement figures following SNCB guidance (Table 9-73). Apportioning for the relevant populations was based on a two-step process: (i) proportion in SPAs, and (ii) across the relevant SPA populations. Further information is provided in Appendix 9.8.

Table 9-73: Effects applied to population models for NnG (54 turbines). Unless indicated as refering to adults (ad), effects are applied using the stable age structure.

Species	SPA Population	Collisions	Displacement	Collisions and displacement (breeding season)
Gannet	Forth Islands	108		
Kittiwake	Forth Islands	6		3 ad + 6
Kittiwake	Fowlsheugh	12		5 ad + 12
Puffin	Forth Islands		35 ad	
Guillemot	Forth Islands		3 ad + 8	
Guillemot	Fowlsheugh		5 ad + 16	
Razorbill	Forth Islands		1 ad + 7	
Razorbill	Fowlsheugh		2 ad + 9	

9.9.2.4.1 Gannet

446. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 25 years are shown in Table 9-74.

Table 9-74: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farm)	Percentage point change with NnG after 25 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Gannet	Forth Islands	1.7171	-0.055	-3.20	96.80%

447. For both the baseline and built scenarios, the gannet breeding population is predicted to increase over the 25 year period, although there is a slight decrease in this growth rate when NnG is present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario is a decrease of 3.20%. Alternatively, the counterfactual of the growth rate is 96.80% of that for the scenario with no wind farm constructed (Table 9-74).

448. Changes in the predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without NnG over 25 years are shown in Table 9-75.

Table 9-75: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 25 years

Species	SPA & start population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Gannet	Forth Islands 75,259 pairs	132,394 pairs	130,761pairs	-1.23	98.77%

449. For both the baseline and built scenarios, the gannet breeding population is predicted to increase over the 25 year period, however, the gannet breeding population at the Forth Islands SPA is predicted to be slightly lower with NnG than with no wind farm present (Table 9-75). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 1.23%. Alternatively, the counterfactual population size is 98.77% of that for the scenario with no wind farm constructed.

450. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 50 years are shown in Table 9-76.

Table 9-76: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farm)	Percentage point change with NnG after 50 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Gannet	Forth Islands	1.7189	-0.064	-3.74	96.26%

451. For both the baseline and built scenarios, the gannet breeding population is predicted to increase over the 50 year period, although as with the 25 year modelling, there is a slight decrease in this growth rate when NnG is present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario after 50 years is a decrease of 3.74%. Alternatively, the counterfactual of the growth rate is 96.26% of that for the scenario with no wind farm constructed (Table 9-76).

452. Changes in the predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without NnG over 50 years are shown in Table 9-77.

Table 9-77: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Gannet	Forth Islands 75,259 pairs	203,046 pairs	197,206 pairs	-2.88	97.12%

453. For both the baseline and built scenarios, the gannet breeding population is predicted to increase over the 50 year period, however the gannet breeding population at the Forth Islands SPA is predicted to be slightly lower with NnG present, than with no wind farm present (Table 9-77). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 2.88%. Alternatively, the counterfactual of population size (CPS) is 97.12% of that for the scenario with no wind farm constructed.

454. A comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 25 years and 50 years is shown in Table 9-78.

Table 9-78: Comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG (collisions all year)	Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG (collisions all year)
Gannet	Forth Islands	0.5	0.39	0.30

455. For an unimpacted population 50% of the model runs would not be lower than the median. For the Forth Islands SPA, comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over 25 years at least 39%, and over 50 years at least 30%, of the runs end not lower than the median population size of the unimpacted population.

9.9.2.4.2 Kittiwake

456. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without NnG over 25 years are shown in Table 9-79.

Table 9-79: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farm)	Percentage point change with NnG after 25 years		Percentage change in median annual growth rate compared to baseline		Counterfactual of the annual growth rate	
			Collision (y)	Collision (y) & Disp (br)	Collision (y)	Collision (y) & Disp (br)	Collision (y)	Collision (y) & Disp (br)
Kittiwake	Forth Islands	0.9099	-0.051	-0.047	-5.56	-5.15	94.44%	94.85%
	Fowlsheugh	-2.2647	-0.054	-0.059	-2.39	-2.61	102.39%	102.61%

457. For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to increase over the 25 year period, although there is a slightly lower rate of increase when NnG is present (Table 9-79). The scenario with collisions all year and displacement during the breeding season resulted in a slightly higher rate of increase suggesting that displacement effects were not predicted to be significant. The counterfactuals of the annual growth rate for collision alone and collision with displacement were also similar to each other.

458. For the Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to decrease over the 25 year period, although there is a slightly higher rate of decrease when NnG is present (Table 9-79). As with the Forth Islands SPA, there was not a large difference between estimated changes in annual growth rate between the collision alone and collision with displacement scenarios, suggesting that displacement effects were not predicted to be significant. For Fowlsheugh SPA, as the baseline population for kittiwake has a negative growth rate, the counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

459. Changes in the predicted population size for kittiwakes breeding at the Forth Islands and Fowlsheugh SPAs with and without NnG over 25 years are shown in Table 9-80.

Table 9-80: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG		Percentage change in median final population size compared to baseline		Counterfactual of Population Size (CPS	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
Kittiwake	Forth Islands 4,663 pairs	6,118 pairs	6,034 pairs	6,059 pairs	-1.37	-0.97	98.63%	99.03%
	Fowlsheugh 9,665 pairs	4,629 pairs	4,577 pairs	4,563 pairs	-1.12	-1.42	98.88%	98.58%

460. For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to increase over the 25 year period, although the end population is predicted to be slightly lower after 25 years when NnG is present, for all collision and displacement scenarios, with the largest difference occurring for annual collisions (Table 9-80). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a maximum decrease of 1.37% for the Forth Islands SPA, for annual collisions. Alternatively, the CPS value is 98.63% of that for the scenario with no wind farm constructed. This suggests that displacement effects were not predicted to be significant. For the Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to decrease over the 25 year period, with the end population predicted to be slightly lower at the end of the 25 year period when NnG is present, for all collision and displacement scenarios (Table 9-80). When annual collisions and breeding season displacement are considered together, the resulting end population is estimated to be slightly lower than the predicted end population for collision alone. The counterfactuals of population size for collision alone and collision with displacement were also similar to each other.

461. Changes in the predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG over 50 years are shown in Table 9-81.

Table 9-81: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farm)	Percentage point change with NnG after 50 years		Percentage change in median annual growth rate compared to baseline		Counterfactual of the annual growth rate	
			Collision (y)	Collision (y) & Disp (br)	Collision (y)	Collision (y) & Disp (br)	Collision (y)	Collision (y) & Disp (br)
Kittiwake	Forth Islands	0.9068	-0.043	-0.051	-4.73	-5.61	95.27%	94.39%
	Fowlsheugh	-2.2758	-0.045	-0.055	-1.96	-2.41	101.96%	102.41%

462. For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to increase over the 50 year period, although there is a slightly higher rate of decrease when NnG is present (Table 9-81). The scenario with collisions all year and breeding season

displacement resulted in a slightly lower rate of increase compared to collisions alone, and this was mirrored by the values for the counterfactual of the annual growth rate.

463. For the Fowlsheugh SPA, for both baseline and built scenarios, the kittiwake breeding population is predicted to decrease over the 50 year period, although there is a slightly higher rate of decrease when NnG is present (Table 9-81). The scenario with collisions all year and breeding season displacement resulted in a slightly higher rate of decrease compared to collisions alone. As the baseline population for kittiwake at Fowlsheugh SPA has a negative growth rate, the counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

464. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG over 50 years are shown in Table 9-82.

Table 9-82: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG		Percentage change in median final population size compared to baseline		Counterfactual of Population Size (CPS	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
Kittiwake	Forth Islands 4,663 pairs	7,665 pairs	7,515 pairs	7,458 pairs	-1.95	-2.70	98.05%	97.30%
	Fowlsheugh 9,665 pairs	2,593 pairs	2,547 pairs	2,532 pairs	-1.76	-2.34	98.24%	97.66%

465. For the Forth Islands SPA, the kittiwake breeding population is predicted to increase over the 50 year period, although the end population is predicted to be slightly lower when NnG is present, for both collision alone and collision with breeding season displacement (Table 9-82). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a maximum decrease of 2.70%, for annual collisions and breeding season displacement. Alternatively, the CPS value is 97.30% of that for the scenario with no wind farm constructed.

466. For the Fowlsheugh SPA, the kittiwake breeding population is predicted to decrease over the 50 year period, although the end poplation is predicted to be slightly lower at the end of the 50 year period when NnG is present, with the largest difference again occurring for annual collisions and breeding season displacement (Table 9-82). The change in the median final population size for this combination when comparing the baseline (no wind farm) with NnG was a maximum decrease of 2.34%. This translates to a CPS value of 97.66% of that of the baseline scenario.

467. A comparison of the 50th centile values for kittiwakes breeding at the Forth Islands and Fowlsheugh SPAs with and without the Project over 25 years and 50 years is shown in Table 9-83.

Table 9-83: Comparison of the 50th centile values for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG		Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
Kittiwake	Forth Islands	0.50	0.43	0.45	0.42	0.38
	Fowlsheugh	0.50	0.41	0.39	0.42	0.40

468. For an unimpacted population 50% of the model runs would not be lower than the median. For the Forth Islands SPA, comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over 25 years at least 43%, and over 50 years at least 38% of the runs end not lower than the median population size of the unimpacted population. For Fowlsheugh SPA, over 25 years at least 39%, and over 50 years at least 40%, of the runs end not lower than the median population size of the unimpacted population.

9.9.2.4.3 Guillemot

469. Changes in the predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years are shown in Table 9-84.

Table 9-84: Change in predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farm)	Percentage point change with NnG after 25 years (displacement all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Guillemot	Forth Islands	1.8949	-0.025	-1.31	98.69%
	Fowlsheugh	2.3258	+0.004	+0.17	100.17%

470. For the Forth Islands SPA, for both the baseline and built scenarios, the guillemot breeding population is predicted to increase over the 25 year period, with a slightly decreased growth rate predicted when NnG is present, compared to the baseline (no wind farm) scenario (Table 9-84). Overall, the change in the median annual growth rate when comparing the baseline with the built scenario is a decrease of 1.31%. Alternatively, the counterfactual of the growth rate is 98.69% of that for the scenario with no wind farm constructed. This suggests that displacement will not have a significant negative effect on breeding guillemots at the Forth Islands SPA.

471. For the Fowlsheugh SPA, for both the baseline and built scenarios, the guillemot breeding population is also predicted to increase over the 25 year period, with a very slightly increase in growth rate predicted when NnG is present, compared to the baseline (no wind farm) scenario (Table 9-84). Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario is a slight increase of 0.17%. The counterfactual of the growth rate is 100.17% of that for the scenario with no wind farm constructed. Again, this indicates that displacement will not have a negative effect on breeding guillemots at the Fowlsheugh SPA.

472. Changes in the predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years are shown in Table 9-85.

Table 9-85: Change in predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG (displacement all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Guillemot	Forth Islands 38,573 pairs	67,234 pairs	67,611 pairs	+0.56	100.56%
	Fowlsheugh 74,379 pairs	150,711 pairs	150,453 pairs	-0.17	99.83%

473. For the Forth Islands SPA, the guillemot breeding population is predicted to increase over the 25 year period, with the end population predicted to be slightly larger at the end of the 25 year period when NnG is present (Table 9-85). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is an increase of +0.56%. This gives a CPS value of 100.56%. As with the result for the growth rate after 25 years (Table 9-84), this indicates that there will be no significant negative effect from displacement on the guillemot population at the Forth Islands SPA, arising from NnG.

474. For the Fowlsheugh SPA, the guillemot breeding population is also predicted to increase over the 25 year period, with the end population predicted to be slightly lower at the end of the 25 year period when NnG is present (Table 9-85). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is decrease of 0.17%. This results in a CPS value of 99.83% of the baseline scenario. This indicates that there will be no significant negative effect from displacement on the guillemot population at Fowlsheugh SPA, arising from NnG.

475. Changes in the predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG over 50 years are shown in Table 9-86.

Table 9-86: Change in predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farm)	Percentage point change with NnG after 50 years (displacement all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Guillemot	Forth Islands	1.8916	-0.014	-0.73	99.27%
	Fowlsheugh	2.3278	-0.026	-1.13	98.87%

476. For both the baseline and built scenarios, the guillemot breeding population at the Forth Islands SPA and Fowlsheugh SPA is predicted to increase over the 50 year period, although there is a slight decrease in this growth rate when NnG is present. Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with NnG is a decrease of 0.73% for the Forth Islands SPA, with a corresponding counterfactual of the growth rate of 99.27%. For Fowlsheugh SPA, there is a predicted decrease of 1.13%, with a corresponding counterfactual of the growth rate of 98.87% (Table 9-86). These changes in the growth rate over 50 years are very similar to the changes

predicted after 25 years (Table 9-84),and indicate that displacement will not have a negative effect on breeding guillemots at the Forth Islands or Fowlsheugh SPAs.

477. Changes in the predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG over 50 years are shown in Table 9-87.

Table 9-87: Change in predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG (displacement all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Guillemot	Forth Islands 38,573 pairs	108,366 pairs	107,270 pairs	-1.01	98.99%
	Fowlsheugh 74,379 pairs	267,057 pairs	264,113 pairs	-1.10	98.90%

478. For the Forth Islands SPA, the guillemot breeding population is predicted to increase over the 50 year period, with the end population being slightly lower when NnG is present (Table 9-87). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a decrease of 1.01%. This results in a CPS value of 98.99% of the baseline scenario. As with the results for 25 years (Table 9-84), this indicates that there will be no significant negative effect from displacement on the guillemot population from the Forth Islands SPA, arising from NnG.

479. For the Fowlsheugh SPA, the guillemot breeding population is also predicted to increase over the 50 year period, with the end population being slightly lower at the end of the 50 year period when NnG is present (Table 9-87). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is decrease of 1.10%. This results in a CPS value of 98.90% of the baseline scenario, indicating that there will be no significant negative effect from displacement on the guillemot population at Fowlsheugh SPA, arising from NnG.

480. A comparison of the 50th centile values for guillemots breeding at the Forth Islands and Fowlsheugh SPAs with and without the Project over 25 years and 50 years is shown in Table 9-88.

Table 9-88: Comparison of the 50th centile values for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG (displacement all year)	Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG (displacement all year)
Guillemot	Forth Islands	0.50	0.52	0.47
	Fowlsheugh	0.50	0.49	0.47

481. For an unimpacted population, 50% of the model runs would not be lower than the median. For the Forth Islands SPA, comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over 25 years at least 52%, and over 50 years at least 47%, of the runs end not lower than the median population size of the unimpacted population.

For Fowlsheugh SPA, over 25 years at least 49%, and over 50 years at least 47%, of the runs end not lower than the median population size of the unimpacted population.

9.9.2.4.4 Razorbill

482. Changes in the predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years are shown in Table 9-89.

Table 9-89: Change in predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farm)	Percentage point change with NnG after 25 years (displacement all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Razorbill	Forth Islands	0.0313	-0.027	-86.58	13.42%
	Fowlsheugh	0.9516	-0.065	-6.78	93.22%

483. For the Forth Islands SPA, for both the baseline and built scenarios, the razorbill breeding population is predicted to increase over the 25 year period, however the growth rate is predicted to be very low (Table 9-89). The growth rate with NnG present is predicted to be slightly lower than the baseline scenario, with an estimated percentage point change of -0.027 predicted. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario is a decrease of 86.58% for the Forth Islands SPA, with a corresponding counterfactual of the growth rate of 13.42%. However, this is due to the fact that the Forth Islands SPA population of razorbill is predicted to be fairly stable over the 25 years, with a population growth rate close to zero. This means that any change will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change, which shows a very slight decrease of 0.027, gives a better representation of the change in growth rate.

484. For Fowlsheugh SPA, for both the baseline and built scenarios, the razorbill breeding population is also predicted to increase over the 25 year period, with a higher growth rate than that predicted for the Forth Islands SPA. There is predicted to be a slight decrease in this growth rate when NNG is present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario is a decrease of 6.78%, with a corresponding counterfactual of the growth rate of 93.22% (Table 9-89).

485. Changes in the predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years are shown in Table 9-90.

Table 9-90: Change in predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG (displacement all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Razorbill	Forth Islands 7,792 pairs	7,862 pairs	7,870 pairs	+0.10	100.10%
	Fowlsheugh 9,950 pairs	13,491 pairs	13,324 pairs	-1.23	98.77%

486. For the Forth Islands SPA, for the baseline and built scenarios, the razorbill breeding population is predicted to increase very slightly over 25 years, with a slightly higher end population predicted when NnG is present (Table 9-90). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is an increase of 0.10%, which gives a corresponding CPS value of 100.10%. This suggests that displacement will not have a significant negative effect on breeding razorbills at the Forth Islands SPA.

487. For the Fowlsheugh SPA, for the baseline and built scenarios, the razorbill breeding population is also predicted to increase over 25 years, with a slightly lower end population when NnG is present (Table 9-90). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 1.23%, which gives a corresponding CPS value of 98.77%. Again, the results indicate that displacement will not have a significant negative effect on breeding razorbills at Fowlsheugh SPA.

488. Changes in the predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years are shown in Table 9-91.

Table 9-91: Change in predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farm)	Percentage point change with NnG after 50 years (displacement all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Razorbill	Forth Islands	0.0631	-0.087	-137.24	-37.24%
	Fowlsheugh	0.9416	-0.071	-7.50	92.50%

489. For the Forth Islands SPA, for the baseline scenario, the razorbill breeding population is predicted to increase over the 50 year period, however the growth rate is predicted to be very low (Table 9-91). The population with NnG present is predicted to decline slightly over 50 years, compared to the baseline scenario, with an estimated percentage point change of -0.087 predicted. The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of razorbill is predicted to be fairly stable over the 50 years, with a population growth rate close to zero. This means that any change will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little

relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

490. For Fowlsheugh SPA, for both the baseline and built scenarios, the razorbill breeding population is predicted to increase over the 50 year period, with a higher growth rate than that predicted for the Forth Islands SPA. There is predicted to be a slight decrease in this growth rate when NnG is present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario is a decrease of 7.50%, with a corresponding counterfactual of the growth rate of 92.50% (Table 9-91).

491. Changes in the predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years are shown in Table 9-92.

Table 9-92: Change in predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG (displacement all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Razorbill	Forth Islands 7,792 pairs	8,063 pairs	7,749 pairs	-3.89	96.11%
	Fowlsheugh 9,950 pairs	16,932 pairs	16,353 pairs	-3.42	96.58%

492. For the Forth Islands SPA, for the baseline and built scenarios, the razorbill breeding population is predicted to increase very slightly over 50 years, with a slightly lower end population predicted when NnG is present (Table 9-92). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a decrease of 3.89%. This results in a CPS value of 96.11% of the baseline scenario.

493. For the Fowlsheugh SPA, for the baseline and built scenarios, the razorbill breeding population is predicted to increase over 50 years, with a slightly lower end population predicted when NnG is present (Table 9-92). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a decrease of 3.42%. This translates into a CPS value of 96.58% of the baseline with no wind farm.

494. A comparison of the 50th centile values for razorbills breeding at the Forth Islands and Fowlsheugh SPAs with and without the Project over 25 years and 50 years is shown in Table 9-93.

Table 9-93: Comparison of the 50th centile values for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG (displacement all year)	Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG (displacement all year)
Razorbill	Forth Islands	0.50	0.50	0.45
	Fowlsheugh	0.50	0.48	0.44

495. For an unimpacted population 50% of the model runs would not be lower than the median. For the Forth Islands SPA, comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over 25 years at least 50%, and over 50 years at least 45%, of the runs end not lower than the median population size of the unimpacted population. For Fowlsheugh SPA, over 25 years at least 48%, and over 50 years at least 44% of the runs end not lower than the median population size of the unimpacted population.

9.9.2.4.5 Puffin

496. Changes in the predicted population growth rate for puffins breeding at the Forth Islands SPA with and without NnG over 25 years are shown in Table 9-94.

Table 9-94: Change in predicted population growth rate for puffins breeding at the Forth Islands SPA with and without the Project over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farm)	Percentage point change with NnG after 25 years (displacement breeding season)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Puffin	Forth Islands	4.6103	-0.016	-0.34	99.66%

497. For both the baseline and built scenarios, the puffin breeding population at the Forth Islands SPA is predicted to increase over the 25 year period, although there is a slight decrease in this growth rate when NnG is present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario is a decrease of 0.34% for the Forth Islands SPA (Table 9-94). Alternatively, the counterfactual of the growth rate is 99.52% of that for the scenario with no wind farm constructed. This indicates that there will be no significant negative effect from displacement on the puffin population at the Forth Islands SPA, arising from NnG.

498. Changes in the predicted population size for puffins breeding at the Forth Islands SPA with and without the Project over 25 years are shown in Table 9-95.

Table 9-95: Change in predicted population size for puffins breeding at the Forth Islands SPA with and without the Project over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG (displacement breeding season)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Puffin	Forth Islands 45,005 pairs	174,231 pairs	172,875 pairs	-0.78	99.22%

499. For the Forth Islands SPA, for both the baseline and built scenarios, the puffin breeding population is predicted to increase over 25 years, with a slightly lower end population when NnG is present (Table 9-95). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 0.78%, which gives a CPS value of 99.22% of that of the baseline estimate. This indicates that there will be no significant negative effect from displacement on the puffin population at the Forth Islands SPA, arising from NnG.

500. Changes in the predicted population growth rate for puffins breeding at the Forth Islands SPA with and without NnG over 50 years are shown in Table 9-96.

Table 9-96: Change in predicted population growth rate for puffins breeding at the Forth Islands SPA with and without the Project over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farm)	Percentage point change with NnG after 50 years (displacement breeding season)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Puffin	Forth Islands	4.6011	-0.027	-0.59	99.41%

501. For both the baseline and built scenarios, the puffin breeding population at the Forth Islands SPA is predicted to increase over the 50 year period, although there is a slight decrease in this growth rate when NnG is present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with NnG is a decrease of 0.59% for the Forth Islands SPA (Table 9-96). Alternatively, the counterfactual of the growth rate is 99.41% of that for the scenario with no wind farm constructed. This is similar to the values predicted after 25 years (Table 9-94), and indicates that there will be no significant negative effect from displacement on the puffin population at the Forth Islands SPA, arising from NnG.

502. Changes in the predicted population size for puffins breeding at the Forth Islands SPA with and without the Project over 50 years are shown in Table 9-97.

Table 9-97: Change in predicted population size for puffins breeding at the Forth Islands SPA with and without the Project over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG (displacement breeding season)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Puffin	Forth Islands 45,005 pairs	531,902 pairs	525,558 pairs	-1.19	98.81%

503. For the Forth Islands SPA, for both the baseline and built scenarios, the puffin breeding population is predicted to increase over 50 years, with a slightly lower end population when NnG is present (Table 9-97). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a decrease of 1.19%. The CPS value is 98.81% that of the baseline situation after the 50 year period. This is similar to the values predicted after 25 years (Table 9-95), and indicates that there will be no significant negative effect from displacement on the puffin population at the Forth Islands SPA, arising from NnG.

504. A comparison of the 50th centile values for puffins breeding at the Forth Islands SPA with and without the Project over 25 years and 50 years is shown in Table 9-98.

Table 9-98: Comparison of the 50th centile values for puffins breeding at the Forth Islands SPA with and without the Project over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG (displacement breeding season)	Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG (displacement breeding season)
Puffin	Forth Islands	0.50	0.47	0.47

505. For an unimpacted population 50% of the model runs would not be lower than the median. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over both 25 years and 50 years at least 47% of the runs end not lower than the median population size of the unimpacted population.

Summary of PVA for the Project alone

506. For gannet, the PVA only considered annual collision effects. For the wind farm scenarios tested, the predicted population growth rate increased, regardless of the modelled build scenario, although the predicted rate of population growth was lower than for the baseline scenario, with no wind farms built. Similarly, the predicted end populations after 25 and 50 years increased for both the baseline and built scenarios, with slightly lower end populations predicted when NnG was present. Overall, results indicate that collision impacts from NnG alone on the breeding gannet population at Forth Islands SPA over the lifetime of the Project are not likely to be significant.

For kittiwake, the PVA considered annual collision effects in isolation and in combination with displacement effects in the breeding season. For the Forth Islands SPA, the kittiwake breeding population is predicted to increase over 25 and 50 years, although there is a slightly lower rate of increase when NnG is present. Similarly, the predicted end populations after 25 and 50 years increased for both the baseline and built scenarios, with slightly lower end populations predicted when NnG was present.

For Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to decrease over 25 and 50 years, although there is a slightly higher rate of decrease when NnG is present. Similarly, the predicted end populations after 25 and 50 years decreased for both the baseline and built scenarios, with slightly lower end populations predicted when NnG was present.

507. Overall, results indicate that collision and displacement impacts from NnG alone on the breeding kittiwake population at Forth Islands SPA and Fowlsheugh SPA over the lifetime of the Project are likely to be small and have relatively little influence on the resulting population size.

508. For guillemot and razorbill, the PVA considered displacement effects throughout the year. For guillemot, for the wind farm scenarios tested, the predicted population growth rate at both the Forth Islands SPA and Fowlsheugh SPA increased, regardless of the modelled build scenario. Similarly, the predicted end populations after 25 and 50 years increased for both the baseline and built scenarios, with slightly lower end populations predicted when NnG was present. For the 25 and 50 year assessments, the difference between the population growth rate and the end population sizes for the baseline and built scenarios were small, indicating that there is likely to be very little impact from displacement from NnG alone on the breeding populations at Forth Islands SPA and Fowlsheugh SPA over the lifetime of the Project.

509. For razorbill, for the wind farm scenarios tested, the predicted population growth rate at Forth Islands SPA and Fowlsheugh SPA increased, regardless of the modelled build scenario, however the growth rate at the Forth Islands SPA was predicted to be very low. Similarly, for both SPA populations, the predicted end populations after 25 and 50 years increased for both the baseline and

built scenarios, with slightly lower end populations predicted when NnG was present. These results indicate that displacement impacts from NnG alone on the breeding razorbill populations at Forth Islands SPA and Fowlsheugh SPA over the lifetime of the Project are not likely to be significant.

510. For puffin, the PVA only considered displacement effects in the breeding season. For the wind farm scenarios tested, the predicted population growth rate increased, regardless of the modelled build scenario, although the predicted rate of population growth was lower than for the baseline scenario, with no wind farms built. Similarly, the predicted end populations after 25 and 50 years increased for both the baseline and built scenarios, with slightly lower end populations predicted when NnG was present. This indicates that displacement impacts from NnG alone on the breeding population at Forth Islands SPA over the lifetime of the Project are not likely to be significant.

9.9.2.5 Impacts on Outer Firth of Forth & St Andrews Bay pSPA

511. Once operational, the presence of the Project could potentially result in collision and displacement impacts on seabirds from the Outer Firth of Forth & St Andrews Bay pSPA. It has not yet been determined how many turbines will lie within the pSPA boundary. However, based on the published current pSPA site boundary (SNH 2016), the Project footprint will overlap the pSPA by a maximum of 34 km^2 (Table 9-2). This corresponds to approximately 1.3% of the overall area of the pSPA (2,720.68 km^2.

512. As outlined in Section 9.7.4.2, there are 21 species currently listed as Qualifying Interests for the pSPA. Of these, nine seabird species were regularly recorded within the Wind Farm Area on baseline surveys. These species have therefore been included in this assessment of impacts on the Outer Firth of Forth & St Andrews Bay pSPA during the operational phase of the Project (Table 9-99). A further four species that are considered Qualifying Interest species for the pSPA (Arctic tern, common tern, shag and Manx shearwater) occurred within the Wind Farm Area in very low numbers on baseline surveys or were not recorded. These species and the remaining eight species of divers, grebes and seaducks which mainly occur in the inner Forth and Tay estuaries, have been scoped out of this assessment, based on advice received in the Scoping Opinion (Marine Scotland, 2017).

Table 9-99: Qualifying Interest species for the Outer Firth of Forth & St Andrews Bay pSPA included in the assessment of displacement and collision impacts

Qualifying interest	Displacement	Collision impacts
Gannet	x	Collision impacts in breeding season
Kittiwake	Displacement impacts in breeding and non-breeding seasons	Collision impacts in breeding and non-breeding seasons
Herring gull	x	Collision impacts in breeding and non-breeding seasons
Guillemot	Displacement impacts in breeding and non-breeding seasons	x
Razorbill	Displacement impacts in non-breeding season	x
Puffin	Displacement impacts in breeding season	x
Little gull	Displacement impacts in non-breeding season	Collision impacts in non-breeding season
Common gull	Displacement impacts in non-breeding season	Collision impacts in non-breeding season

Qualifying interest	Displacement	Collision impacts
Black-headed gull	Displacement impacts in non-breeding season	Collision impacts in non-breeding season

513. Direct habitat loss within the Outer Firth of Forth & St Andrews Bay pSPA arising from the installation of the turbines is assessed in Section 9.9.1.1.

514. The largest potential displacement effect is predicted to occur during the operational phase of the Project, caused by the physical presence of the turbines. For this reason, this assessment only considers displacement effects arising from the presence of the wind turbines. However, it is recognised that temporary displacement of seabirds within the Wind Farm Area may occur during the construction and decommissioning phases, due the physical presence of vessels. However, any such displacement effects, if they do occur, are considered a temporary, localised effect, and are therefore not considered significant.

9.9.2.5.1 Displacement Impacts in the breeding season

515. Displacement impacts have been considered for seven qualifying interest species for the pSPA, based on advice in the Scoping Opinion (Marine Scotland, 2017). Displacement impacts in the breeding season were considered for kittiwake, guillemot and puffin.

516. For the following assessment, it is assumed that for each species considered, the pSPA population is spread evenly across the pSPA. For breeding season impacts, the reference pSPA population was taken as the most recent available counts of the breeding populations of the terrestrial SPA breeding colonies that border the pSPA. This approach was agreed at a meeting between NnG, Marine Scotland, SNH and JNCC to discuss the pSPA designation in October 2016, on the basis that the population estimates presented for the pSPA during the pSPA consulation process (SNH 2016), were the minimum number of birds that occurred regularly within the pSPA boundary that could be used to build the case for designation. Counts from the adjacent terrestrial SPA breeding colonies bordering the pSPA were considered more representative of the numbers of birds likely to occur within the pSPA in the breeding season.

Kittiwake

517. For kittiwake, both the Forth Islands SPA (4,663 pairs), and St. Abb's Head to Fast Castle SPA (3,334 pairs) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 7,997 pairs (Table 9-8).

518. If the pSPA kittiwake population in the breeding season (7,997 pairs) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 104 birds from the pSPA kittiwake population may be displaced, if it is assumed that all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 272 birds from the pSPA kittiwake population may be displaced.

519. However, based on advice in the Scoping Opinion, the displacement rate for kittiwake was assumed to be 30%, resulting in 31 birds (29 adults and two immature birds) being displaced from the overlapping Wind Farm Area, or 82 birds (76 adults and six immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 6.8% immature birds in the breeding season was taken from age data recorded on baseline surveys (Appendix 9.2: Table 5).

520. Applying the 2% mortality rate from the Scoping Opinion would result in one adult from the pSPA kittiwake population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or two birds (all adults) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to between 0.01% and 0.03% of the pSPA population in the breeding season (7,997 pairs) (Table 9-100).

521. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be displaced. The three-year peak mean population of kittiwakes recorded in the Wind Farm Area on breeding season baseline surveys was 1,772 birds (Table 9-12). Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all kittiwakes recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% (567 birds), would be displaced from the overlapping Wind Farm Area in the breeding season, if all birds are displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 2,164 kittiwakes recorded in the Wind Farm Area and 2 km buffer on baseline surveys could be displaced (Table 9-12), which equates to 995 individuals, if all birds are displaced.

522. Applying a displacement rate of 30%, as recommended in the Scoping Opinion (Marine Scotland, 2017), would result in 170 kittiwakes (158 adults and 12 immature birds) being affected from the overlapping Wind Farm Area in the breeding season, or 299 kittiwakes (279 adults and 20 immature birds) from the overlapping Wind Farm Area and 2 km buffer.

523. Applying the 2% mortality rate, as recommended by the Scoping Opinion, would result in three adult birds from the pSPA kittiwake population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or six adult birds if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to 0.04% and 0.08% of the pSPA population in the breeding season (7,997 pairs).

524. Using site-specific baseline data, the estimated number of kittiwakes that would suffer mortality as a result of being displaced within the pSPA is greater than estimated when using the pSPA cited population (Table 9-100).

Table 9-100: Estimated kittiwake mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the breeding season

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of pSPA population	No of birds	% of pSPA population
pSPA population estimate	1	0.01	2	0.03
3-year peak mean population estimate	3	0.04	6	0.08

Guillemot

525. For guillemot, both the Forth Islands SPA (28,786 birds), and St. Abb’s Head to Fast Castle SPA (36,206 birds) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 64,992 birds (Table 9-8).

526. If the pSPA guillemot population in the breeding season (64,992 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 845 birds from the pSPA guillemot population may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 2,210 birds from the pSPA guillemot population may be displaced.

527. However, based on advice in the Scoping Opinion, the displacement rate for guillemot was assumed to be 60%, resulting in 507 birds (259 breeding adults and 248 immature or non-breeding adults) being displaced from the overlapping Wind Farm Area, or 1,326 birds (678 breeding adults and 648 immature or non-breeding adults) from the overlapping Wind Farm Area and 2 km buffer. The above

age breakdown of 48.9% immature or non-breeding adults in the breeding season was based on the PVA stable age structure (Table 9-25).

528. Applying the 1% mortality rate recommended in the Scoping Opinion would result in five birds (three breeding adults and two immature or non-breeding adults) from the pSPA guillemot population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or 13 birds (seven breeding adults and six immature or non-breeding adults) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to between 0.01% and 0.02% of the pSPA population in the breeding season (64,992 birds) (Table 9-101).

529. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be involved. The three-year peak mean population of guillemots recorded in the Wind Farm Area on breeding season baseline surveys was 2,202 birds (Table 9-23). Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all guillemots recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then approximately 32% (705 birds), would be displaced from the overlapping Wind Farm Area in the breeding season, if all birds are displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 4,894 guillemots recorded in the Wind Farm Area and 2 km buffer on baseline surveys could be displaced in the breeding season, which equates to 2,251 individuals, if all birds are displaced.

530. Applying a displacement rate of 60%, as recommended in the Scoping Opinion (Marine Scotland, 2017), would result in 423 guillemots (216 breeding adults and 207 immature or non-breeding adults) being affected from the overlapping Wind Farm Area, or 1,351 guillemots (690 breeding adults and 661 immature or non-breeding adults) from the overlapping Wind Farm Area and 2 km buffer in the breeding season.

531. Applying the 1% mortality rate recommended in the Scoping Opinion would result in four birds (two breeding adults and two immature or non-breeding adults) from the pSPA guillemot population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or 14 birds (seven breeding adults and seven immature or non-breeding adults) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to between 0.01% and 0.04% of the pSPA population in the breeding season (64,992 birds).

532. Using site-specific baseline data, the estimated number of guillemots that would suffer mortality as a result of being displaced from within the pSPA is similar to that estimated when using the pSPA cited population (Table 9-101).

Table 9-101: Estimated guillemot mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the breeding season

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of pSPA population	No of birds	% of pSPA population
pSPA population estimate	5	0.01	13	0.02
3-year peak mean population estimate	4	0.01	14	0.02

Puffin

533. For puffin, the Forth Islands SPA (45,005 pairs), borders the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 45,005 pairs (Table 9-8).

534. If the pSPA puffin population in the breeding season (45,005 pairs) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 1,170 birds from the pSPA puffin population may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 3,060 birds from the pSPA puffin population may be displaced.

535. However, based on advice in the Scoping Opinion, the displacement rate for puffin was assumed to be 60%, resulting in 702 birds (359 breeding adults and 343 immature or non-breeding adults) being displaced from the overlapping Wind Farm Area in the breeding season, or 1,836 birds (938 breeding adults and 898 immature or non-breeding adults) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 48.9% immature or non-breeding adults in the breeding season was based on the PVA stable age structure (Table 9-44).

536. Applying the 2% mortality rate recommended in the Scoping Opinion would result in 14 birds (seven breeding adults and seven immature or non-breeding adults) from the pSPA puffin population suffering mortality in the breeding season, if displacement affected just the overlapping Wind Farm Area, or 37 birds (19 breeding adults and 18 immature or non-breeding adults) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to between 0.02% and 0.04% of the pSPA population in the breeding season (51,956 pairs) (Table 9-102).

537. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be involved. The three-year peak mean population of puffins recorded in the Wind Farm Area on breeding season baseline surveys was 2,682 birds (Table 9-42). Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all puffins recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then approximately 32% (858 birds), would be displaced from the overlapping Wind Farm Area, if all birds were displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 6,173 puffins recorded in the Wind Farm Area and 2 km buffer on baseline surveys (Table 9-42) could be displaced, which equates to 2,840 individuals, if all birds are displaced.

538. Applying a displacement rate of 60%, as recommended in the Scoping Opinion (Marine Scotland, 2017), would result in 515 puffins (261 breeding adults and 254 immature or non-breeding adults) being affected from the overlapping Wind Farm Area in the breeding season, or 1,704 puffins (862 breeding adults and 842 immature or non-breeding adults) from the overlapping Wind Farm Area and 2 km buffer.

539. Applying the 2% mortality rate recommended in the Scoping Opinion would result in 10 birds (five breeding adults and five immature or non-breeding adults) from the pSPA puffin population suffering mortality in the breeding season, if displacement affected just the overlapping Wind Farm Area, or 34 birds (17 breeding adults and 17 immature or non-breeding adults) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to 0.01% and 0.04% of the pSPA population in the breeding season (45,005 pairs.

540. Using site-specific baseline data, the estimated number of puffins that would die as a result of being displaced within the pSPA is lower than estimated when using the pSPA cited population (Table 9-102).

Table 9-102: Estimated puffin mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the breeding season

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of pSPA population	No of birds	% of pSPA population
pSPA population estimate	14	0.02	37	0.04
3-year peak mean population estimate	10	0.01	34	0.04

9.9.2.5.2 Displacement Impacts in the non-breeding season

541. Displacement impacts in the non-breeding season within the pSPA were considered for kittiwake, little gull, common gull, black-headed gull, guillemot and razorbill. It was recommended at a meeting between NnG, Marine Scotland, SNH and JNCC to discuss the pSPA designation in October 2016, that for non-breeding season assessments, the populations given in the pSPA site selection document should be used. However, it should be noted that the populations presented in the pSPA site selection document were intended for designation purposes only, and are effectively the minimum numbers likely to be present. This should be borne in mind when reading the following assessment.

542. For kittiwake, little gull, guillemot and razorbill, it was possible to use the two above approaches to estimate mortality from displacement in the non-breeding season. For common gull and black-headed gull it was only possible to estimate mortality from displacement using the cited pSPA population, as site-specific population estimates were not available, due to the low number of birds recorded during baseline surveys.

Kittiwake

543. For kittiwake, the estimated population for the pSPA in the non-breeding season is given as 3,191 birds (SNH 2016).

544. If the pSPA kittiwake population in the non-breeding season (3,191 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 41 birds from the pSPA kittiwake population in the non-breeding season may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 108 birds from the pSPA kittiwake population in the non-breeding season may be displaced.

545. However, based on advice in the Scoping Opinion, the displacement rate for kittiwake was assumed to be 30%, resulting in 12 birds (eight adults and four immature birds) being displaced from the overlapping Wind Farm Area, or 32 birds (21 adults and 11 immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 35.2% immature birds in the non-breeding season (Table 9-7) was taken from age data recorded on baseline surveys (Appendix 9.2: Table 5).

546. Applying the 2% mortality rate recommended in the Scoping Opinion would result in zero birds from the pSPA kittiwake population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or one adult, if displacement affected the overlapping Wind Farm Area and 2km buffer area (Table 9-103). This is equivalent to 0.03% of the pSPA population in the non-breeding season (3,191 birds).

547. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be involved. The three-year peak mean population of kittiwakes recorded in the Wind Farm Area in the autumn period of the non-breeding season baseline

surveys (1,065 birds) was higher than the peak mean for the spring period (91 birds), so 1,065 birds was used for this assessment (Table 9-12).

548. Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all kittiwakes recorded during baseline surveys were evenly distributed across the Wind Farm Area, then 32% (341 birds), would be displaced from the overlapping Wind Farm Area, if all birds were displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 2,016 kittiwakes recorded in the Wind Farm Area and 2 km buffer on baseline surveys could be displaced (Table 9-12), which equates to 927 individuals, if all birds are displaced.

549. Applying a displacement rate of 30%, as recommended in the Scoping Opinion (Marine Scotland, 2017), would result in 102 kittiwakes (58 adults and 44 immature birds) being affected from the overlapping Wind Farm Area, or 278 kittiwakes (158 adults and 120 immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 43.1% immature birds in the autumn period of the non-breeding season (September to December) was taken from age data recorded on baseline surveys (Appendix 9.2: Table 5).

550. Applying the 2% mortality rate from the Scoping Opinion would result in two birds (one adult and one immature bird) from the pSPA kittiwake population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or six birds (three adults and three immature birds) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to 0.06% and 0.2% of the pSPA population in the non-breeding season (3,191 birds).

551. Using site-specific baseline data, the number of kittiwakes that may die as a result of being displaced from the pSPA is greater than when estimated using the pSPA cited population (Table 9-103).

Table 9-103: Estimated kittiwake mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the non-breeding season

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of pSPA population	No of birds	% of pSPA population
pSPA population estimate	0	0	1	0.03
3-year peak mean population estimate	2	0.06	6	0.2

552. However, this mortality estimate is considered precautionary, as it is based on 3-year mean peak post-breeding numbers recorded in the Wind Farm Area and 2 km buffer, and is assessed against an artificially low population estimate for the pSPA in the non-breeding season. In addition, based on available evidence of low levels of kittiwake displacement from existing wind farm projects, it is considered that applying a 2 km buffer, using a mortality rate of 2%, and a displacement rate of 30% is also precautionary.

Little gull

553. For little gull, the estimated population for the pSPA in the non-breeding season is given as 126 birds (SNH 2016). However, the size of the regional autumn passage population of little gulls is unknown and this presents a constraint in undertaking the assessment. Analysis of ESAS data by Skov *et al.* (1995) identifies a geographically discrete autumn passage concentration in the outer Firth of Forth and Firth of Tay (referred to as Tay Bay by Skov *et al.*). There is uncertainty regarding the current size of this population as the number estimated by Skov *et al*. (450 birds) is far lower than the typical total of about 1,000 birds seen at coastal roost counts in Fife and Lothian (Forrester *et al.,* 2007). Furthermore, survey work commissioned in recent years to inform the proposed offshore wind farms

in the Firth of Forth area has shown that this species is more common than previously appreciated (or numbers have increased), with peak estimates for the NnG Wind Farm Area and 8 km buffer area of 1,756 birds in October of Year 1, 1,352 birds in October of Year 2 and 3,841 birds in September of Year 3 (Appendix 9.2: Table 16), which gives a three-year peak seasonal mean of 2,316 little gulls. The upper limit of 3,000 birds from Forrester *et al.*'s (2007) estimate of 1,500 - 3,000 individuals present between June and November in the Forth and Tay area has been used in this assessment as the best available pSPA population size during autumn passage.

554. If the pSPA little gull population in the non-breeding season (3,000 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 39 birds from the pSPA little gull population in the non-breeding season may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 102 birds from the pSPA little gull population in the non-breeding season may be displaced. As no displacement rate for little gull was given in the Scoping Opinion, the displacement rate was assumed to be the same as for kittiwake (30%), resulting in 12 birds being displaced from the overlapping Wind Farm Area, or 31 birds from the overlapping Wind Farm Area and 2 km buffer.

555. As no mortality rate was given in the Scoping Opinion, a rate of 2% was assumed, which would result in zero birds from the pSPA little gull population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or one bird if displacement affected the overlapping Wind Farm Area and 2km buffer area (Table 9-105). This is equivalent to 0.03% of the assumed pSPA population during autumn passage (3,000 birds).

556. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be involved. The three-year peak mean population of little gulls recorded in the Wind Farm Area on non-breeding season baseline surveys was 268 birds (Table 9-104).

Table 9-104: Seasonal three-year mean peak estimated numbers of little gulls in the Wind Farm Area (plus 2 km buffer)

Year	Wind Farm Area	Wind Farm Area + 2km buffer
	Autumn passage	Autumn passage
Year 1	309	457
Year 2	41	41
Year 3	455	986
3-year mean peak	268	495

557. Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all little gulls recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% (86 birds), would be displaced from the overlapping Wind Farm Area, if all birds are displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 495 little gulls recorded in the Wind Farm Area and 2 km buffer on baseline surveys could be displaced (Table 9-104), which equates to 228 individuals, if all birds are displaced.

558. Assuming a displacement rate of 30%, would result in 26 little gulls being affected from the overlapping Wind Farm Area, or 68 little gulls from the overlapping Wind Farm Area and 2 km buffer.

559. Assuming a 2% mortality rate would result in one bird from the pSPA little gull population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or one bird if displacement

affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to 0.03% of the assumed pSPA population during autumn passage (3,000 birds).

560. Using site-specific baseline data, the number of little gulls that may die as a result of being displaced from the pSPA within the Wind Farm Area is slightly higher than when estimated using the pSPA cited population (Table 9-105).

Table 9-105: Estimated little gull mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the non-breeding season

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of pSPA population	No of birds	% of pSPA population
pSPA population estimate	0	0	1	0.03
3-year peak mean population estimate	1	0.03	1	0.03

Guillemot

561. For guillemot, the estimated population for the pSPA in the non-breeding season is given as 21,968 birds (SNH 2016).

562. If the pSPA guillemot population in the non-breeding season (21,968 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 286 birds from the pSPA guillemot population in the non-breeding season may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 747 birds from the pSPA guillemot population in the non-breeding season may be displaced.

563. However, following advice in the Scoping Opinion (Marine Scotland, 2017), the displacement rate for guillemot was assumed to be 60%, resulting in 172 birds (94 adults and 78 immature birds) being displaced from the overlapping Wind Farm Area, or 448 birds (246 adults and 202 immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 45.1% immature birds in the non-breeding season was based on the PVA stable age structure (Table 9-25).

564. Applying the 1% mortality rate from the Scoping Opinion would result in two birds (one adult and one immature bird) from the pSPA guillemot population dying, if displacement affected just the overlapping Wind Farm Area, or five birds (three adults and two immature birds) if displacement affected the overlapping Wind Farm Area and 2km buffer area (Table 9-106). This is equivalent to between 0.01% and 0.02% of the pSPA population in the non-breeding season (21,968 birds).

565. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be involved. The three-year peak mean population of guillemots recorded in the Wind Farm Area on non-breeding season baseline surveys was 3,890 birds (Table 9-23). Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all guillemots recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% (1,245 birds), would be displaced from the overlapping Wind Farm Area, if all birds are displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 7,618 guillemots recorded in the Wind Farm Area and 2 km buffer on baseline surveys could be displaced (Table 9-23), which equates to 3,504 individuals, if all birds are displaced.

566. Applying a displacement rate of 60%, as recommended in the Scoping Opinion (Marine Scotland, 2017), would result in 747 guillemots (380 adults and 367 immature birds) being affected from the

overlapping Wind Farm Area, or 2,102 guillemots (1,154 adults and 948 immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 45.1% immature birds in the non-breeding season was based on the PVA stable age structure (Table 9-25).

567. Applying the 1% mortality rate recommended in the Scoping Opinion would result in eight birds (four adults and four immature birds) from the pSPA guillemot population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or 21 birds (12 adults and nine immature birds) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to 0.04% and 0.1% of the pSPA population in the non-breeding season (21,968 birds).

568. Using site-specific baseline data, the estimated number of guillemots that may die as a result of being displaced from the pSPA within the Wind Farm Area is greater than when estimated using the pSPA cited population (Table 9-106).

Table 9-106: Estimated guillemot mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the non-breeding season

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of pSPA population	No of birds	% of pSPA population
pSPA population estimate	1	0.01	5	0.02
3-year peak mean population estimate	8	0.04	21	0.1

Razorbill

569. For razorbill, the estimated population for the pSPA in the non-breeding season is given as 5,481 birds (SNH 2016).

570. If the pSPA razorbill population in the non-breeding season (5,481 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 71 birds from the pSPA razorbill population in the non-breeding season may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 186 birds from the pSPA razorbill population may be displaced.

571. However, based on advice in the Scoping Opinion, the displacement rate for razorbill was assumed to be 60%, resulting in 43 birds (26 adults and 17 immature birds) being displaced from the overlapping Wind Farm Area, or 112 birds (68 adults and 44 immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 39.3% immature birds in the non-breeding season was based on the PVA stable age structure (Table 9-35).

572. Applying the 1% mortality rate from the Scoping Opinion would result in zero birds from the pSPA razorbill population dying, if displacement affected just the overlapping Wind Farm Area, or one adult if displacement affected the overlapping Wind Farm Area and 2 km buffer area (Table 9-107). This is equivalent to 0.02% of the pSPA population in the non-breeding season (5,481 birds).

573. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be involved. The three-year peak mean population of razorbills recorded in the Wind Farm Area on non-breeding season baseline surveys was 1,404 birds (Table 9-33). Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all razorbills recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% (449 birds), would be displaced from the overlapping Wind Farm Area, if all birds are displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 2,536 razorbills recorded in

the Wind Farm Area and 2 km buffer on baseline surveys could be displaced (Table 9-33), which equates to 1,167 individuals, if all birds are displaced.

574. Applying a displacement rate of 60%, as recommended in the Scoping Opinion (Marine Scotland, 2017), would result in 269 razorbills (163 adults and 106 immature birds) being affected from the overlapping Wind Farm Area, or 700 razorbills (425 adults and 275 immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 39.3% immature birds in the non-breeding season was based on the PVA stable age structure (Table 9-35).

575. Applying the 1% mortality rate from the Scoping Opinion would result in three birds (two adults and one immature bird) from the pSPA razorbill population suffering mortaity, if displacement affected just the overlapping Wind Farm Area, or seven birds (four adults and three immature birds) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to 0.05% and 0.1% of the pSPA population in the non-breeding season (5,481 birds) (Table 9-107).

576. Using site-specific baseline data, the estimated number of razorbills that may die after being displaced from the pSPA within the Wind Farm Area, is greater than when estimated using the pSPA cited population (Table 9-107).

Table 9-107: Estimated razorbill mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the non-breeding season

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of pSPA population	No of birds	% of pSPA population
pSPA population estimate	0	0	1	0.02
3-year peak mean population estimate	3	0.05	7	0.1

Black-headed gull

577. For black-headed gull, the estimated population for the pSPA in the non-breeding season is given as 26,835 birds (SNH 2016).

578. If the pSPA black-headed gull population in the non-breeding season (26,835 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 349 birds from the pSPA black-headed gull population in the non-breeding season may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 912 birds from the pSPA black-headed gull population in the non-breeding season may be displaced.

579. As no displacement rate for black-headed gull was given in the Scoping Opinion, the displacement rate was assumed to be the same as kittiwake (30%), resulting in 105 birds being displaced from the overlapping Wind Farm Area, or 274 birds from the overlapping Wind Farm Area and 2 km buffer.

580. Assuming a 2% mortality rate would result in two birds from the pSPA black-headed gull population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or six birds if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to between 0.01% and 0.02% of the pSPA population (26,835 birds).

Common gull

581. For common gull, the estimated population for the pSPA in the non-breeding season is given as 14,647 birds (SNH 2016).

582. If the pSPA common gull population in the non-breeding season (14,647 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 190 birds from the pSPA common gull population in the non-breeding season may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 498 birds from the pSPA common gull population in the non-breeding season may be displaced.

583. As no displacement rate for common gull was advised in the Scoping Opinion, the displacement rate was assumed to be the same as kittiwake (30%), resulting in 57 birds being displaced from the overlapping Wind Farm Area, or 149 birds from the overlapping Wind Farm Area and 2 km buffer.

584. Assuming a 2% mortality rate would result in one bird from the pSPA common gull population dying, if displacement affected just the overlapping Wind Farm Area, or three birds if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to between 0.01% and 0.02% of the pSPA population (14,647 birds).

9.9.2.5.3 Displacement throughout the year

585. Displacement impacts were assessed for kittiwake and guillemot in both the breeding and non-breeding seasons, as recommended in the Scoping Opinion (Marine Scotland, 2017) (Table 9-99).

586. For kittiwake, the breeding and non-breeding season displacement assessments were combined, based on the worst-case results from the breeding season (Table 9-100) and non-breeding season (Table 9-103) assessments. Worst-case results were from using the three-year peak mean baseline population for both seasons (Table 9-108).

Table 9-108: Estimated kittiwake mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts throughout the year

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of pSPA population	No of birds	% of pSPA population
Breeding season	3	0.04	6	0.08
Non-breeding season	2	0.06	6	0.2
Total	5	0.1	12	0.3

587. For guillemot, the breeding and non-breeding season displacement assessments were also combined, based on the worst-case results from the breeding season (Table 9-101) and non-breeding season (Table 9-106) assessments. Worst-case results were from using the three-year peak mean baseline population for both seasons (Table 9-109).

Table 9-109: Estimated guillemot mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts throughout the year

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of pSPA population	No of birds	% of pSPA population
Breeding season	4	0.01	14	0.01
Non-breeding season	8	0.04	21	0.1
Total	12	0.05	35	0.1

588. Based on the above displacement assessments, there was no evidence that a significant number of birds from the pSPA populations in the breeding or non-breeding seasons would be affected by displacement impacts resulting from the presence of some of the Project turbines within the pSPA. These assessments are considered precautionery, based on the displacement and mortality rates used, and also on the reference populations for the pSPA in the non-breeding season. In particular, it is considered that the use of mortality rates of 1% or 2% outside of the breeding season, when birds are no longer tied to their breeding colony, is precautionary.

589. Therefore, it is concluded that displacement mortality impacts will have no effect on the key Qualifying Interest species from the Outer Firth of Forth & St Andrews Bay pSPA throughout the year. The sensitivity of the Qualifying Interest species to displacement is assessed as high at worst, and the magnitude of any impacts will be negligible. The significance of any impacts is therefore assessed to be **negligible** and not significant in EIA terms.

9.9.2.5.4 Collision Impacts

590. Collision impacts have been considered for six qualifying interest species for the pSPA, based on advice in the Scoping Opinion (Marine Scotland, 2017). Collision impacts in the breeding season were considered for gannet, kittiwake and herring gull.

Breeding season

591. For the following assessment, it is assumed that for each species considered, the pSPA population is spread evenly across the pSPA. For breeding season impacts, the reference pSPA population was taken as the most recent available counts of the breeding populations of the terrestrial SPA breeding colonies that border the pSPA. This approach was agreed at a meeting between NnGOWL, Marine Scotland, SNH and JNCC to discuss the pSPA designation in October 2016.

592. For gannet, the Forth Islands SPA (75,259 pairs) borders the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 75,259 pairs (Table 9-8). Approximately 32% of the Wind Farm Area overlaps with the pSPA.

593. As details of the number of turbines likely to be placed within the part of the Wind Farm Area that overlaps with the pSPA are not yet available, the area of the Wind Farm within the pSPA was applied to results from Collision Rate Modelling, to allow the proportionate affected number of birds of each species to be estimated. Approximately 32% of the Wind Farm Area overlaps with the pSPA.

594. For the worst-case design scenario (54 turbines), a total of 93 gannet collisions (91 adults and two immature birds) were estimated for the breeding season, using an avoidance rate of 98.9% and Band Option 2 (Table 9-53). Assuming that all gannets recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all breeding season collisions (30 birds), would occur in the overlapping Wind Farm Area. This estimated mortality is equivalent to 0.02% of the pSPA gannet population in the breeding season (75,259 pairs).

595. For kittiwake, both the Forth Islands SPA (4,663 pairs), and St. Abb's Head to Fast Castle SPA (3,334 pairs) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 7,997 pairs (Table 9-8).

596. For the worst case design scenario (54 turbines), nine kittiwake collisions (eight adults and one immature bird) were estimated for the breeding season, using an avoidance rate of 98.9% and Band Option 2 (Table 9-60). Assuming that all kittiwakes recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all breeding season collisions (three birds), would occur in the overlapping Wind Farm Area. This estimated mortality is equivalent to 0.02% of the pSPA kittiwake population in the breeding season (7,997 pairs).

597. For herring gull, both the Forth Islands SPA (6,580 pairs), and St. Abb's Head to Fast Castle SPA (325 pairs) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 6,905 pairs (Table 9-8). Approximately 32% of the Wind Farm Area overlaps with the pSPA.

598. For the worst-case design scenario (54 turbines), a total of two herring gull collisions (both adults) were estimated for the breeding season, using an avoidance rate of 99.5% and Band Option 2 (Table 9-64). Assuming that all herring gulls recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all breeding season collisions (one bird), would occur in the overlapping Wind Farm Area. This estimated mortality is equivalent to 0.01% of the pSPA herring gull population in the breeding season (6,905 pairs).

Non-breeding season

599. Collision impacts in the non-breeding season were considered for kittiwake, herring gull, little gull, common gull and black-headed gull.

600. For kittiwake, the estimated population for the pSPA in the non-breeding season is given as 3,191 birds (SNH 2016). Approximately 32% of the Wind Farm Area overlaps with the pSPA.

601. For the worst-case design scenario (54 turbines), 19 kittiwake collisions (12 adults and seven immature bird) were estimated for the non-breeding season, using an avoidance rate of 98.9% and Band Option 2 (Table 9-60). Assuming that all kittiwakes recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all non-breeding season collisions (six birds), would occur in the overlapping Wind Farm Area. This estimated mortality is equivalent to 0.2% of the pSPA kittiwake population in the non-breeding season (3,191 birds).

602. For herring gull, the estimated population for the pSPA in the non-breeding season is given as 12,313 birds (SNH 2016). Approximately 32% of the Wind Farm Area overlaps with the pSPA.

603. For the worst case design scenario (54 turbines), four herring gull collisions (three adults and one immature bird) were estimated for the non-breeding season, using an avoidance rate of 99.5% and Band Option 2 (Table 9-64). Assuming that all herring gulls recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all non-breeding season collisions (one bird), would occur in the overlapping Wind Farm Area. This estimated mortality is equivalent to 0.01% of the pSPA herring gull population in the non-breeding season (12,313 birds).

604. For the remining three species (little gull, common gull and black-headed gull), no collisions were estimated for the Wind Farm Area over a year (Table 9-70), therefore there will be zero collisions involving birds from the pSPA populations of these species in the non-breeding season.

9.9.2.5.5 Collision impacts throughout the year

605. For kittiwake and herring gull, the breeding and non-breeding season collision assessments were combined, based on the worst-case results from the seasonal assessments. For kittiwake, results

were from the worst case design scenario (54 turbines), using an avoidance rate of 98.9% and Band Option 2 (Table 9-110).

Table 9-110: Estimated kittiwake mortality in the Outer Firth of Forth & St Andrews Bay pSPA from collision impacts throughout the year

Season	Wind Farm Area	
	No of birds	% of pSPA population
Breeding season	3	0.02
Non-breeding season	6	0.2
Total	9	0.2

606. For herring gull, results were from the worst-case design scenario (54 turbines, using an avoidance rate of 99.5% and Band Option 2 (Table 9-111).

Table 9-111: Estimated herring gull mortality in the Outer Firth of Forth & St Andrews Bay pSPA from collision impacts throughout the year

Season	Wind Farm Area	
	No of birds	% of pSPA population
Breeding season	1	0.01
Non-breeding season	1	0.01
Total	2	0.02

607. Based on the above collision assessments, there was no evidence that a significant number of birds from the pSPA populations in the breeding or non-breeding seasons would be affected by collision impacts resulting from the presence of Project turbines within the pSPA. These assessments are considered precautionery, as they are based on the reference populations for the pSPA in the non-breeding season, which is considered artificially low.

608. Therefore, it is concluded that collision mortality impacts will have no effect on the key Qualifying Interest species from the Outer Firth of Forth & St Andrews Bay pSPA throughout the year. The sensitivity of the Qualifying Interest species to collision is assessed as high at worst, and the magnitude of any impacts will be negligible. The significance of any impacts is therefore assessed to be **minor** and not significant in EIA terms.

9.9.2.5.6 Displacement and collision impacts combined

609. Four species (kittiwake, little gull, black-headed gull and common gull) were considered for both displacement and collision impacts, as recommended in the Scoping Opinion (Marine Scotland, 2017). These assessments were combined, using the worst-case results. The combined worst-case mortality for kittiwake from annual displacement (Table 9-108) and collision impacts (Table 9-110) was 21 birds (0.46% of the pSPA population) (Table 9-112).

Table 9-112: Estimated kittiwake mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement and collision impacts throughout the year

Season	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of pSPA population	No of birds	% of pSPA population
Total displacement	5	0.1	12	0.3
Total collisions	9	0.2	9	0.2
Total	14	0.3	21	0.5

610. As there was no additional mortality predicted for little gull, black-headed gull and common gull from the pSPA populations arising from collision impacts, the total combined mortality was as presented in the displacement assessment.

611. Based on the above displacement and collision assessments, there was no evidence that a significant number of birds from the pSPA populations in the breeding or non-breeding seasons would be affected by displacement or collision impacts resulting from the presence of some of the Project turbines within the pSPA. These assessments are considered precautionary, based on the displacement and mortality rates used, and also on the reference populations for the pSPA in the non-breeding season. In particular, it is considered that the use of mortality rates of 1% or 2% outside of the breeding season, when birds are no longer tied to their breeding colony, is precautionary.

612. In addition, as highlighted in the Scoping Opinion (Marine Scotland, 2017), for kittiwake, collision risk and displacement are currently considered to be mutually exclusive impacts, and therefore combining mortality estimates for kittiwake displacement and collision should be considered extremely precautionary.

613. Therefore, it is concluded that displacement and collision mortality impacts will have no effect on the key Qualifying Interest species from the Outer Firth of Forth & St Andrews Bay pSPA throughout the year. The sensitivity of the Qualifying Interest species to displacement and collision is assessed as high at worst, and the magnitude of any impacts will be negligible. The significance of any impacts is therefore assessed to be **minor** and not significant in EIA terms.

9.9.2.6 Disturbance from helicopters

614. The use of a helicopter is envisaged for operational and maintenance activity, for example when performing turbine resets and addressing minor defects, or to facilitate access by technicians at times when sea states do not permit access by vessels. The use of helicopters is anticipated to be reasonably limited, with approximately 80 round trips to site anticipated per annum.

615. Seabird species vary in their reactions to maintenance activities that are associated with offshore wind farms (particularly ship and helicopter traffic), with Garthe and Hüppop (2004) presenting a scoring system for such disturbance factors, which is used widely in offshore windfarm EIAs. Other similar scoring systems such as Furness and Wade (2012), Furness *et al*. (2013) and Bradbury et al. (2014) were also used in this assessment.

616. Sensitivity to disturbance impacts of helicopter traffic on the key seabird species for the Project are shown in Table 9-113. These rankings are based on sensitivity to both boat and helicopter disturbance, so it is possible that the sensitivities will be lower for just helicopter disturbance. Ranking scores are from one to five, where one is “hardly any escape behaviour” and five is “strong escape behaviour”.

Table 9-113: Key species sensitivity to disturbance from helicopter traffic

Species	Garthe & Huppop (2004) ranking	Furness & Wade (2012) ranking	Furness *et al.* 2013 ranking	Bradbury *et al.* 2014 ranking	Summary of Sensitivity
Gannet	2	2	2	2	Low to Medium
Kittiwake	2	2	2	2	Low to Medium
Herring gull	2	2	2	2	Low to Medium
Guillemot	3	3	3	3	Medium
Razorbill	3	3	3	3	Medium
Puffin	2	2	2	2	Low to Medium

617. Therefore, it is concluded that helicopter disturbance impacts will have no effect on seabirds in the vicinity of the Project throughout the year. The sensitivity of species to helicopter disturbance is assessed as medium at worst, and the magnitude of any impacts will be negligible. The duration of any such disturbance will be short-term, and temporary. The significance of any impacts is therefore assessed to be **negligible** and not significant in EIA terms.

9.9.3 Decommissioning Phase Impacts

618. Towards the end of the operational life of the Project all decommissioning options will be considered. It may be deemed that removal of certain pieces of infrastructure may have a greater environmental impact than leaving in-situ. The potential decommissioning options will be presented to MS-LOT in a Decommissioning Programme for approval prior to construction. The Decommissioning Programme will then be reviewed and amended as required prior to the commencement of any decommissioning activities.

619. Currently, impacts on birds resulting from decommissioning activities are expected to be similar to those during the construction phase, and these impacts have therefore been scoped out of this assessment.

9.9.4 Cumulative Impacts

620. Cumulative effects refer to effects upon receptors arising from the Project when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals. In this context, the term ‘projects’ is considered to refer to any project with comparable effects and is not limited to offshore wind projects.

621. Projects and activities considered within the cumulative impact assessment are presented in the relevant sub sections. There is uncertainty regarding the design envelope of proposed projects, therefore a worst case scenario is applied to each.

622. For the cumulative collision assessment, two scenarios have been assessed to take into account the new and consented design envelopes for the Inch Cape and the Seagreen Offshore Wind Farms. Scenario One incorporates the worst case design envelopes for the proposed Inch Cape and Seagreen projects as detailed in the Scoping Reports submitted to MS-LOT (ICOL, 2017; Seagreen, 2017). Scenario Two incorporates the consented design envelopes as detailed in the existing 2014 consents. Scenario Two is considered to be extremely unlikely to be realised due to advances in turbine technology and the considerably greater costs associated with using a larger number of turbines.

623. For the cumulative displacement assessment, one scenario has been assessed, as population estimates for the existing 2014 consents did not change for the 2017 proposed projects. This assessment is based on displacement and mortality rates that were recommended in the Scoping Opinion (Marine Scotland, 2017).

624. Table 9-114 sets out the potential cumulative impacts and the worst case cumulative design envelope scenario considered within the cumulative impact assessment.

Table 9-114: Cumulative worst-case design envelope scenarios.

Impact	Worst Case Design Scenario	Justification
Cumulative collision impacts	In the breeding season, the Project and other Forth and Tay wind farms were included. In the non-breeding season, in addition to the Forth & Tay projects, more distant wind farm projects in the UK North Sea were included for kittiwake, and UK North Sea and English Channel for gannet.	Species from breeding SPA colonies are within mean maximum foraging range of Forth and Tay wind farms but not more distant projects. This approach was recommended in the Scoping Opinion (Marine Scotland, 2017).
Cumulative impacts arising from displacement	In the breeding season, the Project and other Forth and Tay wind farms were included. In the non-breeding season, for guillemot and razorbill, displacement effects from Inch Cape & Seagreen A & B were included.	Displacement and mortality rates followed guidance in Scoping Opinion. This approach was recommended in the Scoping Opinion (Marine Scotland, 2017).

9.9.4.1 Cumulative Construction Phase Impacts

625. It is considered that there will be no significant cumulative disturbance impacts arising from vessels associated with construction activities due to the distances involved between these projects.

626. In addition, there has been a significant reduction in the scale of the Project, and with the other Forth and Tay projects. These combined reductions will reduce the magnitude of impacts. It is also considered unlikely that construction activities for all projects will be undertaken at the same time.

627. The NnG Scoping Report concluded that the cumulative effects arising from the construction phase will therefore be no greater, and likely less than, those previously presented in the Original Application & Addendum, which were considered to be not significant (NnGOWL, 2017). No further assessment of cumulative impacts for the construction phase has been undertaken in this assessment.

9.9.4.2 Cumulative Operational Phase Impacts

628. The Scoping Opinion states that for the breeding season, the Cumulative Impact Assessment should consider effects from projects within mean maximum foraging range of the colony SPA under consideration. This has been applied for the following assessments.

629. The approach recommended in the Scoping Opinion for the non-breeding season depended on the species involved. For guillemot and razorbill, the CIA should incorporate non-breeding season displacement effects from the Forth and Tay wind farms (Inch Cape and Seagreen), apportioning effects to SPA and non-SPA colonies in the same manner as the breeding season.

630. For gannet and kittiwake, the CIA should estimate non-breeding season collision effects from the Forth and Tay wind farms (Inch Cape and Seagreen) in isolation, and cumulatively with the other UK wind farms.

631. For herring gull, if the CRM figures indicate an issue in the non-breeding season then the detailed recommendations given in the Scoping Opinion were to be followed (Marine Scotland, 2017). As collision mortality impacts at NnG were considered to have no effect on herring gulls from the four key SPA populations throughout the year (Table 9-66), a cumulative collision assessment was not undertaken for this species.

9.9.4.2.1 Cumulative Displacement Assessment

Breeding season

632. The assessment for the Project on its own considered displacement impacts for four species in the breeding season (kittiwake, guillemot, razorbill and puffin). These four species are also considered for displacement impacts in the Cumulative Impact Assessment.

633. As recommended in the Scoping Opinion, the Cumulative Impact Assessment should consider effects from projects within mean maximum foraging range of the colony SPA under consideration. All four species have a similar mean maximum foraging range and therefore, the same SPAs are considered applicable for these species. The SPAs considered in this cumulative impact assessment are listed in the text for each species.

634. The following projects were considered in the assessment of cumulative displacement impacts for these species (Table 9-115). As the displacement effects and site boundaries are the same for both the 2014 and 2017 Inch Cape and Seagreen projects, only the 2014 consented projects are presented in this section.

635. As recommended in the Scoping Opinion, for the breeding season, the Cumulative Impact Assessment should consider effects from projects within mean maximum foraging range of the colony SPA under consideration (Marine Scotland, 2017). The following projects were therefore included in the Cumulative Impact Assessment for the breeding season (Table 9-115).

Table 9-115: Projects considered for cumulative assessment of displacement impacts in the breeding season

Project	Status	Data confidence and Information available
Inch Cape Offshore Wind Farm	Consented (2014)	High - published project information available in the public domain.
Inch Cape Offshore Wind Farm	Pre-application (2017)	High - published project information available in the public domain, supplemented by additional information provided by developer.
Seagreen A Offshore Wind Farm	Consented (2014)	High - published project information available in the public domain.
Seagreen B Offshore Wind Farm	Consented (2014)	High - published project information available in the public domain.
Seagreen Phase 1	Pre-application (2017)	High - published project information available in the public domain. Project boundaries synonymous with the Seagreen A and B Offshore Wind Farm Projects.

Project	Status	Data confidence and Information available
Kincardine Offshore Wind Farm	Consented (2017)	High - published project information available in the public domain.
Forthwind Demonstration Project (2 turbines)	Consented (2016)	High - published project information available in the public domain.
Forthwind Offshore Wind Demonstrator (up to 7 turbines)	Pre-application	High - published Scoping Report and Scoping Opinion available in the public domain.
Hywind	Consented (2015)	High - published project information available in the public domain.

636. As for the Project alone displacement assessment, the assessment of displacement and barrier effects in the breeding season followed the recent SNCB guidance (2017). The Scoping Report recommended that the CEH displacement modelling report (2014) was used as a basis for running a comparative assessment of breeding season effects for kittiwake, puffin, guillemot and razorbill (Marine Scotland, 2017). However, as outputs from this study were presented as changes in adult survival rate and chick survival, they were not comparable with outputs from the displacement matrix approach, which does not measure these parameters.

637. For Inch Cape, numbers of displaced birds in the breeding season were based on seasonal mean peak estimated numbers for the Inch Cape Wind Farm Area and a 2 km buffer, using the season definitions from the Scoping Opinion (Marine Scotland, 2017). This information was circulated by Inch Cape by email on 23/11/2017 and is presented in Appendix 9.4.

638. For Seagreen Phase 1, numbers of displaced birds in the breeding season were based on seasonal mean peak estimated numbers for the Seagreen Phase 1 project, using the season definitions from the Scoping Opinion (Marine Scotland, 2017). This information was circulated by Seagreen by email on 8/12/2017 and is presented in Appendix 9.4.

639. For Kincardine Offshore Wind Farm, figures for the estimated population size for the turbine area and a buffer of 1 km in the breeding season were taken from the Kincardine Offshore Wind Farm Environmental Statement (Atkins 2016). No figures were available for the Wind Farm Area alone. This information is presented in Appendix 9.4.

640. For the Forthwind project (two turbines), relevant information was taken from the Forthwind Environmental Statement (Forthwind, 2015). For the Hywind project, relevant information was taken from the project Environmental Statement (Statoil, 2015). No figures were available for the Wind Farm Area alone.

641. As recommended in the SNCB guidance (2017), only adult birds were considered for the breeding season displacement assessment.

642. For each species, a range of potential displacement is presented (in 10% intervals from 0% to 100%), based on the mean seasonal peak estimated numbers from baseline surveys as matrix tables. Values are presented for the Wind Farm Area and the Wind Farm Area plus a 2 km buffer (if available), as recommended in the SNCB guidance (2017).

643. Mortality of adult birds displaced from the development site (plus buffer) was considered in this assessment. Reduction in productivity of breeding birds was not considered in the assessment, as recommended in the SNCB guidance (2017), due to the lack of empirical evidence on the consequence of displacement to seabirds. Mortality of displaced birds was presented in 1% intervals between 1 and 5%, and 10% intervals between 10% and 100%. The rate of displacement and mortality used in the assessment was based on available published evidence and also on recommendations received in the Scoping Opinion (Marine Scotland, 2017).

644. Displacement and mortality matrices for each species and wind farm project are presented in Appendix 9.4.

Kittiwake

645. The four SPAs considered for kittiwake for the cumulative assessment were Buchan Ness to Collieston Coast SPA, Fowlsheugh SPA, Forth Islands SPA and St Abb's Head to Fast Castle SPA. Based on SNH figures, the most recent total combined breeding population estimate for these SPAs is 29,134 pairs (Table 9-8).

646. Seasonal peak mean estimated numbers of kittiwakes for the projects considered in this assessment are presented in Table 9-116. Estimated numbers for NnG were previously presented in Table 9-12. Estimated numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.4. The population of kittiwakes in the Kincardine OWF area and a 1 km buffer in the breeding season was estimated to be 229 birds (Atkins, 2016). A peak of 184 kittiwakes were estimated to be in the potential zone of influence for the Forthwind project (2 turbines) (Arcus, 2015). The population of kittiwakes in the Hywind wind farm and a 1 km buffer in the breeding season was estimated to be 112 birds (Statoil, 2015).

Table 9-116: Peak mean estimated numbers of kittiwakes at Forth and Tay Wind Farms and 2km buffers in the breeding season

Project	Wind Farm Area	Wind Farm Area + 2 km buffer
	No of birds	No of birds
NnG	1,772	2,164
Inch Cape	2,119	3,866
Seagreen A	1,458	N/A
Seagreen B	1,777	N/A
Kincardine OWF [9]	229	N/A
Forthwind (2 turbines)	184	N/A
Hywind [9]	112	N/A

647. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 30% displacement of kittiwakes from the Wind Farm Area (and buffer areas) in the breeding season. This assumption was also applied to all projects (Table 9-117).

[9] Based on Wind Farm Area & 1 km buffer

Table 9-117: Number of displaced kittiwakes at Forth and Tay Wind Farms and 2km buffers in the breeding season

Project	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	Adults	No of birds	Adults
NnG	532	496	649	605
Inch Cape	636	594	1,166	1,089
Seagreen A	437	425	N/A	N/A
Seagreen B	533	518	N/A	N/A
Kincardine OWF [9]	69	66	N/A	N/A
Forthwind (2 turbines)	55	55	N/A	N/A
Hywind[9]	112	34	N/A	N/A

648. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 93.2% of aged kittiwakes were adults (Appendix 9.2: Table 5). For Inch Cape, 93.4% of aged kittiwakes were adults in the breeding season (Appendix 9.4). For Seagreen, as 97.2% of all birds recorded on baseline surveys in Seagreen B in June were adults (Seagreen 2012), this ratio was applied to the above figures for both Seagreen projects. These percentages were applied to the estimated numbers of displaced kittiwakes in the breeding season to estimate the maximum number of adults potentially displaced (Table 9-117).

649. In addition, the number of displaced kittiwakes at Kincardine OWF and 1 km buffer in the breeding season is also shown (Atkins 2016) (Table 9-117).

650. For NnG, assuming 30% of all adult kittiwakes were displaced during the breeding season, this would affect an estimated 496 adults in the Wind Farm Area, increasing to 605 adults including the 2 km buffer (Table 9-117).

651. For Inch Cape, assuming 30% of all adult kittiwakes were displaced during the breeding season, this would affect an estimated 594 adults in the Wind Farm Area, increasing to 1,089 adults including the 2 km buffer (Table 9-117).

652. For Seagreen, assuming 30% of all adult kittiwakes were displaced during the breeding season, this would affect an estimated 425 adults in Seagreen A and 518 adults in Seagreen B (Table 9-117). No figures were available for a 2 km buffer for the Seagreen projects.

653. For Kincardine OWF, assuming 30% of all adult kittiwakes were displaced during the breeding season, this would affect an estimated 66 adults in the Wind Farm Area and 1 km buffer (Atkins 2016) (Table 9-117). For the Forthwind project (2 turbines), all 55 displaced birds were assumed to be adults. For Hywind, assuming 30% of all adult kittiwakes were displaced during the breeding season, this would affect an estimated 34 adults in the Wind Farm Area and 1 km buffer (Statoil, 2015).

654. Predicted displacement mortality for kittiwakes in the breeding season, was summed for all projects, applying a mortality rate of 2% as recommended in the Scoping Opinion (Marine Scotland, 2017), (Table 9-118).

Table 9-118: Estimated adult kittiwake mortality from displacement impacts from Forth and Tay Wind Farms on the key breeding SPAs in the UK waters of the North Sea in the breeding season

Project	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of adults	% of SPA population	No of adults	% of SPA population
NnG	10	0.02	12	0.02
Inch Cape	12	0.02	22	0.04
Seagreen A	9	0.02	9	0.02
Seagreen B	10	0.02	10	0.02
Kincardine OWF [10]	1	0.002	1	0.002
Forthwind (2 turbines)	1	0.002	1	0.002
Hywind [10]	1	0.002	1	0.002
Total	44	0.09	56	0.1

655. For NNG, 10 adult kittiwakes displaced from the NnG Wind Farm Area, or 12 adults from the NnG Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to 0.02% of the SPA population within mean maximum foraging range (29,134 pairs), for the Wind Farm Area and 2 km buffer.

656. For Inch Cape, 12 adult kittiwakes displaced from the Wind Farm Area, or 22 adults from the Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to between 0.02% and 0.04% of the SPA population within mean maximum foraging range (29,134 pairs), for the Wind Farm Area and 2 km buffer.

657. For Seagreen A, nine adult kittiwakes displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to 0.02% of the SPA population within mean maximum foraging range (29,134 pairs). As no figures were available for a 2 km buffer, the Seagreen A total was repeated for this assessment.

658. For Seagreen B, 10 adult kittiwakes displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to 0.02% of the SPA population within mean maximum foraging range (29,134 pairs). As no figures were available for a 2 km buffer, the Seagreen B total was repeated for this assessment.

659. For Kincardine OWF, one adult kittiwake displaced from the Kincardine wind farm and 1 km buffer in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to 0.002% of the SPA population within mean maximum foraging range (29,134 pairs). As this was the only figure available, it was repeated for this assessment.

660. For Forthwind (2 turbines), one adult kittiwake displaced from the wind farm in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to 0.002% of the SPA population within mean maximum foraging range (29,134 pairs). As this was the only figure available, it was repeated for this assessment.

661. For Hywind, one adult kittiwake displaced from the wind farm and 1 km buffer in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to 0.002% of the SPA population

[10] Based on Wind Farm Area & 1 km buffer

within mean maximum foraging range (29,134 pairs). As this was the only figure available, it was repeated for this assessment.

662. No additional information was available for displacement estimates for the proposed seven additional Forthwind turbines. However, based on the low number of kittiwakes recorded on baseline surveys for the adjacent two turbine project (Arcus, 2015), no significant displacement effects on kittiwakes in the breeding season are considered likely to arise from the seven turbine project.

663. Cumulative displacement mortality of 44 adult kittiwakes in the combined wind farms corresponds to 0.09% of the SPA adult breeding population (29,134 pairs) (Table 9-8). Cumulative displacement mortality of 56 adults in the combined wind farms and 2 km buffers corresponds to 0.1% of the SPA adult breeding population.

664. For the surviving displaced adult kittiwakes, there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

665. In comparison, the CEH Displacement model (Searle *et al.*, 2014) estimated that the change in the annual adult kittiwake survival rate for the Forth Islands SPA for the Forth and Tay projects would be -1.97%, based on the homogeneous prey distribution scenario, and -1.82%, based on the heterogeneous prey distribution scenario (Table 9-119).

666. Similarly, for Fowlsheugh SPA, the change in the annual adult survival rates for the Forth and Tay projects were estimated as -0.48% based on the homogeneous prey distribution scenario, and -0.44%, based on the heterogeneous prey distribution scenario.

667. For the St Abb's Head to Fast Castle SPA, the change in the annual adult survival rates for the Forth and Tay projects were estimated as -0.18% based on the homogeneous prey distribution scenario, and -0.22%, based on the heterogeneous prey distribution scenario.

668. The estimated number of adult birds involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-119). Based on the most recent population counts for these three SPAs (17,652 pairs, or 35,304 individuals), the estimated combined change in adult survival rates corresponds to a mortality of 289 adult kittiwakes based on the homogeneous prey distribution scenario, or 270 adult kittiwakes based on the heterogeneous prey distribution scenario.

Table 9-119: Summary of annual kittiwake displacement mortality for SPAs in foraging range of the Forth and Tay projects, as presented in the CEH displacement model (Searle *et al.*, 2014)

SPA	Change in annual adult survival		SPA population	Estimated number of adults	
	Homogeneous [11]	Heterogeneous[11]		Homogeneous	Heterogeneous
Forth Islands	-1.97	-1.82	4,663 pairs	184	170
Fowlsheugh	-0.48	-0.44	9,655 pairs	93	85
St Abb's Head to Fast Castle	-0.18	-0.22	3,334 pairs	12	15
Total	-	-	17,652 pairs	-289 adults	-270 adults

669. A worst-case annual estimated mortality of 289 adult kittiwakes corresponds to a maximum of 0.8% of the SPA breeding population within mean maximum foraging range (17,652 pairs), from displacement effects from the Forth and Tay projects and a 1 km buffer. This demonstrates that if

[11] Figures from Table 3.2, Searle *et al.* (2014)

cumulative adult kittiwake mortality from displacement was at this level, the impact would not be significant at the SPA population level.

670. However, this is an annual estimate, based on the homogeneous prey distribution scenario, which is considered highly unrealistic, an assumed 40% displacement rate for NnG and Inch Cape (30% for Seagreen A & B), as well as several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model (Searle *et al.*, 2014).

671. As previously highlighted, Searle *et al.* (2014) concluded that model outputs are very sensitive to some parameters. The total amount of prey is the most prominent of these, and the report concluded that small changes in this value can have very substantial effects on the model output. The barrier and displacement rates, which were agreed by the Steering Committee, are also likely to be important parameters in determining the magnitude of the response to the wind farm (and the exploratory analyses, which used different scenarios for barrier and displacement rates, suggest that this is indeed the case).

672. However, based on evidence from other operational projects, including a recent study at Westermost Rough offshore wind farm (APEM, 2017), kittiwake displacement is considered to occur at considerably less than 30%, if it occurs at all. As such, it is considered that a displacement rate of 30% as used in this assessment, (or up to 40% as used in the CEH displacement model), represent highly precautionary assumptions.

673. It is concluded that cumulative displacement mortality impacts arising from the assessed projects will have no effect on the breeding SPA populations of kittiwakes within mean maximum foraging range in the breeding season. The sensitivity of kittiwakes to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Guillemot

674. In the breeding season, the mean maximum foraging range of breeding guillemots is 84.2 ± 50.1 km, based on a sample size of five birds (Thaxter et al., 2012). Based on this, four SPAs for breeding guillemots (Buchan Ness to Collieston Coast, Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project. These four SPAs have therefore been used as the SPA reference population for this assessment in the breeding season. Based on SNH figures, the most recent total combined population estimate for these four SPAs is 154,131 birds (Table 9-8).

675. Seasonal peak mean estimated numbers of guillemots for the projects considered in this assessment are presented in Table 9-120. Estimated numbers for NnG were previously presented in Table 9-23. Estimated numbers for Inch Cape and Seagreen A and B presented in Appendix 9.4. The population of guillemots in the Kincardine OWF area and a 1 km buffer in the breeding season was estimated to be 632 birds (Atkins, 2016). A peak of 381 guillemots were estimated to be in the potential zone of influence for the Forthwind project (2 turbines) (Arcus, 2015). The population of guillemots in the Hywind wind farm and a 1 km buffer in the breeding season was estimated to be 295 birds (Statoil, 2015).

Table 9-120: Peak mean estimated numbers of guillemots at Forth and Tay Wind Farms, and 2km buffers in the breeding season

Project	Wind Farm Area	Wind Farm Area + 2 km buffer
	No of birds	No of birds
NnG	2,202	4,894
Inch Cape	4,047	8,184
Seagreen A	8,006	N/A
Seagreen B	7,074	N/A
Kincardine OWF[12]	632	N/A
Forthwind (2 turbines)	381	N/A
Hywind [12]	215	N/A

676. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of guillemots from the Wind Farm Area (and buffer areas) in the breeding season. This assumption was also applied to all projects (Table 9-121).

Table 9-121: Number of displaced guillemots at Forth and Tay Wind Farms and 2km buffers in the breeding season

Project	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	Adults	No of birds	Adults
NnG	1,321	674	2,936	1,497
Inch Cape	2,428	1,619	4,910	3,275
Seagreen A	4,804	4,242	N/A	N/A
Seagreen B	4,244	3,238	N/A	N/A
Kincardine OWF[12][13]	379	379	N/A	N/A
Forthwind (2 turbines)	229	229	N/A	N/A
Hywind [13]	137	137	N/A	

677. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 51.0% of guillemots were adults, based on the PVA stable age structure (Table 9-25). For Inch Cape, 66.7% of guillemots were adults in the breeding season, based on the PVA stable age structure used in the 2014 consent (ICOL, 2014). For Seagreen A, of 287 birds aged on surveys between April and July, 88.3% were aged as adult (Seagreen 2012). For Seagreen B, of 160 birds aged on surveys between April and July, 76.3% were aged as adult (Seagreen 2012). These percentages were applied to the estimated numbers of displaced guillemots in the breeding season to estimate the maximum number of adults potentially displaced (Table 9-121).

[12] Based on Wind Farm Area & 1 km buffer

[13] Based on Wind Farm Area & 1 km buffer

678. In the absence of any additional information on age breakdown, all displaced guillemots at Kincardine OWF and 1 km buffer and Forthwind in the breeding season were assumed to be adults (Table 9-121).

679. For NnG, assuming 60% of all adult guillemots were displaced during the breeding season, this would affect an estimated 674 adults in the Wind Farm Area, increasing to 1,497 adults including the 2 km buffer (Table 9-121).

680. For Inch Cape, this would affect an estimated 1,619 adults in the Wind Farm Area, increasing to 3,275 adults including the 2 km buffer (Table 9-121).

681. For Seagreen, this would affect an estimated 4,242 adults in Seagreen A and 3,238 adults in Seagreen B (Table 9-121). No figures were available for a 2 km buffer for the Seagreen projects.

682. For Kincardine OWF, this would affect an assumed 379 adults in the Wind Farm Area and 1 km buffer (Table 9-121). For Forthwind (2 turbines), this would affect an assumed 229 adults in the Wind Farm Area. For Hywind, this would affect an assumed 137 adults in the Wind Farm Area and 1 km buffer.

683. Predicted displacement mortality for guillemots in the breeding season, was summed for all projects, applying a mortality rate of 1% as recommended in the Scoping Opinion (Marine Scotland, 2017), (Table 9-122).

Table 9-122: Estimated adult guillemot mortality from displacement impacts from Forth and Tay Wind Farms on the key breeding SPAs in the UK waters of the North Sea in the breeding season

Project	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of adults	% of SPA population	No of adults	% of SPA population
NnG	7	0.005	15	0.01
Inch Cape	16	0.01	33	0.02
Seagreen A	42	0.03	42	0.03
Seagreen B	32	0.02	32	0.02
Kincardine OWF [14]	4	0.003	4	0.003
Forthwind (2 turbines)	2	0.001	2	0.001
Hywind [14]	1	0.001	1	0.001
Total	104	0.07	129	0.08

684. For NnG, seven adult guillemots displaced from the NnG Wind Farm Area, or 15 adults from the NnG Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to between 0.005% and 0.01% of the SPA population within mean maximum foraging range (154,131 birds), for the Wind Farm Area and 2 km buffer.

685. For Inch Cape, 16 adult guillemots displaced from the Wind Farm Area, or 33 adults from the Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to between 0.01% and 0.02% of the SPA population within mean maximum foraging range (154,131 birds), for the Wind Farm Area and 2 km buffer.

686. For Seagreen A, 42 adult guillemots displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to 0.03% of the SPA population within

[14] Based on Wind Farm Area & 1 km buffer

mean maximum foraging range (154,131 birds). As no figures were available for a 2 km buffer, the Seagreen A total was repeated for this assessment.

687. For Seagreen B, 32 adult guillemots displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to 0.02% of the SPA population within mean maximum foraging range (154,131 birds). As no figures were available for a 2 km buffer, the Seagreen B total was repeated for this assessment.

688. For Kincardine OWF, four adult guillemots displaced from the Kincardine wind farm and 1 km buffer in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to 0.003% of the SPA population within mean maximum foraging range (154,131 birds). As this was the only figure available, it was repeated for this assessment.

689. For Forthwind (2 turbines), two adult guillemots displaced from the wind farm in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to 0.001% of the SPA population within mean maximum foraging range (154,131 birds). As this was the only figure available, it was repeated for this assessment.

690. For Hywind, one adult guillemot displaced from the wind farm and 1 km buffer in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to 0.001% of the SPA population within mean maximum foraging range (154,131 birds). As this was the only figure available, it was repeated for this assessment.

691. No additional information was available for displacement estimates for the proposed seven additional Forthwind turbines. However, based on the low number of guillemots recorded on baseline surveys for the adjacent two turbine project (Arcus, 2015), no significant displacement effects on guillemots in the breeding season are considered likely to arise from the seven turbine project.

692. Cumulative displacement mortality of 104 birds in the combined Wind Farm Areas corresponds to 0.07% of the SPA adult breeding population (153,676 birds) (Table 9-8). Cumulative displacement mortality of 129 birds in the combined wind farms and 2 km buffers corresponds to 0.08% of the SPA adult breeding population.

693. For the surviving displaced adult guillemots, there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

694. In comparison, the CEH Displacement model (Searle *et al.*, 2014) estimated that the change in the annual adult guillemot survival rate for the Forth Islands SPA would be -0.20, based on the homogeneous prey distribution scenario, and -0.30%, based on the heterogeneous prey distribution scenario, while estimated survival rates for Fowlsheugh SPA were -0.04, based on the homogeneous prey distribution scenario, and -0.10%, based on the heterogeneous prey distribution scenario (Table 9-123).

695. The Forth Islands SPA estimate involved adult guillemots from NnG, while the Fowlsheugh estimate involved adult guillemots from Seagreen B. Comparable estimates for the other SPAs or projects within mean maximum foraging range were not presented in the CEH displacement report (Searle *et al.*, 2014).

696. The estimated number of adult guillemots involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-123). Based on the most recent population counts for the Forth Islands SPA (28,786 birds) and Fowlsheugh SPA (55,507 birds), the estimated change in adult survival rates corresponds to a combined mortality of 80 adult guillemots based on the homogeneous prey distribution scenario, or 142 adult guillemots based on the heterogeneous prey distribution scenario.

Table 9-123: Summary of annual guillemot displacement mortality for the Forth Islands and Fowlsheugh SPAs, from the Forth and Tay projects, as presented in the CEH displacement model (Searle *et al.*, 2014)

SPA	Change in annual adult survival		SPA population	Estimated number of adults	
	Homogeneous [15]	Heterogeneous[15]		Homogeneous	Heterogeneous
Forth Islands	-0.20	-0.30	28,786 birds	-58 adults	-86 adults
Fowlsheugh	-0.04	0.10	55,507 birds	-22 adults	+56 adults
Total	-	-	84,293 birds	-80 adults	-30 adults

697. A worst-case annual estimated mortality of 80 adult guillemots corresponds to a maximum of 0.09% of the Forth Islands and Fowlsheugh SPA breeding population (84,293 birds), from displacement effects from NnG and Seagreen B and 1 km buffers. This demonstrates that if adult guillemot mortality from displacement was at this level, the impact would not be significant at the population level for these two SPAs.

698. However, this is an annual estimate, based on the homogeneous prey distribution scenario, an assumed 60% displacement rate, as well as several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model. As previously highlighted, the barrier and displacement rates, which were agreed by the project Steering Committee, are likely to be important parameters in determining the magnitude of the response to the wind farm (Searle *et al.*, 2014).

699. As stated previously, there is evidence to indicate that the proportion of auks displaced is related to spacing distance between turbines. Overall, based on the available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%. The estimated mortality from displacement presented in this cumulative assessment is therefore considered to be very precautionary.

700. It is concluded that cumulative displacement mortality impacts arising from the assessed projects will have no effect on the breeding SPA populations of guillemots within mean maximum foraging range in the breeding season. The sensitivity of guillemots to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Razorbill

701. In the breeding season, the mean maximum foraging range of breeding razorbills is 48.5 ± 35.0 km, based on a sample size of four birds (Thaxter et al., 2012). Based on this, three SPAs for breeding razorbills (Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project. These three SPAs have therefore been used as the SPA reference population for this assessment in the breeding season. Based on SNH figures, the most recent total combined population estimate for these three SPAs is 15,308 birds (Table 9-8).

702. Seasonal peak mean estimated numbers of razorbills for the projects considered in this assessment are presented in Table 9-124. Estimated numbers for NnG were previously presented in Table 9-33. Estimated numbers for Inch Cape and Seagreen A and B are presented in Appendix 9.4. The population of razorbills in the Kincardine OWF area and a 1 km buffer in the breeding season was estimated to be 22 birds (Atkins, 2016). A peak of 61 razorbills were estimated to be in the potential zone of influence for the Forthwind project (2 turbines) (Arcus, 2015). A peak of 40 razorbills were

[15] Figures from Table 3.2, Searle *et al.* (2014)

estimated to be in the Hywind wind farm area and a 1 km buffer in the breeding season (Statoil, 2015).

Table 9-124: Peak mean estimated numbers of razorbills from Forth and Tay Wind Farms, and 2km buffers in the breeding season

Project	Wind Farm Area	Wind Farm Area + 2 km buffer
	No of birds	No of birds
NnG	613	1,248
Inch Cape	2,591	4,671
Seagreen A	1,818	N/A
Seagreen B	652	N/A
Kincardine OWF [16]	22	N/A
Forthwind (2 turbines)	61	N/A
Hywind [16]	40	N/A

703. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of razorbills from the Wind Farm Area (and buffer areas) in the breeding season. This assumption was also applied to all projects (Table 9-125).

Table 9-125: Number of displaced razorbills from Forth and Tay Wind Farms, and 2km buffers in the breeding season

Project	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	Adults	No of birds	Adults
NnG	368	208	749	422
Inch Cape	1,555	1,107	2,803	1,996
Seagreen A	1,091	682	N/A	N/A
Seagreen B	391	244	N/A	N/A
Kincardine OWF [16]	13	13	N/A	N/A
Forthwind (2 turbines)	37	37	N/A	N/A
Hywind [16]	24	24	N/A	N/A

704. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 56.5% of razorbills were adults, based on the PVA stable age structure (Table 9-35). For Inch Cape, 71.2% of razorbills were adults in the breeding season, based on the PVA stable age structure used in the 2014 consent (ICOL, 2014). For Seagreen A, of 40 birds aged on surveys between April and July, 62.5% were aged as adult (Seagreen 2012). For Seagreen B, as there was no age breakdown reported (Seagreen 2012), the age breakdown from Seagreen A was applied (62.5%). These percentages were applied to the estimated numbers of displaced razorbills in the breeding season to estimate the maximum number of adults potentially displaced (Table 9-125).

[16] Based on Wind Farm Area & 1 km buffer

705. In the absence of any additional information on age breakdown, all displaced razorbills at Kincardine OWF and 1 km buffer and Forthwind in the breeding season were assumed to be adults (Table 9-125).

706. For NnG, assuming 60% of all adult razorbills were displaced during the breeding season, this would affect an estimated 208 adults in the Wind Farm Area, increasing to 422 adults including the 2 km buffer (Table 9-125).

707. For Inch Cape, this would affect an estimated 1,107 adults in the Wind Farm Area, increasing to 1,996 adults including the 2 km buffer (Table 9-125). For Seagreen, this would affect an estimated 682 adults in Seagreen A and 244 adults in Seagreen B (Table 9-125). No figures were available for a 2 km buffer for the Seagreen projects.

708. For Kincardine OWF, this would affect an assumed 13 adults in the Wind Farm Area and 1 km buffer (Table 9-125). For Forthwind, this would affect an assumed 37 adults in the Wind Farm Area. For Hywind, this would affect an assumed 24 adults in the Wind Farm Area and 1 km buffer.

709. Predicted displacement mortality for razorbills in the breeding season, was summed for all projects, applying a mortality rate of 1% as recommended in the Scoping Opinion (Marine Scotland, 2017), (Table 9-126).

Table 9-126: Estimated adult razorbill mortality from displacement impacts from Forth and Tay Wind Farms on the key breeding SPAs in the UK waters of the North Sea in the breeding season

Project	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of adults	% of SPA population	No of adults	% of SPA population
NnG	2	0.01	4	0.03
Inch Cape	11	0.07	20	0.1
Seagreen A	7	0.05	7	0.05
Seagreen B	2	0.01	2	0.01
Kincardine OWF [17]	0	0	0	0
Forthwind (2 turbines)	0	0	0	0
Hywind [17]	0	0	0	0
Total	22	0.1	33	0.2

710. For NnG, two adult razorbills displaced from the NnG Wind Farm Area, or four adults from the NnG Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-126). This corresponds to between 0.01% and 0.03% of the SPA population within mean maximum foraging range (15,298 birds), for the Wind Farm Area and 2 km buffer.

711. For Inch Cape, 11 adult razorbills displaced from the Wind Farm Area, or 20 adults from the Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-126). This corresponds to between 0.07% and 0.1% of the SPA population within mean maximum foraging range (15,298 birds), for the Wind Farm Area and 2 km buffer.

712. For Seagreen A, seven adult razorbills displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-126). This corresponds to 0.05% of the SPA population

[17] Based on Wind Farm Area & 1 km buffer

within mean maximum foraging range (15,298 birds). As no figures were available for a 2 km buffer, the Seagreen A total was repeated for this assessment.

713. For Seagreen B, two adult razorbills displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-126). This corresponds to 0.01% of the SPA population within mean maximum foraging range (15,298 birds). As no figures were available for a 2 km buffer, the Seagreen B total was repeated for this assessment.

714. For Kincardine OWF, Forthwind and Hywind, zero razorbills displaced from the wind farm areas in the breeding season would suffer mortality as a result (Table 9-126).

715. No additional information was available for displacement estimates for the proposed seven additional Forthwind turbines. However, based on the low number of razorbills recorded on baseline surveys for the adjacent two turbine project (Arcus, 2015), no significant displacement effects on razorbills in the breeding season are considered likely to arise from the seven turbine project.

716. Cumulative displacement mortality of 22 birds in the combined wind farms corresponds to 0.1% of the SPA adult breeding population (15,308 birds) (Table 9-8). Cumulative displacement mortality of 33 birds in the combined wind farms and 2 km buffers corresponds to 0.2% of the SPA adult breeding population.

717. For the surviving displaced adult razorbills, there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

718. In comparison, the CEH Displacement model (Searle *et al*., 2014) estimated that the change in the annual adult razorbill survival rate for the Forth Islands SPA from the Forth and Tay projects combined would be -0.82%, based on the homogeneous prey distribution scenario, and -0.24%, based on the heterogeneous prey distribution scenario (Table 9-127). Note that the total figures are larger than the combined sum of the individual projects. This is as presented in Searle *et al.* (2014). The total estimated number ofadults affected was calculated based on the total figure from Searle et al. (2014), rather than by summing the project totals. Comparable results for other SPAs within mean maximum foraging range were not presented in the CEH displacement report (Searle *et al.*, 2014).

719. The estimated number of adult razorbills involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-127). Based on the most recent population counts for the Forth Islands SPA (5,815 birds), the estimated combined change in adult survival rates corresponds to a mortality of 48 adult razorbills based on the homogeneous prey distribution scenario, or 14 adult razorbills based on the heterogeneous prey distribution scenario.

Table 9-127: Summary of annual razorbill displacement mortality for the Forth Islands SPA from the Forth and Tay projects, as presented in the CEH displacement model (Searle *et al.*, 2014)

Project	Change in annual adult survival		SPA population	Estimated number of adults	
	Homogeneous[18]	Heterogeneous[18]		Homogeneous	Heterogeneous
NnG	-0.10	-0.09	5,815 birds	6 adults	5 adults
Inch Cape	-0.09	-0.11	5,815 birds	5 adults	6 adults
Seagreen A	-0.05	-0.05	5,815 birds	3 adults	3 adults
Seagreen B	-0.09	-0.01	5,815 birds	5 adults	1 adult
Total	-0.82	-0.24	5,815 birds	48 adults	14 adults

[18] Figures from Table 3.2, Searle *et al.* (2014)

720. A worst-case annual estimated mortality of 48 adult razorbills corresponds to a maximum of 0.8% of the Forth Islands SPA breeding population (5,815 birds), from displacement effects from the Forth and Tay projects and 1 km buffers. This demonstrates that if cumulative adult razorbill mortality from displacement was at this level, the impact would not be significant at the population level for this SPA.

721. However, this is an annual estimate, based on the homogeneous prey distribution scenario, which is considered highly unrealistic, an assumed 60% displacement rate, as well as several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model. As previously highlighted, the barrier and displacement rates, which were agreed by the project Steering Committee, are likely to be important parameters in determining the magnitude of the response to the wind farm (Searle *et al.*, 2014).

722. As stated previously, there is evidence to indicate that the proportion of auks displaced is related to spacing distance between turbines. Overall, based on the available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%. The estimated mortality from displacement presented in this cumulative assessment is therefore considered to be very precautionary.

723. It is concluded that cumulative displacement mortality impacts arising from the assessed projects will have no effect on the breeding SPA populations of razorbills within mean maximum foraging range in the breeding season. The sensitivity of razorbills to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Puffin

724. In the breeding season, the mean maximum foraging range of breeding puffins is 105.4 ± 46.0 km, based on a sample size of eight birds (Thaxter et al., 2012). Based on this, one SPA for breeding puffins (Forth Islands), is within mean maximum foraging range + 1 SD of the Project. This SPA has therefore been used as the SPA reference population for this assessment in the breeding season. Based on SNH figures, the most recent population estimate for this SPA is 45,005 pairs (Table 9-8).

725. Seasonal peak mean estimated numbers of puffins for the projects considered in this assessment are presented in Table 9-128. Estimated numbers for NnG were previously presented in Table 9-42. Estimated numbers for Inch Cape and Seagreen A and B are presented in Appendix 9.4. The population of puffins in the Kincardine OWF area and a 1 km buffer in the breeding season was estimated to be 19 birds (Atkins, 2016). A peak of 122 puffins were estimated to be in the potential zone of influence for the Forthwind project (2 turbines) (Arcus, 2015). The population of puffins in the Hywind wind farm area and a 1 km buffer in the breeding season was estimated to be 138 birds (Hywind, 2015).

Table 9-128: Peak mean estimated numbers of puffins at Forth and Tay Wind Farms, and 2km buffers in the breeding season

Project	Wind Farm Area	Wind Farm Area + 2 km buffer
	No of birds	No of birds
NnG	2,682	6,173
Inch Cape	3,101	5,678
Seagreen A	2,433	N/A
Seagreen B	3,505	N/A
Kincardine OWF [19]	19	N/A
Forthwind (2 turbines)	122	N/A
Hywind [19]	138	N/A

726. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of puffins from the Wind Farm Area (and buffer areas) in the breeding season. This assumption was also applied to all projects (Table 9-129).

Table 9-129: Number of displaced puffins at Forth and Tay Wind Farms, and 2km buffers in the breeding season

Project	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	Adults	No of birds	Adults
NnG	1,609	814	3,704	1,874
Inch Cape	1,861	1,260	3,407	2,307
Seagreen A	1,460	1,050	N/A	N/A
Seagreen B	2,103	1,340	N/A	N/A
Kincardine OWF[20]	11	11	N/A	N/A
Forthwind (2 turbines)	73	73	N/A	N/A
Hywind [20]	83	83	N/A	N/A

727. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 50.6% of puffins were adults, based on the PVA stable age structure (Table 9-44). For Inch Cape, 67.7% of puffins were adults in the breeding season, based on the PVA stable age structure used in the 2014 consent (ICOL, 2014). For Seagreen A, of 114 birds aged on surveys between April and August, 71.9% were aged as adult (Seagreen 2012). For Seagreen B, of 114 birds aged on surveys between April and August, 63.7% were aged as adult (Seagreen 2012). These percentages were applied to the estimated numbers of displaced puffins in the breeding season to estimate the maximum number of adults potentially displaced (Table 9-129).

[19] Based on Wind Farm Area & 1 km buffer

[20] Based on Wind Farm Area & 1 km buffer

728. In the absence of any additional information on age breakdown, all displaced puffins at Kincardine OWF and 1 km buffer, and Forthwind in the breeding season were assumed to be adults (Table 9-129).

729. For NnG, assuming 60% of all adult puffins were displaced during the breeding season, this would affect an estimated 814 adults in the Wind Farm Area, increasing to 1,874 adults including the 2 km buffer (Table 9-129).

730. For Inch Cape, this would affect an estimated 1,260 adults in the Wind Farm Area, increasing to 2,307 adults including the 2 km buffer (Table 9-129).

731. For Seagreen, this would affect an estimated 1,050 adults in Seagreen A and 1,340 adults in Seagreen B (Table 9-129). No figures were available for a 2 km buffer for the Seagreen projects.

732. For Kincardine OWF, this would affect an assumed 11 adults in the Wind Farm Area and 1 km buffer (Table 9-129). For Forthwind (2 turbines), this would affect an assumed 73 adults in the Wind Farm Area. For Hywind, this would affect an assumed 83 adults in the Wind Farm Area and 1 km buffer.

733. Predicted displacement mortality for puffins in the breeding season, was summed for all projects, applying a mortality rate of 2% as recommended in the Scoping Opinion (Marine Scotland, 2017), (Table 9-130).

Table 9-130: Estimated adult puffin mortality from displacement impacts from Forth and Tay Wind Farms on the key breeding SPAs in the UK waters of the North Sea in the breeding season

Project	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of adults	% of SPA population	No of adults	% of SPA population
NnG	16	0.02	37	0.04
Inch Cape	25	0.03	46	0.05
Seagreen A	21	0.02	21	0.02
Seagreen B	27	0.03	27	0.03
Kincardine OWF [21]	0	0	0	0
Forthwind (2 turbines)	1	0.001	1	0.001
Hywind [21]	2	0.002	2	0.002
Total	92	0.1	134	0.1

734. For NnG, 16 adult puffins displaced from the NnG Wind Farm Area, or 37 adults from the NnG Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-130). This corresponds to between 0.02% and 0.04% of the SPA population within mean maximum foraging range (45,005 pairs), for the Wind Farm Area and 2 km buffer.

735. For Inch Cape, 25 adult puffins displaced from the Wind Farm Area, or 46 adults from the Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-130). This corresponds to between 0.03% and 0.05% of the SPA population within mean maximum foraging range (45,005 pairs), for the Wind Farm Area and 2 km buffer.

736. For Seagreen A, 21 adult puffins displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-130). This corresponds to 0.02% of the SPA population within

[21] Based on Wind Farm Area & 1 km buffer

mean maximum foraging range (45,005 pairs). As no figures were available for a 2 km buffer, the Seagreen A total was repeated for this assessment.

737. For Seagreen B, 27 adult puffins displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-130). This corresponds to 0.03% of the SPA population within mean maximum foraging range (45,005 pairs). As no figures were available for a 2 km buffer, the Seagreen B total was repeated for this assessment.

738. For Kincardine OWF, zero puffins displaced from the Kincardine wind farm and 1 km buffer in the breeding season would suffer mortality as a result (Table 9-130).

739. For Forthwind (2 turbines), one adult puffin displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-130). This corresponds to 0.001% of the SPA population within mean maximum foraging range (45,005 pairs).

740. For Hywind, two adult puffins displaced from the wind farm and 1 km buffer in the breeding season would suffer mortality as a result (Table 9-130). This corresponds to 0.002% of the SPA population within mean maximum foraging range (45,005 pairs).

741. No additional information was available for displacement estimates for the proposed seven additional Forthwind turbines. However, based on the low number of puffins recorded on baseline surveys for the adjacent two turbine project (Arcus, 2015), no significant displacement effects on puffins in the breeding season are considered likely to arise from the seven turbine project. No additional information was available for displacement estimates for the current proposed seven additional Forthwind turbines. No significant displacement effects on puffins in the breeding season were considered likely to arise from these two projects.

742. Cumulative displacement mortality of 92 birds in the combined wind farms corresponds to 0.1% of the SPA adult breeding population (45,005 pairs) (Table 9-8). Cumulative displacement mortality of 134 birds in the combined wind farms and 2 km buffers also corresponds to 0.1% of the SPA adult breeding population.

743. For the surviving displaced adult puffins, there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

744. In comparison, the CEH Displacement model (Searle *et al.*, 2014) estimated that the change in the annual adult puffin survival rate for the Forth Islands SPA for the Forth and Tay projects combined would be -3.32%, based on the homogeneous prey distribution scenario, and +0.04%, based on the heterogeneous prey distribution scenario (Table 9-131). Note that the total figures are larger than the combined sum of the individual projects. This is as presented in Searle *et al.* (2014). The total estimated number ofadults affected was calculated based on the total figure from Searle *et al.* (2014), rather than by summing the project totals.

745. The estimated number of adult puffins involved was calculated by dividing these survival rates by 100, and then multiplying by the Forth Islands SPA population (Table 9-131). Based on the most recent population counts for the Forth Islands SPA (45,005 pairs, or 90,010 birds), the estimated combined change in adult survival rates corresponds to a mortality of 3,181 adult puffins based on the homogeneous prey distribution scenario, or an increase of 38 adult puffins based on the heterogeneous prey distribution scenario.

Table 9-131: Summary of annual puffin displacement mortality for the Forth Islands SPA from the Forth and Tay projects, as presented in the CEH displacement model (Searle *et al.*, 2014)

Project	Change in annual adult survival		SPA population	Estimated number of adults	
	Homogeneous[22]	Heterogeneous[22]		Homogeneous	Heterogeneous
NnG	-0.46	-0.64	45,005 pairs	-414 adults	-576 adults
Inch Cape	-1.44	-0.13	45,005 pairs	-1,296 adults	-117 adults
Seagreen A	-1.15	+0.31	45,005 pairs	-1,035 adults	+279 adults
Seagreen B	-0.17	+0.36	45,005 pairs	-153 adults	+324 adults
Total	-3.32	+0.04	45,005 pairs	-2,988 adults	+36 adults

746. A worst-case annual estimated mortality of 2,988 adult puffins corresponds to a maximum of 3.3% of the Forth Islands SPA breeding population (45,005 pairs), from displacement effects from the Forth and Tay projects and 1 km buffers. This demonstrates that if cumulative adult puffin mortality from displacement was at this level, the impact would be moderately significant at the population level for this SPA, based on the sensitivity and magnitude criteria used in this assessment (Section 9.5.1).

747. However, this is an annual estimate, based on the homogeneous prey distribution scenario, which is considered highly unrealistic, an assumed 60% displacement rate, as well as several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model (Searle *et al.*, 2014).

748. As previously highlighted, Searle *et al.*, (2014) discuss the implications of the assumptions made regarding homogeneous and heterogeneous prey distribution. The report states that both methods rely on assumptions that are unlikely to be realistic in practice, and that considerable caution is needed in cases where bird distributions were inferred from GPS data for small numbers of birds, as was the case with puffin. The modelling for puffins was based on a sample size of seven tagged puffins in 2012, however, it was found that the tagged birds behaved differently from a set of 'control' birds that were not tagged (Harris *et al*., 2012). As a result, displacement model outputs for puffin were considered unreliable by the SNCBs and MSS (Marine Scotland, 2014a).

749. However, as stated previously, there is evidence to indicate that the proportion of auks displaced is related to spacing distance between turbines. Overall, based on the available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%. The estimated mortality from displacement presented in this cumulative assessment is therefore considered to be very precautionary.

750. It is concluded that cumulative displacement mortality impacts arising from the assessed projects will have no effect on the breeding SPA populations of puffins within mean maximum foraging range in the breeding season. The sensitivity of puffins to displacement is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Non-breeding season

751. As recommended in the Scoping Opinion, for guillemot and razorbill, the CIA has incorporated non-breeding season displacement effects from the Forth and Tay wind farms (Inch Cape and Seagreen), apportioning effects as to SPA and non-SPA colonies in the same manner as for the breeding season.

[22] Figures from Table 3.2, Searle *et al.* (2014)

752. The following projects were considered in the assessment of cumulative displacement impacts for these two species, based on recommendations in the Scoping Opinion (Marine Scotland, 2017) (Table 9-132). As the displacement effects and site boundaries are the same for both the 2014 and 2017 Inch Cape and Seagreen projects, only the 2014 consented projects are presented in this section.

Table 9-132: Projects considered for cumulative assessment of displacement impacts in the non-breeding season

Project	Status	Information available
Inch Cape Offshore Wind Farm	Consented (2014)	Published project information available in the public domain.
Seagreen A Offshore Wind Farm	Consented (2014)	Published project information available in the public domain.
Seagreen B Offshore Wind Farm	Consented (2014)	Published project information available in the public domain.

753. As for the breeding season, the cumulative assessment of displacement and barrier effects in the non-breeding season followed the recent SNCB guidance (2017).

754. For Inch Cape, numbers of displaced birds in the non-breeding season were based on seasonal mean peak estimated numbers for the Inch Cape Wind Farm Area and a 2 km buffer, using the season definitions from the Scoping Opinion (Marine Scotland, 2017). This information was circulated by Inch Cape by email on 23/11/2017 and is presented in Appendix 9.4.

755. For Seagreen A & B, numbers of displaced birds in the non-breeding season were based on seasonal mean peak estimated numbers for the Seagreen A & B projects, using the season definitions from the Scoping Opinion (Marine Scotland, 2017). This information was circulated by Seagreen by email on 8/12/2017 and is presented in Appendix 9.4.

756. Displacement and mortality matrices for each species and wind farm project are presented in Appendix 9.4.

Guillemot

757. The non-breeding season for guillemot was defined in the Scoping Opinion as mid-August to March (Marine Scotland, 2017), and in the BDMPS review as August to February (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

758. Four SPAs for breeding guillemots (Buchan Ness to Collieston Coast, Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) were used as the SPA reference population for this assessment in the non-breeding season, as recommended in the Scoping Opinion (Marine Scotland, 2017). Based on SNH figures, the most recent total combined population estimate for these four SPAs is 154,131 birds (Table 9-8).

759. Seasonal peak mean estimated numbers of guillemots for the projects considered in this assessment are presented in Table 9-133. Estimated numbers for NnG were previously presented in Table 9-23. Estimated numbers for Inch Cape and Seagreen A and B are presented in Appendix 9.4.

Table 9-133: Peak mean estimated numbers of guillemots at NnG, Inch Cape and Seagreen A & B, and 2km buffers in the non-breeding season

Project	Wind Farm Area	Wind Farm Area + 2 km buffer
	No of birds	No of birds
NnG	3,890	7,618
Inch Cape	2,009	3,912
Seagreen A	4,027	N/A
Seagreen B	4,450	N/A

760. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of guillemots from the Wind Farm Area (and buffer areas) in the non-breeding season. This assumption was also applied to all projects (Table 9-134).

Table 9-134: Number of displaced guillemots at Forth and Tay Wind Farms and 2km buffers in the non-breeding season

Project	Wind Farm Area	Wind Farm Area + 2 km buffer
	No of birds	No of birds
NnG	2,334	4,571
Inch Cape	1,205	2,347
Seagreen A	2,416	N/A
Seagreen B	2,670	N/A

761. For NnG, assuming 60% of all guillemots were displaced from the Wind Farm Area during the non-breeding season (mid-August to March), this would affect an estimated 2,334 birds (1,281 adults and 1,053 immatures) (Table 9-134) and 4,571 birds (2,509 adults and 2,062 immature birds) including the 2 km buffer. The above age breakdown of 54.8% adult birds in the non-breeding season was based on the PVA stable age structure (Table 9-25).

762. For Inch Cape, this would affect an estimated 1,205 birds, increasing to 2,347 birds including the 2 km buffer (Table 9-134).

763. For Seagreen A, this would affect an estimated 2,416 birds, and 2,670 birds for Seagreen B (Table 9-134). No figures were available for a 2 km buffer for Seagreen A or B.

764. Predicted displacement mortality for guillemots in the non-breeding season, was summed for all projects, applying a mortality rate of 1% as recommended in the Scoping Opinion (Marine Scotland, 2017), (Table 9-135).

Table 9-135: Estimated guillemot mortality from displacement impacts from Forth and Tay Wind Farms on the key breeding SPAs in the UK waters of the North Sea in the non-breeding season

Project	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of SPA population	No of birds	% of SPA population
NnG	23	0.01	46	0.03
Inch Cape	12	0.01	23	0.01
Seagreen A	24	0.02	24	0.02
Seagreen B	27	0.02	27	0.02
Total	86	0.06	120	0.08

765. For NnG, 23 guillemots (adults and immatures) displaced from the NnG Wind Farm Area, or 46 birds from the NnG Wind Farm Area and 2 km buffer in the non-breeding season would suffer mortality as a result (Table 9-135). This corresponds to between 0.01% and 0.03% of the SPA population within mean maximum foraging range (154,131 birds), for the Wind Farm Area and 2 km buffer.

766. For Inch Cape, 12 guillemots displaced from the Wind Farm Area, or 23 adults from the Wind Farm Area and 2 km buffer in the non-breeding season would suffer mortality as a result (Table 9-135). This corresponds to 0.01% of the SPA population within mean maximum foraging range (154,131 birds), for the Wind Farm Area and 2 km buffer.

767. For Seagreen A, 24 guillemots displaced from the Wind Farm Area in the non-breeding season would suffer mortality as a result (Table 9-135). This corresponds to 0.02% of the SPA population within mean maximum foraging range (154,131 birds). As no figures were available for a 2 km buffer, the Seagreen A total was repeated for this assessment.

768. For Seagreen B, 27 guillemots displaced from the Wind Farm Area in the non-breeding season would suffer mortality as a result (Table 9-135). This corresponds to 0.02% of the SPA population within mean maximum foraging range (154,131 birds). As no figures were available for a 2 km buffer, the Seagreen B total was repeated for this assessment.

769. For the surviving displaced guillemots, there would be minimal impact from displacement, as foraging birds are not tied to a breeding colony at this time of year and so would be able to find food outside of the Wind Farm Areas. The assumption of 1% mortality from displacement effects in the non-breeding season is considered an over-estimate, as outside of the breeding season guillemots are no longer limited in their foraging range by having to return to the colony. As birds are free to forage over a wider area, any displacement effects are considerably less likely to have any mortality impact. In addition, this assessment is also precautionary in assuming that birds from other colonies outside of these four SPAs do not occur in the Wind Farm Area during the non-breeding period.

770. In addition, it should be noted that as highlighted in the Scoping Opinion (Marine Scotland, 2017), using the reference population for the SPA breeding population to assess non-breeding season impacts is likely to be extremely precautionary.

771. It is concluded that cumulative displacement mortality impacts arising from the assessed projects will have no effect on the breeding SPA populations of guillemots within mean maximum foraging range in the non-breeding season. The sensitivity of guillemots to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

Razorbill

772. The non-breeding season was defined in the Scoping Opinion as mid-August to March (Table 9-7) (Marine Scotland. However, there are three seasons presented in the BDMPS review for the "non-breeding season", defined as follows: Autumn (August to October), Winter (November and December) and Spring (January to March) (Furness 2015). As the population estimates given in the BDMPS report are the same for the Autumn and Spring periods, these populations have been used as SPA reference populations, and the non-breeding season was taken as mid-August to March, as defined in the Scoping Opinion.

773. Three SPAs for breeding razorbills (Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) were used as the SPA reference population for this assessment in the non-breeding season. Based on SNH figures, the most recent total combined population estimate for these three SPAs is 15,298 birds (Table 9-8).

774. Seasonal peak mean estimated numbers of razorbills for the projects considered in this assessment are presented in Table 9-136. Estimated numbers for NnG were previously presented in Table 9-33. Estimated numbers for Inch Cape and Seagreen A and B are presented in Appendix 9.4.

Table 9-136: Peak mean estimated numbers of razorbills at Forth and Tay Wind Farms, and 2km buffers in the non-breeding season

Project	Wind Farm Area	Wind Farm Area + 2 km buffer
	No of birds	No of birds
NnG	1,404	3,101
Inch Cape	2,154	4,905
Seagreen A	823	N/A
Seagreen B	1,131	N/A

775. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of razorbills from the Wind Farm Area (and buffer areas) in the non-breeding season. This assumption was also applied to all projects (Table 9-137).

Table 9-137: Number of displaced razorbills from Forth and Tay Wind Farms, and 2km buffers in the non-breeding season

Project	Wind Farm Area	Wind Farm Area + 2 km buffer
	No of birds	No of birds
NnG	842	1,861
Inch Cape	1,292	2,943
Seagreen A	494	N/A
Seagreen B	679	N/A

776. For NnG, assuming 60% of all razorbills were displaced from the Wind Farm Area during the non-breeding season (mid-August to March), this would affect an estimated 842 birds (511 adults and 331 immatures) (Table 9-137) and 1,861 birds including the 2 km buffer (1,130 adults and 731 immatures). The above age breakdown of 60.8% adult birds in the non-breeding season was based on the PVA stable age structure (Table 9-35).

777. For Inch Cape, this would affect an estimated 1,292 birds, increasing to 2,943 birds including the 2 km buffer (Table 9-137). For Seagreen A, this would affect an estimated 494 birds, and for Seagreen B this would affect 679 birds (Table 9-137). No figures were available for a 2 km buffer for Seagreen A or B.

778. Predicted displacement mortality for razorbills in the non-breeding season, was summed for all projects, applying a mortality rate of 1% as recommended in the Scoping Opinion (Marine Scotland, 2017), (Table 9-138).

Table 9-138: Estimated razorbill mortality from displacement impacts from Forth and Tay Wind Farms on the key breeding SPAs in the UK waters of the North Sea in the non-breeding season

Project	Wind Farm Area		Wind Farm Area + 2 km buffer	
	No of birds	% of SPA population	No of birds	% of SPA population
NnG	8	0.05	19	0.1
Inch Cape	13	0.08	29	0.2
Seagreen A	5	0.03	5	0.03
Seagreen B	7	0.05	7	0.05
Total	33	0.2	60	0.4

779. For NnG, eight razorbills (adults and immatures) displaced from the NnG Wind Farm Area, or 19 birds from the NnG Wind Farm Area and 2 km buffer in the non-breeding season would suffer mortality as a result (Table 9-138). This corresponds to between 0.05% and 0.1% of the SPA population within mean maximum foraging range (15,298 birds), for the Wind Farm Area and 2 km buffer.

780. For Inch Cape, 13 razorbills displaced from the Wind Farm Area, or 29 adults from the Wind Farm Area and 2 km buffer in the non-breeding season would suffer mortality as a result (Table 9-138). This corresponds to between 0.08% and 0.2% of the SPA population within mean maximum foraging range (15,298 birds), for the Wind Farm Area and 2 km buffer.

781. For Seagreen A, five razorbills displaced from the Wind Farm Area in the non-breeding season would suffer mortality as a result (Table 9-138). This corresponds to 0.03% of the SPA population within mean maximum foraging range (15,298 birds). As no figures were available for a 2 km buffer, the Seagreen A total was repeated for this assessment.

782. For Seagreen B, seven razorbills displaced from the Wind Farm Area in the non-breeding season would suffer mortality as a result (Table 9-138). This corresponds to 0.05% of the SPA population within mean maximum foraging range (15,298 birds). As no figures were available for a 2 km buffer, the Seagreen B total was repeated for this assessment.

783. For the surviving displaced razorbills, there would be minimal impact from displacement, as foraging birds are not tied to a breeding colony at this time of year and so would be able to find food outside of the wind farms. The assumption of 1% mortality from displacement effects in the non-breeding season is considered an over-estimate, as outside of the breeding season razorbills are no longer limited in their foraging range by having to return to the colony. As birds are free to forage over a wider area, any displacement effects are considerably less likely to have any mortality impact. In addition, this assessment is also precautionary in assuming that birds from other colonies outside of these four SPAs do not occur in the Wind Farm Area during the non-breeding period.

784. In addition, it should be noted that as highlighted in the Scoping Opinion (Marine Scotland, 2017), using the reference population for the SPA breeding population to assess non-breeding season impacts is likely to be extremely precautionary.

785. It is concluded that cumulative displacement mortality impacts arising from the assessed projects will have no effect on the breeding SPA populations of razorbills within mean maximum foraging range in the non-breeding season. The sensitivity of razorbills to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

9.9.4.2.2 Cumulative collision risk modelling

786. The Scoping Opinion (Marine Scotland 2017) stated that for gannet and kittiwake, the CIA should estimate non-breeding season collision effects from the Forth and Tay wind farms (Inch Cape and Seagreen) in isolation and cumulatively with other relevant UK wind farms. The cumulative collision assessment for the Forth and Tay Wind Farms is presented below.

787. As outlined previously, there were two scenarios considered for the cumulative collision risk modelling. Scenario One incorporates the design envelopes for the proposed Inch Cape and Seagreen projects as detailed in the Scoping Reports submitted to MS-LOT (ICOL, 2017; Seagreen, 2017). Scenario Two incorporates the consented design envelopes as detailed in the respective project consents.

788. For the Project, the cumulative CRM assessment estimated the number of potential collisions per season for NnG based on 54 turbines (worst-case design scenario). The minimum height for the turbine blades above the sea surface is 32.0 m at mean sea level (MSL) (35 m LAT).

789. For Scenario One, turbine parameters were provided by Inch Cape and Seagreen for their 2017 design scenarios.

790. For Inch Cape, the cumulative CRM assessment was based on using 40 turbines with a rotor diameter of 250m and a minimum rotor height of 27.6m, rather than the design option of 70 turbines with a rotor diameter of 167m, and a minimum rotor height of 32.6m. This was because the 40 turbine option resulted in higher collisions for both gannet and kittiwake.

791. For Seagreen Phase 1, at the time of the cumulative CRM assessment, limited turbine information was available for the new design. The assessment used 120 turbines (the maximum in the Seagreen Scoping Report), a rotor diameter of 167m (based on the NnG worst case) and a minimum rotor height of 27.5m MSL. Full details of the turbine parameters and bird parameters used in the CRM assessment are provided in Appendix 9.3.

792. For Scenario 2, which was based on the 2014 consented projects, CRM figures for Inch Cape and Seagreen were circulated by Marine Scotland in an email dated 11th October 2017. Inch Cape subsequently circulated a revised CRM spreadsheet for the 2014 turbine parameters, based on the seasonal breakdown and avoidance rates advised in the Scoping Opinion (Marine Scotland, 2017), which was used in this assessment. This spreadsheet is included in Appendix 9.3.

793. Two species (gannet and kittiwake) were considered for the cumulative collision risk modelling, on the basis of collision risk modelling for the Project alone. Based on the low estimated collision numbers of herring gull, lesser black-backed gull and great black-backed gull for the Project alone, it was concluded that there would be no significant cumulative collison risk for these three species.

Gannet – breeding season

794. For the purposes of this assessment, all gannets in the breeding season were assumed to be from the Forth Islands SPA, as recommended in the Scoping Opinion (Marine Scotland, 2017). This SPA has therefore been used as the SPA reference population for this assessment in the breeding season (75,259 pairs).

795. Predicted cumulative gannet mortality in the breeding season (mid-March to September) for the Project and additional collisions based on 2017 proposed turbine figures for Inch Cape, Seagreen

Phase 1 (Scenario One) is shown in Table 9-139. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%.

Table 9-139: Estimated cumulative number of gannet collisions in the breeding season for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on Band Model Option 2 and an avoidance rate of 98.9%

	Band Option 2 all birds	% of SPA population	Band Option 2 adults	% of SPA population
NnG (2017)	93 ± 16.9	0.06	91	0.06
Inch Cape (2017)	115 ± 20.9	0.08	112	0.07
Seagreen Phase 1 (2017)	326 ± 59.4	0.2	317	0.2
Total	534 ± 97.2	0.3	520	0.3

796. Based on Scenario One, there will be an estimated 534 gannet collisions (adults and immatures) each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.3% of the breeding population (75,259 pairs) of the key SPA (Forth Islands) (Table 9-8).

797. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 97.5% of aged gannets were adults (Appendix 9.2: Table 3) Based on this, 91 collisions at NnG involved adult birds in the breeding season (Table 9-139). For Inch Cape, 97.1% of aged gannets were adults in the breeding season (Appendix 9.4). Based on this, 112 collisions at Inch Cape involved adult birds in the breeding season. Based on the original application for Seagreen A, the proportion of adults from aged birds in the breeding season was 96.7%, while for Seagreen B, the proportion of adults in the breeding season was 97.8% (Seagreen 2012). This gives an average ratio of 97.3% for both Seagreen projects, which gives a total of 317 adult collisions in the breeding season.

798. Considering only adult gannets, there will be an estimated 520 collisions each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.3% of the breeding population (75,259 pairs) of the key SPA (Forth Islands) (Table 9-8).

799. However, as highlighted in the NnG collision assessment (Section 9.9.2.3), Appendix 9.7 presents maps of breeding adult gannets tracked from the Bass Rock in the breeding season in 2010, 2011, 2012 and 2015. This gannet data was made available by Keith Hamer of the University of Leeds. The maps demonstrate that adult birds travel a considerable distance from the Bass Rock colony, and that the Forth and Tay projects are not a key foraging area for gannets in the breeding season.

800. In addition, the consistent reports of high avoidance of gannets from offshore wind farms in a variety of different study situations in European marine areas indicates that it is likely that this is how breeding birds from the Bass Rock colony will respond to the Forth and Tay projects. Correspondingly, the estimated cumulative number of gannet collisions presented here is therefore considered an over-estimate.

801. Predicted cumulative gannet mortality in the breeding season (mid-March to September) for the Project and additional collisions based on 2014 consented figures (Scenario Two) is shown in Table 9-140. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%.

Table 9-140: Estimated cumulative number of gannet collisions in the breeding season for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on Band Model Option 2 and an avoidance rate of 98.9%

	Band Option 2 all birds	% of SPA population	Band Option 2 adults	% of SPA population
NnG (2017)	93 ± 16.9	0.06	91	0.06
Inch Cape (2014)	384	0.3	375	0.25
Seagreen A (2014)	423	0.3	409	0.27
Seagreen B (2014)	266	0.2	260	0.17
Total	1,166	0.9	1,135	0.75

802. Based on Scenario Two, there will be an estimated 1,166 gannet collisions (adults and immatures) each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.9% of the breeding population (adults) of the key SPA (Forth Islands) (75,259 pairs) (Table 9-8).

803. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 97.5% of aged gannets were adults (Appendix 9.2: Table 3) Based on this, 91 collisions at NnG involved adult birds in the breeding season (Table 9-140). For Inch Cape, 97.7% of aged gannets were adults in the breeding season (Appendix 9.4). Based on this, 375 collisions at Inch Cape involved adult birds in the breeding season. For Seagreen A, the proportion of adults from aged birds in the breeding season was 96.7% (Seagreen 2012), which gives a total of 409 adults in the breeding season. For Seagreen B, the proportion of adults in the breeding season was 97.8% (Seagreen 2012), which gives a total of 260 adult collisions in the breeding season.

804. Considering only adult gannets, there will be an estimated 1,135 collisions each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.75% of the breeding population (75,259 pairs) of the key SPA (Forth Islands) (Table 9-8).

805. Based on either Scenario One or Two, it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B will have no effect on the breeding SPA population of gannets within mean maximum foraging range in the breeding season. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Gannet – non-breeding season

806. The non-breeding season for gannet was defined in the Scoping Opinion as Autumn – October to November; and Spring – December to mid-March (Table 9-7) (Marine Scotland, 2017). In the BDMPS review, the non-breeding season is defined as Autumn migration (September to November), and Spring migration (December to March) (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

807. For the purposes of this assessment, all gannets in the non-breeding season were assumed to be from the Forth Islands SPA, as recommended in the Scoping Opinion (Marine Scotland, 2017). This SPA has therefore been used as the SPA reference population for this assessment in the non-breeding season (75,259 pairs).

808. Predicted cumulative gannet mortality in the autumn (September to November) and spring (December to March) periods of the non-breeding season for the Project and additional collisions based on 2017 proposed turbine figures for Inch Cape, Seagreen Phase 1 (Scenario One) is shown in Table 9-141. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and

an avoidance rate of 98.9%. Estimated collision numbers for NnG were previously presented in Table 9-55 and Table 9-57. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.3.

Table 9-141: Estimated cumulative number of gannet collisions in the autumn and spring periods of the non-breeding season for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on Band Model Option 2 and an avoidance rate of 98.9%

	Band Option 2	% of SPA population
Autumn period of non-breeding season (October to November)		
NnG (2017)	7 ± 1.3	0.004
Inch Cape (2017)	6 ± 1.3	0.003
Seagreen Phase 1 (2017)	19 ± 3.4	0.01
Total	32 ± 6.0	0.02
Spring period of non-breeding season (December to mid-March)		
NnG (2017)	7 ± 1.3	0.003
Inch Cape (2017)	4 ± 0.8	0.002
Seagreen Phase 1 (2017)	20 ± 3.6	0.009
Total	31 ± 5.7	0.01
Combined non-breeding season total		
NnG (2017)	14 ± 2.6	0.007
Inch Cape (2017)	10 ± 2.1	0.005
Seagreen Phase 1 (2017)	39 ± 7.0	0.02
Total	63 ± 11.7	0.03

809. Based on Scenario One, there will be an estimated 32 gannet collisions (adults and immatures) in the autumn period of the non-breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.02% of the North Sea and Channel population from the key SPA (Forth Islands) (191,857 adults and immature birds) in the autumn period of the non-breeding season (Furness, 2015).

810. In the spring period of the non-breeding season, there will be an estimated 31 gannet collisions (adults and immatures), which corresponds to 0.01% of the North Sea and Channel population from the key SPA (Forth Islands) (226,482 adults and immature birds) in the spring period of the non-breeding season (Furness, 2015).

811. Overall, there will be an estimated 63 gannet collisions (adults and immatures), which corresponds to 0.03% of the North Sea and Channel population from the key SPA (Forth Islands) in the autumn and spring periods of the non-breeding season (Furness, 2015). This assessment is precautionary as it assumes that gannets from other colonies outside of the Forth Islands SPA do not occur in the Wind Farm Area during the non-breeding period.

812. Predicted cumulative gannet mortality in the autumn (October to November) and spring (December to mid-March) periods of the non-breeding season for the Project and additional collisions based on 2014 consented figures (Scenario Two) is shown in Table 9-142. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%. Estimated collision

numbers for NnG were previously presented in Table 9-55 and Table 9-57. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.3.

Table 9-142: Estimated cumulative number of gannet collisions in the autumn and spring periods of the non-breeding season for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9%

	Band Option 2	% of SPA population
Autumn period of non-breeding season (October to November)		
NnG (2017)	7 ± 1.3	0.004
Inch Cape (2014)	15	0.008
Seagreen A (2014)	11	0.006
Seagreen B (2014)	6	0.003
Total	39	0.02
Spring period of non-breeding season (December to mid-March)		
NnG (2017)	7 ± 1.3	0.003
Inch Cape (2014)	11	0.005
Seagreen A (2014)	12	0.005
Seagreen B (2014)	6	0.003
Total	36	0.02
Combined non-breeding season total		
NnG (2017)	14 ± 2.6	0.007
Inch Cape (2014)	26	0.013
Seagreen A (2014)	23	0.011
Seagreen B (2014)	12	0.006
Total	75	0.04

813. Based on Scenario Two, there will be an estimated 39 gannet collisions (adults and immatures) in the autumn period of the non-breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.02% of the North Sea and Channel population from the key SPA (191,857 adults and immature birds) in the autumn period of the non-breeding season (Furness, 2015).

814. In the spring period of the non-breeding season, there will be an estimated 36 gannet collisions (adults and immatures), which corresponds to 0.02% of the North Sea and Channel population from the key SPA (226,482 adults and immature birds) in the spring period of the non-breeding season (Furness, 2015).

815. Overall, there will be an estimated 75 gannet collisions (adults and immatures), which corresponds to 0.04% of the North Sea and Channel population from the key SPA (Forth Islands) in the autumn and spring periods of the non-breeding season (Furness, 2015). This assessment is precautionary as it assumes that gannets from other colonies outside of the Forth Islands SPA do not occur in the Wind Farm Area during the non-breeding period.

816. Based on either Scenario One or Two, it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B will have no effect on the breeding SPA population of gannets within mean maximum foraging range in the non-breeding season. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Assessment of cumulative collision mortality throughout the year

817. For Scenario One, predicted cumulative gannet mortality from all seasons from collision impacts as calculated above, was summed for the whole year for the worst case design scenario (54 turbines) (Table 9-143).

Table 9-143: Estimated cumulative number of gannet collisions throughout the year for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9%

	Band Option 2	% of SPA population
Breeding season total (mid-March to September) - Adults		
NnG (2017)	91	0.06
Inch Cape (2017)	112	0.07
Seagreen Phase 1 (2017)	317	0.2
Total	520	0.33
Combined non-breeding season total (October to mid-March)		
NnG (2017)	14 ± 2.6	0.007
Inch Cape (2017)	10 ± 2.1	0.005
Seagreen Phase 1 (2017)	39 ± 7.0	0.02
Total	63 ± 11.7	0.03
Annual total		
NnG (2017)	105	0.067
Inch Cape (2017)	122	0.075
Seagreen Phase 1 (2017)	356	0.22
Total	583	0.4

818. Based on Scenario One, there will be an estimated 583 gannet collisions (adults and immatures) throughout the year, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.4% of the North Sea and Channel population from the key SPA (Forth Islands) based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015). This assessment is precautionary as it assumes that gannets from other colonies outside of the Forth Islands SPA do not occur in the Wind Farm Area during the non-breeding period.

819. For Scenario Two, predicted cumulative gannet mortality from all seasons from collision impacts as calculated above, was summed for the whole year for the worst case scenario (54 turbines) (Table 9-144).

Table 9-144: Estimated cumulative number of gannet collisions throughout the year for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9%

	Band Option 2	% of SPA population
Breeding season total (mid-March to September) - Adults		
NnG (2017)	91	0.06
Inch Cape (2014)	375	0.25
Seagreen A (2014)	409	0.27
Seagreen B (2014)	260	0.17
Total	1,135	0.75
Combined non-breeding season total (October to mid-March)		
NnG (2017)	14 ± 2.6	0.007
Inch Cape (2014)	26	0.013
Seagreen A (2014)	23	0.011
Seagreen B (2014)	12	0.006
Total	75	0.04
Annual total		
NnG (2017)	105	0.067
Inch Cape (2014)	401	0.263
Seagreen A (2014)	432	0.281
Seagreen B (2014)	272	0.176
Total	1,210	0.8

820. Based on Scenario Two, there will be an estimated 1,210 gannet collisions (adults and immatures) throughout the year, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.8% of the North Sea and Channel population from the key SPA (Forth Islands) based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015). This assessment is precautionary as it assumes that gannets from other colonies outside of the Forth Islands SPA do not occur in the Wind Farm Area during the non-breeding period.

821. Based on either Scenario One or Two, it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B will have no effect on the breeding SPA population of gannets within mean maximum foraging range throughout the year. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Kittiwake – breeding season

822. The four SPAs considered for kittiwake for the cumulative assessment were Buchan Ness to Collieston Coast SPA, Fowlsheugh SPA, Forth Islands SPA and St Abb's Head to Fast Castle SPA. Based on SNH figures, the most recent total combined breeding population estimate for these SPAs is 29,134 pairs (Table 9-8).

823. Predicted cumulative kittiwake mortality in the breeding season (mid-April to August) for the Project and additional collisions based on 2017 proposed turbine figures for Inch Cape, Phase 1 (Scenario One) is shown in Table 9-145. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%. Estimated collision numbers for NnG were previously presented in Table 9-63. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.3.

Table 9-145: Estimated cumulative number of kittiwake collisions in the breeding season for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on Band Model Option 2 and an avoidance rate of 98.9%

	Band Option 2 all birds	% of SPA population	Band Option 2 adults	% of SPA population
NnG (2017)	9 ± 1.6	0.02	8	0.01
Inch Cape (2017)	43 ± 7.9	0.07	39	0.07
Seagreen Phase 1 (2017)	119 ± 21.7	0.2	116	0.2
Total	171 ± 31.2	0.3	163	0.3

824. Based on Scenario One, there will be an estimated 171 kittiwake collisions (adults and immatures) each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.3% of the breeding population (adults) for the four key SPAs (29,134 pairs), based on breeding colony counts (Table 9-8).

825. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 93.2% of aged kittiwakes were adults (Appendix 9.2: Table 5) Based on this, eight collisions NnG involved adult birds in the breeding season (Table 9-145). For Inch Cape, 91.3% of aged kittiwakes were adults in the breeding season (Appendix 9.4). Based on this, 39 collisions at Inch Cape involved adult birds in the breeding season. Based on the original application for Seagreen, as 97.2% of all birds recorded on baseline surveys in Seagreen B in June were adults (Seagreen 2012), this ratio was applied to the above figures for Seagreen Phase 1. This gave a total of 116 adult collisions for Seagreen Phase 1 in the breeding season.

826. Considering only adult kittiwakes, there will be an estimated 163 collisions each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.3% of the breeding population (adults) for the four key SPAs (29,134 pairs), based on breeding colony counts (Table 9-8).

827. Predicted cumulative kittiwake mortality in the breeding season (mid-April to August) for the Project and additional collisions based on 2014 consented figures (Scenario Two) is shown in Table 9-146. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%. Estimated collision numbers for NnG were previously presented in Table 9-63. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.3.

Table 9-146: Estimated cumulative number of kittiwake collisions in the breeding season for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on Band Model Option 2 and an avoidance rate of 98.9% ± 2 SD

	Band Option 2 all birds	% of SPA population	Band Option 2 adults	% of SPA population
NnG (2017)	9 ± 1.6	0.02	8	0.01
Inch Cape (2017)	149	0.3	136	0.2
Seagreen A (2014)	126	0.2	122	0.2
Seagreen B (2014)	135	0.2	131	0.2
Total	419	0.7	397	0.6

828. Based on Scenario Two, there will be an estimated 419 kittiwake collisions (adults and immatures) each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.7% of the breeding population (adults) for the four key SPAs (29,134 pairs), based on breeding colony counts (Table 9-8).

829. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 93.2% of aged kittiwakes were adults (Appendix 9.2: Table 5) Based on this, eight collisions NnG involved adult birds in the breeding season (Table 9-146). For Inch Cape, 91.3% of aged kittiwakes were adults in the breeding season (Appendix 9.4). Based on this, 136 collisions at Inch Cape involved adult birds in the breeding season. For Seagreen, as 97.2% of all birds recorded on baseline surveys in Seagreen B in June were adults (Seagreen 2012), this ratio was applied to the above figures for both Seagreen projects. This gave a total of 122 adult collisions for Seagreen A and 131 adults for Seagreen B in the breeding season.

830. Considering only adult kittiwakes, there will be an estimated 397 collisions each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.6% of the breeding population (adults) for the four key SPAs (29,134 pairs), based on breeding colony counts (Table 9-8).

831. Based on either Scenario One or Two, it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B will have no effect on the breeding SPA population of kittiwakes within mean maximum foraging range in the breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Kittiwake – non-breeding season

832. The non-breeding season for kittiwake was defined in the Scoping Opinion as Autumn – September to December; and Spring – January to mid-April (Table 9-7) (Marine Scotland, 2017). In the BDMPS review, the non-breeding season was defined as Autumn migration (August to December), and Spring migration (January to April) (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

833. Predicted cumulative kittiwake mortality in the autumn and spring periods of the non-breeding season for the Project and additional collisions based on 2017 proposed turbine figures for Inch Cape and Seagreen Phase 1 (Scenario One) is shown in Table 9-147. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%. Estimated collision numbers for NnG were previously presented in Table 9-63. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.3.

Table 9-147: Estimated cumulative number of kittiwake collisions in the autumn and spring periods of the non-breeding season for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on Band Model Option 2 and an avoidance rate of 98.9%

	Band Option 2	% of SPA population
Autumn period of non-breeding season (September to December)		
NnG (2017)	17 ± 3.1	0.03
Inch Cape (2017)	30 ± 5.5	0.06
Seagreen Phase 1 (2017)	151 ± 27.4	0.3
Total	198 ± 36.0	0.4
Spring period of non-breeding season (January to mid-April)		
NnG (2017)	2 ± 0.3	0.004
Inch Cape (2017)	6 ± 1.2	0.01
Seagreen Phase 1 (2017)	80 ± 14.5	0.2
Total	88 ± 16.0	0.2
Combined non-breeding season total		
NnG (2017)	19 ± 3.4	0.034
Inch Cape (2017)	36 ± 6.7	0.07
Seagreen Phase 1 (2017)	231 ± 41.9	0.5
Total	286 ± 52.0	0.6

834. Based on Scenario One, there will be an estimated 198 kittiwake collisions (adults and immatures) in the autumn period of the non-breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.4% of the North Sea population from the key SPAs (54,039 adults and immature birds) in the autumn period of the non-breeding season (Furness, 2015) (Table 9-18).

835. In the spring period of the non-breeding season, there will be an estimated 88 kittiwake collisions (adults and immatures), which corresponds to 0.2% of the North Sea population from the key SPAs (49,044 adults and immature birds) in the spring period of the non-breeding season (Furness, 2015) (Table 9-21).

836. Overall, there will be an estimated 286 kittiwake collisions (adults and immatures), which corresponds to 0.6% of the North Sea population from the key SPAs in the autumn and spring periods of the non-breeding season (Furness, 2015). This assessment is precautionary as it assumes that kittiwakes from other colonies outside of these four SPAs do not occur in the Wind Farm Area during the non-breeding period.

837. Based on Scenario One (2017 design scenarios), it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen Phase 1 will have no effect on the breeding SPA population of kittiwakes within mean maximum foraging range in the non-breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

838. Predicted cumulative kittiwake mortality in the autumn and spring periods of the non-breeding season for the Project and additional collisions based on 2014 consented figures (Scenario Two) is

shown in Table 9-148. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%. Estimated collision numbers for NnG were previously presented in Table 9-63. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.3.

Table 9-148: Estimated cumulative number of kittiwake collisions in the autumn and spring periods of the non-breeding season for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on Band Model Option 2 and an avoidance rate of 98.9%

	Band Option 2	% of SPA population
Autumn period of non-breeding season (September to December)		
NnG (2017)	17 ± 3.1	0.03%
Inch Cape (2014)	80	0.1
Seagreen A (2014)	217	0.4
Seagreen B (2014)	123	0.2
Total	437	0.7
Spring period of non-breeding season (January to mid-April)		
NnG (2017)	2 ± 0.3	0.004%
Inch Cape (2014)	18	0.04
Seagreen A (2014)	78	0.2
Seagreen B (2014)	104	0.2
Total	202	0.4
Combined non-breeding season total		
NnG (2017)	19 ± 3.4	0.034
Inch Cape (2014)	98	0.14
Seagreen A (2014)	295	0.6
Seagreen B (2014)	227	0.4
Total	639	1.2

839. Based on Scenario Two, there will be an estimated 437 kittiwake collisions (adults and immatures) in the autumn period of the non-breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.7% of the North Sea population from the key SPAs (54,039 adults and immature birds) in the autumn period of the non-breeding season (Furness, 2015) (Table 9-18).

840. In the spring period of the non-breeding season, there will be an estimated 202 kittiwake collisions (adults and immatures), which corresponds to 0.4% of the North Sea population from the key SPAs (49,044 adults and immature birds) in the spring period of the non-breeding season (Furness, 2015) (Table 9-21).

841. Overall, there will be an estimated 639 kittiwake collisions (adults and immatures), which corresponds to 1.2% of the North Sea population from the key SPAs in the autumn and spring periods of the non-breeding season, based on the BDMPS review (Furness, 2015). This assessment is

precautionary as it assumes that kittiwakes from other colonies outside of these four SPAs do not occur in the Wind Farm Area during the non-breeding period.

842. Based on Scenario Two (2014 consent scenarios), it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B will have a moderate effect on the breeding SPA population of kittiwakes within mean maximum foraging range in the non-breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be low. The significance of this impact is therefore assessed to be **moderate** and **significant** in EIA terms.

Assessment of cumulative collision mortality throughout the year

843. For Scenario One, predicted cumulative kittiwake mortality from all seasons from collision impacts as calculated above, was summed for the whole year for the worst case scenario (54 turbines) (Table 9-149).

Table 9-149: Estimated cumulative number of kittiwake collisions throughout the year for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9%

	Band Option 2	% of SPA population
Breeding season total (mid-April to August) – Adults		
NnG (2017)	8	0.01
Inch Cape (2017)	39	0.07
Seagreen Phase 1 (2017)	116	0.2
Total	163	0.3
Combined non-breeding season total (September to mid-April)		
NnG (2017)	19 ± 3.4	0.034
Inch Cape (2017)	36 ± 6.7	0.07
Seagreen Phase 1 (2017)	231 ± 41.9	0.5
Total	286 ± 52.0	0.6
Annual total		
NnG (2017)	27	0.044
Inch Cape (2017)	75	0.14
Seagreen Phase 1 (2017)	347	0.7
Total	449	0.9

844. Based on Scenario One, there will be an estimated 449 kittiwake collisions (adults and immatures) throughout the year, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.9% of the North Sea population from the key SPAs based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015). This assessment is precautionary as it assumes that kittiwakes from other colonies outside of these four SPAs do not occur in the Wind Farm Area during the non-breeding period.

845. Based on Scenario One (2017 design scenarios), it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen Phase 1 will have no effect on the breeding SPA population of kittiwakes within mean maximum foraging range throughout the year. The sensitivity of kittiwakes

to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

846. For Scenario Two, predicted cumulative kittiwake mortality from all seasons from collision impacts as calculated above, was summed for the whole year for the worst case scenario (54 turbines) (Table 9-150).

Table 9-150: Estimated cumulative number of kittiwake collisions throughout the year for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9%

	Band Option 2	% of SPA population
Breeding season total (mid-April to August) - Adults		
NnG (2017)	8	0.01
Inch Cape (2014)	136	0.2
Seagreen A (2014)	122	0.2
Seagreen B (2014)	131	0.2
Total	397	0.6
Combined non-breeding season total (September to mid-April)		
NnG (2017)	19 ± 3.4	0.034
Inch Cape (2014)	98	0.14
Seagreen A (2014)	295	0.6
Seagreen B (2014)	227	0.4
Total	639	1.2
Annual total		
NnG (2017)	27	0.044
Inch Cape (2014)	234	0.34
Seagreen A (2014)	417	0.8
Seagreen B (2014)	358	0.6
Total	1,036	1.8

847. Based on Scenario Two, there will be an estimated 1,036 kittiwake collisions (adults and immatures) throughout the year, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 1.8% of the North Sea population from the key SPAs based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015). This assessment is precautionary as it assumes that kittiwakes from other colonies outside of these four SPAs do not occur in the Wind Farm Area during the non-breeding period.

848. Based on Scenario Two (2014 consent scenarios), it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B will have a moderate effect on the breeding SPA population of kittiwakes within mean maximum foraging range throughout the year. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be low. The significance of this impact is therefore assessed to be **moderate** and **significant** in EIA terms.

Cumulative collisions for the Project, the other Forth and Tay wind farms and other UK offshore wind farms in the North Sea and English Channel

849. The Scoping Opinion (Marine Scotland, 2017) stated that for gannet and kittiwake, the CIA should estimate non-breeding season collision effects from the Forth and Tay wind farms (Inch Cape and Seagreen) in isolation and in combination with the other UK wind farms. The cumulative collision assessment for the Forth and Tay Wind Farms together with other UK offshore wind farms is presented below.

850. Figures for NnG are taken from this assessment, and are based on the worst-case design scenario (54 turbines). As outlined previously, there were two scenarios considered for Forth and Tay projects. Scenario one incorporates the 2017 design envelopes for the proposed Inch Cape and Seagreen projects (ICOL, 2017; Seagreen, 2017), and Scenario two incorporates the consented 2014 design envelopes. This assessment is based on the worst-case design scenario from 2014.

Cumulative non-breeding season assessment for gannet

851. This part of the assessment is based on the approach recommended by SNH that was recently circulated by Marine Scotland (SNH, 2017). This approach was based on estimated turbine numbers from the recent Headroom Estimates report (Crown Estate 2017), and recommended applying factors to any change in turbine number published elsewhere e.g. changes made during the PINS process, to reduce the estimated number of collisions accordingly.

852. A slightly different approach was used for this part of the assessment. As the Crown Estate report included a review of changes in proposed/built project turbine numbers, based on best available information e.g. developer websites, this was used as a basis for revising collision estimates. However, the Crown Estate report only presented estimated annual collisions, whereas estimated collisions for the non-breeding season were required for this part of the assessment.

853. The draft Hornsea 3 HRA report (Dong Energy, 2017), presents both annual and breeding season collision estimates for the UK North Sea and English Channel Wind Farms used in this assessment. The annual totals were compared to both the original and revised estimates in the Crown Estate report. Where there was good reason given in the Crown Estate report, e.g. information on likely turbine number from the developer websites, the revised Crown Estate estimate was selected. Where there was no information on changes in project number, the most conservative estimate from the three data sources was selected. The selected collision estimate for gannet for each project is highlighted in bold in Table 9-151.

Table 9-151: Comparison of estimated number of gannet collisions in the non-breeding season for UK North Sea and English Channel Wind Farms used in this assessment

Project	Original TCE report estimate	Revised TCE estimate	Hornsea 3 HRA estimate	Reason for selection
East Anglia 3	**49**	49	48	TCE report more conservative
East Anglia 1	213	**96**	68	Revised TCE estimate used. SPR planning building 102 turbines, not 240
Hornsea 3	-	-	**15**	Hornsea 3 HRA estimate only one available
Blyth Demonstrator	8	8	**9**	H3 HRA more conservative
Dogger Creke Beck A&B	32	32	**121**	H3 HRA more conservative
Dogger Teeside A&B	31	31	**136**	H3 HRA more conservative

Project	Original TCE report estimate	Revised TCE estimate	Hornsea 3 HRA estimate	Reason for selection
Dudgeon	80	**37**	37	Revised TCE estimate used. Up to 67 turbines, not 168
Hornsea 1	66	**38**	38	Revised TCE estimate used. Up to 174 turbines, not 240
Hornsea 2	**27**	27	18	TCE report more conservative
Humber Gateway	5	**2**	4	Revised TCE estimate used. 73 turbines built, not 83
Lincs	**5**	5	5	No difference
Race Bank	50	**26**	50	Revised TCE estimate used. Dong website says up to 91 turbines, not 206
Sheringham Shoal	17	17	**18**	H3 HRA estimate more conservative
Teeside	7	**5**	7	Revised TCE estimate used. Built 27 turbines, not 30
Triton Knoll	121	**39**	122	Revised TCE estimate used. 100 turbines likely, not 288
Westermost Rough	**1**	1	1	No difference
Aberdeen demonstrator	**9**	9	9	No difference
Beatrice	96	**58**	42	Revised TCE estimate used. Up to 84 turbines, not 125
Galloper	62	**27**	62	Revised TCE estimate used. Up to 56 turbines, not 140
Greater Gabbard	**28**	28	28	No difference
Kentish Flats	**3**	3	3	No difference
London Array	6	**2**	6	Revised TCE estimate used. Up to 175 turbines, not 341
Moray Firth 1	**125**	125	18	TCE report more conservative
Thanet	**1**	1	1	No difference
Rampion	102	**70**	70	Revised TCE estimate used. Up to 116 turbines, not 175

854. To calculate non-breeding gannet collisions, the selected annual gannet collision estimate for each project was multiplied by the ratio of breeding to annual gannet collision estimates from the draft Hornsea 3 HRA (Table 9-152).

Table 9-152: Estimated number of gannet collisions in the non-breeding season for UK North Sea and English Channel Wind Farms used in this assessment

Project	Annual collision estimate	Hornsea H3 non-breeding estimates	Hornsea H3 annual estimate	Hornsea H3 ratio	Estimated non-breeding season collisions
East Anglia 3	49	35	48	0.73	36
East Anglia 1	96	66	68	0.97	93
Hornsea 3	15	9	15	0.6	9
Blyth Demonstrator	9	5	9	0.56	5
Dogger Creke Beck A&B	121	80	121	0.66	80
Dogger Teeside A&B	136	68	136	0.5	68
Dudgeon	37	27	37	0.73	27
Hornsea 1	38	31	38	0.82	31
Hornsea 2	27	13	18	0.72	20
Humber Gateway	2	2	4	0.5	1
Lincs	5	3	5	0.6	3
Race Bank	26	16	50	0.32	8
Sheringham Shoal	18	4	18	0.22	4
Teeside	5	2	7	0.29	1
Triton Knoll	39	95	122	0.78	30
Westermost Rough	1	1	1	1	1
Aberdeen demonstrator	9	5	9	0.56	5
Beatrice	58	25	42	0.6	35
Galloper	27	44	62	0.71	19
Greater Gabbard	28	14	28	0.5	14
Kentish Flats	3	0	3	0	0
London Array	2	3	6	0.5	1

Project	Annual collision estimate	Hornsea H3 non-breeding estimates	Hornsea H3 annual estimate	Hornsea H3 ratio	Estimated non-breeding season collisions
Moray Firth 1	125	6	18	0.33	42
Thanet	1	0	1	0	0
Rampion	70	70	70	1	70
Total	947	624	936	-	603

855. As a sense check comparing this revised approach to the method recommended by SNH (SNH, 2017), the non-breeding season collision estimates for gannet at East Anglia 1 and Beatrice were compared to the worked example provided in the SNH guidance (Table 9-153). Estimates were very similar.

Table 9-153: Comparison of estimated number of gannet collisions in the non-breeding season for two UK North Sea Wind Farms based on SNH method and revised SNH method used in this assessment

Project	Estimated collisions SNH method	Estimated collisions Revised SNH method
Beatrice	35.4	35
East Anglia 1	93.7	93

856. The draft Hornsea 3 HRA provides a breakdown of the non-breeding season into the post-breeding season (autumn) and the pre-breeding season (spring) for the offshore UK wind farms used in this assessment. The estimated collisions for the non-breeding season from Table 9-152 (final column) were therefore divided using the same ratio, to get the estimated number of collisions in the autumn and spring periods (Table 9-154).

Table 9-154: Estimated number of gannet collisions in the autumn and spring periods of the non-breeding season for UK North Sea and English Channel Wind Farms used in this assessment

Project	Estimated non-breeding season collisions	Hornsea 3 Autumn estimates	Hornsea 3 non-breeding estimates	Hornsea H3 non-breeding ratio	Estimated autumn collisions	Estimated spring collisions
East Anglia 3	36	33	35	0.94	34	2
East Anglia 1	93	64	66	0.97	90	3
Hornsea 3	9	3	9	0.33	3	6
Blyth Demonstrator	5	2	5	0.4	2	3
Dogger Creke Beck A&B	80	48	80	0.6	48	32
Dogger Teeside A&B	68	34	68	0.5	34	34
Dudgeon	27	18	27	0.67	18	9

Project	Estimated non-breeding season collisions	Hornsea 3 Autumn estimates	Hornsea 3 non-breeding estimates	Hornsea H3 non-breeding ratio	Estimated autumn collisions	Estimated spring collisions
Hornsea 1	31	18	31	0.58	18	13
Hornsea 2	20	9	13	0.69	14	6
Humber Gateway	1	1	2	0.5	0.5	0.5
Lincs	3	1	3	0.33	1	2
Race Bank	8	12	16	0.75	6	2
Sheringham Shoal	4	3	4	0.75	3	1
Teeside	1	2	2	1	1	0
Triton Knoll	30	64	95	0.67	20	10
Westermost Rough	1	0	1	0	0	1
Aberdeen demonstrator	5	5	5	1	5	0
Beatrice	35	21	25	0.84	29	6
Galloper	19	31	44	0.7	13	6
Greater Gabbard	14	9	14	0.64	9	5
Kentish Flats	0	0	0	0	0	0
London Array	1	1	3	0.33	0	1
Moray Firth 1	42	5	6	0.83	35	7
Thanet	0	0	0	0	0	0
Rampion	70	35	70	0.5	35	35
Total	603	-	624	-	419	185

857. Following the SNH approach, the next stage is to adjust the total collisions attributed to the Forth Islands SPA for each period (autumn and spring) by the age proportions and the proportional representation of each SPA colony within the BDMPS for that period. As recommended in the SNH approach, the ratio of adult (55%) to immature birds (45%) was taken from the stable age structure percentages as reported in Furness (2015.)

858. The proportion of adult and immature gannets from the SPA colony within the BDMPS for the autumn and spring periods was calculated by dividing the estimated number of adult and immature gannets from the Forth Islands SPA by the total estimated BDMPS population (Table 9-155).

Table 9-155: Proportion of adult and immature birds from Forth Islands SPA in the North Sea and English Channel in the autumn and spring periods of the non-breeding season

SPA	Estimated number of adults in UK N Sea & Channel in autumn period	Estimated number of immature birds in UK N Sea & Channel in autumn period	Estimated number of adults in UK N Sea & Channel in spring period	Estimated number of immature birds in UK N Sea & Channel in spring period
Forth Islands SPA	110,964	80,893	77,675	35,952
Total BDMPS	242,340	213,959	163,701	84,684
Proportion from SPA	0.46	0.38	0.47	0.42

859. Estimated gannet collisions for the autumn period of the non-breeding season for NnG and the other Forth and Tay projects based on the worst-case option (Scenario Two – NnG 2017 and 2014 consents for Inch Cape and Seagreen A and B) (Table 9-142), were also included with the autumn period non-breeding season estimated collisions for the UK North Sea wind farms (Table 9-156).

860. The proportions of adults and immature birds were then used to calculate the numbers of adult gannets from the Forth Islands SPA involved in collisions at each of the UK North Sea and English Channel offshore wind farms in the autumn period of the non-breeding season (Table 9-156). This was repeated for immature birds in the autumn period (Table 9-157).

861. As the seasonal period definitions used in Furness (2015) do not match the definitions in the SNH guidance, the approach recommended by SNH is to assume a flat rate of collisions during the season, and to recalculate according to the relative lengths of the periods. For gannet, the autumn post breeding period in the BDMPS report (Furness 2015) is 12 weeks from September to November. The SNH recommendation is from October to November, which is 30 days less than the BDMPS autumn period. As such, a proportionate recalculation based on the relative length of time in the two periods is required. Therefore 0.67 multiplied by the number of collisions in autumn is the final value required. This recalculation is shown in the final columns of Table 9-156 and Table 9-157.

Table 9-156: Estimated cumulative number of adult gannets from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea and English Channel Wind Farms in the autumn period of the non-breeding season

Project	Estimated autumn collisions (all ages)	Proportion of adult birds	Proportion from SPA	Number of adults from Forth Islands SPA	Corrected number of adults from Forth Islands SPA
NnG (2017)	7	0.55	0.46	2	1
Inch Cape (2014)	15	0.55	0.46	4	3
Seagreen A (2014)	11	0.55	0.46	3	2
Seagreen B (2014)	6	0.55	0.46	2	1
East Anglia 3	34	0.55	0.46	9	6
East Anglia 1	90	0.55	0.46	23	15

Project	Estimated autumn collisions (all ages)	Proportion of adult birds	Proportion from SPA	Number of adults from Forth Islands SPA	Corrected number of adults from Forth Islands SPA
Hornsea 3	3	0.55	0.46	1	1
Blyth Demonstrator	2	0.55	0.46	1	0
Dogger Creke Beck A&B	48	0.55	0.46	12	8
Dogger Teeside A&B	34	0.55	0.46	9	6
Dudgeon	18	0.55	0.46	5	3
Hornsea 1	18	0.55	0.46	5	3
Hornsea 2	14	0.55	0.46	4	2
Humber Gateway	0.5	0.55	0.46	0	0
Lincs	1	0.55	0.46	0	0
Race Bank	6	0.55	0.46	2	1
Sheringham Shoal	3	0.55	0.46	1	1
Teeside	1	0.55	0.46	0	0
Triton Knoll	20	0.55	0.46	5	3
Westermost Rough	0	0.55	0.46	0	0
Aberdeen demonstrator	5	0.55	0.46	1	1
Beatrice	29	0.55	0.46	7	5
Galloper	13	0.55	0.46	3	2
Greater Gabbard	9	0.55	0.46	2	2
Kentish Flats	0	0.55	0.46	0	0
London Array	0	0.55	0.46	0	0
Moray Firth 1	35	0.55	0.46	9	6
Thanet	0	0.55	0.46	0	0
Rampion	35	0.55	0.46	9	6
Total	**457.5**	-	-	**119**	**78**

Table 9-157: Estimated cumulative number of immature gannets from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea and English Channel Wind Farms in the autumn period of the non-breeding season

Project	Estimated autumn collisions (all ages)	Proportion of immature birds	Proportion from SPA	Number of immature birds from Forth Islands SPA	Corrected number of immature birds from Forth Islands SPA
NnG (2017)	7	0.45	0.38	1	1
Inch Cape (2014)	15	0.45	0.38	3	2
Seagreen A (2014)	11	0.45	0.38	2	1
Seagreen B (2014)	6	0.45	0.38	1	1
East Anglia 3	34	0.45	0.38	6	4
East Anglia 1	90	0.45	0.38	15	10
Hornsea 3	3	0.45	0.38	1	0
Blyth Demonstrator	2	0.45	0.38	0	0
Dogger Creke Beck A&B	48	0.45	0.38	8	5
Dogger Teeside A&B	34	0.45	0.38	6	4
Dudgeon	18	0.45	0.38	3	2
Hornsea 1	18	0.45	0.38	3	2
Hornsea 2	14	0.45	0.38	2	2
Humber Gateway	0.5	0.45	0.38	0	0
Lincs	1	0.45	0.38	0	0
Race Bank	6	0.45	0.38	1	1
Sheringham Shoal	3	0.45	0.38	1	0
Teeside	1	0.45	0.38	0	0
Triton Knoll	20	0.45	0.38	3	2
Westermost Rough	0	0.45	0.38	0	0
Aberdeen demonstrator	5	0.45	0.38	1	1
Beatrice	29	0.45	0.38	5	3
Galloper	13	0.45	0.38	2	1
Greater Gabbard	9	0.45	0.38	2	1

Project	Estimated autumn collisions (all ages)	Proportion of immature birds	Proportion from SPA	Number of immature birds from Forth Islands SPA	Corrected number of immature birds from Forth Islands SPA
Kentish Flats	0	0.45	0.38	0	0
London Array	0	0.45	0.38	0	0
Moray Firth 1	35	0.45	0.38	6	4
Thanet	0	0.45	0.38	0	0
Rampion	35	0.45	0.38	6	4
Total	**457.5**	-	-	**78**	**51**

862. This was also repeated for adults (Table 9-158) and immature birds (Table 9-159) in the spring period.

863. In Spring, the BDMPS report (Furness 2015) uses a 16 week period – December to March, whereas the SNH recommended period is January to mid-March – equivalent to a 10 week period. A proportionate recalculation based on relative length of time in the two periods is required. Therefore 10/16 or 0.625 multiplied by the number of collisions in spring is the final value required. This recalculation is shown in the final columns of Table 9-158 and Table 9-159.

Table 9-158: Estimated cumulative number of adult gannets from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea and English Channel Wind Farms in the spring period of the non-breeding season

Project	Estimated spring collisions (all ages)	Proportion of adult birds	Proportion from SPA	Number of adults from Forth Islands SPA	Corrected number of adults from Forth Islands SPA
NnG (2017)	7	0.55	0.47	2	1
Inch Cape (2014)	11	0.55	0.47	4	3
Seagreen A (2014)	12	0.55	0.47	3	2
Seagreen B (2014)	6	0.55	0.47	2	1
East Anglia 3	2	0.55	0.47	1	0
East Anglia 1	3	0.55	0.47	1	1
Hornsea 3	6	0.55	0.47	2	1
Blyth Demonstrator	3	0.55	0.47	1	1
Dogger Creke Beck A&B	32	0.55	0.47	8	6
Dogger Teeside A&B	34	0.55	0.47	9	6
Dudgeon	9	0.55	0.47	2	2

Project	Estimated spring collisions (all ages)	Proportion of adult birds	Proportion from SPA	Number of adults from Forth Islands SPA	Corrected number of adults from Forth Islands SPA
Hornsea 1	13	0.55	0.47	3	2
Hornsea 2	6	0.55	0.47	2	1
Humber Gateway	0.5	0.55	0.47	0	0
Lincs	2	0.55	0.47	1	0
Race Bank	2	0.55	0.47	1	0
Sheringham Shoal	1	0.55	0.47	0	0
Teeside	0	0.55	0.47	0	0
Triton Knoll	10	0.55	0.47	3	2
Westermost Rough	1	0.55	0.47	0	0
Aberdeen demonstrator	0	0.55	0.47	0	0
Beatrice	6	0.55	0.47	2	1
Galloper	6	0.55	0.47	2	1
Greater Gabbard	5	0.55	0.47	1	1
Kentish Flats	0	0.55	0.47	0	0
London Array	1	0.55	0.47	0	0
Moray Firth 1	7	0.55	0.47	2	1
Thanet	0	0.55	0.47	0	0
Rampion	35	0.55	0.47	9	6
Total	**220.5**	-	-	**61**	**39**

Table 9-159: Estimated cumulative number of immature gannets from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea and English Channel Wind Farms in the spring period of the non-breeding season

Project	Estimated spring collisions (all ages)	Proportion of immature birds	Proportion from SPA	Number of immature birds from Forth Islands SPA	Corrected number of immature birds from Forth Islands SPA
NnG (2017)	7	0.45	0.42	1	1
Inch Cape (2014)	11	0.45	0.42	2	1
Seagreen A (2014)	12	0.45	0.42	2	1
Seagreen B (2014)	6	0.45	0.42	1	1
East Anglia 3	2	0.45	0.42	0	0
East Anglia 1	3	0.45	0.42	1	0
Hornsea 3	6	0.45	0.42	1	1
Blyth Demonstrator	3	0.45	0.42	1	0
Dogger Creke Beck A&B	32	0.45	0.42	5	4
Dogger Teeside A&B	34	0.45	0.42	6	4
Dudgeon	9	0.45	0.42	2	1
Hornsea 1	13	0.45	0.42	2	1
Hornsea 2	6	0.45	0.42	1	1
Humber Gateway	0.5	0.45	0.42	0	0
Lincs	2	0.45	0.42	0	0
Race Bank	2	0.45	0.42	0	0
Sheringham Shoal	1	0.45	0.42	0	0
Teeside	0	0.45	0.42	0	0
Triton Knoll	10	0.45	0.42	2	1
Westermost Rough	1	0.45	0.42	0	0
Aberdeen demonstrator	0	0.45	0.42	0	0
Beatrice	6	0.45	0.42	1	1
Galloper	6	0.45	0.42	1	1
Greater Gabbard	5	0.45	0.42	1	1

Project	Estimated spring collisions (all ages)	Proportion of immature birds	Proportion from SPA	Number of immature birds from Forth Islands SPA	Corrected number of immature birds from Forth Islands SPA
Kentish Flats	0	0.45	0.42	0	0
London Array	1	0.45	0.42	0	0
Moray Firth 1	7	0.45	0.42	1	1
Thanet	0	0.45	0.42	0	0
Rampion	35	0.45	0.42	6	4
Total	**220.5**	-	-	**37**	**25**

864. The combined estimated numbers of gannets (adults and immature birds) from the Forth Islands SPA involved with collisions at UK offshore wind farms in the UK North Sea and English Channel are shown in Table 9-160.

Table 9-160: Estimated cumulative number of gannets (all ages) from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea and English Channel Wind Farms in the autumn and spring periods of the non-breeding season

Project	Number of adults from Forth Islands SPA in autumn period	Number of immature birds from Forth Islands in autumn period	Number of adults from Forth Islands SPA in spring period	Number of immature birds from Forth Islands in spring period	Total number of birds in non-breeding season
NnG (2017)	1	1	1	1	4
Inch Cape (2014)	3	2	3	1	10
Seagreen A (2014)	2	1	2	1	6
Seagreen B (2014)	1	1	1	1	4
Other UK OWFs in North Sea & Channel	71	46	32	21	170
Total	**78**	**51**	**39**	**25**	**193**

865. The cumulative estimated number of collisions involving gannets from the Forth Islands SPA in the autumn period of the non-breeding season is 129 adults and immature birds (Table 9-160). This corresponds to 0.07% of the North Sea and English Channel population from the key SPA (Forth Islands) in the autumn period of the non-breeding season (191,857 birds) (Furness, 2015).

866. The cumulative estimated number of collisions involving gannets from the Forth Islands SPA in the spring period of the non-breeding season is 64 adults and immature birds (Table 9-160). This corresponds to 0.06% of the North Sea and English Channel population from the key SPA (Forth Islands) in the spring period of the non-breeding season (113,627 birds) (Furness, 2015).

867. Using the SNH approach (SNH, 2017), a cumulative total of 193 gannets (117 adults and 76 immature birds) from the Forth Islands SPA are estimated to be involved in collisions based on Scenario Two (NnG (2017 design), the consented Forth and Tay Wind Farms (2014 design)), and the other UK North

Sea and English Channel Wind Farms in the autumn and spring periods of the non-breeding season (Table 9-160). This corresponds to 0.1% of the North Sea and English Channel population from the key SPA (Forth Islands) in the autumn and spring periods of the non-breeding season (Furness, 2015).

868. Based on the SNH approach, it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B and the other UK North Sea and English Channel Wind Farms will have no effect on the breeding SPA population of gannets within mean maximum foraging range in the non-breeding season. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

Cumulative non-breeding season assessment for kittiwake

869. This process was then repeated for kittiwake. As before, estimated annual totals for kittiwake collisions in the draft Hornsea 3 HRA were compared to both the original and revised estimates in the Crown Estate report. Where there was good reason given in the Crown Estate report, e.g. information on likely turbine number from the developer websites, the revised Crown Estate estimate was selected. Where there was no information on changes in project number, the most conservative estimate was selected. The selected collision estimate for kittiwake for each project is highlighted in bold in Table 9-161.

Table 9-161: Comparison of estimated number of kittiwake collisions in the non-breeding season for UK North Sea Wind Farms used in this assessment

Project	Original TCE report estimate	Revised TCE estimate	Hornsea 3 HRA estimate	Reason for selection
East Anglia 3	**113**	113	89	TCE report more conservative
East Anglia 1	314	**141**	24	Revised TCE estimate used. SPR planning building 102 turbines, not 240
Hornsea 3	-	-	**124**	Hornsea 3 HRA estimate only one available
Blyth Demonstrator	**5**	5	4	TCE report more conservative
Dogger Creke Beck A&B	**719**	719	218	TCE report more conservative
Dogger Teeside A&B	**533**	533	135	TCE report more conservative
Dudgeon	0	0	0	Revised TCE estimate used. Up to 67 turbines, not 168
Hornsea 1	123	**73**	21	Revised TCE estimate used. Up to 174 turbines, not 240
Hornsea 2	**27**	27	4	TCE report more conservative
Humber Gateway	8	**3**	6	Revised TCE estimate used. 73 turbines built, not 83
Lincs	**3**	3	2	TCE report more conservative
Race Bank	31	**19**	23	Revised TCE estimate used. Orsted website says up to 91 turbines, not 206
Teeside	81	**55**	56	Revised TCE estimate used. built 27 turbines, not 30

Project	Original TCE report estimate	Revised TCE estimate	Hornsea 3 HRA estimate	Reason for selection
Triton Knoll	209	**71**	152	Revised TCE estimate used. 100 turbines likely, not 288
Westermost Rough	**1**	1	0	TCE report more conservative
Aberdeen demonstrator	19	**14**	14	Revised TCE estimate used. Slightly different turbine specifications to original consent
Beatrice	145	**80**	18	Revised TCE estimate used. Up to 84 turbines, not 125
Galloper	66	**28**	48	Revised TCE estimate used. Up to 56 turbines, not 140
Greater Gabbard	28	**29**	20	Revised TCE report more conservative
Kentish Flats Extension	**2**	2	2	No difference
London Array	6	**2**	4	Revised TCE estimate used. Up to 175 turbines, not 341
Moray Firth 1	**45**	45	43	TCE report more conservative
Thanet	**1**	1	1	No difference

870. To calculate non-breeding kittiwake collisions, the selected annual kittiwake collision estimate for each UK project was multiplied by the ratio of breeding to annual kittiwake collision estimates from the draft Hornsea 3 HRA (Table 9-162).

Table 9-162: Estimated number of kittiwake collisions in the non-breeding season for UK North Sea Wind Farms used in this assessment

Project	Annual collision estimate	Hornsea H3 non-breeding estimates	Hornsea H3 annual estimate	Hornsea H3 ratio	Estimated non-breeding collisions
East Anglia 3	113	79	89	0.89	100
East Anglia 1	141	23	24	0.96	135
Hornsea 3	124	43	124	0.35	43
Blyth Demonstrator	5	3	4	0.75	4
Dogger Creke Beck A&B	719	131	218	0.60	432
Dogger Teeside A&B	533	43	135	0.32	170
Dudgeon	0	0	0	0.00	0
Hornsea 1	73	13	21	0.62	45
Hornsea 2	27	2	4	0.50	14
Humber Gateway	3	4	6	0.67	2
Lincs	3	1	2	0.50	2

Project	Annual collision estimate	Hornsea H3 non-breeding estimates	Hornsea H3 annual estimate	Hornsea H3 ratio	Estimated non-breeding collisions
Race Bank	19	22	23	0.96	18
Teeside	55	19	56	0.34	19
Triton Knoll	71	134	152	0.88	63
Westermost Rough	1	0	0	0.00	0
Aberdeen demonstrator	14	4	14	0.29	4
Beatrice	80	3	18	0.17	13
Galloper	28	40	48	0.83	23
Greater Gabbard	29	17	20	0.85	25
Kentish Flats	2	1	2	0.50	1
London Array	2	3	4	0.75	2
Moray Firth 1	45	8	43	0.19	8
Thanet	1	1	1	1.00	1
Total	2,088	594	1,008	-	1,124

871. The draft Hornsea 3 HRA provides a breakdown of the non-breeding season into the post-breeding season (autumn) and the pre-breeding season (spring) for the offshore UK wind farms used in this assessment. The estimated kittiwake collisions for the non-breeding season were therefore divided using the same ratio, to get the estimated number of kittiwake collisions in the autumn and spring periods (Table 9-163).

Table 9-163: Estimated number of kittiwake collisions in the autumn and spring periods of the non-breeding season for UK North Sea Wind Farms used in this assessment

Project	Estimated non-breeding season collisions	Hornsea 3 Autumn estimate	Hornsea 3 non-breeding estimate	Hornsea H3 non-breeding ratio	Estimated autumn collisions	Estimated spring collisions
East Anglia 3	113	54	79	0.68	77	36
East Anglia 1	141	17	23	0.74	104	37
Hornsea 3	124	37	43	0.86	107	17
Blyth Demonstrator	5	2	3	0.67	3	2
Dogger Creke Beck A&B	719	41	131	0.31	223	496
Dogger Teeside A&B	533	27	43	0.63	336	197
Dudgeon	0	0	0	0.00	0	0
Hornsea 1	73	9	13	0.69	50	23

Project	Estimated non-breeding season collisions	Hornsea 3 Autumn estimate	Hornsea 3 non-breeding estimate	Hornsea H3 non-breeding ratio	Estimated autumn collisions	Estimated spring collisions
Hornsea 2	27	1	2	0.50	13.5	13.5
Humber Gateway	3	2	4	0.50	1.5	1.5
Lincs	3	1	1	1.00	3	0
Race Bank	19	17	22	0.77	15	4
Teeside	55	17	19	0.89	49	6
Triton Knoll	71	101	134	0.75	53	18
Westermost Rough	1	0	0	0.00	1	0
Aberdeen demonstrator	14	4	4	1.00	14	0
Beatrice	80	1	3	0.33	26	54
Galloper	28	20	40	0.50	14	14
Greater Gabbard	29	11	17	0.65	19	10
Kentish Flats	2	1	1	1.00	2	0
London Array	2	2	3	0.67	1	1
Moray Firth 1	45	2	8	0.25	11	34
Thanet	1	0	1	0.00	1	0
Total	2,088				1,124	964

872. Following the SNH approach, the next stage is to adjust the total collisions attributed to the four SPAs being considered in this assessment (Table 9-8) for each period (autumn and spring) by the age proportions and the proportional representation of each SPA colony within the BDMPS for that period. As recommended in the SNH approach, the ratio of adult (53%) to immature birds (47%) was taken from the stable age structure percentages as reported in Furness (2015.)

873. The proportion of adult and immature kittiwakes from the SPA colonies within the BDMPS for the autumn and spring periods was calculated by dividing the estimated number of adult and immature kittiwakes from each SPA by the total estimated BDMPS population (Table 9-164).

Table 9-164: Proportion of adult and immature kittiwakes from key SPAs in the North Sea in the autumn and spring periods of the non-breeding season

SPA	Estimated number of adults in UK N Sea in autumn period	Estimated number of immature birds in UK N Sea in autumn period	Estimated number of adults in UK N Sea in spring period	Estimated number of immature birds in UK N Sea in spring period
Buchan Ness to Collieston Coast SPA				
Estimated number of birds	15,050	8,830	15,050	6,622
Total BDMPS	480,815	349,122	375,815	252,001
Proportion from SPA	0.03	0.03	0.04	0.03
Fowlsheugh SPA				
Estimated number of birds	11,204	6,573	11,204	4,930
Total BDMPS	480,815	349,122	375,815	252,001
Proportion from SPA	0.02	0.02	0.03	0.02
Forth Islands SPA				
Estimated number of birds	3,720	2,182	3,720	1,637
Total BDMPS	480,815	349,122	375,815	252,001
Proportion from SPA	0.008	0.006	0.01	0.006
St Abb's Head to Fast Castle SPA				
Estimated number of birds	4,084	2,396	4,084	1,797
Total BDMPS	480,815	349,122	375,815	252,001
Proportion from SPA	0.008	0.007	0.01	0.007

874. Estimated kittiwake collisions for the non-breeding season for NnG and the other Forth and Tay projects based on the worst-case option (Scenario Two – NnG 2017 and 2014 consents for Inch Cape and Seagreen A and B) (Table 9-148), were also included with the non-breeding season estimated collisions for the UK North Sea wind farms (Table 9-165).

875. The proportions of adults and immature birds were then used to calculate the numbers of adult kittiwakes from the four SPAs (Table 9-164) involved in collisions at each of the UK North Sea offshore wind farms in the autumn period of the non-breeding season (Table 9-165). The number of autumn collisions was multiplied by the proportion of adults (53%) (Furness, 2015), and by the proportion of adults from each SPA (Table 9-164).

876. As the seasonal period definitions used in Furness (2015) do not match the definitions in the SNH guidance, the approach recommended by SNH is to assume a flat rate of collisions during the season, and to recalculate according to the relative lengths of the periods. For kittiwake, the autumn post breeding period in the BDMPS report (Furness 2015) is 20 weeks from August to December. The SNH recommendation is from September to December, which is 16 weeks. As such, a proportionate

recalculation based on the relative length of time in the two periods is required. Therefore 0.8 multiplied by the number of collisions in autumn is the final value required. These recalculations are shown in Appendix 9.9: Cumulative Impact Assessment additional calculations.

Table 9-165: Estimated cumulative number of adult kittiwakes from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn period of the non-breeding season

Project	Estimated collisions (all ages)	Number of adults from Buchan Ness to Collieston SPA	Number of adults from Fowlsheugh SPA	Number of adults from Forth Islands SPA	Number of adults from St Abb's to Fast Castle SPA
NnG (2017)	17	0.22	0.14	0.06	0.06
Inch Cape (2014)	80	1.02	0.68	0.27	0.27
Seagreen A (2014)	217	2.76	1.84	0.74	0.74
Seagreen B (2014)	123	1.56	1.04	0.42	0.42
East Anglia 3	77	0.98	0.65	0.26	0.26
East Anglia 1	104	1.32	0.88	0.35	0.35
Hornsea 3	107	1.36	0.91	0.36	0.36
Blyth Demonstrator	3	0.04	0.03	0.01	0.01
Dogger Creke Beck A&B	223	2.84	1.89	0.76	0.76
Dogger Teeside A&B	336	4.27	2.85	1.14	1.14
Dudgeon	0	0.00	0.00	0.00	0.00
Hornsea 1	50	0.64	0.42	0.17	0.17
Hornsea 2	13.5	0.17	0.11	0.05	0.05
Humber Gateway	1.5	0.02	0.01	0.01	0.01
Lincs	3	0.04	0.03	0.01	0.01
Race Bank	15	0.19	0.13	0.05	0.05
Teeside	49	0.62	0.42	0.17	0.17
Triton Knoll	53	0.67	0.45	0.18	0.18
Westermost Rough	1	0.01	0.01	0.00	0.00
Aberdeen demonstrator	14	0.18	0.12	0.05	0.05
Beatrice	26	0.33	0.22	0.09	0.09
Galloper	14	0.18	0.12	0.05	0.05
Greater Gabbard	19	0.24	0.16	0.06	0.06
Kentish Flats	2	0.03	0.02	0.01	0.01

Project	Estimated collisions (all ages)	Number of adults from Buchan Ness to Collieston SPA	Number of adults from Fowlsheugh SPA	Number of adults from Forth Islands SPA	Number of adults from St Abb's to Fast Castle SPA
London Array	1	0.01	0.01	0.00	0.00
Moray Firth 1	11	0.14	0.09	0.04	0.04
Thanet	1	0.01	0.01	0.00	0.00
Total	**1,561**	**19.85**	**13**	**5**	**5**

877. This was repeated for immature birds in the autumn period (Table 9-157), and also for adults in the spring period (Table 9-158) and immature birds in the spring period (Table 9-159). For the immature birds, the number of seasonal collisions was multiplied by the proportion of immature birds (47%) (Furness, 2015), and by the proportion of immature birds from each SPA (Table 9-164).

Table 9-166: Estimated cumulative number of immature kittiwakes from the key SPAs involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn period of the non-breeding season

Project	Estimated collisions (all ages)	Number of immature birds from Buchan Ness to Collieston SPA	Number of immature birds from Fowlsheugh SPA	Number of immature birds from Forth Islands SPA	Number of immature birds from St Abb's to Fast Castle SPA
NnG (2017)	17	0.19	0.13	0.04	0.04
Inch Cape (2014)	80	0.90	0.60	0.18	0.21
Seagreen A (2014)	217	2.45	1.63	0.49	0.57
Seagreen B (2014)	123	1.39	0.92	0.28	0.32
East Anglia 3	77	0.87	0.58	0.17	0.20
East Anglia 1	104	1.17	0.78	0.23	0.27
Hornsea 3	107	1.21	0.80	0.24	0.28
Blyth Demonstrator	3	0.03	0.02	0.01	0.01
Dogger Creke Beck A&B	223	2.52	1.68	0.50	0.59
Dogger Teeside A&B	336	3.79	2.53	0.76	0.88
Dudgeon	0	0.00	0.00	0.00	0.00
Hornsea 1	50	0.56	0.38	0.11	0.13
Hornsea 2	13.5	0.15	0.10	0.03	0.04
Humber Gateway	1.5	0.02	0.01	0.00	0.00
Lincs	3	0.03	0.02	0.01	0.01
Race Bank	15	0.17	0.11	0.03	0.04
Teeside	49	0.55	0.37	0.11	0.13

Project	Estimated collisions (all ages)	Number of immature birds from Buchan Ness to Collieston SPA	Number of immature birds from Fowlsheugh SPA	Number of immature birds from Forth Islands SPA	Number of immature birds from St Abb's to Fast Castle SPA
Triton Knoll	53	0.60	0.40	0.12	0.14
Westermost Rough	1	0.01	0.01	0.00	0.00
Aberdeen demonstrator	14	0.16	0.11	0.03	0.04
Beatrice	26	0.29	0.20	0.06	0.07
Galloper	14	0.16	0.11	0.03	0.04
Greater Gabbard	19	0.21	0.14	0.04	0.05
Kentish Flats	2	0.02	0.02	0.00	0.01
London Array	1	0.01	0.01	0.00	0.00
Moray Firth 1	11	0.12	0.08	0.02	0.03
Thanet	1	0.01	0.01	0.00	0.00
Total	**1,561**	**17.59**	**12**	**4**	**4**

878. For kittiwake, the spring migration period in the BDMPS report (Furness 2015) is 16 weeks from January to April inclusive. The SNH recommendation is from January to mid-April, which is 14 weeks. As such, a proportionate recalculation based on the relative length of time in the two periods is required. Therefore 0.875 multiplied by the number of collisions in spring is the final value required. These recalculations are shown in Appendix 9.9.

Table 9-167: Estimated cumulative number of adult kittiwakes from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the spring period of the non-breeding season

Project	Estimated collisions (all ages)	Number of adults from Buchan Ness to Collieston SPA	Number of adults from Fowlsheugh SPA	Number of adults from Forth Islands SPA	Number of adults from St Abb's to Fast Castle SPA
NnG (2017)	2	0.02	0.02	0.01	0.01
Inch Cape (2014)	18	0.21	0.16	0.05	0.05
Seagreen A (2014)	78	0.90	0.68	0.23	0.23
Seagreen B (2014)	104	1.21	0.90	0.30	0.30
East Anglia 3	36	0.42	0.31	0.10	0.10
East Anglia 1	37	0.43	0.32	0.11	0.11
Hornsea 3	17	0.20	0.15	0.05	0.05
Blyth Demonstrator	2	0.02	0.02	0.01	0.01
Dogger Creke Beck A&B	496	5.75	4.31	1.44	1.44

Project	Estimated collisions (all ages)	Number of adults from Buchan Ness to Collieston SPA	Number of adults from Fowlsheugh SPA	Number of adults from Forth Islands SPA	Number of adults from St Abb's to Fast Castle SPA
Dogger Teeside A&B	197	2.28	1.71	0.57	0.57
Dudgeon	0	0.00	0.00	0.00	0.00
Hornsea 1	23	0.27	0.20	0.07	0.07
Hornsea 2	13.5	0.16	0.12	0.04	0.04
Humber Gateway	1.5	0.02	0.01	0.00	0.00
Lincs	0	0.00	0.00	0.00	0.00
Race Bank	4	0.05	0.03	0.01	0.01
Teeside	6	0.07	0.05	0.02	0.02
Triton Knoll	18	0.21	0.16	0.05	0.05
Westermost Rough	0	0.00	0.00	0.00	0.00
Aberdeen demonstrator	0	0.00	0.00	0.00	0.00
Beatrice	54	0.63	0.47	0.16	0.16
Galloper	14	0.16	0.12	0.04	0.04
Greater Gabbard	10	0.12	0.09	0.03	0.03
Kentish Flats	0	0.00	0.00	0.00	0.00
London Array	1	0.01	0.01	0.00	0.00
Moray Firth 1	34	0.39	0.30	0.10	0.10
Thanet	0	0.00	0.00	0.00	0.00
Total	**1,166**	**14**	**10**	**3**	**3**

Table 9-168: Estimated cumulative number of immature kittiwakes from the key SPAs involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the spring period of the non-breeding season

Project	Estimated collisions (all ages)	Number of immature birds from Buchan Ness to Collieston SPA	Number of immature birds from Fowlsheugh SPA		Number of immature birds from St Abb's to Fast Castle SPA
NnG (2017)	2	0.02	0.01	0.00	0.00
Inch Cape (2014)	24	0.14	0.09	0.03	0.03
Seagreen A (2014)	93	0.60	0.40	0.12	0.14

Project	Estimated collisions (all ages)	Number of immature birds from Buchan Ness to Collieston SPA	Number of immature birds from Fowlsheugh SPA		Number of immature birds from St Abb's to Fast Castle SPA
Seagreen B (2014)	114	0.80	0.53	0.16	0.19
East Anglia 3	36	0.28	0.19	0.06	0.06
East Anglia 1	37	0.29	0.19	0.06	0.07
Hornsea 3	17	0.13	0.09	0.03	0.03
Blyth Demonstrator	2	0.02	0.01	0.00	0.00
Dogger Creke Beck A&B	496	3.82	2.55	0.76	0.89
Dogger Teeside A&B	197	1.52	1.01	0.30	0.35
Dudgeon	0	0.00	0.00	0.00	0.00
Hornsea 1	23	0.18	0.12	0.04	0.04
Hornsea 2	13.5	0.10	0.07	0.02	0.02
Humber Gateway	1.5	0.01	0.01	0.00	0.00
Lincs	0	0.00	0.00	0.00	0.00
Race Bank	4	0.03	0.02	0.01	0.01
Teeside	6	0.05	0.03	0.01	0.01
Triton Knoll	18	0.14	0.09	0.03	0.03
Westermost Rough	0	0.00	0.00	0.00	0.00
Aberdeen demonstrator	0	0.00	0.00	0.00	0.00
Beatrice	54	0.42	0.28	0.08	0.10
Galloper	14	0.11	0.07	0.02	0.03
Greater Gabbard	10	0.08	0.05	0.02	0.02
Kentish Flats	0	0.00	0.00	0.00	0.00
London Array	1	0.01	0.01	0.00	0.00
Moray Firth 1	34	0.26	0.17	0.05	0.06
Thanet	0	0.00	0.00	0.00	0.00
Total	**1,166**	**9**	**6**	**2**	**2**

879. The combined estimated numbers of kittiwakes (adults and immature birds) from Buchan Ness to Collieston Coast SPA involved with collisions at UK offshore wind farms in the UK North Sea are shown in Table 9-169.

Table 9-169: Estimated cumulative number of kittiwakes (all ages) from the Buchan Ness to Collieston Coast SPA involved in collisions at NnG (2017 design), consented Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season

Project	Number of adults from Buchan Ness to Collieston Coast SPA in autumn period	Number of immature birds from Buchan Ness to Collieston Coast SPA in autumn period	Number of adults from Buchan Ness to Collieston Coast SPA in spring period	Number of immature birds from Buchan Ness to Collieston Coast SPA in spring period	Total number of birds in non-breeding season
NnG (2017)	0.22	0.19	0.02	0.02	0.45
Inch Cape (2014)	1.02	0.9	0.21	0.14	2.27
Seagreen A (2014)	2.76	2.45	0.90	0.60	6.71
Seagreen B (2014)	1.56	1.39	1.21	0.80	4.96
Other UK OWFs in North Sea & Channel	14.29	12.66	11.19	7.45	45.59
Total	**19.85**	**17.59**	**13.53**	**9.01**	**59.98**

880. The cumulative estimated number of collisions involving kittiwakes from the Buchan Ness to Collieston Coast SPA in the autumn period of the non-breeding season is 37 adults and immature birds (Table 9-169). This corresponds to 0.15% of the North Sea population for this SPA in the autumn period of the non-breeding season (23,880 birds) (Furness, 2015).

881. The cumulative estimated number of collisions involving kittiwakes from the Buchan Ness to Collieston Coast SPA in the spring period of the non-breeding season is 23 adults and immature birds (Table 9-169). This corresponds to 0.1% of the North Sea population for this SPA in the spring period of the non-breeding season (21,673 birds) (Furness, 2015).

882. Using the SNH approach (SNH, 2017), a cumulative total of 60 kittiwakes (33 adults and 27 immature birds) from the Buchan Ness to Collieston Coast SPA are estimated to be involved in collisions based on Scenario Two (NnG (2017 design), the proposed Forth and Tay Wind Farms (2014 design)), and the other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season (Table 9-169). This corresponds to 0.25% of the North Sea population for this SPA in the autumn and spring periods of the non-breeding season (Furness, 2015).

883. The combined estimated numbers of kittiwakes (adults and immature birds) from Fowlsheugh SPA involved with collisions at UK offshore wind farms in the UK North Sea are shown in Table 9-170.

Table 9-170: Estimated cumulative number of kittiwakes (all ages) from Fowlsheugh SPA involved in collisions at NnG (2017 design), consented Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season

Project	Number of adults from Fowlsheugh SPA in autumn period	Number of immature birds from Fowlsheugh SPA in autumn period	Number of adults from Fowlsheugh SPA in spring period	Number of immature birds from Fowlsheugh SPA in spring period	Total number of birds in non-breeding season
NnG (2017)	0.14	0.13	0.02	0.01	0.3
Inch Cape (2014)	0.68	0.60	0.16	0.09	1.53

Project	Number of adults from Fowlsheugh SPA in autumn period	Number of immature birds from Fowlsheugh SPA in autumn period	Number of adults from Fowlsheugh SPA in spring period	Number of immature birds from Fowlsheugh SPA in spring period	Total number of birds in non-breeding season
Seagreen A (2014)	1.84	1.63	0.68	0.40	4.55
Seagreen B (2014)	1.04	0.92	0.90	0.53	3.39
Other UK OWFs in North Sea & Channel	9.54	8.47	8.38	4.96	31.55
Total	**13.24**	**11.75**	**10.14**	**5.99**	**41.32**

884. The cumulative estimated number of collisions involving kittiwakes from Fowlsheugh SPA in the autumn period of the non-breeding season is 25 adults and immature birds (Table 9-170). This corresponds to 0.1% of the North Sea population for this SPA in the autumn period of the non-breeding season (17,778 birds) (Furness, 2015).

885. The cumulative estimated number of collisions involving kittiwakes from Fowlsheugh SPA in the spring period of the non-breeding season is 16 adults and immature birds (Table 9-170). This corresponds to 0.1% of the North Sea population for this SPA in the spring period of the non-breeding season (16,134 birds) (Furness, 2015).

886. Using the SNH approach (SNH, 2017), a cumulative total of 41 kittiwakes (23 adults and 18 immature birds) from Fowlsheugh SPA are estimated to be involved in collisions based on Scenario Two (NnG (2017 design), the proposed Forth and Tay Wind Farms (2014 design)), and the other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season (Table 9-170). This corresponds to 0.2% of the North Sea population for this SPA in the autumn and spring periods of the non-breeding season (Furness, 2015).

887. The combined estimated numbers of kittiwakes (adults and immature birds) from Forth Islands SPA involved with collisions at UK offshore wind farms in the UK North Sea are shown in Table 9-171.

Table 9-171: Estimated cumulative number of kittiwakes (all ages) from Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season

Project	Number of adults from Forth Islands SPA in autumn period	Number of immature birds from Forth Islands SPA in autumn period	Number of adults from Forth Islands SPA in spring period	Number of immature birds from Forth Islands SPA in spring period	Total number of birds in non-breeding season
NnG (2017)	0.06	0.04	0.01	0	0.11
Inch Cape (2014)	0.27	0.18	0.05	0.03	0.53
Seagreen A (2014)	0.74	0.49	0.23	0.12	1.58
Seagreen B (2014)	0.42	0.28	0.30	0.16	1.16
Other UK OWFs in North Sea & Channel	3.82	2.50	2.8	1.49	10.61
Total	**5.31**	**3.49**	**3.39**	**1.8**	**13.99**

888. The cumulative estimated number of collisions involving kittiwakes from the Forth Islands SPA in the autumn period of the non-breeding season is nine adults and immature birds (Table 9-171). This corresponds to 0.15% of the North Sea population for this SPA in the autumn period of the non-breeding season (5,902 birds) (Furness, 2015).

889. The cumulative estimated number of collisions involving kittiwakes from the Forth Islands SPA in the spring period of the non-breeding season is five adults and immature birds (Table 9-171). This corresponds to 0.09% of the North Sea population for this SPA in the spring period of the non-breeding season (5,357 birds) (Furness, 2015).

890. Using the SNH approach (SNH, 2017), a cumulative total of 14 kittiwakes (nine adults and five immature birds) from Forth Islands SPA are estimated to be involved in collisions based on Scenario Two (NnG (2017 design), the proposed Forth and Tay Wind Farms (2014 design)), and the other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season (Table 9-171). This corresponds to 0.24% of the North Sea population for this SPA in the autumn and spring periods of the non-breeding season (Furness, 2015).

891. The combined estimated numbers of kittiwakes (adults and immature birds) from St Abbs Head to Fast Castle SPA involved with collisions at UK offshore wind farms in the UK North Sea are shown in Table 9-172.

Table 9-172: Estimated cumulative number of kittiwakes (all ages) from St Abbs Head to Fast Castle SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season

Project	Number of adults from St Abbs Head to Fast Castle SPA in autumn period	Number of immature birds from St Abbs Head to Fast Castle SPA in autumn period	Number of adults from St Abbs Head to Fast Castle SPA in spring period	Number of immature birds from St Abbs Head to Fast Castle SPA in spring period	Total number of birds in non-breeding season
NnG (2017)	0.06	0.04	0.01	0	0.11
Inch Cape (2014)	0.27	0.21	0.05	0.03	0.56
Seagreen A (2014)	0.74	0.57	0.23	0.14	1.68
Seagreen B (2014)	0.42	0.32	0.30	0.19	1.23
Other UK OWFs in North Sea & Channel	3.82	2.96	2.8	1.72	11.30
Total	**5.31**	**4.1**	**3.39**	**2.08**	**14.88**

892. The cumulative estimated number of collisions involving kittiwakes from St Abbs Head to Fast Castle SPA in the autumn period of the non-breeding season is nine adults and immature birds (Table 9-172). This corresponds to 0.1% of the North Sea population for this SPA in the autumn period of the non-breeding season (6,479 birds) (Furness, 2015).

893. The cumulative estimated number of collisions involving kittiwakes from St Abbs Head to Fast Castle SPA in the spring period of the non-breeding season is six adults and immature birds (Table 9-172). This corresponds to 0.09% of the North Sea population for this SPA in the spring period of the non-breeding season (5,880 birds) (Furness, 2015).

894. Using the SNH approach (SNH, 2017), a cumulative total of 15 kittiwakes (nine adults and six immature birds) from St Abbs Head to Fast Castle SPA are estimated to be involved in collisions based on Scenario Two (NnG (2017 design), the proposed Forth and Tay Wind Farms (2014 design)), and the

other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season (Table 9-172). This corresponds to 0.19% of the North Sea population for this SPA in the autumn and spring periods of the non-breeding season (Furness, 2015).

895. The combined estimated numbers of kittiwakes (adults and immature birds) from all four SPAs involved with collisions at UK offshore wind farms in the UK North Sea are shown in Table 9-173.

Table 9-173: Estimated cumulative number of kittiwakes (all ages) from St Abbs Head to Fast Castle SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season

Project	Total number of birds from Buchan Ness to Collieston Coast SPA in non-breeding period	Total number of birds from Fowlsheugh SPA in non-breeding period	Total number of birds from Forth Islands SPA in non-breeding period	Total number of birds from St Abbs Head to Fast Castle SPA in non-breeding period	Total number of birds in non-breeding season
NnG (2017)	0.45	0.3	0.11	0.11	0.97
Inch Cape (2014)	2.27	1.53	0.53	0.56	4.89
Seagreen A (2014)	6.71	4.55	1.58	1.68	14.52
Seagreen B (2014)	4.96	3.39	1.16	1.23	10.74
Other UK OWFs in North Sea & Channel	45.59	31.55	10.61	11.30	99.05
Total	**59.98**	**41.32**	**13.99**	**14.88**	**130.17**

896. Using the SNH approach (SNH, 2017), a cumulative total of 130 kittiwakes from the four SPAs are estimated to be involved in collisions from Scenario Two (NnG (2017 design), the proposed Forth and Tay Wind Farms (2014 design)), and the other UK North Sea Wind Farms in the non-breeding season each year (Table 9-173). This corresponds to 0.9% of the North Sea population for these four SPAs in the autumn and spring periods of the non-breeding season (Furness, 2015).

897. Based on the SNH approach, it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B and the other UK North Sea Wind Farms will have no effect on the breeding SPA population of kittiwakes within mean maximum foraging range in the non-breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

9.9.5 PVA for NnG, Inch Cape and Seagreen A & B

898. This section presents the results of the Population Viability Analysis on NnG cumulatively with the Inch Cape and Seagreen A and B projects, as well as with other offshore wind farm projects in the UK North Sea and English Channel. For the purposes of clarity, in this section NnG refers to the 2017 design scenario for the Project, while “F&T” refers to Inch Cape, Seagreen and Seagreen B.

899. Methods for the PVA are presented in Appendix 9.8.

Scenarios

900. For the cumulative assessment, effects from collisions and displacement were apportioned to the relevant SPA populations based on the scenarios outlined in Table 9-72. In summary, these covered cumulative collision impacts for NnG, Inch Cape, and Seagreen projects and other UK offshore wind

projects in the North Sea and English Channel for gannet and kittiwake. For guillemot, razorbill and puffin, the PVA covered cumulative displacement effects for NnG, Inch Cape and Seagreen Phase 1 or Seagreen A and B. Further details are presented in Appendix 9.8.

901. Effects from NnG were based on collision rate modelling using Band Option 2 and displacement figures following SNCB guidance (Table 9-73). Apportioning for the relevant populations was based on a two-step process: (i) proportion in SPAs, and (ii) across the relevant SPA populations. Further information is provided in Appendix 9.8.

902. For the 2017 Inch Cape and Seagreen Phase 1 design scenarios (Scenario One), collision rate estimates were based on figures from 2017 proposals using Band Option 2. These were combined with estimates from NnG (54 turbines, Table 9-73). Displacement figures followed SNCB guidance. Apportioning for the relevant populations was based on a two-step process: (i) proportion in SPAs, and (ii) across the relevant SPA populations (Table 9-174).

Table 9-174: Effects applied to population models for NnG Worst-case design scenario (54 turbines) and Inch Cape & Seagreen 2017 design scenarios. Unless indicated as refering to adults (ad), effects are applied using the stable age structure.

Species	Population	Collisions	Displacement	Collisions & Displacement (year round)	Collisions and displacement (breeding season)
Gannet	Forth Islands	595			
Kittiwake	Forth Islands	80		11 ad + 80	
Kittiwake	Fowlsheugh	166		22 ad + 166	
Puffin	Forth Islands		107 ad		
Guillemot	Forth Islands		15 ad + 21		
Guillemot	Fowlsheugh		30 ad + 41		
Razorbill	Forth Islands		8 ad + 17		
Razorbill	Fowlsheugh		11 ad + 22		

903. For the 2014 Inch Cape and Seagreen A and B design scenarios (Scenario Two), collision rate estimates were based on figures from 2014 proposals using Band Option 2 . These were combined with estimates from NnG (54 turbines, Table 9-73). Displacement figures followed SNCB guidance. Apportioning for the relevant populations was based on a two-step process: (i) proportion in SPAs, and (ii) across the relevant SPA populations (Table 9-175).

Table 9-175: Effects applied to population models for NnG Worst-case design scenario (54 turbines) and Inch Cape & Seagreen 2014 design scenarios. Unless indicated as refering to adults (ad), effects are applied using the stable age structure.

Species	Population	Collisions	Displacement	Collisions & Displacement (year round)	Collisions and displacement (breeding season)
Gannet	Forth Islands	1,302			
Kittiwake	Forth Islands	228		11 ad + 228	
Kittiwake	Fowlsheugh	473		22 ad + 473	

Species	Population	Collisions	Displacement	Collisions & Displacement (year round)	Collisions and displacement (breeding season)
Puffin	Forth Islands		107 ad		
Guillemot	Forth Islands		15 ad + 21		
Guillemot	Fowlsheugh		30 ad + 41		
Razorbill	Forth Islands		8 ad + 17		
Razorbill	Fowlsheugh		11 ad + 22		

904. Breeding season effects from Forth & Tay wind farms were summed with the non-breeding effects from Forth & Tay wind farms and relevant UK wind farms (Table 9-176). Displacement of kittiwake at English offshore wind farms has been considered as nil and has not been assessed. The effects of UK wind farms outside of the Forth and Tay wind farms were therefore limited to collisions during the non-breeding season.

Table 9-176: Effects applied to population models for NnG Worst-case design scenario (54 turbines) and population models for UK waters. Unless indicated as refering to adults (ad), effects are applied using the stable age structure.

Species	Population	Collisions	Displacement	Collisions & Displacement (year round)	Collisions and displacement (breeding season)
Gannet	Forth Islands SPA	668			
Kittiwake	Forth Islands SPA	11 ad + 41			
Kittiwake	Fowlsheugh SPA	22 ad + 94			

9.9.5.1.1 Gannet

905. For gannet, only collision impacts were modelled in the cumulative PVA. For the Forth and Tay projects there were two scenarios modelled. As previously, Scenario One was for the NnG 2017 design scenario, and Inch Cape and Seagreen Phase 1 2017 design scenarios. Scenario Two considered the NnG 2017 design scenario with the 2014 consented designs for Inch Cape and Seagreen A and B.

Scenario One: NnG 2017 design scenario and Inch Cape and Seagreen Phase 1 2017 (Phase 1) design scenarios

906. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 F&T projects over 25 years are shown in Table 9-177.

Table 9-177: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 Forth and Tay projects over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farms)	Percentage point change with NnG & F&T projects after 25 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Gannet	Forth Islands	1.7171	-0.294	-17.10	82.90%

907. The gannet population growth rate is predicted to increase over the 25 year period, although there is a decrease in this growth rate when the NnG and Forth and Tay projects are present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the NnG and Forth and Tay projects is a decrease of 17.10% (Table 9-177). Alternatively, the counterfactual of the growth rate is 82.90% of that for the scenario with no wind farm constructed.

908. Changes in the predicted population size for gannets breeding at the Bass Rock with and without the NnG and 2017 Forth and Tay projects over 25 years are shown in Table 9-178.

Table 9-178: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 Forth and Tay projects over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG & F&T projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Gannet	Forth Islands 75,259 pairs	132,394 pairs	123,131 pairs	-7.00	93.00%

909. After 25 years, the gannet breeding population at the Forth Islands SPA is predicted to have increased considerably with the NnG and 2017 Forth and Tay projects present, compared to the current population level (75,259 pairs), although the increase is not predicted to be as high as the scenario with no wind farms present (Table 9-178). Overall, the change in the median final population size when comparing the baseline (no wind farms) with the built scenario is a decrease of 7.00%. This equates to a CPS value of 93.00% of the scenario with no wind farm.

910. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 Forth and Tay projects over 50 years are shown in Table 9-179.

Table 9-179: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 Forth and Tay projects over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farm)	Percentage point change with NnG & F&T projects after 50 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Gannet	Forth Islands	1.7189	-0.296	-17.24	82.76%

911. The gannet population growth rate at the Forth Islands SPA is predicted to increase over the 50 year period, although there is a decrease in this growth rate when the NnG and 2017 Forth and Tay projects are present. Overall, the change in the median annual growth rate when comparing the

baseline (no wind farms) with the built scenario after 50 years is a decrease of 17.24% (Table 9-179). Alternatively, the counterfactual of the growth rate is 82.76% of that for the scenario with no wind farm constructed. These values are similar to those predicted after 25 years (Table 9-177).

912. Changes in the predicted population size for gannets breeding at the Bass Rock with and without the NnG and 2017 Forth and Tay projects over 50 years are shown in Table 9-180.

Table 9-180: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario 1 Forth and Tay projects over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG & F&T projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Gannet	Forth Islands 75,259 pairs	203,046 pairs	175,208 pairs	-13.71	86.29%

913. After 50 years, the gannet breeding population at the Forth Islands SPA is predicted to have increased considerably with the NnG and Forth and Tay projects present, compared to the current population level (75,259 pairs), although the increase is not predicted to be as high as the scenario with no wind farms present (Table 9-180). This was similar to but slightly lower than the prediction after 25 years (Table 9-178). Overall, the change in the median final population size when comparing the baseline (no wind farms) with the built scenario is a decrease of 13.71%. This equates to a CPS value of 86.29% of the scenario with no wind farm.

914. A comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 Forth and Tay projects over 25 years and 50 years is shown in Table 9-181.

Table 9-181: Comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 Forth and Tay projects over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG & F&T projects (collisions all year)	Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG & F&T projects (collisions all year)
Gannet	Forth Islands	0.5	0.05	0.01

915. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over 25 years at least 5% and over 50 years at least 1% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a low probability of the unimpacted population being at or below the median of the impacted population.

Scenario 2: NnG 2017 design scenario and Inch Cape and Seagreen A and B 2014 design scenarios

916. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 25 years are shown in Table 9-182.

Table 9-182: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farms)	Percentage point change with NnG & F&T projects after 25 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Gannet	Forth Islands	1.7171	-0.632	-36.81	63.19%

917. The gannet population growth rate is predicted to increase over the 25 year period, although the growth rate when the NnG and 2014 Forth and Tay projects are present is reduced. Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the NnG and Forth and Tay projects is a decrease of 36.81% (Table 9-182), which is more than double the decrease in rate compared to Scenario One (Table 9-177). Alternatively, the counterfactual of the growth rate is 63.19% of that for the scenario with no wind farm constructed, which is also lower than was estimated for Scenario One after 25 years (Table 9-177).

918. Changes in the predicted population size for gannets breeding at the Bass Rock with and without the NnG and 2014 Forth and Tay projects over 25 years are shown in Table 9-183.

Table 9-183: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG & F&T projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Gannet	Forth Islands 75,259 pairs	132,394 pairs	112,892 pairs	-14.73	85.27%

919. After 25 years, the gannet breeding population at the Forth Islands SPA is predicted to have increased with the NnG and 2014 Forth and Tay projects present, compared to the current population level (75,259 pairs), although the increase is not predicted to be as high as the scenario with no wind farms present (Table 9-183). Comparing the Scenario Two results with Scenario One (Table 9-178), the predicted percentage change in the median final population size is approximately double for Scenario Two, at -14.73%. The CPS value for Scenario Two after 25 years is also lower than for Scenario One, at 85.27% of the scenario with no wind farm.

920. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 50 years are shown in Table 9-184.

Table 9-184: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farm)	Percentage point change with NnG & F&T projects after 50 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Gannet	Forth Islands	1.7189	-0.632	-36.79	63.21%

921. The gannet population growth rate at the Forth Islands SPA is predicted to increase over the 50 year period, although there is a decrease in this growth rate when the NnG and 2014 Forth and Tay projects are present (Table 9-184). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with Scenario Two after 50 years is a decrease of 36.79%, which is more than double the decrease in rate compared to Scenario One (Table 9-179). Alternatively, the counterfactual of the growth rate is 63.21% of that for the scenario with no wind farm constructed, which is also lower than was estimated for Scenario One after 50 years (Table 9-179).

922. Changes in the predicted population size for gannets breeding at the Bass Rock with and without the NnG and 2014 Forth and Tay projects over 50 years are shown in Table 9-185.

Table 9-185: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without NnG and the 2014 Forth and Tay projects over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG & F&T projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Gannet	Forth Islands 75,259 pairs	203,046 pairs	148,150 pairs	-27.04	72.96%

923. After 50 years, the gannet breeding population at the Forth Islands SPA is predicted to have increased considerably with NnG and the 2014 Forth and Tay projects present, compared to the current population level (75,259 pairs), although the increase is not predicted to be as high with no wind farms present (Table 9-185). As expected, the predicted final population size after 50 years is also lower for Scenario Two than for Scenario One (Table 9-180). Overall, the change in the median final population size after 50 years when comparing the baseline (no wind farms) with Scenario Two present is a decrease of 27.04%. The CPS value for Scenario Two after 50 years is also lower than for Scenario One, at 72.96% of the scenario with no wind farm.

924. A comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 25 years and 50 years is shown in Table 9-186.

Table 9-186: Comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG & F&T projects (collisions all year)	Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG & F&T projects (collisions all year)
Gannet	Forth Islands	0.5	0	0

925. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over both 25 years and 50 years, 0% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a very low probability of the unimpacted population being at or below the median of the impacted population.

NnG, Inch Cape and Seagreen A and B, plus UK North Sea and English Channel OWF projects

926. For gannet, the Scoping Opinion recommended that the PVA assessed cumulative collision impacts arising from NnG, Inch Cape and Seagreen in the breeding season, together with collision impacts in the non-breeding season from other projects in the UK North Sea and English Channel (Marine Scotland, 2017).

927. As previously, Scenario One was for the NnG design scenario, and Inch Cape and Seagreen A and B 2017 design scenarios. Scenario Two considered the NnG 2017 design scenario with the 2014 consented designs for Inch Cape and Seagreen A and B.

928. For clarity, these are referred to as “Scenario One & UK” and “Scenario Two & UK” in the following text and tables.

Scenario 1 and UK

929. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 25 years are shown in Table 9-187.

Table 9-187: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farms)	Percentage point change with NnG, F&T & UK projects after 25 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Gannet	Forth Islands	1.7171	-0.319	-18.57	81.43%

930. The gannet population growth rate at the Forth Islands SPA is predicted to increase over the 25 year period, although there is a decrease in this growth rate when the Scenario One & UK projects are present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 18.57% (Table 9-187). Alternatively, the counterfactual of the growth rate is 81.43% of that for the scenario with no wind farms constructed.

931. This change in median annual growth rate is lower for the Scenario One & UK projects, compared with Scenario Two and no UK projects (Table 9-182). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and of subsequent apportioning of impacts across these populations.

932. Changes in the predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 25 years are shown in Table 9-188.

Table 9-188: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG, F&T & UK projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Gannet	Forth Islands 75,259 pairs	132,394 pairs	121,977 pairs	-7.87	92.13%

933. The gannet breeding population at the Forth Islands SPA is predicted to increase over the 25 year period, although the predicted end population is lower when the Scenario One & UK projects are present (Table 9-188). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 7.87%. The predicted end population and the CPS value are both higher for the Scenario One & UK projects, compared with Scenario Two (NnG & 2014 F&T projects, no UK projects) (79,322 pairs) (Table 9-183). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and of subsequent apportioning of impacts during the non-breeding season across these populations.

934. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 50 years are shown in Table 9-189.

Table 9-189: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farm)	Percentage point change with NnG, F&T & UK projects after 50 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Gannet	Forth Islands	1.7189	-0.322	-18.72	81.28%

935. The gannet population growth rate at the Forth Islands SPA is predicted to increase over the 50 year period, although there is a decrease in this growth rate when the Scenario One & UK projects are present (Table 9-189). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 18.72%, which is similar to the 25 year assessment (Table 9-187). The corresponding counterfactual of the annual growth rate is 81.28%, which is also similar to the 25 year assessment value.

936. This change in median annual growth rate and the associated counterfactual is lower for the Scenario One & UK projects, compared with Scenario Two (NnG & 2014 F&T projects, no UK projects) (Table 9-182). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and of subsequent apportioning of impacts during the non-breeding season across these populations.

937. Changes in the predicted population size for gannets breeding at the Bass Rock with and without the Scenario One & UK projects over 50 years are shown in Table 9-190.

Table 9-190: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG, F&T & UK projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Gannet	Forth Islands 75,259 pairs	203,046 pairs	172,618 pairs	-14.99%	85.01%

938. The gannet breeding population at the Forth Islands SPA is predicted to increase over the 50 year period, although the predicted end population is lower when the Scenario One & UK projects are present compared to the baseline (Table 9-190). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 14.99%. The predicted end population and the CPS value are both higher for the Scenario One & UK projects, compared with Scenario Two (NnG & 2014 F&T projects, no UK projects) after 50 years (148,150 pairs) (Table 9-185), but slightly lower than the predicted end population for Scenario One (No UK projects) (175,208 pairs) (Table 9-180). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment and of subsequent apportioning of impacts during the non-breeding season across these populations.

939. A comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One and UK projects over 25 years and 50 years is shown in Table 9-191.

Table 9-191: Comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One and UK projects over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG, F&T & UK projects (collisions all year)	Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG, F&T & UK projects (collisions all year)
Gannet	Forth Islands	0.5	0.03	0.01

940. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over 25 years at least 3% and over 50 years at least 1% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a low probability of the unimpacted population being at or below the median of the impacted population.

Scenario 2 & UK

941. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 25 years are shown in Table 9-192.

Table 9-192: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farms)	Percentage point change with NnG, F&T & UK projects after 25 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Gannet	Forth Islands	1.7171	-0.648	-37.76	62.24%

942. For both the baseline and built scenarios, the gannet population growth rate at the Forth Islands SPA is predicted to increase over the 25 year period, although there is a decrease in this growth rate when the Scenario Two and UK projects are present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 37.36% (Table 9-192). Alternatively, the counterfactual of the growth rate is 62.24% of that for the scenario with no wind farms constructed.

943. The change in median annual growth rate for the Scenario Two and UK projects, was only slightly larger (-37.76%) than Scenario Two with no UK projects) (-36.81%) (Table 9-182). The value for the associated counterfactual (62.24%) followed a similar pattern (63.19%). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and of subsequent apportioning of impacts across these populations.

944. Changes in the predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 25 years are shown in Table 9-193.

Table 9-193: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG, F&T & UK projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Gannet	Forth Islands 75,259 pairs	132,394 pairs	112,406 pairs	-15.10	84.90%

945. For both the baseline and built scenarios, the gannet breeding population at the Forth Islands SPA is predicted to increase over the 25 year period, although the predicted end population is lower when the Scenario Two and UK projects are present (Table 9-193). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 15.10%. The predicted end population and the CPS value are both only slightly lower for the Scenario Two and UK projects, compared with Scenario Two (NnG & 2014 F&T projects, no UK projects) (112,892 pairs and CPS value of 85.27% (Table 9-183). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and of subsequent apportioning of impacts during the non-breeding season across these populations.

946. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 50 years are shown in Table 9-194.

Table 9-194: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farms)	Percentage point change with NnG, F&T & UK projects after 50 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Gannet	Forth Islands	1.7189	-0.650	-37.81	62.19%

947. For both the baseline and built scenarios, the gannet population growth rate at the Forth Islands SPA is predicted to increase over the 50 year period, although there is a decrease in this growth rate when the Scenario Two and UK projects are present (Table 9-194). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 37.81%, which is very slightly larger than for the 25 year assessment (-37.76%) (Table 9-192). The counterfactual of the growth rate (62.19%) is also correspondingly slightly lower than for the 25 year assessment (62.24%).

948. This change in median annual growth rate is only slightly larger for the Scenario Two and UK projects, compared with Scenario Two (NnG & 2014 F&T projects, no UK projects) (-36.79%), with a corresponding similarity between the values for the counterfactual of the growth rate (Table 9-184). This is a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and of subsequent apportioning of impacts during the non-breeding season across these populations.

949. Changes in the predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 50 years are shown in Table 9-195.

Table 9-195: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG, F&T & UK projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Gannet	Forth Islands 75,259 pairs	203,046 pairs	146,818 pairs	-27.69	72.31%

950. For both the baseline and built scenarios, the gannet breeding population at the Forth Islands SPA is predicted to increase over the 50 year period, although the predicted end population is lower when the Scenario Two and UK projects are present compared to the baseline (Table 9-195). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of -27.69%, with a corresponding CPS value of 72.31%. The predicted end population and the CPS value are both only slightly lower for the Scenario Two and UK projects, compared with Scenario Two (NnG & 2014 F&T projects, no UK projects) after 50 years (148,150 pairs and CPS value of 72.96%) (Table 9-185). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment and of subsequent apportioning of impacts during the non-breeding season across these populations.

951. A comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 25 years and 50 years is shown in Table 9-196.

Table 9-196: Comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG, F&T & UK projects (collisions all year)	Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG, F&T & UK projects (collisions all year)
Gannet	Forth Islands	0.5	0	0

952. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over both 25 years and 50 years 0% of the model runs end below the median population size of the unimpacted population. This indicates that there is a low probability of the unimpacted population being at or below the median of the impacted population.

9.9.5.1.2 Kittiwake

953. As with gannet, the PVA modelled outputs from the 2017 and 2014 design scenarios for Inch Cape and Seagreen A and B, termed Scenario One and Scenario Two respectively. As recommended in the Scoping Opinion, the PVA modelled the effects of annual collisions on their own, and also with annual displacement (Marine Scotland, 2017).

Scenario One: NnG 2017 design scenario and 2017 Inch Cape and Seagreen Phase 1 design scenarios

954. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 25 years are shown in Table 9-197.

Table 9-197: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farm)	Percentage point change with NnG & F&T projects after 25 years		Percentage change in median annual growth rate compared to baseline		Counterfactual of the annual growth rate	
			Collision (y)	Collision (y) & Disp (br)	Collision (y)	Collision (y) & Disp (br)	Collision (y)	Collision (y) & Disp (br)
Kittiwake	Forth Islands	0.9099	-0.508	-0.628	-55.87	-68.99	44.13%	31.01%
	Fowlsheugh	-2.2647	-0.384	-0.475	-16.93	-20.96	116.93%	120.96%

955. For the Forth Islands SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to increase slightly over the 25 year period, although there is a slightly lower rate of increase when NnG and the 2017 Forth and Tay projects are present (Table 9-197). When collision and displacement effects were considered together, the percentage point change in the predicted population growth rate was larger, compared to collision effects alone. The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both

overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

956. For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease over the 25 year period, with a slightly higher rate of decrease when NnG and the 2017 Forth and Tay projects are present (Table 9-197). Collision and displacement effects combined resulted in a larger percentage change than collision alone. For the counterfactual of the annual growth rate, as the baseline population for kittiwake at Fowlsheugh SPA has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

957. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 25 years are shown in Table 9-198.

Table 9-198: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG & F&T projects		Percentage change in median final population size compared to baseline		Counterfactual of Population Size (CPS	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
Kittiwake	Forth Islands 4,663 pairs	6,118 pairs	5,380 pairs	5,202 pairs	-12.07	-14.97	87.93%	85.03%
	Fowlsheugh 9,665 pairs	4,629 pairs	4,166 pairs	4,084 pairs	-9.99	-11.77	90.01%	88.23%

958. For the Forth Islands SPA, the kittiwake breeding population is predicted to be higher than the start population at the end of the 25 year period, although the end population is predicted to be lowerwhen NnG and the 2017 Forth and Tay projects are present (Table 9-198). The largest difference was predicted to occur for combined collisions throughout the year and displacement in the breeding season. Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG and the 2017 Forth and Tay projects is a maximum decrease of 14.97% for the Forth Islands SPA, for collisions throughout the year and displacement in the breeding season. This gives a CPS value of 85.03% of the scenario with no wind farm.

959. For the Fowlsheugh SPA, the kittiwake breeding population is predicted to be lower than the start population at the end of the 25 year period, with a lower predicted end population when NnG and the 2017 Forth and Tay projects are present (Table 9-198). There was a slightly lower end population predicted for combined collisions throughout the year and displacement in the breeding season, compared to collisions alone. Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG and the 2017 Forth and Tay projects is a maximum decrease of 11.77% for Fowlsheugh SPA, for combined collisions throughout the year and displacement in the breeding season. This gives a CPS value of 88.23% of the scenario with no wind farm.

960. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 50 years are shown in Table 9-199.

Table 9-199: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farm)	Percentage point change with NnG & F&T projects after 50 years		Percentage change in median annual growth rate compared to baseline		Counterfactual of the annual growth rate	
			Collision (y)	Collision (y) & Disp (br)	Collision (y)	Collision (y) & Disp (br)	Collision (y)	Collision (y) & Disp (br)
Kittiwake	Forth Islands	0.9068	-0.511	-0.625	-56.36	-68.88	43.64%	31.12%
	Fowlsheugh	-2.2758	-0.385	-0.466	-16.90	-20.49	116.90%	120.49%

961. For the Forth Islands SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to increase slightly over the 50 year period, although there is a slightly lower rate of increase when NnG and the 2017 Forth and Tay projects are present (Table 9-199). When collision and displacement effects were considered together, the percentage point change in the predicted population growth rate was slightly larger, compared to collision effects alone. The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 50 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease over the 50 year period, with a slightly higher rate of decrease when NnG and the 2017 Forth and Tay projects are present (Table 9-199). Collision and displacement effects combined resulted in a larger percentage change than collision alone. For the counterfactual of the annual growth rate, as the baseline population for kittiwake at Fowlsheugh SPA has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios. Percentage change and associated CPS values were similar to those estimated after 25 years (Table 9-197).

962. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 50 years are shown in Table 9-200.

Table 9-200: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG & F&T projects		Percentage change in median final population size compared to baseline		Counterfactual of Population Size (CPS	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
Kittiwake	Forth Islands 4,663 pairs	7,665 pairs	5,920 pairs	5,593 pairs	-22.77	-27.03	77.23%	72.97%
	Fowlsheugh 9,665 pairs	2,593 pairs	2,125 pairs	2,036 pairs	-18.03	-21.50	81.97%	78.50%

963. Overall, with no wind farms present, the Forth Islands SPA population was predicted to be higher after 50 years than the current population level. When NnG and the 2017 Forth and Tay projects are present, the end population is predicted to be lower than the baseline end population, with a slightly lower end population predicted for combined collisions throughout the year and displacement in the breeding season, compared to collisions alone (Table 9-200). This gives a CPS value of 72.97% of the scenario with no wind farm.

964. For the Fowlsheugh SPA population, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be lower than the start population after 50 years, with a lower predicted end population when NnG and the 2017 Forth and Tay projects are present (Table 9-200). There was a slightly lower end population predicted for combined collisions throughout the year and displacement in the breeding season, compared to collisions alone. Similarly, CPS values were slightly lower for collisions and displacement throughout the year, compared to collisions alone.

965. A comparison of the 50th centile values for kittiwakes breeding at the Forth Islands and Fowlsheugh SPAs with and without NnG and the 2017 Forth and Tay projects over 25 years and 50 years is shown in Table 9-201.

Table 9-201: Comparison of the 50th centile values for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG & F&T projects		Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG & F&T projects	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
Kittiwake	Forth Islands	0.50	0.03	0.01	0.01	0
	Fowlsheugh	0.50	0.06	0.03	0.03	0.01

966. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below

the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted Forth Islands SPA populations shows that over 25 years, between 1% and 3%, and over 50 years between 0% and 1% of the model runs end not lower than the median population size of the unimpacted population. For Fowlsheugh SPA, over 25 years, between 3% and 6%, and over 50 years between 1% and 3% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a low probability of the unimpacted population being at or below the median of the impacted population.

Scenario Two: NnG 2017 design scenario and 2014 Inch Cape and Seagreen A and B design scenarios

967. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 25 years are shown in Table 9-202.

Table 9-202: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farm)	Percentage point change with NnG & F&T projects after 25 years		Percentage change in median annual growth rate compared to baseline		Counterfactual of the annual growth rate	
			Collision (y)	Collision (y) & Disp (br)	Collision (y)	Collision (y) & Disp (br)	Collision (y)	Collision (y) & Disp (br)
Kittiwake	Forth Islands	0.9099	-1.464	-1.583	-160.92	-174.00	-60.92%	-74.00%
	Fowlsheugh	-2.2647	-1.104	-1.193	-48.73	-52.69	148.73%	152.69%

968. For the Forth Islands SPA, for the baseline scenario, the population growth rate for kittiwake is predicted to increase slightly over the 25 year period. With NnG and the 2014 Forth and Tay projects present, the population is predicted to decline, with a percentage point change of -1.464 from the baseline, for collision alone (Table 9-202). When collision and displacement effects were considered together, the percentage point change in the predicted population growth rate was slightly larger (-1.583), compared to collision effects alone. The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

969. For Fowlsheugh SPA, for both baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease slightly over the 25 year period, with a higher rate of decrease for combined annual collision and breeding season displacement effects, compared to collision alone. The difference between the associated counterfactual of the growth rate values was also slightly greater for collision and displacement than for collision alone. For the counterfactual of the annual growth rate, as the baseline population for kittiwake has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

970. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 25 years are shown in Table 9-203.

Table 9-203: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG & F&T projects		Percentage change in median final population size compared to baseline		Counterfactual of Population Size (CPS	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
Kittiwake	Forth Islands 4,663 pairs	6,118 pairs	4,199 pairs	4,059 pairs	-31.36	-33.66	68.64%	66.34%
	Fowlsheugh 9,665 pairs	4,629 pairs	3,454 pairs	3,367 pairs	-25.39	-27.27	74.61%	72.74%

971. For the Forth Islands SPA, for the baseline scenario, the kittiwake end population is predicted to be higher after 25 years than the start population. With NnG and the 2014 Forth and Tay projects present, the kittiwake end population is predicted to be lower after 25 years than the start population (Table 9-203). The largest difference is predicted to occur for annual collisions and displacement in the breeding season. Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG and the 2014 Forth and Tay projects is a maximum decrease of 33.66% for the Forth Islands SPA, for annual collisions and breeding season displacement. This gives a CPS value of 66.34% of the scenario with no wind farm.

972. For the Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding end population is predicted to be lower than the start population, after 25 years, with a lower end population predicted when NnG and the 2014 Forth and Tay projects are present (Table 9-203). There was a lower end population predicted for annual collisions and breeding season displacement combined, compared to collisions only and this was also the same for the CPS values.

973. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 50 years are shown in Table 9-204.

Table 9-204: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farm)	Percentage point change with NnG & F&T projects after 50 years		Percentage change in median annual growth rate compared to baseline		Counterfactual of the annual growth rate	
			Collision (y)	Collision (y) & Disp (br)	Collision (y)	Collision (y) & Disp (br)	Collision (y)	Collision (y) & Disp (br)
Kittiwake	Forth Islands	0.9068	-1.460	-1.561	-160.97	-172.12	-60.97%	-72.12%
	Fowlsheugh	-2.2758	-1.103	-1.194	-48.47	-52.46	148.47%	152.46%

974. For the Forth Islands SPA, for the baseline scenario, the population growth rate for kittiwake is predicted to increase slightly over the 50 year period. With NnG and the 2014 Forth and Tay projects present, the population is predicted to decline, with a percentage point change of -1.460 from the baseline, for collision alone (Table 9-204). When collision and displacement effects were considered

together, the percentage point change in the predicted population growth rate was slightly larger (-1.561), compared to collision effects alone. These values were very similar to those predicted for the 25 year scenario (Table 9-202). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

975. For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease slightly over the 50 year period, with the rate of population decrease higher when NnG and the 2014 Forth and Tay projects are present (Table 9-204). When collision and displacement effects were considered together, the change in the predicted population growth rate was slightly larger, compared to collision effects alone. The difference between the associated counterfactual of the growth rate values was also slightly greater for collision and displacement than for collision alone. For the counterfactual of the annual growth rate, as the baseline population for kittiwake has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

976. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 50 years are shown in Table 9-205.

Table 9-205: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG & F&T projects		Percentage change in median final population size compared to baseline		Counterfactual of Population Size (CPS	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
Kittiwake	Forth Islands 4,663 pairs	7,665 pairs	3,644 pairs	3,458 pairs	-52.46	-54.88	47.54%	45.12%
	Fowlsheugh 9,665 pairs	2,593 pairs	1,462 pairs	1,399 pairs	-43.61	-46.07	56.39%	53.93%

977. For the Forth Islands SPA, for the baseline scenario, the kittiwake end population is predicted to be higher after 50 years than the start population. With NnG and the 2014 Forth and Tay projects present, the kittiwake end population is predicted to be lower than the start population after 50 years (Table 9-203). The largest difference is predicted to occur for annual collisions and displacement in the breeding season. Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG and the 2014 Forth and Tay projects is a maximum decrease of 54.88% for the Forth Islands SPA, for annual collisions and breeding season displacement. This gives a CPS value of 45.12% of the scenario with no wind farm. These values are lower than predicted after 25 years (Table 9-203).

978. For Fowlsheugh SPA, for both baseline and built scenarios, the end population was predicted to be lower than the start level after 50 years, with a lower end population predicted when NnG and the 2014 Forth and Tay projects are present (Table 9-205). A slightly lower end population was predicted for annual collisions and breeding season displacement combined, compared to collisions alone. Similarly, CPS values were slightly lower for annual collisions and breeding season displacement, compared to collisions alone. Predicted values are lower than predicted for Fowlsheugh SPA after 25 years (Table 9-203).

979. As expected, the 2014 Forth & Tay design scenarios gave lower predicted end populations than the 2017 Forth & Tay design scenarios, largely due to the greater number of turbines (Table 9-200).

980. A comparison of the 50th centile values for kittiwakes breeding at the Forth Islands and Fowlsheugh SPAs with and without NnG and the 2014 Forth and Tay projects over 25 years and 50 years is shown in Table 9-206.

Table 9-206: Comparison of the 50th centile values for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG & F&T projects		Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG & F&T projects	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
Kittiwake	Forth Islands	0.50	0	0	0	0
	Fowlsheugh	0.50	0	0	0	0

981. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over both 25 years and 50 years, 0% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a very low probability of the unimpacted population being at or below the median of the impacted population.

NnG, Inch Cape and Seagreen, plus UK North Sea OWF projects

982. For kittiwake, the Scoping Opinion recommended that the PVA assessed cumulative collision impacts arising from NnG, Inch Cape and Seagreen in the breeding season, together with collision impacts in the non-breeding season from other projects in the UK North Sea (Marine Scotland, 2017).

983. As previously, Scenario One was for the NnG 2017 design scenario, and Inch Cape and Seagreen Phase 1 design scenarios. Scenario Two considered the NnG 2017 design scenario with the 2014 consented designs for Inch Cape and Seagreen A and B.

984. For clarity, these are referred to as “Scenario One & UK” and “Scenario Two & UK” in the following text and tables.

Scenario 1 and UK

985. For kittiwake, the Scoping Opinion recommended that the PVA assessed cumulative collision impacts arising from NnG, Inch Cape and Seagreen Phase 1 in the breeding season, together with collision impacts in the non-breeding season from other projects in the UK North Sea (Marine Scotland, 2017).

For clarity, these are referred to as NnG, F & T and UK projects in the following text and tables. As previously stated, the PVA only considered collision impacts for kittiwake for the UK North Sea OWF projects.

986. Changes in the predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 25 years are shown in Table 9-207.

Table 9-207: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farms)	Percentage point change with NnG, F&T & UK projects after 25 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Kittiwake	Forth Islands	0.9099	-0.353	-38.74	61.26%
	Fowlsheugh	-2.2647	-0.303	-13.38	113.38%

987. For the Forth Islands SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to increase slightly over 25 years, although there is a lower rate of increase when the Scenario One and UK projects are present. With Scenario One and the UK projects present, there is a predicted percentage point change of -0.353 from the baseline (Table 9-207). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

988. For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease over 25 years, with a slightly higher rate of decrease when the Scenario One and UK projects are present. For the counterfactual of the annual growth rate, as the baseline population for kittiwake has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

989. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 25 years are shown in Table 9-208.

Table 9-208: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG, F&T & UK projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Kittiwake	Forth Islands 4,663 pairs	6,118 pairs	5,603 pairs	-8.42	91.58%
	Fowlsheugh 9,665 pairs	4,629 pairs	4,285 pairs	-7.43	92.57%

990. For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be higher than the start population after 25 years, although the end population is predicted to be lower when the Scenario One and UK projects are present, compared to the baseline end population (Table 9-208). For the Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be lower than the start population after 25 years, with the end population when the Scenario One and UK projects are present predicted to be lower than the baseline end population.

991. Overall, for both SPA populations, the change in the median final population size when comparing the baseline (no wind farm) with the Scenario One and UK projects was lower (and CPS values higher) than predicted for Scenario One (no UK projects) (Table 9-198) and Scenario Two (no UK projects) (Table 9-203). This is a result of including kittiwakes from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and the subsequent apportioning of impacts during the non-breeding season across these populations.

992. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 50 years are shown in Table 9-209.

Table 9-209: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farms)	Percentage point change with NnG, F&T & UK projects after 50 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Kittiwake	Forth Islands	0.9068	-0.343	-37.84	62.16%
	Fowlsheugh	-2.2758	-0.299	-13.13	113.13%

993. For the Forth Islands SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to increase slightly over 50 years, although there is a lower rate of increase when the Scenario One and UK projects are present. With Scenario One and the UK projects present, there is a predicted percentage point change of -0.343 from the baseline (Table 9-209). This is similar to the corresponding value predicted after 25 years (Table 9-207). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median

annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

994. For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease over 25 years, with a slightly higher rate of decrease when the Scenario One and UK projects are present. The predicted percentage point decline of -0.299 after 50 years was very similar to the value predicted after 25 years (Table 9-207). For the counterfactual of the annual growth rate, as the baseline population for kittiwake has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

995. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 50 years are shown in Table 9-210.

Table 9-210: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG, F&T & UK projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Kittiwake	Forth Islands 4,663 pairs	7,665 pairs	6,451 pairs	-15.84	84.16%
	Fowlsheugh 9,665 pairs	2,593 pairs	2,229 pairs	-14.03	%

996. For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be higher than the start population after 50 years, although the end population is predicted to be lower when the Scenario One and UK projects are present, compared to the baseline end population (Table 9-210). For the Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be lower than the start population after 25 years, with the end population when the Scenario One and UK projects are present predicted to be lower than the baseline end population.

997. Overall, for both SPA populations, the change in the median final population size when comparing the baseline (no wind farm) with the Scenario One and UK projects was lower (and CPS values higher) than predicted for Scenario One (no UK projects) (Table 9-200) and Scenario Two (no UK projects) (Table 9-205).

998. This is a result of including kittiwakes from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and the subsequent apportioning of impacts during the non-breeding season across these populations.

999. A comparison of the 50th centile values for kittiwakes breeding at the Forth Islands and Fowlsheugh SPAs with and without Scenario One and the UK projects over 25 years and 50 years is shown in Table 9-211.

Table 9-211: Comparison of the 50th centile values for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without Scenario One and the UK projects over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG, F&T & UK projects (collisions all year)	Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG, F&T & UK projects (collisions all year)
Kittiwake	Forth Islands	0.5	0.10	0.04
	Fowlsheugh	0.5	0.13	0.07

1000.For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that for the Forth Islands SPA over 25 years at least 10%, and 50 years at least 4% of the model runs end not lower than the median population size of the unimpacted population. Similarly, for Fowlsheugh SPA, over both 25 years and 50 years, between 13% and 7% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a low probability of the unimpacted population being at or below the median of the impacted population.

Scenario 2 and UK

1001.For kittiwake, the Scoping Opinion recommended that the PVA assessed cumulative collision impacts arising from NnG, Inch Cape and Seagreen A and B in the breeding season, together with collision impacts in the non-breeding season from other projects in the UK North Sea (Marine Scotland, 2017). For clarity, these are referred to as the Scenario Two and UK projects in the following text and tables. As previously stated, the PVA only considered collision impacts for kittiwake for the UK North Sea OWF projects.

1002.Changes in the predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 25 years are shown in Table 9-212.

Table 9-212: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farms)	Percentage point change with NnG, F&T & UK projects after 25 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Kittiwake	Forth Islands	0.9099	-0.778	-85.50	14.50%
	Fowlsheugh	-2.2647	-0.660	-29.14	129.14%

1003.For the Forth Islands SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to increase slightly over the 25 year period, although there is a lower rate of increase when the Scenario Two and UK projects are present (Table 9-212). With Scenario Two and the UK projects present, there is a predicted percentage point change of -0.778 from the baseline (Table 9-212). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

1004.For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease over 25 years, with a slightly higher rate of decrease when the Scenario Two and UK projects are present (Table 9-212). For the counterfactual of the annual growth rate, as the baseline population for kittiwake has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

1005.Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 25 years are shown in Table 9-213.

Table 9-213: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG, F&T & UK projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Kittiwake	Forth Islands 4,663 pairs	6,118 pairs	4,990 pairs	-18.44	81.56%
	Fowlsheugh 9,665 pairs	4,629 pairs	3,893 pairs	-15.89	84.11%

1006.For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be higher than the start population after 25 years, although the end population is predicted to be lower when the Scenario Two and UK projects are present, compared to the baseline end population (Table 9-213). For Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be lower than the start population after 25 years, with the end population when the Scenario Two and UK projects are present predicted to be lower than the baseline end population.

1007.Overall, for both SPA populations, the percentage change in the median final population size when comparing the baseline (no wind farm) with the Scenario Two and UK projects was lower than Scenario Two (no UK projects) for both SPAs, for the collisions only scenario (Table 9-203). The CPS values for the Scenario Two and UK projects were also higher than for Scenario Two (no UK projects). This is a result of including kittiwakes from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and the subsequent apportioning of impacts during the non-breeding season across these populations.

1008.Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 50 years are shown in Table 9-214.

Table 9-214: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farms)	Percentage point change with NnG, F&T & UK projects after 50 years (collisions all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Kittiwake	Forth Islands	0.9068	-0.784	-86.49	13.51%
	Fowlsheugh	-2.2758	-0.642	-28.19	128.19%

1009.For the Forth Islands SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to increase slightly over the 50 year period, although there is a lower rate of increase when the Scenario Two and UK projects are present (Table 9-214). With Scenario Two and the UK projects present, there is a predicted percentage point change of -0.774 from the baseline. This is similar to the value predicted after 25 years (Table 9-212). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

1010.For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease over 50 years, with a slightly higher rate of decrease when the Scenario Two and UK projects are present (Table 9-214). For the counterfactual of the annual growth rate, as the baseline population for kittiwake has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

1011.Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 50 years are shown in Table 9-215.

Table 9-215: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG, F&T & UK projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Kittiwake	Forth Islands 4,663 pairs	7,665 pairs	5,164 pairs	-32.63	67.37%
	Fowlsheugh 9,665 pairs	2,593 pairs	1,867 pairs	-27.99	72.01%

1012.For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be higher than the start population after 50 years, although the end population is predicted to be lower when the Scenario Two and UK projects are present, compared to the baseline end population (Table 9-215). For Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be lower than the start population after 50 years, with the end population when the Scenario Two and UK projects are present predicted to be lower than the baseline end population.

1013.Overall, for both SPA populations, the percentage changes in the median final population size when comparing the baseline (no wind farm) with the Scenario Two and UK projects for collision only, were lower than predicted for Scenario Two (no UK projects) (Table 9-205). The respective CPS values were also higher for the Scenario Two and UK projects. This is a result of including kittiwakes from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and the subsequent apportioning of impacts during the non-breeding season across these populations.

1014.A comparison of the 50th centile values for kittiwakes breeding at the Forth Islands and Fowlsheugh SPAs with and without Scenario Two and the UK projects over 25 years and 50 years is shown in Table 9-216.

Table 9-216: Comparison of the 50th centile values for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without Scenario Two and the UK projects over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG, F&T & UK projects (collisions all year)	Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG, F&T & UK projects (collisions all year)
Kittiwake	Forth Islands	0.5	0	0
	Fowlsheugh	0.5	0	0

1015.For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that for both the Forth Islands SPA and Fowlsheugh SPA over both 25 years and 50 years, 0% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a low probability of the unimpacted population being at or below the median of the impacted population.

9.9.5.1.3 Guillemot

1016.For guillemot, only annual displacement impacts were modelled in the cumulative PVA, covering cumulative displacement effects for NnG, Inch Cape and Seagreen A and B, as recommended in the Scoping Opinion (Marine Scotland, 2017). Only one scenario was modelled, as the displacement effects and site boundaries are the same for both the 2014 and 2017 Inch Cape and Seagreen projects.

1017.Changes in the predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years are shown in Table 9-217.

Table 9-217: Change in predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth and Tay projects over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farm)	Percentage point change with NnG & F&T projects after 25 years (displacement all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Guillemot	Forth Islands	1.8949	-0.063	-3.32	96.68%
	Fowlsheugh	2.3258	-0.024	-1.01	98.99%

1018.For both the baseline and built scenarios, the guillemot population growth rate at both the Forth Islands SPA and Fowlsheugh SPA is predicted to increase over 25 years, although there is a slight decrease in these growth rates when NnG and the Forth & Tay projects are present. Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with the built scenario was similar for the two SPAs, with a slightly higher rate of decrease for the Forth Islands SPA (Table 9-217). The counterfactual of the growth rate also followed this pattern. These results indicate that displacement arising from NnG and the Forth and Tay projects will not have a significant negative effect on breeding guillemots at these two SPAs.

1019.Changes in the predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years are shown in Table 9-218.

Table 9-218: Change in predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG & F&T projects (displacement all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Guillemot	Forth Islands 38,573 pairs	67,234 pairs	66,454 pairs	-1.16	98.84%
	Fowlsheugh 74,379 pairs	150,711 pairs	149,071 pairs	-1.09	98.91%

1020.For the Forth Islands SPA, for both the baseline and built scenarios, the guillemot breeding population is predicted to increase over 25 years, although the end population is predicted to be slightly lower when NnG and the Forth & Tay projects are present (Table 9-218). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 1.16%. This gives a CPS value of 98.84% of the scenario with no wind farm.

1021.For the Fowlsheugh SPA, for both the baseline and built scenarios, the guillemot breeding population is also predicted to increase over 25 years, although the end population is predicted to be slightly lower when NnG and the Forth & Tay projects are present. Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is decrease of 1.09%, while the CPS value is 98.91% of the scenario with no wind farm. This indicates that there is predicted to be very little impact from displacement from NnG and the Forth and Tay projects on the guillemot breeding populations at Forth Islands SPA and Fowlsheugh SPA over 25 years.

1022.Changes in the predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years are shown in Table 9-219.

Table 9-219: Change in predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farm)	Percentage point change with NnG & F&T projects after 50 years (displacement all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Guillemot	Forth Islands	1.8916	-0.045	-2.39	97.61%
	Fowlsheugh	2.3278	-0.045	-1.94	98.06%

1023.The population growth rate for guillemots at both the Forth Islands SPA and Fowlsheugh SPA is predicted to increase over the 50 year period, although there is a slight decrease in this growth rate when NnG and the Forth & Tay projects are present. Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with NnG and the Forth & Tay projects is a decrease of 2.39% for the Forth Islands SPA and a slightly lower decrease (-1.94%) for Fowlsheugh SPA (Table 9-219). The counterfactuals of the growth rate also followed this pattern. These results were similar to the predicted growth rates for the first 25 year period (Table 9-217), and indicate that displacement arising from NnG and the Forth and Tay projects will not have a significant negative effect on breeding guillemots at these two SPAs.

1024.Changes in the predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years are shown in Table 9-220.

Table 9-220: Change in predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG & F&T projects (displacement all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Guillemot	Forth Islands 38,573 pairs	108,366 pairs	105,244 pairs	-2.88	97.12%
	Fowlsheugh 74,379 pairs	267,057 pairs	261,912 pairs	-1.93	98.07%

1025.For the Forth Islands SPA, for both the baseline and built scenarios, the guillemot breeding population is predicted to increase over 50 years, with a slightly lower end population predicted when NnG and the Forth & Tay projects are present (Table 9-220). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 2.88%. This gives a counterfactual population size that is 97.12% of the scenario with no wind farm.

1026.For the Fowlsheugh SPA, for both the baseline and built scenarios, the guillemot breeding population is also predicted to increase over 50 years, with a slightly lower end population predicted when NnG and the Forth & Tay projects are present. Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is decrease of 1.93%, while the CPS value is 98.07% of the scenario with no wind farm. These results were similar to the predicted end populations for the first 25 year period (Table 9-218), and indicate that there is predicted to be very little impact from displacement from NnG and the Forth & Tay projects on the breeding populations at Forth Islands SPA and Fowlsheugh SPA over the 50 year lifetime of the Project.

1027. A comparison of the 50th centile values for guillemots breeding at the Forth Islands and Fowlsheugh SPAs with and without NnG and the Forth & Tay projects over 25 years and 50 years is shown in Table 9-221.

Table 9-221: Comparison of the 50th centile values for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG & F&T projects (displacement all year)	Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG & F&T projects (displacement all year)
Guillemot	Forth Islands	0.50	0.47	0.43
	Fowlsheugh	0.50	0.45	0.45

1028. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted Forth Islands SPA populations shows that over 25 years and 50 years, between 47% and 43% of the model runs end not lower than the median population size of the unimpacted population. For the Fowlsheugh SPA, both 25 years and 50 years were similar, with a maximum of 45% of the model runs ending not lower than the median population size of the unimpacted population. This indicates that there is a high probability of the unimpacted population being at or below the median of the impacted population.

9.9.5.1.4 Razorbill

1029. Changes in the predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years are shown in Table 9-222.

Table 9-222: Change in predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farm)	Percentage point change with NnG & F&T projects after 25 years (displacement all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Razorbill	Forth Islands	0.0313	-0.113	-360.70	-260.70%
	Fowlsheugh	0.9516	-0.181	-19.00	81.00%

1030. For the Forth Islands SPA, for the baseline scenario, the population growth rate for razorbill is predicted to increase slightly over the 25 year period. With NnG and the Forth and Tay projects present, the population is predicted to decline, with a percentage point change of -0.113 from the baseline (Table 9-222). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA razorbill population is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

1031. For Fowlsheugh SPA, for the baseline and built scenarios, the razorbill population growth rate is predicted to increase over 25 years, although there is a slight decrease in this growth rate when NnG and the Forth & Tay projects are present (Table 9-222). Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with the built scenario is a decrease of 19.00%, with a corresponding counterfactual of the growth rate of 81.00%.

1032. Changes in the predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years are shown in Table 9-223.

Table 9-223: Change in predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG & F&T projects (displacement all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Razorbill	Forth Islands 7,792 pairs	7,862 pairs	7,563 pairs	-3.80	96.20%
	Fowlsheugh 9,950 pairs	13,491 pairs	12,923 pairs	-4.21	95.79%

1033. For the Forth Islands SPA, for the baseline scenario, the razorbill breeding population is predicted to be slightly higher than the start population after 25 years. With NnG and the Forth & Tay projects present, the end population after 25 years is predicted to be slightly lower than the start population (Table 9-223). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 3.80%. This results in a CPS value of 96.20% of the scenario with no wind farm.

1034. For the Fowlsheugh SPA, for both the baseline and built scenarios, the razorbill breeding population is predicted to be higher than the start population after 25 years, although the end population is predicted to be slightly lower when NnG and the Forth & Tay projects are present (Table 9-223). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 4.21%, and the CPS value is 95.79% of the scenario with no wind farm.

1035. Changes in the predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years are shown in Table 9-224.

Table 9-224: Change in predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years

Species	SPA Population	Baseline change after 50 years (no wind farm)	Percentage point change with NnG & F&T projects after 50 years (displacement all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Razorbill	Forth Islands	0.0631	-0.173	-274.17	-174.17%
	Fowlsheugh	0.9416	-0.133	-14.14	85.86%

1036.For the Forth Islands SPA, for the baseline scenario, the population growth rate for razorbill is predicted to increase slightly over the 25 year period. With NnG and the Forth and Tay projects present, the population is predicted to decline, with a percentage point change of -0.173 from the baseline (Table 9-224), which was slightly larger than predicted after 25 years (Table 9-222). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA razorbill population is predicted to be fairly stable over 50 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

1037.For Fowlsheugh SPA, for the baseline and built scenarios, the razorbill population growth rate is predicted to increase over 50 years, although there is a slight decrease in this growth rate when NnG and the Forth & Tay projects are present (Table 9-224). Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with the built scenario is a decrease of 14.14%, with a corresponding counterfactual of the growth rate of 85.86%.

1038.Changes in the predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years are shown in Table 9-225.

Table 9-225: Change in predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG & F&T projects (displacement all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Razorbill	Forth Islands 7,792 pairs	8,063 pairs	7,428 pairs	-7.88	92.12%
	Fowlsheugh 9,950 pairs	16,932 pairs	15,910 pairs	-6.04	93.96%

1039.For the Forth Islands SPA, for the baseline scenario, the razorbill breeding population is predicted to be slightly higher than the start population after 50 years. With NnG and the Forth & Tay projects present, the end population after 50 years is predicted to be slightly lower than the start population (Table 9-225). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG and the Forth & Tay projects is a decrease of 7.88%. This results in a CPS value of 92.12% of the scenario with no wind farm.

1040.For the Fowlsheugh SPA, for both the baseline and built scenarios, the razorbill breeding population is predicted to be higher than the start population after 25 years, although the end population is predicted to be slightly lower when NnG and the Forth & Tay projects are present. Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG and the Forth & Tay projects is a decrease of 6.04%, with a CPS value that is 93.96% of the scenario with no wind farm. The percentage change in population size and associated CPS values were slightly lower than predicted values after 25 years (Table 9-223), but indicate that there is predicted to be little impact from displacement from NnG and the Forth & Tay projects on the breeding populations at Forth Islands SPA and Fowlsheugh SPA over the 50 year lifetime of the Project.

1041.A comparison of the 50th centile values for razorbills breeding at the Forth Islands and Fowlsheugh SPAs with and without NnG and the Forth & Tay projects over 25 years and 50 years is shown in Table 9-226.

Table 9-226: Comparison of the 50th centile values for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years and 50 years

Species	SPA Population	50th centile for unimpacted population (Baseline)	Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG & F&T projects (displacement all year)	Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG & F&T projects (displacement all year)
Razorbill	Forth Islands	0.50	0.42	0.39
	Fowlsheugh	0.50	0.42	0.41

1042.For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted Forth Islands SPA populations shows that over 25 years and 50 years, between 42% and 39% of the model runs end not lower than the median population size of the unimpacted population. For the Fowlsheugh SPA, over 25 years and 50 years, between 42% and 41% of the model runs ended not lower than the median population size of the unimpacted population. This indicates that there is a high probability of the unimpacted population being at or below the median of the impacted population.

9.9.5.1.5 Puffin

1043.Changes in the predicted population growth rate for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 25 years are shown in Table 9-227.

Table 9-227: Change in predicted population growth rate for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 25 years

Species	SPA Population	Baseline change after 25 years (no wind farm)	Percentage point change with NnG & F&T projects after 25 years (displacement all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Puffin	Forth Islands	4.6103	-0.088	-1.92	98.08%

1044.The puffin population growth rate at the Forth Islands SPA is predicted to increase over the 25 year period, although there is a slight decrease in this growth rate when NnG and the Forth & Tay projects are present. Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with the built scenario is a decrease of 1.92%, with a corresponding counterfactual of the growth rate of 98.08% (Table 9-227).

1045.Changes in the predicted population size for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 25 years are shown in Table 9-228.

Table 9-228: Change in predicted population size for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 25 years

Species	SPA & start Population	Baseline population after 25 years (no wind farm)	Population after 25 years with NnG & F&T projects (displacement all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Puffin	Forth Islands 45,005 pairs	174,231 pairs	169,773 pairs	-2.56	97.44%

1046.For the Forth Islands SPA, for both the baseline and built scenarios, the puffin breeding population is predicted to increase over 25 years compared to the start population, with a slightly lower end population when NnG and the Forth & Tay projects are present (Table 9-228). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 2.56%. This results in a CPS value of 97.44% of the scenario with no wind farm, indicating that displacement will not have a negative effect on breeding puffins at the Forth Islands SPA over 25 years.

1047.Changes in the predicted population growth rate for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 50 years are shown in Table 9-229.

Table 9-229: Change in predicted population growth rate for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 50 years

Species	SPA Population	Baseline change after 25 years (no wind farm)	Percentage point change with NnG & F&T projects after 25 years (displacement all year)	Percentage change in median annual growth rate compared to baseline	Counterfactual of the annual growth rate
Puffin	Forth Islands	4.6011	-0.084	-1.82	98.18%

1048.The puffin population growth rate at the Forth Islands SPA is predicted to increase over the 50 year period, although there is a slight decrease in this growth rate when NnG and the Forth & Tay projects are present. Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with NnG and the Forth & Tay projects is a decrease of 1.82% for the Forth Islands SPA (Table 9-229). This is a slightly lower decrease than was predicted over 25 years (-1.92%) (Table 9-227). The corresponding counterfactual value showed a similar pattern, compared to the 25 year period.

1049.Changes in the predicted population size for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 50 years are shown in Table 9-230.

Table 9-230: Change in predicted population size for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 50 years

Species	SPA & start Population	Baseline population after 50 years (no wind farm)	Population after 50 years with NnG & F&T projects (displacement all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
Puffin	Forth Islands 45,005 pairs	531,902 pairs	510,482 pairs	-4.03	95.97%

1050. For the Forth Islands SPA, for both the baseline and built scenarios, the puffin breeding population is predicted to increase over 50 years compared to the start population, with a lower end population when NnG and the Forth & Tay projects are present (Table 9-230). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 4.03%. This is a slightly larger decrease than was predicted over 25 years (-2.56%) (Table 9-228). The CPS value for the 50 year assessment is also slightly lower than for the 25 year period.

PVA conclusions

1051. For gannet, the cumulative PVA only considered annual collision effects. For all cumulative wind farm scenarios tested, the predicted population growth rate increased, regardless of the modelled build scenario, although the predicted rate of population growth and resulting end population was lower than for the baseline scenario, with no wind farms built. As would be expected, the population growth rate and end population was lowest for NnG and the 2014 Forth and Tay projects, as this scenario involves the highest number of turbines, and consequently a higher predicted number of collisions, with all of these being assigned to the local breeding populations. Overall, results indicate that collision impacts from NnG and the Forth and Tay projects on the breeding gannet population at Forth Islands SPA over the lifetime of the Project are not likely to be significant.

1052. For kittiwake, the cumulative PVA considered collision effects in isolation and in combination with breeding season displacement effects for the Forth and Tay wind farms for both Scenarios One and Two, as well as collision effects for other UK North Sea wind farms in the non-breeding season. Of the two SPA populations modelled, Forth Islands SPA showed an increase in the baseline scenario, while Fowlsheugh SPA showed a decline in the baseline scenario. For the Forth Islands SPA, the increases remained evident for NnG and the 2017 Forth and Tay projects, even when other UK North Sea projects were included. When NnG and the 2014 Forth and Tay projects were included, the population growth rate and resulting end population decreased, as this scenario involves the highest number of turbines, and consequently a higher predicted number of collisions, with all of these being assigned to the local breeding populations.

1053. For Fowlsheugh SPA, for the modelled wind farm scenarios, the declines in the baseline scenario remained evident and were slightly enhanced, with lowest results for NnG and the 2014 Forth and Tay projects, as would be expected.

1054. Overall, results indicate that cumulative collision and displacement impacts from NnG, the Forth and Tay projects and other UK North Sea wind farms on the breeding kittiwake population at Forth Islands SPA and Fowlsheugh SPA over the lifetime of the Project are likely to be small and have relatively little influence on the resulting population size.For guillemot and razorbill, the cumulative PVA only considered displacement effects throughout the year for Forth Islands SPA and Fowlsheugh SPA. For guillemot, for all cumulative wind farm scenarios tested, the predicted population growth rate and end populations increased, regardless of the modelled build scenario. For both the 25 year and 50 year assessments, the difference between the population growth rate and end populations for the baseline and built scenarios was very small, indicating that displacement impacts from NnG and the

Forth and Tay projects on the breeding population of guillemots at Forth Islands SPA and Fowlsheugh SPA over the lifetime of the Project are not likely to be significant.

1055. For razorbill, of the two SPA populations modelled, both Forth Islands SPA and Fowlsheugh SPA showed an increase in the baseline scenario over 25 and 50 years, although the increase at Forth Islands SPA was very low. For the Forth Islands SPA, cumulative displacement effects were predicted to result in a decline in the population growth rate when NnG and the Forth and Tay projects were present, while the end populations after 25 and 50 years were slightly lower than the end populations for the baseline scenario. For Fowlsheugh SPA, for both the 25 year and 50 year assessments, the difference between the population growth rate and end populations for the baseline and built scenarios was small. Overall, results indicated that there is likely to be little impact from displacement from NnG and the Forth and Tay projects on the breeding populations of razorbills at Forth Islands SPA and Fowlsheugh SPA over the lifetime of the Project.

1056. For puffin, for the cumulative wind farm scenarios tested, the predicted population growth rate and end population increased, regardless of the modelled build scenario, although the predicted rate of population growth and resulting end population was lower than for the baseline scenario, with no wind farms built. This indicates that displacement impacts from NnG and the Forth and Tay projects on the breeding population of puffins at Forth Islands SPA over the lifetime of the Project are not likely to be significant.

1057. When interpreting the PVA results, it should be remembered that predicting longer term trends in seabird populations is difficult and that a number of assumptions have been made for this PVA assessment.

1058. Following the advice in the Scoping Opinion (Marine Scotland, 2017), the models used were density independent, which means that no account is taken of potentially limiting factors at a breeding colony such as lack of space for additional breeding birds. In other words, the model can predict increasing numbers of birds over time, and these increasing numbers of birds will have no effect on the model results. Although this makes the modelling process simpler, this may not be an accurate reflection of the situation at a breeding colony. However, Cook and Robinson (2015) concluded that density-independent models are likely to represent a more precautionary approach where there is uncertainty about the magnitude of a response, as they do not assume a compensatory increase in survival or productivity at low population sizes.

1059. As the models used are density independent, they are likely to over-estimate declines in small populations. Similarly, they may show population increases above those witnessed, due to modelled populations not being limited by density dependent effects. In addition, PVA modelling assumes that environmental conditions will remain the same over the runtime of the model (25 or 50 years in this case) as they were when the demographic data were collected, which is also unlikely.

1060. As highlighted in previous PVAs, a critical feature for interpreting population model outputs is to focus on the relative changes predicted, rather than viewing an absolute prediction as an indication of how the population is going to change. However, caution must be exercised before assuming that the absolute predictions can be relied upon. For this reason, the most robust interpretation of the results from a density independent model is in terms of the relative change in outputs between impacted and un-impacted scenarios (MacArthur Green 2015).

9.9.6 Transboundary Statement

1061. The Project Scoping Report concluded that given the location of the Project and the likely key receptors, potential transboundary effects are considered unlikely (NnGOWL, 2017).

1062. Based on the location of the Project and the likely key receptors, it was considered that there will be no significant transboundary effects on birds. In the breeding season, there are no non-UK seabird colonies within mean-maximum foraging range of the Project, therefore there will not be any transboundary impacts.

1063. In the non-breeding season, although it is possible that birds from non-UK seabird colonies may pass through the Wind Farm Area, there will be minimal impact from displacement or barrier effects, as foraging birds would be able to find food outside of the Wind Farm Area, and so would not be affected if they avoided the Wind Farm Area due to the presence of turbines. Although it is possible that birds from non-UK seabird colonies may collide with the turbines, it is considered very unlikely that significant numbers of a species from non-UK colonies would be affected, based on the number of birds predicted to be killed in the non-breeding season.

9.9.7 Mitigation and Monitoring

1064. The assessment of impacts on birds, both in isolation and cumulatively, as a result of the construction, operation and decommissioning of the Project are predicted to be of no significance. Based on the predicted effects it is concluded that no specific mitigation is required beyond the embedded mitigation set out in Section 9.8.1.

9.9.8 Monitoring

1065. Following consent, a Project Environmental Monitoring Plan (PEMP) will be developed and agreed with MS-LOT, in discussion with the Forth and Tay Regional Advisory Group (FTRAG). Monitoring will be required to validate the findings of the EIA.

1066. To date, there have been some high level discussions regarding future monitoring requirements for NnG. An ornithology sub-group for the FTRAG has been established, comprising representatives from NnG, Inch Cape, Seagreen, Marine Scotland, SNH, JNCC and RSPB. Initial discussions considered where monitoring should focus, in terms of research questions, key species, SPAs and effects to be addressed.

1067. The above discussions will continue and will inform the selection of the most appropriate monitoring methods. Methods selected will be subject to regular review, as technologies improve and as information from monitoring programmes at other offshore projects is published, together with results from industry-led research projects such as the Offshore Renewables Joint Industry Programme (ORJIP).

1068. At this stage it is considered likely that monitoring will focus on collision/avoidance, displacement/barrier, as well as population-level effects. Various methods and technologies are available to monitor displacement/barrier, including GPS tagging, radar, boat-based and digital aerial surveys. For monitoring collision/avoidance, there is the potential to use turbine mounted cameras, radar, human observers and laser range finders. In addition, if looking at population effects, it would be beneficial to have a better understanding of survival and productivity rates for breeding adults at these SPA colonies.

1069. The different potential methods are still being considered, and a future decision on a monitoring system will be determined depending on the most appropriate technology available at the time of selection. There is the potential for collaboration with other developers, government and NGOs, which could be progressed via the PEMP or separate studies.

9.10 Summary of Residual Effects

1070. This chapter has assessed the potential effects on birds of the construction, operation and decommissioning of the Project, both in isolation and cumulatively. Where significant effects were identified additional mitigation has been considered and incorporated into the assessment. Table 9-231 summarises the impact determinations discussed in this chapter and presents the post-mitigation residual significance.

Table 9-231: Summary of predicted impacts of the Project

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Construction			
Impacts of installation of Export cables	Minor, adverse	Embedded mitigation	Minor, adverse
Direct impacts of construction activites	Negligible, adverse	Embedded mitigation	Negligible, adverse
Indirect impacts of construction activities	Minor, adverse	Embedded mitigation	Minor, adverse
Operation			
Displacement & barrier impacts	Puffine: Minor, adverse All other species considered: Negligible, adverse	Embedded mitigation	Puffine: Minor, adverse All other species considered: Negligible, adverse
Collision impacts	Gannet and Kittiwake: Minor, adverse All other species considered: negligible, adverse	Embedded mitigation. Collision reduction technologies will be explored post-consent in consultation with FTRAG.	Gannet and Kittiwake: Minor, adverse All other species considered: negligible, adverse
Decommissioning			
As assessed for construction.			
Cumulative Effects			
Displacement & barrier impacts	Puffine: Minor, adverse All other species considered: Negligible, adverse	Embedded mitigation.	Puffine: Minor, adverse All other species considered: Negligible, adverse

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Collision impacts	**Scenario 1** – Gannet and Kittiwake: Minor, adverse All other species considered: negligible, adverse **Scenario 2** – Kittiwake: Moderate effects predicted in the non-breeding season, and by association, throughout the year for NnG and 2014 Forth and Tay projects Gannet: Minor, adverse All other species considered: negligible, adverse	Embedded mitigation. Will explore collision reduction technologies post-consent in consultation with FTRAG. It is considered highly unlikely that Inch Cape and Seagreen A & B will be built to the maximum extent of their consented envelopes, therefore the outcome of this assessment is considered to be highly precautionary and unrealistic. Mitigation – reducing the number of turbines constructed and increasing average rotor height, both of which are anticipated.	**Scenario 1** – Gannet and Kittiwake: Minor, adverse All other species considered: negligible, adverse **Scenario 2** – Kittiwake: Moderate effects likely to be mitigated if projects are not built to their maximum consented 2014 design. Gannet: Minor, adverse All other species considered: negligible, adverse

9.11 References

- Alerstam T., Rosén M., Bäckman J., Ericson P.G.P. & Hellgren O. (2007) *Flight speeds among bird species: allometric and phylogenetic effects.* (PLoS Biology, 5, 1656-1662)
- APEM (2017). *Mainstream Kittiwake and Auk Displacement Report. APEM Scientific Report P000001836*. (Neart na Gaoithe Offshore Wind Limited, 04/12/17, v2.0 Final, 55 pp)
- Arcus. (2015) *Forthwind Demonstration Project Technical Appendix A7.1 Ornithology*.
- Atkins. (2016) *Kincardine Offshore Windfarm Environmental Statement*.
- Band, W., M. (2012) *Using a collision risk model to assess bird collision risks for offshore windfarms. Final version, August 2012*. (SOSS, The Crown Estate) http://www.bto.org/science/wetland-and-marine/soss/projects;
- Barton, C., Pollock, C. & Harding, N. (2009) *Arklow Bank seabird and marine mammal monitoring programme. Year 8.* (A report to Airtricity)
- Barton, C., Pollock, C. & Harding, N. (2010) *Arklow Bank seabird and marine mammal monitoring programme. Year 9.* (A report to Airtricity)
- BERR (Department for Business, Enterprise and regulatory Reform. (2008). *Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Windfarm Industry*. Available Online: http://webarchive.nationalarchives.gov.uk/+/http:/www.berr.gov.uk/files/file43527.pdf
- Bradbury G, Trinder M, Furness B, Banks AN, Caldow RWG, et al. (2014) *Mapping Seabird Sensitivity to Offshore Windfarms*. (PLoS ONE 9(9): e106366. doi:10.1371/ journal.pone.0106366).
- Callaway, R., Alsvag, J., de Boois, I., Cotter, J., Ford, A., Hinz, H., Jennings, S., Kröncke, I., Lancaster, J., Piet, G., Prince, P., and Ehrich, S (2002). *Diversity and community structure of epibenthic invertebrates and fish in the North Sea.* (ICES Journal of Marine Science, 59: 1199–1214).
- 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. K., Clausager, I. & Petersen, I. K. (2003) *Base-line investigations of birds in relation to an offshore wind farm at Horns Rev, and results from the year of construction.* (National Environmental Research Institute commissioned by Tech-wise A/S 2002)
- Christensen, T. K., Hounisen, J. P., Clausager, I. & Petersen, I. K. (2004) *Visual and radar observations of birds in relation to collision risk at the Horns Rev offshore wind farm*. (Department of Wildlife Ecology and Biodiversity, National Environmental Research Institute commissioned by Elsam Engineering A/S 2003)
- Christensen, K. & Hounisen, J. P. (2005) *Investigations of migratory birds during operation of Horns Rev offshore wind farm 2004*. (Department of Wildlife Ecology and Biodiversity, National Environmental Research Institute to Elsam Engineering A/S).
- Cleasby, I.R., Wakefield, E.D., Bearhop, S., Bodey, T.W., Votier, S.C., & Hamer, K.C. (2015). *Three dimensional tracking of a wide-ranging marine predator: flight heights and vulnerability to offshore wind farms*.(Journal of Applied Ecology, 52(6), 1474-1482).
- Cook, A.S.C.P., Humphreys, E.M., Masden, E.A. and Burton, N.H.K. (2014) *The avoidance rates of collision between birds and offshore turbines.* (BTO Research Report No. 656);
- Cook, A.S.C.P & Robinson, R.A. (2015) *The Scientific Validity of Criticisms made by the RSPB of Metrics used to Assess Population Level Impacts of Offshore Wind Farms on Seabirds*. (BTO Research Report No. 665).
- Cook, A.S.C.P & Robinson, R.A. (2016) *Testing sensitivity of metrics of seabird population response to offshore wind farm effects*. (JNCC Report No. 553. JNCC, Peterborough)
- Coull, K. A., Johnstone, R and Rogers, S. I., (1998) *Fishery sensitivity Maps in British Waters.* (Published and distributed by UKOOA Ltd. Available online from: https://www.cefas.co.uk/media/52612/sensi_maps.pdf
- Crown Estate. (2017) *Estimates of Ornithological Headroom in Offshore Wind Farm Collision Mortality.*
- Daunt, F., Bogdanova,M., Newell, M., Harris, M. and Wanless, S. (2011a) *GPS tracking of common guillemot, razorbill and black-legged kittiwake on the Isle of May, summer 2010.* (A report to FTOWDG)
- Daunt, F., Bogdanova,M., Redman, P., Russell, S. and Wanless, S. (2011b) *GPS tracking of black-legged kittiwake and observations of trip durations and flight directions of common guillemot at Fowlsheugh and St Abb's Head, summer 2011*. (A report to FTOWDG).
- Dickson, D. 2002. *Fife Bird Report 2001*. (Fife Bird Club)
- Diersche, V. & Garthe, S. (2006) *Literature review of offshore wind farms with regard to seabirds.* In: Zucco, C., Wende, W., Merck, T., Köchling, I. & Köppel, J. (eds.) *Ecological research of offshore wind farms: international exchange of experiences (Project No. 804 46 001), Part B: Literature review of the ecological impacts of offshore wind farms*. (Bonn, Germany: BfN-Skripten).
- Dong Energy. (2017) *Hornsea Project Three Offshore Wind Farm Preliminary Environmental Information Report: Draft Report to Inform Appropriate Assessment*.
- Eaton MA, Aebischer NJ, Brown AF, Hearn RD, Lock L, Musgrove AJ, Noble DG, Stroud DA and Gregory RD. (2015) *Birds of Conservation Concern 4: the population status of birds in the United Kingdom, Channel Islands and Isle of Man*. (British Birds 108, 708–746). https://britishbirds.co.uk/wp-content/uploads/2014/07/BoCC4.pdf
- Ellis, J. R., Milligan, S. P., Readdy, L., Taylor, N. and Brown, M..J., (2012) *Spawning and nursery grounds of selected fish species in UK waters.* (Sci. Ser. Tech. Rep., Cefas, Lowestoft, 147: 56 pp).
- Emu. (2010) *NnG Proposed Offshore Wind Farm Benthic Ecology Characterisation Survey Final Report.* (A Report for NnG Offshore Wind Ltd).
- Forthwind Ltd. (2015) *ForthWind Offshore Wind Demonstration Project*, (Methil, Fife.) Volume 1: Environment Statement.

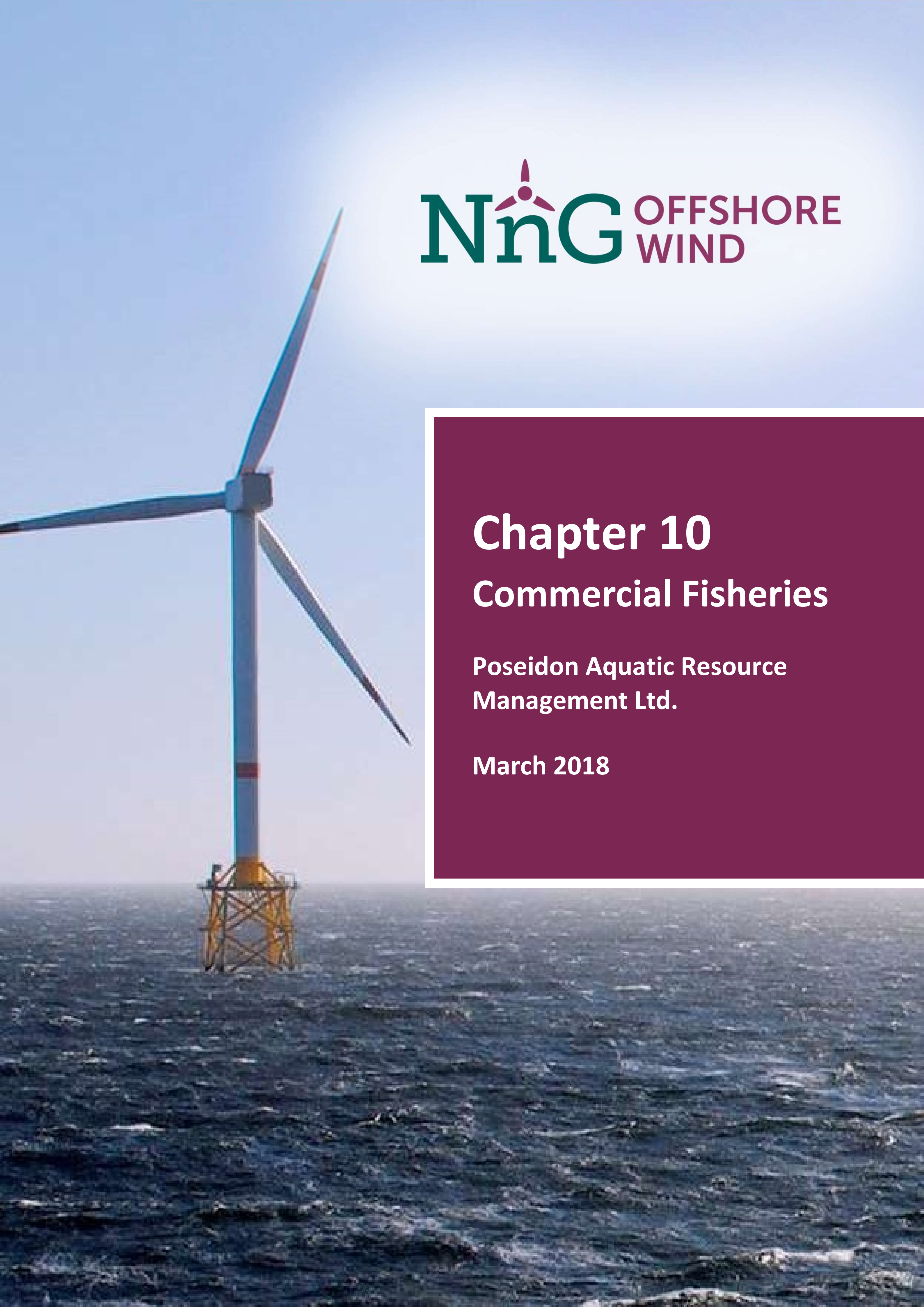
- Forrester, R.W., Andrews, I.J., McInerny, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds) 2007. *The Birds of Scotland. The Scottish Ornithologists' Club, Aberlady.*
- Freeman, S., Searle, K., Bogdanova, M., Wanless, S. & Daunt, F. (2014) *Population dynamics of Forth and Tay breeding seabirds: Review of available models and modelling of key breeding populations.* (Ref: MSQ-0006. Final Report to Marine Scotland Science).
- Furness R.W., and Wade H.M. (2012) *Vulnerability of Scottish seabirds to offsore wind turbines - Report to Marine Scotland.* (Glasgow: MacArthur Green Ltd).
- Furness R. W., Wade, H. M. and Masden E.A. (2013) *Assessing vulnerability of marine bird populations to offshore wind farms.* (Journal of Environmental Management 119 pp.56-66).
- Furness, R.W. (2015) *Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS)*. (Natural England Commissioned Report Number 164. 389 pp).
- Furness, R.W. & Tasker, M.L. (2000) *Seabird-fishery interactions: quantifying the sensitivity of seabirds to reductions in sandeel abundance, and identification of key areas for sensitive seabirds in the North Sea*. (Marine Ecology Progress Series 202: 253-264).
- Garthe, S. and Hüppop, O. (2004) *Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index*. (J. Ap. Ecol. 41: 724-734)
- Greenstreet, P. R., Holland, G. J., Guirey, E. R. J., Armstrong, E., Fraser, H. M. and Gibb, I. M., (2010) *Combining hydroacoustic seabed survey and grab samling techniques to assess "local" sandeel population abundance.* (ICES Journal of Marine Science, 67 (5), 971-984).
- Hamer K.C., Phillips R.A., Wanless S., Harris M.P. & Wood A.G. (2000) *Foraging ranges, diets and feeding locations of gannets (Morus bassanus) in the North Sea: evidence from satellite telemetry.* (Marine Ecology Series, 200, 257-264).
- Hamer K.C., Humphreys E.M., Garthe S., Hennicke J., Peters G., Grémillet D., Phillips R.A., Harris M.P. & 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)
- Hamer, K.C., Holt, N. & Wakefield, E. (2011) *The distribution and behaviour of northern gannets in the Firth of Forth and Tay area. A review on behalf of the Forth and Tay Offshore Wind Developers Group.* (Institute of Integrative & Comparative Biology, University of Leeds).
- Harris, M.P. (1984) *The Puffin*. (T & A.D. Poyser, Calton).
- Harris, M.P., Bogdanova, M.I, Daunt, F. and Wanless, S. 2012*. Using GPS technology to assess feeding areas of Atlantic Puffins Fratercula arctica*. (Ringing and Migration 27(1): 43-49)
- Highways Agency Scottish Government, Welsh Assembly Government and the Department for Regional Development Northern Ireland (2008). *Design Manual for Roads and Bridges (DMRB) Volume 11: Environmental Assessment.* [Online] Available at: http://www.dft.gov.uk/ha/standards/dmrb/ [Accessed 03 August 2017]
- Holling, M. and Rare Breeding Birds Panel. (2010) *Rare breeding birds in the United Kingdom in 2007.* (British Birds, **103**, pp 2-52) Also available online at: http://www.rbbp.org.uk/downloads/rbbp-report-2007.pdf
- Horswill, C. & Robinson, R.A. (2015) *Review of seabird demographic rates and density dependence.* (JNCC Report No. 552. Joint Nature Conservation Committee, Peterborough).
- ICOL. (2014) *Inch Cape Offshore Wind Farm Offshore Environmental Statement: Volume 2F. Appendix 15B: Population Viability Analysis.*

- ICOL. (2017) *Inch Cape Wind Farm Offshore Scoping Report 2017*. http://www.gov.scot/Topics/marine/Licensing/marine/scoping/InchCape/InchCapeScoping2017
- IEEM 2010. *Guidelines for ecological impact assessment in Britain and Ireland*. (Marine and Coastal)
- Jennings, S., J. Lancaster, A. Woolmer & J. Cotter (1999). *Distribution, diversity and abundance of epibenthic fauna in the North Sea.* (J. Mar. Biol. Assoc. UK 79: 385-399).
- Jitlal, M., Burthe, S., Freeman, S. & Daunt, F (2017). *Testing and Validating Metrics of Change Produced by Population Viability Analysis (PVA).* (Final report to Marine Scotland Science, Scottish Marine and Freshwater Science Vol 8 No 23)
- JNCC (2015). *Seabird Displacement Impacts from Offshore Wind Farms: report of the MROG Workshop, 6- 7th May 2015*. (JNCC Report No 568. JNCC Peterborough)
- JNCC. (2016) Online information on Gannets. Available from http://jncc.defra.gov.uk/page-2875
- JNCC. (2001) Online information on Special Protection Areas. Available from http://jncc.defra.gov.uk/page-1417
- Johnston, A., Cook, A. S. C. P., Wright, L. J., Humphreys, E. M. and Burton, N. H. K. (2014), *Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines*. (J Appl Ecol, 51: 31–41. doi:10.1111/1365-2664.12191).
- Krijgsveld, K.L., (2014) *Avoidance behaviour of birds around offshore wind farms - Overview of knowledge including effects of configuration*. (A report by Bureau Waardenburg)
- Krijgsveld, K.L., R.C. Fijn, M. Japink, P.W. van Horssen, C. Heunks, M.P. Collier, M.J.M. Poot, D. Beuker, S. Dirksen (2011) Effect studies Offshore Wind Farm Egmond aan Zee. Final report on fluxes, flight altitudes and behaviour of flying birds. NoordzeeWind report OWEZ_R_231_T1_20111114_flux&flight / Bureau Waardenburg report nr 10-219. Bureau Waardenburg, Culemborg, Netherlands.
- Langston, R.H.W. (2010) *Offshore wind farms and birds: Round 3 zones, extensions to Round 1 & 2 sites & Scottish Territorial Waters.* (RSPB Research Report No. 39).
- Leopold, M. F., Dijkman, E. M. & Teal, L. (2011) *Local Birds in and around the Offshore Wind Farm Egmond aan Zee (OWEZ) (T-0 & T-1, 2002-2010).* (Texel, The Netherlands: Wageningen IMARES).
- MacArthur Green (2014) *Bass Rock Gannet PVA. Report to Marine Scotland Science*.
- MacArthur Green (2015) *North Sea Kittiwake Population Viability Analysis. Appendix 13.4. East Anglia Three Environmental Statement Volume 3.*
- MacArthur Green (2016) *Qualifying impact assessments for selected seabird populations: A review of recent literature and understanding*. (Report commissioned by Vattenfall, Statkraft and Scottish Power Renewables).
- Maclean I.M.D., Wright L.J., Showler D.A. & Rehfisch M.M. (2009) *A review of assessment methodologies for offshore wind farms.* (British Trust for Ornithology commissioned by Cowrie Ltd).
- Marine Scotland. (2014a) *Application For Consent Under Section 36 Of The Electricity Act 1989 And Applications For Marine Licences Under The Marine (Scotland) Act 2010 For The Construction And Operation Of The NnG Offshore Windfarm. Marine Scotland's Consideration Of A Proposal Affecting Designated Special Areas Of Conservation ("SACs") Or Special Protection Areas ("SPAs")*
- Marine Scotland. (2014b) *Scottish Marine and Freshwater Science Report Vol 5 No 12. Strategic assessment of collision risk of Scottish offshore wind farms to migrating birds. Wildfowl & Wetlands Trust (Consulting) Ltd*. http://www.gov.scot/Resource/0046/00461026.pdf
- Marine Scotland. (2014c) *Population consequences of displacement from proposed offshore wind energy developments for seabirds breeding at Scottish SPAs* (CR/2012/03).

- Marine Scotland. (2017) *Scoping Opinion for the proposed Section 36 Consent and Associated Marine Licence Application for the Revised NnG Cape Offshore Wind Farm and Revised NnG Offshore Transmission Works*. Available from http://www.gov.scot/Topics/marine/Licensing/marine/scoping/NnGRev2017/SO-092017
- Masden, E. A., Haydon, D. T., Fox, A. D. & Furness, R. W. (2010) *Barriers to movement: Modelling energetic costs of avoiding marine wind farms amongst breeding seabirds*. (Marine Pollution Bulletin, 60, 1085-1091).
- Mendel, B., J. Kotzerka, J. Sommerfeld, H. Schwemmer, N. Sonntag & S. Garthe (2014). *1. Effects of the offshore test site Alpha Ventus on distribution patterns, behaviour and flight heights of seabirds.* (Chapter in StUK-plus publication)
- Mitchell, P.I., Newton, S.F., Ratcliffe, N. & Dunn, T.E. (2004) *Seabird populations of Britain and Ireland.* (T & AD Poyser, London).
- Murray, S., Harris, M.P. and Wanless, S. (2015) *The status of the Gannet in Scotland in 2013–14.* (Scottish Birds 3-18) http://nora.nerc.ac.uk/510050/1/N510050JA.pdf
- NnGOWL (2017) *NnG Offshore Wind Farm Scoping Report.* http://www.gov.scot/Topics/marine/Licensing/marine/scoping/NnGRev2017/NnG-ScopingReport-May2017
- Nelson, E., Caryl, F. & Vallejo, G. (2015) *Analysis of Marine Ecology Monitoring Plan Data – Robin Rigg Offshore Wind Farm Operational Year Five Technical Report – Ornithological Monitoring.* (Natural Power report for E.ON Climate & Renewables).
- Ouwehand J., Leopold M.F. & Camphuysen C.J. (2004) *A comparative study of the diet of Guillemots Uria aalge and Razorbills Alca torda killed during the Tricolor oil incident in the south-eastern North Sea in January 2003.* (Atlantic Seabirds (special issue) 6: 147-166).
- Pennycuick, C. J. 1987. *Flight of auks (Alcidae) and other northern seabirds compared with southern Procellariiformes: Ornithodolite observations*.(Journal of Experimental Biology, 128, 335-347).
- Pennycuick, C.J. (1997) *Actual and 'optimum' flight speeds: Field data reassessed*. (The Journal of Experimental Biology 200: 2355-2361).
- Petersen, I. K., Christensen, T. K., Kahlert, J., Desholm, M. & Fox, A. D. (2006) *Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark. National Environmental Research Institute*. (Report to DONG energy and Vattenfall A/S).
- PMSS (2006) *North Hoyle Offshore Wind Farm: FEPA monitoring post construction (04-05).* (Project Management Support Services).
- Regini, K. (2000) *Guidelines for ecological evaluation and impact assessment. In Practice.* (Bulletin of the Institute of Ecology and Environmental Management, 29, 2-7).
- RSPB (2017) *Online information about GPS tracking of breeding puffins at Hermaness, Shetland and Shiant Isles* http://www.rspb.org.uk/our-work/conservation/project-puffin/index.aspx
- Robinson, R.A. (2017) *BirdFacts: profiles of birds occurring in Britain & Ireland* (BTO Research Report 407. BTO, Thetford). https://blx1.bto.org/birdfacts/results/bob710.htm
- RWE Group (2007) *North Hoyle Offshore Wind Farm: FEPA monitoring post construction (06-07)*. (RWE Group for Npower Renewables).
- Sanderson, W.G. (1996). *Rare marine benthic flora and fauna in Great Britain: the development of criteria for assessment*. (JNCC (report no. 240). Peterborough).
- Seagreen (2012) *Environmental Statement Volume III: Appendices. Appendix F1 Baseline Technical Report for projects Alpha and Bravo. Round 3 Zone 2 Firth of Forth Offshore Wind Farm Development.*
- Seagreen (2017) *Seagreen Phase 1 Offshore Project Scoping Report Round 3: Firth of Forth.* http://www.gov.scot/Topics/marine/Licensing/marine/scoping/SeagreenPhase1-2017/SeagreenPhase1-ScopingReport

- Searle, K., Mobbs, D., Butler, A., Bogdanova, M., Freeman, S., Wanless, S. & Daunt, F. (2014) *Population consequences of displacement from proposed offshore wind energy developments for seabirds breeding at Scottish SPAs (CR/2012/03).* (Final Report to Marine Scotland Science).
- Skov, H., Durinck, J., Leopold, M. & Tasker, M.L. (1995) *Important Bird Areas for Seabirds in the North Sea including the Channel and the Kattegat*. (BirdLife international, Cambridge. 156 p).
- SMP (Seabird Monitoring Programme) (2017) *Online Database*. Available at: http://www.jncc.gov.uk/smp/
- SNCBs (2017) *Joint SNCB Interim Displacement Advice Note: Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments*. http://jncc.defra.gov.uk/pdf/Joint_SNCB_Interim_Displacement_AdviceNote_2017.pdf
- SNH. 2014 (Updated 2016). Interim Guidance on Apportioning Impacts from Marine Renewable Developments to Breeding Seabird Populations in Special Protection Areas. https://www.nature.scot/sites/default/files/2017-07/A2176850%20-%20Interim%20Guidance%20on%20Apportioning%20Impacts%20from%20Marine%20Renewable%20Developments%20to%20breeding%20seabird%20populations%20in%20special%20Protection%20Areas%20-%2021%20Dec%202016.pdf
- SNH (2016) Outer Firth of Forth and St Andrews Bay Complex Proposed Special Protection Area (pSPA) (NO. UK9020316. SPA Site Selection Document: Summary of the scientific case for site selection).
- SNH (2017) *Example of calculation of non-breeding season impacts to Forth Islands SPA - to consider non-breeding season impacts and application of the Crown Estate 'Headroom' recalculations to inform cumulative wind farm impacts.*
- Snow, D.W. & Perrins, C.M. (Eds). 1997. The Birds of the Western Palearctic. Volume 1. Concise Edition. Oxford University Press.
- Statoil. 2015. *Hywind Scotland Pilot Park Environmental Statement.*
- Stone. C.J., Webb, A., Barton, C., Ratcliffe, N., Redd, T.C., Tasker, M.L., Camphuysen, C.J. and Pienkowski, M.W., (1995). *An atlas of seabird distribution in north-west European waters*. (Joint Nature Conservation Committee and Nederlands Institute voor Onderzoek der Zee, Peterborough).
- Stroud, DA, Chambers, D, Cook, S, Buxton, N, Fraser, B, Clement, P, Lewis, P, McLean, I, Baker, H & Whitehead, S (eds). 2001. *The UK SPA network: its scope and content.* (JNCC, Peterborough.) http://jncc.defra.gov.uk/page-1412
- Thaxter, C.B. Lascelles, B. Sugar, K. Cook, A.S.C.P. Roos, S. Bolton, M. Langston, R.H.W. and Burton, N.H.K. (2012). *Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas*. (Biological Conservation);
- Vanermen N., E.W.M. Stienen, W. Courtens, T. Onkelinx, M. Van de walle & H. Verstraete (2013). *Bird monitoring at offshore wind farms in the Belgian part of the North Sea - Assessing seabird displacement effects*. (Rapporten van het Instituut voor Natuur- en Bosonderzoek 2013 (INBO.R.2013.755887). Instituut voor Natuur- en Bosonderzoek, Brussels, Belgium).
- Wade H.M., Masden. E.A., Jackson, A.C. and Furness, R.W. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. (Marine Policy 70, 108–113). Available online at https://www.macarthurgreen.com/files/Incorporating_Data_Uncertainty_when_Estimating_Potential_Vulnerability_of_Scottish_Seabirds_to_Marine_Renewable_Energy_Developments.pdf
- Walls, R., Canning, S., Lye, G., Givens, L., Garrett, C. & Lancaster, J. (2013a) *Analysis of Marine Environmental Monitoring Plan Data from the Robin Rigg Offshore Wind Farm, Scotland (Operational Year 1).* (Natural Power report to E.ON Climate and Renewables).

- Walls, R., Pendlebury, C., Lancaster, J., Lye, G., Canning, S., Malcom, F., Rutherford, V., Givens., L. & Walker, A. (2013b) *Analysis of Marine Environmental Monitoring Plan Data from the Robin Rigg Offshore Wind Farm, Scotland (Operational Year 2).* (Natural Power report to E.ON Climate and Renewables).
- 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 Journal of Marine Science, 55: 1141–1151).
- 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, I.W.R.B. Special Publication No.19).
- Wernham C.V., Toms M.P., Marchant J.H., Clark J.A., Siriwardena G.M. & Baille S.R. (eds.) (2002). *The migration atlas: movements of the birds of Britain and Ireland.*



NnG OFFSHORE WIND

Chapter 10

Commercial Fisheries

Poseidon Aquatic Resource Management Ltd.

March 2018

Table of Contents

Table of Figures

Table of Illustrations

Table of Tables

10 Commercial Fisheries

10.1 Introduction

1. This chapter of the Environmental Impact Assessment (EIA) Report presents an assessment of the potential impacts upon commercial fisheries arising from the construction, operation and decommissioning of the Project, as detailed in Chapter 4: Project Description.
2. The assessment is based on a combination of the understanding of the Project in terms of the potential for impact and the resultant effects on receptors that were identified within the study area, as detailed in Appendix 10.1: Commercial Fisheries Technical Report.
3. This chapter is comprised of the following elements:
   - A summary of relevant policy, guidance and legislation;
   - Details of the data sources used to characterise the study area;
   - A summary of the relevant consultations with stakeholders;
   - A description of the methodology for assessing the impacts of the Project, including details of the study area and approach to the assessment of potential effects;
   - A review of the baseline conditions;
   - A description of the worst case design scenario relevant to commercial fisheries;
   - An assessment of the likely effects for the construction, operation and decommissioning phases of the Project, including cumulative effects;
   - Identification of any further mitigation measures or monitoring requirements in respect of any significant effects;
   - A summary of the residual impact assessment determinations taking account of any additional mitigation measures identified.

10.2 Policy, Guidance and Legislation

4. A number of plans and policies exist that are relevant to offshore renewable energy development within Scottish Territorial Waters. These are summarised in Chapter 2: Policy and Legislation and include:
   - 2020 Route Map for Renewable Energy in Scotland
   - Draft Scottish Energy Strategy: The Future of Energy in Scotland
   - Scotland's National Marine Plan: A Single Framework for Managing Our Seas
5. Scotland's National Marine Plan (NMP) includes specific marine planning policies related to commercial fisheries, which should be taken into consideration by marine planners and decision makers. The fisheries marine planning polices 1 to 3 are summarised in Table 10.1[1].

[1] Fisheries policies 4 and 5 are not included as they relate to port and harbour infrastructure and inshore fisheries management, respectively and are not relevant to offshore energy development.

Table 10.1: Summary of Scotland's NMP provisions relevant to commercial fisheries.

Summary of Scotland's NMP provisions	How addressed in the EIA Report
FISHERIES 1: Taking account of the EU's Common Fisheries Policy, Habitats Directive, Birds Directive and Marine Strategy Framework Directive, marine planners and decision makers should aim to ensure:	▪ Existing fishing opportunities and activities are safeguarded wherever possible. ▪ That other sectors take into account the need to protect fish stocks and sustain healthy fisheries for both economic and conservation reasons. ▪ Mechanisms for managing conflicts between fishermen and/or between the fishing sector and other users of the marine environment.
FISHERIES 2: The following key factors should be taken into account when deciding on uses of the marine environment and the potential impact on fishing:	▪ The cultural and economic importance of fishing, in particular to vulnerable coastal communities. ▪ The potential impact (positive and negative) of marine developments on the sustainability of fish and shellfish stocks and resultant fishing opportunities in any given area. ▪ The environmental impact on fishing grounds (such as nursery, spawning areas), commercially shed species, habitats and species more generally. ▪ The potential effect of displacement on: fish stocks; the wider environment; use of fuel; socio-economic costs to fishers and their communities and other marine users.
FISHERIES 3: Where existing fishing opportunities or activity cannot be safeguarded, a Fisheries Management and Mitigation Strategy should be prepared by the proposer of development or use, involving full engagement with local fishing interests (and other interests as appropriate) in the development of the Strategy. All efforts should be made to agree the Strategy with those interests. Those interests should also undertake to engage with the proposer and provide transparent and accurate information and data to help complete the Strategy. The Strategy should be drawn up as part of the discharge of conditions of permissions granted.	The content of the Strategy should be relevant to the particular circumstances and could include: ▪ An assessment of the potential impact of the development or use on the affected fishery or fisheries, both in socio-economic terms and in terms of environmental sustainability. ▪ A recognition that the disruption to existing fishing opportunities/activity should be minimised as far as possible. ▪ Reasonable measures to mitigate any constraints which the proposed development or use may place on existing or proposed fishing activity. ▪ Reasonable measures to mitigate any potential impacts on sustainability of fish stocks (e.g. impacts on spawning grounds or areas of fish or shellfish abundance) and any socio- economic impacts.

6. The principal guidance documents and information used to inform the assessment of potential impacts on commercial fisheries are as follows:

- Fishing Liaison with Offshore Wind and Wet Renewables Group (FLOWW) (2014) Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison;
- FLOWW (2015) Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Disruption Settlements and Community Funds;
- Marine Scotland (2010) Strategic Environmental Assessment (SEA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Volume 1: Environmental Report;
- Sea Fish Industry Authority and UK Fisheries Economic Network (UKFEN) (2012) Best practice guidance for fishing industry financial and economic impact assessments;
- Blyth-Skyrme, R.E. (2010a) *Options and opportunities for marine fisheries mitigation associated with wind farms.* Final report for Collaborative Offshore Wind Research into the Environment contract FISHMITIG09. COWRIE Ltd, London;
- Blyth-Skyrme, R.E. (2010) Developing guidance on fisheries CIA for wind farm developers;

- UK Oil and Gas (2008) *Fisheries Liaison Guidelines* - Issue 5; and
- International Cable Protection Committee (2009) *Fishing and Submarine Cables - Working Together*.

10.3 Data Sources

7. The assessment considers the potential interaction between the Project, as described in Chapter 4: Project Description, and commercial fisheries receptors within the local and regional commercial fisheries study areas.

8. The Development Area is within the northwest portion of the International Council for the Exploration of the Sea (ICES) Division 4b (Central North Sea) and lies inside the 12 nautical miles (NM) limit of Scottish Territorial Waters, within the UK Exclusive Economic Zone (EEZ). For the purposes of recording fisheries landings, ICES Division 4b is divided into statistical rectangles, which are consistent across all Member States operating in the North Sea.

9. From a commercial fisheries perspective, the study areas are defined by the ICES statistical rectangles that the Wind Farm Area and Offshore Export Cable Corridor overlaps (Figure 10.1 (Volume 2). The Development Area overlaps with ICES rectangles 41E7 and 40E7, which form the Local Study Area. The Regional Study Area includes these ICES rectangles (40E7 and 41E7) together with adjacent ICES rectangles: 40E6, 40E8, 41E6, 41E8, 42E7 and 42E8. The Regional Study Area is intended to inform the assessment of any potential displacement into the wider area.

10. The commercial fisheries study areas are defined as follows:

- The Local Study Area: ICES rectangles 40E7 and 41E7, and
- The Regional Study Area: ICES rectangles 40E6, 40E7, 40E8, 41E6, 41E7, 41E8, 42E7, and 42E8.

11. Key fishing ports for vessels operating within the local and Regional Study Areas are presented in Figure 10.2 (Volume 2). A detailed profile of the vessels operating from these ports is provided in Appendix 10.1, including number of vessels, length and age profiles, as well as descriptions of the fishing methods deployed.

10.3.1 Desktop Study

12. Baseline characterisation was undertaken through a desk-based study of available data and analysis of commercial fisheries statistics. No specific commercial fisheries surveys were undertaken, but this Chapter is informed by the data sources described in Chapter 7: Fish and Shellfish Ecology and Chapter 11: Shipping and Navigation. Table 10.2 details the data sources used for the baseline characterisation for both the local and Regional Study Areas.

13. In addition, consultation with Scottish and Anglo-Scottish inshore and offshore fisheries stakeholders was undertaken to both ground-truth data and to understand temporal and spatial patterns of fishing activity.

Table 10.2: Data sources used to inform the baseline description.

Data Source	Years	Overview
Marine Management Organisation (MMO)	2011 to 2015	Landing statistics data for UK registered vessels **by ICES rectangle** with data query attributes for: landing year; landing month; vessel length category; country code; ICES rectangle; vessel/gear type; species; live weight (tonnes); and value. *Note: 2011 to 2015 represents the most up-to-date five-year dataset available at the time data was ground-truthed during commercial fisheries industry consultation.*

Data Source	Years	Overview
MMO	2016	Landing statistics data for UK registered vessels **by ICES rectangle** with data query attributes for: landing year; landing month; vessel length category; country code; ICES rectangle; vessel/gear type; species; live weight (tonnes); and value. *Note: 2016 data became available in November 2017, and therefore has not been validated / ground-truthed during industry consultation. It is presented within the report to ensure appropriate consideration of the most recent dataset available.*
MMO	2013 to 2016	Landing statistics data for UK registered vessels **by port of landing** with data query attributes for: landing year; landing month; vessel length category; country code; vessel/gear type; port of landing; species; live weight (tonnes); and value. *Note: 2012 data was not available in this format and 2013 to 2016 represents the most up-to-date dataset available at the time of industry consultation and at the time of writing.*
MMO	2011 to 2015	Vessel Monitoring System (VMS) data for UK registered vessels with attributes for time fishing and value of catch at a resolution of 200th of an ICES rectangle amalgamated for all mobile vessels and all static vessels. *Note: 2011 to 2015 represents the most up-to-date five-year dataset available at the time of industry consultation and at the time of writing.*
MMO	2011 to 2015	Surveillance data with data query attributes for: sighting date; ICES rectangle; ICES sub-square; latitude; longitude; vessel/gear type; activity; nationality; course; speed; and number of sightings. *Note: 2011 to 2015 represents the most up-to-date five-year dataset available at the time of industry consultation and at the time of writing.*
European Union Data Collection Framework	2003 to 2016	Long term landings statistics for UK registered vessels for: landing year; quarter; ICES rectangle; vessel length; gear type; species and landed weight (tonnes).
European Union Data Collection Framework	2012 to 2016	Fishing effort data for UK registered vessels for: landing year; quarter; ICES rectangle; vessel length; gear type; species and fishing effort (hours fishing).
European Commission, MMO, Marine Scotland	2010 onwards	Published fisheries controls and legislation.
Marine Traffic/ AIS validation document	2017	Selected on review of data and information presented in the AIS validation document, as relevant to fishing vessels. See Appendix 11.2.
Marine Traffic	2017	AIS records relevant to fishing vessels. See Appendix 11.2.
Succorfish data	2015	Small vessel position data as recorded by the voluntary Succorfish system as available.
Industry consultation	2010 to 2017	Direct consultation with fishermen’s associations, federations, fish selling agents, producer organizations, fisheries representatives and non-affiliated fishermen (as detailed in Section 10.4).

10.3.1.1 Landing Statistics

14. Commercial fisheries data on landings and effort are collected by the MMO, Marine Scotland and the EU as part of monitoring and control requirements set out under various EU legislation, in particular:

- The basic regulation that sets out the measures under the EU Common Fisheries Policy: Council regulation (EU) No. 1380/2013; and
- The regulation that sets out the control system for ensuring compliance with the rules of the common fisheries policy: Council regulation (EU) No. 1224/2009.

15. Skippers and/or vessel owners are required to keep and submit logbooks, and provide landing declarations and sales notes. Landings data for all species are collected and recorded by ICES statistical rectangle and stored in the MMO iFISH database and provided to the EU Joint Research Committee under the EU Data Collection Framework (DCF).

16. To inform the commercial fisheries assessment, landings data were collated for all EU Member States for all ICES statistical rectangles that overlap the regional commercial fisheries study area, as shown in Figure 10.3 (Volume 2). No non-UK vessels were recorded as having activity within the study area and, therefore, the focus of the assessment is on UK vessels.

17. Landing statistics were collated across a five-year period (2011 to 2015) and thirteen-year period (2003 to 2015) to capture long-term trends. Landing statistics include all landings into all ports by a country's registered vessels. The following parameters were examined in each dataset:

    - EU DCF database: year; season (month); gear type; ICES rectangle; species; effort (hours fished); and live weight (tonnes) for 2003 to 2016. This is the longest time series available;
    - MMO iFISH database: year; month; gear type; ICES rectangle; species; live weight (tonnes) and first sales value (£) for 2011 to 2015 and 2016. Data for 2016 is presented within the report to ensure appropriate consideration of the most recent dataset available. However, it should be noted that 2016 data became available in November 2017, and therefore has not been validated / ground-truthed during industry consultation. For this reason, 2011 to 2015 forms the time period for the majority of the baseline assessment; and
    - MMO iFISH database: year; month; gear type; port of landing; species; live weight (tonnes) and first sales value (£) for 2013 to 2016. This is the most recent annual data that is publicly available. The MMO publish landings statistics by port of landing, which are updated monthly. The most recent data available at the time of this assessment was for May 2017. This 2017 dataset was explored, however as it represents a partial year (Jan to May), it was not comparable to pervious annual statistics and therefore not included within the assessment.

18. Data limitations for landings statistics are summarised in Section 10.5.2.

10.3.1.2 Vessel Monitoring System data

19. All EU fishing vessels (i.e. fishing vessels registered with an EU Member State), and third-party fishing vessels operating in EU waters, that are ≥ 12 metres (m) in length, are required to have a VMS on board. This reports an EU vessel's position to fisheries management authorities every two hours. Since 1 January 2012, this obligation has applied to vessels that are ≥ 12 m in length (before 1 January 2012 it applied to vessels ≥ 15 m in length, see Council Regulation (EC) No 1224/2009). However, the MMO does not yet include VMS data for vessels between 12 to 14.9 m within its datasets. Therefore, all MMO VMS data (2011 to 2015) presented within this chapter and Appendix 10.1: Commercial Fisheries Technical Report includes only vessels that are ≥ 15 m in length.

20. A vessel's range varies due to weather conditions and skipper preferences as well as technical aspects such as vessel power. It is common that vessels < 12 m in length fish within 20 NM of shore. Vessels ≥ 12 m in length can and do fish further afield, but in recent years many skippers have altered fishing patterns to favour fishing grounds closer to homeports due to operating costs and restrictions placed

on time at sea (i.e. vessels being permitted a specific number of kW days at sea as per EU and national legislation).

21. Although figures mapping VMS data may appear to show inshore areas with lower (or no) fishing activity compared with offshore areas, this is not accurate because VMS data does not include many of the vessels operating in inshore areas (i.e. typically < 15 m in length). This is particularly important when assessing the activity across the Development Area. Consultation has therefore, been important throughout the EIA process to determine the extent and distribution of activity by all vessels but particularly the < 15 m fleet. The <15m fleet are included in the other data sources used to inform this assessment, including the landing statistics and surveillance data.

22. The MMO collates VMS data for UK registered vessels by aggregating the number of position plots by general gear type (mobile or static) in a grid of sub-rectangles approximately 5.3 NM^2 (i.e. at a resolution of 200th of an ICES rectangle). This has been integrated with landings values, thereby providing both effort (hours fished) and value (£) for each sub-rectangle for mobile and static gears. These data have been analysed for a five-year period from 2011 to 2015.

23. Data limitations for VMS data are summarised in Section 10.5.2.

10.3.1.3 Surveillance Data

24. The UK has seven fisheries patrol vessels and four surveillance aircraft. Patrols are undertaken by Marine Scotland Compliance, Royal Navy Fisheries Patrol vessels and aircraft. UK surveillance aircraft are used to construct an on-going picture of fishing activity within the UK EEZ and to make effective use of patrol vessel activity by coordinated use of surveillance data. Surveillance data include fishing vessels of all lengths, thereby allowing complete fleet coverage. In addition, individual gear types are identified, which can be cross-referenced with VMS data and inshore fishery maps to identify fleet activity. Surveillance data alone do not give an accurate picture of the actual level of activity and have a number of limitations, primarily focused on the frequency and aerial coverage of patrols.

25. Data limitations for surveillance data are summarised in Section 10.5.2.

10.4 Relevant Consultations

26. As part of the EIA process, NnGOWL has undertaken consultations with various statutory and non-statutory stakeholders. A formal scoping opinion was requested from MS-LOT following submission of the Scoping Report, with the Scoping Opinion received on 8 September 2017. Ongoing consultation with stakeholders continued post-scoping and responses have been used to develop an appropriate methodology and parameters for assessment. Consultation with key commercial fisheries stakeholders has been ongoing in respect of the Originally Consented Project since 2009.

27. The Scoping Opinion identified those issues to be considered further within this Project EIA in respect of commercial fisheries; these are summarised in Table 10.3.

28. The issues identified during further Project EIA consultation are presented in Table 10.4.

Table 10.3: Summary of Scoping consultation relating to commercial fisheries.

Date and consultation phase	Consultation and Key Points Raised	Section where comment addressed
08/09/2017 Scoping Opinion – Scottish Ministers	The Scottish Ministers agreed that there is a requirement to update and review the commercial fisheries baseline as set out in the Scoping Report and advised that NnGOWL should take into account the information provided by stakeholders.	The baseline has been updated and is presented in Section 10.6 and Appendix 10.1

Date and consultation phase	Consultation and Key Points Raised	Section where comment addressed
	The Scottish Ministers agreed that the embedded mitigation was adequate but advised that NnGOWL ensure that the most up to date information is used to inform the mitigation.	Consent Condition Commitments in Table 10.9 commits to developing a Commercial Fisheries Mitigation Strategy and engaging the Working Group throughout mitigation procedures.
	In addition, the Scottish Ministers advised that NnGOWL discuss with the SFF how best to ensure the proposed mitigation measures can be developed and agreed.	
	MSS recommended that a 1 kilometre (km) spacing be considered between structures and requested that NnGOWL provide information to support using less than this where it is necessary to do so.	Minimum spacing between turbines is 800 m, but expected to be greater than this for the majority of turbines. It is anticipated that a Design Specification and Layout Plan will be required (see section 10.7.2) and will justify the final layout based on further geotechnical and geophysical work taking account of physical constraints.
	The Scottish Ministers advised that there is a need for cable burial to be carried out in a way that ensures the seabed is left in a safe condition for fishing taking account of the most up to date baseline information.	Chapter 4: Project Description provides details of a range of cable protection measures that will be considered following further ground conditions investigation works.
		Furthermore, Consent Condition Commitments in Table 10.9 commits to developing a Cable Plan: setting out obligations relevant to commercial fisheries, including a cable burial assessment and over trawl surveys where cable protection is installed.
	The Scottish Ministers advised that there would be a need to consider anchorages and queuing of vessels.	Section 10.8.4 and Table 10.14 details the production for approval of a post-consent compliance Vessel Management Plan. This plan will consider anchorages and queuing of vessels as part of a wider vessel management strategy.
	MSS advised that the FLOWW guidance should be referenced in relation to disruption payments within the EIA Report.	Table 10.15 sets out proposed further mitigation, which commits to following FLOWW guidance in relation to justifiable disruption payments.
	The Scottish Ministers recommend the following projects are included in the cumulative impact assessment: ▪ Worst case scenario of Inch Cape (2014 as consented) or Inch Cape (2017 scoping report) ▪ Worst case scenario of Seagreen Alpha and Bravo (2014 as consented) or Seagreen Phase 1 (2017 scoping report) ▪ Kincardine Wind Farm Area ▪ Forthwind Wind Farm Area (2016 consent)	Cumulative effects assessment is presented in Section 10.8.4 and includes all of these projects.

Date and consultation phase	Consultation and Key Points Raised	Section where comment addressed
	▪ Forthwind Offshore Wind Demonstration Project ▪ Offshore Renewable Energy Catapult LevenmouthThe Scottish Ministers advised on including the following projects in the cumulative assessment of the impact on nomadic fishing fleets: ▪ European Offshore Wind Deployment Centre ▪ Hywind Scotland Pilot Park ▪ Blyth Wind Farm Area – 2 turbines ▪ Blyth Offshore Wind Demonstration Project – 15 turbines ▪ Beatrice Offshore Wind Farm Area ▪ Moray Offshore East Development ▪ Moray East Wind Farm Area – Alternative Design ▪ Moray Firth Offshore Wind Western Development Area ▪ Rampion Wind Farm Area	
	The Scottish Ministers advised that the scope of the Project EIA should consider the potential effects of sediments and smothering on the following commercial species: shellfish, scallops, nephrops, crabs and lobsters as raised at the scoping consultation meeting on the 27^{th} June 2017.	MSS and the Scottish Ministers agreed that the effects of increased suspended sediment and smothering could be scoped out of the EIA as the Project is not considering the use of Gravity Base Structures, see Chapter 7: Fish and Shellfish Ecology.
	The Scottish Ministers noted that further information was been provided to update the baseline and advised that NnGOWL include this with the information already identified to inform the update of the baseline data in relation to commercial fisheries. In addition, the Scottish Ministers advised that NnGOWL validate the data from the fishing industry to discuss with the SFF how this could best be done.	Baseline data was ground-truthed during consultation with local fisheries associations and organisations.
08/09/2017 Scoping Opinion – Scottish Fishermen's Federation	The SFF agreed with the Scoping Report that the commercial fisheries baseline should be updated. SFF highlighted that it is necessary to assess scallop activity over a ten-year cycle to gain a true picture of the fishery.	The baseline in Appendix 10.1: Commercial Fisheries Technical Report provides long-term trends for key commercial species, including scallop landings from 2003 to 2015.

Date and consultation phase	Consultation and Key Points Raised	Section where comment addressed
	The SFF recommend that NnGOWL use the Commercial Fisheries Working Group to verify the updated baselines.	Due to varying timelines for the Firth and Tay Projects, namely NnG, Inch Cape and Seagreen, it was not possible for the Commercial Fisheries Working Group to be reactivated prior to writing of the baseline description. Instead, baseline data was ground-truthed during consultation with local fisheries associations and organisations. The CFWG will be reactivated by the Firth and Tay Developers following submission of this EIA Report.
	The SFF requested that the Commercial Fisheries Working Group be the recognised method for developing and agreeing all relevant mitigation needed.	This is detailed within Section 10.7.2 in Table 10.9.
	The SFF raised concerns about cable burial and the need to take into account the safety of fishing vessels in relation to state of the seabed post burial. The SFF noted some research carried out by Xodus in relation to the Caithness to Moray cable project and recommended incorporating this information into the EIA for the Project where relevant.	The impact assessment presented in Section 10.8 assesses snagging risk related to different gear types and operations.
	The SFF noted the need for the potential impacts from both the Wind Farm and Offshore Export Cable to be included in a cumulative assessment with other projects. This includes taking into account the volume of scour protection to be used and all options for cable protection. It was recommended that the route of the cables be considered in the assessment of potential impacts on commercial fisheries. The SFF also note the need to consider Forth Ports projects.	Cumulative effects assessment includes both wind farms and export cable routes and is presented in Section 10.8.4.
08/09/2017 Scoping Opinion – The Under 10m Association	The Under 10m Association noted that the impact on all inshore fishing vessels must be considered regardless of their size and that the impact on vessels less than 15m in length was not fully considered within the Scoping Report.	The baseline in Section 10.6 and Appendix 10.1: Commercial Fisheries Technical Report provides detailed assessment for vessels under 15 m in length.
	The Under 10m Association raised concerns about cable burial and the need to take into account the safety of fishing vessels in relation to state of the seabed post burial.	The impact assessment presented in Section 10.8 assesses snagging risk related to different gear types and operations.
	The Under 10m Association noted that there has been additional consents granted to wind farms in the area and the cumulative effect of these and the potential impact for displacement of fishing vessels should be considered.	Cumulative effects assessment is presented in Section 10.8.4.

Date and consultation phase	Consultation and Key Points Raised	Section where comment addressed
08/09/2017 Scoping Opinion – East Lothian Council	East Lothian Council recommended that the fisheries baseline information include what fish are being targeted and where incorporating information provided by fishery stakeholders and commercial landings data. These data should then be used to assess the impact of the Project on the industry.	The baseline in Section 10.6 and Appendix 10.1 includes data from MMO iFISH database, which correlates landings declarations with sales notes. In addition, consultation with local fisheries associations and organisations provided further context and detail that informed the baseline description.
27/06/2017: Scoping consultation Face to face meeting with: MS-LOT and SFF	Confirmation that data sources within scoping report are the best available Discussion on methodology and impact assessment confirming that all impacts remained scoped into the assessment.	Section 10.3 and Table 10.2 provide details on the data sources. Section 10.5 provides impact assessment methodology.

Table 10.4: Summary of EIA consultation relating to commercial fisheries.

Date and consultation phase / type	Consultation key points raised	Section where comment addressed
26/07/2017: EIA consultation Face to face meeting with: ▪ **Fife Fishermen's Association** ▪ **Fife Creel Association** ▪ **Pittenweem Fishermen's Mutual Association** ▪ **Under 10m Association**	Raised concern that the Original ES did not present data or information on vessels under 15m in length. Requested long-term trends be considered. Requested Fisheries Liaison Officer be established. Highlighted range of fishing grounds that are targeted by potting vessels in the area. Concern over loss of fishing grounds and access due to Offshore Wind Farm and Offshore Export Cable.	The baseline in Section 10.6 and Appendix 10.1 provides detailed assessment for under 15m vessels. Long-term trends are presented in Appendix 10.1: Commercial Fisheries Technical Report. It is anticipated that NnGOWL will be required to procure the services of a Fisheries Liaison Officer as a condition of any future consents granted for the Project (See section 10.7.2). Potting fishing grounds map has been updated and presented in Figure 10.6 (Volume 2). The impact assessment in Section 10.8 provides assessment of loss of fishing grounds and displacement leading to gear conflict.

Date and consultation phase / type	Consultation key points raised	Section where comment addressed
26/07/2017: EIA consultation **Face to face meeting with:** ▪ **Dunbar Fishermen's Association** ▪ **Including 25 fishermen based at Dunbar, St. Abbs and Cove.**	Raised concern with time period of data in original assessment and data provided at consultation meeting. Corroborated that fishing maps provided good representation for demersal trawl activity. Corroborated that all landings were recorded through the RBS system. Raised low landings into Dunbar, but confirmed this is likely to be due to landings by Dunbar vessels being made into Port Seton and elsewhere. Concern over loss of fishing grounds and access specifically due to the Offshore Export Cable.	At the time of assessment, the most recent datasets by ICES rectangle was 2016. Therefore 2012 to 2016 represents the most recent five-year period. Data by port was also assessed for 2016 in Section 10.6 and Appendix 10.1 Face-to-face meetings facilitated collation of qualitative information on historic and recent trends since last data set was published. The impact assessment in Section 10.8 provides assessment of loss of fishing grounds.
01/08/2017: EIA consultation **Face to face meeting with:** ▪ **Anglo-Scottish Fishermen's Association** ▪ **Eyemouth Fishermen's Association**	Corroborated that fishing maps provided good representation for demersal trawl activity. Corroborated that all landings were recorded through the RBS system. Concern over loss of fishing grounds and access specifically due to the Offshore Export Cable.	The impact assessment in Section 10.8 provides assessment of loss of fishing grounds. Embedded mitigation in Section 10.7.1 commit to over trawl-ability trawls to ensure it is safe to resume fishing.
02/08/2017: EIA consultation **Face to face meeting with:** **Scottish Fishermen's Federation (SFF)**	Provided insight into fishing grounds and target species. Raised concern over trawl-ability of areas post construction.	Information given has informed the baseline section 10.6. Embedded mitigation in Section 10.7.1 commit to over trawl-ability trawls to ensure it is safe to resume fishing.
08/08/2017: EIA consultation **Face to face meeting with:** ▪ **North Berwick Fishermen's Association**	Confirmed that fishing vessels from North Berwick do not extend their operational range to the Development Area and so expect little impact in terms of loss of ground. Noted potential for displacement into grounds currently fished by North Berwick potting vessels.	The impact assessment in Section 10.8 provides assessment of loss of fishing grounds and displacement leading to gear conflict.
16/08/2017: EIA consultation **Face to face meeting with:** ▪ **St Andrews Fishermen's Association**	Raised concern over displacement leading to gear conflict within grounds typically targeted by St Andrews vessels.	The impact assessment in Section 10.8 provides assessment of displacement leading to gear conflict.

Date and consultation phase / type	Consultation key points raised	Section where comment addressed
24/08/2017: EIA consultation **Face to face meeting with:** ▪ **Scottish Creel Fishermen's Federation**	Discussed member coverage across East, North and West coast of Scotland. Raised concern over gear conflict associated with squid demersal trawl fishery. Considers potting vessels would be able to operate within a wind farm.	The impact assessment in Section 10.8 provides assessment of displacement leading to gear conflict. The impact assessment in Section 10.8 assumes a level of co-existence between potters and the Offshore Wind Farm.
July – August: EIA consultation **Email and telephone correspondence:** ▪ **North and East Coast Inshore Fisheries Group (IFG)**	Declined direct consultation. Provided contacts for members of North & East Coast IFG.	This table provides details of the consultation undertaken.
July – August: EIA consultation **Email and telephone correspondence:** ▪ **Scallop Association** ▪ **Scottish White Fish Producer's Association** ▪ **Scottish White Fish Producers' Association-Inshore** ▪ **Arbroath and Montrose Static Gear** ▪ **Arbroath non-affiliated fishermen**	No replies were received from these organisations. However, these organisations either are members of the SFF or are in communication with the SFF (e.g. Arbroath consultees). The SFF have agreed to provide any feedback on behalf of these organisations.	N/A
July – August: EIA consultation **Email and telephone correspondence:** ▪ **Aberdeenshire Inshore** ▪ **North east Creel and Line**	No replies were received from these organisations. The SFF indicate that fishermen from these organisations are unlikely to fish as far south as the Development Area.	N/A
July – August: EIA consultation **Email and telephone correspondence:** ▪ **Scottish Pelagic Fishermen's Association**	Provided confirmation that there are no active pelagic vessels operating in the Forth and Tay.	This detail has informed the baseline in Section 10.6 and the impact assessment in Section 10.8.
July – August: EIA consultation **Email and telephone correspondence** ▪ **Port Seton Fishermen's Association**	Organised face-to-face meetings were unable to go-ahead. No response received to date on questions and information submitted to Port Seton Fishermen's Association.	N/A

10.5 Impact Assessment Methodology

29. This assessment considers the potential impacts associated with the construction, operation and decommissioning of the Project and the effects on commercial fisheries. The impact assessment process and methodology follows the principles and general approach outlined in Chapter 6: EIA Methodology. The methodology and parameters assessed also take into account issues identified through consultation with stakeholders as detailed in (Section 10.4) and the understanding of baseline conditions informed by the data sources referenced in (Section 10.3).

30. The Project Description (Chapter 4) and the Project activities for all stages of the Project life cycle (construction, operation (including maintenance) and decommissioning) have been assessed against the environmental baseline to identify the potential interactions between the Project and the environment. These are known as the potential impacts and are then assessed to determine a level of significance of effect upon the receiving environment.

10.5.1 Assessment and Assignment of Significance

31. The sensitivities of commercial fishing fleets are defined by both their potential vulnerability to an impact from the Project, their recoverability and value or importance of the receptor. The definitions of sensitivity terms relating to commercial fishing fleets are given in Table 10.5.

Table 10.5 Sensitivity/ importance of the receptor

Receptor sensitivity / importance	Description / justification
High	Receptor is generally vulnerable to impacts that may arise from the project and recoverability is slow and/or costly. Low levels of alternative fishing grounds are available and/or fishing fleet has low operational range.
Medium	Receptor is somewhat vulnerable to impacts that may arise from the project and has moderate levels of recoverability. Moderate levels of alternative fishing grounds are available and/or fishing fleet has moderate operational range.
Low	Receptor is not generally vulnerable to impacts that may arise from the project and/or has high recoverability. High levels of alternative fishing grounds are available and/or fishing fleet has large to extensive operational range; fishing fleet is adaptive and resilient to change.
Negligible	Receptor is not vulnerable to impacts that may arise from the project and/or has high recoverability. Extensive alternative fishing grounds available and/or fishing fleet is highly adaptive and resilient to change.

32. The magnitude of impact is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact. The definitions of the levels of magnitude used in this assessment in respect of commercial fisheries are described in Table 10.6

Table 10.6 Magnitude of the impact

Magnitude of impact	Description (adverse effects)	Description (beneficial effects)
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements.	Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality.
Medium	Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements.	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
Low	Some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring.

Magnitude of impact	Description (adverse effects)	Description (beneficial effects)
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements.	Very minor benefit to, or positive addition of one or more characteristics, features or elements.
No change	No loss or alteration or characteristics, features or elements; no observable impact in either direction.	

33. In assessing the magnitude of the impact, the value and vulnerability of the receptor, i.e. the fishing fleet under assessment, together with the reversibility of the impact are considered. Due to the range in scale, value (in terms of both landings and income / profit) and operational practises, within the commercial fishing fleets assessed, specific economic criteria were not set for defining value within the categories of high, medium, low, negligible or no change. Instead, these classifications were based on judgement informed from the baseline characterisation and consultation with the industry.

34. The magnitude of the impact is correlated against the sensitivity of the receptor to provide a level of significance. For the purposes of the commercial fisheries assessment, any effect that is considered to be of moderate or major significance, are considered to be potentially significant in EIA terms, and therefore may consider further consideration and / or mitigation. Any effect that is minor or below is not considered to be significant.

Table 10.7: Significance of potential effects

		Magnitude			
		High	**Medium**	**Low**	**Negligible**
Sensitivity	**High**	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

10.5.2 Uncertainty and Technical Difficulties Encountered

35. The following sections summarise limitations within the datasets analysed.

10.5.2.1 Landings Statistics

36. Limitations of landings data include the spatial size of ICES rectangles (e.g. the surface area of the Wind Farm Area is 105 km^2, which is 4% of the surface area of ICES rectangle 41E7). This can misrepresent actual activity across the Wind Farm Area and care is therefore required when interpreting these data. A further limitation of landings data is the potential for under-reporting as some catches may fall below the acceptable limit as defined within the UK RBS (i.e. when purchases of first sale fish direct from a fishing vessel are wholly for private consumption or less than 30 kg is bought per day). However, industry consultation across the Angus, Fife, East Lothian and Scottish Border regions confirmed that all landings are recorded through the RBS system, which is correlated with landing declarations within the MMO iFISH database.

37. Data limitations were managed by ensuring accurate interpretation of the data and a clear understanding of its scope. Consultation was fundamental to understanding the validity of data, enabling appropriate interpretation and to ground-truth landings data.

10.5.2.2 VMS Data

38. Limitations of VMS data are primarily focused on the coverage being limited to vessels ≥15 m in length and therefore not representing all inshore activity, which is dominated by vessels that are under 10 m in length.

10.5.2.3 Surveillance Data

39. UK surveillance aircraft are used to construct an ongoing picture of fishing activity within the UK EEZ and to make effective use of patrol vessel activity by coordinated use of surveillance data. These data cannot be considered to give a complete picture of the actual level of activity and have limitations, including the following key aspects:

- Patrol effort by Marine Scotland Compliance, Royal Navy Fisheries Patrol Vessels and patrol aircraft are optimised for enforcement purposes and not collection of sightings data. Areas with fewer fisheries enforcement issues are therefore likely to be visited less often and result in lower data confidence;
- Surveillance data are only indicative of areas where fishing activities occur, as there is no continuous monitoring of activities;
- Surveillance data present a snapshot of activity in an area and it cannot be assumed that if no vessels have been sighted then no fishing takes place; and
- Vessels fishing at night would likely remain undetected.

10.6 Baseline Description

10.6.1 Commercial Fisheries Regional Study Area

40. A full baseline characterisation is provided within Appendix 10.1, which should be read in conjunction with this chapter. This baseline description provides an overview of the key fisheries in the Local and Regional Study Areas, as well as specifically across the Development Area.

41. The average annual landings across the regional commercial fisheries study area (Illustration 10.1) show the highest quantity of catch (tonnes) and value of catch (£) is from ICES rectangle 41E7.

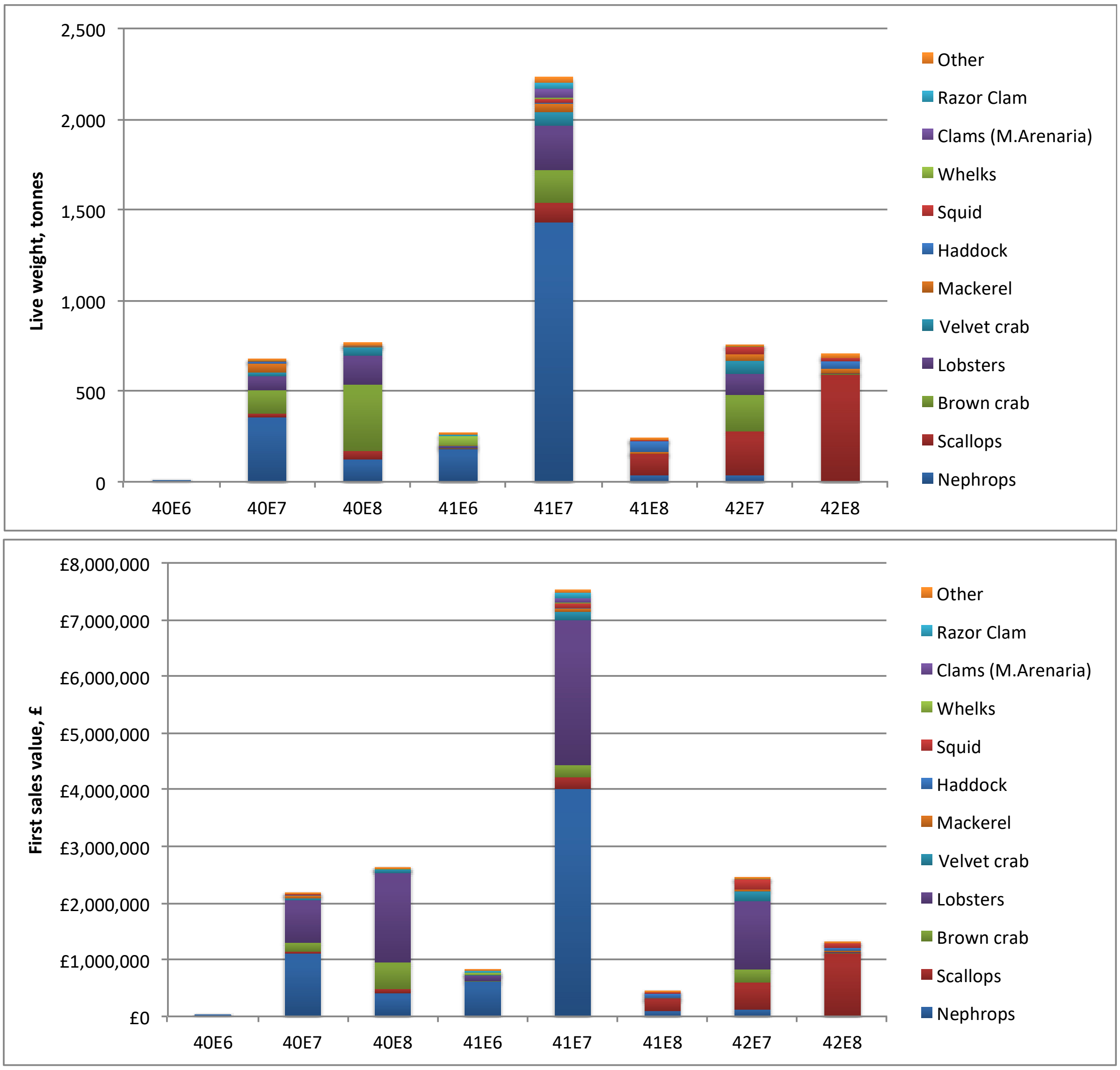


Illustration 10.1: Average annual live weight, tonnes (top) and first sale value (£) (bottom) of all species landed by UK vessels from the regional commercial fisheries study area indicating ICES rectangle and species (based on a five-year average from 2011 to 2015). (Data source: MMO, 2017).

42. Nephrops (*Nephrops norvegicus),* known as langoustine, prawn and Norway lobster, hereon referred to as nephrops, and lobster (*Homarus gammarus)* represent the most commercially important species for inshore ICES rectangles 40E6 to 41E7 (Figure 10.4 (Volume 2)), while scallops (*Pecten maximus)* become increasingly prominent in landings from 41E8, 42E7 and 42E8. In 42E8 scallops account for 83% of the total value landed from this ICES rectangle.

43. The value of catch landed by vessels that are 10 m and under in length represents 47% of the total landings from the Regional Study Area, with 53% taken by vessels over 10 m in length.

44. Most landings from E7 ICES rectangles are made by vessels 10 m and under in length (Illustration 10.2), while most landings from E8 ICES rectangles are made by vessels over 10 m in length. Given the operational ranges of vessels under 10 m in length, it is to be expected that their effort is higher in inshore waters, rather than beyond 12 NM.

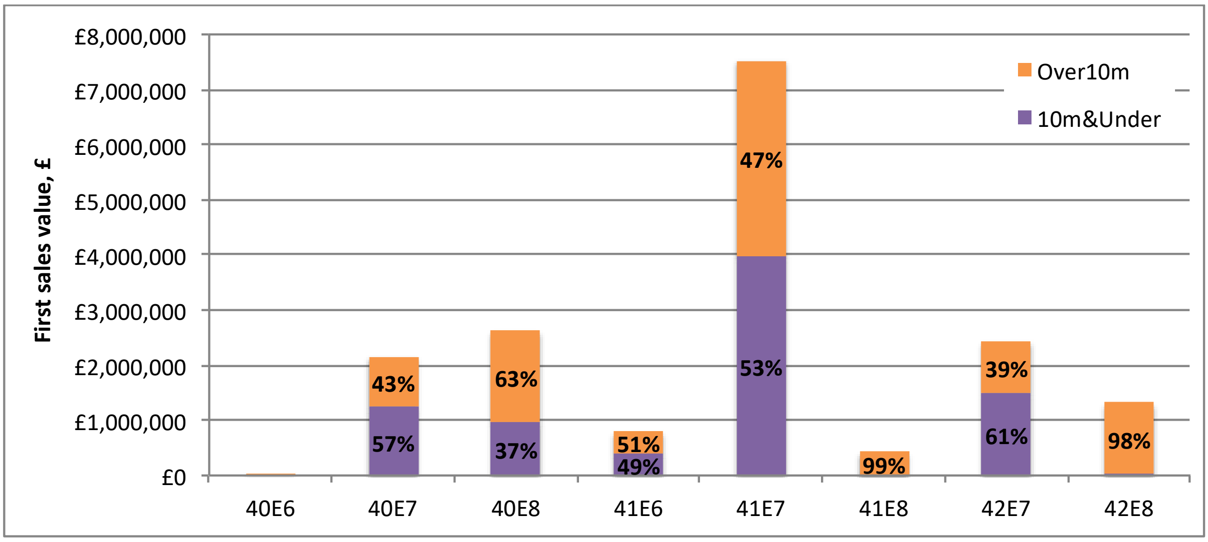


Illustration 10.2: Average annual first sale value (£) of all species landed by UK vessels from the regional commercial fisheries study area indicating ICES rectangle and vessel length category (based on a five-year average from 2011 to 2015). (Data source: MMO, 2017).

10.6.2 Wind Farm Area

45. The Wind Farm Area is located within ICES rectangle 41E7. In terms of spatial overlap, the Wind Farm Area is 105 km^2 and covers approximately 4% of ICES rectangle 41E7. It cannot be assumed that the landings from the Wind Farm Area are 4% of the total value landed from 41E7, as this does not take account of specific fishing grounds that may be present within the Wind Farm Area, or elsewhere in 41E7. Nevertheless, it provides useful context for the detailed landings described below. Unless otherwise stated, all average annual figures are based on a five-year average from 2011 to 2015

46. An average annual value of £7.5 million is landed from ICES rectangle 41E7, with 97% of landings (£7.3 million) taken by Scottish registered vessels.

47. Most landings from 41E7 are taken by vessels that are 10 m and under in length (53%, Illustration 10.2), with the remaining 47% landed by vessels >10 m. Given the fleet structure as outlined in Appendix 10.1, a significant proportion of landings by the over 10 m fleet is likely to be by vessels that are <15 m in length.

48. Five-year annual trends for landings from 41E7 are presented in Illustration 10.3 by first sales value and weight, tonnes. The most important commercial species landed from 41E7 is nephrops, with annual values ranging from £2.6 to £5.2 million and an average annual value of £4 million. A drop in nephrops landings is noted from 2012 to 2013, but significant growth is seen in 2014, while the 2015 value is closer to the annual average, at £4.4 million.

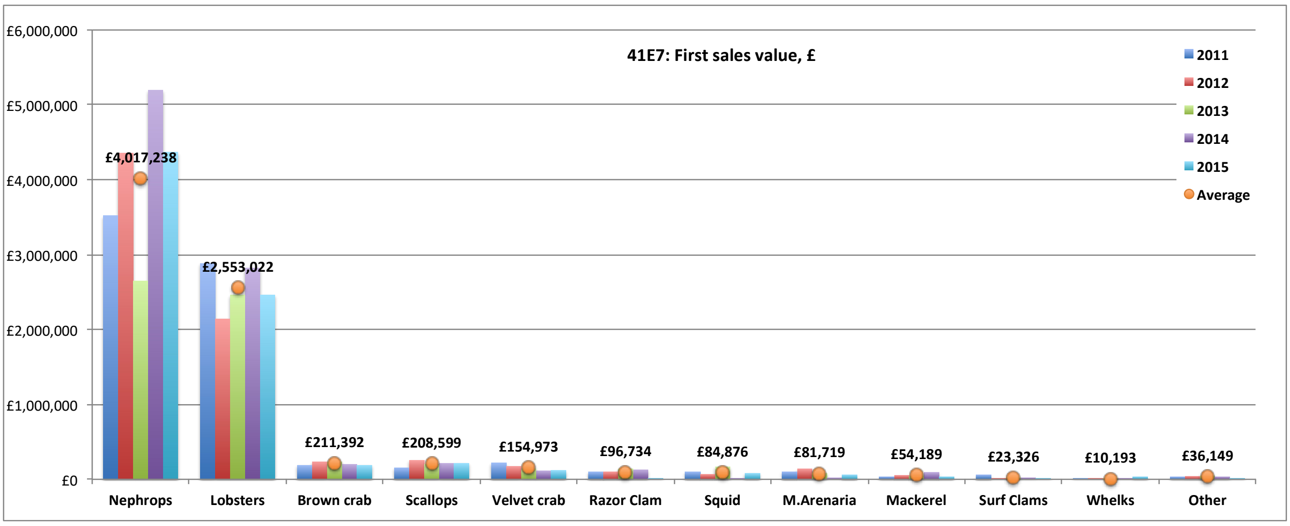
49. Lobster landings have also fluctuated, growing from 2012 to 2014, with a small drop in 2015; annual value ranges from £2.1 to £2.9 million, with an average annual value of £2.5 million.

50. Brown crab and velvet crab have an average annual value of £211,392 and £154,973 respectively. Brown crab landings equate to an average of 182 tonnes (compared to lobster at 245 tonnes) but they are nine times lower in value than lobster, which is reflected in the much lower first sales value. Brown crab landings have remained consistent across the five-year period, while a continuous decline is noted in velvet crab landings, both in terms of weight and value.

51. Scallop landings increased from 2011 to 2012 and have remained relatively consistent since then, with an average annual weight of 108 tonnes, worth £208,599.

52. Other notable shellfish species are razor shell (*Ensis ensis*) (£96,734 annually) and soft-shelled clam (*Mya arenaria*) (£81,719 annually), which are both landed by hydraulic dredge.

53. Small quantities of squid are taken by demersal trawl (£84,876 annually), and potting vessels that also deploy hook and lines to catch mackerel (£54,189 annually).



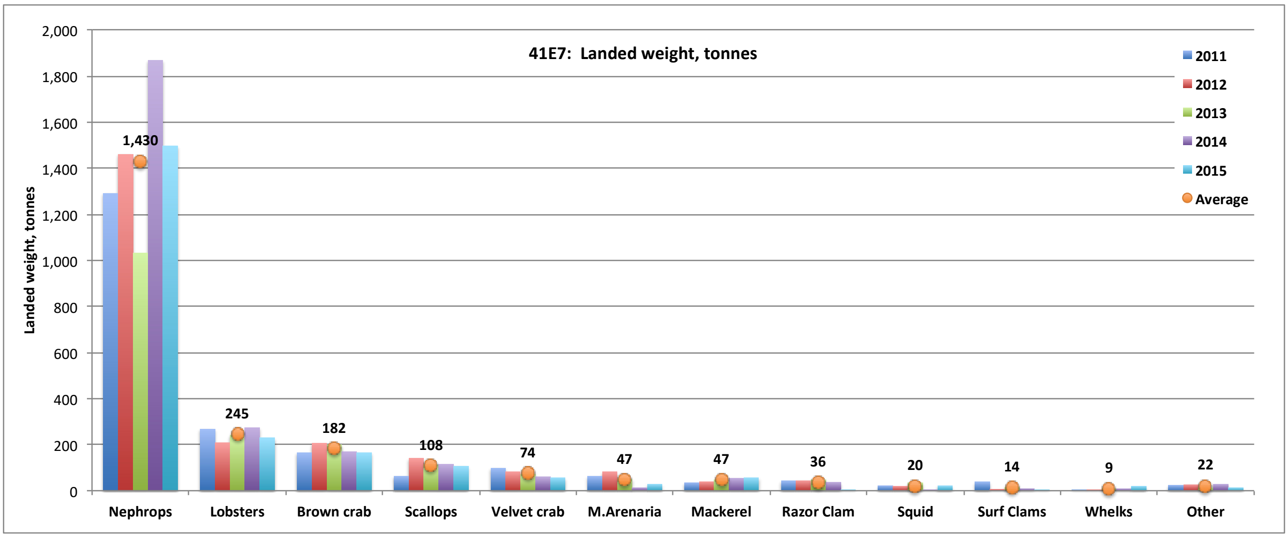


Illustration 10.3: Annual landings by UK registered vessels from ICES rectangles 41E7 by species and first sales value (top) and weight, tonnes (bottom) from 2011 to 2015, (Data source: MMO, 2017)

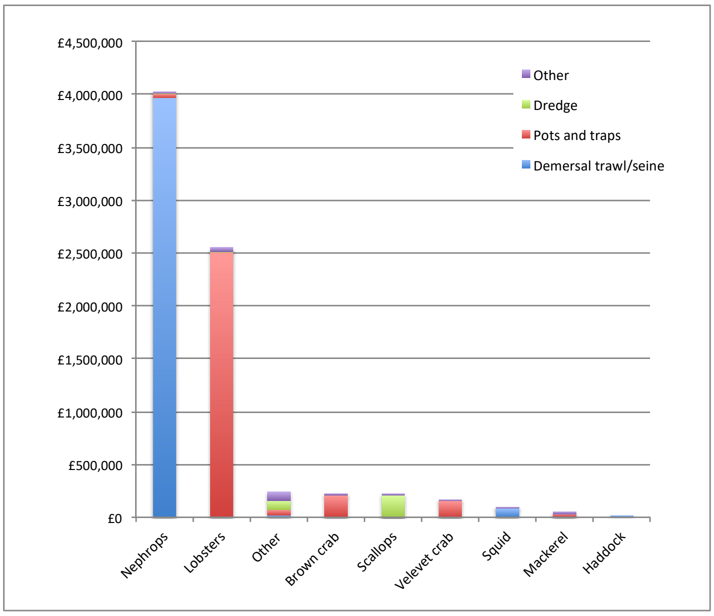
54. The annual first sales value of species landed from 41E7 are shown in Illustration 10.4 by method of capture and vessel length category and based on average annual values from 2011 to 2015). Lobster, brown crab and velvet crab are landed by creels, almost entirely by vessels 10 m and under in length (95% by value).

55. Nephrops are landed by demersal trawl, primarily by vessels over 10 m in length (76% by value), but also by vessels under 10 m in length (24%). There is no direct targeting of nephrops using creels.

56. The fishing fleets in terms of gears used to target different species and vessel length categories have remained consistent for 2016, as presented in Illustration 10.5, meaning that no new specific fisheries have emerged in 2016. It should be noted that 2016 data has not been ground-truthed or verified through industry consultation, but provides the most recent dataset available. The value of nephrops landed from 41E7 in 2016 totalled £4.4 million, which is above the five-year annual average seen during 2011 to 2015, but below the peak in 2014.

57. Similarly, lobster landings from 41E7 were higher in 2016 (at £2.8 million) compared to the annual average, but consistent with peaks seen in 2011 and 2014. Scallop landings were also higher in 2016 (at £400,000) compared to the annual average of £208,000 from 2011 to 2015. All other species have landings values consistent with the annual averages seen for 2011 to 2015.

58. It is therefore considered that 2016 data does not change the baseline assessment presented for 2011 to 2015 for fisheries operating in 41E7.



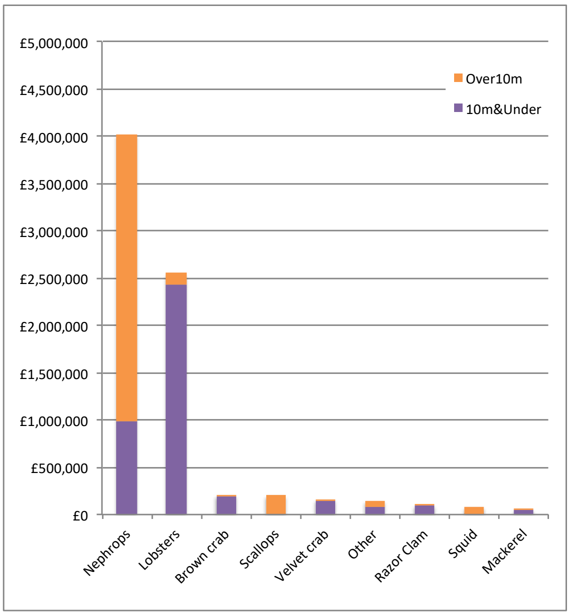
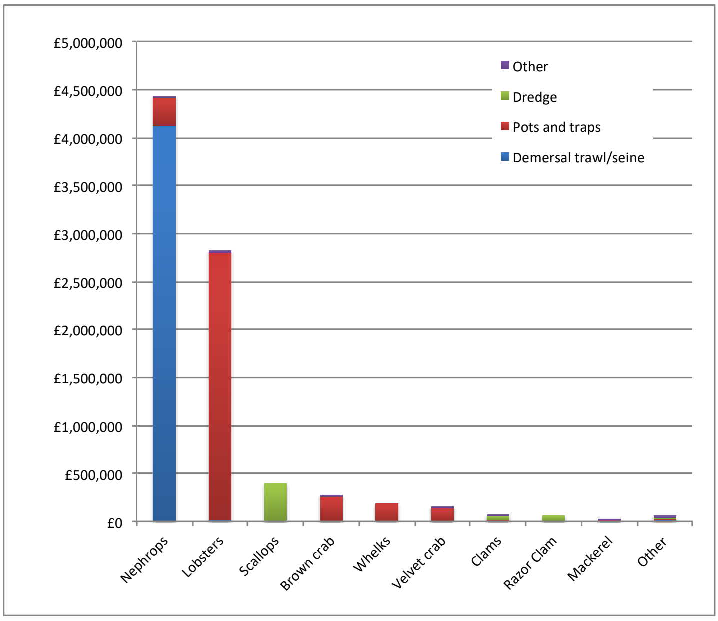


Illustration 10.4: Average annual value of species landed by UK vessels from ICES rectangle 41E7 indicating gear type (left) and vessel length category (right) (based on five-years' data from 2011 to 2015) (Data source: MMO, 2017)



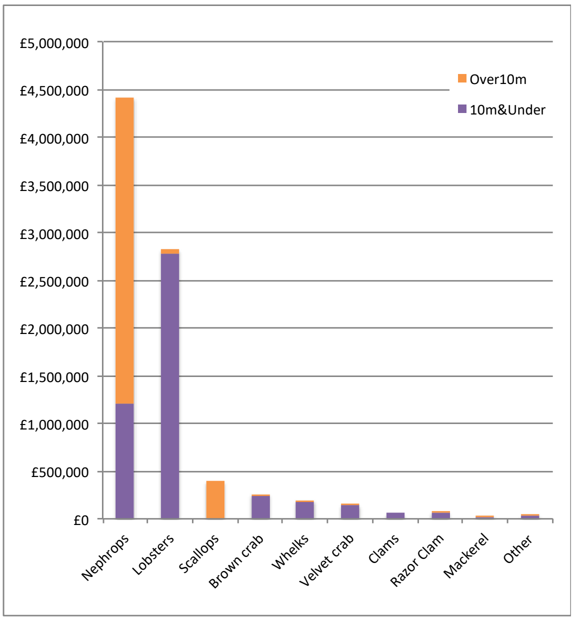


Illustration 10.5: Value of species landed by UK vessels from ICES rectangle 41E7 indicating gear type (left) and vessel length category (right) in 2016 (Data source: MMO, 2017)

59. Long-term trends in scallop landings from 41E7 show a significant spike in 2007, when approximately 560 tonnes were landed, compared to the average of 190 tonnes (see Appendix 10.1). This is characteristic of scallop fisheries where nomadic vessels can target a wide range of grounds, focusing effort on specific locations on a rolling 7-10 year basis.

60. The fishing effort (hours fished) within ICES rectangle 41E7 for demersal trawl and potting vessels is presented in Illustration 10.6 from 2011 to 2015 indicating the vessel length category. The EU DCF database reports on vessel lengths in three categories: under 10 m, 10 to 15 m and over 15 m in length (this contrasts with the MMO landings data, which reports in two categories).

61. Fishing effort for both demersal trawl and potting was relatively consistent from 2011 to 2013. A significant increase in effort occurs in 2014 for both gear types, which is maintained in 2015. For demersal trawl and potting, this effort increase is specifically pronounced for the under 10 m fleet.

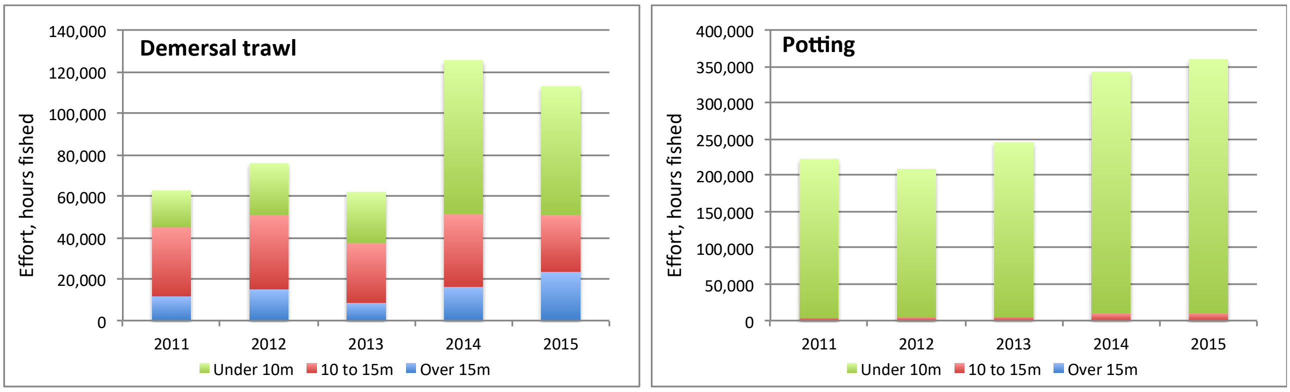


Illustration 10.6: Effort, hours fished, by demersal trawl and potting vessels in ICES rectangle 41E7 from 2011 to 2015, indicating length of vessel (Data source: EU DCF, 2017).

62. Industry consultation undertaken in 2010 has been extremely helpful in mapping the representative fishing grounds that are targeted by the nephrops demersal trawl vessels (Figure 10.4 (Volume 2)) and lobster and crab potting vessels (Figure 10.6 (Volume 2)).

63. Nephrops grounds in this region are typically targeted from 0.5 NM from shore, out to 20 NM. Fishing grounds are noted to occur across the Development Area. However, consultation, VMS data for >15 m demersal trawlers (Figure 10.5 (Volume 2)) and surveillance data (Figure 10.7 (Volume 2)), indicates that effort and landings are primarily focused on grounds inshore from the Wind Farm Area, running parallel to the coast.

64. Specific potting grounds (identified by a sample of individual fishermen), and general potting grounds (identified by fisheries representatives) indicate a large area of operation for the eastern and southeast Scottish potting fleet. It is understood that potting vessels routinely deploy gear within the Wind Farm Area.

65. Industry consultation with fishermen's associations across the east and southeast coast of Scotland consistently communicated that no gear conflict is experienced during commercial fisheries operations. There are some voluntary codes of practice, e.g. related to how potting gear is set and marked, but ultimately the approach is one of common sense whereby potters avoid key trawling grounds and trawlers avoid areas where potting gear is set. Furthermore, the key target species inhabit very different seabed habitats with nephrops linked to fine muddy benthos and lobster found in rocky, hard substrate and crevices.

10.6.3 Offshore Export Cable Corridor

66. The Offshore Export Cable Corridor is routed through ICES rectangle 40E7 and 41E7. In terms of spatial overlap, the Offshore Export Cable Corridor is 43 km in length and 300 m wide, equating to an area of 12.9 km^2, which overlaps with approximately 0.39% of ICES rectangles 40E7 and 41E7. In terms of spatial overlap for ICES rectangles individually, the Offshore Export Cable Corridor overlaps with approximately 1.43% of 40E7 and 0.27% of 41E7.

67. An average annual value of £9.7 million is landed from 41E7 and 40E7, with 96% of landings (£9.3 million) taken by Scottish registered vessels. Most landings are taken by vessels that are 10 m and under in length (54%), with the remaining 46% landed by vessels >10 m in length. It should be noted that, given the fleet structure as outlined in Appendix 10.1, a significant proportion of landings by the over 10 m fleet is likely to be by vessels that are <15 m in length.

68. Five-year annual trends for landings from 40E7 and 41E7 are presented in Illustration 10.7 by first sales value and weight, tonnes. The most important commercial species to be landed from 40E7 and 41E7 is nephrops, with annual value ranges from £3.6 to £6.3 million and an average annual value of £5.1 million. The trends for nephrops landings across the five-year period are consistent with those described for the Wind Farm Area as they occur within the same ICES rectangle, 41E7.

69. Lobster are the next most commercially important species with a range in annual value from £2.9 to £3.6 million and an average annual value of £3.3 million.

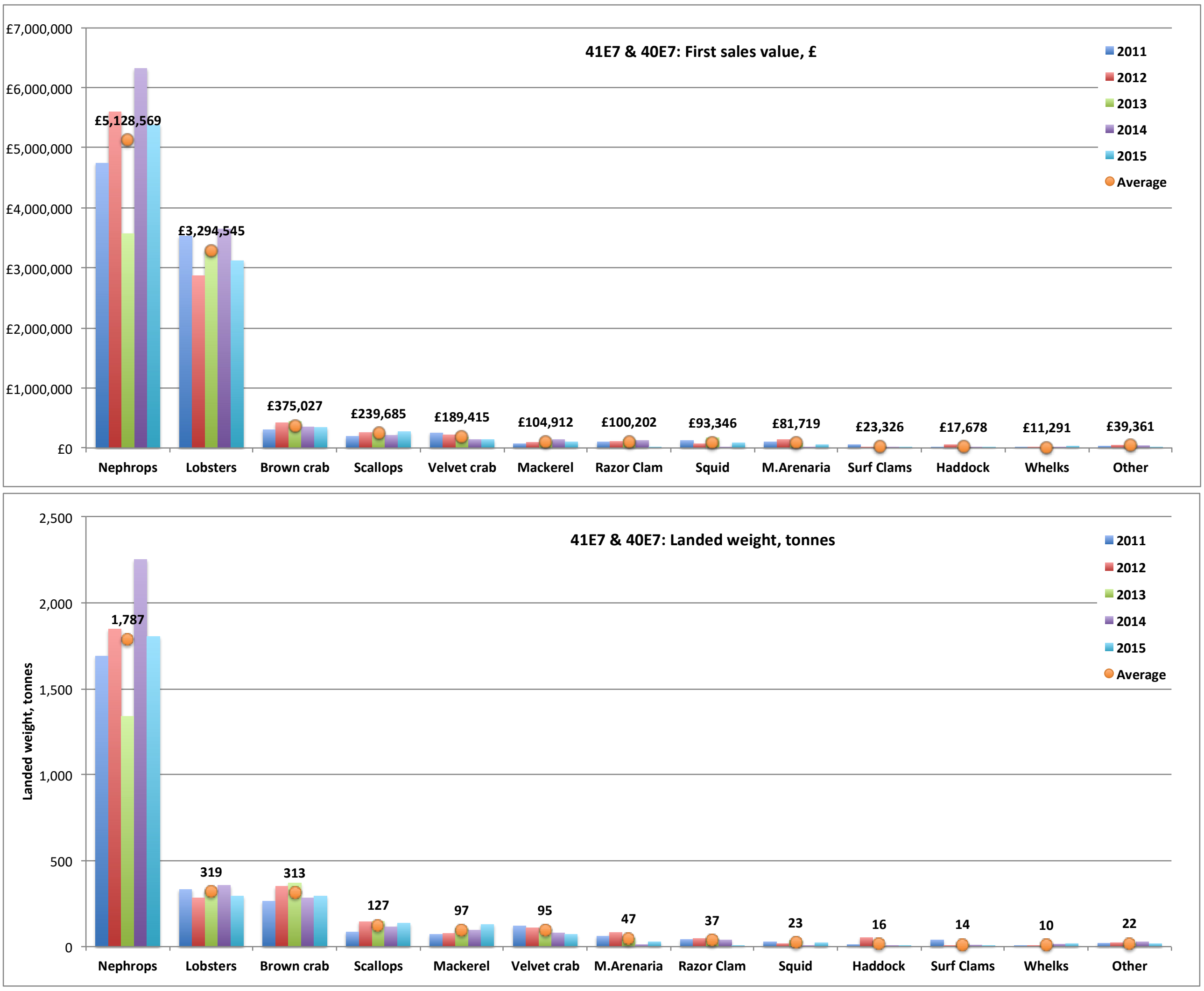


Illustration 10.7: Annual landings by UK registered vessels from ICES rectangles 41E7 and 40E7 by species and first sales value (top) and weight, tonnes (bottom) from 2011 to 2015, (Data source: MMO, 2017)

70. Landing statistics by method of capture and vessel length category are presented in full in Appendix 10.1, for both 2011 to 2015 and 2016, and reflect the findings reported for 41E7 in Illustration 10.4.

71. The fishing effort (hours fished) within ICES rectangles 40E7 and 41E7 for demersal trawl and potting vessels are presented in full in Appendix 10.1, and reflect the findings reported for 41E7 in Illustration 10.6.

72. Maps based on industry consultation show nephrops demersal trawl grounds (Figure 10.4 (Volume 2)) and lobster and crab potting grounds (Figure 10.6 (Volume 2)) occur across the entirety of the Offshore Export Cable Corridor. Consultation pointed to more focused demersal trawl grounds, running parallel to the coast and across the Offshore Export Cable Corridor. Potting around the area that overlaps the Offshore Export Cable Corridor is generally more exploratory. This is consistent with

the message from consultation of no gear conflict, as the two different fishing methods would be expected to have limited spatial overlap.

73. The 2015 VMS data (Figure 10.5 (Volume 2)) shows considerable effort and value by the demersal trawl ≥15 m vessels across the Offshore Export Cable Corridor. A specific hot spot of activity is noted from half way along the Offshore Export Cable Corridor running towards the Wind Farm Area. This is corroborated by industry consultation, which cited the areas inshore from the Wind Farm Area as being important nephrops grounds.

74. The VMS for dredging activity shows some activity in the inshore areas of the Offshore Export Cable Corridor, immediately adjacent to the shore out to approximately 4 NM. More pronounced effort is noted in areas northwest, east and southeast from the Offshore Export Cable Corridor.

10.6.4 Development of Baseline Conditions without the Project

75. Commercial fisheries patterns change and fluctuate based on a range of natural and management controlled factors. This includes, but may not be limited to, the following:

- **Stock abundance:** fluctuation in the biomass of individual species stocks in response to status of the stock, recruitment, natural disturbances (e.g. due to storms, sea temperature etc.), changes in fishing pressure etc.;
- **Fisheries management:** including changes in Total Allowable Catches (TACs) leading to the relocation of effort, and/or an overall increase/decrease of effort, changes to Minimum Landing Size (MLS), changes to gear technology etc.;
- **Environmental management:** including the potential restriction of certain fisheries within protected areas;
- **Improved efficiency and gear technology:** with fishing fleets constantly evolving to reduce operational costs e.g. by adapting gear to have a lighter footprint;
- **Sustainability:** with seafood buyers more frequently requesting certification of the sustainably of fish and shellfish products, such as the Marine Stewardship Council certification, industry is adapting to improve fisheries management and wider environmental impacts; and
- **Markets:** commercial fishing fleets respond to market prices by focusing effort on higher value target species when prices are high and markets in demand.

76. The variations and trends in commercial fisheries activity is an important aspect of the baseline assessment, and forms the principle reason for assessing five years of baseline data. In some cases, a longer period may be considered in the baseline to ensure long-term trends inform the assessment, either as a result of fisheries stakeholder’s requests, or to reflect natural cycles in specific fisheries such as scallop (see Appendix 10.1 for long-term trends in nephrops, lobster, brown crab and scallop landings). Therefore, for commercial fisheries, the future baseline scenario would be expected to be fluctuate within the ranges that are represented within the current baseline.

10.6.5 Summary of fleets to be assessed

77. For this assessment, the commercial fisheries fleets have been defined as:

- Potting vessels targeting lobster, brown crab and velvet crab with creels, and seasonally deploying hook and lines to target mackerel;
- Demersal otter trawling vessels targeting nephrops and (seasonally) squid, using single or twin trawl;
- Scallop dredging vessels targeting scallop; and
- Other (hydraulic) dredging vessels targeting razor shell and soft-shelled clam.

10.7 Design Envelope – Worst Case Design Scenario

78. The Application is for the construction, operation and decommissioning of an offshore wind farm with a maximum output of 450 MW, comprising of a maximum of 54 turbines. The assessment scenarios identified in respect of commercial fisheries have been selected as those having potential to represent the greatest effect on an identified receptor based on the design envelope described in Chapter 4: Project Description. The worst-case design scenarios are set out in Table 10.8 and drawn from the project details set out in Chapter 4: Project Description.

Table 10.8: Worst-case design envelope scenario assessed

Potential Impact	Worst-Case Design Scenario	Justification
Construction		
Wind Farm Area construction activities and physical presence of constructed wind farm infrastructure leading to reduction in access to, or exclusion from established fishing grounds. **Displacement from Wind Farm Area leading to gear conflict and increased fishing pressure on adjacent grounds.**	▪ Wind Farm Area ▪ Maximum number of turbines: 54 ▪ Minimum distances between turbines: approx. 800 m ▪ Area of seabed occupied by jackets based on up to 54 turbines x 4 leg jacket foundations equates to approximately 1200 m^2 footprint per turbine (including scour protection), with total for up to 54 turbines of = approximately 0.065 km^2 ▪ Safety zones around turbine and OSP installation activities (where a vessel is present): 500 m ▪ Safety zones around turbine and OSP installation activities (where a vessel is not present): 50 m ▪ Construction period: 2 - 3 years ▪ Number of OSPs: 2 ▪ Total seabed occupied by OSP (piles, legs and scour protection): approximately 2,400 m^2. Total for 2 OSPs: 4800 m^2 (0.0048 km^2). ▪ Number of met masts: 1 ▪ Inter-array and inter-connector cables with total length of up to 140km, with 2 m width of direct disturbance plus 8 m width of minor disturbance. ▪ Advisory minimum safe passing distances around inter-array and inter-connector cable installation activities: 500 m ▪ Cable burial likely to involve ploughing/cutting/jetting or if burial cannot be achieved due to rock at sea-bed surface then a protective cover will be applied over the cable using one of the methods described in Chapter 4: Project Description. ▪ Cable burial target depth of 1.0 – 1.5 m, but potentially up to 3 m in places. It is estimated that up to 20% of inter-array and inter-connector cables may be covered with rock protection where target burial depths cannot be achieved. ▪ All the above infrastructure has the potential to be placed anywhere within the entire Wind Farm Area of 105 km^2.	The maximum number of turbines will lead to the maximum area for potential impact on fishing activity during the construction phase. The assessment assumes that the entire Wind Farm Area will not be excluded to fisheries during the construction phase, but that access is limited to areas of construction and installation activity and associated 500 m safety zones or advisory safe passing distances. The maximum width of inter-array and inter-connector corridor will lead to the maximum area for potential impact on fishing in relation to inter-array and inter-connector installation activities.

Potential Impact	Worst-Case Design Scenario	Justification
Offshore Export Cable construction activities leading to reduction in access to, or exclusion from, established fishing grounds. **Displacement from the Offshore Export Cable Corridor leading to gear conflict and increased fishing pressure on adjacent grounds.**	Offshore Export Cable Corridor ▪ Maximum number of cables: 2 ▪ Maximum length: approximately 43 km each ▪ Maximum width of corridor: approximately 300 m ▪ Target burial depth between 1.0 – 1.5 m but potentially up to 3 m in places. It is estimated that up to 15% of the offshore export cables may be covered with rock protection where target burial depths cannot be achieved. ▪ 500 m advisory safe passing distance around major construction activities along the Offshore Export Cable Corridor (i.e. a roaming exclusion of approximately 0.79 km^2 along the 43 km cable route corridor). ▪ Construction period: 9 months.	The assessment assumes fishing activity would be prevented from the Offshore Export Cable Corridor within advisory safe passing distances around construction activities, on a rolling basis for periods within a maximum construction duration of up to 9 months.
Wind Farm Area and Offshore Export Cable Corridor construction activities leading to displacement or disruption of commercially important fish and shellfish resources.	The worst case design scenarios for impacts on fish and shellfish species during the construction activities that have been scoped into the EIA Report are presented in Chapter 7: Fish and Shellfish Ecology, Table 7.15.	The scenarios presented in Chapter 7: Fish and Shellfish Ecology, for those issues scoped into the EIA Report, provide for the greatest disturbance to fish and shellfish species and therefore the greatest potential inter-related effect to associated commercial fisheries.
Wind Farm Area and Offshore Export Cable Corridor construction activities leading to additional steaming to alternative fishing grounds for vessels that would otherwise be fishing within the wind farm and export cable areas. **Increased vessel traffic within fishing grounds as a result of changes to shipping routes and construction vessel traffic from Wind Farm Area and Offshore Export Cable Corridor leading to interference with fishing activity.**	As per the worst case design scenarios described above for the Wind Farm Area and Offshore Export Cable during the construction phase.	As per the above justifications for the Wind Farm Area and Offshore Export Cable during the construction phase.
Operation and Maintenance		
Physical presence of Wind Farm Area leading to reduction in access to, or exclusion from established fishing grounds.	Wind Farm Area ▪ Maximum number of turbines: 54 ▪ Area seabed occupied by turbines and scour protection: approximately 300 m^2 per turbine jacket leg. Total for up to	The assessment assumes that fishing vessels will resume operation within the Wind Farm Area, with exception of a 50 m advisory safe passing distance from

Potential Impact	Worst-Case Design Scenario	Justification
Displacement from Wind Farm Area leading to gear conflict and increased fishing pressure on adjacent grounds. **Physical presence of Wind Farm Area leading to gear snagging.**	54 turbines of = approximately 0.064 km^2 ▪ Minimum distances between turbines: approx. 800 m ▪ Maximum number of substations: 2 ▪ Total area seabed occupied by OSP (piles, legs and scour protection): approximately 2400 m^2. Total for 2 OSPs: 4800 m^2 (0.0048 km^2). ▪ Number of OSPs: 2 ▪ Number of met masts: 1 ▪ Up to 140 km of buried or protected inter-array and inter-connector cables. Installed cable protection where burial is not possible is anticipated to be approximately 2 m wide and 0.5 m high. ▪ 500 m safety zones or advisory safe passing distances around infrastructure undergoing major maintenance. ▪ Advisory operational distance of 50 m from turbines.	the turbines and avoiding any rock cover protection that may be used at points along the inter-array and inter-connector cable where over trawl surveys show fishing may not resume.
Physical presence of Offshore Export Cable Corridor leading to reduction in access to, or exclusion from established fishing grounds. **Displacement from the Offshore Export Cable Corridor leading to gear conflict and increased fishing pressure on adjacent grounds.** **Physical presence of the Offshore Export Cable leading to gear snagging.**	<u>Offshore Export Cable</u> ▪ Up to 2 x 43 km buried or protected Offshore Export Cables. ▪ 500 m advisory safe passing distances around infrastructure undergoing major maintenance.	The assessment assumes that fishing vessels will resume operation across the Offshore Export Cable Corridor with the exception of avoiding any rock cover protection that may be used at points along the cable where over trawl surveys show fishing may not resume.
Physical presence of Wind Farm Area and Offshore Export Cable leading to additional steaming to alternative fishing grounds for vessels that would otherwise be fishing within these areas. **Increased vessel traffic within fishing grounds as a result of changes to shipping routes and maintenance vessel traffic from the Wind Farm Area and the Offshore Export Cable Corridor leading to interference with fishing activity.**	As per the worst case design scenarios described for Wind Farm Area and Offshore Export Cable during the operation and maintenance phase.	As per the above justifications for the Wind Farm Area and Offshore Export Cable during the operation and maintenance phase.
Decommissioning		

Potential Impact	Worst-Case Design Scenario	Justification
As per potential impacts, worst case design scenarios and justifications presented for operation and maintenance.		

10.7.1 Embedded Mitigation

79. A number of mitigation options, both embedded and for implementation, were identified within the design envelope for the Originally Consented Project, during the consultation phase of the Original Application, and during the ongoing liaison with fisheries stakeholders, their representatives and with MS-LOT. As set out in the Scoping Report (and as summarised in Chapter 5: Scoping and Consultation) these have been adopted into the Project design as the design envelope has evolved. Those relating to commercial fisheries are as follows:

- Establishment of and participation in a working group to assist with the following:
  - Dissemination of Project information;
  - Application of safety zones and advisory safe passing distances and implications for fisheries;
  - Navigation of Project construction and maintenance works vessels to and from the site (i.e., agreement of transit lanes to minimise interference to fishing activities, agreement for 'holding' areas for vessels in the event of bad weather);
  - Procedures in the event of interactions between Project construction and fishing activities (i.e. claims for lost and/or damaged gear);
  - Burial and protection of inter-array, inter-connector and Offshore Export Cables;
  - Removal of seabed obstacles during and post-construction; and
  - Post-construction surveys and seabed rectification procedures.
- All infrastructure installed during the construction phase will be marked and lit, in line with standard industry practice, and relevant information will be distributed to fishermen through the agreed channels.
- Cables will be buried where it is reasonably practicable to do so. In instances where adequate burial cannot be achieved then the developers will seek to install cable protection.
- Over trawl surveys will be carried out on the Offshore Export Cable and inter-array and inter-connector cables where cable protection has been required to ensure that the protection scheme has been successful.

10.7.2 Anticipated Consent Conditions

80. A number of consent conditions were attached to the Consents to manage the environmental risk associated with the Originally Consented Project. Those consent condition commitments that are relevant to the potential impacts on commercial fisheries are set out in Table 10.9. If further mitigation is required following the impact assessment process, then this will be included as additional mitigation and is set out in Section 10.9.

Table 10.9: Consent condition commitments relating to commercial fisheries

Design Parameter	Consent Condition requirement
Commercial Fisheries Mitigation Strategy	Setting out, for approval, the mitigation strategy for each commercial fishery in the area that the Scottish Ministers agree may be adversely affected by the Project.
Fisheries Liaison Officer	Appointment of a Project Fishing Liaison Officer (FLO) to establish and maintain effective communications with fishery industry.

Design Parameter	Consent Condition requirement
Cable Plan	Setting out, for approval, the following measures to manage the risk to commercial fisheries: ▪ Details of the location and cable laying techniques for the cables; ▪ The results of survey work (including geophysical, geotechnical and benthic surveys) which help inform cable routing; ▪ Technical specifications of cables, including a desk based assessment of attenuation of electro-magnetic field strengths and shielding; ▪ A burial risk assessment to ascertain burial depths and, where necessary, alternative suitable protection measures; ▪ Methodologies for over trawl surveys of the cables through the operational life of the wind farm where mechanical protection of cables laid on the sea bed is deployed; and ▪ Methodologies for cable inspections with measures to address and report any cable exposure.
Commercial Fisheries Working Group	Continued membership of, and participation in the Forth & Tay Commercial Fisheries Working Group to assist with the following: ▪ Dissemination of Project information; ▪ Application of safety zones and implications for fisheries; ▪ Navigation of Wind Farm Area construction and works vessels to and from the site (i.e., agreement of transit lanes to minimise interference to fishing activities, agreement for 'holding' areas for vessels in the event of bad weather); ▪ Procedures in the event of interactions between Wind Farm Area construction and fishing activities (i.e. claims for lost and/or damaged gear); ▪ Burial and protection of inter-array, inter-connector and export cabling; ▪ Removal of seabed obstacles during and post-construction; and ▪ Post-construction surveys and seabed rectification procedures.
Navigational Safety Plan	Navigational Safety Plan: Setting out, for approval, the navigational safety measures to mitigate navigational risk to commercial fisheries operating in the area.
Lighting and Marking Plan	Lighting and Marking Plan: Setting out, for approval, the navigational lighting strategy to be installed at the site to ensure safe marking of the structures and Development Area to mitigate the navigational risk to commercial fisheries operating in the area.
Monitoring and Mitigation	Monitoring and mitigation: ▪ Participation in the Forth and Tay Regional Advisory Group (FTRAG) established by the Scottish Ministers for the purposes of advising the Scottish Ministers on monitoring and mitigation of, among other things, commercial fish. ▪ Participation in the Scottish Strategic Marine Environment Group (SSMEG) established by the Scottish Ministers for the purposes of advising the Scottish Ministers on monitoring and mitigation of, among other things, commercial fish.

Design Parameter	Consent Condition requirement
Navigational Safety	Navigational Safety: ▪ Notify the UKHO prior to the commencement of construction to facilitate the promulgation of maritime safety information and updating of nautical charts and publications through the national Notice to Mariners System. ▪ Issue local Notice to Mariners to ensure local mariners, fishermen's organisations and HM coastguard are aware of the Licensable Marine Activities. ▪ Consult with local harbour masters as appropriate. ▪ Ensure that details of the works are promulgates in the Kingfisher Fortnightly Bulletin [KIS-ORCA], prior to the commencement of the works to inform the Sea Fish industry of vessel routes, timings and the locations of Project activities. ▪ Ensure appropriate notifications are made following completion of the works to all relevant stakeholders including UKHO, the Maritime Rescue and Coordination Centre Aberdeen and all mariners and fishermen's organisations. ▪ Ensure appropriate notifications are made through the Kingfisher Fortnightly Bulletin to inform the Sea Fish Industry. ▪ All infrastructure installed will be marked and lit, in line with standard industry practice, and relevant information will be distributed to fishermen through the agreed channels.
Lighting and Marking	Markings, lighting and signals of the Works ▪ Ensure that the Project is lit in accordance with the requirements of the relevant statutory stakeholders including marking of the site with appropriate construction buoyage during construction and continued lighting of the site following completion of construction as required by the MCA and NLB. ▪ Ensure that any vessels engaging in the work are marked in accordance with the International Rules for the Prevention of Collisions at Sea if under way and in accordance with the UK Standard Marking Schedule for Offshore Installations if secured to the seabed.

10.8 Impact Assessment

81. The commercial fisheries impact assessment is undertaken at a fleet level, with each impact assessed for each fleet.

10.8.1 Construction Phase Impacts

82. The impacts resulting from the construction of the Project have been assessed on commercial fisheries receptors identified within the study area. A discussion of the likely significance of each effect resulting from each impact is presented below.

10.8.1.1 Wind Farm Area construction activities and physical presence of constructed Project infrastructure leading to reduction in access to, or exclusion from established fishing grounds.

83. During construction in the Wind Farm Area, commercial fisheries will be prevented from fishing within 500 m safety zones (for OSP(s) and turbines) and 500 m advisory safe passing distances (for inter-array and inter-connector) cable installation works) around construction activities (i.e. a roaming exclusion of approximately 0.79 km^2 around construction activities), including any 50 m safety zones around any structures prior to commissioning. It is assumed the construction will take place as a continual phase for a maximum of 3 years' duration.

84. This impact will lead to a temporary loss of access to specific fishing grounds within active construction areas and loss of access to the fish resources within these grounds for a range of fishing opportunities during a period within the 3-year construction phase, which will directly affect fleets over a short-term duration. The impact is predicted to be continuous in respect of the Wind Farm Area as a whole and is of relevance to national and local fishing fleets, which is described below on a fleet-by-fleet basis.

85. Embedded mitigation commits to ensuring appropriate notifications are made through the Kingfisher Fortnightly Bulletin to inform the fishing industry of construction activities.

10.8.1.1.1 Potting Vessels

86. Two to three potting vessels are understood to currently operate across the Wind Farm Area, with the potential for up to 70 potting vessels with the operational range to explore these grounds. Combined lobster, brown crab and velvet crab landings have an average annual value of £2.9 million to UK vessels landing from ICES rectangle 41E7, the overwhelming majority of which are Scottish and based at local ports. Specific ports with potting vessels that have potential to operate across the Wind Farm Area include (in no particular order) Pittenweem, Dunbar, Burnmouth, Eyemouth, St Abbs, Crail, Cove, Methil, Leven and Johnshaven (Figure 10.2 (Volume 2)). This is informed by landing statistics by port and industry consultation.

87. The Wind Farm Area has a spatial overlap of 4% of ICES rectangle 41E7. However, fishing activity mapping indicates specific potting grounds over the Wind Farm Area and therefore a higher proportional value is considered likely. Based on the high value of the potting landings, together with the fact that there will be a partial loss of access to shellfish resources and a partial loss of the ability to carry on fishing within parts of the Wind Farm Area during some part of the construction period, across a moderate physical extent, the magnitude is considered to be medium for potting vessels.

88. The potting fleet are typically <10 m in length and operate across more distinct areas of ground, typically 0 to 12 NM from shore. Moderate levels of alternative ground are available to fish and the fleet has a moderate operational range. The sensitivity of the receptor is therefore considered medium.

89. The effect on potting vessels will therefore be of moderate adverse significance, which is significant in EIA terms. Further mitigation is provided in Section 10.9.

10.8.1.1.2 Demersal Otter Trawling Vessels

90. The average annual value of nephrops landed from 41E7 is £4 million. However, it is understood, based on consultation with the industry, that nephrops are typically not heavily targeted across the entirety of the Wind Farm Area. This is supported by aerial surveillance data (for all vessel lengths) and VMS data for >15 m vessels which show some effort along the western portion of the Wind Farm Area. Specific ports with demersal trawling vessels that have potential to operate across the Wind Farm Area include (in no particular order) Pittenweem, Eyemouth, Port Seton and Dunbar. This is informed by landing statistics by port and industry consultation.

91. The squid fishery is not associated with any specific habitat, and thereby demersal trawlers targeting squid could do so throughout the Local Study Area and across the Wind Farm Area. Squid is a highly seasonal and highly fluctuating fishery, which is of relatively low value (£85,000 annually from 41E7).

92. Overall, the magnitude of the impact is considered medium for demersal otter trawling vessels.

93. Demersal otter trawlers generally fish over a moderate operational range, and are expected to be able to avoid the Wind Farm Area given adequate notification. The sensitivity of the receptor is therefore considered low.

94. The effect on demersal otter trawling vessels will therefore be of minor adverse significance, which is not significant in EIA terms.

10.8.1.1.3 Scallop Dredging Vessels

95. Annual landings of scallops from 41E7 show relatively low value fishing in this area (£239,685 annually from 41E7), and VMS indicates significant dredging activity in the adjacent ICES rectangle (42E8). However, the long-term data series shows a prominent spike in scallop landings (in 2007), followed by three years of higher than average landings from 41E7. This fits with the nature of the scallop fishery

moving between grounds throughout the UK on a 7-10 year rolling basis. Indeed, 2015 VMS data shows some dredging activity in the centre of the Wind Farm Area. As such, the magnitude of the impact is considered medium for scallop dredging vessels.

96. Scallop dredgers generally fish over a moderate operational range, and are expected to be able to avoid the Wind Farm Area given adequate notification. The sensitivity of the receptor is therefore, considered to be low.

97. The effect on scallop dredging vessels will therefore be of minor adverse significance, which is not significant in EIA terms.

10.8.1.1.4 Other Dredging Vessels

98. Are understood not to operate across the Wind Farm Area by virtue of the fisheries for razor shell and soft-shell clam typically being undertaken in inshore waters within 6 NM. Given this distribution, the magnitude of the impact is considered negligible and the sensitivity is also considered negligible.

99. The effect on other dredging vessels will therefore be negligible, which is not significant in EIA terms.

10.8.1.2 Displacement from Wind Farm Area leading to gear conflict and increased fishing pressure on adjacent grounds.

100. Exclusion from fishing grounds during construction of the Wind Farm Area may lead to temporary increases in fishing effort in other areas that may already be exploited thereby leading to gear conflict.

101. Industry activity mapping, surveillance data and VMS (for >15m vessels) indicate that there are numerous areas surrounding the Wind Farm Area that are targeted by the same gear types used within the Wind Farm Area. Whether displaced vessels are likely to disperse into these areas depends on the normal fishing patterns of the fleets targeting the area.

10.8.1.2.1 Potting Vessels

102. Conflict over diminished grounds has been repeatedly raised as a concern during consultation with skippers operating potting vessels, both in relation to increased effort by potters and displaced vessels operating mobile gear exploring grounds traditionally fished by potters. Displacement of mobile gear may increase the risk of interaction with potting grounds and gear. However, exclusion impacts for demersal trawl from the Wind Farm Area are not predicted to be significant. As such, the displacement resulting from the Wind Farm Area relates to potters being displaced into grounds already targeted by potters. In this case, two scenarios are feasible:

- Alternative fishing grounds are available to relocate gear, in which case gear conflict and displacement effects will be low; or
- Alternative fishing grounds are not available as adjacent areas are already being fished by potters and at or near full capacity, in which case the gear already on the ground limits the level of displacement. While there remains potential for gear conflicts and increased fishing pressure to arise, appropriately mitigated exclusion impacts will limit this.

103. The magnitude is therefore considered low for potting vessels.

104. This form of static fishing gear is considered to be of higher vulnerability to gear conflict interactions since it is left unattended on the seabed. The sensitivity of the receptor is therefore considered medium.

105. The effect on potting vessels will therefore be of minor adverse significance, which is not significant in EIA terms.

10.8.1.2.2 Demersal Otter Trawling Vessels

106. Displaced potting vessels may seek to locate gear in adjacent areas e.g. inshore from the Wind Farm Area and across grounds specifically targeted by demersal trawlers, thereby preventing mobile gear from operating, or resulting in gear conflict. This may lead to a reduction in the level of nephrops trawling activity, and/or gear conflict, which could result in, towed creels and trawl net damage. Overall, the magnitude of the impact is considered medium for demersal otter trawling vessels.

107. Demersal otter trawlers generally fish over a moderate operational range and can therefore avoid areas where potting gear is deployed and clearly marked. The sensitivity of the receptor is therefore considered low.

108. The effect on demersal otter trawling vessels will therefore, be of minor adverse significance, which is not significant in EIA terms.

10.8.1.2.3 Scallop Dredging and Other Dredging Vessels

109. For all dredging gear, due to the lower level of activity across the Wind Farm Area, together with the range of alternative grounds, the magnitude of the impact is considered low and the sensitivity of the receptor is considered low.

110. The effect on scallop dredging and other dredging vessels will therefore be negligible, which is not significant in EIA terms.

10.8.1.3 Offshore Export Cable construction activities within the Offshore Export Cable Corridor leading to reduction in access to, or exclusion from, established fishing grounds.

111. Fishing activity will be locally and temporarily excluded at the location of construction owing to the presence of construction vessels, construction operations and the need to observe The Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS).

112. The construction scenario assumes a 9-month construction period, built in a continuous phase. An advisory safe passing distance of 500 m will be in place around major construction activities along the export cable corridor (i.e. a roaming approximately 0.79 km^2 exclusion along the 43 km cable route corridor). Target burial depth will likely be in the region of 1.0 – 1.5 m, but could potentially be up to 3 m (with cable protection installed only where necessary, estimated to be around 20% of the Offshore Export Cable) with the final burial depth being determined by a cable burial assessment.

113. Embedded mitigation commits to ensuring appropriate notifications are made through the Kingfisher Fortnightly Bulletin to inform the fishing industry of construction activities.

10.8.1.3.1 Potting Vessels

114. As described below, the area crossed by the Offshore Export Cable Corridor supports a high value nephrops fishery targeted by demersal trawlers. The mobile effort across this area (which makes co-existence of these gear types challenging) means that potting activity is expected to be relatively limited. However, there are some grounds immediately adjacent to shore that are not targeted by trawlers, and potting vessels could be expected to set creels across this near-shore area. Localised impacts in these inshore areas are anticipated but will be limited to the immediate area of construction activity and associated construction vessels. Overall, and given the likely short term duration of construction, the magnitude is, considered to be low for potting vessels.

115. The potting vessels are mostly <10 m in length and operate across more distinct areas of ground, typically 0 to 12 NM from shore. Moderate levels of alternative ground are available to fish and the fleet has a moderate operational range. The sensitivity of the receptor is therefore considered medium.

116. The effect on potting vessels will therefore be of minor adverse significance, which is not significant in EIA terms.

10.8.1.3.2 Demersal Otter Trawling Vessels

117. The Offshore Export Cable Corridor crosses ICES rectangles 41E7 and 40E7, which have a combined value of £5.1 million in nephrops landings. The nephrops fishery in this area is considered by this assessment to be nationally significant. Defined nephrops grounds occur across the Offshore Export Cable Corridor, a finding supported by industry consultation, industry activity mapping, VMS data specific to demersal trawling, and aerial surveillance data. This would result in a partial loss of resource and partial loss of fishing ground over a moderate-high extent during a short-term period of disruption within a total period of up to 3 years. As such, localised impacts are anticipated but will be limited to the immediate area of construction activity and associated construction vessels. Overall, the magnitude of the impact is considered medium for demersal otter trawling vessels.

118. Demersal otter trawlers generally fish over a moderate operational range, and can avoid areas given adequate notification. However, the Offshore Export Cable Corridor is located across specifically targeted nephrops grounds, making the options for alternative fishing grounds less attractive and less economically viable. The sensitivity of the receptor is therefore considered medium.

119. The effect on demersal otter trawling vessels will therefore be of moderate adverse significance, which is considered significant in EIA terms.

10.8.1.3.3 Scallop Dredging Vessels

120. Scallop dredgers are understood not to operate across the Offshore Export Cable Corridor, with effort focused on the northeast portion of 41E7. As such the magnitude of the impact is, considered low for scallop dredging vessels.

121. Scallop dredgers generally fish over a moderate operational range, and are expected to be able to avoid the area given adequate notification. The sensitivity of the receptor is therefore considered low.

122. The effect on scallop dredging vessels will therefore, be negligible, which is not significant in EIA terms.

10.8.1.3.4 Other Dredging Vessels

123. Are more likely to operate in inshore waters within 6 NM, although it is not known whether the Offshore Export Cable Corridor is specifically targeted. For these reasons, the magnitude of the impact is considered medium and the sensitivity is low.

124. The effect on other dredging vessels will therefore be of minor adverse significance, which is not significant in EIA terms.

10.8.1.4 Displacement from the Offshore Export Cable Corridor leading to gear conflict and increased fishing pressure on adjacent grounds.

10.8.1.4.1 Potting Vessels

125. Demersal otter trawlers are likely to be displaced from the Offshore Export Cable Corridor and could be expected to explore alternative grounds that may already be targeted by potting vessels. Consultation has repeatedly raised displacement as a concern for the potting industry. The magnitude is therefore considered medium for potting vessels.

126. Due to the higher vulnerability of this gear to conflict (as it is left *in situ* on the seabed), the sensitivity of the receptor is considered medium.

127. The effect on potting vessels will therefore be of moderate adverse significance, which is significant in EIA terms.

10.8.1.4.2 Demersal Otter Trawling Vessels

128. Displacement of potting gear from near-shore locations due to the installation of the Offshore Export Cable, into areas targeted by demersal trawlers could lead to gear conflict. Overall, the magnitude of the impact is considered medium for demersal otter trawling vessels.

129. Demersal otter trawlers generally fish over a moderate operational range, and can avoid areas given adequate notification. The sensitivity of the receptor is therefore, considered to be low.

130. The effect on demersal otter trawling vessels will therefore be of minor adverse significance, which is not significant in EIA terms.

10.8.1.4.3 Scallop Dredging and Other Dredging Vessels

131. For all dredging gear, due to the lower level of activity across the Offshore Export Cable Corridor, together with the range of alternative grounds, the magnitude of the impact is considered low and the sensitivity of the receptor is considered low.

132. The effect on scallop dredging and other dredging vessels will therefore, be negligible, which is not significant in EIA terms.

10.8.1.5 Wind Farm Area and Offshore Export Cable construction activities leading to displacement or disruption of commercially important fish and shellfish resources.

133. Temporary displacement due to noise and disruption of habitats during construction activities may decrease or displace commercially important shellfish populations from the area. This section assesses the potential temporary indirect impact for the owners of fishing vessels, where commercially important stocks may be disturbed or displaced to a point where normal fishing practices would be affected.

134. Detailed assessments of the following potential construction impacts have been undertaken in Chapter 7: Fish and Shellfish Ecology for key commercial species (including nephrops, lobster, brown crab, and 'other' fish and finfish species such as mackerel, squid and scallops). Following the Scoping exercise, as described in Chapter 5: Scoping and Consultation, the scope of the EIA in respect of fish and shellfish ecology focused on the following potential impact:

- Particle motion as a result of foundation installation, cable installation and seabed preparation resulting in potential effects on fish and shellfish receptors.

135. With respect to the magnitude of this impact on commercial fisheries, the overall significance of the effect on fish and shellfish species is considered (i.e. both the magnitude and sensitivity of fish and shellfish species are considered to assess the magnitude on commercial fishing fleets). For instance, where an effect of negligible significance is assessed for a species, a negligible magnitude is assessed for commercial fishing; where an effect of minor adverse significance is assessed for a species, a low magnitude is assessed for commercial fishing, and so on.

136. Details of the fish and shellfish ecology assessment are summarised in Table 10.10, justifications for this assessment are not repeated in this chapter. Evidence, modelling and justifications for these assessments are provided in Chapter 7: Fish and Shellfish Ecology.

137. The impact is predicted to be of regional spatial extent, of relevance to international fishing fleets, and of short-term duration. It is predicted that the impact will affect the receptor directly through loss of resources. The magnitude is therefore considered to be low or negligible for all species and all potential impacts.

Table 10.10 Significance of effects of construction impacts on fish and shellfish ecology

Potential impact	Species	Fish and shellfish ecology: Significance of effect	Commercial fisheries: Magnitude
Particle motion	Nephrops	Minor	Low
	Lobster	Minor	Low
	Brown crab	Minor	Low
	All other fish and shellfish species	Minor	Low

138. Exposure to the impact is likely and commercial fleets targeting key species will be affected, specifically lobster, brown crab, and nephrops.

139. Due to the locality of the impact on these species, the sensitivity of all commercial fisheries fleets is considered medium. This is based on the potential for grounds beyond the immediate construction activities to be affected by increased suspended sediment and sediment deposition, impacting the wider commercial fisheries fleets.

140. The effect on commercial fishing fleets will therefore, be of minor adverse significance for demersal trawlers targeting nephrops and all other fleets, which is not significant in EIA terms.

10.8.1.6 Wind Farm Area and Offshore Export Cable construction activities leading to additional steaming to alternative fishing grounds for vessels that would otherwise be fishing within the Wind Farm Area and Offshore Export Cable Corridor.

141. A detailed Navigational Risk Assessment (Chapter 11: Shipping and Navigation, Appendix 11.1) was undertaken for the Original EIA2, which includes full consideration of commercial fishing vessels while transiting (i.e. from a collision and avoidance perspective). This assessment focuses on the potential impact of longer steaming distances to alternative fishing grounds while construction processes are ongoing.

142. The construction programme for the Project will be communicated through Notice to Mariners and Kingfisher Bulletins with ample warning provided. Construction works will only necessitate minor deviations for fishing vessels transiting along the Offshore Export Cable Corridor during the construction phase. Localised impacts are anticipated but will be limited to the immediate area of construction activity and associated construction vessels. The magnitude is therefore considered low for all fishing fleets.

143. The potting fleet targeting the Wind Farm Area and Offshore Export Cable Corridor operate across a range of grounds to haul and re-set different fleets of creels/pots on a daily basis. Their normal operating range is expected to extend well beyond the various advisory safe passing distances of 500 m radius that will be in place around installation activities. Given adequate notification, it is expected that these vessels will be able to avoid construction areas with no or minimal impact upon steaming times. The sensitivity of the receptor is therefore also considered low.

144. Demersal otter trawlers and dredging vessels also fish over a moderate operational range, and can avoid areas given adequate notification. The sensitivity of these receptors is therefore also considered low.

[2] The MCA agreed that an updated NRA was not required for the Project EIA, following work undertaken to update the shipping and navigation baseline (presented in Chapter 11: Shipping and Navigation, Appendix 11.2).

145. The effect on all commercial fishing fleets will therefore be negligible, which is not significant in EIA terms.

10.8.1.7 Increased vessel traffic within fishing grounds as a result of changes to shipping routes and construction vessel traffic from Wind Farm Area and Offshore Export Cable Corridor leading to interference with fishing activity.

146. This assessment focuses on the potential impact of the Project related vessel traffic and changes to shipping patterns leading to interference with fishing activity (i.e. reduced access) during construction.

147. Vessel movements (i.e. construction vessels transiting to and from areas undergoing construction works) related to the construction of the Project will add to the existing level of shipping activity in the area (see Chapter 11: Shipping and Navigation). All construction impacts were scoped out of the Shipping and Navigation assessment and are therefore not considered significant.

148. Based on the extent of vessel movements and normal operating procedures around co-existence of fishing vessels with baseline shipping and navigation, a low magnitude of impact is considered for all fleets.

149. Construction traffic is likely to constrain most potting activity across established construction supply routes due to the vulnerability of the marker buoys to the propellers of passing construction vessels. The sensitivity of potting is therefore considered medium.

150. The sensitivity of all other mobile gear types is considered to be low, on account of unlikely interaction between these gears and transiting construction vessels.

151. The effect on the potting vessels will therefore be of minor adverse significance, which is not significant in EIA terms.

152. The effect on all other mobile gears will therefore be negligible, which is not significant in EIA terms.

153. A summary of the impact assessment per commercial fisheries receptor, including magnitude, sensitivity and impact significance for potential impacts during construction is provided in Table 10.11.

Table 10.11: Summary of effect significance per commercial fisheries receptor for potential impacts during construction (and decommissioning).

Potential impact	Potting vessels targeting lobster (with bycatch of brown crab and velvet crab) and seasonal hook & line mackerel fishery			Demersal trawl vessels targeting nephrops & seasonal squid fishery			Scallop dredge vessels targeting scallops			Other dredge fisheries targeting razor shell and soft-shelled clam		
	Magnitude	Sensitivity	Significance pf Effect	Magnitude	Sensitivity	Significance pf Effect	Magnitude	Sensitivity	Significance pf Effect	Magnitude	Sensitivity	Significance pf Effect
Construction												
Wind Farm Area construction activities and physical presence of constructed Project infrastructure leading to reduction in access to, or exclusion from established fishing grounds.	Medium	Medium	**Moderate**	Medium	Low	Minor	Medium	Low	Minor	Negligible	Negligible	Negligible
Displacement from the Project Wind Farm Area leading to gear conflict and increased fishing pressure on adjacent grounds.	Low	Medium	Minor	Medium	Low	Minor	Low	Low	Negligible	Low	Low	Negligible
Offshore Export Cable construction activities within the Offshore Export Cable Corridor leading to reduction in access to, or exclusion from, established fishing grounds.	Low	Medium	Minor	Medium	Medium	**Moderate**	Low	Low	Negligible	Medium	Low	Minor

Potential impact	Potting vessels targeting lobster (with bycatch of brown crab and velvet crab) and seasonal hook & line mackerel fishery			Demersal trawl vessels targeting nephrops & seasonal squid fishery			Scallop dredge vessels targeting scallops			Other dredge fisheries targeting razor shell and soft-shelled clam		
	Magnitude	Sensitivity	Significance pf Effect	Magnitude	Sensitivity	Significance pf Effect	Magnitude	Sensitivity	Significance pf Effect	Magnitude	Sensitivity	Significance pf Effect
Displacement from the Offshore Export Cable Corridor leading to gear conflict and increased fishing pressure on adjacent grounds.	Medium	Medium	**Moderate**	Medium	Low	Minor	Low	Low	Negligible	Low	Low	Negligible
Wind Farm Area and Offshore Export Cable construction activities leading to displacement or disruption of commercially important fish and shellfish resources.	Low	Medium	Minor	Low	Medium	Minor	Low	Low	Minor	Low	Low	Minor
Wind Farm Area and Offshore Export Cable construction activities leading to additional steaming to alternative fishing grounds for vessels that would otherwise be fishing within the Wind Farm Area and Offshore Export Cable Corridor.	Low	Low	Negligible	Low	Low	Negligible	Low	Low	Negligible	Low	Low	Negligible

Potential impact	Potting vessels targeting lobster (with bycatch of brown crab and velvet crab) and seasonal hook & line mackerel fishery			Demersal trawl vessels targeting nephrops & seasonal squid fishery			Scallop dredge vessels targeting scallops			Other dredge fisheries targeting razor shell and soft-shelled clam		
	Magnitude	Sensitivity	Significance pf Effect	Magnitude	Sensitivity	Significance pf Effect	Magnitude	Sensitivity	Significance pf Effect	Magnitude	Sensitivity	Significance pf Effect
Increased vessel traffic within fishing grounds as a result of changes to shipping routes and construction vessel traffic from Wind Farm Area and Offshore Export Cable Corridor leading to interference with fishing activity.	Low	Medium	Minor	Low	Low	Negligible	Low	Low	Negligible	Low	Low	Negligible

10.8.2 Operational Phase Impacts

154. The impacts resulting from the operation and maintenance phase of the Project have been assessed on commercial fisheries receptors identified within the study area. A discussion of the likely significance of each effect resulting from each impact is presented below.

10.8.2.1 Physical presence of Project infrastructure within the Wind Farm Area leading to reduction in access to, or exclusion from established fishing grounds.

155. The worst case scenario for the Wind Farm Area includes up to 54 turbines and 2 OSPs with jacket foundations with piles (each with a footprint of up to 300 m^2 inclusive of scour protection), inter-array and inter-connector cables (total of up to 140 km in length, with a target burial depth of 1.0 – 1.5m (but potentially up to 3 m), with an estimated area of 20% surface laid with cable protection installed where adequate cable burial is not possible) and with final target burial depth being defined by a cable burial assessment.

156. There may be a 500 m safety zone or advisory safe passing distance during major maintenance activities. For the purpose of the impact assessment, a 50 m advisory safe passing distance from turbines and OSPs is assumed during operation, equating to a total area of approximately 0.74 km^2 (i.e. 15 m radius of turbine and scour protection, plus 50 m operating distance, equates to radius of 65 m per turbine, and approximately 0.0132 km^2 for each turbine, x 54, and each OSP, x2, = approximately 0.74 km^2). In relation to inter-array and inter-connector cables and OSPs, there will be a 500 m advisory safe passing distance around maintenance operations, centred on the cable maintenance vessel. The project design envelope specifies the minimum turbine separation distance as being at least 800 m and target burial of cables in the region of 1.0 – 1.5 m, with estimated 20% of cable lengths requiring additional protection.

157. It is therefore expected, on the basis of this worst case scenario that fishing within the Wind Farm Area may be disrupted in places, but would still be possible. Although this is very much dependant on the attitude to risk of the individual skippers, as well as prevailing weather, tidal conditions and different operating requirements associated with gear width when actively fishing.

158. A recent report undertaken by the NFFO (2016) for The Crown Estate explored the potential for fishing to continue within operational wind farms in the Eastern Irish Sea. This was based on interviews with fishermen to understand the extent to which they have chosen to operate within a wind farm, together with assessment of landings statistics and VMS data to identify trends in fishing procedures in these areas. The key findings of the report are as follows (NFFO, 2016):

- Fishing activity within offshore wind farm boundaries has changed, primarily due to the risk associated with fishing gear becoming entrapped by seabed obstacles such as cables, cable crossing points and rock armouring, and in event of vessel breakdown, the additional consequential risk of turbine collision;
- Wind farm maintenance work was claimed to cause disruption by closing areas to fishing and increasing steaming distances to fishing grounds;
- The relationship between fishermen and wind farm developers and their service companies was often described as poor in terms of communication and information exchange;
- However, fishing was found to co-exist with offshore wind farms. A small number of fishermen claimed to operate demersal trawl gear in cable-free corridors between the turbines; and
- Other fishermen thought confidence to operate inside offshore wind farms would increase as experience and knowledge increased.

159. It should be noted that the focus of this NFFO (2016) study was on demersal trawl vessels targeting nephrops across the wind farm areas, but potting skippers were also interviewed to understand their views.

160. The following embedded mitigation (also outlined in Table 10.9) seeks to mitigate many of the reservations expressed with in the NFFP (2016) report:

- Development of a Commercial Fisheries Mitigation Strategy;
- Appointment of FLO;
- Commitment to undertake over trawls on Offshore Export Cable and inter-array and inter-connector cables where cable protection has been required to ensure that the protection scheme has been successful;
- Continued membership of, and participation in the Forth & Tay Commercial Fisheries Working Group; and
- Participation in the Forth and Tay Regional Advisory Group and Scottish Marine Environment Group with respect to monitoring and mitigation of commercial fish.

10.8.2.1.1 Potting Vessels

161. During consultation with the local industry, skippers of potting vessels had varying views as to whether they would chose to continue to fish within the operational site. Some believed a wind farm could provide an opportunity to operate without the pressure of mobile gear conflict, while others considered the risk associated with operating within a wind farm to be too great to fish.

162. The minimum spacing between turbines is 800 m. The indicative layout of turbines is presented within Chapter 4: Project Description, in which the spacing ranges from 800 m up to approximately 3.5 km. The layout of the turbines is dense around most of the perimeter of the Wind Farm Area, with four areas of ground within the Wind Farm Area that have no infrastructure. In addition, there is potential to locate gear between approximately five rows or columns, although again this is subject to individual skippers' decision to fish. It is expected that inter-array and inter-connector cabling and associated required protection would not disrupt potting activity.

163. Overall, given that potting activity is known to occur across the Wind Farm Area, together with concerns raised during consultation and the findings of the NFFO (2016) report, it is expected that there will be a reduction in the level of effort that can be undertaken, and therefore a medium magnitude is assessed.

164. The potting fleet are typically <10 m in length and operate across more distinct areas of ground, typically 0 to 12 NM from shore. Moderate levels of alternative ground are available to fish and the fleet has a moderate operational range. The sensitivity of the receptor is therefore considered medium.

165. The effect on potting vessels will therefore be of moderate adverse significance, which is significant in EIA terms.

10.8.2.1.2 Demersal Trawl Vessels and Scallop Dredge Vessels

166. Mobile gears are understood to focus effort in areas out with the Wind Farm Area, notably demersal trawl grounds to the southwest of the Wind Farm Area, and scallop grounds northeast of the Wind Farm Area. However, VMS data do show some effort by demersal trawl and scallop dredgers within the Wind Farm Area. It is considered that 800 m minimum turbine distance would be sufficient to allow fishing to resume in places, subject to weather and tidal conditions and skippers' preferences towards fishing within a wind farm. However, it is assumed that mobile trawling and dredging gear may be impacted in areas in the event that any rock protection is necessary to protect inter-array and inter-connector cabling in the event of inadequate burial. Therefore, overall, based on some rock protection being deployed, a medium magnitude is assessed.

167. Demersal otter trawlers and scallop dredgers generally fish over a moderate operational range, and are expected to be able to avoid the Wind Farm Area given adequate notification of any major maintenance works. Embedded mitigation commits to ensuring appropriate notifications are made through the Kingfisher Fortnightly Bulletin to inform the fishing industry of maintenance works. The sensitivity of the receptor is therefore considered low.

168. The effect on demersal otter trawling vessels and scallop dredgers will therefore be of minor adverse significance, which is not significant in EIA terms.

10.8.2.1.3 Other Dredging Vessels

169. Other dredging vessels are understood not to operate across the Wind Farm Area as the fisheries for razor shell and soft-shell clam are typically undertaken in inshore waters within 6 NM. For this reason, the magnitude of the impact is considered low and the sensitivity is also considered low.

170. The effect on other dredging vessels will therefore be negligible, which is not significant in EIA terms.

10.8.2.2 Physical presence of Export Cable and infrastructure within the Offshore Export Cable Corridor leading to reduction in access to, or exclusion from established fishing grounds.

171. The worst case scenario for the Export Cable Corridor consists of 43 km length of cable, up to two cables approximately 300 m apart along the majority of the corridor. Cable protection is estimated along 20% of the Offshore Export Cable, subject to burial assessment. 500 m advisory safe passing distances may be requested around vessels engaged in Offshore Export Cable repair or reburial works, which could limit fishing opportunities within localised areas of repair works.

172. The assessment assumes that fishing will resume within the vicinity of the Offshore Export Cables soon after their installation. Minimum burial depth of the Offshore Export Cables is uncertain and subject to confirmation in burial assessment, but it is assumed that where areas of cable protection are not necessary, the cable will be buried to a depth that allows demersal trawling gear to operate safely.

173. Notices to Mariners will be issued in advance of any maintenance works. Potting vessels may be required to temporarily relocate pots during maintenance works, although such works are likely to be infrequent.

174. The impact is predicted to be of local spatial extent and of short-term duration for maintenance works that may be required along the Offshore Export Cable. It is predicted that the impact will affect the receptor directly. It is assumed that fishing will resume across the Offshore Export Cable Corridor shortly after installation is complete and during the operational phase, subject to the presence of any cable protection installed and following the completion of over-trawl surveys or other relevant surveys to confirm the condition of the seabed.

175. Given that fishing can resume, subject to confirmation following the over-trawl surveys, across the majority of the Offshore Export Cable Corridor, fishing would only be excluded from discrete areas where repairs or maintenance operations are being completed. The magnitude is considered low for all fishing fleets.

176. Given the importance of the grounds to demersal trawlers, and the higher sensitivity of mobile gear interaction with cable protection where this is installed, the sensitivity of demersal trawlers is considered medium. The sensitivity is low for all other fleets.

177. The effect on demersal trawl vessels will therefore be of minor adverse significance, which is not significant in EIA terms, and negligible for all other fleets which is not significant in EIA terms.

10.8.2.3 Displacement from Wind Farm Area leading to gear conflict and increased fishing pressure on adjacent grounds.

10.8.2.3.1 Potting Vessels

178. The scenarios for potters being displaced into grounds already targeted by potters is provided in Section 10.8.1.2, which remains relevant for this impact. The magnitude is therefore considered low.

179. This form of static fishing gear is considered highly vulnerable to gear conflict interactions since it is left unattended on the seabed. The sensitivity of the receptor is therefore considered medium.

180. The effect on potting vessels will therefore be of minor adverse significance, which is not significant in EIA terms.

10.8.2.3.2 Demersal Otter Trawling Vessels

181. Displaced potting vessels may seek to locate gear in adjacent areas e.g. inshore from the Wind Farm Area and across grounds specifically targeted by demersal trawlers, thereby preventing mobile gear from operating, or resulting in gear conflict. Overall, the magnitude of the impact is considered medium for demersal otter trawling vessels.

182. Demersal otter trawlers generally fish over a moderate operational range and can avoid areas where potting gear is deployed and clearly marked. The sensitivity of the receptor is therefore considered low.

183. The effect on demersal otter trawling vessels will therefore be of minor adverse significance, which is not significant in EIA terms.

10.8.2.3.3 Scallop Dredging and Other Dredging Vessels

184. For all dredging gear, due to the lower level of activity across the Wind Farm Area, together with the range of alternative grounds, the magnitude of the impact is considered low and the sensitivity of the receptor is considered low.

185. The effect on scallop dredging and other dredging vessels will therefore be negligible, which is not significant in EIA terms.

10.8.2.4 Displacement from the Offshore Export Cable Corridor leading to gear conflict and increased fishing pressure on adjacent grounds.

186. It is assumed that fishing will resume across the Offshore Export Cable Corridor shortly after installation is complete and during the operational phase, subject to the presence of any cable protection installed and following the completion of over-trawl surveys or other relevant surveys to confirm the condition of the seabed. Localised exclusions will be in place 500 m around major maintenance activities, but the frequency of such activities is expected to be low. The magnitude of impact and sensitivity of all fleets are therefore considered low.

187. The effect on all fleets will therefore be of negligible, which is not significant in EIA terms.

10.8.2.5 Physical presence of Wind Farm Area and associated infrastructure leading to gear snagging.

188. For all demersal trawling fleets (including otter trawl and dredging), the risk of snagging gear towed on the seabed includes potential interaction with the turbine foundations, OSP foundations and inter-array and inter-connector cabling and any associated cable protection (where this is necessary).

189. Snagging poses a risk to fishing equipment and, in extreme cases, may potentially lead to capsize of the vessel and crew fatalities, as well as potentially damaging the subsea infrastructure. Three phases of interaction are possible: initial impact of gear and subsea infrastructure; pullover of gear across

subsea infrastructure; and snagging or hooking of gear on the subsea infrastructure. The snagging or hooking phase is the most hazardous to the vessel and crew due to the possibility of capsize.

190. A range of embedded mitigation is proposed to reduce the risk of snagging occurrence, including:

- Appropriate notifications will be made following completion of the work including through the Kingfisher Fortnightly Bulletin;
- Inter-array and inter-connector cables will be buried to a target depth of 1.0 – 1.5 m where it is reasonably practicable to do so. In instances where adequate burial cannot be achieved then the developers will seek to install cable protection;
- Over trawl surveys will be carried out on inter-array and inter-connector cables where cable protection has been required to ensure that the protection scheme has been successful; and
- All infrastructure installed will be marked and lit, in line with standard industry practice, and relevant information will be distributed to fishermen through the agreed channels.

191. Should snagging occur, the developer would work to the protocols laid out within the guidance by the FLOWW group and *'Recommendations for Fisheries Liaison: Best Practice'* guidance for offshore renewable developers, in particular Section 9: *Dealing with claims for loss or damage of gear* (FLOWW, 2006 and 2014; BERR, 2008).

192. Given the mitigation to avoid snagging occurrences and the provision for protocols to follow should snagging occur, it is considered that the magnitude of impact is low for all mobile and potting fishing fleets.

193. Due to the nature and operation of mobile trawling gear (i.e. it is actively towed and demersal gear directly penetrates the seabed with near continuous contact), there is increased vulnerability to this impact and the sensitivity is therefore considered to be medium for mobile fleets.

194. Potters show a lower vulnerability as the gear is placed, not towed and is less likely to penetrate the seabed. However, potting gear does still move with currents, and can therefore become entangled with turbine, OSP and associated seabed infrastructure, although it is not attached to the vessel at the time that this entanglement may happen. Therefore the sensitivity of potters is considered low.

195. The effect on mobile fleets (including demersal otter trawl and scallop dredge) will therefore be of minor adverse significance, which is not significant in EIA terms.

196. The effect on all other fleets will be of minor adverse significance, which is not significant in EIA terms.

10.8.2.6 Physical presence of the Offshore Export Cable leading to gear snagging.

197. Due to the correlation between impacts of gear snagging with inter-array and inter-connector cables and the export cables, the assessment is the same as that presented above (Section 10.8.2.5), summarised as minor adverse significance, which is not significant in EIA terms.

10.8.2.7 Physical presence of Wind Farm Area, Offshore Export Cable and associated infrastructure leading to additional steaming to alternative fishing grounds for vessels that would otherwise be fishing within these areas.

198. During the operation and maintenance phase, it is expected that fishing will resume across the Offshore Export Cable Corridor soon after cable installation is complete and within areas throughout the Wind Farm Area and. As such, additional steaming outside normal operating ranges will not be necessary.

199. The effects of the operation and maintenance phase are expected to be the same or similar to the effects from construction. The significance of effect is therefore negligible for all commercial fishing fleets (see Section 10.8.1.6), which is not significant in EIA terms.

10.8.2.8 Increased vessel traffic within fishing grounds as a result of changes to shipping routes and maintenance vessel traffic from Wind Farm Area and Offshore Export Cable Corridor leading to interference with fishing activity.

200. The effects of the operation and maintenance phase are expected to be similar or lower to the effects from construction based on lower level of Development Area vessel movements. The significance of effect is therefore negligible for all commercial fishing fleets (see Section 10.8.1.7), which is not significant in EIA terms.

201. A summary of the impact assessment per commercial fisheries receptor, including magnitude, sensitivity and impact significance for potential impacts during operation and maintenance is provided in Table 10.12.

Table 10.12: Summary of impact significance per commercial fisheries receptor for potential impacts during operation and maintenance.

Potential impact	Potting vessels targeting lobster (with bycatch of brown crab and velvet crab) and seasonal hook & line mackerel fishery			Demersal trawl vessels targeting nephrops & seasonal squid fishery			Scallop dredge vessels targeting scallops			Other dredge fisheries targeting razor shell and soft-shelled clam		
	Magnitude	Sensitivity	Significance of Effect	Magnitude	Sensitivity	Impact Significance of Effect	Magnitude	Sensitivity	Impact	Magnitude	Sensitivity	Impact Significance of Effect
Operation and maintenance												
Physical presence of Wind Farm Area leading to reduction in access to, or exclusion from established fishing grounds.	Medium	Medium	**Moderate**	Medium	Low	Minor	Medium	Low	Minor	Low	Low	Negligible
Physical presence of Offshore Export Cable leading to reduction in access to, or exclusion from established fishing grounds.	Low	Low	Negligible	Low	Medium	Minor	Low	Low	Negligible	Low	Low	Negligible

Potential impact	Potting vessels targeting lobster (with bycatch of brown crab and velvet crab) and seasonal hook & line mackerel fishery			Demersal trawl vessels targeting nephrops & seasonal squid fishery			Scallop dredge vessels targeting scallops			Other dredge fisheries targeting razor shell and soft-shelled clam		
	Magnitude	Sensitivity	Significance of Effect	Magnitude	Sensitivity	Impact Significance of Effect	Magnitude	Sensitivity	Impact	Magnitude	Sensitivity	Impact Significance of Effect
Displacement from Neart na Gaoithe Wind Farm Area leading to gear conflict and increased fishing pressure on adjacent grounds.	Low	Medium	Minor	Medium	Low	Minor	Low	Low	Negligible	Low	Low	Negligible
Displacement from the Offshore Export Cable Corridor leading to gear conflict and increased fishing pressure on adjacent grounds.	Low	Low	Negligible	Low	Low	Negligible	Low	Low	Negligible	Low	Low	Negligible
Physical presence of Wind Farm Area leading to gear snagging.	Low	Low	Minor	Low	Medium	Minor	Low	Medium	Minor	Low	Medium	Minor

Potential impact	Potting vessels targeting lobster (with bycatch of brown crab and velvet crab) and seasonal hook & line mackerel fishery			Demersal trawl vessels targeting nephrops & seasonal squid fishery			Scallop dredge vessels targeting scallops			Other dredge fisheries targeting razor shell and soft-shelled clam		
	Magnitude	Sensitivity	Significance of Effect	Magnitude	Sensitivity	Impact Significance of Effect	Magnitude	Sensitivity	Impact	Magnitude	Sensitivity	Impact Significance of Effect
Physical presence of the Offshore Export Cable leading to gear snagging.	Low	Medium	Minor	Low	Medium	Minor	Low	Medium	Minor	Low	Medium	Minor
Physical presence of Wind Farm Area and Offshore Export Cable leading to additional steaming to alternative fishing grounds for vessels that would otherwise be fishing within these areas.	Low	Low	Negligible	Low	Low	Negligible	Low	Low	Negligible	Low	Low	Negligible

Potential impact	Potting vessels targeting lobster (with bycatch of brown crab and velvet crab) and seasonal hook & line mackerel fishery			Demersal trawl vessels targeting nephrops & seasonal squid fishery			Scallop dredge vessels targeting scallops			Other dredge fisheries targeting razor shell and soft-shelled clam		
	Magnitude	Sensitivity	Significance of Effect	Magnitude	Sensitivity	Impact Significance of Effect	Magnitude	Sensitivity	Impact	Magnitude	Sensitivity	Impact Significance of Effect
Increased vessel traffic within fishing grounds as a result of changes to shipping routes and maintenance vessel traffic from Wind Farm Area and Offshore Export Cable leading to interference with fishing activity.	Low	Low	Negligible	Low	Low	Negligible	Low	Low	Negligible	Low	Low	Negligible

10.8.3Decommissioning Phase Impacts

202. Impacts from the decommissioning of the Development Area are anticipated to be similar to those assessed during operation and maintenance where the infrastructure remains in-situ at the end of the Project's operational life. Effects resulting from decommissioning activities on commercial fisheries receptors would be expected to be similar to those described during the operational phase.

203. A summary of the impact assessment per commercial fisheries receptor, including magnitude, sensitivity and impact significance for potential impacts during decommissioning is provided in Table 10.11 (as for construction).

204. Towards the end of the operational life of the Project, all decommissioning options will be considered. It may be deemed that removal of certain pieces of infrastructure may have a greater environmental impact than leaving them in-situ. The potential decommissioning options will be presented to MS-LOT in a Decommissioning Programme prior to construction. The Decommissioning Programme will then be reviewed and amended as required prior to the commencement of any decommissioning activities.

10.8.4 Cumulative Impacts Assessment

205. Cumulative effects refer to effects upon receptors arising from the Project when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals. In this context, the term 'projects' is considered to refer to any project with comparable effects and is not limited to offshore wind projects.

206. Project and activities considered within the cumulative impact assessment are set out in Table 10.13. There may be an element of uncertainty associated with the design envelope of proposed projects; therefore a judgement is made on the confidence associated with the latest available design envelope.

207. Two projects included within Table 10.13 are currently operational, however the timing of construction and/or expected extension in operational life means that temporal overlap may occur and therefore these projects are included within the cumulative impact assessment. To provide further context to this:

- Hywind Scotland Pilot Park construction commenced at the wind farm in April 2017, and became commissioned in October 2017. Part of the Export Cable HDD was installed in September 2016, and all other offshore construction was completed in 2017. These activities are therefore not reflected within the baseline assessment of this Chapter and so included in the CIA.
- Offshore Renewable Energy Catapult Levenmouth (formerly Fife Energy Park) consist of one demonstration turbine that was installed in 2013 and became operational in 2014. It is consented until 2019; a variation to extend the operational life until 2029 is currently being sought. However, the outcome is unknown, and decommissioning after 2019 represents a temporal overlap for inclusion within the CIA.

208. In assessing the cumulative impacts for the Project, two scenarios are considered to take into account the consented design envelopes of the Inch Cape Wind Farm Area and the Seagreen Phase 1 or Seagreen Alpha and Bravo Wind Farm projects. Scenario One incorporates the design envelopes for the proposed Inch Cape and Seagreen projects as detailed in the Scoping Reports submitted to MS-LOT (ICOL, 2017; Seagreen, 2017). Scenario Two incorporates the consented design envelopes as detailed in the respective project consents.

Table 10.13: Projects for cumulative assessment

Development Type	Project	Status	Data Confidence Assessment / Phase
Wind Farm	Inch Cape Wind Farm Area	Consented	High - project details available
	Inch Cape Wind Farm Area	Proposed	High - Project details provided by Developer
	Seagreen Alpha and Bravo	Consented	High - project details available
	Seagreen Phase I Wind Farm Project	Proposed	High - Project details provided by Developer
	Forthwind Wind Farm Area	Consented	High - project details available
	Forthwind Offshore Wind Demonstration Project	Proposed	High - Scoping Report available
	Kincardine Wind Farm Area	Consented	High - Project details available
	Offshore Renewable Energy Catapult Levenmouth	Operational	High - project details available
	European Offshore Wind Deployment Centre	Consented	High - project details available
	Hywind Scotland Pilot Park	Operational	High - project details available
	Blyth Wind Farm Area	Decommissioning Phase	High - project details available
	Blyth Offshore Wind Demonstration Project	Consented	High - project details available
	Beatrice Wind Farm Area	Under construction	High - project details available
	Moray Offshore East Development	Consented	High - project details available
	Moray East Wind Farm Area – Alternative Design	Proposed	High - Scoping Report available
	Moray Firth Offshore Wind Western Development Area	Proposed	High - Scoping Report available
	Rampion Wind Farm Area	Under construction	High - project details available
Coastal developments	Rosyth International Container Terminal	Proposed	High - Scoping Report available
Marine Protected Areas	Firth of Forth Banks Complex	Designated	Medium – management proposed, but not yet implemented.

209. In addition to the projects outlined in Table 10.13 a review of plans and projects that have entered the planning process was undertaking to inform the cumulative impact assessment for commercial fisheries. Marine Scotland's marine licensing register detailed no licenses currently being considered or having being determined within the Forth and Tay region. Babcock International sought a scoping opinion for Rosyth International Container Terminal in February 2014. No apparent progress has been made on an application for the Rosyth Terminal. Public consultation events were held in June 2016, but a marine licence application is yet to be submitted. Nevertheless, potential temporal overlap exists and this project has been scoped into the CIA.

210. The operations and projects developed by Forth Ports were also considered for assessment within the CIA. Forth Ports own and operate seven commercial ports on the Firth of Forth and the Firth of Tay: Grangemouth, Dundee, Leith (Edinburgh), Rosyth, Methil, Burntisland and Kirkcaldy. Forth Ports provide maritime services including ship handling, pilotage, navigation, conservancy, towage, anchorages and berthing facilities. Forth Ports issue regular Notice to Mariners providing details of any upcoming works, including surveys and anchorages. Anchorage positions may be provided to vessels whose size makes berthing impossible, and are subject to application assessment and approval by Forth Ports, with positions of successful applications communicated via Notice to Mariners.

211. It is understood that there are no planned new developments or projects by Forth Ports e.g. port re-development. The normal working operations of Forth Ports, including ship handling services and anchorages is considered within the normal operating baseline for commercial fisheries. No specific new anchorages are known at this time, and any future occurrence would be subject to their own specific application assessment. As such, no Forth Ports projects are considered within the commercial fisheries CIA.

212. Other coastal developments considered include the INEOS Grangemouth Renaissance project and NPF3 national development designations including Dundee Waterfront, Cockenzie and Longannet. These projects have been scoped out of the commercial fisheries CIA on account of the lack of temporal overlap and/or nature of these projects e.g. a new energy plant at the Grangemouth site will be located onshore and therefore not impact commercial fisheries.

213. A review of marine designated sites was undertaken to understand the likelihood of additional fisheries management measures being implemented to protect designated features. The Firth of Forth Banks Complex lies to the east of the Forth and Tay area and is designated for ‘ocean quahog’ aggregations and ‘offshore subtidal sands and gravels’. The area lies outside the UKs 12 nautical mile limit and as such is exclusively managed under the EU Common Fisheries Policy (CFP). Management measures therefore need to be developed jointly with the UK Government and any Member States with management interests in the area affected. The Scottish Government, jointly with the UK Government, have proposed fishery management measures for the Firth of Forth Complex to the European Commission proposing a zonal management strategy to protect proportions of the designated habitats. Implementation of such a strategy would be subject to agreement with Member States with fishery interests in the area. Such management measures are considered to be a cumulative impact to commercial fisheries and this is included in the CIA.

214. Table 10.14 sets out the potential cumulative impacts and the worst case cumulative design envelope scenario considered within the cumulative impact assessment.

Table 10.14: Cumulative worst-case design envelope scenarios.

Impact	Worst Case Design Scenario	Justification
Construction		
Cumulative effects of reduction in access to, or exclusion from, potential and/or established fishing grounds.	15 offshore wind farm developments with potential	The outcome of the CIA will be greatest when the

Impact	Worst Case Design Scenario	Justification
Cumulative effects of displacement leading to gear conflict and increased fishing pressure on alternative grounds.	combined number of turbines of up to 981 turbines.	greatest number of other schemes, present or planned, are considered.
Cumulative effects of longer steaming distances to alternative fishing grounds.		
Cumulative effects of changes in shipping routes, leading to interference with fishing activity.		
Operation and maintenance		
As per construction	As per construction	As per construction
Decommissioning		
As per construction	As per construction	As per construction

10.8.4.1 Cumulative Construction Phase Impacts

10.8.4.1.1 Cumulative effects of reduction in access to, or exclusion from, potential and/or established fishing grounds.

215. In relation to the potting and demersal trawl fleets, Inch Cape, Seagreen Alpha and Bravo and Forthwind Wind Farm Area and Demonstration Project have the most potential to result in cumulative impacts due to the location of these wind farms and export cable routes and the grounds targeted by these commercial fishing fleets. All other wind farms are expected to have a negligible to minor significance to these fleets.

216. The Original Inch Cape ES concludes a minor/moderate significance of loss of access to squid and crab and lobster fishing grounds during construction of the NnG Development Area, and a minor/moderate significance to squid fisheries and moderate significance to crab, lobster and nephrops fisheries during construction of the export cable route.

217. The Original Seagreen Alpha and Bravo ES concludes significant effects related to loss of ground for the creel fleet during construction of the export cable route, but effects were of minor significance to all other fleets for impacts within the Seagreen wind farms and export cable route.

218. The Forthwind Wind Farm Area predicts minor effects related to all fisheries.

219. The significance of effect, combined with the significance of effect for the Development Area is considered to cumulatively raise the overall significance level to moderate for the lobster and crab potting fleet and nephrops demersal trawl fleet, particularly in relation to the construction of the Offshore Export Cables.

220. In relation to scallop dredgers, Inch Cape, Seagreen Alpha and Bravo and Forthwind Wind Farm Area and Demonstration Project, together with the additional 11 wind farms listed in Table 10.13, have potential to cause cumulative impacts, due to the nomadic nature of the scallop dredge fleet.

221. The Inch Cape ES assesses a moderate significance of loss of access to fishing grounds within the development area for scallop dredgers during construction (and operation and maintenance), and a minor/moderate significance related to the construction of the export cable route. The Seagreen Alpha, Bravo, and Forthwind Wind Farm Area predict no significant impacts to the scallop fleet.

222. Based on the phasing of construction activities, there will be very limited, or no, temporal overlap with the following projects: the Rampion Wind Farm Area; Beatrice Wind Farm Area; Blyth Offshore Wind Demonstration Project; and Offshore Renewable Energy Catapult Levenmouth. Based on the locations of the remaining wind farms within the cumulative assessment (Kincardine Wind Farm Area; European

Offshore Wind Deployment Centre; Hywind Scotland Pilot Park; Moray Offshore East Development; Moray East Wind Farm Area – Alternative Design and Moray Firth Offshore Wind Western Development Area), it is expected that the local scallop fleet would have very limited, or no, physical overlap with these projects and that the nomadic scallop dredge fleet would, with advance warning of activities, be in a position to avoid these specific areas and plan fishing operations accordingly.

223. Given the low level of activity by scallop dredge and other dredge fisheries across the Development Area, it is considered that the combined magnitude does not raise the cumulative impact of the Project above the level that which has already been assessed for this fishery i.e. the resultant effect is of minor significance and not significant in EIA terms.

224. In terms of the scenarios for the Inch Cape Wind Farm Area and the Seagreen Phase 1 Wind Farm Project, the findings of this CIA are consistent for scenarios One and Two, as the most prominent impacts relate to the export cable routes, which have remained consistent from the originally consented projects to the currently proposed projects. It is noted however that the reduced number of turbines proposed for the Inch Cape Wind Farm Area, may lead to a higher levels of fishing resuming within the site, which may overall reduce the cumulative impact.

10.8.4.1.2 Cumulative effects of displacement leading to gear conflict and increased fishing pressure on alternative grounds.

225. The effect of displacement leading to gear conflict and increased fishing pressure is directly correlated to the previous impact of reduced access to fishing grounds (i.e. if there is no reduction in access, then there will be no displacement). There is a moderate impact for reduced access to crab and lobster and nephrops fishing grounds and therefore displacement is expected. As such, the impact of displacement leading to gear conflict is assessed as moderate for potting and nephrops trawling fleets; and minor for all other commercial fisheries fleets. This assessment takes account of a high degree of uncertainty.

10.8.4.1.3 Cumulative effects of longer steaming distances to alternative fishing grounds.

226. Based on the fact that vessels will not be prohibited from transiting through offshore wind farms, with the exception of localised construction activities, the cumulative impact of longer steaming distances is considered to be minor for all fishing fleets.

10.8.4.1.4 Cumulative effects of changes in shipping routes, leading to interference with fishing activity.

227. Based on the fact that vessels will not be prohibited from transiting through offshore wind farms, with the exception of localised construction activities, the cumulative impact of changes in shipping routes, leading to interference with fishing activity is considered to be minor for all fishing fleets.

10.8.4.2 Cumulative Operation and Maintenance Phase Impacts

10.8.4.2.1 Cumulative effects of reduction in access to, or exclusion from, potential and/or established fishing grounds.

228. The justifications provided within the construction assessment are applicable to the assessment of the cumulative effects of reduction in access or exclusion from fishing grounds during operation and maintenance, with the exception of the impacts resulting from Inch Cape Wind Farm Area. The Inch Cape ES found no significant impacts related to reduction in access to the export cable route during operation and maintenance, as resumption of fishing was assumed. The cumulative impact to the lobster and crab potting fleet and nephrops trawl fleet is therefore considered minor. Given this minor cumulative effect of reduced access/ exclusion, the cumulative effect of displacement is also considered to be minor for these fleets.

229. Given the low level of activity by scallop dredge and other dredge fisheries across the Development Area, it is considered that the combined magnitude does not raise the cumulative impact of the Project above the level that which has already been assessed for this fishery i.e. the resultant effect is of minor significance for scallop dredge and negligible for other dredge fisheries, and not significant in EIA terms.

230. For all other effects including longer steaming distances and changes in shipping routes, leading to interference with fishing activity, the cumulative effect is consistent with the assessment of the Project in isolation, which is negligible for all gears and fleets during operation and maintenance.

10.8.4.3 Cumulative Decommissioning Phase Impacts

231. The CIA for the decommissioning phase is consistent with the operation and maintenance assessment.

10.8.5 Inter-relationships

232. Inter-relationships considers the impacts and associated effects of different aspects of the proposal on the same receptor. These are considered to be:

- Project lifetime effects: Assessment of the scope for effects that occur throughout more than one phase of the project (construction, operation, decommissioning) to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three key project phases (e.g. displacement of fishing vessels from the Development Area as a result of construction activities, and during operation due to vessel presence and decommissioning);
- Receptor led effects: Assessment of the scope for all effects to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on a given receptor such as commercial fishing fleets – displacement of fishing vessels leading to gear conflict, changes to fishery resources, longer steaming times and loss of fishing grounds may interact to produce a different or greater effect on this receptor than when the effects are considered in isolation. Receptor led effects might be short term, temporary or transient effects, or incorporate longer term effects.

233. The accumulation of effects associated with individual impacts is not expected to result in a change to the overall impacts detailed above. This is for two reasons; firstly, embedded mitigation has been identified, and secondly, the impacts relates to different commercial fishing fleets, so are not accumulated across one single receptor.

234. For project lifetime effects, most disturbance (resulting in displacement of fisheries) will occur during the construction and decommissioning phases with minimal disturbance considered likely to arise from maintenance activities (apart from temporary 500 m advisory safe passing distances or safety zones for major maintenance activities) during the operation and maintenance phase. The expected level of significance stated for the construction and decommissioning phases is based upon the reduction in access to, or exclusion from, fishing grounds only. Therefore, across the project lifetime, the effects on commercial fisheries are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.

235. The impacts on receptors addressed in other ES chapters may potentially further contribute to the impact assessed on commercial fisheries. These are primarily from the Fish and Shellfish Ecology, and Shipping and Navigation chapters. However, no inter-relationships have been identified where an accumulation of impacts on commercial fisheries give rise to a need for additional mitigation over and above that proposed for each individual phase of the project.

10.9 Mitigation and Monitoring

236. The assessment of impacts, both in isolation and cumulatively, on commercial fisheries receptors predicted effects resulting from reduction in access to or exclusion from established fishing grounds to be of moderate significance. In addition to the embedded mitigation set out in Section 10.7.1, the following additional mitigation measures have been identified to reduce or manage the residual effects.

237. Impacts of moderate adverse significance for potting vessels relate to the following impacts and phases:

- Project impact during construction, operational and decommissioning phases: reduction in access to or exclusion from established fishing grounds across the Wind Farm Area.
- Project impact during construction phase: displacement from the Offshore Export Cable Corridor leading to gear conflict and increased fishing pressure on adjacent grounds.
- Cumulative impact during construction phase: reduction in access to, or exclusion from, potential and/or established fishing grounds.
- Cumulative impact during construction phase: displacement leading to gear conflict and increased fishing pressure on alternative grounds.

238. Impacts of moderate significance for demersal trawling vessels relate to the following impacts and phases:

- Project impact during construction phase: reduction in access to or exclusion from established fishing grounds across the Offshore Export Cable Corridor.
- Cumulative impact during construction phase: reduction in access to, or exclusion from, potential and/or established fishing grounds.
- Cumulative impact during construction phase: displacement leading to gear conflict and increased fishing pressure on alternative grounds.

239. All other impacts and fleet combinations were of minor adverse significance or negligible, and not significant in EIA terms.

240. While embedded mitigation is applicable to the moderate impacts listed above, it does not lower the impact to be non-significant. These significant impacts relate to potential loss of earnings and loss of the ability to carry out normal working procedures. These are economic issues and therefore the appropriate means to address them is through commitment to disturbance payments. With respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible. For all of the significant impacts identified, it is considered that justifiable disturbance payments will reduce the magnitude of the effect to low and the residual effect will therefore, be of minor adverse significance, which is not significant in EIA terms.

10.10 Summary of Residual Effects

241. This chapter has assessed the potential effects on commercial fisheries of the construction, operation and decommissioning of the Project, both in isolation and cumulatively. Where significant effects were identified, additional mitigation has been considered and incorporated into the assessment. Table 10.15 summarises the impact determinations discussed in this chapter and presents the post-mitigation residual significance.

Table 10.15: Summary of predicted impacts of the Project

Potential Impact	Receptor	Significance of Effect	Additional Mitigation Measures	Residual Significance of Effect
Construction				
Wind Farm Area construction activities and physical presence of constructed Offshore Wind Farm leading to reduction in access to, or exclusion from established fishing grounds.	Potters	Moderate	Potters: with respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.	Minor
	Demersal trawl	Minor	n/a	Minor
	Scallop dredge	Minor	n/a	Minor
	All other gear	Negligible	n/a	Negligible
Offshore Export Cable construction activities leading to reduction in access to, or exclusion from, established fishing grounds.	Potters	Minor	n/a	Minor
	Demersal trawlers	Moderate	Demersal trawl: with respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.	Minor
	Scallop Dredge	Negligible	n/a	Negligible
	Other Dredge	Minor	n/a	Minor
Displacement from Neart na Gaoithe Wind Farm Area leading to gear conflict and increased fishing pressure on adjacent grounds.	Potters	Minor	n/a	Minor
	Demersal trawl	Minor	n/a	Minor
	All other gear	Negligible	n/a	Negligible
Displacement from the Offshore Export Cable Corridor leading to gear conflict and increased fishing pressure on adjacent grounds.	Potters	Moderate	Potters: with respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.	: Minor
	Demersal trawl	Minor	n/a	Minor
	All other gear	Negligible	n/a	Negligible
Wind Farm Area and Offshore Export Cable construction activities leading to displacement or disruption of commercially important fish and shellfish resources.	Potters	Minor	n/a	Minor
	Demersal trawl	Minor	n/a	Minor
	All other gear	Minor	n/a	Minor

Potential Impact	Receptor	Significance of Effect	Additional Mitigation Measures	Residual Significance of Effect
Wind Farm Area and Offshore Export Cable construction activities leading to additional steaming to alternative fishing grounds for vessels that would otherwise be fishing within the Wind Farm Area and Offshore Export Cable Corridor.	All other gear	All: Negligible	n/a	All: Negligible
Increased vessel traffic within fishing grounds as a result of changes to shipping routes and construction vessel traffic from Wind Farm Area and Offshore Export Cable Corridor leading to interference with fishing activity.	Potters	Minor	n/a	Minor
	All other gear	Negligible	n/a	Negligible
Operation and maintenance and decommissioning				
Physical presence of Wind Farm Area leading to reduction in access to, or exclusion from established fishing grounds.	Potters	Moderate	With respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.	Minor
	Demersal trawl	Moderate	With respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.	Minor
	Scallop dredge	Minor	n/a	Minor
	All other gear	Negligible	n/a	Negligible
Physical presence of Offshore Export Cable leading to reduction in access to, or exclusion from established fishing grounds.	Demersal trawl	Minor	n/a	Demersal trawl: Minor All others: Negligible
	All other gear	Negligible	n/a	Negligible
Displacement from Neart na Gaoithe Wind Farm Area leading to gear conflict and increased fishing pressure on adjacent grounds.	Potter	Minor	n/a	Minor
	Demersal trawl	Minor	n/a	Minor
	All other gear	Negligible	n/a	Negligible
Displacement from the Offshore Export Cable Corridor leading to gear conflict and increased fishing pressure on adjacent grounds.	All gear types	All: Negligible	n/a	All: Negligible
Physical presence of Wind Farm Area leading to gear snagging.	All gear types	All: Minor	n/a	All: Minor

Potential Impact	Receptor	Significance of Effect	Additional Mitigation Measures	Residual Significance of Effect
Physical presence of the Offshore Export Cable leading to gear snagging.	All gear types	All: Minor	n/a	All: Minor
Physical presence of Wind Farm Area and Offshore Export Cable leading to additional steaming to alternative fishing grounds for vessels that would otherwise be fishing within these areas.	All gear types	All: Negligible	n/a	All: Negligible
Increased vessel traffic within fishing grounds as a result of changes to shipping routes and maintenance vessel traffic from Wind Farm Area and Offshore Export Cable leading to interference with fishing activity.	All gear types	All: Negligible	n/a	All: Negligible
Cumulative				
Construction				
Cumulative effects of reduction in access to, or exclusion from, potential and/or established fishing grounds.	Potter	Moderate	Potters: with respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.	Minor
	Demersal trawl	Moderate	Demersal trawl: with respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.	Minor
	Scallop dredge	Minor	n/a	Minor
	All other gears	Minor	n/a	Minor
Cumulative effects of displacement leading to gear conflict and increased fishing pressure on alternative grounds	Potter	Moderate	Potters: with respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.	Minor
	Demersal trawl	Moderate	Demersal trawl: with respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.	Minor

Potential Impact	Receptor	Significance of Effect	Additional Mitigation Measures	Residual Significance of Effect
	All other gears	Minor	n/a	Minor
Cumulative effects of longer steaming distances to alternative fishing grounds	All gear types	Minor	n/a	Minor
Cumulative effects of changes in shipping routes, leading to interference with fishing activity.	All gear types	Minor	n/a	Minor
Operation and maintenance and decommissioning				
Cumulative effects of reduction in access to, or exclusion from, potential and/or established fishing grounds	Other dredge vessels	Negligible	n/a	Negligible
	All gear types	Minor	n/a	Minor
Cumulative effects of displacement leading to gear conflict and increased fishing pressure on alternative grounds	Other dredge vessels	Negligible	n/a	Negligible
	All gear types	Minor	n/a	Minor
Cumulative effects of longer steaming distances to alternative fishing grounds	All gear types	All: Negligible	n/a	All: Negligible
Cumulative effects of changes in shipping routes, leading to interference with fishing activity.	All gear types	All: Negligible	n/a	All: Negligible

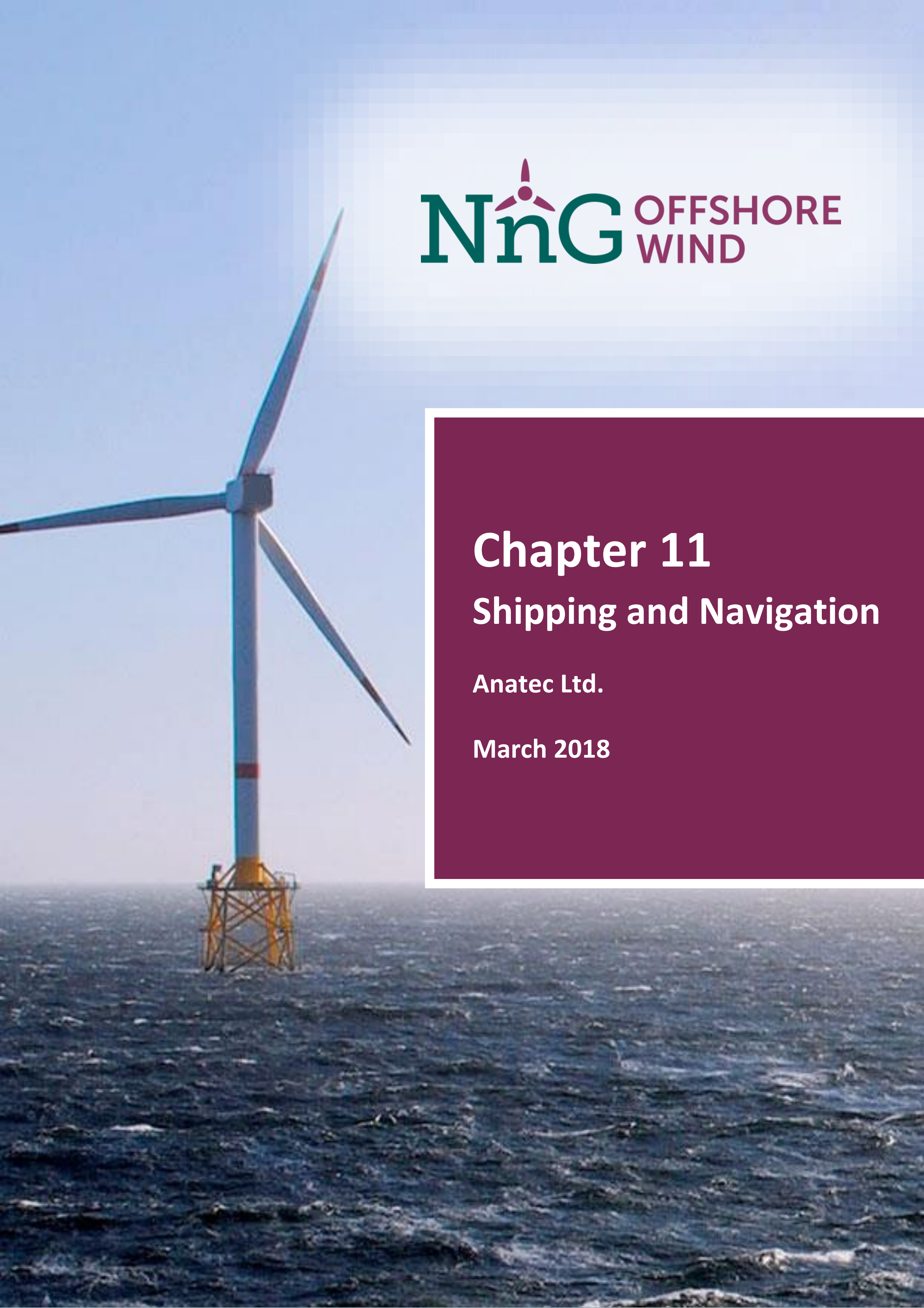
10.11 References

- Barreto, E., Bailey, N., Mclay, A., Mesquita, C., and Dobby, H. (2017). Marine Scotland Science Fish and Shellfish Stocks, 2017 Edition.
- BERR (Department for Business, Enterprise and Regulatory Reform) (2008). *Fisheries Liaison with Offshore Wind and Wet Renewables Group (FLOWW) Recommendations For Fisheries Liaison: Best Practice guidance for offshore renewable developers.*
- Blyth-Skyrme, R.E. (2010) *Developing guidance on fisheries CIA for wind farm developers*
- Blyth-Skyrme, R.E. (2010a). *Options and opportunities for marine fisheries mitigation associated with wind farms. Final report for Collaborative Offshore Wind Research Into the Environment contract FISHMITIG09.* (COWRIE Ltd, London).
- Blyth-Skyrme, R.E. (2010). Options and opportunities for marine fisheries mitigation associated with windfarms: Summary report for COWRIE contract FISHMITIG09. (COWRIE Ltd, c/o Nature Bureau, Newbury, UK 8pp)
- Centre for Environment, Fisheries and Aquaculture Science (Cefas) (2012) *Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects.* (Contract report: ME5403, May 2012);
- Cefas, Marine Consents and Environment Unit (MCEU), Department for Environment, Food and Rural Affairs (DEFRA) and Department of Trade and Industry (DTI) (2004) *Wind Farm Areas - Guidance note for Environmental Impact Assessment In respect of FEPA and CPA requirements, Version 2;*

- Council Regulation (EC) (1998). *No 850/98 of 30 March 1998 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms*
- Defra, (2017). *Vessel lists for UK vessels 10 m and under in length.*
- Defra, (2017). *Vessel lists for UK vessels Over 10 m in length.*
- EU Data Collection Framework (EU DCF). (2017). *Data by quarter-rectangle: Tables and maps of effort and landings by ICES statistical rectangles for 2003 to 2015.* Available at: https://stecf.jrc.ec.europa.eu/dd/effort
- Fisheries Liaison with Offshore Wind and Wet Renewables group FLOWW (2015). *FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Disruption Settlements and Community Funds* (FLOWW, 2015);
- FLOWW (2014). *FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison.*
- Food and Agriculture Organisation (FAO) (2005*). Fisheries Technical Paper 472. Impacts of trawling and scallop dredging on benthic habitats and communities*. (By Svein Løkkeborg).
- Gray, M., Stromberg, P-L., Rodmell, D. (2016) *Changes to fishing practices around the UK as a result of the development of offshore windfarms – Phase 1.* (For The Crown Estate)
- ICES, (2017). *ICES Advice on fishing opportunities, catch, and effort Greater North Sea Ecoregion Published 30 June 2017 nep.fu.8 Norway lobster (Nephrops norvegicus) in Division 4.b, Functional Unit 8 (central North Sea, Firth of Forth)*
- International Cable Protection Committee (2009) *Fishing and Submarine Cables - Working Together.*
- Marchal, P. (2008). *A comparative analysis of métiers and catch profiles for some French demersal and pelagic fleets.* (ICES Journal of Marine Science, 65: pp. 674–686).
- Marine Management Organisation (MMO) (2017). *IFISH database with landing statistics data for UK registered vessels for 2011 to 2015 with attributes for: landing year; landing month; vessel length category; country code; ICES rectangle; vessel/gear type; species; live weight (tonnes); and value; and landing year; landing month; vessel length category; country code; vessel/gear type; port of landing; species; live weight (tonnes); and value.*
- Marine Management Organisation (MMO) (2017). *Surveillance data for 2011-2015 with data query attributes for: sighting date; ICES rectangle; ICES subsquare; latitude; longitude; vessel/gear type; activity; nationality; course; speed; and number of sightings*.
- Marine Management Organisation (MMO) (2017). *Vessel Monitoring System data for UK registered vessels ≥15 m in length, for 2011 to 2014, indicating hours fished and value of catch for mobile and static vessels to a resolution of 200th of an ICES rectangle.*
- Marine Management Organisation (MMO) (2017). *Vessel Monitoring System data for UK registered vessels ≥15 m in length, for 2015, indicating hours fished and value of catch for vessels using demersal trawl, pelagic gear, dredge, potting, nets and lines to a resolution of 200th of an ICES rectangle.*
- Marine Scotland, (2017), *Consultation on Landing Controls for the Scottish Crab and Lobster Fisheries - Outcome Report*
- Polagye, B., B. Van Cleve, A. Copping, and K. Kirkendall (editors) (2011). *Environmental effects of tidal energy development.* (U.S. Dept. Commerce, NOAA Tech. Memo. F/SPO-116, 181).
- RenewableUK (2013*) Cumulative impact assessment guidelines, guiding principles for cumulative impacts assessments in offshore wind farms*;
- Sabatini, M. and Hill, J. (2008). Nephrops norvegicus. Norway lobster. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line].

(Plymouth: Marine Biological Association of the United Kingdom) Available from: http://www.marlin.ac.uk/generalbiology.php?speciesID=3892

- Sea Fish Industry Authority and UK Fisheries Economic Network (UKFEN) (2012) *Best practise guidance for fishing industry financial and economic impact assessments*;
- Seitz, R.D., Wennhage, H., Bergstrom, U., Lipcius, R.N., Ysebaert, T. (2014). *Ecological value of coastal habitats for commercially and ecologically important species*. (ICES Journal of Marine Science. 71: 648-665).
- Switzer, T. & Meggitt, D. (2010). *Review of Literature and studies on Electro Magnetic Fields (EMF) generated by undersea power cables and associated influence on Marine Organisms.* (Sound & Sea Technol. DOI: .1109/OCEANS.2010.5664611).
- UK Oil and Gas (2008) *Fisheries Liaison Guidelines - Issue 5*



NnG OFFSHORE WIND

Chapter 11

Shipping and Navigation

Anatec Ltd.

March 2018

Table of Contents

Table of Figures

Table of Tables

11 Shipping and Navigation

11.1 Introduction

1. This chapter of the EIA Report presents an assessment of the potential impacts upon Shipping and Navigation arising from the construction, operation and decommissioning of the Project, as detailed in Chapter 4: Project Description.

2. The assessment is based upon a combination of the understanding of the Project in terms of the potential for impact and the resultant effects on receptors that were identified within the study area as detailed within Section 11.8.

3. This chapter is comprised of the following elements:

- A summary of relevant policy, guidance and legislation;
- Details of the data sources used to characterise the study area;
- A summary of the relevant consultations with stakeholders;
- A description of the methodology for assessing the impacts of the Project, including details of the study area and approach to the assessment of potential effects;
- A review of the baseline conditions;
- A description of the worst-case design scenario relevant to Shipping and Navigation;
- An assessment of the likely effects for the construction, operation and decommissioning phases of the Project, including cumulative effects;
- Identification of any further mitigation measures or monitoring requirements in respect of any significant effects;
- A summary of the residual impact assessment determinations taking account of any additional mitigation measures identified.

11.2 Policy, Guidance and Legislation

4. The principal guidance documents and information used to inform the assessment of potential impacts on Shipping and Navigation are as follows:

- Maritime and Coastguard Agency (MCA) Marine Guidance Note (MGN) 543 - Safety of Navigation: Offshore Renewable Energy Installations – Guidance on UK Navigational Practise, Safety, and Emergency Response (MCA 2016);
- MCA Methodology for Assessing Marine Navigational Risk (MCA, 2015);
- International Maritime Organisation (IMO) Formal Safety Assessment (FSA) Process (IMO 2002);
- MCA MGN 372 (MGN 372 M+F) Guidance to Mariners Operating in the Vicinity of UK Offshore Renewable Energy Installations (OREIs) (MCA, 2008);
- International Association of Lighthouse Authorities (IALA) Recommendations O-139 on the Marking of Man-Made Structures (IALA 2013);
- The Royal Yachting Association’s (RYA) Position on Offshore Renewable Energy Developments: Paper 1 – Wind Energy (RYA, 2013); and
- The Recreational Craft Regulations 2017 which gives guidance on what vessels are considered recreational craft.

11.3 Data Sources

5. The assessment undertaken considers the potential interaction between the Project, as described in Chapter 4: Project Description, and Shipping and Navigation receptors within the study area.
6. The study area comprises a 10 nautical mile (NM) buffer of the Wind Farm Area (the Wind Farm Study Area), as shown in Figure 11.1, Volume 2. This was chosen to encompass relevant passing traffic, while still remaining site-specific to the Wind Farm Area.
7. Baseline characterisation data has been collated combining a thorough desk-based study of extant data supplemented with site-specific marine traffic survey data. Marine traffic survey data was first collected in 2010 and 2011, however given the time elapsed since these initial surveys, they have been validated using updated data collected during 2016. The 2016 data is presented within this chapter. This approach was agreed with the MCA, and further details are provided in Section 11.5.
8. Table 11-1 details the data sources used to inform the baseline characterisation within the study area.

Table 11-1: Data sources used to inform the baseline description – Shipping and Navigation.

Data Source	Study/Data Name	Overview
NnGOWL	Marine Traffic Survey Data, Anatec Ltd, 2016.	Total of 28 days of Automatic Identification System (AIS) data collected from coastal receivers for the purpose of validating the original data collected in 2010 and 2011. It is noted that this data only accounts for vessels required to broadcast via AIS.
NnGOWL	Marine Traffic Survey Data, Anatec Ltd, 2010/11.	Two marine traffic surveys undertaken as follows: ▪ 29 days of AIS and radar data collected between August and October 2010 by the geotechnical survey vessel *Ocean Discovery.* ▪ AIS recorded from coastal receivers during July 2011.
United Kingdom Hydrographic Office (UKHO)	Admiralty Nautical Navigational Charts, UKHO, 2017. Admiralty Sailing Directions – North Sea (West) Pilot – NP54, UKHO, 2016	Charts and pilots used to establish the baseline conditions in the context of relevant navigational features within the study area.
The Crown Estate	Marine Aggregate Dredging Areas, The Crown Estate, 2017.	Geographic Information System (GIS) files displaying the aggregate dredging areas within UK waters.
RYA	UK Coastal Atlas of Recreational Boating, RYA, 2016	Recreational vessel intensity grid and route markers based on input AIS data. Data set also includes positions of boating areas and other recreational facilities. This data set is used at the request of the RYA.

Data Source	Study/Data Name	Overview
Marine Accident Investigation Branch (MAIB)	Marine Incident Data, MAIB, 2005 to 2014.	Data set providing details of marine incidents investigated by the MAIB between 2005 and 2014. Data covers all incidents involving commercial UK vessels or non-UK commercial vessels within UK 12 NM territorial waters.
Royal National Lifeboat Institution (RNLI)	Marine Incident Data, RNLI, 2005 to 2014.	Data covers all incidents responded to by the RNLI excluding cases of a hoax or false alarm.
Marine Scotland	Fishing Sightings Surveillance Data, Marine Scotland, 2015 to 2016	Data recorded manually via visual surveillance.
Marine Scotland	Fishing Satellite Surveillance Data, Marine Scotland, 2015 to 2016	Fishing vessel data recorded via satellite. Covers all vessels of 12 metres (m) and above for all EU countries (and selected other countries, e.g., Norway) within UK waters.

9. The following technical appendices to this EIA Report should also be read in conjunction with this chapter.

- Appendix 11.1: Navigational Risk Assessment (NRA) (2012).
- Appendix 11.2: AIS Traffic Validation Study (2017).
- Appendix 11.3: MGN543 Checklist (2017)

11.4 Relevant Consultations

10. As part of the EIA process, NnGOWL has consulted with various statutory and non-statutory stakeholders. A formal scoping opinion was requested from MS-LOT following submission of the Scoping Report. Ongoing consultation with stakeholders continued post-scoping and responses have been used to develop an appropriate methodology and parameters for assessment.

11. In response to NnGOWL's request, MS-LOT issued a Scoping Opinion identifying a number of potential impacts that could not be scoped out of the assessment at this stage following review of the Scoping Report. The issues to be considered further within this EIA in respect of Shipping and Navigation are summarised in Table 11-2.

Table 11-2: Summary of consultation relating to Shipping and Navigation

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
08/09/17 Scoping Opinion – MS-LOT Summary	The Scottish Ministers agreed that the shipping baseline assessment requires updating with marine traffic survey data (in line with MGN 543) but recommend that NnGOWL have on-going discussions with the MCA and the RYA to agree these requirements. The Scottish Ministers recommended that NnGOWL discuss and agree the specific requirements for an updated NRA with the MCA.	A traffic validation was undertaken using AIS data collected during 2016, as summarised in Section 11.6. Appendix 11.2 includes the full assessment. No significant changes in traffic were observed, and therefore an updated NRA has not been undertaken. This approach has been agreed with the MCA. The updated UK Coastal Atlas has been considered within the establishment of the baseline presented in Section 11.6.
	The Scottish Ministers noted the MCA's requirement for an NRA update and advised NnGOWL to discuss and agree the specific requirements for an updated NRA with the MCA. The outcomes of these discussions would determine whether the previous NRA remains representative of the baseline. If so, the Scottish Ministers agreed that the conclusions of the Original EIA remain valid.	A traffic validation was undertaken using AIS data collected during 2016, as summarised in Section 11.6. Appendix 11.2 includes the full assessment. No significant changes in traffic were observed, and therefore an updated NRA has not been undertaken. This approach has been agreed with the MCA.
	The Scottish Ministers agreed that the embedded mitigation from the Originally Consented Project and additional measures detailed in The Consents are appropriate to the potential level of the effect from the Project.	Embedded mitigation is listed in Section 11.7.1.and anticipated consent conditions commitments are in Section 11.7.2 where they relate to Shipping and Navigation. Table 11-8.
	The Scottish Ministers agreed that the Project EIA should only focus on those receptors considered to be significantly affected by the Project as reported within the Scoping Report, and subject to agreement with the MCA.	The baseline assessment (Section 11.6) has been used to identify those receptors which potentially may be significantly affected by the Project. The subsequent impact assessment is presented in Section 11.8.
	The Scottish Ministers recommended that NnGOWL confirms with the MCA which receptors should be included in the NRA (if required, see above) to ensure the requirements the MCA outline in their consultation response are taken into account.	As agreed with the MCA (and as summarised in Section 11.5), an updated NRA is not required. The baseline assessment (Section 11.6) has been used to identify those receptors which potentially may be significantly affected by the Project. The subsequent impact assessment is presented in Section 11.8.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	The Scottish Ministers agreed that the following should be included in the cumulative impact assessment and advise that NnGOWL confirm with the MCA that this is appropriate: ▪ Worst case scenario of Inch Cape (2014 as consented) or Inch Cape (2017 scoping report) ▪ Worst case scenario of Seagreen Alpha and Bravo (2014 as consented) or Seagreen (2017 scoping report)	The cumulative assessment is presented in Section 11.8.4, based on a worst case approach as required.
08/09/17 Scoping Response from the East Lothian Council (ELC)	ELC asked for reassurance that the potential for a vessel carrying a polluting load being involved in a collision or allision incident as a result of the project, with subsequent discharge of the polluting load into the sea, had been considered within the EIA Report. If any significant risk of pollution from this source would be created, an indication of its likelihood, and potential impacts should be included. ELC acknowledged that this may be better assessed under "Water Quality", however noted the clear link to shipping and navigation.	Collision (vessel to vessel) and allision (vessel to structure) impacts are assessed in Section 11.8.2. Appendix 11.1 also details likely pollution resulting from any base case and future case allision or collision incidents. All were found to be within acceptable parameters. Embedded mitigation includes an Emergency Response and Cooperation Plan (ERCoP) which would include details of cooperation with the Coastguard in the event of pollution incidents. Additionally, the Marine Pollution Contingency Plan (MCMP) will set out relevant management measures to mitigate risk of accidental spills, as per Table 11-8.
08/09/17 Scoping Response from the MCA	The MCA noted that an NRA update will need to be submitted in accordance with MGN 543 and the MCA Methodology for Assessing the Marine Navigational Safety & Emergency Response Risks of Offshore Renewable Energy Installations.	Following agreement with the MCA, Appendix 11.3 has been undertaken in order to demonstrate that navigational safety impacts have been addressed satisfactorily without any updates required to the NRA.
	The MCA noted that traffic studies were carried out in 2010 and 2012, however in line with the requirement that traffic studies be completed within 24 months prior to the Environmental Statement submission, an expectation that a new traffic study be undertaken was stated.	A traffic validation was undertaken using AIS data collected during 2016, as summarised in Section 11.6. Appendix 11.2 includes the full assessment. This approach has been agreed with the MCA.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	The MCA stated that particular attention should be paid to cabling routes and where appropriate burial depth for which a Burial Protection Index study should be completed and, subject to traffic volumes, an anchor penetration study may be necessary. If cable protection were to be required e.g. rock bags, concrete mattresses, the MCA would be willing to accept a 5% reduction in surrounding depths referenced to Chart Datum. This will be particularly relevant where depths are decreasing towards shore and potential impacts on navigable water increase.	Embedded mitigations (section 11.7.1) states: *"Cables will be protected appropriately taking into account fishing and anchoring practices. Positions of the cable routes notified to Kingfisher Information Services – Offshore Renewables Cable Awareness (KIS - ORCA) for inclusion in cable awareness charts and plotters for the fishing industry"*. In addition it is anticipated that a Cable Plan (which will include a Cable Burial Risk Assessment) will be required as a condition of any future consents for the Project as detailed in Section 11.7.2, Table 11-8
	The MCA stated that any application for safety zones will need to be carefully assessed and additionally supported by experience from the development and construction stages.	A successful application for safety zones are assumed as embedded mitigation, as described in Section 11.7.1. The application will be submitted with a supporting safety case, providing justification of the need for safety zones, and an assessment of the likely impacts arising from their use.
	The MCA stated that particular consideration will need to be given to the implications of the site size and location on Search and Rescue (SAR) resources and ERCoP. Attention should be paid to the level of radar surveillance, AIS and shore-based Very High Frequency (VHF) radio coverage and give due consideration for appropriate mitigation measures such as radar, AIS receivers and in-field, Marine Band VHF radio communications aerial(s) (VHF voice with Digital Selective Calling (DSC)) that can cover the entire wind farm sites and their surrounding areas.	It is anticipated that a Navigational Safety Plan (NSP) will be required as a condition of any future consents granted for the Project, for approval, which will include an ERCoP as described in Section 11.7.1 Similarly, it is anticipated that a Development Specification and Layout Plan (DSLP) will be required as a condition of any future consents which will require a final layout to be submitted for approval by MS-LOT, subject to consultation with the MCA (See Section 11.7.2).
08/09/2107 Scoping Response from the Northern Lighthouse Board (NLB)	The NLB are content with the topics to be included in the EIA and those sections requiring updated data, as detailed in the Scoping Report.	This EIA has followed the methodology outlined within the Scoping Report, as agreed with the MCA.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
08/09/17 Scoping Response from RYA Scotland	RYA Scotland stated that should a traffic validation exercise against recent AIS data confirm that there has been no significant change in the Shipping and Navigation baseline, the NRA for the Original EIA will remain valid. RYA Scotland requested that the new edition of the UK Coastal Atlas of Recreational Boating be used to inform the assessment, and considered this data set to provide good representation of reactional activity within the area.	A traffic validation exercise of AIS data collected in 2016 showed an increase in recreational activity when compared to the original assessment; however the change was not considered significant. The updated 2016 data has been used as the primary input to the assessment of impacts to recreational traffic (Section 11.8 and Appendix 11.1). The updated UK Coastal Atlas has been considered within the establishment of the baseline presented in Section 11.6.
08/09/17 Scoping Response from the Under 10m Association	The Under 10m Association noted that since the original scoping consultation, additional consents have been granted to other companies for wind farms in the area and the cumulative effect of these and the impact for displacement of the fishing vessels should be considered.	Fishing vessel displacement has been considered cumulatively in Section 11.8.4. This includes consideration of the Seagreen and Inch Cape wind farms. Further assessment is provided in Chapter 10: Commercial Fisheries.
	The Under 10m Association stated that the impact on all inshore fishing vessels must be considered regardless of their size.	See Chapter 10: Commercial Fisheries
	The Under 10m Association stated it was imperative that cables are buried to a minimum depth of 1-1.5 m. The potential for the laying of cables to disturb large clumps of material, which are subsequently brought to the surface and hence become a snagging hazard for trawlers was noted. Such a situation must be considered and mitigation measures put in place.	A cable burial assessment will be undertaken post consent to mitigate the risk of cable snagging. It is currently expected that additional cable protection may be required over approximately 20% of the inter-array cable and 15% of the export cable lengths, in locations where desired burial depths are difficult to achieve. Where cable protection is required over-trawlability surveys will be completed to confirm the condition of the seabed (see Chapter 10: Commercial Fisheries). Section 11.7.1 (embedded mitigation) states: *"Cables will be protected appropriately taking into account fishing and anchoring practices. Positions of the cable routes notified to KIS - ORCA for inclusion in cable awareness charts and plotters for the fishing industry"*. In addition it is anticipated that a Cable Plan (which will include a Cable Burial Risk Assessment) will be required as a condition of any future consents for the Project as detailed in Section 11.7.2,

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
18/10/2017 Post-scoping Responses from MCA on proposed EIA methodology	The MCA is content that the traffic validation (Appendix 11.2) met the requirements for marine traffic survey data for the Project. It was agreed that the EIA Report would be submitted with the existing NRA, the traffic validation report, and the MGN543 checklist as appendices.	This chapter has followed the methodology detailed in Section 11.5, as agreed with the MCA.
	The MCA is content with the indicative Project layout, however noted a preference for two lines of orientation across the whole Wind Farm Area for SAR purposes.	It is anticipated that as stated in Section 11.7.1 (embedded mitigation) the wind farm layout will be agreed with the MCA prior to finalisation via approval of the Development Specification and Layout Plan (DSLP), which will be required as a condition of any future consents which will require a final layout be submitted for approval by MS-LOT, subject to consultation with the MCA (See Section 11.7.2).
07/12/2017 – Email correspondence[1] from MCA confirming EIA methodology approach	The MCA is content with an updated EIA, with the original NRA, a completed MGN543 checklist, and the traffic validation report as appendices. There will be aspects such as the SAR Checklist which will need to be discussed and agreed going forward (post-consent / pre-construction).	This methodology has been followed in this chapter.
	The MCA is content with the impacts carried through to the EIA. Those scoped out were already assessed as part of the original EIA, and on the understanding that there are no potential changes in traffic to result in a different significance ranking upon re-assessment, then the MCA is content with this approach.	As agreed with the MCA, only impacts where there is potential for changes in traffic to effect ranking upon re-assessment have been carried forward to the EIA.
	The MCA is content with the embedded mitigation in place for the Project.	Embedded mitigation is listed in Section 11.7.1.
	The MCA is content with the list of Projects to be scoped into the cumulative assessment.	Projects considered cumulatively are listed in Section 11.8.4.

12. In line with the proposed methodology set out in the Scoping Report, the impacts listed below have been scoped in to the EIA Report for shipping and navigation as set out in Section 11.8:

[1] This email correspondence followed a telephone call with the MCA on the 7 December 2017, undertaken for the purpose of finalising the approach to EIA followed in this chapter.

- Physical presence of structures within the Wind Farm Area leading to a loss of navigable sea room and deviations around structures resulting in an increased collision risk (vessel-to-vessel) (**during operation and maintenance**);
- Physical presence of structures within the Wind Farm Area leading to a loss of navigable sea room and deviations around structures resulting in an increased allision risk (vessel-to-structure) (**during operation and maintenance**);
- Physical presence of structures within the Wind Farm Area leading to a loss of navigable sea room and deviations around structures resulting in an increased collision risk (vessel-to-vessel) (**cumulative with other developments**); and
- Physical presence of structures within the Wind Farm Area leading to a loss of navigable sea room and deviations around structures resulting in an increased allision risk (vessel-to-structure) (**cumulative with other developments**).

13. It is noted that the MCA has agreed and approved the justification for the scoping in and out of impacts, as set out in the Scoping Report. In line with the Scoping Report, and as agreed with the MCA, the following impacts have been scoped out of the EIA for shipping and navigation, and are therefore not assessed in Section 11.8. It is noted that impacts during the decommissioning phase have been considered to be the same as those identified for construction, on the basis that these phases present similar scenarios (e.g. increased Project vessel presence, use of safety zones).

- Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased collision risk (vessel-to-vessel[2] and vessel-to-structure) (**during construction/decommissioning**);
- Physical presence of Offshore Wind Farm structures and inter-array and Offshore Export Cables and presence of operation/maintenance vessels leading to an increase in the number of SAR incidents (**during operation**);
- Physical presence of Offshore Wind Farm structures causing radar interference to nearby traffic (**during operation**);
- Physical presence of inter-array and Offshore Export Cables, leading to a risk of hostile anchor interaction and vessel grounding (**during operation**);
- Physical presence of inter-array and Offshore Export Cables leading to a risk of fishing gear interaction (snagging) (**during operation**);
- Physical presence of inter-array and Offshore Export Cables leading to interference on small vessel navigation equipment (**during operation**);
- Physical presence of Offshore Wind Farm structures and inter-array and Offshore Export Cables leading to a depletion of SAR Resources (**cumulative with other developments**);
- Physical presence of Offshore Wind Farm structures causing radar interference to nearby traffic (**cumulative with other developments**);
- Physical presence of inter-array and Offshore Export Cables leading to a risk of hostile anchor interaction and vessel grounding (**cumulative with other developments**);
- Physical presence of inter-array and Offshore Export Cables leading to a risk of fishing gear interaction (snagging) (**cumulative with other developments**); and
- Physical presence of inter-array and Offshore Export Cables leading to interference on small vessel navigation equipment (**cumulative with other developments**).

14. For clarity, and as per the Scoping Report, all construction and decommissioning impacts have been scoped out, as have impacts associated with the subsea cables (both the Offshore Export Cable and the inter-array cables). It is noted that impacts associated with vessels engaged in active fishing (as opposed to being in transit) are considered in Chapter 10: Commercial Fisheries.

[2] This includes both collisions involving a Project associated vessel, and collisions involving only third party vessels arising from displacement issues.

11.5 Impact Assessment Methodology

15. This assessment considers the potential impacts of the Project and the effects on Shipping and Navigation, as scoped into the EIA. The impact assessment process and methodology follows the principles and general approach outlined in Chapter 6: EIA Methodology. The methodology and parameters assessed have also taken into account issues identified through consultation with stakeholders as detailed in Section 11.4 and the understanding of baseline conditions informed by the data sources referenced in Section 11.3 and as described in Section 11.6.

16. The Project Description (Chapter 4) and the relevant project activities have been assessed against the environmental baseline to identify the potential interactions between the Project and the environment (in line with the requirements of the scoping opinion). These are known as the potential impacts and are then assessed to determine a level of significance of effect upon the receiving environment.

17. It is noted that the NRA undertaken for the Originally Consented Project provided an FSA on all of the potential impacts identified, based on the design parameters presented in the Original ES (the NRA is provided as Appendix 11.1 to this EIA Report).

18. For the purposes of the current application and this EIA Report, it was agreed with the MCA that if a traffic validation report showed no significant changes to the baseline, then an updated NRA was not necessary provided an MGN543 Checklist was completed to demonstrate compliance of the Project with the current MCA guidance.

19. A traffic validation report was therefore undertaken using marine traffic survey data collected during 2016, which showed no significant changes in traffic since the original NRA. The validation report was subsequently approved by the MCA, and is presented in Appendix 11.2.

20. The MGN543 checklist is presented in Appendix 11.3. The results of the NRA and the traffic validation have both been used as input to this assessment.

11.5.1 Assessment and Assignment of Significance

21. The sensitivities of Shipping and Navigation receptors are defined by both their potential vulnerability to an impact from the Project, their recoverability and value, or importance of the receptor. The definitions of terms relating to Shipping and Navigation receptor sensitivity are detailed in Table 11-3.

Table 11-3: Sensitivity/ importance of the environment – Shipping and Navigation

Receptor sensitivity	Definition
High	Feature of international importance e.g. IMO Routeing Measure such as a Traffic Separation Scheme (TSS) or Deep Water Route (DWR).
Medium	Feature of national importance, e.g., busy shipping lanes and port approach routes/channels, such as Firth of Forth and River Tay, used by a range of ships, including medium/large size vessels.
Low	Feature of local or regional importance, i.e. notable navigable channels used by small to medium sized vessels, such as coastal routes east/west of Bell Rock and off the Fife coast.
Negligible	Negligible impact in terms of shipping and navigation.

22. The magnitude of impact is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact. The definitions of the levels of magnitude used in this assessment in respect of Shipping and Navigation are described

in Table 11-4 (note that only adverse impacts are considered and, therefore, no definitions for potentially beneficial impacts are presented).

Table 11-4: Magnitude of the impact – Shipping and Navigation

Magnitude	Description (adverse effects)
High	Total loss or very major alteration to internationally important shipping lanes, i.e. IMO routeing measures.
Medium	Major alteration or loss of strategically important shipping lanes and navigational port approaches, i.e. shipping routes used by vessels headed in/out of Firth of Forth and River Tay.
Low	Minor shift from baseline conditions leading to a partial loss or alteration to lower use navigational routes from baseline conditions, i.e. shipping routes and channels used by small and medium sized vessels using coastal routes.
Negligible	Very slight change from baseline shipping and navigation routeing.
No Change	No loss or alteration or characteristics, features or elements; no observable impact in either direction.

23. The magnitude of the impact is correlated against the sensitivity of the receptor to provide a level of significance. For the purposes of this assessment, any effect that is considered moderate or major is considered to be significant in EIA terms.

Table 11-5: Significance of potential effects – Shipping and Navigation

		Magnitude			
		High	**Medium**	**Low**	**Negligible**
Sensitivity	**High**	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

11.5.2 Uncertainty and Technical Difficulties Encountered

24. The primary input to this assessment is the marine traffic survey data collected during 2016, as described in Section 11.3. This data set was collected for the purpose of validating the marine traffic survey data collected in 2010 and 2011 (see Appendix 11.2, which presents both the 2016 and 2010/11 data sets), and to identify any key changes in traffic patterns. As the 2016 data comprised AIS only, vessels not required to broadcast via AIS are likely to be underrepresented, most notably fishing vessels under 15 m, and recreational vessels.

25. As indicated in Table 11-2, the RYA are content with the use of AIS data alone for assessment of recreational traffic, as it should provide a fair indication of the overall activity so long as it was considered alongside the new RYA Coastal Atlas. Therefore the updated RYA Coastal Atlas of Recreational Boating (2016) has also been included within the assessment and the recreational vessel baseline has been validated using the Coastal Atlas and the 2016 AIS data.

26. As noted above, fishing vessels under 15 m may be underrepresented within the 2016 data used to assess the baseline as AIS transmission is not compulsory for such vessels. However it was observed that a significant proportion of fishing vessels recorded within the 2016 AIS data were less than 15m (approximately 60% based on a count of unique vessels per day) and were therefore voluntarily carrying AIS transmitters and allowing consideration of their activity. It is noted that further detailed information on fishing activity is provided within Chapter 10: Commercial Fisheries.

27. A worst case scenario for each impact in terms of the Project parameters has been assumed within the assessment, as discussed in Section 11.7.

28. For the impacts assessed, the worst case scenario from a Shipping and Navigation perspective was considered to be a maximum build out scenario, i.e. the maximum number of turbines and OSPs built within the Wind Farm Area.

11.6 Baseline Description

11.6.1 Wind Farm Study Area

11.6.1.1 Existing Data

29. Navigational features within the study area have been identified based on a review of Admiralty Charts and the Pilot Book (UKHO, 2016).

11.6.1.1.1 Aids to Navigation

30. Aids to Navigation (AtoNs) within the area are shown relative to the Project in Figure 11.2, Volume 2. The Bell Rock lighthouse is located approximately 7 NM north-west of the Wind Farm Area, and is fitted with a Racon transmitter. While not strictly an Aid to Navigation, the Inch Cape Met Mast transmits via AIS, and is also positioned north of the Wind Farm Area. AtoNs to the west of the wind farm include the Fife Ness Lighthouse (which transmits via AIS), the North Carr Buoy (also transmitting via AIS), and a light marking Crail Harbour.

31. The Isle of May is marked with a coastal light, and by two buoys east of the island. It is noted that a note on Admiralty Charts states that there are two buoys marking the island, however only one is charted.

11.6.1.1.2 Ports and Harbours

32. There is only one harbour within the Wind Farm Study Area, located at Crail. The harbour is mainly used by small fishing and recreational vessels. It is noted that significant commercial traffic routes associated with other ports do pass through the Wind Farm Study Area. Fishing activity associated with other ports was also recorded within the Wind Farm Study Area during the marine traffic surveys (see Chapter 10: Commercial Fisheries for further details of fishing ports within the area). Assessments of this traffic are presented in Section 11.6.1.2.1 and Section 11.6.1.2.3, respectively, and a summary of the key commercial ports is presented below.

- Grangemouth, a commercial port located within the Firth of Forth, can handle all types of vessels (tankers up to 10.7 m draught, other vessels up to 7.4 m);
- Methil, a commercial port within the Firth of Forth, accommodating vessels up to 5.5 m draught;
- Leith, berths within the Firth of Forth handling cruise liners, general cargoes and dry bulk;
- Rosyth, a commercial port within the Firth of Forth handling general cargo and cruise liners;
- Dundee, at the mouth of the Firth of Tay handling general cargoes; and

- Perth, commercial port in the Firth of Tay handling agricultural products, timber, and chemical salts.

33. As shown in Figure 11.2, Volume 2, the Forth Ports authority limit is positioned at the mouth of the Forth and intersects the Wind Farm Study Area. The Forth vessel traffic service is operated from Grangemouth, and covers the area within the ports limit.

11.6.1.1.3 Anchorage

34. There is one charted anchorage within the Wind Farm Study Area, located approximately 9.5 NM west of the Wind Farm Area, off Crail. It is noted that vessels at anchor here are extremely unlikely to interact with the Offshore Wind Farm. There are no charted anchorages within the Wind Farm Area itself, though it is noted that with the exception of the military wrecks mentioned below, there are currently no restrictions on anchoring within the Wind Farm Area. Anchoring activity observed within the marine traffic survey data is summarised in Section 11.6.1.2.2.

11.6.1.1.4 Marine Environmental High Risk Areas

35. The Isle of May (located approximately 8 NM west of the Wind Farm Area) is designated as a Marine Environmental High Risk Area (MEHRA) as shown in Figure 11.2, Volume 2. The designation was based on a high concentration of vulnerable seabirds, and the high density of traffic passing the island. It is noted that sections of the coast on either side of the mouth of the Forth are also designated as MEHRAs; however, these areas lie outside the Wind Farm Study Area.

11.6.1.1.5 Military Practice and Military Wrecks

36. The Wind Farm Area intersects a military practice area (UKHO-PEXA-X5641) which is designated as an area used for general practice, however it is noted that Admiralty Charts indicate that the area south of the Wind Farm Area is available for submarine practice. Further areas intersect the Wind Farm Study Area as shown in Figure 11.2, Volume 2. Within the Wind Farm Area itself, military wrecks lay on the seabed, with a note on Admiralty Charts stating that these should not be interfered with by an unauthorised party.

37. Two ammunition dumping grounds are positioned within the study area, approximately 1 NM east of the Isle of May; however, neither is in use.

11.6.1.1.6 Marine Incidents

38. Locations of marine incidents recorded by the MAIB and the RNLI are presented in Figure 11.3, Volume 2, and Figure 11.4, Volume 2, respectively.

39. A review of the incidents recorded by the MAIB between 2005 and 2014 showed a total of 85 incidents within the Wind Farm Study Area, two of which occurred within the Wind Farm Area itself:

- An ’Accident to person’ on a survey/research vessel leading to an injury to one crew member in September 2010; and
- A ’Fire/Explosion’ on a fishing vessel in June 2011.

40. The majority of vessels involved in recorded incidents (approximately 72%) were fishing vessels, with the remainder largely made up of commercial vessels. No incidents of a vessel-to-vessel collision were reported. However a total of nine incidents, listed as either ’Hazardous Incident’ or ’Machinery Failure’, involved two vessels, and it should be considered that these may have been collision or near miss incidents. Of these nine, five were recorded at the mouth of the Forth, and three to the south of the Wind Farm Area.

41. The RNLI data showed a total of 79 incidents occurring within the Wind Farm Study Area, with one recorded within the Wind Farm Area. The details provided with this incident (date and time, incident location, vessel type, incident type) indicate it is the same ’Fire/Explosion’ incident described within the MAIB data above.

42. As with the MAIB data, no incidents classified as a 'collision' were recorded, however there were a high density of incidents recorded within the mouth of the Forth, including one incident of a fishing vessel snagging gear on a subsurface obstruction.

11.6.1.2 Wind Farm Study Area Survey Results

43. This section summarises the key findings of the marine traffic survey data collected during 2016 from onshore AIS receivers. Any changes observed from the data collected during 2010 and 2011 have been highlighted, and, as the 2016 data is AIS only, details of the traffic recorded via radar in 2010 have been referenced where necessary. The 2016 marine traffic data is presented in Figure 11.5, Volume 2.

44. It was estimated from the 2016 data that 22 unique vessels per day passed within the Wind Farm Study Area, with approximately three of these intersecting the Wind Farm Area itself per day.

45. A review of the marine traffic survey data collected in 2016 (for the purpose of validating the pre-existing data) showed the majority of traffic within the Wind Farm Study Area was from fishing vessels, and commercial vessels (cargo and tanker). Further details are provided below.

46. It is noted that the below analysis is primarily based on the 2016 marine traffic survey data, although reference has also been made to the 2010/11 data where appropriate (noting that no radar data was collected within the 2016 data; as agreed with MCA and NLB (Table 11-2). As stated in Appendix 11.2, there have been no significant changes in traffic since the 2010/11 surveys that would impact the outcomes of any assessment undertaken.

11.6.1.2.1 Commercial Traffic

47. Most commercial traffic in the area was observed on routes passing south of the Wind Farm Area, between the Firth of Forth and other European ports, including Eemshaven (Netherlands), Rotterdam (Netherlands), and Immingham (UK). Commercial traffic passing through the Wind Farm Area was largely comprised of tankers running between Lerwick (UK) and Immingham (UK).

48. Two regular commercial routes were observed intersecting the Wind Farm Area. One runs between the Humber estuary, and various northern Scottish and island ports including Aberdeen, Peterhead, and Lerwick. The other is associated with the Firth of Tay, with destination / origin ports including both southern UK and mainland European ports.

49. It was estimated that 13 unique commercial vessels per day passed within the Wind Farm Study Area, with two of these per day intersecting the Wind Farm Area.

11.6.1.2.2 Anchoring Vessels

50. The marine traffic survey data showed anchoring from tankers immediately south-east of the Wind Farm Area, and also towards the southern boundary of the Wind Farm Study Area. Additionally, one cargo vessel was also recorded at anchor, in the area immediately south-east of the Wind Farm Area. The information transmitted via AIS by these vessels suggested they were anchoring while awaiting orders, on occasion for a period of more than one week.

51. No anchoring was recorded within the Wind Farm Area itself.

11.6.1.2.3 Fishing Vessels

52. The majority of fishing within the Wind Farm Study Area was observed to be associated with the Firth of Forth and to the south west of the Wind Farm Area, largely from beam trawlers and dredgers. Potting activity was also recorded off Fife Ness, and to the north, east, and south-east of the Wind Farm Area. Only three unique fishing vessels were recorded within the Wind Farm Area, and their behaviour suggested they were in transit at the time rather than actively engaged in fishing. Fishing vessel activity is presented in Figure 11.6, Volume 2.

53. Non-AIS vessels accounted for approximately 80% of fishing vessel tracks recorded during the 2010/11 marine traffic surveys, including vessels recorded within the Wind Farm Area. It is noted that stricter

AIS carriage requirements were in place during the 2016 data period (all fishing vessels of length 15 m and above) than those active during 2010/11 (only fishing vessels above 45 m), and the percentage of non-AIS fishing vessel traffic is therefore expected to be significantly lower in 2016 (approximately 65% of fishing vessel activity was from vessels less than 15 m in length within the 2016 data). Further information on fishing activity is contained within Chapter 10: Commercial Fisheries.

54. Longer term satellite and sighting surveillance data recorded from January 2015 to December 2016 was used to validate the findings of the AIS analysis, and to assess fishing activity over a longer period. As observed in the AIS data, the satellite data showed the majority of fishing activity occurred to the south-west of the Wind Farm Area, within and around the Firth of Forth. It is noted that the satellite data showed activity from vessels within the Wind Farm Area itself at speeds suggesting they may have been engaged in fishing at the time. However levels here were limited when compared to areas of the Firth of Forth to the south-west. Gear type information is not provided with the satellite data, and further analysis into types of fishing (based on the satellite data) was therefore not possible.

55. The sightings data showed two key forms of fishing: demersal trawling occurring mainly to the south-west of the Wind Farm Area, and scallop dredging largely concentrated to the north-east. No vessels were sighted within the Wind Farm Area itself.

11.6.1.2.4 Recreational Vessels

56. Approximately one recreational vessel per day was recorded during the summer 2016 survey period, none of which intersected the Wind Farm Area (no recreational vessels were recorded during winter). It is noted that during the vessel based survey undertaken in 2010, a recreational vessel not broadcasting on AIS was recorded within the Wind Farm Area via radar, and that vessels not broadcasting on AIS are not accounted for within the AIS data. A general upwards trend in voluntary AIS broadcast by recreational vessels has been observed since 2010/11; however, it is nonetheless considered likely that the AIS data alone still underrepresents actual traffic levels.

57. The RYA Coastal Atlas (RYA, 2016), shows the Wind Farm Area to be of low recreational density when compared to coastal areas, as shown in Figure 11.7, Volume 2. This correlates well with the findings of the marine traffic surveys. The Coastal Atlas also notes a general boating area associated with the Firth of Tay located approximately 6 NM to the northwest of the Wind Farm Area.

11.6.2 Development of Baseline Conditions without the Project

11.6.2.1 Commercial Traffic

58. The main, established routes within the study areas are those associated with the Firth of Forth. Based on the navigable sea area in which vessels can transit within the Forth, and the presence of the Isle of May within its entrance, significant changes to the positions (mean or percentile) of these routes within the study areas are not considered likely. Vessel levels may vary depending on import/export demand.

11.6.2.2 Anchoring Vessels

59. Established anchoring activity by tankers within the study areas can be expected to continue. As the tankers are not using a charted anchorage, but rather a known preferred anchoring area, there is the potential for these vessels to anchor in different positions within the general vicinity; however, significant changes are not expected. It should be noted that vessels may anchor where they choose, assuming there are no charted restrictions.

11.6.2.3 Fishing Vessels

60. Fishing activity can vary on both a seasonal and annual basis and is dependent on a number of factors, including weather, fish migration, and quota fulfilment. For this reason it is difficult to predict future

fishing patterns within the study areas, however it can be assumed that if fish are available within the study areas, then fishing will continue to occur.

11.6.2.4 Recreational Vessels

61. Significant changes to recreational activity are not anticipated, however it should be noted that there is a general upwards trend in the uptake of voluntary AIS broadcast from small recreational vessels. Any future marine traffic surveys may therefore show increased recreational activity to that observed within the (AIS only) 2016 marine traffic survey.

11.7 Design Envelope – Worst Case Design Scenario

62. The Application is for the construction, operation and decommissioning of an offshore wind farm with a maximum output of 450 MW, comprising a maximum of 54 turbines. The assessment scenarios identified in respect of Shipping and Navigation, for those issues scoped into the assessment, have been selected as those having potential to represent the greatest effect on an identified receptor based on the Design Envelope described in Chapter 4: Project Description. The worst case design scenarios are set out in Table 11-6.

Table 11-6: Design envelope scenario assessed

Potential Impact	Worst Case Design Scenario	Justification
Operation and Maintenance		
Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased collision risk (vessel-to-vessel)	Maximum number of turbines installed (54) Maximum number of OSPs installed (2) 800m minimum spacing Minimum blade clearance of 35 m above lowest astronomical tide (LAT) which is in excess of the 22m above Mean High Water Springs (MHWS) required for marine regulators.	The maximum number of structures will create the largest area from which vessels may be displaced. It is noted that while commercial vessels are likely to avoid travelling through the Wind Farm Area, and hence are only impacted by the periphery turbines, smaller vessels (e.g., fishing, recreation) could be impacted by the structures.
Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased allision risk (vessel-to-structure)	Maximum number of turbines installed (54) Maximum number of OSPs installed (2) 800m minimum spacing Minimum blade clearance of 35 m above lowest astronomical tide (LAT) which is in excess of the 22m above MHWS required for marine regulators.	The maximum number of structures will create the largest surface area into which a vessel could allide.

11.7.1 Embedded Mitigation

63. Embedded mitigation measures to minimise the potential effects on shipping and navigation are captured within the Project design envelope. The scoping of the assessment of effects on shipping and navigation, has taken account of the embedded mitigation measures set out in Table 11-7.

64. In the event that further mitigation is required that cannot be embedded into the Project, this has been included as additional mitigation and is set out in Section 11.9.

65. It is noted that construction and decommissioning impacts have been scoped out of the EIA (see Section 11.4). However, as the embedded mitigation formed a key assumption within the scoping process (combined with impacts already assessed as being of minor significance within the Original ES), the embedded mitigation within these phases has been included in the table.

Table 11-7: Embedded mitigation relating to Shipping and Navigation

Parameter	Embedded Mitigation
Construction	
Information Circulation	Appropriate liaison to ensure information on the construction of the Offshore Wind Farm is circulated in Notice to Mariners, Kingfisher Bulletin, Navigation Information Broadcasts and other appropriate media. As part of the Notice to Mariners process the information will be supplied to Imray publications.
Navigational Chart Marking	While construction work is in progress, Admiralty Charts will provide a note over the Wind Farm Area stating as such including position of construction buoyage.
Lighting and Marking	The Project construction works will be marked in line with IALA-O136, and as agreed with NLB, MCA and the Civil Aviation Authority (CAA).
Compliance with relevant MCA Guidance (MGN 543 and Annexes)	The Project will be designed in compliance with MGN543. Annex 5 (Requirements, Guidance and Operational Considerations for Search and Rescue) specifies *"Standards and procedures for generator shutdown and other operational requirements in the event of a SAR, counter pollution or salvage incident in or around an OREI."*
Formulation of an ERCoP as per MCA template	Creation of an ERCoP based on the MCA template and Project Safety Management Systems (SMS), in consultation with the MCA. Procedures will be followed in the event of an emergency situation during the construction phase.
Onshore Operations Base	The onshore operations base will also serve as a Marine Control Centre that will monitor vessel activity (AIS and non-AIS) and record the movements of vessels around the Wind Farm Area as well as infield (company) vessels working at the Offshore Wind Farm. Possible errant vessels identified in construction areas or safety zones will be identified and contacted.
Safety zones and guard vessels	Construction safety zones of 500 m around major activities will be in place to exclude vessels not associated with the construction works for the Offshore Wind Farm. Guard vessels, or another nominated vessel, will be used to monitor passing traffic and contact vessels, which could infringe the safety zones. 50 m pre-commissioning safety zones may also be included. Minimum safe passing distance may be requested by vessels where safety zones are not applicable.
Operation and Maintenance	
Marked on Admiralty Charts	The Project will be charted by the UKHO using the magenta turbine tower chart symbol found in the publication NP5011 - *Symbols and Abbreviations used in Admiralty Charts* (UKHO, 2016a). The buried, subsea cables associated with the Project will also be charted on the appropriate scale charts. Offshore Export Cables will be charted by the UK Hydrographic Office on the appropriate scale charts who may provide a note on the charts to state no anchorage areas over charted cables.
Information Circulation	Appropriate liaison to ensure information on any major maintenance of the wind farm is circulated in Notice to Mariners, Kingfisher Bulletin, Navigation Information Broadcasts and other appropriate media.

Parameter	Embedded Mitigation
Lighting and Marking	During the operational phase, the Project will be marked in line with IALA-O136, and as agreed with NLB, MCA and CAA.
Turbine Air Draught	Lowest point of rotor sweep is a minimum of 35m above LAT which is in line with the MCA and RYA recommendation of 22 m above MHWS.
Cable protection (inter-array and Offshore Export Cable)	Cables will be protected appropriately taking into account fishing and anchoring practices. Positions of the cable routes notified to Kingfisher Information Services – Offshore Renewables Cable Awareness (KIS - ORCA) for inclusion in cable awareness charts and plotters for the fishing industry.
Compliance with relevant MCA Guidance (MGN 543 and Annexes)	The Project will be operated as required in MGN543. Annex 5 (Requirements, Guidance and Operational Considerations for Search and Rescue) specifies *Standards and procedures for generator shutdown and other operational requirements in the event of a SAR, counter pollution or salvage incident in or around an OREI*.
Formulation of an Emergency Response Co-operation Plan as per MCA template	Creation of an ERCoP based on the MCA template and Project SMS, in consultation with the MCA. Procedures will be the followed in the event of an emergency situation during the operational phase.
Subsea surveys of cables and burial depths	Periodic and planned surveys of cable to monitor burial depths/protection and seabed mobility (cable movement).
Safety zones and guard vessels	Safety zones of 500 m around major maintenance activities to exclude vessels not associated with the works from the offshore site. Guard vessels, or another nominated vessel, will be used to monitor passing traffic and contact vessels, which could infringe the safety zones. Minimum safe passing distance may be requested by vessels where safety zones are not applicable.
Decommissioning	
Information Circulation	Appropriate liaison to ensure information on the decommissioning of the Offshore Wind Farm is circulated in Notice to Mariners, Kingfisher Bulletin, Navigation Information Broadcasts and other appropriate media.
Lighting and Marking	During the decommissioning phase, all structures will be lit and marked in agreement with NLB. Should any structures be left in situ, consideration will be given to lighting and marking, again in agreement with NLB.
Cable Protection and Monitoring	Cable protection and monitoring of any cables left in situ will be agreed in advance of decommissioning taking place.
Safety Zones and Guard Vessels	Safety zones of 500 m around certain decommissioning activities (where necessary) to exclude vessels not associated with the works from the Development Area. Guard vessels or another nominated vessel will be used to monitor passing traffic and contact vessels, which could infringe the safety zones.

11.7.2 Anticipated Consent Conditions Commitments

66. A number of consent conditions were attached to The Consents to manage the environmental risk associated with the Originally Consented Project. NnGOWL anticipate that any future consents issued to the Project may incorporate similar conditions to manage the risk to shipping and navigation commensurate with the Project design envelope where it remains necessary to do so. Table 11-8 sets out the conditions attached to The Consents for the Originally Consented Project which have some relevance to the management of effects on shipping and navigation.

Table 11-8: Consent conditions for the Originally Consented Project relevant to Shipping and Navigation

Original Consent Requirement	Relevance to shipping and navigation	Relevant project phase
Construction Method Statement	Requires the final construction methods to be set out for approval to ensure that they remain consistent with the methods assessed in the Project ES and to ensure appropriate construction management taking into account mitigation measures to protect the environment and other users of the marine area.	Construction
Development Specification and Layout Plan	Setting out, for approval, the final design and layout of the Project to ensure it remains consistent with the design assessed in the ES as relevant to shipping and navigation.	Construction
Vessel Management Plan	Setting out, for approval, the number and types of vessels, vessel management practices, port and harbour locations, and transit routes relevant to the Project.	Construction and Operation and Maintenance
Navigational Safety Plan	Setting out, for approval, the navigational safety measures to mitigate navigational risk of other marine users operating in the area.	Construction and Operation and Maintenance
Cable Plan	Setting out, for approval, the location and installation methods for the cables (including burial) to ensure they remain consistent with the installation process assessed in the ES, as relevant to Shipping and Navigation.	Construction and Operation and Maintenance
Lighting and Marking Plan	Setting out, for approval, the navigational lighting strategy to be installed at the site to ensure safe marking of the structures and Development Area to mitigate the navigational risk to other marine users.	Construction and Operation and Maintenance
Navigational Safety (Construction)	Notify the UKHO prior to the commencement of construction to facilitate the promulgation of maritime safety information and updating of nautical charts and publications through the national Notice to Mariners System. Issue local Notice to Mariners to ensure local mariners, fishermen's organisations and HM coastguard are aware of the Licensable Marine Activity. Consult with local harbour masters as appropriate. Ensure that details of the works are promulgated in the Kingfisher Fortnightly Bulletin [KIS-ORCA], prior to the commencement of the works to inform the Sea Fish industry of vessel routes, timings and the locations of Project Activities.	Construction
Markings, lighting and signals of the Works	Ensure that the Project is lit in accordance with the requirements of the relevant statutory stakeholders including marking of the site with appropriate construction buoyage during construction and continued lighting of the site following completion of construction as required by the MCA and NLB.	Construction and Operation and Maintenance
Markings, lighting and signals of the Works	Ensure that any vessels engaging in the work are marked in accordance with the International Rules for the Prevention of Collisions at Sea if under way and in accordance with the UK Standard Marking Schedule for Offshore Installations if secured to the seabed.	Construction
Navigational Safety (Operation)	Ensure appropriate notifications are made following completion of the works to all relevant stakeholders including UKHO, the Maritime Rescue and Coordination Centre Aberdeen and all mariners and fishermen's organisations. Ensure appropriate notifications are made through the Kingfisher Fortnightly Bulletin to inform the Sea Fish Industry.	Operation and Maintenance

Original Consent Requirement	Relevance to shipping and navigation	Relevant project phase
Marine Pollution Contingency Plan	Setting out, for approval, relevant management measures to mitigate risk of accidental spills and subsequent remedial action, response measures relating to spills and collision incidents and practices used to refuel vessels at sea if relevant.	Construction and Operation and Maintenance

11.8 Impact Assessment

11.8.1 Construction Phase Impacts

67. All impacts relevant to the construction phase have been scoped out of this EIA Report (see Section 11.4).

11.8.2 Operational and Maintenance Phase Impacts

68. The impacts resulting from the operation and maintenance of the Project have been assessed on Shipping and Navigation receptors identified within the study areas and for those issues scoped into the assessment. A discussion of the likely significance of each effect resulting from each of the impacts scoped into the EIA is presented below.

11.8.2.1 Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased collision risk (vessel-to-vessel)

69. The physical presence of the structures within the Wind Farm Area may displace any pre-existing vessel activity, including commercial vessels, recreational activity, and fishing activity. This could increase vessel density in the surrounding area, leading to an increase in vessel-to-vessel collision risk.

11.8.2.1.1 Commercial Traffic

70. Past experience has shown that commercial vessels will not transit through and between offshore wind turbines, instead choosing to deviate in advance to avoid the structures altogether. This may lead to an increase in vessel density inshore of the Wind Farm Area from traffic either accessing or exiting the Firths of Forth Tay, which may increase the risk of a collision. It should be considered that the sea room in this inshore area is limited by the shore, and that there may be pre-existing marine activity in these coastal areas (e.g. fishing or recreational), which may further increase the collision risk.

71. Vessels using the area for transit only (i.e. those vessels whose destination and origin ports both lie elsewhere) are considered likely to pass east of the Wind Farm Area, rather than inshore, where there is ample sea room for safe navigation and where fishing and recreational activity would be expected to be less than those areas inshore of the Wind Farm Area. Any rise in collision risk associated with these commercial vessels is therefore anticipated to be minimal.

72. Two commercial routes were identified as intersecting the Wind Farm Area and both will therefore be required to re-route. However, as shown in Appendix 11.2, neither deviation is expected to be significant.

73. Within the modelling undertaken in the NRA (Appendix 11.1), vessel to vessel collision rates were estimated at approximately one collision per 900 years. It is also noted that no 'Collision' incidents were recorded within the MAIB or RNLI incident data assessed as part of the baseline. However, 'Hazardous Incidents' involving two vessels were recorded.

74. With the embedded mitigation in place such as promulgation of information via notice to mariners and the marking of the structures on Admiralty Charts, it is assumed that commercial vessels will be aware of the presence of the Project by the operational and maintenance phase (noting that during the

construction phase displacement impacts will be managed by the embedded mitigation listed in Table 11-7), and hence be able to effectively passage plan. This will ensure they passage plan in advance and are able to avoid the Wind Farm Area safely, taking into account the limited sea room inshore of the Wind Farm Area and any pre-existing activity.

75. On this basis, and taking into account the collision modelling undertaken in the NRA, the magnitude is considered to be **low** given the limited number of routes impacted and minor shift in baseline conditions, and sensitivity is considered to be **low** due to the available navigable sea room. This impact is therefore estimated to be of **minor significance** to commercial vessels, and not significant in EIA terms.

11.8.2.1.2 Fishing Vessels

76. Based on the marine traffic surveys, fishing activity was observed within the Wind Farm Study Area; however (based purely on the available marine traffic data), fishing vessels within the Wind Farm Area were considered likely to be in transit, rather than actively fishing. It should be noted that fishing is highly seasonal and can also vary on an annual basis and fishing will therefore occur within the Wind Farm Area during other periods of the year. Chapter 10: Commercial Fisheries provides a more detailed long term assessment of fishing activity and discusses the extent to which fishing takes place within the Wind Farm Area.

77. During the operational phase there will be no restrictions on fishing vessels entering into the Wind Farm Area (except during periods of major maintenance, when localised safety zones may be employed) and fishing vessels may therefore continue to transit the Wind Farm Area if they choose. Fishing vessel activity was observed to be busiest to the south-west of the Wind Farm Area and notable activity was also observed to the west of Fife Ness. These areas may see a small increase in commercial traffic density from those vessels deviating inshore of the Wind Farm Area (as discussed in section11.8.2.1.1), which may increase the risk of a collision.

78. As information on the Project will be promulgated to relevant stakeholders (including through Kingfisher Bulletins aimed at fishermen), it has been assumed that both fishing vessels and commercial traffic will be aware of the potential for increased traffic inshore of the Wind Farm Area. It is also assumed that by the operational phase, regular fishing users of the area will be aware of how commercial traffic patterns have adapted as a result of the construction phase of the Project and vice versa (noting that embedded mitigation will manage displacement risks to fishing vessels during the construction phase).

79. The magnitude is considered to be **low** given the limited number of fishing vessel transits and the sensitivity is considered to be **low** given the available navigable sea room. The impact to fishing vessels is therefore assessed to be of **minor significance** and not significant in EIA terms.

11.8.2.1.3 Recreational Vessels

80. As with fishing vessels, recreational vessels may still freely transit the Wind Farm Area post-construction, (except during periods of major maintenance, when localised safety zones may be employed). No significant displacement impact is therefore anticipated. However, there may be an increased collision risk to recreational vessels using the area inshore of the Wind Farm Area, arising from an increase in commercial vessels created by commercial traffic deviating to avoid the Wind Farm Area.

81. The prospect of a recreational user being unfamiliar with the area is more likely than an unfamiliar fishing user, and it should also be considered that some recreational users may lack marine experience. However based on the findings of the marine traffic survey, the majority of recreational activity in the area is expected to be coastal, and unaffected by the Wind Farm Area.

82. The magnitude is considered to be **low** given the limited number of recreational routes affected, and the sensitivity is considered to be **low** given the available navigable sea room. The impact to recreational vessels is therefore assessed to be **minor significance** and not significant in EIA terms.

11.8.2.2 Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased allision risk (vessel-to-structure)

83. The physical presence of the structures within the Wind Farm Area create an allision risk (vessel-to-structure) to passing traffic, including commercial vessels, fishing vessels and recreational vessels.

11.8.2.2.1 Commercial Vessels

84. Commercial vessels are unlikely to choose to transit through the Wind Farm Area and will instead passage plan in advance to avoid the structures altogether. Therefore, any allision risk from commercial traffic is anticipated to be from vessels outside of the Wind Farm Area. This could be from a vessel under power at the time entering the Wind Farm Area unintentionally, or from a drifting vessel (engine failure) not under command. An allision between a vessel and a turbine or substation could lead to damage to both the vessel and the structure, and there is also the potential for a pollution spill (either fuel or cargo).

85. Allision modelling was undertaken as part of the NRA (Appendix 11.1) to estimate the likelihood of a vessel allision with a structure. Powered allision rates were estimated at one per 7,700 years, while an allision from a vessel not under command (i.e. a drifting vessel) was estimated to occur once every 31,000 years.

86. Based on this, and the embedded mitigation in place (lighting and marking, marking on charts, information circulation), the magnitude is considered to be **low** given the small number of routes impacted, and sensitivity is considered to be **low** given the available navigable sea room. The impact is therefore assessed to be of **minor significance** to commercial vessels, and not significant in EIA terms.

11.8.2.2.2 Fishing Vessels

87. Fishing vessels may choose to transit the Wind Farm Area during the operational phase, and there is therefore an increased risk of an allision from a vessel with the structures themselves. Based on the relatively small size of a fishing vessel, when compared to a commercial vessel, the primary concern in an allision situation would be for the safety of the vessel and crew, rather than damage to the structure, which would likely be superficial. However, it is considered likely that any fishing vessel within the Wind Farm Area would be transiting at a speed unlikely to result in a serious allision, with minor damage to the vessel and structure considered to be the most likely outcome.

88. Fishing vessel specific allision modelling undertaken in the NRA (Appendix 11.1) estimated a fishing vessel would contact a structure once every 53 years.

89. Based on this relatively high frequency, the magnitude is considered to be **medium** given the number of fishing transit impacts, with sensitivity assessed as **low** given the minor change in baseline conditions. The impact to fishing vessels is therefore assessed to be of **minor significance** and not significant in EIA terms.

11.8.2.2.3 Recreational Vessels

90. An allision scenario for a recreational vessel is likely to be similar to that of a fishing vessel, based on the relatively small hull size when compared to a commercial vessel. However, it should be considered that recreational users may be inexperienced, or even if they are experienced, may choose to approach the structures within the Wind Farm Area out of curiosity.

91. However, with embedded mitigation in place (notably that blade clearance will exceed the 22m above MHWS requirement of the MCA and RYA), and the likelihood that any contact between a recreational vessel and wind farm structure is likely to be a low speed interaction, the magnitude is assessed to be **low** given the number of routes impacts, with sensitivity assessed as **low** given the minor change compared to baseline conditions. The impact to recreational vessels is therefore assessed to be of **minor significance** and not significant in EIA terms.

11.8.3 Decommissioning Phase Impacts

92. Impacts from decommissioning are anticipated to be similar to those assessed during construction during the period that infrastructure is removed from the seabed at the end of the Project's operational life. Effects resulting from decommissioning activities on Shipping and Navigation receptors would therefore be expected to be no greater than during the construction phase which have been scoped out of the EIA.

11.8.4 Cumulative Impacts

93. Cumulative effects refer to effects upon receptors arising from the Project when considered alongside other proposed developments, activities and any other reasonably foreseeable project(s) proposals. In this context, the term 'projects' is considered to refer to any project with comparable effects and is not limited to offshore wind projects.

94. Projects and activities considered within the shipping and navigation cumulative impact assessment are set out in Table 11-9[3]. There may be an element of uncertainty associated with the design envelope of proposed projects; therefore, a judgement is made on the confidence associated with the latest available design envelope.

95. In assessing the cumulative impacts for the Project, two scenarios are considered to take into account the consented design envelopes of the Inch Cape Offshore Wind Farm and the Seagreen Offshore Wind Farm Projects (Table 11-10).

96. Scenario one incorporates the design envelopes for the proposed Inch Cape and Seagreen projects as detailed in the Scoping Reports submitted to MS-LOT (ICOL, 2017; Seagreen, 2017). Scenario two incorporates the consented design envelopes as detailed in the respective project consents.

Table 11-9: Projects for cumulative assessment – shipping and navigation

Development Type	Project	Status	Data Confidence Assessment / Phase
Offshore Wind Farm	Inch Cape Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Inch Cape Offshore Wind Farm - revised design	Proposed	High – project details in the Scoping Report and additional information provided by the Developer.
Offshore Wind Farm	Seagreen Alpha and Bravo	Consented	High – Consented project details available.
Offshore Wind Farm	Seagreen Phase 1- revised design	Proposed	High – project details in the Scoping Report and additional information provided by the Developer.
Offshore Wind Farm	Kincardine Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	European Offshore Wind Deployment Centre	Under construction	High – final development within public domain.

[3] It is noted that the Scoping Opinion states only the Seagreen and Inch Cape developments are required to be considered in the cumulative section. However, given the potential for vessel routeing to be cumulatively affected by developments further afield, the additional wind farm projects presented in the table have also been included as per the methodology agreed for Shipping and Navigation.

Development Type	Project	Status	Data Confidence Assessment / Phase
Offshore Wind Farm	Hywind Pilot Park	Operational	High – wind farm is commissioned and operational.
Offshore Wind Farm	Blyth Offshore Demonstrator Wind Farm	Construction / Pre- commissioning	High – final development within public domain.
Offshore Wind Farm	Beatrice Offshore Wind Farm	Under Construction	High - final development within public domain.
Offshore Wind Farm	Moray East	Consented	High - final development within public domain.
Offshore Wind Farm	Moray West	Planned	Medium – proposed, scoping opinion requested. Published project information available in the public domain.

Table 11-10: Cumulative worst case design scenario

Impact	Worst Case Design Scenario	Justification
Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased collision risk (vessel-to-vessel)	9 offshore wind farm developments, assuming maximum build out in each Development Area.	The outcome of the cumulative assessment will be greatest when the greatest number of other schemes, present or planned, are considered. The assessment is based on deviation around the development areas of the respective projects as the worst case scenario.
Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased allision risk (vessel-to-structure)		

11.8.4.1 Cumulative Impacts – Operational Phase

11.8.4.1.1 Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased collision risk (vessel-to-vessel)

97. The key cumulative impact of wind farms on Shipping and Navigation receptors is the displacement of established vessel routeing. The reduction in sea room resulting from the presence of multiple offshore wind farms may lead to increases in vessel density as multiple vessel routes are displaced into similar transit patterns to avoid the multiple developments. These areas of increased density may increase the risk of a vessel-to-vessel collision, particularly if the routes are displaced into areas of pre-existing vessel activity (for example fishing or recreation).

Commercial Traffic

98. The marine traffic survey identified two routes, which will be displaced by the presence of the Wind Farm Area (see Appendix 11.2). It has been assumed that the Firth of Tay route will pass south of the

Wind Farm Area post construction (and therefore also south of both the Inch Cape and Seagreen projects), and is not expected to be significantly impacted on a cumulative basis. The route between the Humber and Northern Scottish ports is likely to pass in between Inch Cape and Seagreen, and to the east of the Wind Farm Area.

99. The results of the hazard workshop (Appendix 11.1) indicated that smaller commercial vessels and tankers in the area are likely to be on tight time schedules and will seek the fastest route to transit the area. It is assumed that the majority of such vessel masters will be familiar with the Project during the operational phase (including through promulgation of information and nautical chart updates) and will be able to passage plan in advance, accommodating the offshore wind farms in the Firth of Forth and Tay region.

100. The presence of multiple wind farms will lead to an increase in the length of deviations, create a reduction in the available sea room and therefore increase commercial vessel density between and surrounding the arrays. The collision risk within these areas are therefore expected to rise, particularly in cases where there is pre-existing vessel activity (e.g., fishing or recreational).

Fishing Vessels

101. Based on the marine traffic survey data, and the additional assessment provided in Chapter 10: Commercial Fisheries, fishing vessels both transit and actively fish within the Wind Farm Area, and the surrounding waters. Once the Forth and Tay wind farms are operational, fishing vessels will be able to transit through the array structures (as per their own passage plans taking into accounts conditions) and there is therefore not expected to be a significant displacement impact to fishing vessels in transit from a cumulative perspective (see Chapter 10: Commercial Fisheries for impacts to vessels engaged in active fishing).

Recreational Vessels

102. Similarly to fishing vessels, recreational vessels will be free to transit through operational wind farms (as per their on passage plans taking into accounts conditions) and therefore no significant displacement impact is expected (particularly as recreational traffic was observed to be largely coastal in the baseline).

Significance

103. Based on the potential for reduced sea room and subsequent increased collision risk associated with displacement and routeing associated with all the cumulative developments, the magnitude of this impact is assessed to be **medium**. This is due to the size of the alterations when considered against those associated with the project in isolation. The sensitivity assessed as **medium** given the potential for the loss or reduction in key navigational routes within the area (Firth of Forth and Firth of Tay routes) used by a variety of vessel types and sizes. The cumulative displacement and collision impact is therefore assessed to be, with embedded mitigation in place, of **moderate significance** and significant in EIA terms.

11.8.4.1.2 Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased allision risk (vessel-to-structure)

104. The presence of multiple offshore wind farms along the Scottish East coast will increase the risk of a vessel-to-structure allision. In particular, the arrangement of the offshore wind farms in the Firth of Forth and Tay region creates situations where vessels may transit in between two sets of turbines associated with separate projects (such as those between the Project and Inch Cape, or between Inch Cape and Seagreen). Should a vessel suffer engine failure within one of these ’corridors’, or if a vessel is required to take avoidance action to avoid a collision, then there will be allision risks either side of the vessel and thus an increase in allision risk.

Commercial Vessels

105. As commercial vessels will avoid entering into wind farm arrays, any allision risk is expected to be from commercial traffic passing outside of the structures. High risk areas are therefore the aforementioned 'corridors' between wind farms, as allision risks border both sides of the corridor. It is also noted that commercial vessels will have less ability to manoeuvre within such corridors in an emergency situation than that of smaller vessels (such as fishing or recreational vessels).

Fishing Vessels

106. It is likely that fishing vessels will transit through wind farm arrays once operational (as per their on passage plans taking into account conditions), and there will therefore be an increased allision risk to such vessels once multiple wind farms are active within the Forth Zone. Fishing vessels navigating within the arrays or between projects will be subject to a small increase in cumulative allision risk associated with exposure to turbines on either side.

Recreational Vessels

107. The cumulative allision risk for recreational vessels is considered similar to that of fishing vessels, with allision scenarios most likely for those vessels transiting through wind farm arrays or between projects.

Significance

108. The magnitude is assessed to be **medium** given that all vessel types and sizes will be affected, with sensitivity also assessed as **medium** given that the increased risk is associated with key routes and activities located within the Firth of Forth and Tay area. The allision impact is therefore assessed, with embedded mitigation in place, to be of **moderate significance** (and significant in EIA terms) when considered on a cumulative basis.

11.8.5 Inter-relationships

11.8.5.1 Commercial Fisheries

109. The assessment in this chapter considers allision and collision risk to fishing vessels in transit (as opposed to fishing vessels engaged in fishing) during the operational phase of the Project. Impacts associated with fishing vessels actively engaged in fishing are considered in Chapter 10: Commercial Fisheries.

11.9 Mitigation and Monitoring

110. The assessment of impacts, in isolation, on Shipping and Navigation receptors as a result of the construction, operation and decommissioning of the Project are predicted to be of minor significance (noting that construction and decommissioning impacts were scoped out of this assessment on the basis that they were already assessed as part of the Original ES). Based on the predicted effects it is concluded that no specific additional mitigation is required beyond the embedded mitigation set out in Section 11.7.1 for the Project alone or cumulatively.

111. The assessment of impacts, cumulatively with other Forth and Tay wind farm projects determined that there is potential for significant effects during operation as a result of reduction in navigable sea room leading to greater risk of vessel to vessel collision or vessel to structure allision. The assessment assumes maximum build out scenarios of the Inch Cape and Seagreen projects. NnGOWL propose to consult with the MCA and NLB and other stakeholders to identify appropriate further mitigation as required. Further mitigation may include additional aids to navigation to assist internal navigation and additional means of communication to assist third parties throughout the operational phase of the Project, such as, marine coordination facilities, offshore VHF aerials and AIS transceivers/receivers.

11.9.1 Monitoring

1.1.1.1 Traffic Monitoring

112. Appendix 11.2 provides an indication of the rerouting that may occur as a result of the Project. However, it is recommended that marine traffic is monitored via AIS post-construction to ensure actual changes in shipping behaviour resulting from the Wind Farm Area can be fully understood. This will serve to confirm deviated routeing, and will also provide an indication of any vessel activity occurring within the Wind Farm Area.

11.10 Summary of Residual Effects

113. This chapter has assessed the potential effects on Shipping and Navigation of the construction, operation and decommissioning of the Project, both in isolation and cumulatively and for those impacts scoped into this EIA. No effects greater than minor significance were identified for the Project alone, whilst cumulative effects were predicted to be of moderate significance

114. Table 11-11 summarises the impact determinations discussed in this chapter and presents the post-mitigation residual significance.

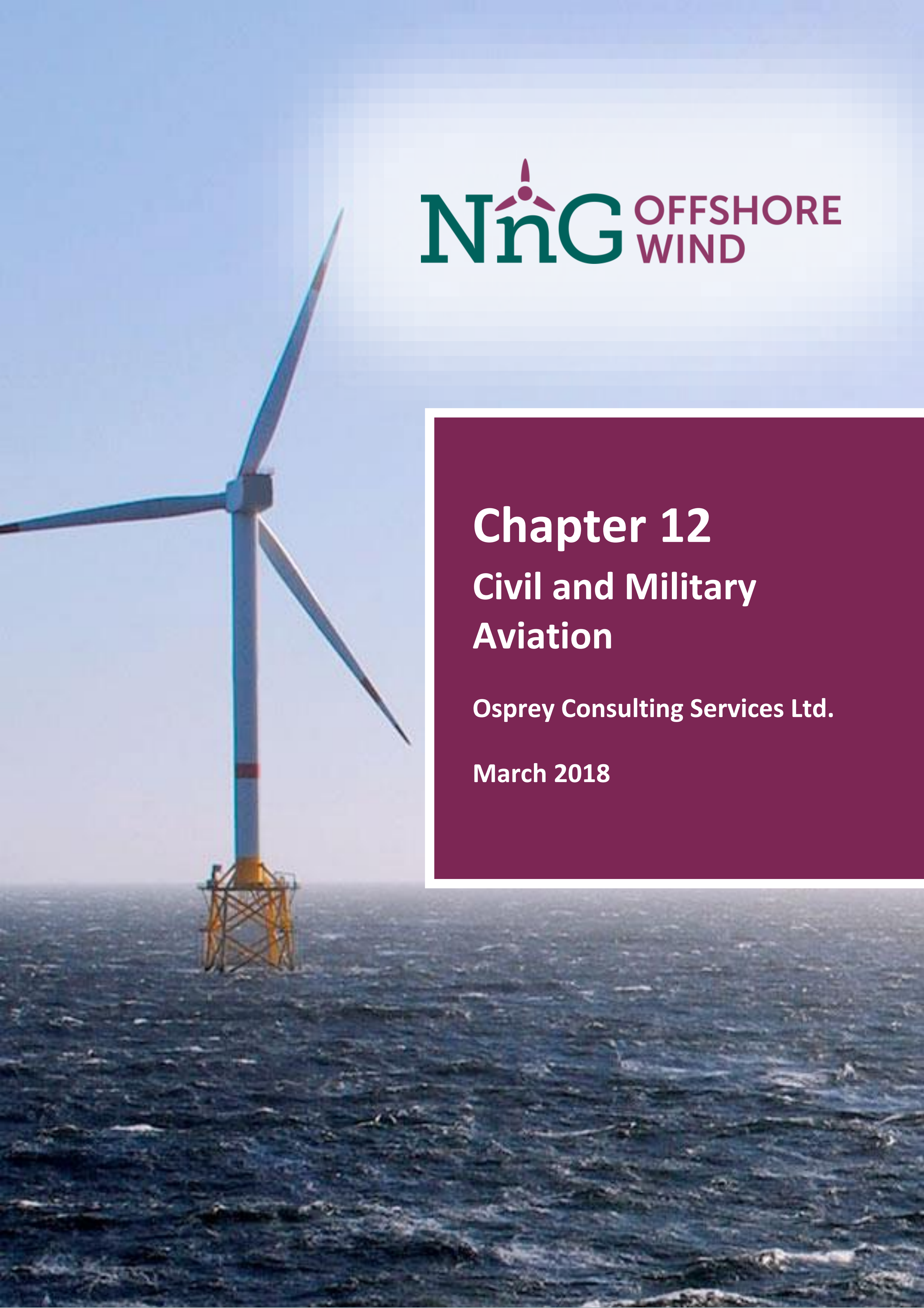
Table 11-11: Summary of predicted impacts of the Project

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Operation			
Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased collision risk (vessel-to-vessel)	*Commercial Vessels:* **Minor Significance** *Fishing Vessels:* **Minor Significance** *Recreational Vessels:* **Minor Significance**	n/a	*Commercial Vessels:* **Minor Significance** *Fishing Vessels:* **Minor Significance** *Recreational Vessels:* **Minor Significance**
Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased allision risk (vessel-to-structure)	Commercial Vessels: **Minor Significance** Fishing Vessels: **Minor Significance** Recreational Vessels: **Minor Significance**	n/a	Commercial Vessels: **Minor Significance** Fishing Vessels: **Minor Significance** Recreational Vessels: **Minor Significance**
Cumulative Effects			
Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased collision risk (vessel-to-vessel)	**Moderate Significance** for all vessel types.	To be considered in consultation with MCA and NLB. May include additional aids to navigation to assist with navigation and additional means of communication to assist third parties.	**Moderate Significance**
Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea	**Moderate Significance** for all vessel types.	To be considered in consultation with MCA and NLB.	**Moderate Significance**

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
room and deviations around structures resulting in an increased allision risk (vessel-to-structure)		May include additional aids to navigation to assist with navigation and additional means of communication to assist third parties.	

11.11 References

- IALA (2013) *Recommendations O-139 on the Marking of Man-Made Structures*. Edition 2. December 2013.
- ICOL (2017) *Revised Design Scoping Report*.
- IMO, (2002) *Formal Safety Assessment Process*.
- MCA (2008) *MGN372 (M+F) Guidance to Mariners Operating in the Vicinity of United Kingdom (UK) Offshore Renewable Energy Installations*.
- MCA (2015) *Methodology for Assessment Marine Navigational Risk.*
- MCA (2016) *MGN543 (M+F) Safety of Navigation: Offshore Renewable Energy Installations – Guidance on UK Navigational Practise, Safety, and Emergency Response*. 2016
- RYA (2013) *The RYA's Position on Offshore Renewable Energy Developments: Paper 1 – Wind Energy*. 2013
- RYA (2016) *Coastal Atlas*.
- Seagreen (2017) *Revised Design Scoping Report.*
- UKHO (2016a) *Admiralty Sailing Directions, North Sea (West) Pilot, NP54*. 10th Edition. 2016
- UKHO (2016b) *Symbols and Abbreviations used on Admiralty Paper Charts, NP5011*. 6th Edition. 2016



Chapter 12

Civil and Military Aviation

Osprey Consulting Services Ltd.

March 2018

Table of Contents

Table of Figures

Table of Illustrations

Table of Tables

12 Civil and Military Aviation

12.1 Introduction

1. This chapter of the EIA Report presents an assessment of the potential impacts upon aviation arising from the construction, operation and decommissioning of the Project, as detailed in Chapter 4: Project Description.

2. The assessment is based upon a combination of the understanding of the Project in terms of the potential for impact and the resultant effects on receptors through the evaluation of existing data sources, desk studies and consultation with key stakeholders.

3. This chapter is comprised of the following elements:

- A summary of relevant legislation, policy and guidance;
- Details of the data sources used to characterise the study area;
- A summary of the relevant consultations with stakeholders;
- A description of the methodology for assessing the impacts of the Project, including details of the study area and approach to the assessment of potential effects;
- A review of the baseline conditions;
- A description of the worst-case design scenario relevant to aviation;
- An assessment of the likely effects for the construction, operation and decommissioning phases of the Project, including cumulative and in-combination effects;
- Identification of any further mitigation measures or monitoring requirements in respect of any significant effects; and
- A summary of the residual impact assessment determinations taking account of any additional mitigation measures identified.

This chapter is supported by one appendix which is contained within Volume 4 of this EIA Report:

- Appendix 12.1: Radar Line of Sight Analysis.

12.2 Relevant Legislation, Policy and Guidance

4. The assessment of potential impacts on aviation has been undertaken with specific reference to The Scottish Planning Policy (SPP). Paragraph 169 of SPP notes that considerations in the determination of applications for energy infrastructure developments are likely to include impacts on aviation and defence interests.

5. A variety of aviation publications contain guidance and information relating to the potential effects of wind energy development on aviation stakeholders. The Civil Aviation Authority (CAA) publishes a number of guidance documents in the form of Civil Aviation Publications (CAP). Those relevant, and which contain information and guidance relating to the potential effects of wind energy development on aviation stakeholders are outlined in Table 12.1 below.

Table 12.1: Guidance and Policy Context - Aviation.

Relevant guidance	Purpose	Relevance to the Project
CAP 393: The Air Navigation Order 2016 and Regulations (CAA, 2017)	The document sets out the provisions of the Air Navigation Order as amended together with regulations made under the Order. It is prepared for those concerned with day to day matters relating to air navigation that require an up to date version of the air navigation regulations. CAP 393 also includes application of aviation obstruction lighting to wind turbines in UK territorial waters.	The Project will be fitted with aviation lighting, which will be incorporated into the design of the Project as embedded mitigation and will be submitted to Marine Scotland for approval post-consent in the Lighting and Marking Plan. Section 12.7.1 provides further information on the guidance provided by the CAA.
CAP 437: Standards for Offshore Helicopter Landing Areas (CAA, 2016a)	The criteria applied by the CAA in assessing helicopter landing areas for worldwide use by helicopters registered in the UK. It includes design of winching area arrangements located on turbine platforms to represent current best practice.	There will be no helicopter landing areas provided within the Development Area. However, the wind turbines will be fitted with helihoist platforms on the roof of the nacelle. The Offshore Substation Platforms (OSPs) will also include helihoist platforms. Section 12.7.1 provides further information on the guidance provided by the CAA.
CAP 670: Air Traffic Services Safety Requirements (CAA, 2014a)	Sets out the safety regulatory framework and requirements associated with the provision of an ATS.	Consideration of impacts is contained within section 12.8; mitigation is contained in section 12.9.
CAP 764: Policy and Guidance on Wind Turbines (CAA, 2016b)	Provides assistance to aviation stakeholders to help understand and address wind energy related issues, thereby ensuring greater consistency in the consideration of the potential impact of proposed wind farm developments.	The assessment and consideration of potential impacts are contained in section 12.8 of this report.
Military Aviation Authority (MAA): Manual of Aerodrome Design and Safeguarding (MADS) (MAA, 2014)	MADS provides details of safeguarding of military aerodromes and the management of obstacles on or near to military aerodromes.	Consideration of the safeguarding of military aerodromes has been completed through a desktop assessment included in this EIA Report. Leuchars Station is the only military aerodrome impacted and consideration of impact is provided in Sections 12.6.1.3.3 and 12.6.1.3.4.

6. A variety of aviation publications contain information and guidance relating to the potential effects of an offshore wind development on aviation stakeholders.

7. Whilst not definitive, CAP 764 (CAA, 2016b) provides criteria for assessing whether a wind turbine development might have an impact on civil aerodrome related operations.

8. CAP 764 (CAA, 2016b) and the Manual of Aerodrome Design and Safeguarding (MADS) (MAA, 2014) also provide criteria for assessing whether wind turbine developments might have an impact on military aerodrome related operations.

9. Consideration of the Project's potential to impact on aviation stakeholders and receptors has been undertaken in accordance with the standard consultation distances stated in CAP 764 however, the impact to a radar system is dependent on a radar's technical and operational range and effect created by the detectability of operational wind turbines within radar Line of Sight (LoS).

10. Helicopters which may operate in the operation and maintenance role are likely to route direct to the development area under the provision of an ATS from Leuchars Station and will be operating under the specific rules of that Air Traffic Service (ATS) and within the bounds of CAP 393 Air Navigation Order and Regulations 2016 (CAA, 2017).

11. Impact to Practice and Exercise Areas (PEXA) would be due to the potential for interference to radar systems which are utilised in providing a radar service to aircraft operating in the PEXA. Therefore policy, legislation and guidance relevant to radar systems would also be relevant to PEXA in this case.

12.3 Data Sources

12. The assessment considers the potential interaction between the Project, as described in Chapter 4: Project Description, and aviation receptors within the study area. Table 12.2 details the data sources used to inform the baseline characterisation within the study area.

13. The study area will depend on the maximum operating ranges of each of the radar systems scoped in, relative position of military PEXAs and use of Operation and Maintenance (O&M) helicopters; this will vary from system to system, even between different installations of the same system. The operational range of a radar system is dependent on the type of radar used, its function and its operational requirement; consequently the study area can vary significantly.

14. The study area has been defined by applying the criteria set out within CAP 764 (CAA, 2016b), as follows:

- Within 30 km of an aerodrome with a surveillance radar (although it is acknowledged that the distance quoted in CAP 764 can be greater than 30 km dependent on a number of factors at individual aerodromes, including type and coverage of radar utilised);
- Airspace coincidental with published Instrument Flight Procedures (IFP) to take into account the requirement for an aerodrome to protect its IFPs; there is no such airspace within the Project vicinity; and
- Within 17 km of a non-radar equipped licensed aerodrome with a runway of 1,100 m or more; there are no such aerodromes within 17 km of the Project.

15. Where relevant, the maximum operating range of the radar system identified is used within the baseline study and is as follows:

- The Leuchars Primary Surveillance Radar (PSR) is located on the airfield at Leuchars Station and has a standard operating range of 40 nautical miles (NM) (74.1 km) radius.
- The Leuchars Precision Approach Radar (PAR) operates a narrow radar beam which has a standard operating range of 20 NM (37 km) and has a safeguarded area of 20° either side of the runway centreline to which it operates.
- The Brizlee Wood and Buchan Air Defence Radar (ADR) are long range radar systems which have an estimated operational range of 200 NM (370 km), however due to their individual strategic value to national security their exact operating parameters are not known.

16. For military operations to, from and within PEXAs, Offshore Wind Farm maintenance helicopter operations, the orientation of approach and departure flight paths, physical safeguarding of flight, airspace characteristics and flight procedures (as published in the UK Integrated Aeronautical Information Package (IAIP) and Military AIP) are all considered.

17. Baseline characterisation data has been collated combining a thorough desk-based study of extant data supplemented with a detailed literature review and a radar LoS analysis to establish theoretical radar detectability of turbines operating in the Offshore Wind Farm.

Table 12.2 Data sources used to inform the baseline description – Aviation.

Data Source	Study / Data Name	Overview
CAA	Visual Flight Rules Charts (CAA, 2016c)	Aeronautical range of charts, which provide information of airspace boundaries and areas of aviation activity and obstructions above a specified datum.
Ministry of Defence (MOD) No1 Aeronautical Information Distribution Unit	Military Aeronautical Information Publication (Mil AIP) (MOD, 2017)	Provides details of military aerodromes in the UK and abroad together with Air Traffic Control (ATC) procedures, infrastructure and facilities.
CAA CAP 032	UK Integrated Aeronautical Information Package (UKIAIP) (NATS, 2017)	The UKIAIP is updated every 28 days, and contains information for the safe conduct of flight and is essential to air navigation.
NnGOWL	Radar LoS Analysis (Osprey CSL, 2017)	Provides results of the radar LoS assessment – Appendix 12.1.

12.4 Relevant Consultations

18. As part of the EIA process, NnGOWL has consulted with various statutory and non-statutory stakeholders / receptors of relevance to aviation. In response to NnGOWL's request, Marine Scotland Licensing and Operations Team (MS-LOT) issued a Scoping Opinion identifying a number of impacts that could not be scoped out of the aviation assessment at this stage following review of the Scoping Report together with confirming the scope of the assessment to be presented in this EIA Report, as summarised in Table 12.4 below.

Table 12.3 Summary of Consultation – Aviation.

Date and consultation phase / type	Response	Section where comment addressed
08/09/17 MS-LOT Scoping Opinion	The Scottish Ministers note that there will be a requirement to carry out further desk based studies in relation to increase in turbine blade tip height and radar detectability. The Scottish Ministers agree that the potential increase in turbine height could affect Brizlee Wood, Buchan, Allanshill and Perwinnes radar systems and notes that Leuchars Station would also be affected. The Scottish Ministers recommend that NnGOWL liaise with the MOD regarding its objections to the Project and provide precise turbine location, hub height and rotor	The Scoping Opinion was based on a maximum turbine blade tip height of 230 m above Lowest Astronomical Tide (LAT). A radar LoS assessment was completed at heights of 230, 220, 210, 205 and 200 m above Mean Sea Level (MSL) in order to establish any additional aviation receptors that may be

Date and consultation phase / type	Response	Section where comment addressed
	diameter so a more detailed assessment can be completed and the impacts on the MOD radar defined. The Scottish Ministers recommend that NnGOWL and the MOD Defence Infrastructure Organisation (DIO) have discussions, prior to submission of any application, to resolve any issues. The Scottish Ministers note that NnGOWL propose to scope out radar systems that have previously been mitigated in the cumulative impact assessment. The Scottish Ministers note the comments from the DIO with regard to temporary mitigation measures and not assuming that mitigation and consent conditions previously agreed will be applicable to the Project. NnGOWL should take this into account when identifying cumulative effects to scope into the Project EIA. The Scottish Ministers have provided a list of projects that should be included in the Project cumulative assessment and advise that NnGOWL confirm with MOD (DIO) that this is appropriate.	relevant. The maximum blade tip height is now 208 m LAT (equivalent to 205 above mean sea level (AMSL). Appendix 12.1 provides the results of the radar LoS assessment; the height of 205 m AMSL has been used within this impact assessment as this is the closest measurement to the maximum height of the wind turbines. Section 12.8 provides the results of the impact assessment. Wind turbine coordinates for an indicative layout within the Wind Farm Area, at a maximum blade tip height of 208 m LAT, have been provided to the DIO for further assessment. Consultation with MOD (DIO) continues with regard to potential impact to RRH Brizlee Wood and Buchan ADRs and impact to Leuchars Station infrastructure; results of the MOD (DIO) assessment are awaited. Impacts on these aviation receptors are assessed under Section 12.8, with cumulative impacts assessed under Section 12.8.2.
08/09/17 DIO Response to Scoping (note that the Scoping Opinion lists four responses received from the MOD DIO which are listed here as presented in the Scoping Opinion .	22/06/17: Increase in turbine height and blade length may cause issues not previously identified within the existing consented wind farm. 27/06/17: MOD (DIO) objects to the proposal. MOD assessment of the Project conducted based on 56 turbines at 215[1] m LAT blade tip located in the provided boundary positions. MOD objected to the Project based on impact to the Leuchars Station PSR and RRH Brizlee Wood ADR (based on several of the turbines being in LoS of the radar and the number of turbines visible to the radar at Brizlee Wood exceeding the 'cumulative threshold').	The MOD (DIO) response to scoping pointed to the proposed increase in turbine rotor diameter when compared to the Originally Consented Project and that a number of turbine locations encroach on the PAR 'Protection Zone' A telephone conference with the MOD (DIO) was held on the 28/09/17 in which a

[1] MOD (DIO) provided a footnote in their response to scoping which stated that "The Scoping Report states the maximum rotor tip height above LAT (m) will be approximately 230 m.

Date and consultation phase / type	Response	Section where comment addressed
	The MOD (DIO) also requested the fitting of aviation lighting in accordance with Article 219[2] of the Air Navigation Order. In its first response received on 29/06/17, the MOD (DIO) maintains its objection (set out in its response dated 27/6/17) based on assessment of 56 turbines at 230 m LAT blade tip (although the MOD (DIO) response states 230m in height from ground level) located in the provided boundary positions. An additional objection is noted based on impact to the Leuchars Station PAR resulting from a number of turbine locations. The MOD's (DIO) second response received on 29/06/17 provided additional comments specifically on the Scoping Report and in addition to the objections set out in its responses dated 27/6/17 and earlier on 29/6/17. MOD (DIO) stated that as the turbine rotor diameter has increased, a number of turbines would encroach on the Leuchars Station PAR 'Protection Zone'. Furthermore, the MOD (DIO) stated that the regulator-approved airspace change of the Transponder Mandatory Zone (TMZ), which was established to mitigate the Leuchars Station PSR was agreed by the MOD as an interim solution pending delivery of an enduring technical solution and the assumption should not be made *"that any mitigation, temporary or enduring, agreed for the Original Consented Project is applicable to the new proposed project"*. The MOD (DIO) requested precise turbine location, hub height and rotor diameter information so *"a more detailed assessment can be completed and the impacts on MOD radar defined"*. The MOD (DIO) also required confirmation that during the construction phase of the Project, turbines would not be rotational. The MOD (DIO) objection and comments are based on turbine and wind farm parameters supplied to them.	discussion on the MOD response to scoping was held. In order for the MOD (DIO) to complete its assessment (as indicated in the scoping response), details of wind turbine coordinates and reduced turbine blade tip height of 208 m above LAT were provided to the MOD (DIO) by email on the 6/10/17, results of the MOD (DIO) analysis are awaited. During the gradual construction of above LAT infrastructure in the Wind Farm Area, the effect on radar, and on ATS, would be incrementally increased as the turbines are commissioned and the blades start turning. However, since it is not known at this stage in what turbine order this will occur, for the purposes of this aviation assessment, the operational phase is taken to be from the point when the first turbines start turning, until the last turbine ceases to turn, during that time any agreed mitigation will need to be in place and maintained. Impacts on these aviation receptors are assessed under Section 12.8.
08/09/17 NATS response to scoping	NATS stated that the Project has been examined from a technical safeguarding aspect and does not conflict with NATS safeguarding criteria and therefore NATS has no safeguarding objection to the proposal.	Results of the radar LoS analysis contained in Appendix 12.1 has confirmed that the Perwinnes and Allanshill PSRs will not theoretically detect the turbines and that NATS infrastructure will not be impacted by the Project. Section 12.6.1.1 considers potential impact to NATS infrastructure.

[2] CAP 393: The Air Navigation Order 2016 and Regulations was amended in June 2017 and Article 219, providing guidance relating to the lighting of wind turbine generators in UK territorial waters became Article 223.

Date and consultation phase / type	Response	Section where comment addressed
06/10/17 MOD (DIO) EIA Consultation. An indicative layout with turbines at 208 m maximum tip height was provided for detailed assessment of radar impacts.	No response has been received to date.	Since no response has been received, this assessment has been carried out on the basis of the results of the radar LoS analysis (Appendix 12.1) however as the exact operating parameters of ADR are not known, the Buchan ADR has also been taken forward to the assessment phase of the EIA.
29/10/17 Aberdeen Airport EIA consultation. Contacted by email to clarify whether on basis that NATS raised no objection, Aberdeen Airport would also be in the same position.	No response has been received to date.	Aberdeen Airport's safeguarding and ATC utilises data from NATS Allanshill and Perwinnes PSRs. It is Osprey's professional judgement that, given the fact that the Project lies outside of Aberdeen Airport's safeguarded Obstacle Limitation Surfaces and published IFPs and that no radar objection was raised by NATS, there would be no impact on Aberdeen Airport. Section 12.6.1.1 considers potential impact to NATS infrastructure.

19. In summary, the Scoping Opinion provided by the Scottish Ministers confirmed that (based on the scheme design as set out in the Scoping Report and on the assumption that the embedded mitigation will be applied) that only the following matters should be scoped into the EIA.

- Operational impacts[3]:
  - Increase in risk due to clutter resulting from reflected turbine signals and reduced detectability of aircraft resulting from shadowing behind turbines – Leuchars Station PSR.
  - Increase in risk due to clutter resulting from reflected turbine signals and reduced detectability of aircraft resulting from shadowing behind turbines – Leuchars Station PAR.
  - Increase in risk due to clutter resulting from reflected turbine signals and reduced detectability of aircraft resulting from shadowing behind turbines – Royal Air Force (RAF) Remote Radar Head (RRH) Brizlee Wood and RRH Buchan ADR systems.
  - Effects on activities carried out in military PEXA.

[3] NB. As noted above in Table 12.4 during the gradual construction of above LAT infrastructure in the Wind Farm Area, the effect on radar, and on ATS, would be incrementally increased as the turbines are commissioned and the blades start turning. However, since it is not known at this stage in what turbine order this will occur, for the purposes of this aviation assessment, the operational phase is taken to be from the point when the first turbines start turning, until the last turbine ceases to turn, during that time any agreed mitigation will need to be in place and maintained.

- Use of helicopters for O&M of the Project.

20. During the construction phase, stationary elements, such as the tower of the wind turbine will not be processed and presented onto a Radar Data Display Screen (RDDS) by the associated aviation radar. Therefore, for the purpose of this aviation assessment, the operational phase is taken to be from the point at which wind turbine blades are capable of turning to the point at which the last turbine ceases to turn. Any required mitigation will be in place prior to this point. On this basis, contrary to the approach proposed in the Scoping Report, a separate assessment of the construction and decommissioning phase has not been presented.
21. Following consideration of the Scoping Report, MS-LOT confirmed in their Scoping Opinion, that the following impacts can be scoped out of the EIA, and are therefore not assessed in Section 12.8:

- Construction and decommissioning impacts:
  - Increase in risk due to clutter resulting from reflected turbine signals and reduced detectability of aircraft resulting from shadowing behind turbines – NATS Allanshill and Perwinnes PSR systems including utilisation of data from these systems by Aberdeen International Airport.
  - Increased meteorological radar clutter resulting in impacts on quality of meteorological data.
  - Construction activities and structures impacting accuracy of Civil and Military Secondary Surveillance Radar (SSR) systems.
  - Physical obstruction and increased risk of collision around airfields.
  - Effects on Military Low Flying Aircraft resulting from increased collision risk.
  - Search and Rescue (SAR) Flight Operations.
  - Effects on quality/interference of VHF communications.
  - Effects on RACONs due to reflection from turbines.
  - Reduction or loss of Automatic Information Services (AIS).
  - Reduction in positional accuracy of Loran.
  - Interference resulting in reduction in positional accuracy of GPS.
  - Interference increasing difficulty in locating distress beacons/SARTs.
  - Reduction in bearing estimation accuracy.
  - Reduction/loss in coverage of mobile phone signals.
  - Reduction/loss in coverage of satellite phone signals.
  - Reduction/loss in picture of TV signals.
  - Reduction/loss in signal of public radio.
  - Intermittent or incomplete loss of data associated with Line-of-Sight links.
- Operational impacts:
  - Increase in risk due to clutter resulting from reflected turbine signals and reduced detectability of aircraft resulting from shadowing behind turbines – NATS Allanshill and Perwinnes PSR systems including utilisation of data from these systems by Aberdeen International Airport.
  - Increased meteorological radar clutter resulting in impacts on quality of meteorological data.
  - Operational activities and structures impacting accuracy of Civil and Military Secondary Surveillance Radar (SSR) systems.
  - Physical obstruction and increased risk of collision around airfields.
  - Effects on Military Low Flying Aircraft resulting from increased collision risk.
  - SAR Flight Operations.
  - Effects on quality/interference of VHF communications.
  - Effects on RACONs due to reflection from turbines.
  - Reduction or loss of AIS.
  - Reduction in positional accuracy of Loran.

- Interference resulting in reduction in positional accuracy of GPS.
- Interference increasing difficulty in locating distress beacons/SARTs.
- Reduction in bearing estimation accuracy.
- Reduction/loss in coverage of mobile phone signals.
- Reduction/loss in coverage of satellite phone signals.
- Reduction/loss in picture of TV signals.
- Reduction/loss in signal of public radio.
- Intermittent or incomplete loss of data associated with Line-of-Sight links.

22. Consultation with the MOD (DIO) is ongoing with the aim of discussing the potential impacts of the Project with regard to the RRH Brizlee Wood and Buchan ADRs and Leuchars Station PSR and PAR and its assessment of whether any operational impact would be apparent (and in light of the technical assessments set out in this EIA Report). The discussions are expected to include (if required), the applicability of a technical mitigation solution for relevant radar receptors and the viability of any other identified mitigation strategy.
23. As the entire Offshore Export Cable is below sea level, it will not have an impact on aviation interests and therefore is not assessed in this chapter.
24. Further details on the technical assessment and the need for, and options related to, radar mitigation are set out in Section 12.9.

12.5 Impact Assessment Methodology

25. This assessment considers the potential impacts associated with the construction, operation and decommissioning of the Project and the effects on aviation. The impact assessment process and methodology follows the principles and general approach outlined in Chapter 6: EIA Methodology. The methodology and parameters assessed have also taken into account issues identified through consultation with stakeholders as detailed in Section 12.4 and the understanding of baseline conditions informed by the data sources referenced in Section 12.3.
26. The Project Description (Chapter 4) and the Project activities for all stages of the Project life cycle (construction, operation and decommissioning) have been assessed against the baseline to identify the potential interactions between the Project and the relevant aviation receptors defined in Section 12.4. These are known as the potential impacts and are then assessed to determine a level of significance of effect upon the receptors.

12.5.1 Assessment and Assignment of Significance

27. The sensitivity of aviation receptors are defined by both their potential vulnerability to an impact from the Project, their recoverability and value or importance of the receptor. The definitions of terms relating to the sensitivity of aviation receptors are detailed in Table 12.4.

Table 12.4: Sensitivity / importance of the receptor – Aviation.

Receptor sensitivity / importance	Description / justification
High	Receptor provides a service, which is of major importance to the local, regional or national economy, and / or the receptor is generally vulnerable to impacts that may arise from the Project, and / or recoverability is slow and / or costly.
Medium	Receptor provides a service, which is of moderate value to the local, regional or national economy, and / or the receptor is somewhat vulnerable to impacts that may arise from the Project, and / or has moderate to high levels of recoverability.
Low	Receptor provides a service, which is of minor value to the local, regional or national economy, and / or the receptor is not generally vulnerable to impacts that may arise from the Project, and / or has high recoverability.
Negligible	Receptor provides a service, which is of negligible value to the local, regional or national economy, and / or the receptor is not vulnerable to impacts that may arise from the Project, and / or has high recoverability.

28. The magnitude of impact is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact.

29. The definitions of the levels of magnitude used in this assessment in respect of aviation are described in Table 12.5.

Table 12.5: Magnitude of the impact – Aviation.

Magnitude of impact	Description (adverse effects)
High	Loss of resource and / or quality and integrity of resource; severe damage to key characteristics, features or elements.
Medium	Loss of resource, but not adversely affecting integrity of resource; partial loss of / damage to key characteristics, features or elements.
Low	Some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements.
No change	No loss or alteration or characteristics, features or elements; no observable impact in either direction.
High	Receptor provides a service, which is of major importance to the local, regional or national economy, and / or the receptor is generally vulnerable to impacts that may arise from the Project, and / or recoverability is slow and / or costly.

30. The magnitude of the impact is correlated against the sensitivity of the receptor to provide a level of significance. It is noted that significance criteria for aviation impacts are typically difficult to establish; they are not strictly based on the sensitivity of the receptor or magnitude of change but on whether the industry regulations for safe obstacle avoidance or radar separation (from radar clutter) can be maintained in the presence of wind turbines. Any anticipated impact upon aviation receptors, which results in restricted operations is considered to be of significance.

31. For the purposes of this assessment any effect that is considered major or moderate, and shaded in red or orange in Table 12.6, is considered significant in EIA terms. Any effect that is minor or below is not considered to be significant.

Table 12.6: Significance of potential effects – Aviation.

		Magnitude of Impact			
		High	Medium	Low	Negligible
Sensitivity	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Negligible	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

32. During the gradual decommissioning of above LAT infrastructure in the Wind Farm Area, the effect on radar, and on ATS, would be incrementally reduced as the turbines are decommissioned and the blades cease turning. However, since it is not known at this stage in what turbine order this will occur, for the purposes of this aviation assessment, the operational phase is taken to be the point until which all turbines have ceased turning. Until that time, any agreed mitigation will need to be maintained.

12.5.2 Uncertainty and Technical Difficulties Encountered

33. The LoS analysis is a limited and theoretical desk based study; in reality there are variable levels of signal diffraction and attenuation within a given radar environment that can influence the probability of a wind turbine being detected by a particular radar. The analysis is designed to give an indication of the likelihood of the wind turbine being detected such that the operational significance of the Project relative to nearby aviation radar stakeholders can be assessed.

12.6 Baseline Description

12.6.1 Wind Farm Area

12.6.1.1 Existing Airspace Environment

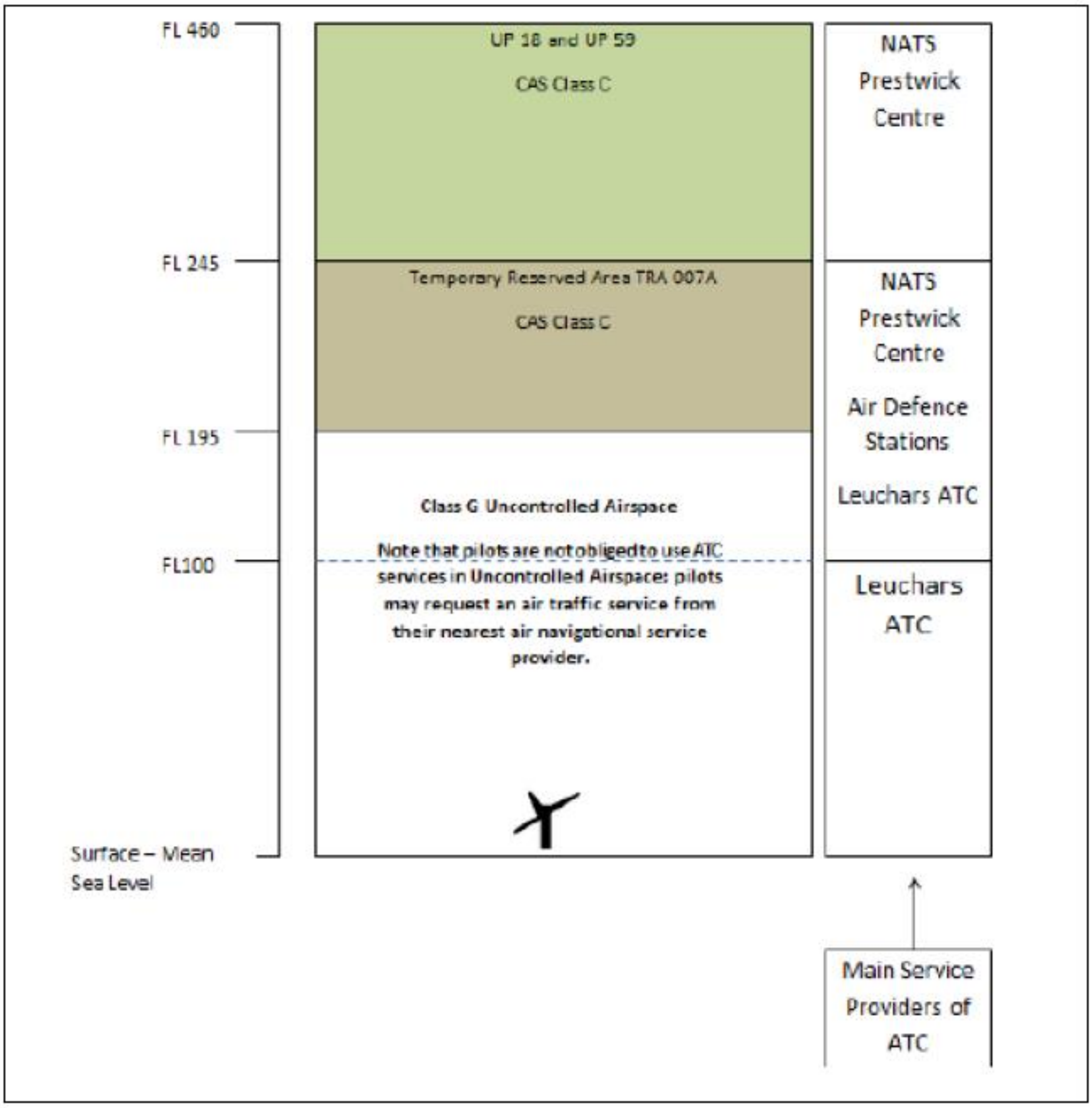
34. The airspace above the Wind Farm Area (see Illustration 12.1 below) is predominately Class G uncontrolled airspace, which is established from the surface up to Flight Level (FL) 195 (approximately 19,500 feet (ft)). There are also discrete areas of Class C controlled airspace (CAS) above FL 195. Under these classifications of airspace, the following applies:

- **Class G uncontrolled airspace:** any aircraft can operate in this area of uncontrolled airspace without any mandatory requirement to be in communication with, or receive a radar service from, any ATC establishment. Pilots of aircraft operating in Class G airspace are ultimately responsible for seeing and avoiding other aircraft and obstructions; and
- **Class C controlled airspace:** only aircraft that have filed a flight plan can operate within controlled airspace. Controllers apply the required levels of separation to aircraft operating in controlled airspace and generally, instructions issued to the pilot flying in controlled airspace are mandatory. Aircraft operating in controlled airspace must be in receipt of an ATS from NATS or a separate authorised military service provider.

35. The Class C controlled airspace above FL 195 contains a number of airways designated P18[4], UP18 and UP59; UP18 and UP59 are located above FL 245 and are designated upper airways. Airways are predominantly used by en-route civil aircraft and an ATS to pilots operating on the airways above the Project is routinely provided by NATS controllers operating from the Prestwick Area Control Centre (ACC) utilising remote long-range radar. It is noted that NATS has responded to Scoping confirming that they have no safeguarding objection to the Project.

36. Military air defence controllers utilising radar data from ADRs provide an airways crossing service to aircraft under air defence control, utilising ADR systems, and are likely to operate in the airspace above the Project.

Illustration 12.1: Airspace classifications above the Wind Farm Area



12.6.1.2 Military Practice and Exercise Areas

37. The only aeronautical Military PEXA within the study area is Temporary Reserved Area (TRA) 007A which is used by military aircraft for activities including air combat training, training exercises and supersonic flight. It is established above the Wind Farm Area from FL 195 (19,500 ft) to FL 245 (24,500 ft) and is activated Monday to Friday 0830 to 1700 (0730 to 1700 during the months of summer). TRA

[4] NB. P18 is not included in Illustration 12.1 as P18 is not located directly above the Wind Farm Area.

007A does not include controlled airspace within Airway P18 during the published hours of the airway. TRAs allow military aircraft to work autonomously or to be in receipt of an ATS service from approved ATS units, to avoid operational restrictions. Air defence controllers using radar data from ADR systems and airborne radar assets are responsible for navigation services and support to aircraft activity within TRA 007A.

12.6.1.3 Radar Coverage within the Study Area

12.6.1.3.1 NATS PSRs

38. NATS operates a number of long-range PSR systems positioned to provide maximum coverage of UK airspace. Wind farm developments have the potential to impact NATS radar and operations and by association other users of radar data supplied by NATS.

39. The NATS Perwinnes PSR is located to the north of Bridge of Don; approximately 97.6 km from the northern edge of the Project and together with the Allanshill PSR, which is located to the south west of Fraserburgh; approximately 146 km from the northern edge of the Project (see Figure 12.2 (Volume 2)), are the only NATS long range PSR that could potentially detect the operational turbine blade tips of the Wind Farm Area.

40. Results of the radar LoS analysis contained within Appendix 12.1 indicate that the wind turbines within the Wind Farm Area will not be detected by assessed NATS PSRs.

12.6.1.3.2 Aberdeen International Airport

41. Aberdeen International Airport utilises the two NATS radars at Perwinnes and Allanshill for the provision of ATC services. These services are provided to aircraft inbound and outbound to the airport and in the northern North Sea airspace, including the Atlantic rim airspace and the East Shetland Basin.

42. Aberdeen Airport also provides ATC services for Helicopter Main Routes (HMRs) which are utilised on a frequent basis by helicopters in support of the oil and gas industries. HMRs between Aberdeen and the offshore platforms are situated approximately 50 NM north of the Wind Farm Area and outside any CAA recommended consultation range. This is discussed further in section 12.6.1.3.6. Furthermore, all Aberdeen International Airport flight procedures are located within 30 NM of the airport and therefore aircraft would not be routed in close proximity to the Wind Farm Area whilst established on these procedures.

43. A number of defined airfield Obstacle Limitation Surfaces (OLS) are established at the airport particular to the runway and its intended use. The OLS for the airport will extend to approximately 15 km from the airfield and will not be impacted by the Project.

44. NATS provides under contract ATC services to aircraft operating to and from the airport utilising the NATS Perwinnes and Allanshill PSRs, results of the radar LoS analysis contained within Appendix 12.1 indicate that the wind turbines within the Wind farm Area will not be detected by the PSRs.

12.6.1.3.3 Leuchars Station PSR

45. Leuchars Station operates a standard Watchman PSR, which is located on the airfield at the Station; the radar has an operating range of 40 NM (74.1 km) radius. The PSR is located approximately 18 NM (34 km) from the western edge of the Wind Farm Area (see Figure 12.2 (Volume 2)) and is utilised by Leuchars Station ATC in the provision of air traffic services to aircraft operating in and out of the airfield and the provision of a Lower Airspace Radar Service (LARS) below FL 100 to transitory civil and military aircraft within a radius of 40 NM (74.1 km) of the airfield every day of the year, 24 hours per day.

46. Leuchars Station used to be known as RAF Leuchars however, on the 31 March 2015 the Station was handed over to the British Army. Based Typhoon aircraft were relocated to RAF Lossiemouth, Morayshire and continued their Quick Reaction Alert in defence of the UK from their new base. The airfield at Leuchars Station remains open and is administered by RAF personnel who also provide ATC

with a number of skilled personnel in specific roles. The proximity of the airfield to the military practice Danger Areas to the east and southeast makes Leuchars Station an attractive, and possibly the only military aerodrome option, for aircraft diverting in following an emergency or due to inclement weather conditions at their home base.

12.6.1.3.4 Leuchars Station PAR

47. Leuchars Station also has a PAR in addition to the PSR described above in Section 12.6.1.3.3. The Exelis (formerly ITT Gilfillan) PAR system employed by the MOD, at Leuchars Station and other locations, is a radar guidance system designed to provide lateral and vertical guidance to an aircraft pilot for landing, or until the landing threshold is reached. In general terms, the radar's 'Protection Zone' (Safeguarded Area) extends out to 20 NM (37 km) from the runway touchdown point and 20° either side of the extended runway centreline. The Leuchars Station PAR is located approximately 18 NM (34 km) from the western edge of the Wind Farm Area (see Figure 12.2 (Volume 2)). Further information on the PAR system can be found in Appendix 12.1.

12.6.1.3.5 RRH Brizlee Wood and RRH Buchan ADRs

48. The MOD operates a series of fixed ADR that feed into the Control and Reporting Centres (CRC) at RAF Boulmer and RAF Scampton, where the UK Recognised Air Picture (RAP) is produced. The nearest ADR to the Wind Farm Area is the Lockheed Martin TPS-77 equipped RRH Brizlee Wood located at Alnwick Moor Northumberland, 91.7 km from the southern boundary of the Wind Farm Area (see Figure 12.2 (Volume 2)). The Wind Farm Area is within the estimated operational range of 200 NM (370 km), however due to their individual strategic value to national security their exact operating parameters are not known

49. The RRH Buchan ADR houses a Lockheed Martin Type 92(B3), which has been upgraded to TPS-77 standard, and is located just south of Peterhead on the Aberdeenshire coast, 127.7 km from the northern boundary of the Wind Farm Area (see Figure 12.2 (Volume 2)). As above, the Wind Farm Area is within the estimated operational range of the radar.

12.6.1.3.6 Offshore Helicopter Operations in Support of Oil and Gas Operations

50. Offshore oil and gas platforms in the North Sea are supported by a number of helicopter operators who ferry crews and supplies to and from the mainland. Helicopters operate offshore in support of the oil and gas industry and normally route along HMRs, which are non-mandatory routes, where helicopters may operate on a frequent basis. HMRs, which are concentrated in the northern North Sea, east and northeast of Aberdeen International Airport and route to the offshore oil and gas platforms, are all situated outside of CAA recommended consultation distances which states that there should be no obstacles within 2 NM either side of the HMR.

12.6.1.3.7 Helicopters Operating in Support of O&M

51. As there are no HMRs between the coast and the Wind Farm Area, helicopters operating in an O&M role to the Project are likely to route direct to the Wind Farm Area under a LARS provided by Leuchars Station ATC dependent on suitable radar and radio frequency coverage.

12.6.2 Development of Baseline Conditions without the Project

52. In the future, it is anticipated that the airspace would continue to be used by military and civil aviation stakeholders and the baseline would remain as detailed.

12.7 Design Envelope – Worst Case Design Scenario

53. The Application is for the construction, operation and decommissioning of an offshore wind farm with a maximum output of 450 Megawatts (MW), comprising a maximum of 54 turbines. The assessment scenarios identified in respect of aviation have been selected as those having potential to represent

the greatest effect on an identified receptor based on the design envelope described in Chapter 4: Project Description.

54. The worst-case design scenarios are set out in Table 12.7.

55. The worst-case scenario for impacts on aviation and radar assumes that the entirety of the Wind Farm Area will be populated with wind turbines. This is because the largest area of turbines will create the largest impact from an obstruction perspective, leading to a greater effect on radar and aviation services. Any aspects of the infrastructure that are lower in height than the wind turbines and within the Wind Farm Area will not create an incremental effect on aviation interests.

56. As discussed in Section 12.4, during the gradual construction of above LAT infrastructure in the Wind Farm Area, the effect on radar, and on ATS, would be incrementally increased as the turbines are commissioned and the blades start turning. However, since it is not known at this stage in what turbine order this will occur, for the purposes of this aviation assessment, the operational phase is taken to be from the point when the first turbines start turning, until the last turbine ceases to turn, during that time any agreed mitigation will need to be in place and maintained. On this basis, construction and decommissioning effects were scoped out of this assessment and therefore no worst-case design scenario is identified for these phases.

Table 12.7: Design envelope scenario assessed – Aviation.

Potential Impact	Worst Case Design Scenario	Justification
Operation		
Turbines causing persistent interference on Leuchars Station PSR system from reflected turbine signals.	Wind turbines with maximum blade tip height of 208 m above LAT across the full extent of the Wind Farm Area.	Maximum number of the tallest turbines in the Wind Farm Area. Modelling assumes that the entirety of the Wind Farm Area will be populated with turbines. This is because the largest area of turbines will create the largest impact from an obstruction perspective, leading to a greater effect on radar and aviation services. Any aspects of the infrastructure that are lower in height than the wind turbines and within the Wind Farm Area will not create an incremental effect on aviation interests.
Turbines causing persistent interference on Leuchars Station PAR system from reflected turbine signals.	Wind turbines with maximum blade tip height of 208 m above LAT across the full extent of the Wind Farm Area.	Maximum number of the tallest turbines in the Wind Farm Area. Modelling assumes that the entirety of the Wind Farm Area will be populated with turbines. This is because the largest area of turbines will create the largest impact from an obstruction perspective, leading to a greater effect on radar and aviation services. Any aspects of the infrastructure that are lower in height than the wind turbines and within the Wind Farm Area will not create an incremental effect on aviation interests.
Turbines causing persistent interference on RRH Brizlee Wood and RRH Buchan ADRs from reflected turbine signals	Wind turbines with maximum blade tip height of 208 m above LAT across the full extent of the Wind Farm Area.	Maximum number of the tallest turbines in the Wind Farm Area. Modelling assumes that the entirety of the Wind Farm Area will be populated with turbines. This is because the largest area of turbines will create the largest impact from an obstruction perspective, leading to a greater effect on radar and aviation services. Any aspects of the infrastructure that are lower in height than the wind turbines and within the Wind Farm Area will not create an incremental effect on aviation interests.

Potential Impact	Worst Case Design Scenario	Justification
Effects on activities carried out in military PEXA.	Wind turbines with maximum blade tip height of 208 m above LAT across the full extent of the Wind Farm Area.	The impact to the military PEXA is a consequence of radar interference created by the detectability of the Wind Farm Area and is based on the maximum number of the tallest turbines in the Wind Farm Area. Modelling assumes that the entirety of the Wind Farm Area will be populated with wind turbines. This is because the largest area of turbines will create the largest impact from an obstruction perspective, leading to a greater effect on radar and aviation services in and around the PEXA. Any aspects of the infrastructure that are lower in height than the wind turbines and within the Wind Farm Area will not create an incremental effect on aviation interests.
Use of helicopters for O&M of the Wind Farm Area.	Wind turbines with maximum blade tip height of 208 m above LAT across the full extent of the Wind Farm Area.	Maximum number of the tallest wind turbines in the Wind Farm Area. Modelling assumes that the entirety of the Wind Farm Area will be populated with wind turbines. This is because the largest area of turbines will create a reduced area for manoeuvre of the helicopter, leading to an increased risk of collision.

12.7.1Embedded Mitigation

57. A number of mitigation options, both embedded and for implementation, were identified within the design envelope for the Originally Consented Project, during the consultation phase of the Original Application and during the on-going liaison with aviation stakeholders, their representatives and with MS-LOT.

58. As set out in the Scoping Report (and as summarised in Chapter 5: Scoping and Consultation) these have been adopted into the Project design as the design envelope has evolved as embedded mitigation. Those embedded mitigation measures that are relevant to the potential impacts on aviation are set out below.

- During construction
  - Information Circulation: Appropriate liaison to ensure information on the construction of the wind farm is circulated in Notice to Airman (NOTAM) and other appropriate media;
  - Hydrographic Office (UKHO) will be provided with the positions and maximum heights of the wind turbines and construction equipment above 150 m LAT. Coordinates and maximum heights of the wind turbines will be provided to the UKHO for aviation charting purposes within one month of the final commissioning of the Project. The UK IAIP is updated on a monthly basis under the Aeronautical Information Regulation and Control (AIRAC) system. Information provided under the AIRAC system shall be distributed by AIS at least 42 days in advance of the effective date with the objective of reaching recipients at least 28 days in advance of the effective date;
  - Lighting and Marking Plan: The Project construction works will be marked in line with CAP 393 (CAA, 2017) and CAP 437 (CAA, 2016a) and as agreed with the CAA. A Lighting and Marking Plan will be submitted for approval, to MS-LOT outlining the Projects lighting and marking strategy to mitigate the risk to aviation safety during construction of the Project;
  - The Project will be designed as per MGN 543, including Annex 5 which details ‘Standards and procedures for generator shutdown and other operational requirements in the event of a SAR, counter pollution or salvage incident in or around an Offshore Renewable Energy Installation (OREI)’; and

    - Creation of an Emergency Response Co-operation Plan (ERCoP) based on the Maritime and Coastguard Agency (MCA) template and site Safety Management Systems (SMS), in consultation with the MCA. Procedures will be the followed in the event of an emergency during the construction phase.
- During Operation
    - Information Circulation: Appropriate liaison to ensure information on the operation and maintenance of the wind farm is circulated in Notice to Airman (NOTAM) and other appropriate media;
    - Aviation Chart Marking: Prior to operation, information in line with that previously provided to the UKHO will be promulgated to NATS AIS for inclusion in the UK IAIP (NATS, 2017)and to the Defence Geographic Centre (DGC) for marking on related aeronautical charts and documentation;
    - During the operational phase, the Project will be lit in line with CAP 393 (CAA, 2017) and CAP 437 (CAA, 2016a), and as agreed with the CAA. A Lighting and Marking Plan will be submitted for approval, to MS-LOT outlining the Projects lighting, and marking strategy to mitigate the risk to aviation safety during operation of the Project;
    - The Project will be operated as per MGN 543, including Annex 5 which specifies ‘Standards and procedures for generator shutdown and other operational requirements in the event of a SAR, counter pollution or salvage incident in or around an OREI’; and
    - Maintenance of the previously established ERCoP based on the MCA template and site SMS, in consultation with the MCA. Procedures will be followed in the event of an emergency during the operational phase.
- During Decommissioning
    - Aviation Chart Marking: Prior to decommissioning, in line with information previously provided to the UKHO, information on decommissioning equipment above 150 m LAT and dates of commencement and final decommissioning of the Wind Farm Area will be promulgated to NATS AIS for inclusion in the UK IAIP (NATS, 2017)and to the Defence Geographic Centre (DGC) for marking on related aeronautical charts and documentation under the AIRAC system;
    - Information Circulation: Appropriate liaison to ensure information on the decommissioning of the wind farm is circulated by NOTAM and other appropriate media;
    - Lighting and Marking Plan: During the decommissioning phase, the Project will be lit in line with CAP 393 and CAP 437, and as agreed with the CAA. The operational Lighting and Marking Plan will have been previously approved. Should any structures be left in situ, appropriate prior modification to lighting and marking will be discussed and agreed with the CAA;
    - The Project will be decommissioned as per MGN 543, including Annex 5 which specifies ‘Standards and procedures for generator shutdown and other operational requirements in the event of a SAR, counter pollution or salvage incident in or around an OREI’; and
    - Maintenance of the previously established ERCoP based on the MCA template and site SMS, in consultation with the MCA. Procedures will be followed in the event of an emergency during the decommissioning phase.

59. The embedded mitigation, where relevant, will comply with current guidelines and be agreed with the appropriate stakeholders, as follows:

- CAP 393 Article 223 (CAA, 2017) sets out the mandatory requirements for lighting of offshore wind turbines.

  - Legislation requires the fitting of obstacle lighting on offshore wind turbines with a height of 60 m or more above the level of the sea at Highest Astronomical Tide (HAT);
  - Where four or more turbines are located together in the same group, with the permission of the CAA, only those on the periphery of the group need to be fitted with at least one medium intensity steady red light positioned as close as reasonably practicable to the top of the fixed structure; and
  - The obstruction light or lights must be fitted to show when displayed in all directions without interruption. The requirements of the angle of the plane of the beam and peak intensity levels are defined within CAP 393 (CAA, 2017).
- CAP 437 (CAA, 2016a) sets out a procedure to indicate to a helicopter operator that a wind turbine blades and nacelle are safely secured in position prior to helicopter hoist operations commencing.
  - CAP 437 states that this is best achieved through the provision of a helihoist status light located on the nacelle of the turbine within the pilot's field of view, which is capable of being operated remotely and from the platform itself or from within the nacelle;
  - A steady green light is displayed to indicate to the pilot that the turbine blades and nacelle are secure and it is safe to operate. A flashing green light is displayed to indicate that the turbine is in a state of preparation to accept hoist operations or, when displayed during hoist operations, that parameters are moving out of limits. When the light is extinguished this indicates to the operator that it is not safe to conduct helicopter hoist operations; and
  - Obstruction lighting in the vicinity of the winching area that has a potential to cause glare or dazzle to the pilot or to a helicopter hoist operations crew member should be switched off prior to, and during, helicopter hoist operations.
- Information will be circulated to relevant military and aviation stakeholders including NATS and MOD. Information on potential aviation obstructions will be promulgated within the UK IAIP and notified to the Defence Geographic Centre (DGC) for marking on aeronautical related charts and documentation.
- An ERCoP will be in place for the construction, operation and decommissioning phases of the Project. The content and structure of the ERCoP will be agreed post-consent.

12.7.2 Anticipated Consent Conditions

60. A number of consent conditions were attached to the Original Consents to manage the environmental risk associated with the Originally Consented Project. Those consent condition commitments that are relevant to the potential impacts on Aviation are set out in Table 12.8. If further mitigation is required following the impact assessment process, then this will be included as additional mitigation and is set out in Section12.9.

Table 12.8: Consent conditions for the Originally Consented Project relevant to aviation

Original Consent Requirement	Relevance to Military and Civil Aviation
Lighting and Marking Plan	Setting out for approval, the final lighting and marking of structures to ensure aviation safety at the Offshore Wind Farm.
Air Traffic Control Mitigation Scheme (ATC Scheme)	Setting out, for approval, an ATC scheme to mitigate the adverse impacts of the Project on the air traffic control radar at Leuchars Station and the operations of the MOD.

Original Consent Requirement	Relevance to Military and Civil Aviation
Provision of Turbines and Construction Equipment above 150 m LAT	Provide the positions and maximum heights of the turbines and construction equipment above 150 m LAT and any offshore substation platform to the United Kingdom Hydrographic Office (UKHO) for aviation and nautical charting purposes to ensure aviation and navigational safety.

12.8 Impact Assessment

61. The impacts resulting from the operation of the Project have been assessed on aviation receptors identified within the study area and as defined under Section 12.4 and described under Section 12.6. A discussion of the likely significance of each effect resulting from each impact is presented below.

12.8.1 Operational Phase Impacts

12.8.1.1 Radar Impacts

62. There are unpredictable levels of signal diffraction and attenuation within a given radar environment that can influence the probability of a wind turbine being detected by a radar system. Occasional detectability of a wind turbine may take place when there is intervening terrain blocking the radar signal or due to radar signal properties. Wind turbines detectable by a radar system might degrade the system by creating false targets, reduce system sensitivity, create radar shadowing behind the turbines and saturate the radar receiver leading to clutter potentially concealing real aircraft targets.

12.8.1.2 Line of Sight Assessment

63. Radar performance and propagation modelling has been undertaken to determine the theoretical detection of wind turbines by the region's radar infrastructure (LoS assessment). The assessment has utilised the Advanced Topographic Development and Images (ATDI) ICS LT (Version 4.3.0) tool to model the terrain elevation profile between the identified PSR and ADR systems and the Wind Farm Area. The LoS assessment is presented in detail in Appendix 12.1.

64. The qualitative definitions utilised in the LoS assessment are defined in Table 12.9 below.

Table 12.9: Qualitative definitions of LoS results – Aviation.

Result	Definition
Yes	The turbine is highly likely to be detected by radar, as a direct LoS exists between the radar and the turbine.
Likely	The turbine is likely to be detected by the radar at least intermittently.
Unlikely	The turbine is unlikely to be detected by the radar but cannot rule out occasional detection.
No	The turbine is unlikely to be detected by the radar, as significant intervening terrain exists.

65. For the purpose of the LoS assessment, the final individual wind turbine locations within the Wind Farm Area are not relevant. That is because the maximum extent of the Wind Farm Area will represent the greatest extent of radar clutter that could be expected to occur on radar systems that detect the wind turbines. Therefore, 25 random points[5] were selected across the Wind Farm Area to complete the LoS analysis.

[5] NB. These 25 points are not intended to show actual locations where turbines will be installed, these locations have been chosen to provide an even spread of turbines across the Wind Farm Area to gauge theoretical detection.

12.8.1.2.1 Creation of Wind Turbine Induced Clutter to the Leuchars Station PSR

66. Radar LoS analysis between the Wind Farm Area and the Leuchars Station PSR was carried out for the Original EIA. This previous analysis demonstrated that due to the coastal location of the PSR, the lack of intervening terrain, and the range from the Wind Farm Area, the Leuchars Station PSR system will theoretically detect the operational wind turbines, potentially creating turbine derived clutter to be presented on the Leuchars Station RDDS. As the turbines in the Project design envelope are taller than those in the Original EIA, there was no requirement to repeat the LoS analysis.

67. The direct, persistent effect of clutter as generated by the Offshore Wind Farm may hamper the radar operator's ability to distinguish actual aircraft returns from those created by the wind turbines, and therefore degrade the safety and efficiency of the ATS being provided. MOD (DIO) has confirmed wind turbines within the Wind Farm Area will be detectable by, and will cause unacceptable interference to the ATC PSR at Leuchars Station.

68. In the vicinity of the Wind Farm Area aircraft under the control of Leuchars ATC will be operating in Class G airspace and may request a Deconfliction Service (DS) from the controllers at Leuchars. DS is the highest level of radar service provided to pilots in Class G uncontrolled airspace: essentially the controller must provide instructions to the pilot to ensure the aircraft remains adequately separated from 'unknown traffic' or clutter. For a pilot requesting a DS, on a flight path within 5 NM of the Wind Farm Area, the air traffic controller will be unable to provide the 5 NM separation (between clutter within the Wind Farm Area and an aircraft) required for the safe provision of the ATS.

69. The sensitivity of the receptor is high. The magnitude of impacts is assessed as high; therefore without mitigation, the impacts would be of major significance, which is significant in EIA terms.

12.8.1.2.2 Creation of Wind Turbine Induced Clutter to the Leuchars Station PAR

70. Radar LoS analysis between the Wind Farm Area and the Leuchars Station PAR was carried out for the Original EIA. This previous analysis demonstrated that due to the coastal location of the PAR, the lack of intervening terrain, and the range from the Wind Farm Area, the Leuchars Station PAR system will theoretically detect the operational wind turbines, potentially creating turbine derived clutter to be presented on the Leuchars Station RDDS. As the turbines in the Project design envelope are taller than those in the Original EIA, there was no requirement to repeat the LoS analysis.

71. PAR provides lateral and vertical guidance for aircraft approaching a runway. ATC Leuchars use PAR derived information to determine an aircraft's course and height during approach and provides heading and descent advice to maintain an aircraft's correction to the runway centreline using voice communication. The use of PAR is limited to a narrow sector centred on the extended runway centreline of the runway of approach. MOD (DIO) safeguards the PAR within an arc of radar coverage which extends to 20 NM from the runway touchdown point and 20° either side of the centreline. Part of the Wind Farm Area would overlap a small area of the PAR 'Protection Zone' (Safeguarded Area). Wind turbines when operated within the arc of coverage have the capacity to affect PAR in a variety of ways. In particular, MOD DIO has previously objected to wind farm proposals based on track loss, track seduction, and processor overload.

72. The sensitivity of the receptor is high. The magnitude of impacts is assessed as high; therefore without mitigation, the impacts would be of major significance, which is significant in EIA terms.

12.8.1.2.3 Creation of Wind Turbine Induced Clutter to the RRH Brizlee and RRH Buchan ADR Systems

73. Radar clutter has the potential to obscure genuine targets and could have safety implications for aircraft under control. Furthermore, wind turbine generated clutter could shield the radars from genuine aircraft targets from the air defence controller. These direct and persistent effects would affect the air defence controller's ability detect an airborne threat and to provide a safe service to aircraft in support of air defence activities.

74. The results of the radar LoS assessment to potentially affected radar systems at a blade tip height of 205 m AMSL indicate that theoretically the RRH Buchan ADR will not detect turbines at 208 m above LAT within the Wind Farm Area.

75. There are mixed results from the LoS assessment to the ADR at RRH Brizlee Wood at 205 m AMSL. Of the 25 points assessed 12 are likely to be detected by RRH Brizlee Wood and of the other 13 points assessed analysis cannot rule out occasional detection.

76. Because the exact operating parameters of the RRH Buchan and RRH Brizlee Wood ADRs are not known, the results of assessment by the MOD (DIO) are awaited to establish if an effect to RRH Buchan or RRH Brizlee Wood ADRs is likely.

77. Based on the LoS assessment carried out, the sensitivity of the receptor is high. The magnitude of impacts is assessed as high; therefore without mitigation, the impacts would be of major significance, which is significant in EIA terms.

12.8.1.2.4 Effects on Activities Carried Out in Military PEXA

78. TRA 007A is a military PEXA and is an area of airspace temporarily reserved and allocated for the exclusive use of a specific user during a predetermined period of time. The creation of radar clutter onto RDDS may impact the provision of air traffic/air defence radars services to aircraft. Air defence controllers using radar data from ADRs are responsible for navigation services and support to aircraft activity within and crossing TRA 007A and wind turbine induced clutter created on an RDDS is likely to impact the safe provision of the service. The sensitivity of this receptor is high. The magnitude of impacts is assessed as medium; therefore, the impacts are considered to be of major significance, which is significant in EIA terms.

12.8.1.3 Use of Helicopters for O&M of the Offshore Wind Farm

79. Helicopters may be required access to the Wind Farm Area for troubleshooting minor defects and resets to wind turbines or to facilitate access to the Wind Farm Area when sea states do not allow vessel access. Physical obstruction caused by the infrastructure within the Wind Farm Area may present a potential collision risk to helicopter flight operations.

80. A range of embedded mitigation measures relating to lighting, notification, promulgation and the inclusion of the Project on relevant aviation material will reduce impact to helicopter operators providing O&M support to the Wind Farm Area. When operating in the Class G airspace above the Wind Farm Area pilots are ultimately responsible for seeing and avoiding other aircraft and obstructions. Operations will be conducted in Visual Flight Rules (VFR) conditions which dictate a minimum in-flight visibility of 5 km (approximately 3 NM).

81. Helicopters are likely to be under an ATS from Leuchars when operating in or in transit to the Wind Farm Area. Aircraft can be in receipt of an ATS and may be provided with traffic information on other aircraft, but ultimately pilots are responsible for their own separation from other aircraft, obstacles and terrain. Due to the low number of helicopter movements predicted for O&M duties (80 trips per annum) the procedures existing for the avoidance of obstacles, and the availability of existing ATS, the impact to other aircraft operators in the vicinity of the Wind Farm Area is not considered to be an issue.

82. The sensitivity of the receptor is medium. The magnitude of impacts is assessed as low; therefore, the impacts would be of minor significance, which is not significant in EIA terms.

12.8.2 Cumulative Impacts

83. Cumulative effects refer to effects upon receptors arising from the Project when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals. In this context, the term ‘projects’ is considered to refer to any project with comparable effects and is not limited to offshore wind projects.

84. Project and activities considered within the cumulative impact assessment are set out in Table 12.10.

Table 12.10: Projects for cumulative assessment – Aviation.

Development Type	Project	Status	Data Confidence Assessment / Phase
Offshore Wind Farm	Inch Cape Offshore Wind Farm (Scenario 2)	Consented	High - project details available
Offshore Wind Farm	Inch Cape Offshore Wind Farm (Scenario 1)	Proposed	High - Scoping Report available
Offshore Wind Farm	Seagreen Alpha and Bravo Offshore Wind Farms (Scenario 2)	Consented	High - project details available
Offshore Wind Farm	Seagreen Phase 1 Offshore Wind Farm (Scenario 1)	Proposed	High - Scoping Report available.
Offshore Wind Farm	Hywind Scotland Pilot Park	Operational	High – final design information published by MS-LOT.
Offshore Wind Farm	Blyth Offshore Demonstrator Wind Farm (Phase 1 to 3)	Under construction	High – consented, Phase 1 under construction final design information available.
Offshore Wind Farm	Beatrice Offshore Wind Farm	Under construction	High – consented, under construction. Final design information published by MS-LOT.
Offshore Wind Farm	MORL Eastern Development Area	Consented	High – consented, details published in the public domain but not confirmed as being accurate.
Offshore Wind Farm	MORL Eastern Development Area (Alternative Design) a.k.a. Moray East Offshore Wind Farm	Scoping	High – Scoping Report available.
Offshore Wind Farm	Moray West Offshore Wind Farm	Proposed	High – Scoping Report available.
Offshore Wind Farm	European Offshore Wind Deployment Centre	Consented	High – consented, details published in the public domain but not confirmed as being accurate.
Offshore Wind Farm	Kincardine Floating Offshore Wind Farm	Consented	High – consented, details published in the public domain but not confirmed as being accurate.
Offshore Wind Farm	Forthwind Offshore Wind Farm	Consented	High - consented, details published in the public domain but not confirmed as being accurate.
Offshore Wind Farm	Forthwind Offshore Wind Demonstration Project Phase 2	Scoping	High – Scoping Report available.
Offshore Wind Farm	Offshore Renewable Energy Catapult Levenmouth	Operational	High – final design information published by MS-LOT.

85. It is assumed that those offshore wind farms, that have been consented, or are operational, have (or will have) technical mitigation in place (if required), which will mitigate effects to any relevant radar systems. Currently, for any other radar systems for which impacts are not mitigated it is assumed that

any effects are deemed acceptable; however, the addition of unmitigated clutter created by the Project turbines could create a cumulative effect where existing detectable turbines are currently considered manageable.

86. In assessing the cumulative impacts for the Project, two scenarios are considered with respect to the Inch Cape and Seagreen offshore wind farm projects. Scenario One incorporates the design envelopes for the proposed Inch Cape and Seagreen projects as detailed in the Scoping Reports submitted to MS-LOT in 2017 (ICOL, 2017; Seagreen, 2017). Scenario Two incorporates the consented design envelopes as detailed in the respective project consents. Scenario 1 (Table 12.10: Projects for cumulative assessment – Aviation.) is likely to be the worst case scenario as any increase in wind turbine blade tip height above LAT, and increase in turbine numbers, is likely to increase detectability to regional radar systems.

87. Table 12.11 sets out the potential cumulative impact and the worst case cumulative design envelope scenario considered within the cumulative impact assessment.

88. Due to the narrow beam of radar coverage provided by PAR and the small 'Protection Zone' (Safeguarded Area) of the system (20 NM from the runway touchdown point, 20° either side of the runway centreline), and that there are no other projects within the PAR 'Protection Zone', the Leuchars Station PAR is not considered for cumulative effect.

89. Since the impact on PEXA is a consequence of the radar detectability of the Wind Farm Area by the radar systems that would be utilised for control of aircraft in TRA 007A, the cumulative effect is to the radar system (RRH Brizlee Wood and RRH Buchan), not the PEXA itself, assuming that any effects, direct or residual, by other offshore wind farms are deemed acceptable.

90. Effects relating to helicopter use during O&M were specific to the Project and therefore do not need to be considered on a cumulative basis.

Table 12.11: Cumulative worst-case design envelope scenarios – Aviation.

Impact	Project	Worst Case Design Scenario	Justification
Cumulative impact of wind turbines causing persistent interference on the Leuchars Station PSR system from reflected turbine signals	Scenario 1 Inch Cape Offshore Wind Farm	Max no. turbines: 72 Max. tip height: 291 m	The Leuchars Station PSR has a Declared Operational Range (DOC) of 40 NM. Therefore, the potential for cumulative effect is limited to those developments, within 40 NM of the PSR, which unmitigated could create a cumulative impact. The parameters which make up the worst case scenario are those which would cause the greatest cumulative impact on the Leuchars PSR i.e. largest number of tallest turbines.
	Scenario 1 Seagreen Phase 1 Offshore Wind Farm	Max no. turbines: 120 Max. tip height: 280 m	
	Forthwind Offshore Wind Farm	Max no. turbines: 2 Max. tip height: 185 m	
	Offshore Renewable Energy Catapult Levenmouth	Max no. turbines: 1 Max. tip height: 195.6 m	
	Forthwind Offshore Wind Demonstration Project Phase 2	Max no. turbines: 7 Max. tip height: 225 m	
Cumulative impact of wind turbines causing	Scenario 1 Inch Cape Offshore Wind Farm	Max no. turbines: 72 Max. tip height: 291 m	The operational range of RRH Brizlee Wood and RRH Buchan ADR systems is unknown

Impact	Project	Worst Case Design Scenario	Justification
persistent interference on RRH Brizlee Wood and RRH Buchan ADRs from reflected turbine signals	Scenario 1 Seagreen Phase 1 Offshore Wind Farm	Max no. turbines: 120 Max. tip height: 280 m	however; it is expected to be in the region of 200 NM radius from the location of the ADRs. Therefore, the potential for cumulative effect is limited to those developments, within 200 NM of the ADRs, which unmitigated could create a cumulative impact. The parameters which make up the worst case scenario are those which would cause the greatest cumulative impact on the ADRs i.e. largest number of tallest turbines.
	Hywind Scotland Pilot Park	Max no. turbines: 5 Max. tip height: 178 m	
	Blyth Offshore Demonstrator Wind Farm Phase 1 to 3	Max no. turbines: 5 Max. tip height: 191.5 m	
	Beatrice Offshore Wind Farm	Max no. turbines: 84 Max. tip height: 198.4 m	
	MORL Eastern Development Area	Max no. turbines: 186 Max. tip height: 204 m	
	MORL Eastern Development Area (Alternative Design) a.k.a. Moray East Offshore Wind Farm	Max no. turbines: 100 Max. tip height: 280 m	
	European Offshore Wind Deployment Centre	Max no. turbines: 8 Max. tip height: 191 m	
	Forthwind Offshore Wind Farm	Max no. turbines: 2 Max. tip height: 185 m	
	Offshore Renewable Energy Catapult Levenmouth	Max no. turbines: 1 Max. tip height: 195.6 m	
	Kincardine Floating Offshore Wind Farm	Max no. turbines: 7 Max. tip height: 191 m	
	Moray West Offshore Wind Farm	Max no. turbines: 90 Max. tip height: 272 m	
	Forthwind Offshore Wind Demonstration Project Phase 2	Max no. turbines: 7 Max. tip height: 225 m	

12.8.2.1 Operational Phase Impacts

91. As set out in Table 12.10, there are a number of other operational and proposed wind farms, at various stages in the planning process, within the vicinity of the Wind Farm Area.

12.8.2.1.1 Creation of Wind Turbine Induced Clutter to the Leuchars PSR System

92. It is assumed that those wind farms, both offshore and onshore, that are operational, have technical mitigation in place (if required), which will remove effects to those radar systems that require it, within radar LoS. Currently, for radar systems for which impacts are not mitigated it is assumed that any effects are deemed acceptable; however, the addition of unmitigated clutter created by the Project wind turbines could create a cumulative effect where existing detectable wind turbines are currently considered manageable.

93. The Offshore Renewable Energy Catapult (Levenmouth) turbine and the Forthwind Offshore Wind Farm received no objections from the MOD (DIO) with reference to effect on Leuchars PSR and are therefore no considered further in this assessment. 2B Energy state in their Scoping Report for the Forthwind Offshore Wind Demonstration Project Phase 2 that the MOD (DIO) have confirmed they do not object to the development.

94. As discussed in Section 12.8.1.2.1, radar propagation modelling provided in Appendix 12.1 indicates that the Wind Farm Area is likely to be detectable by the PSR at Leuchars Station. It is expected that due to the distances to the Inch Cape and Seagreen Phase 1 wind farms, and the lack of intervening terrain, it is likely that all three wind farms would be detectable by the Leuchars Station PSR. In addition, the wind farms are located in areas where controllers using the Leuchars Station PSR are required to detect and control aircraft, depending on the service provided. As per the Project alone, this could hamper the controllers' ability to distinguish actual aircraft returns from those created by the wind farms. Radar detectability of the wind farms would create, in effect, a large area within which significant clutter can be expected. It is evident that, as larger areas are covered and the extent of the clutter increases, the availability of uncluttered airspace reduces.

95. The sensitivity of the receptor is high. The magnitude of impact would remain high; therefore, the cumulative impact would be of major significance, which is significant in EIA terms.

12.8.2.1.2 Creation of Wind Turbine Induced Clutter to the RRH Brizlee and RRH Buchan ADR Systems

96. Wind turbines detectable by a radar system might degrade the system by creating 'false' targets, reduce system sensitivity, create radar shadowing behind the turbines and saturate the radar receiver leading to clutter potentially concealing real aircraft targets. It is assumed that those wind farms, both offshore and onshore, that are operational have technical mitigation in place (if required), which will remove effects on any radar systems within radar LoS. Currently, for radar systems for which impacts are not mitigated it is assumed that any effects are deemed acceptable; however, the addition of unmitigated clutter created by the Project wind turbines could create a cumulative effect where existing detectable wind turbines are currently considered manageable

97. 'False' targets might potentially conceal real aircraft targets under control and also those targets that might be conflicting to aircraft under control of air defence controllers, leading to potential reduction of safety margins. Other radar detectable developments within the individual operational range of the two ADR systems may create adverse technical impact; the appearance of multiple 'false' targets created by wind turbines in close proximity can lead to degradation of radar tracking ability leading to a significant cumulative effect.

98. The Beatrice Offshore Wind Farm, MORL Eastern Development Area, MORL Eastern Area (Alternative Design) a.k.a. Moray East Offshore Wind Farm, the Moray West Offshore Wind Farm, the Offshore Renewable Energy Catapult (Levenmouth) turbine and the Forthwind Offshore Wind Farm have no objections from the MOD (DIO) on the basis of ADR. These projects have therefore not been considered further in this cumulative assessment.

99. 2B Energy state in their Scoping Report for the Forthwind Offshore Wind Demonstration Project Phase 2 that the MOD (DIO) have confirmed they do not object to the development.

100. As discussed in Section 12.8.1.2.3, radar propagation modelling provided in Appendix 12.1 indicates that the Wind Farm Area is likely to be detectable by RRH Brizlee Wood, but theoretically not by RRH

Buchan. Until the results of the requested MOD (DIO) assessment of impact to its radar systems are known both RRH Brizlee Wood and RRH Buchan ADR systems are included within the cumulative assessment. There will be potential for cumulative effect, dependent on the radar detectability of the Projects to the two ADR systems which are located in areas where controllers using the ADR systems are required to detect and control aircraft.

101. It is understood that the Hywind Scotland Pilot Park, the European Offshore Wind Deployment Centre and the Kincardine Floating Offshore Wind Farm all either have mitigation in place, or have a consent condition in place, to mitigate their impact on the RRH Buchan ADR.

102. The Blyth Offshore Demonstrator Wind Farm Phase 1 to 3 has a consent condition in place to mitigate its impact on the RRH Brizlee Wood ADR.

103. On the basis of information provided in the scoping report and scoping opinion for the Seagreen Phase 1 Offshore Wind Farm and the Inch Cape Offshore Wind Farm, the developments are understood to be potentially detectable to both the RRH Brizlee Wood and RRH Buchan ADRs.

104. It is implicit that the more sites that are proposed or built, the greater the impact on the provision of radar services. In effect, a larger area within which significant clutter can be expected will be created. Without mitigation, the Project would likely create cumulative effects on RRH Brizlee Wood and Buchan ADR systems with these other projects, in terms of the area affected by radar clutter and the distances between areas of clutter on the RDDS.

105. The sensitivity of the receptor is high. The magnitude of impact would remain high; therefore, the cumulative impact would be of major significance, which is significant in EIA terms.

12.8.3 Inter-relationships

106. This chapter has an inter-relationship with Chapter 11: Shipping and Navigation. Aviation lighting to offshore wind turbines could cause confusion to maritime activities as the specification for lighting to be displayed below the horizontal plane of the light fitment itself could cause mariners some confusion. Work has been undertaken to develop an aviation warning light standard which is clearly distinguishable from maritime lighting. Within CAP 764 (CAA, 2016b) the CAA state that where it is evident that the default aviation warning lighting standard for offshore obstacles may generate issues for the maritime community, a developer can make a case, that is likely to receive CAA approval, for the use of a flashing red Morse Code Letter 'W' instead. There is however, no intent to change the lighting intensity specifications set out for offshore obstacles; indeed, those specifications remain the default aviation warning lighting requirement. A detailed Lighting and Marking Plan will be submitted which will be discussed and agreed with the CAA and MCA prior to construction.

107. The Project will be designed as per MGN 543. Annex 5 specifies 'Standards and procedures for generator shutdown and other operational requirements in the event of a SAR, counter pollution or salvage incident in or around an Offshore Renewable Energy Installation (OREI)'; and creation of an Emergency Response Co-operation Plan (ERCoP) based on the Maritime and Coastguard Agency (MCA) template and site Safety Management Systems (SMS), in consultation with the MCA. Procedures will be the followed in the event of an emergency during all phases.

12.9 Mitigation and Monitoring

108. The assessment of impacts, both in isolation and cumulatively, on aviation receptors as a result of the operation of the Project are predicted to be of minor, moderate and major significance. In addition to the embedded mitigation set out in Section 12.7.1 a number of further mitigation measures have been identified to reduce or manage the residual effects.

12.9.1 Leuchars Station PSR

109. Analysis has concluded that the Project would be theoretically detectable by the Leuchars Station PSR system. The effect of the detectability of the Offshore Wind Farm to the Leuchars Station PSR would result in an unacceptable effect on Leuchars Station operations and would therefore require the implementation of an agreed mitigation strategy.

110. The airspace regulator, the CAA, has approved an Airspace Change Proposal for the introduction of a TMZ over the Wind Farm Area. The Airspace Change occurs in two stages; stage one includes radar blanking of the Leuchars Station PSR; stage two is the introduction of the TMZ covering the Wind Farm Area.

111. The carriage and operation of transponder equipment in the aircraft is mandatory whilst flying within a TMZ, this enables a controller to track the aircraft using the data from its SSR transponder and provide a SSR Alone radar service. The TMZ is considered an interim solution, until an enduring technical solution is identified, tested and implemented, that will remove any unwanted effect created by the Project to the Leuchars Station PSR until the enduring solution is found.

112. The MOD has previously accepted the TMZ as an interim solution ahead of any enduring technical solution. With the agreed two stage TMZ mitigation in place, the sensitivity of the receptor is high, and the magnitude of impact is negligible; therefore, the residual impact would be of minor significance, which is not significant in EIA terms.

113. With regard to cumulative effects, it is understood that a TMZ has also been approved for the Inch Cape Offshore Wind Farm. It is assumed that such an arrangement will also be agreed for Seagreen Phase 1 Offshore Wind Farm if required.

114. Cumulatively, and assuming TMZ mitigation is in place for all the wind farms, the sensitivity of the receptor is high, and the magnitude of the impact is negligible; therefore the residual cumulative impact would be of minor significance, which is not significant in EIA terms.

12.9.1.1 Enduring Technical Solution

115. Previous technical mitigation solutions accepted by the MOD (DIO) for radar impacts have included 'in-fill' solutions. A resolution in-fill solution involves the removal of PSR data where radar clutter is anticipated in the vicinity of the wind turbines, and replacing it with an alternate radar source which is not affected by radar clutter. A number of emerging technologies may potentially offer acceptable technical mitigation (no one technology has been proven against an offshore wind farm of this kind) for ATC radar impacts and have been considered by some airports across the UK in wind farm mitigation procurement activities. Consultation with the MOD (DIO) is continuing to establish an enduring technical solution for the Leuchars Station PSR.

116. With respect to cumulative effects, it is understood that the developers of the Inch Cape Offshore Wind Farm are also engaging in discussions regarding an enduring technical solution. Given that the Seagreen Offshore Wind Farm also has an objection on the basis of the Leuchars Station PSR, it is expected that the developer will also engage in discussions with the MOD (DIO) regarding an enduring mitigation solution.

12.9.2 Leuchars Station PAR

117. There is no technical mitigation solution for the impact the turbines create to the PAR system at Leuchars Station. NnGOWL has therefore committed to not siting any wind turbines within the PAR 'Protection Zone' (Safeguarded Area), including turbine blades, to remove the potential for radar detectability of any element of a turbine.

118. With the above mitigation in place, the sensitivity of the receptor is high and the magnitude of impact is negligible; therefore, the residual impact would be of minor significance, which is not significant in EIA terms.

12.9.3 RRH Brizlee Wood and RRH Buchan ADRs

119. Radar LoS analysis indicates that RRH Brizlee Wood is likely to detect wind turbines of 208 m above LAT within the Wind Farm Area. Ongoing consultation with the MOD (DIO) aims to ascertain its position regarding the potential that the Project may be detectable by RRH Buchan, and its assessment of whether any operational impact would be apparent. It is likely that the MOD (DIO) would need to consider the cumulative effects of multiple wind farms in the region as there might be limitations on the signal processing capability of the ADR TPS-77 radar system to implement a technical solution for other offshore wind farms within the area (consented and in development) which are also detectable by the RRH Brizlee Wood and RRH Buchan ADRs.

120. RRH Brizlee Wood and RRH Buchan (which have been upgraded to TPS-77 radar standard) have an inherent resilience, utilising hardware and software, to wind turbine induced clutter through the use of pulse Doppler processing. However, where the inherent radar performance is not considered satisfactory for ADR purposes, the TPS-77 has an enhanced signal processing capability, which enables the implementation of a Non-Automatic Initiation Zone (NAIZ).

121. A NAIZ prevents the radar from automatically creating tracks from any returns that originate within the lateral confines of the NAIZ. In creating a NAIZ around a wind farm, none of the wind turbine radar returns will be processed, thereby significantly reducing the possibility of unwanted tracks. Mature tracks, which have been formed from returns originating outside the NAIZ (an aircraft transiting through the NAIZ) will still be tracked and updated. If it is concluded that the addition of NAIZ to the TPS-77 at RRH Brizlee Wood and RRH Buchan is not suitable, NnGOWL will consult with MoD regarding other technical mitigation solutions prior to construction.

122. With the above mitigation in place, the sensitivity of the receptor is high and the magnitude of impact is negligible; therefore, the impact would be of minor significance, which is not significant in EIA terms.

123. Should the Seagreen Phase 1 Offshore Wind Farm and Inch Cape Offshore Wind Farm also be visible to RRH Brizlee Wood or RRH Buchan ADR, it is expected that the developers would also engage in discussions with the MOD (DIO) regarding mitigation. Cumulatively, with the above mitigation in place, the sensitivity of the receptor is high, and the magnitude of the impact is negligible; therefore the residual cumulative impact would be of minor significance, which is not significant in EIA terms.

12.9.4 Military PEXA

124. Military PEXA activity within TRA 007A may be impacted by the creation of clutter onto an RDDS displaying data from radar systems assessed in this EIA. Mitigation of radar impact as detailed in Section 12.9.2 and 12.9.3 above, will remove impact to military PEXA activity.

125. The sensitivity of the receptor is high. The magnitude of impacts is assessed as negligible; therefore, the impacts would be of minor significance, which is insignificant in EIA terms.

12.9.5 Use of Helicopters for O&M of the Offshore Wind Farm

126. The physical presence of the wind turbines within the Wind Farm Area has the potential to represent a collision risk to helicopters operating in the vicinity of the Wind Farm Area in support of O&M. As detailed in Section 12.8.1.3, a range of embedded mitigation measures are already in place to reduce the risk of collision.

127. Since the assessment concluded that the effect was minor and not significant in EIA terms, no further mitigation is proposed.

12.10 Summary of Residual Effects

128. This chapter has assessed the potential effects on aviation of operation of the Project, both in isolation and cumulatively. Where significant effects were identified, additional mitigation has been considered

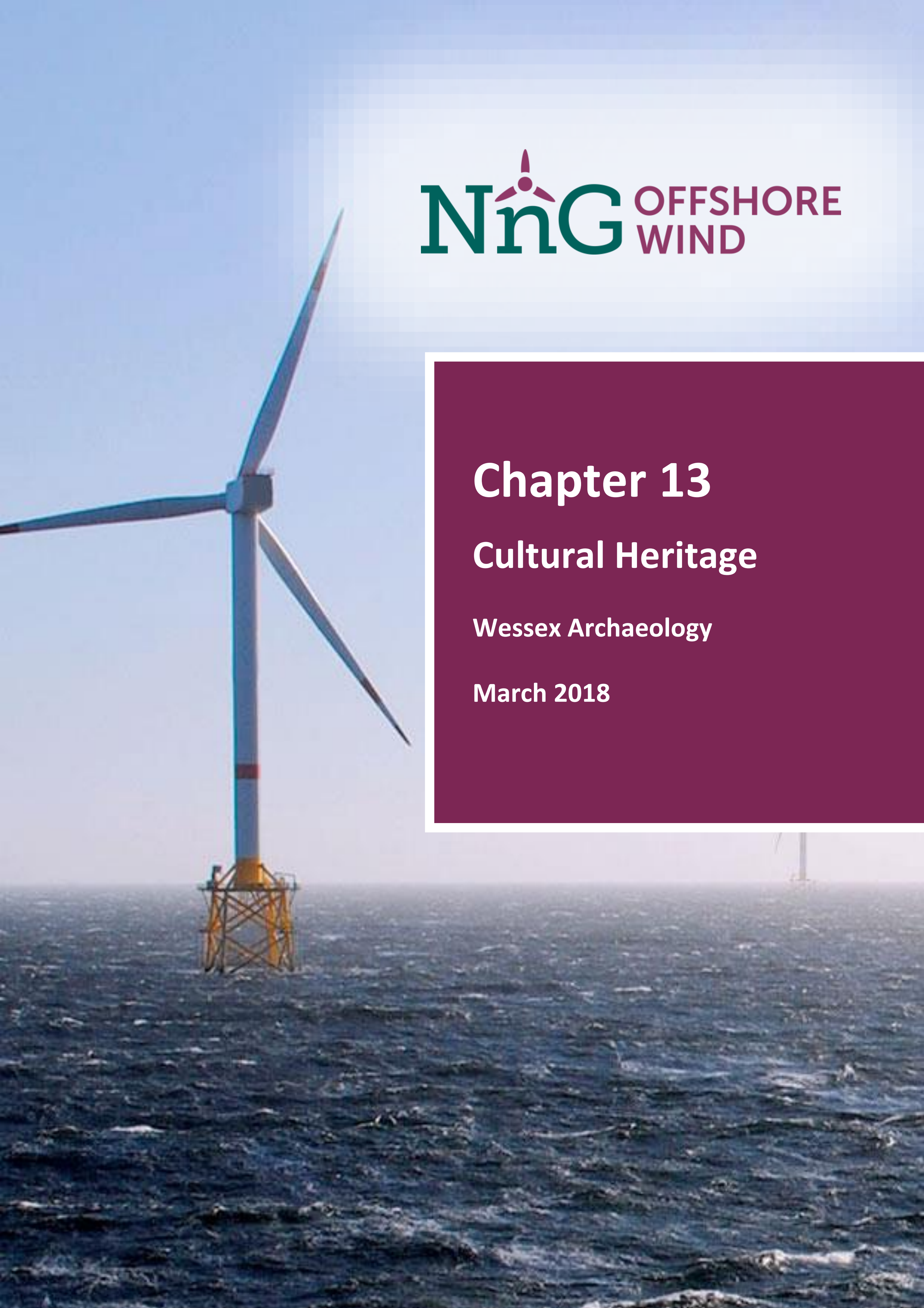
and incorporated into the assessment. Table 12.12 summarises the impact determinations discussed in this chapter and presents the post-mitigation residual significance.

Table 12.12 Summary of predicted impacts of the Project – Aviation.

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Operation			
Wind turbines causing persistent interference to the Leuchars Station PSR from reflected turbine signals	Major (significant)	Mitigation in the form of the regulator approved TMZ and associated radar blanking will remove the wind turbine radar returns from the Leuchars Station PSR RDDS until an enduring technical solution is established and agreed.	Minor (not significant)
Wind turbines causing persistent interference to the Leuchars Station PAR from reflected turbine signals	Major (Significant)	The removal of wind turbine infrastructure including overlap from rotation of turbine blades from the Leuchars Station PAR Safeguarded Area will remove any impact to the PAR system.	Minor (not significant)
Wind turbines causing persistent interference to RRH Brizlee Wood and RRH Buchan ADR from reflected turbine signals	Major (significant)	Subject to stakeholder approval, technical mitigation in the form of a NAIZ will remove impact to the Brizlee Wood and Buchan ADR systems. If this mitigation solution is not applicable a technical mitigation solution will be agreed with the MOD before construction.	Minor (not significant)
Effects on Activities carried out in military PEXA	Major (significant)	Removal of wind turbine induced clutter through NAIZ mitigation on the ADRs. If this mitigation solution is not applicable a technical mitigation solution will be agreed with the MOD before construction.	Minor (not significant)
Use of helicopters for O&M of the Wind Farm Area	Minor / Negligible (not significant)	n/a	Minor (not significant)
Cumulative Effects			
Wind turbines causing persistent interference to RAF Leuchars PSR	Major (significant)	Mitigation in the form of the regulator approved TMZ and associated radar blanking will remove the wind turbine generated radar returns from the Leuchars Station PSR RDDS until an enduring technical solution is established and agreed.	Minor (not significant)
Wind turbines causing persistent interference to RRH Brizlee Wood and RRH Buchan ADRs.	Major (significant)	Removal of wind turbine induced clutter through NAIZ mitigation on the ADRs. If this mitigation solution is not applicable a technical mitigation solution will be agreed with the MOD before construction.	Minor (not significant)

12.11 References

- CAA. (2014). *CAP 168 Licensing of Aerodromes.*
- CAA. (2014a). *CAP 670 Air Traffic Services Safety Requirements.*
- CAA. (2016). *CAA Airspace Change Decision Introduction of the Neart na Goaithe (NNG) and Inch Cape (IC) TMZs.*
- CAA. (2016a). *CAP 437 Standards for Offshore Helicopter Landing Areas.*
- CAA. (2016b). *CAP 764 Policy and Guidelines on Winbd Turbines.*
- CAA. (2016c). Visual Flight Rules Charts.
- CAA. (2017). *CAP 393 The Air Navigation Order 2016 and Regulations.*
- DECC. (2011). *National Pollicy Statement for Renewable Energy Infrastructure (EN-3).*
- DECC. (2011a). *Overarching National Policy Statement for Energy (EN-1).*
- DECC. (2011b). *Overarching National Policy Statement for Energy (EN-1).*
- MAA. (2014). *Manual of Aerodrome Design and Safeguarding.*
- MCA. (2016). *MGN 543 Safety of Navigation Offshore Renewable Energy Installations.*
- MOD. (2017). *Military Aeronautical Information Publication.*
- NATS. (2017). *CAP 032 UK Integrated Aeronautical Information Package.*
- Osprey. (2017). *Additional radar line of sight analysis.*



Chapter 13

Cultural Heritage

Wessex Archaeology

March 2018

Table of Contents

Table of Figures (within Volume 2)

Table of Tables

13 Cultural Heritage

13.1 Introduction

1. This chapter of the EIA Report presents an assessment of the potential impacts upon the setting of archaeology and cultural heritage receptors, both onshore and offshore arising, from the construction, operation and decommissioning of the Project, as detailed in Chapter 4: Project Description (at the site location illustrated in Figure 13.1 (Volume 2)).

2. The assessment is based upon a combination of the understanding of the Project in terms of the potential for impact and the resultant effects on receptors that were identified within the study area.

3. This chapter is comprised of the following elements:

- A summary of relevant policy, guidance and legislation;
- Details of the baseline data sources used to characterise the study area;
- A summary of the relevant consultations with stakeholders;
- A description of the methodology for assessing the impacts of the Project, and approach to the assessment of potential effects;
- A review of the baseline conditions;
- A description of the worst-case design scenario relevant to archaeology and cultural heritage;
- An assessment of the likely effects for the construction, operation and decommissioning phases of the Project, including cumulative effects;
- Identification of any further mitigation measures or monitoring requirements in respect of any significant effects; and
- A summary of the residual impact assessment determinations taking account of any additional mitigation measures identified.

4. In addition to the assessment on settings this chapter presents a refresh of baseline information following data requests to the UK Hydrographic Office (UKHO), Historic Environment Scotland (HES), Angus Historic Environment Record (AHER), East Lothian Historic Environment Record (ELHER) and Fife Historic Environment Record (FHER). The refresh of the maritime archaeology baseline has been used to inform the Project embedded mitigation strategy (see Section 13.7.1) to ensure the adequacy of the mitigation measures assumed for the Project.

13.2 Policy, Guidance and Legislation

5. In undertaking the assessment, the following legislation has been considered (see Table 13.1 for more details):

- Ancient Monuments and Archaeological Areas Act 1979;
- Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997; and,
- Marine (Scotland) Act 2010.

6. The principal policy documents and information used to inform the assessment of potential impacts on archaeology and cultural heritage are as follows:

- Scottish Planning Policy (SPP) (The Scottish Government, 2014);
- Scotland’s National Marine Plan (The Scottish Government, 2015); and
- Historic Environment Scotland (HES) Policy Statement (HES, 2016a);

Table 13.1: Legislation and policy context.

Policy / Legislation	Key Provisions	Section where requirement is addressed
Ancient Monuments and Archaeological Areas Act 1979	Legal protection for scheduled cultural heritage receptors of national importance.	Impacts to the setting of scheduled cultural heritage receptors of national importance are discussed in Section 13.7.2. These are identified in Section 13.6.1.
Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997	Legal protection for designated cultural heritage receptors of local, regional and national importance.	Impacts to the setting of cultural heritage receptors of national importance are discussed in Section 13.7.2. These are identified in Section 13.6.1.
Marine (Scotland) Act 2010	Provides for the establishment of national and regional marine plans and for offshore sites of national importance to be designated as Historic Marine Protected Areas.	The need for mitigation against impacts on identified archaeological and cultural heritage receptors is addressed in Section 13.7.1 and Section 13.9.
Scottish Planning Policy (SPP) 2014	Sets out the role of the planning system in protecting ancient monuments, archaeological sites and landscapes.	The standards and guidance within this document are applied to all discussions of impacts on cultural heritage receptors in Section 13.7.2.
Scotland's National Marine Plan 2015	This includes statements on the need for appropriate mitigation of offshore development on cultural heritage (General Planning Principle 6 in Chapter 4 of the document).	The need for mitigation against impacts on identified archaeological and cultural heritage receptors is addressed in Section 13.7.1 and Section 13.9.
HES Policy Statement	Sets out guidance for the implementation of SPP 2014 in relation to the Historic Environment.	The standards and guidance within this document are applied to all discussions of impacts on cultural heritage receptors in Section 13.7.2.

7. Additional guidance documents utilised to inform the assessment of potential impacts on archaeology and cultural heritage are as follows:

- Planning Advice Note 2/2011: Planning and Archaeology (The Scottish Government, 2011);
- Managing Change in the Historic Environment: Setting (HES, 2016b);
- The Code of Practice for Seabed Developers (The Joint Nautical Archaeology Policy Committee (JNAPC), 2006);
- Collaborative Offshore Wind Research Into the Environment (COWRIE), Historic Environment Guidance for the Renewable Energy Sector (Wessex Archaeology, 2007);
- COWRIE Guidance for Assessment of Cumulative Impact on the Historic Environment from Offshore Renewable Energy (Oxford Archaeology, 2008); and
- Standard and Guidance for Desk Based Assessment (Chartered Institute for Archaeologists, revised 2014).

13.3 Data Sources

8. The assessment considers the potential interaction between the Project, as described in Chapter 4: Project Description, cultural heritage receptors within the study area as required by the Scoping Opinion.

9. The cultural heritage study area for the setting analysis of onshore cultural heritage receptors is defined by the zone of theoretical visibility (ZTV) of the Offshore Wind Farm using the maximum blade tip height.

10. The cultural heritage study area for refreshing the maritime archaeological baseline was the Development Area and Export Cable Corridor plus a 1 km buffer.

11. Baseline characterisation data has been collated combining a thorough desk-based study of extant Historic Environment Record (HER) data supplemented with a series of site visits to selected designated onshore cultural heritage assets detailed in the Scoping Opinion and agreed through further consultation with stakeholders (see Section 13.4). Table 13.2 details the data sources used to inform the baseline characterisation within the study area.

Table 13.2: Data sources used to inform the baseline description

Data Source	Study/Data Name	Overview
UK Hydrographic Office (UKHO)	Data request from UKHO dataset. Requested by WA.	Data request for Recorded Wrecks and Obstructions within the marine archaeology study area.
Historic Environment Scotland (HES)	Data request from HES dataset. Requested by WA.	Data request for Recorded Losses, maritime and aviation archaeology, and cultural heritage receptors within the study areas.
FHER	Data request from FHER dataset. Requested by WA.	Identification of archaeology and cultural heritage receptors likely to have their setting changed due to Project construction/operation.
AHER	Data request from AHER dataset. Requested by WA.	Identification of archaeology and cultural heritage receptors likely to have their setting changed due to Project construction/operation.
ELHER	Data request from ELHER dataset. Requested by WA.	Identification of archaeology and cultural heritage receptors likely to have their setting changed due to Project construction/operation.

12. NnGOWL commissioned site-specific geotechnical and geophysical surveys which were carried out in the vicinity of the Development Area, and data requests from national and regional repositories for recorded archaeology and cultural heritage receptors were made. Figure 13.2 (Volume 2) presents the known cultural heritage assets with proposed Archaeological Exclusion Zones (AEZs). Regional collaborative studies on sediment movement were also commissioned jointly by NnGOWL and Inch Cape Offshore Limited (ICOL) covering the outer Firth of Forth and Tay area in and around the Development Area and the Inch Cape Offshore Wind Farm.

13. WA conducted site visits to each of the identified onshore receptors for the setting analysis, as well as utilising wirelines and photomontages provided by the NnGOWL commissioned SLVIA consultants LUC.

13.4 Relevant Consultations

14. As part of the EIA process, NnGOWL has consulted with various, relevant statutory and non-statutory stakeholders. A formal scoping opinion was requested from MS-LOT following submission

of the Scoping Report. In response to NnGOWL's request, MS-LOT issued a Scoping Opinion within which HES noted that a re-assessment of impacts on marine archaeology was not required and therefore should be scoped out. It was subsequently confirmed that MS-LOT were also of this opinion. Additionally, all potential physical cultural heritage should be scoped out, as identified seabed features and submerged prehistory are mitigated for by the inclusion of the embedded mitigation (Section 13.7.1).

15. MS-LOT also identified a number of issues that could not be scoped out of the assessment. Table 13.3 summarises the comments received from stakeholders and where they have been addressed within this EIA in respect of archaeology and cultural heritage.

Table 13.3: Summary of consultation relating to archaeology and cultural heritage.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
08/09/17, Scoping Opinion – Scottish Ministers	The Scottish Ministers agreed that the existing data available, with the proposed updated data requests as noted in the Scoping Report, to describe the archaeology and cultural heritage baseline were sufficient to inform this EIA.	See Section 13.6
	The Scottish Ministers agreed that, with the exception of blade tip height, the assessment scenario previously applied in conducting the Original EIA represents the worst-case scenario when compared to the project design envelope for the Project. The Scottish Ministers noted that impacts on the setting of cultural heritage assets from the potential increase in blade tip height should be scoped into the EIA for the Project and recommended that NnGOWL provide justification for the worst-case scenario considered in the assessment.	See Section 13.8
	The Scottish Ministers agreed that the embedded mitigation described within the Scoping Report provides a suitable means for managing and mitigating the potential effects of the Project on the archaeology and cultural heritage receptors. The Scottish Ministers noted the concerns of East Lothian Council (ELC) and recommended that NnGOWL describe how the embedded or other potential mitigation strategies will suitably manage and mitigate the potential effects.	See Section 13.7.1
	The Scottish Ministers agreed that an updated settings analysis, in conjunction with any updated Seascape Landscape and Visual Impact Assessment (SLVIA) is required. The Scottish Ministers also noted the concerns of Angus Council with respect to Bell Rock lighthouse and Arbroath signal tower and recommended that NnGOWL continue discussions with appropriate stakeholders with regard to setting changes.	See Section 13.6
	The Scottish Ministers agree that the cumulative effects on archaeology and cultural heritage receptors should be scoped in to the Project EIA only where it applies to impacts on the settings of cultural heritage assets, based on the increase in turbine size for the Project.	See Section 13.8.4

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
08/09/2017, Scoping - HES	HES confirm that there are no marine or terrestrial heritage assets within their remit located within the Development Area. HES note that it is proposed to scope direct impacts on marine archaeology out of the EIA assessment. In light of the previous survey work undertaken, and the detailed baseline data available, HES are content that this is acceptable for their interests. HES welcome the identified mitigation measures for direct impacts. These include AEZs, a written scheme of investigation (WSI), and a protocol for archaeological discoveries (PAD). HES would be happy to provide comments on any of these elements of the scheme	N/A
	HES can confirm that there are a number of terrestrial heritage assets within a seascape setting in the vicinity of the Development Area which may be affected by the Project. There is the potential for cumulative impacts on the setting of terrestrial heritage assets caused by the development of the Project both alone and cumulatively with other existing and proposed offshore wind farms in the area. In this case, HES also recommend that cumulative impacts be carefully considered. HES welcome the fact that impacts on the setting of cultural heritage assets are to be scoped in to the assessment, and that reference has been made to HES' revised Managing Change guidance note on 'setting' in the Scoping Report. HES also note that potential cumulative effects have also been identified for assessment. HES support this approach and also welcome where it is proposed to ensure that appropriate mitigation is embedded into the Project.	See Sections 13.6 and 13.8
08/09/2017, Scoping - East Lothian Council	In terms of the historic environment, ELC notes that indirect setting impacts on East Lothian are scoped in and supports this. The indirect impacts should be identified by first producing a ZTV and identifying the heritage receptors, which need to be further assessed. This should be done in consultation with East Lothian Council Archaeology Service (ELCAS). ELC note that, although complimentary, a Heritage Assessment is not the same as a LVIA assessment.	See Sections 13.6 and 13.8.2 and Chapter 14: SLVIA
	With regard to existing data, ELC agrees that the baseline data from UKHO, HES and the two council Historic Environment Records will need to be refreshed.	See Section 13.6
	ELC states that it is not clear that the embedded mitigation described provides a suitable means for managing and mitigating the potential effects of the Project on the archaeology and cultural heritage receptors.	The refresh of baseline information has been undertaken to confirm the adequacy of the embedded mitigation, see Section 13.7.1.
	ELC request that the impact of turbine height and layout to the setting of onshore receptors be reassessed because of the increase in turbine height, and any potential mitigation strategies for indirect impacts should be included within the EIA as appropriate.	See Section 13.8.2

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	ELC agrees that the changes in turbine number and increase in blade tip height require an updated Settings analysis, in conjunction with any updated SLVIA analysis. This should include producing a ZTV and identifying the onshore heritage receptors, which need to be further assessed, in consultation with ELCAS. It should be noted that additional heritage specific visualisations may be required in the updated setting assessment.	See Section 13.8.2
	ELC agrees that the cumulative effects on archaeology and cultural heritage receptors should be scoped in to the Project EIA only where it applies to impacts on the settings of cultural heritage assets, based on the increase in turbine size for the Project.	See Section 13.8.4
26/10/2017. ELCAS additional Scoping clarifications via email	ELCAS response on whether additional sites should be assessed in East Lothian for setting effects. They have requested additional setting assessment on five sites within East Lothian, as follows: ▪ Dunbar Battery; ▪ Dunbar Castle and Castle Park; ▪ Tantallon Castle; ▪ North Berwick Law; and ▪ Doon Hill Forts.	See Sections 13.6 and 13.8.2
08/12/2017 MS-LOT – Scoping clarifications via email	MS-LOT confirmed on behalf of the Scottish Ministers that direct physical impacts on maritime archaeology receptors can be scoped out of the assessment.	n/a

16. The Scoping Report set out embedded mitigation, which will be incorporated into the Project at the design phase to mitigate any risk to archaeology and cultural heritage receptors (NnGOWL, 2017). The embedded mitigation was considered by MS-LOT in determining the scope of this assessment.

17. Although the assessment will focus on the potential impacts to setting of designated onshore and island cultural heritage receptors as agreed in the Scoping Opinion, the Project embedded mitigation, set out in Section 13.7.1, details the full list of measures relevant to marine archaeology that NnGOWL will implement during the Project lifecycle.

13.5 Impact Assessment Methodology

18. This assessment considers the potential impacts associated with the construction, operation and decommissioning of the Project and the effects on the setting of archaeology and cultural heritage receptors, both onshore and offshore (Figure 13.3 (Volume 2)). The impact assessment process and methodology follows the principles and general approach outlined in Chapter 6: EIA Methodology. The methodology and parameters assessed have also taken into account issues identified through consultation with stakeholders as detailed in Section 13.4 and the understanding of baseline conditions informed by the data sources referenced in Section 13.3.

19. The Project Description (Chapter 4) and the project activities for all stages of the project life cycle (construction, operation and decommissioning) have been assessed against the archaeological and cultural heritage baseline to identify the potential interactions between the Project and the relevant receptors. These are known as the potential impacts and are then assessed to determine a level of significance of effect upon those receptors.

20. The methodology for the assessment of setting impacts upon the cultural heritage receptors has been undertaken with reference to current guidance *Managing Change in the Historic Environment: Setting* (HES, 2016b). The approach taken is to:

- Identify the cultural heritage assets that might be affected;
- Define the setting of each asset (without reference to the Project); and
- Assess how the Project would impact upon this defined setting.

21. Cultural heritage receptors have been defined through a process of stakeholder consultation, as outlined in Section 13.4. The setting of these receptors was established through site visits to all assets in July and August 2017 excluding the Bell Rock Lighthouse (HB no. 45197), which was inaccessible, and the sites in East Lothian which were reviewed using the wireline models provided by LUC only. The potential magnitude was assessed in conjunction with SLVIA wireline models and photomontages in Section 13.8.4.

22. Most of the selected archaeology and cultural heritage receptors (or nearby locations) were also analysed in the SLVIA (Chapter 14). This assessment concentrates on the cultural heritage setting impacts, which are distinct from the aesthetic heritage setting impacts discussed within Chapter 14: SLVIA, and are identified using cultural heritage specific guidance (e.g. HES, 2016b). This setting assessment has been conducted to identify potential changes in setting which may affect the cultural heritage significance of individual receptors, distinct from the aesthetic landscapes and seascapes discussed in Chapter 14: SLVIA. There is therefore no correlation between the magnitude and significance of setting impacts identified within each chapter, even if a receptor is analysed in both.

23. Setting as defined in the HES guidance (2016b) includes both visual factors and the contributions of the surroundings to the experience, understanding and appreciation of a cultural heritage asset. It is noted that the distances between the Wind Farm Area and the onshore receptors are considerable in almost all cases. Any significant indirect impacts on the setting of receptors that do not directly reference the sea due to their historic function will therefore only be considered minor impacts.

24. The assessment of the impact to the setting of cultural heritage receptors remains rooted in the professional judgement of the assessor; however, a number of key factors can be noted which are considered in defining the setting of a receptor. These include the prominence of the receptor within views of the surrounding area, key vistas from the receptor and the relationship between built and natural features. The assessment of setting effects on a cultural heritage receptor is therefore complex and not simply a function of the proximity or intervisibility of the development in question.

25. It is also noted that impacts on setting relating to the construction and decommissioning of the Wind Farm and Offshore Export Cable will be short term and temporary. The assessment of setting impacts therefore focuses solely on the operational impacts arising from the Wind Farm.

13.5.1 Assessment and Assignment of Significance

26. The sensitivities of the setting of archaeology and cultural heritage receptors are defined variously by their potential sensitivity to an impact, their recoverability and importance of the receptor.

27. The potential importance of a receptor to setting changes is firstly based on relevant statutory designations e.g. scheduling under the Ancient Monuments and Archaeological Areas Act 1979 or Category ‘A’ listed buildings through the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 or through non-statutory designations e.g. Inventory Battlefields and Inventory Gardens and Designed Landscapes. These are all considered as nationally important, with all nationally designated receptors assigned as being of high importance.

28. In accordance with the Scottish Government and local historic environment and planning policies noted in Section 13.2, while designation indicates that a receptor has been identified as being of high value, non-designated heritage assets are not necessarily of lesser importance. Relatively few archaeological sites are designated, and non-designated receptors that can be demonstrated to be

of equivalent value to designated sites should be considered subject to the same policies. The value of non-designated receptors is therefore attributed based on the historical importance at an international, national, regional or local scale and the potential for identifying alternative examples of the receptor.

29. The sensitivity of a receptor to setting impacts can be more finely assessed through site visits and analysis of the surroundings of the site, for example, does it have intervisibility with the Offshore Wind Farm? Does it specifically reference the Offshore Wind Farm Area or deliberately ignore it? Is the view important to the function and/or appreciation of the site?

30. To inform the potential level of change induced by the Offshore Wind Farm, wireline models and photomontages showing the Offshore Wind Farm from a given viewpoint, within or close to the receptor, are also consulted. It is noted that the setting impacts will cease upon decommissioning of the Project, which would give all impacts a high degree of recoverability; however, all operational impacts should be assumed to be at least semi-permanent in relation to the operational life of the Project (i.e. 50 years). The definitions of terms relating to setting of archaeology and cultural heritage are detailed in Table 13.4 below.

Table 13.4: Definition of term relating to the environmental value (sensitivity of the receptor) (adapted from Highways Agency et al., 2008).

Value (sensitivity of the receptor)	Description
High	High or very high importance and rarity (World Heritage Sites, Scheduled Monuments, Category A Listed Buildings, some Inventory Battlefields), Receptor known and valued on an international or national scale, limited potential for substitution.
Medium	High or medium importance and rarity (Category B Listed Buildings, some Inventory Battlefields, Historic Gardens and Designed Landscape), Receptor known and valued on a regional scale, limited potential for substitution.
Low	Low or medium importance and rarity (Category C Listed Buildings, non-designated buildings of local interest), Receptor known and valued on a local scale.
Negligible	Very low importance and rarity (non-designated buildings of limited local interest) Receptor known and valued on a local scale.

31. The magnitude of impact is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact. The definitions of the levels of magnitude used in this assessment in respect of the setting of archaeology and cultural heritage are described in Table 13.5.

32. The magnitude of an impact considers the level of change to a receptor's setting - the magnitude of a 4-storey building in close proximity to the asset would be judged to potentially induce a larger magnitude adverse impact than a 20-storey building four miles away. Several factors can affect the overall magnitude of an impact including:

- Obstruction of or distraction from key views - some assets are placed deliberately in the landscape to be afforded a certain view which visitors can still enjoy e.g. prehistoric tombs overlooking a particular bay or the designed vista of a country house;
- Changes in prominence - Assets can be placed on a prominent place in the landscape, which is key to their importance and experience e.g. ridgetop cairns and castles on hilltops;
- Changes in landscape character - Assets may be linked to a particular land use, the changing or removal of which may compromise their setting and the importance of the asset as a whole e.g. the extra-mural fortifications of a town are of significance to the defensive town wall;

- Duration of impact - the longer the impact will continue, the larger the magnitude of the impact will be; and
- Reversibility of impacts - if the setting will be restored at the end of the development or can be easily reversed then it will be of lesser magnitude than an irreversible change.

Table 13.5: Definition of terms relating to the magnitude of impacts (adapted from Highways Agency et al., 2008)

Magnitude of impact	Description (adverse effects)	Description (beneficial effects)
High	Comprehensive, long term or permanent negative changes to the defined setting.	Comprehensive, long term or permanent positive changes to the defined setting.
Medium	Considerable negative medium/long term semi-permanent or long term temporary changes that affect the character of the receptor.	Considerable positive medium/long term semi-permanent or long term temporary changes that affect the character of the receptor.
Low	Minor medium/short term temporary or semi-permanent negative change that partially affect the setting of the receptor.	Minor medium/short term temporary or semi-permanent positive change that partially affect the setting of the receptor.
Negligible	Very minor or negligible temporary or semi-permanent negative change to the defined setting of the receptor.	Very minor or negligible temporary or semi-permanent positive change to the defined setting of the receptor.
No change	No change to the defined setting of the receptor in either direction.	

33. The magnitude of the impact is correlated against the sensitivity of the receptor to provide a level of significance. For the purposes of this assessment any effect that is considered major or moderate is considered to be significant in EIA terms (Table 13.6). Any effect that is minor or below is not considered significant.

Table 13.6: Significance of potential effects

		Magnitude			
		High	Medium	Low	Negligible
Sensitivity	**High**	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

34. The definitions of the levels of significance are provided in Table 13.7.

Table 13.7: Significance of impacts

Impact	Description (judgement based on receptor sensitivity and impact magnitude)	Impact significance (EIA Regulations)
Major	Impacts are likely to be highly noticeable and have long-term effects, or permanently alter the character of an internationally or nationally important asset's setting and are likely to disrupt the status and/or value of the receptor. Mitigation likely to be required to reduce or avoid significant effects.	Significant

Impact	Description (judgement based on receptor sensitivity and impact magnitude)	Impact significance (EIA Regulations)
Moderate	Impacts are likely to be noticeable and result in lasting changes to the character of a nationally or regionally important asset's setting and are likely to disrupt the status and/or value of the receptor, although the overall value of the overall baseline is not disrupted. Mitigation may be required to reduce or avoid significant effects.	Significant
Minor	Impacts are expected to comprise changes to the character of a regionally important asset's setting but are not expected to cause long term damage to the value of the receptor. However, such impacts may be of interest to stakeholders and / or represent a contentious issue during the decision-making process, and should therefore be avoided or mitigated as far as reasonably practicable.	Not significant
Negligible	Impacts are expected to be of minor consequence to a locally important asset's setting, with minimal changes overall. These impacts do not require mitigation and are not anticipated to be a stakeholder concern and/or a potentially contentious issue in the decision-making process.	Not significant

13.5.2 Uncertainty and Technical Difficulties Encountered

35. This assessment has been conducted in consideration of the worst-case design scenario and, therefore, considers the maximum impact on cultural heritage assets. This also reduces the risk of later design changes falling outside the scope of this assessment.

36. It is judged that the data utilised in the assessment of scoped-in receptors, i.e. setting effects supported by SLVIA wirelines and other modelled outputs and site visits, are sufficient for the assessment. The receptors which were visited during poor weather were all either revisited in better weather or analysed using photomontages from the SLVIA consultants LUC which were taken during better weather. Therefore, we consider there are no significant uncertainties and technical difficulties that would affect the significance assigned in the assessment process.

37. It was impossible to conduct a site visit to the Bell Rock Lighthouse. It is considered that the main setting of this receptor is based around its interaction with the Arbroath signal tower, which was revisited in better weather on 11/08/2017, and as the lighthouse itself is inaccessible to the public, it is appropriate to discuss its setting only in connection with the Arbroath signal tower.

13.6 Baseline Description

38. This section contains the results of the archaeology and cultural heritage baseline assessment. All receptors are also included in Appendices 13.1 and 13.2.

39. As proposed in the Scoping Report, a review of updated datasets from the UKHO was undertaken to establish if additional information on maritime assets was available; no new data was encountered in relation to the existing baseline gazetteer. The known archaeology and cultural heritage receptors within the Development Area are shown in Figure 13.2 (Volume 2).

40. As agreed in the Scoping Opinion, impacts to seabed prehistory, maritime and aviation archaeology resulting from construction, operation and decommissioning have been scoped out of the assessment. Therefore, the following section will refer to setting impacts during the operational phase only. Receptors identified for setting analysis are numbered using their relevant designation/catalogue number.

13.6.1 Setting: Designated Onshore and Island Cultural Heritage Receptors

41. The Offshore Wind Farm Area will be visible from a number of designated cultural heritage receptors, both on the mainland of Fife, Angus and East Lothian and on the Isle of May and Bell Rock. The Scoping Response from Historic Environment Scotland lists eleven receptors with a *"seascape setting"*, to which we have added a site, which has a setting explicitly referencing one of these sites. A further five sites were added in on consultation with ELCAS. Accordingly, the following sites have been assessed for setting impact (Figure 13.3 (Volume 2)):

13.6.1.1 Scheduled Monuments:

- Tentsmuir coastal defences (Index no. 9712);
- Crail Airfield, airfield 1 km E of Kirklands Farm (Index no. 6642);
- Crail Airfield, pillbox, Foreland Head (Index no. 6461);
- St Andrews Castle (Index no. 90259);
- St Andrews Cathedral and adjacent ecclesiastical remains (Index no. 90260);
- Isle of May Old Lighthouse (Index no. 887);
- Isle of May Priory (Index no. 838);
- Dunbar Castle and Castle Park (Index no. 766; Index no. 5960);
- Tantallon Castle (Index no. 13326);
- North Berwick Law (Index no. 3863); and
- Doon Hill forts (Index no. 5764).

13.6.1.2 Category A Listed Buildings:

- St Andrews Harbour (Historic Building (HB) no. 40596);
- Bell Rock Lighthouse (HB no. 45197);
- Arbroath signal tower (HB no. 21230); and
- Dunbar Battery (Listed Building (LB) no. 24831)

13.6.1.3 Gardens and Designed Landscapes:

- St Andrews Links (Garden and Designed Landscape (GDL) no. 00344); and
- Cambo Estate Designed Landscape (GDL no. 00080).

42. The Category 'A' listed Arbroath signal tower (HB no. 21230) in Arbroath has been assessed due to its explicit connection to the Bell Rock lighthouse.

13.6.1.3.1 Tentsmuir Coastal Defences

43. Tentsmuir coastal defences are a complex of World War II (WWII) coastal defences built because the low sandy coastline of the area was considered to be at risk from a sea-borne invasion. The scheduled area is in two parts, a large coastal strip of over 500 hectares (ha), extending over 6.6 km from north to south, and 4 km from east to west. This area contains a wide variety of defences most of which are dispersed along the back-beach of the prograding shoreline, east of Tentsmuir Forest. These include anti-glider posts, lines of anti-tank blocks, command posts, quadrant towers and pillboxes. Inland to the west of this is the site of a former army camp built for those who constructed and monitored the line, many of whom were Polish forces. The camp is situated within forest and is 590 m on its north-south axis and 190 m on its east-west axis.

44. The setting of these defences is clearly referencing the open sea, protecting Angus, Fife and the Tay Estuary from a sea-borne invasion during WWII, and so a clear vista out to sea is part of the heritage of the site as a whole. Changes that restrict this open view would potentially have an impact on the significance of the receptor. The area of defences themselves are within a thick forest, split by paths and tracks, with the coastal defences overlooking an expanse of sand dunes, a flat sandy beach and the open sea (Figure 13.4 (Volume 2)).

13.6.1.3.2 Crail Airfield

45. The airfield, built during WWI and recommissioned by the Royal Navy in WWII as a torpedo bomber training airfield for carrier-based crews, is considered one of the best-preserved WWII airfields in the UK, with almost all the hangars, outbuildings and other features remaining. It currently is used for drag and kart racing, and houses a small museum, which is occasionally open. The setting of the airfield clearly was important for the Royal Navy, who were able to conduct training for their carrier pilots close to the RN base at Rosyth. Despite this, as the airfield was neither a fighter station nor a coastal command station, the overall views out to sea are not integral to the setting of the airfield, which is more based on the flat landscape at this point in the East Neuk (Figure 13.5 (Volume 2)) and its relative proximity to Rosyth.

13.6.1.3.3 Crail Airfield Pillbox

46. This is a concrete pillbox of WWII date at the tip of Fife Ness. It comprises a pillbox with stone walls, steel lintels, and a concrete roof into which stone was set for camouflage, set at the base of a small cliff below the Fife Ness lighthouse (Figure 13.6 (Volume 2)). It commands views out into the North Sea as an observation post and coastal defence installation, and these views out to sea are integral to the function and setting of the pillbox.

13.6.1.3.4 St Andrews Castle

47. St Andrews Castle is a Property in Care, a Category A-Listed Building and a Scheduled Monument. It was first mentioned in 1200 but the present fabric largely dates to the 14th to 16th centuries. It takes the form of a partially ruined tower with an enclosure. The castle is built on a slight promontory of the rocky shoreline a few hundred metres to the northwest of the cathedral, with views out into the North Sea which are partially integral to the setting of the castle (Figure 13.7 (Volume 2)).

13.6.1.3.5 St Andrews Cathedral

48. St Andrews Cathedral is a Property in Care, a Category A-Listed Building and a Scheduled Monument. The site consists of a large walled complex of buildings including a partially ruined cathedral. The cathedral occupies a prominent position in St Andrews on an elevated site overlooking the harbour and dominating views of the town, particularly through the high visibility of its towers. The cathedral grounds are surrounded to the north, east and south by a high stonewall containing memorials on the inner face, meaning that the view out to the sea is blocked within the grounds of the cathedral and only visible from the top of the tower (Figure 13.8 (Volume 2)).

13.6.1.3.6 Isle of May Old Lighthouse

49. The Old Lighthouse on the Isle of May is a Scheduled Monument made up of the remains of a white harl painted coal-fired lighthouse built in 1636, originally 12.2 m high and square in plan. It has been reduced over time to 7.3 m. It is situated on the highest point of the Isle of May, commanding extensive views across the sea in all directions, except for to the southwest where the view is compromised by the current lighthouse. The view out to sea is evidently integral to the setting and purpose of the lighthouse, as it needed to have intervisibility with ships out at sea (Figure 13.9 (Volume 2)).

13.6.1.3.7 Isle of May Priory

50. The priory on the Isle of May is located on the southwest side of the Isle. It is a Scheduled Monument including the upstanding and excavated remains of the St Adrian's Benedictine priory, dating to the 13th Century. The main upstanding structure belongs to the Priory's accommodation, with lancet windows to the north, containing a roughly dressed font. Excavations by GUARD in the

1990s (James and Yeoman, 2008) uncovered the full ground plan of the priory, which remains exposed for visitors. The site sits above the small harbour to the east and below two hills to the west in a sheltered dip (Figure 13.10 (Volume 2)). It has open views to the east, with more restricted views to the north and west obscured by the terrain of the Isle and the more recent lighthouse buildings. The views out to sea are important but not necessarily integral to the setting of the priory, as the function of the buildings was at least in part insular.

13.6.1.3.8 Dunbar Castle and Castle Park

51. The ruins of Dunbar Castle stand scattered on a high rock to the west of Victoria Harbour. They are the remains of a 15th century castle with curtain wall and gatehouse, with later round gunports in some of the sea facing walls. The castle ruins were heavily damaged when the entrance to the Victoria Harbour was cut through the rock spur in the 19th century. The setting of the monument is centred around its position on the rock above the town of Dunbar and the harbour, and while the views out to sea are of some significance to the setting, they are not totally integral to it (Figure 13.11 (Volume 2)).
52. Below the ruins of the castle, the remains of an Iron Age promontory fort were found, as well as potential for early medieval occupation. The castle and later changes have almost totally compromised the setting of these features.

13.6.1.3.9 Tantallon Castle

53. Tantallon Castle is a well preserved medieval castle on a promontory above the Forth made up of a massive curtain wall with D-towers and a central gatehouse cutting off a small promontory. The internal features of the castle have been lost to coastal erosion during the last 300 years. Further out, Civil War era defences are also present (Figure 13.12 (Volume 2)). The monument is isolated, with its setting above the Forth being key to its enjoyment by the visiting public. The sea therefore acts as a background, and while being integral to the setting of the castle, is so by reference.

13.6.1.3.10 North Berwick Law

54. North Berwick Law represents a highly important Iron Age hilltop site, perched on top of a steep sided volcanic plug that rises sharply out of the surrounding flat topography, close to the south coast of the Forth at North Berwick. It commands extensive views across the surrounding landscape, as well as out to sea towards the Offshore Wind Farm. The summit contains the scanty remains of a dry stone walled fort, the enclosed area being of roughly 160 m x 100 m, with further areas enclosed by two more outer walls. The potential remains of roundhouses or similar structures can be discerned from the undulating ground surface. The unrestricted views are an important part of the setting of the monument, allowing the prehistoric occupants and visitors long distance unencumbered views (Figure 13.13 (Volume 2)).

13.6.1.3.11 Doon Hill forts

55. The Iron Age hill forts at Doon Hill, similarly to North Berwick Law, occupy a high point in the landscape, allowing the prehistoric occupants to see a long distance. Both forts are triangular in plan, but have been badly damaged over time by ploughing so that they are only visible on aerial photographs. One once measured 130 m by 80 m and had an inner and outer rampart. The setting of the forts on a high point in the landscape is one of high visibility, both in terms of being viewed from elsewhere and the view from the fort. The view out to sea was, however, probably less important than that of the surrounding landscape, and is therefore not considered integral to the overall understanding or appreciation of the forts (Figure 13.4 (Volume 2)).

13.6.1.3.12 St Andrews Harbour

56. The harbour at St Andrews, a Category A-Listed Structure, is built on the small estuary of the Kinness Burn, downhill from the cathedral and priory. The earliest sections of the current harbour walls dates to the late 18th or 19th century, with some sections being later in the 19th century and 20th century, although a harbour has been present on the site since the 13th century. The current harbour is made of stone, with the outer wall being built of vertically set stones for 230 m out from the land, before becoming horizontal set stones. Several sections have been heavily and crudely buttressed with concrete during the second half of the 20th century. The harbour has views out into the Tay Estuary and across the North Sea (Figure 13.15 (Volume 2)) which are integral to the setting of the harbour.

13.6.1.3.13 Bell Rock Lighthouse

57. The Bell Rock lighthouse, a Category A listed building, was built between 1807 and 1811 by Robert Stephenson. It is a curved 36 m tall tapering masonry tower with base courses set into rock, and is the first lighthouse ever constructed on a half-tide rock. Although the internal fittings of the lighthouse have all been replaced, there have been only minor alterations to the exterior since the lighthouse was built. These include minor external additions and renewal of the lantern and gallery. The lighthouse was de-manned in 1988 and is now fully automated.

58. The current setting of the lighthouse is a solitary setting, exposed on a tide washed rock 18 miles out to sea. The wide 360° views across the sea are part of the setting, but as it sits in a busy and important seaway, they are rarely completely empty. The key view is onshore directly towards to the Arbroath signal tower at Arbroath, which used to send and receive messages from the Lighthouse when both were manned. It is also worth noting that the lighthouse is not accessible to the public and therefore the ability to appreciate the 360° views from the top of the lighthouse is not possible. It was not possible to complete site visits of Bell Rock Lighthouse.

13.6.1.3.14 Arbroath Signal Tower

59. The Bell Rock Lighthouse signal tower is a castellated group of twin lodges and Signal Tower in a classical style, built in 1813. The structure now functions as a museum and houses exhibitions on the lives of the fishermen of the area, 'Arbroath Smokies' and the story of the building of the lighthouse including historical artefacts from the lighthouse itself. The buildings were constructed to serve as the shore station of the Bell Rock lighthouse and housed its keepers and their families until 1955. The signal tower itself was built to facilitate signalling between the lighthouse and the shore. This was undertaken by a variety of means and at times involved the use of telescopes, flags, pigeons and a large copper signal-ball. The building complex has been kept in a condition very similar to its original design, however the Tower itself is not accessible to visitors.

60. The important part of the setting for this building in terms of its working heritage is the key view of the Bell Rock lighthouse out to sea, which the signal tower would need to see clearly to communicate with it, which as Figure 13.16 (Volume 2) shows is not affected by the Wind Farm, which lies off to the south on the horizon, a large gap of open sea between it and the Bell Rock. The setting of the tower within Arbroath is coastal, and set slightly aside from the town buildings, split off by the main road and an open area of grass (Figure 13.17 (Volume 2)).

13.6.1.3.15 Dunbar Battery

61. Dunbar Battery is located on Lamer Island and is connected to the mainland by a causeway which forms part of Dunbar Harbour. It was built in 1781 to protect Dunbar from privateers and foreign raiders. Originally holding 16 guns of various calibres, following the end of the Peninsula War these were removed to Edinburgh Castle and the fort fell into disuse. During the World War (WWI), a small hospital was built within the battery, going out of use after the war. Excavations and historic building recording by AOC Archaeology during the 2010s (Marot pers. comm.) have fully exposed

the floor plan of the battery, which has been fully conserved. The site has views out over the mouth of the Forth which are integral to its function as a defensive battery (Figure 13.18 (Volume 2)).

13.6.1.3.16 St Andrews Links

62. The historic part of the Links, a series of golf courses to the northwest of St Andrews are made up of six individual courses: the Old Course, the New Course, the Jubilee Course, the Eden Course, the Strathtryum Course and the Balgrove Course. It is recorded as an inventoried Historic Garden and Designed Landscape (HGDL) and renowned internationally as 'The Home of Golf'. These courses and their associated infrastructure of benches, outbuildings and paths are set on a headland at the mouth of the River Eden, with open sea to the east, the river estuary to the north and west and the coastal plain of north Fife to the south (Figure 13.19 (Volume 2)). The views out to sea are not integral to the function or setting of the Links.

13.6.1.3.17 Cambo Estate Designed Landscape

63. The Inventory HGDL at Cambo dates to the 18th and 19th centuries, including Cambo House and its associated gardens, woodland walk areas, the estate farm and the Kingsbarns golf course. Of these, the House and gardens are very enclosed, while the farmland and golf course, which is along the coastline, are more open, with wide views out to sea.
64. It is clear that the design of the grounds at Cambo House were intended to be inward referencing, with the viewer being enclosed by trees and structures and no obvious view of the coastline. The golf course and farmland make more reference to the sea, although this view does not seem to be integral to the designation (Figure 13.20 (Volume 2)).

13.6.2 Development of Baseline Conditions without the Project

65. Generally, without the Project, natural processes will continue to affect the cultural heritage baseline influenced by local environmental conditions and climate change, which may preserve or deteriorate their condition, above and below the ground. Natural processes may be of longer duration and occurring over longer timescales.

13.7 Design Envelope – Worst Case Design Scenario

66. The Project will comprise the construction, operation and decommissioning of an offshore wind farm with a capacity of up to 450 MW, comprising of up to 54 turbines. The assessment scenarios identified in respect of the setting of archaeology and cultural heritage have been selected as those having the potential to represent the greatest effect on an identified receptor based on the design envelope described in Chapter 4: Project Description. Appendix 14.1: SLVIA Technical Report presents a design analysis to ensure that the indicative layout presented in Chapter 4: Project Description represents the worst case design scenario in visual terms. The worst-case design scenarios are set out in Table 13.8.

Table 13.8: Design envelope scenario assessed

Potential Impact	Worst Case Design Scenario	Justification
Operation		
Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Number of structures = 54 wind turbines on 6-legged jacket structures plus Met Mast, 2 OSPs on 8-legged jacket structures. Maximum rotor tip height of 208m. Maximum rotor diameter of 167m. Maximum hub height of 126m. Minimum turbine spacing of 800m. Turbines and rotors to be painted Light Grey RAL 7035	Largest ZTV from largest size and number of turbines.
Cumulative Effects		
Cumulative effect with other nearby offshore wind farms on the setting of onshore receptors	Consented design specifications (2014: Inch Cape Offshore Wind Farm (up to 110 turbines, with blade tip height at 215 m), Seagreen Alpha and Seagreen Bravo Offshore Wind Farms (150 turbines with blade tip height around 210 m). Planned updated design specifications (2017): Inch Cape Offshore Wind Farm (up to 72 turbines, with blade tip height up to 301m) and Seagreen Phase 1 Offshore Wind Farm (up to 120 turbines with blade tip height up to 280 m). **N.B. The blade tip height for Inch Cape Offshore Wind Farm has been reduced to 291m, slightly lower (10 m) than the worst-case considered here and depicted in the subsequent illustrations**.	These two offshore wind farms are located within the Forth/Tay estuaries and have the potential to have a cumulative impact on the setting of onshore receptors

13.7.1Embedded Mitigation

67. A range of Embedded Mitigation measures to minimise the potential effects on cultural heritage and marine archaeology are captured within the Project design envelope. The scoping of the assessment of effects on cultural heritage and marine archaeology, together with the assessment of settings, has taken account of the following Embedded Mitigation measures:

- Analysis of pre-construction survey data will be undertaken to refine the identified potential marine archaeology assets at infrastructure locations. Appropriate micro-siting allowance for identified assets will be agreed in consultation with HES;
- Both the micro-siting allowance and exclusion zones will be detailed in the WSI described above. This will reduce any potential impacts on marine archaeology;
- Mitigation relating to effects of the Offshore Wind Farm on the setting of cultural heritage receptors will include:
- Turbines will all be of similar dimensions for hub height and blade tip level subject to turbine and substructure design and installation specification;
- The Turbines will all be pale grey in colour (Light Grey RAL 7035) with a semi-matt finish. This tends to reduce the distance over which the turbines are visible, especially in dull or overcast conditions, which often occur. As offshore turbines are often viewed against the sky, pale grey is the most appropriate colour as it is closest to that of the lower part of the sky under the most frequent UK weather conditions;
- In order to consider the aesthetic aspects of wind farm design, an analysis was undertaken of alternative layouts to inform Chapter 14: SLVIA. The Design Analysis is presented in Annex 1 of Appendix 14.1. The design analysis provides 'design objectives' that can be used to refine the appearance of the final wind farm layout. Detailed siting of the offshore turbines will also be driven by a range of physical and environmental

constraints including localised geological conditions, ecology, aviation, navigation, wind resource and marine archaeology.

13.7.2 Anticipated Consent Conditions Commitments

68. A number of consent conditions were attached to The Consents to manage the environmental risk associated with the Originally Consented Project. NnGOWL anticipate that any future consents issued to the Project may incorporate similar conditions to manage the risk to marine archaeology or cultural heritage assets commensurate with the Project design envelope where it remains necessary to do so. Table 13.9 sets out the conditions attached to The Consents which have some relevance to the management of effects on marine archaeology and cultural heritage.

Table 13.9: Consent conditions for the Originally Consented Project relevant to maritime archaeology and cultural heritage

Original Consent Requirement	Relevance to marine archaeology and cultural heritage
Environmental Management Plan	Setting out, for approval, an EMP detailing a WSI to be followed in the event of an archaeological discovery.
Marine Archaeology Reporting Protocol	Setting out, for approval, procedures to follow on discovery any marine archaeology during the construction, operation, maintenance and monitoring of the Project.

13.8 Impact Assessment

13.8.1 Construction Phase Impacts

69. The impacts resulting from the construction of the Project have been assessed on the setting of archaeology and cultural heritage receptors identified within the study area. It has been concluded that there will be no construction phase impacts on the setting of the receptors identified in Section 13.7.

13.8.2 Operational Phase Impacts

70. The impacts resulting from the operation of the Project have been assessed on the setting of archaeology and cultural heritage receptors identified within the study area. A discussion of the likely significance of each effect resulting from each impact is presented below.

13.8.2.1 Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors

13.8.2.1.1 Tentsmuir Coastal Defences

71. The open coastal setting of the coastal defences, considered a receptor of high sensitivity due to their scheduled monument status, will look out on to the Project, which will be 32 km offshore. The turbines will only visible as very small features on the horizon from the features within the scheduled area along the east coastal strip, not from the southern bank of the Tay Estuary or from the inland woodland areas. The pillboxes are on the edge of the forest, looking out to sea across dune fields and a wide sandy beach, with the beach and intertidal area being their key view as defensive structures against seaborne invasions. The stark openness of the environment and the wide, open views across the sea form a less important part of the setting of these receptors. During the site visit the weather conditions and visibility were poor, however the photomontage from LUC, alongside the wireline model from Tentsmuir gives a good indication of the impact of the Offshore Wind Farm on the setting (Figure 13.14 (Volume 2)). At this distance, the turbines will not compromise the views over the beaches and intertidal zones or the open sea view of the receptors, visible only as small thin vertical features on the horizon, and visitors will still be able to appreciate

their setting as defensive installations and observation posts. The magnitude of the effect on the setting of the receptor is therefore judged to be negligible as shown in Table 13.10.

Table 13.10: Impacts on Tentsmuir coastal defences

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Tentsmuir coastal defences	Negligible	High	Minor

13.8.2.1.2 Crail Airfield

72. Crail Airfield, a scheduled monument and therefore of high sensitivity, situated on the coastal plain north of Crail, is 16 km west of the Project and will have intervisibility with all of the turbines, which will be visible as small thin vertical features on the horizon to the east. As noted before, the setting of the airfield is down to the flat nature of the topography in the area, along with its proximity to the Royal Navy base at Rosyth in the Forth. The hangers, runways and control tower all have a setting based on intervisibility between them, particularly the control tower which required full visibility of the runways and much of the airfield. The Project will not impact on this intervisibility within the airfield and, as the destination for the aircraft stationed there was the inner Forth off to the southwest, the Project will not affect the wider setting for the airfield (Figure 13.15 (Volume 2)). The magnitude of effect of the Project on Crail Airfield is judged to be negligible as shown in Table 13.11.

Table 13.11: Impacts on Crail Airfield

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Crail Airfield	Negligible	High	Minor

13.8.2.1.3 Crail Airfield Pillbox

73. The setting of the pillbox on Foreland Head is entirely based on its view across the foreshore, as a beach defence installation, rather than out to sea (Figure 13.16 (Volume 2)). The whole Offshore Wind Farm will be visible from the pillbox, which is 15.5 km from it, as thin vertical features on the horizon. The overall understanding and appreciation of the pillbox, a particularly well-preserved example that remains in its original position, will not be affected as it will remain clear that it was placed there to protect the coastline from invasion and to defend against enemy landings, reflected in the judgement that the receptor's sensitivity is medium in this case. During the site visit, the weather conditions were clear and the Bell Rock Lighthouse, a similar distance away as the Wind Farm Area, was only just visible on the horizon. It is therefore judged that the magnitude of effect on the setting of the pillbox will be low as shown in Figure 13.6 (Volume 2), with it retaining much of the significance of a defensive position on the shore.

Table 13.12: Impacts on Crail Airfield Pillbox

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Crail Airfield Pillbox	Low	Medium	Minor

13.8.2.1.4 St Andrews Castle

74. St Andrews Castle, a scheduled monument and therefore considered of high sensitivity, lies 29 km to the northwest of the Wind Farm Area, with a commanding position on the cliffs overlooking the sea. The sensitivity of the receptor has been assigned as high. The turbines will be visible on a clear day as small thin vertical features on the horizon, with roughly half of the turbines visible extending out north from behind the Fife coast as it turns south at Foreland Head. The turbines will take up less than 1% of the vertical field of views. During the site visit, the weather conditions and visibility were poor, with partially restricted views due to rain; however the photomontage provided by the SLVIA consultants provides a good demonstration of the view. The important views from the castle (along the coast and out to sea- Figure 13.7 (Volume 2)) are not compromised by the turbines in the extreme distance, nor is the appreciation of the castle from the town itself. The magnitude of the effect on the receptor is therefore judged to be negligible as shown in Table 13.13.

Table 13.13: Impacts on St Andrews Castle

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	St Andrews Castle	Negligible	High	Minor

13.8.2.1.5 St Andrews Cathedral

75. The Cathedral in St Andrews, a scheduled monument and therefore considered of high sensitivity, has commanding views across the area to the east of the town and the sea to the northeast from the Cathedral Tower, although these views are fully restricted by the boundary walls at ground level. St Rules Tower is accessible to visitors however and so the turbines will be visible from the top (Figure 13.8 (Volume 2)) as small thin vertical features on the far horizon, extending out north from behind the Fife coast as it turns southward at Foreland Head. These will only be visible on days when conditions are clear, as it was on the site visit. While they will be modern features within the wider landscape, their distance to the receptor means that they do not impinge on the near distance or medium distance views from the Cathedral tower nor do they distract from the impressive setting of the Cathedral within St Andrews. The magnitude of the effect on this receptor is therefore judged to be negligible as shown in Table 13.14.

Table 13.14: Impacts on St Andrews Cathedral

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	St Andrews Cathedral	Negligible	High	Minor

13.8.2.1.6 Isle of May Old Lighthouse

76. The old lighthouse or beacon on the Isle of May sits on the highest point on the island, and though much reduced in height from its period of use (it is now roughly 7.3 m high when it was originally around 12.5 m high), remains an impressive monument, considered of high sensitivity. Its setting during its working lifetime was as a beacon standing as the highest point on the island, visible to shipping within the mouth of the Firth of Forth. This has already been compromised by the 19th century lighthouse which stands to the west, taller than the current remains of the beacon. It has further been compromised by two small brick buildings and a helipad down slope to the east which detract from the isolation of the original monument (Figure 13.9 (Volume 2)). The whole of the Offshore Wind Farm will be visible from the beacon on clear days 16 km to the east as thin vertical features on the horizon. This receptor is highly sensitive to the impact associated with the presence of the turbines on the horizon. Similarly, as with the priory buildings (see Section 13.8.2.1.7), the main significance of the current setting of the Beacon is its local setting on the island and the visibility of it from the sea nearby. It is currently not accessible to visitors as no paths leads directly to it and visitors to the island are asked to keep to designated paths to avoid disturbing the seabird colonies. The main view point of the beacon is from an information board in a small valley to the west of it, with visitors looking up to the structure. From this point, the Offshore Wind Farm is entirely hidden (Figure 13.9 (Volume 2)). It is therefore judged that the magnitude of the effect on the setting is negligible as shown in Table 13.15.

Table 13.15: Impacts on Isle of May Old Lighthouse

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Isle of May Old Lighthouse	Negligible	High	Minor

13.8.2.1.7 Isle of May Priory

77. The extant and excavated remains of the 13th century priory on the Isle of May have a setting based on isolation, but also of visibility from passing shipping, in common with many of the island and coastal monasteries of the east coast e.g. Lindisfarne. The priory sits nestled in a sheltered spot below two small hills to the west overlooking the small sandy landing place on the southeast of the island (Figure 13.10 (Volume 2)) and is a scheduled monument, considered of high sensitivity. Its setting is therefore firstly clearly referencing the landing place, and the visibility of any shipping coming from the south and east towards the island (Figure 13.10 (Volume 2)). This has been

slightly compromised by the 19th century foghorn building to the south and the lighthouse to the northwest, although neither are close enough to the priory remains to affect their setting directly. This receptor is highly sensitive to the impact associated with the presence of the turbines on the horizon. The Offshore Wind Farm, which will be 16.5 km to the east will be visible from the priory on clear days, with the turbines being small thin vertical features on the horizon. While they will be directly in view of the remains, the distance from the receptor means that the impact will be muted, particularly as the key part of the setting of the priory is based on its immediate surroundings and its visibility from the sea, neither of which will be affected. The magnitude of effect is therefore judged to be negligible as shown in Table 13.16.

Table 13.16: Impacts on Isle of May Priory

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Isle of May Priory	Negligible	High	Minor

13.8.2.1.8 Dunbar Castle and Castle Park

78. The setting of Dunbar Castle, a scheduled monument and therefore considered of high sensitivity, 29.3 km from the Wind Farm Area, is based around its relationship with the town, towering over parts of it on the large rock outcrop. As much of the castle was damaged or destroyed by the cutting of the entrance to Victoria Harbour in the 19th century, the setting of the castle is already at least partially compromised. Therefore the sensitivity of the receptor is considered to be high. As the wireline model in Figure 13.11 (Volume 2) shows, the impact of the Offshore Wind Farm is minor, with the individual turbines visible on the horizon and only taking up less than 1 % of the vertical view. The magnitude of effect is therefore judged to be negligible on the setting of Dunbar Castle, as shown in Table 13.17.

Table 13.17: Impacts on Dunbar Castle and Castle Park

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Dunbar Castle and Castle Park	Negligible	High	Minor

13.8.2.1.9 Tantallon Castle

79. Tantallon Castle, a scheduled monument and therefore considered of high sensitivity, sitting high on a promontory 30.3 km from the Wind Farm Area, has a setting of isolation and exposure, which strongly references the sea. The individual turbines will be visible on the horizon behind the castle but only taking up 1% of the vertical view (Figure 13.12 (Volume 2)), with the Bass Rock remaining far more prominent in the view. The turbines are pinpricks on the horizon. The magnitude of effect

is therefore judged to be negligible on the overall setting of Tantallon Castle, as shown in Table 13.18.

Table 13.18: Impacts on Tantallon Castle

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Tantallon Castle	Negligible	High	Minor

13.8.2.1.10 North Berwick Law

80. The site at North Berwick Law, a scheduled monument and therefore considered of high sensitivity, 33.5 km from the Wind Farm Area has a setting which references the sea but is not integral to it, nonetheless the sensitivity of the receptor is considered to be high. The Offshore Wind Farm sits on the horizon, taking up less than 1% of the vertical view (Figure 13.13 (Volume 2)) and does not interfere with the views to the Bass Rock or Isle of May therefore the magnitude of the effect is considered to be negligible. The individual turbines will be visible but will not distract from the monument or its setting as a dominant feature of the local and regional landscape, making the magnitude of the effect negligible, therefore the significance of the impact is minor (Table 13.19).

Table 13.19: Impacts on North Berwick Law

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	North Berwick Law	Negligible	High	Minor

13.8.2.1.11 Doon Hill Fort

81. The setting of the fort at Doon Hill, a scheduled monument and therefore considered of high sensitivity, 37.1 km from the Wind Farm Area is mostly based on the prominence of the fort above the surrounding landscape, with only part of this being based on the views out to sea. The Offshore Wind Farm, as presented in the wireline model (Figure 13.14 (Volume 2)), is only visible as pinpricks on the horizon, taking up very little space in the overall view and not compromising the setting of the monument. This gives a negligible magnitude of effect with an impact of only minor significance to the monument, as shown in Table 13.20.

Table 13.20: Impacts on Doon Hill Fort

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Doon Hill Fort	Negligible	High	Minor

13.8.2.1.12 St Andrews Harbour

82. The harbour at St Andrews, a Scheduled Monument regarded as of high sensitivity, 29 km from the Project, has open views to the sea, clearly referencing the wider North Sea, although the view from within the harbour mouth is restricted to the north by the outer harbour wall (Figure 13.15 (Volume 2)). The setting of the harbour as a haven and place of safety from the sea remains, although the sites setting is also as a place to voyage out from into the North Sea and beyond (Figure 13.15 (Volume 2)). Around half of the Offshore Wind Farm will be visible from the harbour on clear days, with the rest hidden behind the Fife coastline. The turbines will only be visible as small thin vertical features on the horizon, and will not obscure the wide views of the sea from the outer harbour wall or compromise the setting of the harbour within the local landscape of St Andrews. The magnitude of effect on the setting is therefore judged to be negligible as shown in Table 13.21.

Table 13.21: Impacts on St Andrews Harbour

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	St Andrews Harbour	Negligible	High	Minor

13.8.2.1.13 Bell Rock Lighthouse

83. This receptor, a Scheduled Monument regarded as of high sensitivity is 12.6 km distant from the turbines, is the closest receptor to the Wind Farm Area and therefore has the greatest potential for an impact to occur on its setting. The key view from this receptor is focussed towards the Arbroath signal tower and this intervisibility would remain unaffected following the construction of the Project, which is further offshore. The distance of 12.6 km between the Lighthouse and Wind Farm Area means that the turbines do not compete with the lighthouse for size, and do not surround it either, as shown in Figure 13.16 (Volume 2). From the Angus coastline, the turbines will be visible on the horizon to the south of the lighthouse, while from the Fife coastline they will be visible to the east of the lighthouse, but again only on the horizon and as thin vertical features. The magnitude of effect is therefore judged to be negligible on the Bell Rock, as shown in Table 13.22.

Table 13.22: Impacts on Bell Rock Lighthouse

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Bell Rock Lighthouse	Negligible	High	Minor

13.8.2.1.14 Arbroath Signal Tower

84. The Wind Farm Area is over 30 km from the Arbroath Signal tower, a receptor considered of high sensitivity, meaning that the turbines would only be visible on clear days and then only as small thin vertical features on the horizon. The weather during the first site visit was poor, with very low visibility and the Bell Rock lighthouse was not visible, even from the top of the tower. A return visit was made during better visibility on 11/08/2017, with the Bell Rock lighthouse being just visible on the horizon. The photomontage of the view from the site to the Wind Farm Area shows the view on a clear day, and so both are presented to illustrate the variability of visibility from the signal tower out to sea (Figure 13.17 (Volume 2)). The tower is generally inaccessible to visitors and so this elevated view should not be taken as typical of a visitor experience. While the turbines add a modern element to the views out to sea, they do not block or interfere with the key view from the Signal tower: that of the Bell Rock Lighthouse. The turbines will take up less than 1 % of the vertical field of view and so the magnitude of the effect on the setting is judged to be negligible, as shown in Table 13.23.

Table 13.23: Impacts on Arbroath Signal Tower

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Arbroath Signal Tower	Negligible	High	Minor

13.8.2.1.15 Dunbar Battery

85. The Category B medium sensitivity receptor Dunbar Battery, 18.3 miles from the Wind Farm Area, commands extensive views out to sea which are integral to its setting as a defensive structure protecting Dunbar from raiders and seaborne invasions. The extent to which the Offshore Wind Farm detracts from this, as shown in the wireline model in Figure 13.18 (Volume 2), is negligible as the turbines are only visible as pinpricks on the horizon, taking up very little of the view, and allowing visitors to still experience the expansive views from the Battery out to sea. The impact is therefore negligible, as shown in Table 13.24.

Table 13.24: Impacts on Dunbar Battery

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Dunbar Battery	Negligible	Medium	Negligible

13.8.2.1.16 St Andrews Links

86. The Offshore Wind Farm will be visible on the horizon from much if not all of the HGDL area of St Andrews Links, considered a receptor of medium sensitivity, at a distance of 30 km to the southeast along the north Fife coast. The setting of the Links is generally internally referencing, with the important views being along the fairways from tees to greens, which generally run northwest-southeast or vice versa. The Offshore Wind Farm will be visible along the coast beyond Fife Ness but will not interrupt the key views along the fairways or beyond them, or the view of St Andrews itself from the Links, which is also a critical view (Figure 13.19 (Volume 2)). This distance will mean that the turbines will only be visible on clear days and only as small thin vertical features on the horizon, taking up less than 1% of the vertical field of view (weather and visibility conditions during the site visit were poor due to heavy rain and so the location of the turbines was not visible at the time, however the photomontage of the view from the site towards the Offshore Wind Farm does present a clear view of the area). While this is adding in a modern aspect to the overall setting of the Links, the turbines are at such a distance to the receptor, and the open vistas from the Links to the historic centre of St Andrews will be unaffected that the magnitude of the effect is judged to be negligible as shown in Table 13.25.

Table 13.25: Impacts on St Andrews Links HGDL

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	St Andrews Links	Negligible	Medium	Negligible

13.8.2.1.17 Cambo Estate Designed Landscape

87. The Cambo Estate Designed Landscape, a receptor of medium sensitivity is 18.2 km from the Wind Farm Area and, as noted before, is a restricted visibility landscape, deliberately closed off from the outside world by extensive woodlands, hiding the house and close gardens from public view (Figure 13.20 (Volume 2)). This also means that the house and gardens have restricted visibility with the Offshore Wind Farm and no turbines would be visible from them. The wider landscape including the farm buildings and golf course will have intervisibility with roughly half of the turbines, with the remainder hidden behind the coastline. The setting of these features will not be overly impacted, as the turbines will be only visible on clear days as small thin vertical features on the horizon, taking

up 1% of the vertical field of view. Also, it is judged that they will not adversely impact the setting of the farm buildings, which are nestled within agricultural fields (Figure 13.20 (Volume 2)) or the golf course for which the key views are up/down the fairways from tee to green and only obliquely references the sea. The magnitude of effect is therefore judged to be negligible as shown in Table 13.26.

Table 13.26: Impacts on Cambo Estate HGDL

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Turbines	Presence of Offshore Wind Farm, Met Mast and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Cambo Estate designed landscape	Negligible	Medium	Negligible

13.8.3 Decommissioning Phase Impacts

88. Impacts from decommissioning are anticipated to be similar to those during construction as infrastructure is removed from the seabed at the end of the Project's operational life. There would be no effects resulting from decommissioning activities on the setting of archaeology and cultural heritage receptors, as with the construction phase.

89. Although currently it is anticipated that all of the Project infrastructure, towards the end of the operational life of the Project, all decommissioning options will be considered. It may be deemed that removal of certain pieces of infrastructure may have a greater environmental impact than leaving in-situ; however, this is most likely to relate to certain aspects of the subsea infrastructure rather than the above-water structures which would be entirely removed such that any effects on setting would be entirely reversed. The potential decommissioning options will be presented to MS-LOT in a Decommissioning Programme for approval prior to construction. The Decommissioning Programme will then be reviewed and amended as required prior to the commencement of any decommissioning activities.

13.8.4 Cumulative Impacts

90. Cumulative effects refer to effects upon receptors arising from the Project when considered alongside other proposed developments and activities and any other reasonably foreseeable project proposals. In this context, the term 'projects' is considered to refer to any project with comparable effects and is not limited to offshore wind projects. The cumulative assessment focuses on the scope of this EIA, i.e. potential setting effects during the Operation phase on agreed receptors within the cumulative ZTV. Construction and Decommissioning phases are not considered, as setting effects are not considered to be induced during these phases.

91. Projects and activities considered within the cumulative impact assessment are set out in Table 13.27. There may be an element of uncertainty associated with the design envelope of proposed projects, therefore a judgement is made on the confidence associated with the latest available design envelope.

92. In assessing the cumulative impacts for the Project, two scenarios are considered to take into account the previously consented and currently proposed design envelopes of the Inch Cape Offshore Wind Farm and the Seagreen Phase 1 Wind Farm Project. Scenario one incorporates the design envelopes for the proposed Inch Cape and Seagreen projects as detailed in the Scoping Reports submitted to MS-LOT (ICOL, 2017; Seagreen, 2017) updated to take account of additional

project information provided by the developers. Scenario two incorporates the consented design envelopes as detailed in the respective project consents (ICOL, 2014; Seagreen, 2014a; Seagreen, 2014b) as presented in Table 13.27. While the Forthwind and Kincardine Offshore Wind Farms were considered for the cumulative assessment in the SLVIA chapter, the analysis conducted there is on a broad landscape basis rather than individual receptors and therefore requires a wider scope. These two wind farms are considered to be too distant from the receptors discussed to have any impact on their setting, and therefore will not be considered within this assessment.

Table 13.27: Projects for cumulative assessment

Development Type	Project	Status	Data Confidence Assessment / Phase
Offshore Wind Farm	Inch Cape Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Inch Cape Offshore Wind Farm	Proposed	High – project details in the Scoping Report and additional information provided by the Developer.
Offshore Wind Farm	Seagreen Alpha Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Seagreen Bravo Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Seagreen Phase 1 Offshore Wind Farm	Proposed	High - project details provided by Developer.

93. Table 13.28 sets out the potential cumulative impacts and the worst case cumulative design envelope scenario considered within the cumulative impact assessment. For individual cultural heritage receptors, it is considered that the size rather than the density of the turbines is the important factor in cumulative assessments, with four larger turbines being more obvious within the setting than 20 smaller ones, particularly at the distances from the Offshore Wind Farm that the receptors are. Therefore scenario one is considered the worst case scenario for potential impacts on cultural heritage receptor settings. Details of other wind farms are taken from their respective scoping reports, accessed via http://www.gov.scot/Topics/marine/Licensing/marine/scoping

Table 13.28: Cumulative worst-case design envelope scenarios.

Impact	Worst Case Design Scenario	Justification
Cumulative setting impacts for proposed projects in the vicinity	Both Inch Cape Offshore Wind Farm (up to 72 turbines, with blade tip height up to 301 m) and Seagreen Phase 1 Offshore Wind Farm (70-120 turbines with blade tip height up to 280 m) are built according to their current published worst case scenario designs	The Inch Cape and Seagreen Offshore Wind Farms will be behind or to one side of the Project when viewed from onshore receptors and so may have a cumulative impact on the setting of some or all of those receptors.

13.8.4.1 Cumulative Operation Phase Impacts: Setting of onshore receptors

13.8.4.1.1 Tentsmuir coastal defences

94. As the cumulative wireline model for Tentsmuir (Figure 13.4 (Volume 2)) shows the turbines of Seagreen Phase 1 are almost totally invisible from this distance. The revised Inch Cape turbines are clustered in approximately 20 horizontal degrees of the view on the horizon, a similar size to those of the Project. They are separate to the Project turbines by roughly 30 horizontal degrees, which take up a further 20 degrees of the horizon. Both Offshore Wind Farms take up less than 1% of the vertical view, and so the magnitude of effect is judged to be negligible, as both are only just visible

on the horizon and do not form a single wide block taking up large proportions of the key views from the coastal defences, as shown in Table 13.29.

Table 13.29: Impacts on Tentsmuir coastal defences

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Tentsmuir coastal defences	Negligible	High	Minor

13.8.4.1.2 Crail Airfield

95. The cumulative wireline drawing (Figure 13.5 (Volume 2)) shows that only the Project turbines will be visible from Crail Airfield, with the other Offshore Wind Farms hidden behind Fife Ness with only the upper blade tip of each turbine visible above the land. The cumulative impact of the Projects on Crail Airfield is therefore judged to have a negligible magnitude of effect, as shown in Table 13.30.

Table 13.30: Impacts on Crail Airfield

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Crail Airfield	Negligible	High	Minor

13.8.4.1.3 Crail Airfield Pillbox

96. The cumulative wireline model for Fife Ness, close to the Crail airfield pillbox (Figure 13.6 (Volume 2)) shows the turbines of Seagreen Phase 1 Offshore Wind Farm are almost totally invisible from at this distance, and are generally obscured by the turbines of Inch Cape Offshore Wind Farm. The Offshore Wind Farm is the most prominent development, taking up approximately 35 horizontal degrees of the horizon, with a gap of 15 degrees between it and the more distant Inch Cape Offshore Wind Farm to the north, which takes up 30 degrees of the horizon. The Inch Cape turbines are only visible on the horizon and are much smaller than the turbines, however both still take up less than 2% of the vertical view, and as noted above the key view for the pillbox is across the beach, not the long distance views out to sea. The turbines leave enough gaps and open sea for the effect to be considered low, as shown in Table 13.31, with it retaining much of the significance of a defensive position on the shore.

Table 13.31: Impacts on Crail Airfield Pillbox

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Crail Airfield Pillbox	Low	Medium	Minor

13.8.4.1.4 St Andrews Castle

97. The view from St Andrews East Scores, applicable for the castle, cathedral and harbour, shows that the turbines of Seagreen Phase 1 are almost invisible and almost totally obscured by the slightly closer turbines of Inch Cape Offshore Wind Farm. These take up 30 degrees of the horizon, with a gap to the Offshore Wind Farm, which takes up 20 degrees of the horizon before being partially obscured by the north Fife coastline (Figure 13.7 (Volume 2)). The turbines of these two Offshore Wind Farms are roughly the same size, take up less than 1% of the vertical view directly on the horizon and do not obscure any part of the important or intrinsic views from the receptor. The magnitude of the effect on the receptor is therefore judged to be negligible as shown in Table 13.32.

Table 13.32: Impacts on St Andrews Castle

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	St Andrews Castle	Negligible	High	Minor

13.8.4.1.5 St Andrews Cathedral

98. The view from St Andrews East Scores, applicable for the castle, cathedral and harbour, shows that the turbines of Seagreen Phase 1 are almost invisible and almost totally obscured by the slightly closer turbines of Inch Cape Offshore Wind Farm. These take up 30 degrees of the horizon, with a gap to the Offshore Wind Farm, which takes up 20 degrees of the horizon before being partially obscured by the north Fife coastline (Figure 13.8 (Volume 2)). The turbines of these two Offshore Wind Farms are roughly the same size, take up less than 1% of the vertical view directly on the horizon and do not obscure any part of the important or intrinsic views from the receptor. The magnitude of the effect on this receptor is therefore judged to be negligible as shown in Table 13.33.

Table 13.33: Impacts on St Andrews Cathedral

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	St Andrews Cathedral	Negligible	High	Minor

13.8.4.1.6 Isle of May Old Lighthouse

99. The receptors on the Isle of May are the closest to the Neart na Gaoithe Offshore Wind Farm, and as the wireline model for the Isle shows (Figure 13.9 (Volume 2)), the Neart na Gaoithe turbines are the most obvious within the view, taking up approximately 40 degrees of the horizon and 2% of the vertical view. The turbines of Inch Cape Offshore Wind Farm take up an additional 25 degrees of the horizon, appearing directly to the north of the edge of the Neart na Gaoithe Offshore Wind Farm, but also obscuring the turbines of Seagreen Phase 1 Offshore Wind Farm, which are almost invisible on the horizon. It should be noted that the Inch Cape turbines appear considerably smaller than the Neart na Gaoithe turbines from the Lighthouse on the Isle of May, and as noted in Section 13.6.1.3.6, the setting of the lighthouse has been at least partially compromised by the later lighthouse to the west, and by the lack of visibility of much of the horizon from the only viewpoint for the old lighthouse. Therefore, for visitors viewing the lighthouse, very few of the turbines will be visible to those appreciating the setting of the lighthouse. It is therefore judged to comprise a negligible magnitude effect on the receptors setting, as shown in Table 13.34.

Table 13.34: Impacts on Isle of May Old Lighthouse

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Isle of May Old Lighthouse	Negligible	High	Minor

13.8.4.1.7 Isle of May Priory

100. The receptors on the Isle of May are the closest to the Neart na Gaoithe Offshore Wind Farm, and as the wireline model for the Isle shows (Figure 13.10 (Volume 2)), the Neart na Gaoithe turbines are the most obvious within the view, taking up approximately 40 degrees of the horizon and 2% of the vertical view. The turbines of Inch Cape Offshore Wind Farm take up an additional 25 degrees of the horizon, appearing directly to the north of the edge of the Neart na Gaoithe Offshore Wind Farm, but also obscuring the turbines of Seagreen Phase 1 Offshore Wind Farm, which are almost invisible on the horizon. It should be noted that the Inch Cape turbines appear considerably smaller than the Neart na Gaoithe turbines from the Lighthouse on the Isle of May, and as noted in Section 13.6.1.3.6, the setting of the priory has been at least partially compromised by the later lighthouse to the north and the Victorian foghorn building to the southwest. Equally the key view of the setting of the priory is looking west from the sea towards the priory, and this view is not impacted by any of the projects within the cumulative assessment. Nevertheless, the cumulative wireline

shows an uninterrupted development of turbines on the horizon for 65 degrees of the horizon which will be visible to visitors to the priory and therefore contributes to a low level negative effect on the setting of the priory; the magnitude of effect is therefore judged to be low as shown in Table 13.35.

Table 13.35: Impacts on Isle of May Priory

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Isle of May Priory	Low	High	Moderate

13.8.4.1.8 Dunbar Castle and Castle Park

101. The cumulative wireline for the three Offshore Wind Farm developments as seen from Dunbar (Figure 13.11 (Volume 2)) shows that only the Neart na Gaoithe Offshore Wind Farm turbines are visible, with the Inch Cape Offshore Wind Farm and Seagreen Phase 1 Offshore Wind Farm turbines almost totally obscured by the larger nearer turbines of Neart na Gaoithe. The cumulative setting impact is therefore the same as that described in Section 13.6.1.3.8, on the setting of Dunbar Castle, as shown in Table 13.36.

Table 13.36: Impacts on Dunbar Castle and Castle Park

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Dunbar Castle and Castle Park	Negligible	High	Minor

13.8.4.1.9 Tantallon Castle

102. The cumulative wireline model for Tantallon Castle shows that the Neart na Gaoithe Offshore Wind Farm turbines are the most prominent, taking up approximately 20 degrees of the horizon but still only taking up 1% of the vertical view (Figure 13.12 (Volume 2)), with the Bass Rock remaining far more prominent in the view. The turbines of Inch Cape and Seagreen Phase 1 are pinpricks on the horizon. It is therefore considered that the cumulative effect of the three Offshore Wind Farms will have a negligible magnitude of effect on the overall setting of Tantallon Castle, as shown in Table 13.37.

Table 13.37: Impacts on Tantallon Castle

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Tantallon Castle	Negligible	High	Minor

13.8.4.1.10 North Berwick Law

103. The turbines of Neart na Gaoithe, Inch Cape and Seagreen Phase 1 Offshore Wind Farms form a block covering 35 degrees of the horizon when viewed in the wireline model from North Berwick Law (Figure 13.13 (Volume 2)) but all the turbines are restricted to taking up less than 1% of the vertical view and do not obscure or interrupt the views to the Bass Rock or Isle of May. They are relegated to the horizon, and do not block any of the key views from the receptor, with the turbines of Neart na Gaoithe at least partially obscuring those of the more distant Offshore Wind Farms. The individual turbines will be visible but will not distract from the monument or its setting as a dominant feature of the local and regional landscape, as shown in Table 13.38.

Table 13.38: Impacts on North Berwick Law

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	North Berwick Law	Negligible	High	Minor

13.8.4.1.11 Doon Hill Forts

104. As the cumulative model shows, these sites are on a similar alignment to the Offshore Wind Farms to the receptors at Dunbar, although slightly further away. The Neart na Gaoithe Offshore Wind Farm turbines are barely visible, with the Inch Cape Offshore Wind Farm and Seagreen Phase 1 Offshore Wind Farm turbines almost totally obscured by the larger nearer turbines of Neart na Gaoithe, which are shown in the individual wireline model in Figure 13.14 (Volume 2). The Neart na Gaoithe Offshore Wind Farm turbines visible as pinpricks on the horizon, taking up very little space in the overall view and not compromising the setting of the monument. This gives a negligible magnitude of effect with an impact of minor significance to the monument, as shown in Table 13.39.

Table 13.39: Impacts on Doon Hill Fort

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Doon Hill Fort	Negligible	High	Minor

13.8.4.1.12 St Andrews Harbour

105. The view from St Andrews East Scores, applicable for the castle, cathedral and harbour, shows that the turbines of Seagreen Phase 1 are almost invisible and almost totally obscured by the slightly closer turbines of Inch Cape Offshore Wind Farm. These take up 30 degrees of the horizon, with a gap to the Neart na Gaoithe Offshore Wind Farm, which takes up 20 degrees of the horizon before being partially obscured by the north Fife coastline (Figure 13.15 (Volume 2)). The turbines of these two Offshore Wind Farms are roughly the same size, take up less than 1% of the vertical view directly on the horizon and do not obscure any part of the important or intrinsic views from the receptor. The magnitude of the effect on this receptor is therefore judged to be negligible as shown in Table 13.40.

Table 13.40: Impacts on St Andrews Harbour

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	St Andrews Harbour	Negligible	High	Minor

13.8.4.1.13 Bell Rock Lighthouse

106. As the cumulative wireline for the Bell Rock lighthouse demonstrates (Figure 13.16 (Volume 2)), the turbines from Inch Cape Offshore Wind Farm, Seagreen Phase 1 Offshore Wind Farm and Neart na Gaoithe Offshore Wind Farm are all further out to sea than the lighthouse. It is considered that the most important of these views being that from the lighthouse towards the Arbroath signal tower which had a known connection with the lighthouse. The cumulative impact will therefore be discussed in Section 13.8.4.1.14 below.

13.8.4.1.14 Arbroath Signal Tower

107. The Neart na Gaoithe Offshore Wind Farm is over 30 km from the Arbroath signal tower, meaning that the turbines would only be visible on clear days and then only as small thin vertical features on the horizon. Far more prominent is the Inch Cape Offshore Wind Farm which partly obscures the Seagreen Phase 1 Offshore Wind Farm behind it (Figure 13.17 (Volume 2)). The overall effect does add a large amount of additional structures into the seascape, but does not obscure the intervisibility between the lighthouse and the Arbroath signal tower, which remains the key view.

The cumulative assessment is therefore considered to have a negligible magnitude of effect from a cultural heritage stance, as shown in Table 13.41.

Table 13.41: Impacts on Arbroath Signal Tower

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Arbroath Signal Tower	Negligible	High	Minor

13.8.4.1.15 Dunbar Battery

108. The cumulative wireline for the three Offshore Wind Farm developments as seen from Dunbar (Figure 13.18 (Volume 2)) shows that only the Neart na Gaoithe Offshore Wind Farm turbines are visible, with the Inch Cape Offshore Wind Farm and Seagreen Phase 1 Offshore Wind Farm turbines almost totally obscured by the larger nearer turbines of Neart na Gaoithe Offshore Wind Farm. The cumulative setting impact is therefore the same as that described in Section 13.6.1.3.8, which gives a negligible magnitude of effect on the setting of Dunbar Castle, as shown in Table 13.42.

Table 13.42: Impacts on Dunbar Battery

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Dunbar Battery	Negligible	Medium	Negligible

13.8.4.1.16 St Andrews Links

109. The cumulative wireline model for St Andrews West Sands Road (directly to the east of the Links) shows that the turbines of Seagreen Phase 1 Offshore Wind Farm are totally invisible, while the turbines of Inch Cape Offshore Wind Farm appear very small, covering 30 degrees of the horizon and only 0.5% of the vertical view. The turbines of Neart na Gaoithe Offshore Wind Farm similarly are only visible on the horizon, split from the Inch Cape turbines by 20 degrees of open horizon and partially obscured by the north coast of Fife (Figure 13.19 (Volume 2)). The cumulative developments will not affect the key views and open vistas from the Links to the historic centre of St Andrews will be unaffected such that the magnitude of the effect is judged to have a negligible magnitude of effect as shown in Table 13.43.

Table 13.43: Impacts on St Andrews Links HGDL

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	St Andrews Links	Negligible	Medium	Negligible

13.8.4.1.17 Cambo Estate Designed Landscape

110. As noted in Section 13.6.1.3.17 there is no intervisibility between Cambo and the Neart na Gaoithe Offshore Wind Farm and therefore there is no requirement for cumulative analysis. The magnitude of effect is therefore judged to be negligible as shown in Table 13.44.

Table 13.44: Impacts on Cambo Estate HGDL

Source of impact	Pathway	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact
Cumulative Offshore Wind Farm turbines	Presence of Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Cambo Estate designed landscape	Negligible	Medium	Negligible

13.8.5 Inter-relationships

111. No inter-related accumulations of impacts or effects have been identified for archaeology and cultural heritage that have not already been mitigated against through the embedded mitigation from the Original ES.

13.9 Mitigation and Monitoring

112. The assessment of impacts, both in isolation and cumulatively, on archaeology and cultural heritage receptors as a result of the construction, operation and decommissioning of the Project are predicted to be of generally minor or negligible adverse significance, with only one prediction of moderate adverse significance on one receptor. As set out in Section 14.7.1 of the SLVIA chapter, mitigation of landscape and visual effects relies on post-consent design processes that may help to reduce the levels of the identified effects, and it is at this point that mitigation to reduce the impact should occur.

13.9.1 Monitoring

113. As set out in the embedded mitigation, the monitoring and enforcing of AEZs around archaeology and cultural heritage receptors will be an important part of the mitigation strategy for all phases of construction, operation and decommissioning of the Project.

13.10 Summary of Residual Effects

114. This chapter has assessed the potential effects on the setting of archaeology and cultural heritage of the construction, operation and decommissioning of the Project, both in isolation and cumulatively. Table 13.45 summarises the impact determinations discussed in this chapter and presents the post-mitigation residual significance.

Table 13.45: Summary of predicted impacts of the Project

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Operation			
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: Tentsmuir coastal defences	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: Crail Airfield	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: Crail Airfield pillbox	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: St Andrews Castle	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: St Andrews Cathedral	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: Isle of May Old Lighthouse	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: Isle of May Priory	Minor Significance	N/A	Minor Significance

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: Dunbar Castle	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: Tantallon Castle	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: North Berwick Law	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: Doon Hill Forts	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: St Andrews Harbour	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: Bell Rock Lighthouse	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: Arbroath Signal tower	Minor Significance	N/A	Minor Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: Dunbar Battery	Negligible Significance	N/A	Negligible Significance
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: St Andrews Links	Negligible Significance	N/A	Negligible Significance

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Presence of Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology: Cambo Estate	Negligible Significance	N/A	Negligible Significance
Cumulative Effects			
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: Tentsmuir coastal defences	Minor Significance	N/A	Minor Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: Crail Airfield	Minor Significance	N/A	Minor Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: Crail Airfield Pillbox	Minor Significance	N/A	Minor Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: St Andrews Castle	Minor Significance	N/A	Minor Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: St Andrews Cathedral	Minor Significance	N/A	Minor Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: Isle of May Old Lighthouse	Minor Significance	N/A	Minor Significance

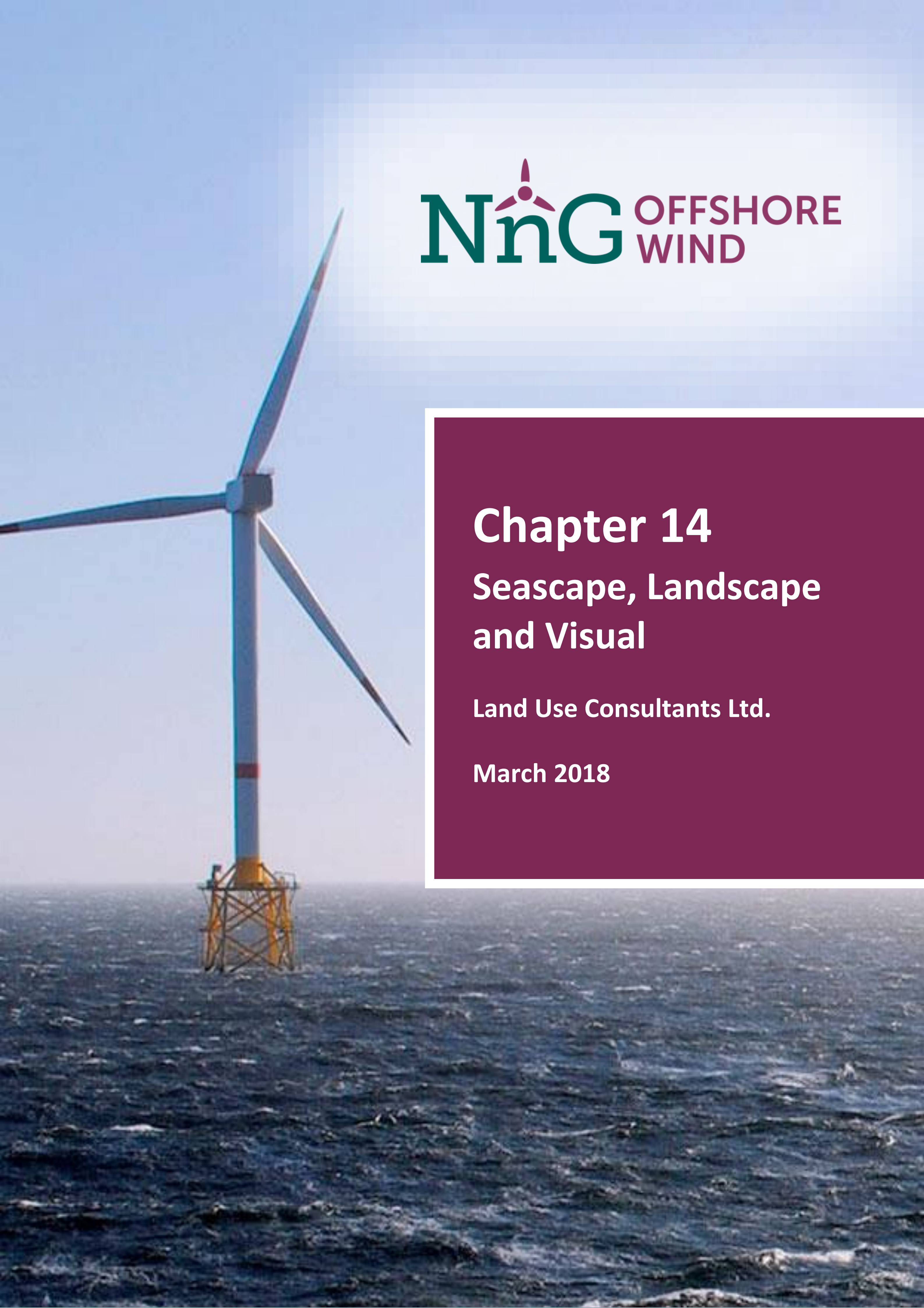
Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: Isle of May Priory	Moderate Significance	None proposed	Moderate Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: Dunbar Castle	Minor Significance	N/A	Minor Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: Tantallon Castle	Minor Significance	N/A	Minor Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: North Berwick Law	Minor Significance	N/A	Minor Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: Doon Hill Forts	Minor Significance	N/A	Minor Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: St Andrews Harbour	Minor Significance	N/A	Minor Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: Bell Rock Lighthouse	Minor Significance	N/A	Minor Significance

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: Arbroath signal tower	Minor Significance	N/A	Minor Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: Dunbar Battery	Negligible Significance	N/A	Negligible Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: St Andrews Links	Negligible Significance	N/A	Negligible Significance
Presence of Neart na Gaoithe, Inch Cape and Seagreen Offshore Wind Farms, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors: Cambo Estate	Negligible Significance	N/A	Negligible Significance

13.11 References

- HES (2016a) *Historic Environment Scotland Policy Statement*. Available at https://www.historicenvironment.scot/advice-and-support/planning-and-guidance/legislation-and-guidance/historic-environment-scotland-policy-statement/
- HES(2016b) *Managing Change in the Historic Environment: Setting.* Available at https://www.historicenvironment.scot/archives-and-research/publications/publication/?publicationId=80b7c0a0-584b-4625-b1fd-a60b009c2549
- ICOL (2014) *Inch Cape Offshore Wind Farm Environmental Impact.* Available at http://www.gov.scot/Resource/0046/00460548.pdf
- ICOL (2017) *Inch Cape Offshore Wind Farm Environmental Impact Assessment Offshore Scoping Report.* Available at http://www.gov.scot/Resource/0051/00517517.pdf
- James and Yeoman, H F and P, (2008) *Excavations at St Ethernan's Monastery, Isle of May, Fife 1992-7*, (Edinburgh: Tayside and Fife Archaeological Committee Monograph)
- JNAPC (Joint Nautical Archaeology Policy Committee) (2006) *Code of Practice for Seabed Development. The Joint Nautical Archaeology Policy Committee.* Available at http://www.jnapc.org.uk/jnapc_brochure_may_2006.pdf
- Marine Scotland (2014) *Section 36 consent*. Available at http://www.gov.scot/Resource/0046/00460581.pdf
- NnGOWL (2017) *Neart na Gaoithe Offshore Wind Farm Environmental Impact Assessment Scoping Report, Chapter 13: Archaeology and Cultural Heritage Chapter.*

- Oxford Archaeology (2008) *Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy.* (Commissioned by COWRIE Ltd (project reference CIARCH-11-2006)).
- Seagreen (2014a) *Seagreen Alpha Offshore Project Environmental Impact Assessment*
- Seagreen (2014b) *Seagreen Bravo Offshore Project Environmental Impact Assessment*
- Seagreen (2017) *Seagreen Phase 1 Offshore Project Scoping Report.* Available at http://www.gov.scot/Resource/0052/00520547.pdf
- The Crown Estate (2014) *Protocol for Archaeological Discoveries: Offshore Renewables Projects.* Available at http://www.thecrownestate.co.uk/media/148964/ei-protocol-for-archaeological-discoveries-offshore-renewables-projects.pdf
- The Scottish Government (2011*) Planning Advice Note 2/2011: Planning and Archaeology.* Available at http://www.gov.scot/Publications/2011/08/04132003/0
- The Scottish Government (2014) *SPP.* Available at http://www.gov.scot/Publications/2014/06/5823
- The Scottish Government (2016) *National Marine Plan.* Available at http://www.gov.scot/Topics/marine/seamanagement/national
- Wessex Archaeology Ltd (2007) *Historic Environment Guidance for the Offshore Renewable Energy Sector.* (Commissioned by COWRIE Ltd (project reference ARCH-11-05)).



NnG OFFSHORE WIND

Chapter 14

Seascape, Landscape and Visual

Land Use Consultants Ltd.

March 2018

Table of Contents

Table of Figures (in Volume 3)

Table of Illustrations

Table of Tables

14 Seascape, Landscape and Visual

14.1 Introduction

1. This chapter of the Environmental Impact Assessment (EIA) Report presents an assessment of the potential impacts arising from the construction, operation and decommissioning of the Project, as detailed in Chapter 4: Project Description, upon:
   - Seascape/landscape as a resource in its own right (caused by changes to its constituent elements, its specific aesthetic or perceptual qualities and/or its character); and
   - Views and visual amenity as experienced by people (caused by changes in the appearance of the landscape and seascape).

2. This chapter summarises the findings of the seascape, landscape and visual impact assessment (SLVIA), which is included in full in Appendix 14.1: SLVIA Technical Report. This chapter is comprised of the following elements:
   - A summary of relevant policy, guidance and legislation;
   - Details of the data sources used to characterise the study area;
   - A summary of the relevant consultations with stakeholders;
   - A description of the methodology for assessing the impacts of the Project, including details of the study area and approach to the assessment of potential effects;
   - A review of the baseline conditions;
   - A description of the worst-case design scenario relevant to SLVIA;
   - An assessment of the likely effects for the construction, operation and decommissioning phases of the Project, including cumulative effects;
   - Identification of any further mitigation measures or monitoring requirements in respect of any significant effects; and
   - A summary of the residual impact assessment determinations taking account of any additional mitigation measures identified.

14.2 Policy, Guidance and Legislation

3. There is no specific legislation relating to SLVIA.

4. Policy GEN7 of Scotland's National Marine Plan states: *"Marine planners and decision makers should ensure that development and use of the marine environment take seascape, landscape and visual impacts into account."* The plan notes the value placed on coastal landscapes, and refers to available guidance on good siting and design practice.

5. The methodology for this SLVIA has been developed primarily in accordance with the principles contained within the *Guidelines for Landscape and Visual Impact Assessment,* 3rd Edition (GLVIA3) (LI and IEMA, 2013). Reference is made to other published guidance as appropriate, as listed below:
   - Scottish Natural Heritage (2017a) Siting and designing wind farms in the landscape. Version 3;
   - Scottish Natural Heritage (2017b) Visual Representation of Wind Farms: Good Practice Guidance. Version 2.2;
   - Scottish Natural Heritage (2012a) Offshore Renewables: Guidance on assessing the impact on coastal landscape and seascape;
   - Scottish Natural Heritage (2012b) Assessing the cumulative impact of onshore wind energy developments;

- Landscape Institute (2011) Photography and photomontage in landscape and visual impact assessment. Advice Note 01/2011; and
- Enviros (2005) Guidance on the Assessment of the Impact of Offshore Wind Farms: Seascape and Visual Impact Report. Prepared for the Department of Trade and Industry (DTI).

14.3 Data Sources

6. The assessment considers the potential interaction between the Project, as described in Chapter 4: Project Description, and seascape / landscape and visual receptors within the study area.

7. The study area for the SLVIA has been defined as a radius of 50 kilometres (km) from the outer edge of the Wind Farm Area. For the purposes of cumulative assessment, a search area of 65 km radius has been adopted. These distances have been adopted on the advice of Scottish Natural Heritage (SNH), and agreed with SNH and local planning authorities (LPAs). The 50 km study area is illustrated in Illustration 14.1.

8. Baseline characterisation data has been collated from a combination of national and local sources, as well as project-specific information. details the data sources used to inform the baseline characterisation within the study area.

Table 14.1: Data sources used to inform the baseline description for SLVIA

Data Source	Study/Data Name	Overview
Forth and Tay Offshore Wind Developers Group (FTOWDG)	Regional Seascape Character Assessment: Aberdeen to Holy Island (2012) (Referenced in the Scoping Opinion as "baseline coastal character assessment")	Criteria-based characterisation of the seascape along the east coast of Scotland and Northern England, and evaluation of sensitivity to offshore wind energy development. Undertaken as a joint baseline to inform SLVIA for all offshore wind farms proposed in the Forth and Tay area.
SNH	Landscape Character Assessments (1998-1999)	A series of reports giving description and classification of onshore landscape character, published as part of a nationwide programme in 1998-1999. Relevant reports cover South and Central Aberdeenshire, Tayside, Fife, the Lothians and the Scottish Borders.
LPAs	Development plans and background documents relating to landscape character and local landscape designations	Landscape character, capacity and local landscape designation studies produced by Aberdeenshire, Angus, Fife, East Lothian and Scottish Borders Councils.
Historic Environment Scotland (HES)	Inventory of Gardens and Designed Landscapes	Database of nationally important designed landscapes across Scotland, including their location, extent and qualifying interests.
Met Office	Atmospheric visibility data	Average visibility, recorded at Leuchars over a 10 year period from January 2007 to December 2016.
Various	Wind farms within the study area.	A list of operational, consented and proposed wind farms within the 65 km agreed cumulative study area, compiled from information provided by SNH, LPAs, and wind energy developers.

14.4 Relevant Consultations

9. As part of the EIA process, NnGOWL has undertaken a number of consultations with various statutory and non-statutory stakeholders. A formal scoping opinion was also requested from MS-LOT following submission of the Scoping Report. In response to NnGOWL's request, MS-LOT issued a Scoping Opinion that indicated all aspects of SLVIA should be scoped in to the EIA process.

10. Ongoing consultation with relevant stakeholders continued post-scoping and responses have been used to develop an appropriate methodology and parameters for the SLVIA.

11. The recommendations made in the Scoping Opinion, and in subsequent correspondence, in respect of SLVIA are summarised in Table 14.2.

Table 14.2: Summary of consultation relating to SLVIA

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
Scoping Opinion: Scottish Ministers responses to scoping questions	Agree that 2012 baseline coastal character assessment can be used.	This is discussed at Section 14.6.1.1.
	Baseline information as described by Angus and East Lothian Councils should be used.	Landscape baseline information is discussed below and in Section 14.6.
	The assessment should be based on the maximum turbine height.	The SLVIA is based on the maximum turbine height of 208 m above LAT.
	No potential effects should be scoped out of the SLVIA.	Effects on onshore landscape character and Inventory Gardens and Designed Landscapes have been considered, see Sections 14.6.1.2 and 14.6.1.3.
	Provided a list of projects to be considered in the cumulative SLVIA.	These are included in the assessment, see Section 14.8.4.
	Advised NnGOWL to present approach to Offshore Wind Farm design, and provide comparison with the Originally Consented Project.	This material is presented in Annex 1 to Appendix 14.1.
	Accepted re-use of photography taken for the Original ES, but note photography should be retaken were stakeholders recommend.	This has been done, see detailed comments below.
	Effects of lighting should be considered, and advice of stakeholders should be considered in relation to location of night time visualisations.	This has been done, see detailed comments below.
	NnGOWL should consider the detailed advice provided by stakeholders in relation to viewpoint locations.	This has been done, see detailed comments below.
Scoping Opinion: Scottish Natural Heritage	Concerns that increased height may increase visual complexity, drawing attention to wind farm design.	Annex 1 to Appendix 14.1 provides further information in relation to wind farm design.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	No potential effects should be scoped out of the SLVIA.	Accepted, see above.
	A study area of 50 km radius from the Wind Farm Area should be used.	The 50 km study area is described in Section 14.3.
	Changes in visibility from use of larger turbines should be examined using ZTVs.	Changes in visibility compared to the Consented Project are considered in Annex 1 to Appendix 14.1.
	SNH defer to local authorities on viewpoint selection.	See local authority comments below.
	Accepted re-use of photography taken for the Original ES, but note that new photography may be required where baseline changes have occurred, and request new photo from at least one Angus coast viewpoint taken in late afternoon.	New photography has been taken where required. New photography taken from Carnoustie in late afternoon. See Figure 14.22 (Volume 3)
	Larger turbines could alter perspective, appearing closer than the consented turbines – this should be explored using wirelines.	Changes in appearance compared to the Consented Project are considered in Annex 1 to Appendix 14.1.
	Turbine circumference and blade width should be accurately modelled into photomontages.	Turbine circumference and blade width has been modelled in proportion to the dimensions of the turbine.
	The assessment should cover the landscape and visual impacts of turbine lighting.	This is addressed in the assessment of operational impacts.
	Recommend a 'rigorous design process' in relation to other offshore developments.	A collaborative approach to design has not been undertaken due to the differing implementation timescales between the three offshore wind farms. However, current design envelopes were exchanged to inform the cumulative assessment. See Section 14.8.4.
	Methil and Kincardine offshore wind farms should be considered in the cumulative assessment.	These are listed in Section 14.8.4.
Scoping Opinion: Angus Council	Capacity studies for Arbroath, Carnoustie and Monifieth could be relevant to the SLVIA baseline.	These studies were reviewed, but primarily focus on capacity for settlement expansion, so are not referenced specifically.
	Highlighted the visual contrast likely to arise from the difference in turbine size between proposed offshore wind farms.	These differences are considered in the cumulative impact assessment, Section 14.8.4.
	Photography may need to be retaken where turbines now appear in the view.	All locations have been checked and photography retaken where this may alter the assessment.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
	Suggested locations away from ambient light for night-time visualisations, including the Carmyllie area.	Wirelines were provided to Angus Council as part of follow up consultation, see below.
	Requested detailed ZTVs to inform viewpoint selection.	ZTVs provided for follow up consultation, see below.
Scoping Opinion: Dundee Council	No comment.	N/A.
Scoping Opinion: Fife Council	No comments on SLVIA.	N/A.
Scoping Opinion: East Lothian Council	Existing Areas of Great Landscape Value and proposed Special Landscape Areas should be included in the baseline.	These local landscape designations have been considered, see section 14.6.1.3.
	Greater turbine height could lead to more widespread and more significant effects, and lesser density could lead to more noticeable movement of blades.	These factors are considered throughout the SLVIA, and in Annex 1 to Appendix 14.1.
	'Changes to the character of landscape character types' can be scoped out for non-coastal landscapes, but not for coastal landscapes.	All effects have been scoped in on the advice of Scottish Ministers (see above). Coastal landscapes are covered under the Coastal Character Areas (see Annex 2 to Appendix 14.1).
	Effects on Gardens And Designed Landscapes should be scoped in.	These effects are considered in Section 14.8.2.3.
	A number of onshore and offshore projects are listed for consideration in the cumulative assessment.	These have been included in the assessment. See Section 14.8.4, and detailed list of schemes in Appendix 14.1, Table 7.1 and Table 7.2.
	A number of detailed comments were made in relation to viewpoints and photography, including requests for new and amended viewpoints.	These suggestions were discussed further with consultees. A number of wirelines and ZTVs were provided for follow up consultation, as detailed below.
	Raised potential for significant lighting impacts on the Tantallon to Tyninghame coast. Recommend use of Dunbar and North Berwick viewpoints for night-time visualisations.	Night time effects are discussed at Section 14.8.2, with reference to visualisations from these locations. See Table 14.12 for list of night viewpoint locations.
Scoping Opinion: Scottish Borders Council	Suggested additional viewpoints at Ewieside Hill and Fast Castle.	Wirelines were provided for follow up consultation, see below.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
Follow up consultation: Scottish Natural Heritage (email 20 October 2017 and subsequent phone calls)	Support the stated approach to wind farm design, request comparison of the proposed layout with a 'most likely' consented scheme.	This comparison is presented in Annex 1 to Appendix 14.1.
	Agree with the approach to night time visualisations, and suggest Tentsmuir and Arbroath as night viewpoint locations.	Arbroath to be used along with others in Angus, on advice of Angus Council. St Andrews used in place of Tentsmuir, as elevated location more likely to enable views of navigation lighting.
	Assessment should consider impacts through twilight and night time, as well as in different daylight conditions.	Different light conditions considered for each viewpoint assessment (see Annex 3 to Appendix 14.1).
Follow up consultation: Scottish Natural Heritage (email 18 December 2017)	Confirmed that there was no requirement to provide cumulative photomontages, and that cumulative representation can be by wireline only.	Cumulative wirelines have been produced for all viewpoints. In addition, supplementary cumulative photomontages have been produced for a selection of key viewpoints. See Section 14.6.2.6.
Follow up consultation: Angus Council (email 9 November 2017 and subsequent phone calls)	Stated agreement with approach to ZTV, viewpoints and photography.	N/A.
	Requested an additional night time visualisation from a location with minimal light pollution.	Follow up conversation agreed night time viewpoints at East Haven and Carmyllie. See Table 14.12 for list of all night viewpoint locations.
	Suggested all turbines over 50 m should be included in the cumulative assessment.	These turbines are not listed or included in modelling, but their presence is recognised in the assessment.
	Cumulative assessment to address design envelopes for other offshore schemes.	'Worst case' for cumulative assessment discussed at Section 14.8.4.
Follow up consultation: East Lothian Council (email 9 November 2017)	Requested additional viewpoint locations on A199, A198, and Hopetoun Monument	These have been included in the viewpoint assessment, see Table 14.11 for full list of representative viewpoints.
	Further locations to be included as wirelines to inform the assessment.	Wirelines for the requested locations are provided in Figures 14.52 (Volume 3) to 14.55 (Volume 3), see Table 14.13.
	Agree with Seabird Centre and Dunbar for night time visualisations. Request an additional night montage from the A199 viewpoint.	This has been included. See Table 14.12 for list of night viewpoint locations.
	Confirmed all relevant wind farms included in proposed cumulative assessment scope.	Scope of cumulative assessment set out in Section 14.8.4.

Date and consultation phase / type	Consultation and key issues raised	Section where comment addressed
Follow up consultation: Scottish Borders Council (email 11 October 2017)	Confirmed illustration of views from Ewieside Hill and Fast Castle could be with wirelines only.	Wirelines for the requested locations are provided in Figures 14.56 (Volume 3) to 14.57 (Volume 3), see Table 14.13

14.5 Impact Assessment Methodology

12. This assessment considers the potential impacts associated with the construction, operation and decommissioning of the Project and the effects on landscape character and visual amenity. The impact assessment process and methodology follows the principles and general approach outlined in Chapter 6: EIA Methodology, modified as appropriate in line with accepted good practice for SLVIA, as set out in GLVIA3. The methodology and parameters assessed have also taken into account issues identified through consultation with stakeholders as summarised in Section 14.4 and the understanding of baseline conditions informed by the data sources referenced in Section 14.3.

13. The Project Description (Chapter 4) and the project activities for all stages of the project life cycle (construction, operation and decommissioning) have been assessed against the environmental baseline to identify the potential interactions between the Project and the environment. These are known as the potential impacts and are then assessed to determine a level of significance of effect upon the receiving environment.

14. The key steps in the methodology for SLVIA are as follows:

- the marine, coastal and landscape character of the study area is analysed, and receptors are identified, informed by desk and field based survey;
- the area over which the development will potentially be visible is established through the creation of a Zone of Theoretical Visibility (ZTV) map;[1]
- the visual baseline is recorded in terms of the different groups of receptors (people) who may experience views of the development (informed by the ZTV) and the nature of their existing views and visual amenity;
- assessment viewpoints are selected (including representative viewpoints, specific viewpoints and illustrative viewpoints) to represent a range of different receptors and views, in consultation with statutory consultees;
- likely significant effects on landscape and coastal character as a resource and on visual receptors are identified; and
- the level (and significance) of effects is judged with reference to the sensitivity of the receptor, which considers both susceptibility and value, and the magnitude of impact, which considers a combination of judgements including scale, geographical extent, duration and reversibility.

15. As recommended by GLVIA3, effects on landscape and coastal character and on visual amenity are assessed separately, though given the nature of the Project both assessments are informed by the viewpoint assessment. The detailed methodology for each assessment process is set out in Appendix 14.1, and is summarised below for landscape and visual assessments.

[1] A ZTV indicates areas from where a development is theoretically visible, but cannot show what it would look like, nor indicate the nature or magnitude of any resulting landscape or visual impacts.

14.5.1 Assessment and Assignment of Significance

16. The sensitivities of landscape and visual receptors are defined by both the susceptibility of the receptor to an impact from the Project, and the value placed on the resource.

For landscape receptors, criteria including scale, landform, pattern etc. are used to evaluate susceptibility, while value is assessed with reference to factors including scenic qualities, designations and rarity. The definitions of terms relating to the sensitivity of landscape receptors are detailed in Table 14.3.

Table 14.3 Sensitivity of landscape receptors

Receptor sensitivity	Description
Very high	Key characteristics and attributes are highly vulnerable to the type of change proposed. May be within a nationally designated landscape that has rarity and strong scenic qualities.
High	Key characteristics and attributes are vulnerable to the type of change proposed. May be within a nationally or locally designated landscape that is uncommon or particularly scenic.
Medium	Key characteristics and attributes are reasonably resilient to the type of change proposed. May be within a locally designated landscape that has some scenic quality.
Low	Key characteristics and attributes are resilient to the type of change proposed. Unlikely to be designated but may have other indicators of local value.
Very low	Key characteristics and attributes are unlikely to be affected by the type of change proposed. Little or no indication of value.

17. As set out in Appendix 14.1, sensitivity of Coastal Character Areas is described according to a different scale, which derives from a stand-alone report undertaken to inform all offshore wind farm developments in the Forth and Tay area (see Section 14.6.1 and Annex 2 to Appendix 14.1).

18. For visual receptors, susceptibility is mainly a factor of their occupation and the resulting level of attention likely to be given to the view. The value of the view is judged based on indicators such as recognition in maps and guides, presence of seating, or scenic quality. The definitions of terms relating to the sensitivity of visual receptors are detailed in Table 14.4.

Table 14.4: Sensitivity of visual receptors

Receptor sensitivity	Description
Very high	Viewers with proprietary interest and prolonged viewing opportunities, or those who are present mainly to appreciate the view, and where there are open marine views. Views may be recognised as important to a national designation or widely promoted for their scenic value. For example: residents in large coastal settlements; people at nationally valued viewpoints.
High	Viewers with proprietary interest, or people whose attention is likely to be focused on appreciation of their surroundings, including open marine views. Views may be recognised in relation to local designations, or marked as viewpoints on maps. For example: residents in smaller coastal settlements/houses; users of coastal footpaths/cycleways; or visitors to locally promoted viewpoints.

Receptor sensitivity	Description
Medium	Viewers with a passing interest in their environment such as those travelling in vehicles on scenic routes and tourist routes, where attention is focussed on the surrounding landscape, but is transitory. Views that may be locally recognised and valued for their scenic quality. For example: people on non-coastal cycleways; a local viewpoint indicated by a bench at the edge of a village.
Low	People travelling more rapidly on major road, rail or transport routes that are not recognised as scenic routes, and/or those engaged in outdoor sport or recreation, which does not involve or depend upon appreciation of views of the landscape. Views are unlikely to be recognised for their scenic quality. For example: people passing on the A1 or main line railway.
Very low	People whose attention is not on their surroundings, who may be primarily indoors, and where setting is not important to their activity. No indications that value is placed on views. For example: people at their place of work.

19. The magnitude of impact is defined by a series of factors including the scale of the change, its geographical extent, and its duration and reversibility. The definitions of the levels of magnitude used in this assessment in respect of landscape and visual impacts are described in Table 14.5 and Table 14.6.

Table 14.5: Magnitude of impact on the landscape

Magnitude	Definition
Very high	Extensive changes in key characteristics, including potential creation of new characteristics, across a regional-scale area. And/or a change that is long-term and likely to be permanent and irreversible.
High	Changes in key characteristics, including potential creation of new characteristics, across a district-scale area. And/or a change that is long-term but may be at least partly reversible.
Medium	Some changes in key characteristics, including potential creation of new characteristics, across a local-scale area. And/or a change that is medium-term or short-term, and likely to be at least partly reversible.
Low	Limited changes in key characteristics, including potential creation of new characteristics, across a localised area. And/or a change that is medium-term or short-term, and likely to be fully reversible.
Very low	Little or no change in key characteristics, across a very localised area. And/or a change that is short-term and likely to be fully reversible.

Table 14.6: Magnitude of impact on visual amenity

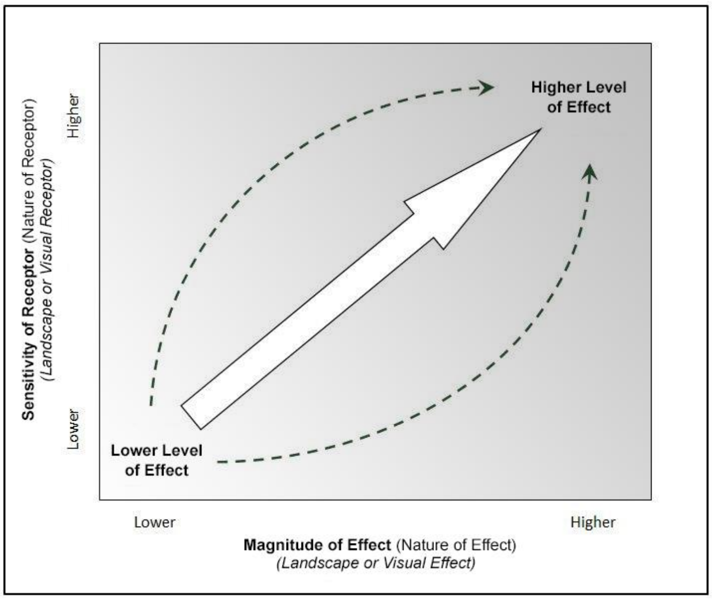
Magnitude	Definition
Very high	Extensive visual change, likely to result from the Project being the main, focal feature in the view. Strong contrast with existing views and changes in scenic quality, experienced across a regional-scale area. And/or a change that is long-term and likely to be permanent and irreversible.

Magnitude	Definition
High	Extensive visual change, likely to result from the Project being a focal feature in the view. Contrast with existing views and changes in scenic quality, experienced across a district-scale area. And/or a change that is long-term but may be at least partly reversible.
Medium	Some visual change, likely to result from the Project being a feature in the view. More limited contrast with existing views and limited changes in scenic quality, experienced across a local-scale area. And/or a change that is medium-term or short-term, and likely to be at least partly reversible.
Low	Limited visual change, likely to result from the Project being visible in the view. Limited changes in scenic quality, experienced across a localised area. And/or a change that is medium-term or short-term, and likely to be fully reversible.
Very low	Little or no visual change, likely to result from occasional or glimpsed views of the Project. Little change in scenic quality across a very localised area. And/or a change that is short-term and likely to be fully reversible.

20. The magnitude of the impact is correlated against the sensitivity of the receptor to provide a level of significance. In line with guidance provided in GLVIA3, a matrix is not used. Instead, judgements are made on a case by case basis, guided by the principles set out in Illustration 14.1. Levels of visual effect are identified as negligible, minor, moderate or major. For the purposes of this assessment, any effect that is judged to be major or moderate is considered to be significant in the context of the EIA Regulations.

21. The direction of effects (beneficial or adverse) is determined in relation to the degree to which the Project fits with the existing landscape or view, and/or the contribution made by the Project, even if it is in contrast to the existing character of the view. With regard to wind energy development there is a broad spectrum of response from the strongly positive to the strongly negative. However, to cover the 'maximum effect' situation, for the purposes of this SLVIA potential effects are assumed to be adverse.

Illustration 14.1 Judging levels of effect



14.5.2 Uncertainty and Technical Difficulties Encountered

22. The SLVIA has assumed a 'worst-case' scenario as described in Section 14.7 below. This adopts a range of maximum design parameters that may not reflect the final development, but does provide a realistic worst case scenario for assessment. This approach ensures that the eventual design will be certain to fall within the assessed parameters.

23. In relation to turbine lighting for aviation and navigation, assumptions have been made as to the number, position and brightness of the lights. Although based on statutory requirements and recommendations, the final arrangement of lights will be subject to consultation with the relevant statutory bodies and approval by MS-LOT. Particular uncertainty applies to the relative brightness of the aviation and navigation lights, which are specified differently. Aviation lights have been modelled at the specified 2000 candela, but navigation lights are specified by the minimum visible distance (either 2 nautical miles (NM) or 5NM). Precautionary assumptions have been made that these distances equate to 50 candela and 500 candela, and these specifications have been modelled.

14.6 Baseline Description

24. This section sets out the existing conditions within the 50 km study area, and describes the baseline against which the assessment of changes in seascape, landscape and views is undertaken. This section provides information about:

- the character of the coastal part of the study area;
- the character of the non-coastal landscapes of the study area;
- landscape designations within the study area; and
- existing visual amenity.

25. The study area is further refined through mapping of the Zone of Theoretical Visibility (ZTV) of the Offshore Wind Farm. The ZTV indicates areas from where the Offshore Wind Farm is theoretically visible, but cannot indicate the nature or magnitude of any resulting landscape or visual impacts. ZTVs have been calculated to show the visibility of the maximum blade tip height and hub height, and these are shown in Figure 14.2 (Volume 3) and 14.3 (Volume 3) respectively.

14.6.1 Seascape and Landscape

14.6.1.1 Coastal Character

26. The baseline seascape character is described in *Seascape Character Assessment: Aberdeen to Holy Island*, included as Annex 2 to Appendix 14.1. This document was prepared in 2012 specifically to inform the SLVIA of offshore wind farms in the Forth and Tay area and was submitted alongside the Original ES.

27. The seascape character assessment defines 21 'Regional Seascape Units' along the coast, and includes an assessment of each area's sensitivity to offshore wind farm development. There are 16 Regional Seascape Units within the study area. Regional Seascape Units considered in the assessment are listed in Table 14.7 and are shown on Figure 14.4 (Volume 3).

Table 14.7: Regional Seascape Units

Regional Seascape Unit	Brief summary of key characteristics
SA4: Montrose	Long, sweeping beach backed by cliffs to the north around St Cyrus, and by low lying coastal settlement and promenade at Montrose.
SA5: Long Craig	Rocky headland and associated agricultural hinterland that stretches between Scurdie Ness in the north and Lunan Bay to the south.

Regional Seascape Unit	Brief summary of key characteristics
SA6: Lunan Bay	Broad sandy beach between Boddin Point and the Lang Craig, backed by dunes and framed by low cliffs the north and south.
SA7: Lang Craig to the Deil's Head	Continuous stretch of sea cliffs, reaching up to 50 m, and associated rocky coastline between Lang Craig and Whiting Ness.
SA8: Arbroath to Monifieth	Low lying coast with rock-cut platforms, areas of dunes, and backed by settlement.
SA9: Dundee	Developed and settled coastal edge between Monifieth and Invergowrie, centred on Dundee.
SA10: Inner Firth of Tay	The Inner Firth of Tay includes a narrow strip of land adjacent to the southern coastline and the extensive area of predominantly low-lying farmland of the Carse of Gowrie.
SA11: St Andrews Bay	Large stretch of sandy coastline backed by dunes and forestry between Tayport and St Andrews.
SA12: St Andrews to Fife Ness	Gently sloping agricultural hinterland, rocky coastline and low cliffs stretching between St Andrews and Fife Ness.
SA13: East Neuk of Fife	Rocky coastline and shingle beaches between Fife Ness and Earlsferry, including agricultural hinterland and fishing villages.
SA14: Kirkcaldy and Largo Bay	Generally low-lying coast of sandy beaches and bays, backed by large coastal settlements with an industrial character.
SA16: Edinburgh to Gullane	Broad bay including the built-up shoreline of Portobello, Musselburgh, Cockenzie and Port Seton, as well as the less developed East Lothian coast around Gullane.
SA17: Eyebroughy to Torness Point	Generally low-lying coast, with an alternation of rocky headlands and sandy pocket bays, backed by relatively unfragmented agricultural land and towns.
SA18: Torness Point to St Abb's Head	Coastline formed by high, near vertical cliffs, with a barren, exposed character and dramatic open views.
SA19: St Abb's Head to Eyemouth	Diverse coastal landscape of rugged sea cliffs with sheltered folds and valleys, rising to the dramatic St Abb's Head.
SA20: Eyemouth to Berwick upon Tweed	Linear coastline of rocky cliffs and several small headlands, with undulating hinterland and major transport corridor close to the coast.

14.6.1.2 Landscape Character

28. The landscape character of the onshore part of the study area is defined in a series of landscape character assessments (LCA) published by SNH, covering Aberdeenshire, Angus, Fife, The Lothians and The Borders (ASH Consultants, 1998a; ASH Consultants, 1998b; David Tyldesley and Associates, 1999; Environmental Resources Management, 1998; Land Use Consultants, 1999), and for Northumberland in the Countryside Character of England, Volume 1: North East England landscape character assessment published by Natural England (Countryside Commission, 1996).

29. A total of 33 landscape character types (LCTs) are present in the study area (not including 'urban' areas) as shown in Figure 14.5 (Volume 3). In order to focus on potentially significant effects, the LCTs were examined to identify those in which marine views are important. This involved a review of the written descriptions in the published LCA reports to ascertain whether marine or coastal views are identified as a key characteristic of each unit, followed by verification in the field. A further cross-check was undertaken with the ZTV to identify any units which have only limited visibility of the Project, and were therefore unlikely to be affected.

30. LCTs with no or very limited theoretical visibility of the development were excluded from the baseline. LCTs with some view, but where marine views are not characteristic, were also excluded. This scoping exercise, set out in detail in Appendix 14.1, concluded that 15 LCTs had coastal/marine views or characteristics, and were within the ZTV. These LCTs form the landscape character baseline, and are described further in Appendix 14.1. LCTs considered in the assessment are listed in Table 14.8 and are shown on Figure 14.5 (Volume 3).

Table 14.8: Landscape Character Types included in the SLVIA

Landscape Character Type (numbers refer to Figure 14.5 (Volume 3))		Brief summary of key characteristics
1	Coastal Hills Headlands Plateaux and Moorlands	Expansive, flat to gently rolling coastal plateau, with predominantly large, open, undulating arable fields, coarse grassland, and heather moorland. Limited woodland cover, infrequent settlements. A medium to large-scale, open or exposed coastal landscape.
4	Coastal Margins	Transitional landscape between hills and sea, ranging from rolling hills to virtually flat coastal plain. Medium to large arable fields and extensive estate woodlands, wind-sculpted coastal woods, scattered hedgerow trees and shelterbelts. Distinctive coastal settlements and man-made features.
5	Coastal Raised Beaches and Terraces	Mostly flat or gently sloping landform, forming a transition between hills and coastal flats. Open, arable fields with some hedgerows, or stone dykes or post and wire fencing. Limited woodland cover except policy planting and shelterbelts, some built-up areas.
6	Dipslope Farmland	Land generally sloping down towards the coast, from low outlying hills. Productive agricultural land, with woodland cover limited to shelterbelts, except on large estates and along river corridors. Dispersed settlement pattern.
9	Fife Lowland Farmland	Varied and subtle landform, predominantly large, open, regular arable fields. Extensive woodland on lower ground. Dispersed farmsteads and occasional villages and towns well related to the landscape.
11	Foothills	Highly conspicuous hills, forming a backdrop in wider views. Modest in height, the foothills are occasionally steep-sided and rugged. A mix of arable and pastoral farmland, with burns in gullies or small valleys. General lack of settlement.
15	Low Coastal Farmlands	Strongly varied topography with rock outcrops, mounds, and rolling terrain interrupted by narrow, deeply incised valleys. Land cover of arable and pastoral fields, with rough pasture and scattered gorse scrub on steep ground. Coastal villages and scattered small farms and cottages, and transport corridors.
16	Lowland Coastal Flats Sands and Dunes	Flat, low-lying, large-scale, exposed coastal landscapes. Intensively cultivated landscape of geometrical arable fields and extensive forestry plantations. Industrial and other man-made developments including golf courses.
20	Lowland Hills (South)	Distinctive hills, aligned east-northeast, with prominent northwest-facing crags. Arable land with grazing on upper slopes, and scattered areas of deciduous woodland. Limited development aside from farmsteads.

Landscape Character Type (numbers refer to Figure 14.5 (Volume 3))		Brief summary of key characteristics
22	Lowland Plains	Extensive, gently undulating plain, interrupted by rugged volcanic hills. Chequerboard pattern of large arable fields with pasture on higher ground, and prominent policy woodlands. Dispersed settlement pattern with larger settlements having extensive 20th-century housing developments.
23	Lowland River Valleys	Small twisting rivers within shallow, narrow incised valleys. Arable land on gentler slopes, with pasture on the valley floor. Clipped hedges with hedgerow trees. Extensive mixed and broadleaf woodlands, including policy woodlands. Small villages.
24	Narrow Wooded River Valleys	Narrow, deep, gorge-like valleys cut into surrounding hills by fast flowing burns. Semi-natural woodlands on the steeply sloping banks. Occasional small villages and many historic buildings.
26	Pronounced Hills	Pronounced, often distinctive hills protruding high above the lowlands. Steep rugged hilltops, with more vegetated and more intensively used lower slopes. Mixed woodlands and burns in valleys. Farmsteads and quarries.
29	Upland Fringe Moorland and Grassland: the Lammermuir, Pentland and Moorfoot Hills	Steep hills and flat or gently rolling plateau, descending to low rounded hills dissected by incised valleys. Some arable on lower ground but predominantly pasture and rough grazing. Stone walls and occasional hedges with hedgerow trees. Ancient woodland along narrow valleys. Limited settlement.
32	Upland Hills: the Lammermuir, Pentland and Moorfoot Hills	Smooth convex hills and level-topped ridges forming a broad, gently undulating plateau, dissected by small and large incised valleys. Peatland, heather and grass moorland, with occasional improved pasture in valleys. Very limited tree cover aside from coniferous plantations. Few farms or roads, overhead power lines are prominent.

14.6.1.3 Landscape Designations

31. Since effects on coastal and landscape character are already assessed, landscape designations are not assessed as discrete receptors since this would lead to double counting of effects. Instead, the special qualities of each landscape designation are evaluated against the findings of the coastal and landscape impact assessment, to determine whether the designated area would be adversely affected by the Offshore Wind Farm.

32. The offshore part of the study area is not designated for visual or aesthetic reasons. Only onshore landscape designations are therefore considered. Landscape designations are shown on Figure 14.6 (Volume 3).

33. There are no National Parks, National Scenic Areas or Areas of Outstanding Natural Beauty within the study area.

34. There are 49 sites listed on the Inventory of Gardens and Designed Landscapes in Scotland within the study area (Historic Scotland, 1987-2017). As with LCTs, a scoping exercise was undertaken, set out in detail in Appendix 14.1, to identify those Gardens and Designed Landscapes (GDLs) which are within the ZTV, and from which marine views are important, as noted in the Inventory descriptions. A total of eight GDLs were included within the baseline, and are listed in Table 14.9. Impacts on the historic environment value of the GDLs are considered in Chapter 13: Cultural Heritage.

Table 14.9: Gardens and Designed Landscapes included in the SLVIA

Site name	Brief description	Distance from Wind Farm Area (km)
St Andrews Links	Some of the oldest public links golf courses in the world, renowned as the Home of Golf. Provides an important coastal scenic setting for St. Andrews.	30
Cambo	Good example of late 18th and early 19th-century coastal policies embracing model farms, picturesque estate layout, mid-20th-century golf course and gardens of botanical and horticultural interest.	19
Grey Walls	An important example of Edwin Lutyens' 20th century design style.	39
Leuchie	An early 19th century informal landscape of parkland, woodland, lawns and walled garden that together form an attractive setting for Leuchie House.	32
Tyninghame	Outstanding landscape, which still has its 18th century structure, within which can be seen 19th century development and the particularly fine 20th century gardens.	30
Biel	A beautiful designed landscape particularly notable for the terraced gardens, arboretum and outstanding architectural features. Makes an important contribution to the surrounding scenery.	33
Broxmouth Park	A remarkable example of late 17th/early 18th century formal landscape associated with the Battle of Dunbar, laid out around a series of long-distance vistas.	28
Dunglass	A fine example of the late 18th century picturesque style of landscape design. Of particular value are the gorges, woods, rocks and water features seen as early sublime features in the picturesque design.	31

35. A number of local landscape designations lie within the study area, within Aberdeenshire, Fife, East Lothian and the Scottish Borders. A scoping exercise was undertaken to identify those local designations where the coast or coastal views are among the reasons for designation, and where the ZTV indicated the potential for these reasons to be affected. All local landscape designations identified as being relevant to the assessment are listed in Table 14.10, and are illustrated in Figure 14.6 (Volume 3).[2]

Table 14.10: Local Landscape Designations included in the SLVIA

Designation name and local authority	Local authority	Distance from Wind Farm Area (km)
South-East Aberdeenshire Coast Special Landscape Area (SLA) (part only)	Aberdeenshire	47
Tentsmuir Coast Local Landscape Area (LLA)	Fife	31
St Andrews Links LLA	Fife	29

[2] East Lothian Council requested assessment of both existing local landscape designations and the proposed SLAs that will shortly supersede them. The SLAs are listed here, and existing designations are considered in Annex 4 to Appendix 14.1.

Designation name and local authority	Local authority	Distance from Wind Farm Area (km)
St Andrews to Fife Ness LLA	Fife	15.5
East Neuk LLA	Fife	18
Forth Islands LLA (Isle of May only)	Fife	16
Port Seton to North Berwick Coast SLA	East Lothian	31
North Berwick Law SLA	East Lothian	31
Tantallon Coast SLA	East Lothian	27
Belhaven Bay SLA	East Lothian	28
Dunbar to Barns Ness Coast SLA	East Lothian	27
Thorntonloch to Dunglass Coast SLA	East Lothian	28
Berwickshire Coast SLA	Scottish Borders	30

14.6.2Visual Amenity

14.6.2.1 Visibility

36. The Met Office records visibility on a regular basis. Data were obtained from the Met Office, giving average visibility recorded at Leuchars over a 10 year period from January 2007 to December 2016. These data are presented in Table 3.8 in Appendix 14.1. They show that visibility reduces steadily with distance from the observation point. The following observations can be made:

- There is no visibility beyond 15 km for 14% of the time, suggesting that the wind turbines would not be visible from Fife Ness on 51 days per year;
- There is no visibility beyond 30 km for 37% of the time, suggesting that the turbines would not be visible from most of Angus or East Lothian on 135 days per year; and
- There is no visibility beyond 50 km for 75% of the time, suggesting that the turbines would not be visible from the outer edge of the study area on 274 days per year.

37. This information is noted for each viewpoint in Annex 3 to Appendix 14.1. While this information provides background data, it is acknowledged that many viewers, particularly recreational users, are more likely to be present when conditions and hence visibility are better. Therefore, all assessment work has been carried out in good visibility, and these conditions are considered in the assessment of impacts.

14.6.2.2 Visual Receptors

38. Likely viewers or visual receptors of the offshore wind farm include:

- Residents living in any of the settlements or individual residences across the area which lies within the ZTV of the wind farm;
- Tourists visiting, staying in, or travelling through the area within the ZTV;
- Recreational users of the landscape, including those using golf courses, cycle routes and footpaths;
- Recreational users of the marine environment, including those involved in yachting, angling, people on boat trips to the Isle of May, and passengers on ships;

- People (tourists, workers, visitors or local people) using transport (road and rail) routes passing through the study area;
- People working in the countryside or in any of the towns, villages or dwellings across the area lying within the ZTV of the wind farm; and
- People working in the marine environment, such as fishermen and crews of ships.

39. Detailed consideration of the most sensitive visual receptors is included in Appendix 14.1.

14.6.2.3 Assessment Viewpoints

40. Assessment viewpoints were selected to be representative of views from the landward parts of the 50 km radius study area, reflecting places and routes frequented by the public. They were chosen through field work and a study of maps, to represent key locations where the public may view the offshore development.

41. For the purposes of the Original ES SLVIA, viewpoints were selected in 2011 in consultation with interested statutory consultees (including SNH and MS-LOT) and LPAs (Aberdeenshire, Angus, Dundee, Fife, East Lothian and Scottish Borders), initially as cumulative viewpoints. A total of 21 viewpoints were selected for use in relation to all Forth and Tay offshore wind farms, of which 18 are within the 50 km study area.

42. Following submission of the Original ES, some additional viewpoints were identified by stakeholders as being of relevance to the assessment, and were included in the Addendum.

43. Consultation undertaken through Scoping and subsequent correspondence for the current application has identified further viewpoints for assessment. All assessment viewpoints considered in this SLVIA are listed in Table 14.11, and their locations are shown on the ZTVs in Figures 14.2 (Volume 3) and 14.3 (Volume 3).

44. Some of the SLVIA viewpoints are also considered in Chapter 13: Cultural Heritage. The SLVIA considers the effect on views experienced by people, while the cultural heritage assessment considers the effect on the setting of a particular historic environment asset. Though related, these are different assessments and so conclusions may be considerably different.

Table 14.11: Representative Viewpoints

No.	Viewpoint	Distance to closest turbine (km)	Reason for Selection
2	Beach Road, Kirkton, St Cyrus	49.0	Car park offering beach access, and wide elevated views over Montrose Bay, on a coastal footpath.
5	Dodd Hill	43.9	Inland location on walking route offering views across Angus to the coast.
6	Braehead of Lunan	39.0	Representative of views from a hamlet, located on National Cycle Network (NCN) Route 1, enables views south over Red Head.
7	Arbroath Signal Tower	30.8	Listed building with an elevated platform and historic connection to the Bell Rock, now a museum.
8	Carnoustie	31.7	Recently upgraded promenade with car parking and beach access.
9	Dundee Law	44.9	Most prominent viewpoint in Dundee, a popular recreational location with large numbers of visitors, and long views down the Firth of Tay.

No.	Viewpoint	Distance to closest turbine (km)	Reason for Selection
10	Tentsmuir	31.8	Forestry Commission car park in a popular recreational area. Views across sandbanks. Located on Fife Coastal Path and NCN Route 1.
11	Strathkinness	33.1	Within coastal hills, small settlement overlooking St Andrews and the Firth of Tay.
12	St Andrews, East Scores	28.2	Popular location within the town, by the abbey, overlooking St Andrews Bay, on the Fife Coastal Path.
13	Fife Ness, Lochaber Rock	15.5	Easternmost point of Fife, unobstructed views across the outer Firth and Tay, on the Fife Coastal Path.
14	Anstruther Easter	21.8	Representative of views from a coastal settlement at a local play park with foreshore access, on the Fife Coastal Path.
15	Largo Law	36.8	Elevated location, enabling wide views across the Firth of Forth, on a locally-signposted footpath
16	Isle of May	16.3	The island is a popular day-trip destination, and a useful proxy for marine views.
17	North Berwick Law	33.0	Popular walking destination close to North Berwick, enabling wide views over the Firth of Forth.
18	Dunbar	28.0	Representative of views from coastal settlement, on the John Muir Way long-distance path.
19	Innerwick	30.4	Elevated viewpoint from a small settlement, enabling views across the coastal plain to the Firth of Forth.
20	Coldingham Moor	32.8	Elevated headland with wide seaward views, enabling northward views over the Firth of Forth.
21	St Abb's Head	33.0	Marked as a viewpoint on OS map, within National Trust for Scotland access land, offering extensive coastal views.
22	St Andrews, West Sands	29.9	Recreational location close to the town of St Andrews, with important associations between golf course and coast.
23	Crail	18.4	Fishing village on the Fife coast, popular with visitors and with open views across the outer Firth of Forth.
24	Scottish Seabird Centre, North Berwick	32.4	Popular visitor location close to the settlement centre, with coastal views towards the Bass Rock.
25	Tantallon Castle	29.3	Popular visitor attraction on elevated coast, with views over the Forth including the Bass Rock.
26	Broad Sands, North Berwick	34.9	Views across the Forth, including the inshore islands, from this popular beach near North Berwick.
27	A198, North Berwick	30.2	Views to the Bass Rock from a tourist route and core path.

No.	Viewpoint	Distance to closest turbine (km)	Reason for Selection
28	A199, East Linton	36.1	Views from higher ground across Belhaven Bay from a tourist route and core path.
29	Hopetoun Monument	42.0	View from the top of a hilltop monument, which offers panoramic vistas across East Lothian.

14.6.2.4 Night Time Assessment Viewpoints

45. Due to the statutory requirement to install visible aviation and navigation lighting on some of the wind turbines and the Offshore Substation Platform(s) (OSP(s)), an assessment of effects during the hours of darkness has been carried out. A smaller selection of viewpoints, including some of those listed in Table 14.11, was included in this night-time assessment. These were agreed with stakeholders to represent a range of viewpoints where people are most likely to be present during darkness, i.e. populated places rather than coastal walks or beaches. The eight representative night-time viewpoints are listed in Table 14.12, and their locations are shown on the ZTVs in Figures 14.2 (Volume 3) and 14.3 (Volume 3).

Table 14.12 Representative Night-time Viewpoints

No.	Viewpoint	Distance to closest turbine (km)	Reason for Selection
N1	King's Road, Arbroath	30.1	Located close to the town, but away from the brightest lights
N2	Carmyllie	38.4	An elevated inland location with limited light intrusion
N3	East Haven	31.7	A coastal location with limited light intrusion
N4	St Andrews, East Scores	28.2	Popular location close to the settlement centre, likely to be frequented at night.
N5	Crail	18.4	Location in the settlement, likely to be frequented at night.
N6	North Berwick Seabird Centre	32.4	Popular location close to the settlement centre, likely to be frequented at night.
N7	Dunbar	28.0	Location in the settlement, likely to be frequented at night.
N8	A199, East Linton	36.1	Views from higher ground across Belhaven Bay from a route likely to be well used at night.

14.6.2.5 Additional Viewpoints

46. In addition to the assessment viewpoints, the illustration of a number of specific viewpoints was requested by statutory consultees. These locations were considered to be of interest, but detailed assessment was not required. Most of these viewpoints illustrate views from more distant locations, or views that are similar to locations listed in Table 14.11. The additional viewpoints are listed in Table 14.13, and their locations are shown on the ZTVs in Figures 14.2 (Volume 3) and 14.3 (Volume 3).

Table 14.13: Additional viewpoints illustrated with wirelines

No.	Viewpoint	Distance to closest turbine (km)	Reason for Selection
A1	West Steel	35.0	A viewpoint in the Lammermuirs used in the Original SLVIA, replaced with Innerwick as requested by East Lothian Council.
A2	Traprain Law	37.4	Requested by East Lothian Council to illustrate the view over Belhaven Bay from this prominent hill.
A3	B6370 north of Garvald	39.7	Requested by East Lothian Council to illustrate the view from the lower fringe of the Lammermuirs.
A4	B6355 west of B6368	48.0	Requested by East Lothian Council to illustrate distant view from inland location.
A5	Ewieside Hill	34.0	Requested by Scottish Borders Council to illustrate the elevated view over Cockburnspath.
A6	Fast Castle	31.5	Requested by Scottish Borders Council to illustrate the view from a cliff top historic site.

14.6.2.6 Visualisations

47. Rendered photomontage visualisations have been prepared for all viewpoints listed in Table 14.11 and Table 14.12. These are presented in Figures 14.18 (Volume 3) to 14.51 (Volume 3), and include wirelines showing the Inch Cape and Seagreen offshore wind farms. In addition, cumulative photomontages showing the Offshore Wind Farm with Inch Cape and Seagreen have been produced for five key viewpoints: VP 7 Arbroath Signal Tower; VP 12 St Andrews, East Scores; VP 13 Fife Ness; VP 17 North Berwick Law; and VP 21 St Abb's Head. Wirelines for viewpoints listed in Table 14.13 are presented in Figures 14.52 (Volume 3) to 14.57 (Volume 3). The methodology for preparing these visualisations is included in Section 2 of Appendix 14.1.

14.6.3 Development of Baseline Conditions without the Project

48. In the absence of the Project, it is likely that the Wind Farm Area will remain an area of open sea. The character of coastal landscapes, and the nature of views out to sea, will remain largely unchanged in the short term, though natural processes and human activities will continue to shape the coast.

14.7 Design Envelope – Worst Case Design Scenario

49. The Application is for the construction, operation and decommissioning of an offshore wind farm with a maximum output of 450 MW, comprising a maximum of 54 turbines. The assessment scenarios identified in respect of the SLVIA have been selected as those having potential to represent the greatest effect on an identified receptor based on the design envelope described in Chapter 4: Project Description.

50. The worst case design scenarios for SLVIA are set out in Table 14.14.

Table 14.14: Design envelope scenario assessed for SLVIA

Potential Impact	Worst Case Design Scenario	Justification
Construction		
Impact of landfall construction activities on landscape receptors at Thorntonloch Beach **Impact of landfall construction activities on visual receptors at Thorntonloch Beach**	Both open trenching and HDD have been considered for the installation of the Offshore Export Cable at the landfall. Open trenching will require a construction width of 30 m across the beach, for approximately 3 months. HDD will require a sheet-piled dry area of up to 400 m^2 to be established below low water, for approximately 4 months.	Both methods involve visible disturbance to coastal landscape features and could give rise to significant adverse effects.
Operation		
Impact of the Offshore Wind Farm on coastal character **Impact of the Offshore Wind Farm on landscape character** **Impact of the Offshore Wind Farm on visual amenity**	54 turbines, with a blade tip height of 208 m (above LAT), including a rotor diameter of 167 m and a hub height of 126 m (above LAT). Two OSPs installed within the Wind Farm Area.	Maximum turbine dimensions within the design envelope. Maximum number of OSPs within the design envelope. Likely to give rise to most widespread visibility and greatest potential effect.
Impact of aviation and navigation lighting on coastal character **Impact of aviation and navigation lighting on landscape character** **Impact of aviation and navigation lighting on visual amenity**	Lighting installed in line with CAA and IALA requirements. 2000 candela aviation lights fitted on nacelles of 33 peripheral turbines, flashing Morse W (dot dash dash). 500 candela navigation lights with 5-second flash fitted on nine 'significant peripheral structures'. 50 candela navigation lights with 2.5-second flash fitted on six 'intermediate peripheral structures'. All navigation lights fitted at maximum 36.5 m above LAT.	Likely worst case number of lights. Brighter than are likely to be installed, to ensure worst case assessed. Higher position of navigation lights means they are more likely to be visible from shore.

14.7.1 Embedded Mitigation

51. It is acknowledged that traditional methods of landscape and visual mitigation, such as screen planting, are ineffective for offshore wind farm development. Mitigation for wind farms is generally limited to the reduction of potential direct effects through detailed siting, and the reduction in adverse aesthetic effects through wind farm design. This is made clear in Siting and Designing Wind Farms in the Landscape (SNH, 2017a).

52. In order to consider the aesthetic aspects of wind farm design, an analysis was undertaken of alternative layouts, and this is presented in Annex 1 of Appendix 14.1. This provides 'design objectives' that can be considered in order to refine the appearance of the final layout. Detailed siting of the turbines will also be driven by a range of physical and environmental constraints including localised geological conditions, bathymetry, ecology, aviation, navigation, wind resource, and marine archaeology.

53. Detailed design of the aviation and navigation lighting will also take place post-consent, in line with the requirements of the relevant statutory authorities. It is possible that the lights installed may be less bright than those modelled and assessed, such that actual impacts could be less than is assessed in this SLVIA.

54. Since the wind farm design is dependent on detailed design that will only take place post-consent, this mitigation cannot be adopted into the Project design at this stage.

14.7.2 Anticipated Consent Conditions

55. A number of consent conditions were attached to the Original Consents to manage the environmental risk associated with the Originally Consented Project. NnGOWL anticipate that any future consents issued to the Project may incorporate similar conditions to manage the environmental risk commensurate with the design envelope, where it remains necessary to do so.

56. Table 14.15 sets out the conditions attached to The Consents which have relevance to the management of effects on seascape, landscape and visual amenity.

Table 14.15 Consent conditions for the Originally Consented Project relevant to Seascape Landscape and Visual impacts

Original Consent Requirement	Relevance to seascape landscape and visual impacts
Development Specification and Layout Plan	Setting out, for approval, the final design and layout of the Project to ensure it remains consistent with the design assessed in the ES as relevant to SLVIA.
Design Statement	Providing representative visualisations of the Offshore Wind Farm based on the final Development Specification and Layout Plan. The requirements for the design statement will be discussed with MS-LOT and relevant stakeholders following award of consent.
Lighting and Marking Plan	Setting out, for approval, how the Offshore Wind Farm will be lit and marked in accordance with the current aviation and navigation policy and guidance.

14.8 Impact Assessment

57. This section addresses the impacts associated with construction, operation and maintenance and decommissioning, of the Project, on landscape and visual receptors in the study area.

14.8.1 Construction Phase Impacts

58. The impacts resulting from the construction of the Project have been assessed on landscape and visual receptors identified within the study area. A discussion of the likely significant effect resulting from each impact is presented below.

59. Impacts on landscape and visual amenity may arise as a result of the following activities associated with construction of the Offshore Wind Farm and Offshore Transmission Works:

- Movement of installation vessels, cranes and other equipment visible in and around the Wind Farm Area;
- Views of turbines and other structures under construction; and
- Laying of the subsea cables, particularly the Offshore Export Cable where it connects to the Onshore Export Cable.

60. Construction activities may affect landscape resources and views in areas where they can be seen. The ZTV maps (Figures 14.2 (Volume 3) and 14.3 (Volume 3)) indicate the extent of theoretical visibility of the proposed Offshore Wind Farm. The extent of theoretical visibility for the site during construction would initially be much smaller, being limited to areas with views of the Wind Farm Area. As construction progresses, visibility of the works, including vessels, cranes and partially-built structures, will increase as more turbines are erected. As such, potential impacts arising from the construction phase of the Project will never be significantly greater than those arising from the operational phase. Visibility of vessels outside the Wind Farm Area is not considered likely to give rise to any significant impacts on landscape or visual amenity. Construction phase impacts will be short term (2-3 years).

61. The pattern of any impacts would be the same for construction activities as it would be for operational activities. While it is acknowledged that there are likely to be significant effects arising from views of the Offshore Wind Farm under construction, they have not been assessed separately. Operational phase impacts are assessed in Section 14.8.2. Construction impacts associated with the landfall only are assessed in detail below.

14.8.1.1 Impact of landfall construction activities on landscape receptors at Thorntonloch Beach

62. The method for landing the Offshore Export Cable at Thorntonloch beach is dependent on ground conditions. The options currently being considered are horizontal directional drilling (HDD) and open cut trenching.

63. If HDD is used, the drill will pass from landward of Thorntonloch Beach, to a point below mean low water springs (MLWS), i.e. within the water. To complete the operation, a temporary dry area may need to be established below MLWS, using sheet piling driven into the sand. Impacts on the coastal landscape of the beach arising from this temporary works area would be medium in scale, small in extent, short term and reversible.

64. If open trenching is required, Thorntonloch beach will be directly affected by excavation and burial works. This would be a large-scale impact across a small geographical extent, and would be short term and reversible.

65. The sensitivity of the coast at this location is high, due to the susceptibility of the beach landscape to change and the value placed upon the landscape. For either HDD or open trenching, the effect will be minor and not significant.

14.8.1.2 Impact of landfall construction activities on visual receptors at Thorntonloch Beach

66. The visual disturbance arising from either HDD or open trenching is likely to be seen by residents of a small number of nearby properties, people at the caravan park, and walkers on the beach and coastal footpaths. These recreational and residential viewers are considered to have a high sensitivity to change.

67. If open trenching is used, the scale of impact on these receptors will be large, but affecting a small geographical extent. The impact will be short term and reversible. The impact will be minor and not significant.

68. Should the HDD method be used, this would lessen the visual intrusion of construction activities on the beach, though the dry area below MLWS would be clearly visible. In this case, impacts are also predicted to be minor and not significant.

14.8.2 Operational Phase Impacts

69. Impacts on landscape character and visual amenity may arise as a result of the following aspects of the offshore development:

- Introduction of wind turbines and OSP(s) within an area of formerly open sea;
- Introduction of night-time lighting of the turbines; and
- Operational activities such as operational and maintenance vessel movements.

70. This would result in potential changes to the perception of coastal and landscape character, and to the visual amenity of people, within the study area.

71. There will be no physical effects on landscape/coastal features or elements, and the assessment is therefore primarily concerned with effects on the perception of character, arising from changes occurring at a distance. The assessment is informed by the ZTV maps (Figures 14.2 (Volume 3) and 14.3 (Volume 3)), and by the visualisations of the Offshore Wind Farm (Figures 14.18 (Volume 3) to 14.43 (Volume 3)).

72. Maintenance activities will require regular vessel movements to and from the Wind Farm Area. This vessel activity will not result in landscape and visual effects. Increased vessel movements at the O&M port / harbour may have some effects. At present, the location of the O&M port / harbour, and the extent of vessel movements, is undetermined. The increases in vessel movements would be seen in the context of existing port/harbour activity and wider marine activity in the outer Firth and Tay, and no significant effects are predicted.

73. Operational effects will continue for the lifetime of the Offshore Wind Farm. Operational effects are therefore long term and fully reversible.

14.8.2.1 Impacts of the Offshore Wind Farm on Coastal Character

74. The SLVIA has identified significant (moderate) effects on the following three regional seascape units (see Figure 14.4 (Volume 3)):

- SA12: St Andrews to Fife Ness;
- SA13: East Neuk of Fife; and
- SA17: Eyebroughy to Torness.

75. These areas are the closest to the Wind Farm Area, and have a generally open outlook towards the turbines. The Offshore Wind Farm may impact on the characteristic relationships between these coasts, the sea, and the islands in the Forth. The presence of the turbines, as well as the aviation and navigation lighting at night, will affect perception of these areas as relatively wild coasts that are generally undeveloped. Effects on all other regional seascape units are assessed as minor or negligible, due to greater distance from the Offshore Wind Farm and/or greater levels of human influence, that limit the additional influence of the turbines.

76. At night, turbine lighting will alter the character of darker coastal landscapes, and will give rise to moderate (significant) effects on coastal character in eastern Fife (SA12 and SA13). Effects on other coastal landscapes will not be significant.

77. The detailed assessment is set out in Appendix 14.1, and summarised in Table 14.16.

Table 14.16: Impacts on Regional Seascape Units

Regional Seascape Unit	Sensitivity	Magnitude of impact	Significance of effect
SA4: Montrose	High	Very low	Negligible
SA5: Long Craig	Medium	Very low	Negligible

Regional Seascape Unit	Sensitivity	Magnitude of impact	Significance of effect
SA6: Lunan Bay	High	Very low	Negligible
SA7: Lang Craig to the Deil's Head	High	Low	Minor
SA8: Arbroath to Monifieth	Medium	Low	Minor
SA9: Dundee	Low	Very low	Negligible
SA10: Inner Firth of Tay	Low	Very low	Negligible
SA11: St Andrews Bay	High	Low	Minor
SA12: St Andrews to Fife Ness	High	Medium	**Moderate**
SA13: East Neuk of Fife	High	Medium	**Moderate**
SA14: Kirkcaldy and Largo Bay	Medium	Very low	Negligible
SA16: Edinburgh to Gullane	Medium	Very low	Negligible
SA17: Eyebroughy to Torness Point	Medium	Medium	**Moderate**
SA18: Torness Point to St Abb's Head	Medium	Low	Minor
SA19: St Abb's Head to Eyemouth	High	Low	Minor
SA20: Eyemouth to Berwick upon Tweed	Medium	Very low	Negligible

14.8.2.2 Impacts of the Offshore Wind Farm on Landscape Character

78. The SLVIA has identified no significant impacts on (non-coastal) landscape character. Effects on four landscape character types were assessed as minor (not significant), restricted to areas of Fife and East Lothian that have a strong coastal element (see Figure 14.5 (Volume 3)). Effects on all other areas were assessed as negligible (not significant). This reflects the limited effect of the offshore development on the character of inland areas.

79. At night, turbine lighting is not predicted to have significant effects on any inland landscape character types.

80. The detailed assessment is set out in Appendix 14.1, and is summarised in Table 14.17.

Table 14.17: Impacts on Landscape Character Types

Landscape Character Type	Sensitivity	Magnitude of impact	Significance of effect
Coastal Hills Headlands Plateaux and Moorlands	Medium	Low	Minor
Coastal Margins	Medium	Low	Minor
Coastal Raised Beaches and Terraces	High	Very low	Negligible
Dipslope Farmland	Medium	Very low	Negligible
Fife Lowland Farmland	Medium	Low	Minor
Foothills	Medium	Very low	Negligible

Landscape Character Type	Sensitivity	Magnitude of impact	Significance of effect
Low Coastal Farmlands	Medium	Low	Minor
Lowland Coastal Flats Sands and Dunes	High	Very low	Negligible
Lowland Hills (South)	Low	Very low	Negligible
Lowland Plains	Low	Very low	Negligible
Lowland River Valleys	Low	Very low	Negligible
Narrow Wooded River Valleys	Low	Very low	Negligible
Pronounced Hills	Low	Very low	Negligible
Upland Fringe Moorland and Grassland: the Lammermuir, Pentland and Moorfoot Hills	Medium	Very low	Negligible
Upland Hills: the Lammermuir, Pentland and Moorfoot Hills	Medium	Very low	Negligible

14.8.2.3 Implications for Landscape Designations

81. The SLVIA concluded that significant effects on coastal character will only occur along sections of the Fife and East Lothian coasts, with lesser effects in other coastal areas and inland. Since effects on coastal and landscape character are already assessed, landscape designations are not assessed as discrete receptors since this would lead to double counting of effects.

82. Instead, the special qualities of each landscape designation were evaluated against the findings of the coastal and landscape impact assessment, to determine whether the designated area would be adversely affected by the Offshore Wind Farm.

83. The assessment concludes that, for most of the areas examined, there will be some effect on one or two identified qualities or reasons for designation, but in each case there are several other reasons for designation that will not be affected. The historic character of GDLs in particular was not judged to be affected at any site. The assessment of GDLs is summarised in Table 14.18.

84. Qualities of local landscape designations relating to open marine views and wildness are most likely to be affected where coastal character effects have been identified, namely along the eastern coasts of Fife and the northeast coast of East Lothian. The assessment of local landscape designations is set out in Table 14.19.

85. The detailed assessment is provided in Appendix 14.1.

Table 14.18: Implications for Gardens and Designed Landscapes

GDL Name	Implications for special qualities
St Andrews Links	The coastal setting of the links is considered important, and views of offshore turbines may affect the open character of the site to some extent. The historic importance of the site is unlikely to be affected.
Cambo	Effects are unlikely within the wooded core area. From peripheral areas such as the golf course, the turbines will be clearly visible in the middle distance (19 km), and significant effects on views may be anticipated.

GDL Name	Implications for special qualities
Grey Walls	Glimpsed views of the Offshore Wind Farm from peripheral areas will not affect the character of the designation.
Leuchie	Views to northeast toward the Offshore Wind Farm would only be glimpsed from peripheral locations, with no effect on historic character.
Tyninghame	The presence of the offshore turbines may affect the character of coastal parts of the GDL, but will not be experienced in the central parkland, which is screened by woodland.
Biel	Views of the turbines would only be perceived from peripheral areas of the policies, where they would not affect the character of the GDL.
Broxmouth Park	There is an axial view along the Brox Burn towards the Isle of May, in which the Offshore Wind Farm may be visible in oblique views. Views of the turbines are likely from peripheral areas of the policies, but the historic character of the GDL will not be affected.
Dunglass	The northern coastal flank of the designed landscape has open sea views over the A1 and Torness Power Station, which would include the Offshore Wind Farm. The turbines would be a relatively distant feature in the view, and are unlikely to result in changes to the historic character of the GDL.

Table 14.19: Implications for Local Landscape Designations

Local landscape designation name	Implications for special qualities
Aberdeenshire Special Landscape Areas	
South East Aberdeenshire Coast SLA	Minimal effect on two ‘qualifying interests’ of the designation.
Fife Local Landscape Areas	
Tentsmuir Coast LLA	Some effect on perception of remoteness, but other qualities unaffected.
St Andrews Links LLA	The Offshore Wind Farm will have some effect on the open seaward views, but will not affect other identified qualities.
St Andrews to Fife Ness LLA	Significant effects on coastal character predicted in this area, and effects on characteristic seaward views, but not on other identified qualities, including historic environment and recreational value.
East Neuk LLA	Significant effects on coastal character and seaward views predicted in this area, but other identified qualities of the LLA, such as traditional villages and policy landscapes, will not be affected.
Forth Islands LLA	Significant effects on coastal character and seaward views predicted in this area, but the Isle of May will retain its scenic, heritage and nature conservation value.
East Lothian Special Landscape Areas	
Port Seton to North Berwick Coast SLA	Some effect on coastal character in part of this SLA, arising from distant views of the Offshore Wind Farm, with some implications for particular views. However, the Project will not affect the overall scenic quality of the SLA, particularly as it will not be visible across much of the SLA.

Local landscape designation name	Implications for special qualities
North Berwick Law SLA	The Offshore Wind Farm will be visible from the summit, including in views of the Bass Rock, and significant effects on visual amenity are predicted. The Project will not affect the setting of this landmark, or its relationship with the wider East Lothian landscape.
Tantallon Coast SLA	In clear weather, the turbines will be an unavoidable presence in views from this coastline, and significant effects on landscape character and visual amenity are predicted. At night, lighting on the turbines will also be visible, affecting the lack of lighting that contributes to wildness. The many other scenic, recreational cultural and natural qualities of this SLA will be unaffected.
Belhaven Bay SLA	On days when visibility is suitable, the Offshore Wind Farm will be an unavoidable presence in seaward views. At night, lighting on the turbines will also be visible, affecting the experience of wildness. The many other scenic, recreational cultural and natural qualities of this SLA will be unaffected.
Dunbar to Barns Ness Coast SLA	Significant effects on landscape character and visual amenity are predicted along this coast as a result, which will impact on some of the qualities of the SLA associated with offshore views. Other qualities of the SLA, such as the rugged landform and the fossil beach, will be unaffected.
Thorntonloch to Dunglass Coast SLA	Effects on this coastal character area are not anticipated to be significant. Although views from the coast may be affected, other qualities of the SLA, including the setting of Torness Power Station, will be unaffected.
Scottish Borders Special Landscape Areas	
Berwickshire Coast SLA	There will be some effects on the local experience of wildness but other qualities of the SLA, such as the attractive rocky scenery, will be unaffected and the reasons for designation will not be undermined.

14.8.2.4 Viewpoint Assessment

86. In the viewpoint assessment, summarised in Table 14.20, significant impacts on viewers have been predicted at viewpoints located at up to 35 km from the Offshore Wind Farm. Significant effects at this distance would be restricted to high-sensitivity viewers at the coastal edge. The most distant significant effects are identified where the Offshore Wind Farm would be seen in the context of existing focal points in the view, such as inshore islands and the Bass Rock as perceived from East Lothian.

87. Effects judged major are predicted at viewpoints up to 22 km from the Offshore Wind Farm. Again, these effects would be anticipated for high-sensitivity receptors along the north and south coasts of eastern Fife. Other significant effects are graded moderate.

88. These distances are greater than those at which significant impacts would normally be expected to occur as a result of an onshore wind farm. This is because of the lack of intervening landform and vegetation, which would screen many views of an onshore wind farm. It also reflects the unusual appearance of large vertical structures in the marine environment, where manmade structures are an unexpected element in the view.

89. Views from inland locations have not generally been judged as significant, due to the greater variety of views available over land. The simplicity of views over sea is therefore more vulnerable to changes as a result of the introduction of offshore turbines.

90. The assessment of night-time impacts considered a more limited set of viewpoints, and the findings are summarised in Table 14.21. This suggests that a similar extent of effects is anticipated, with significant effects on views from high-sensitivity coastal locations at up to 30 km. Beyond this distance, lights will become increasingly distant point sources, and are not predicted to be particularly noticeable features. Night time views are anticipated to be experienced by sensitive receptors most commonly during the hours of dusk, when the lighter sky will render the lights less prominent. Their prominence is likely to increase in the hours of full darkness, though fewer receptors will be present to experience this effect. As distant point sources, the lights will not cause sky glow or affect dark sky activities such as stargazing.

91. The detailed assessment of day time and night-time effects is presented in Annex 3 to Appendix 14.1.

92. Effects on viewpoints listed in Table 14.13 have not been assessed in detail. Wirelines in Figures 14.52 (Volume 3) to 14.57 (Volume 3) illustrate the appearance of the Offshore Wind Farm from these locations. They confirm the general conclusions set out above that at coastal locations with open views effects are more likely to be significant, for example Fast Castle (Figure 14.57 (Volume 3)), where effects are likely to be similar to nearby St Abb's Head (VP 21, moderate and significant). In views from inland locations, the turbines are more distant features. For example, in the views from the B roads in East Lothian (Figures 14.55 (Volume 3) and 14.56 (Volume 3)), the Offshore Wind Farm forms a relatively small element in the view, and will be further screened by woodland in the foreground.

Table 14.20: Effects at Representative Viewpoints

No.	Viewpoint	Distance from Wind Farm Area (km)	Sensitivity	Magnitude of impact	Level of effect
2	Beach Road, Kirkton, St Cyrus	49.0	High	Very low	Negligible
5	Dodd Hill	43.9	Medium	Very low	Negligible
6	Braehead of Lunan	39.0	High	Low	Minor
7	Arbroath Signal Tower	30.8	High	Medium	**Moderate**
8	Carnoustie	31.7	High	Medium	**Moderate**
9	Dundee Law	44.9	Medium	Very low	Negligible
10	Tentsmuir	31.8	High	Medium	**Moderate**
11	Strathkinness	33.1	High	Low	Minor
12	St Andrews, East Scores	28.2	High	Medium	**Moderate**
13	Fife Ness, Lochaber Rock	15.5	High	High	**Major**
14	Anstruther Easter	21.8	High	High	**Major**
15	Largo Law	36.8	Medium	Low	Minor
16	Isle of May	16.3	High	High	**Major**
17	North Berwick Law	33.0	High	Medium	**Moderate**
18	Dunbar	28.0	High	Medium	**Moderate**

No.	Viewpoint	Distance from Wind Farm Area (km)	Sensitivity	Magnitude of impact	Level of effect
19	Innerwick	30.4	High	Medium	**Moderate**
20	Coldingham Moor	32.8	Medium	Low	Minor
21	St Abb's Head	33.0	High	Medium	**Moderate**
22	St Andrews, West Sands	29.9	High	Medium	**Moderate**
23	Crail	18.4	High	High	**Major**
24	Scottish Seabird Centre, North Berwick	32.4	High	Medium	**Moderate**
25	Tantallon Castle	29.3	High	Medium	**Moderate**
26	Broad Sands, North Berwick	34.9	High	Medium	**Moderate**
27	A198, North Berwick	30.2	High	Medium	**Moderate**
28	A199, East Linton	36.1	Medium	Low	Minor
29	Hopetoun Monument	42.0	High	Low	Minor

Table 14.21: Effects at Representative Night Time Viewpoints

No.	Viewpoint	Distance from Wind Farm Area (km)	Sensitivity	Magnitude of impact	Level of effect
N1	King's Road, Arbroath	30.1	High	Low	Minor
N2	Carmyllie	38.4	Medium	Low	Minor
N3	East Haven	31.7	High	Low	Minor
N4	St Andrews, East Scores	28.2	High	Medium	**Moderate**
N5	Crail	18.4	High	Medium	**Moderate**
N6	Scottish Seabird Centre, North Berwick	32.4	High	Low	Minor
N7	Dunbar	28.0	High	Medium	**Moderate**
N8	A199, East Linton	36.1	Medium	Low	Minor

14.8.2.5 Impacts of the Offshore Wind Farm on Visual Amenity

93. The following sections provide some interpretation of the viewpoint assessment, in terms of the predicted effects on visual amenity across the study area, as likely to be experienced by the visual receptors identified at 14.6.2.2.

14.8.2.5.1 Settlements

94. Based on the findings of the viewpoint assessment, major effects may be anticipated for sensitive receptors in coastal settlements within 22 km of the Offshore Wind Farm. This includes the East Neuk villages of Crail (VP 23), Anstruther (VP 14) and Pittenweem, as well as smaller settlements in the eastern most part of Fife. Major (significant) effects will only occur where the Offshore Wind Farm is clearly visible from locations with an existing open sea view. In the densely clustered East Neuk villages, this is likely to be limited to houses and harbour side locations along the sea front, as well as some properties higher up on the raised beach.

95. Coastal settlements between 22 and 35 km, where up to moderate (significant) effects may be anticipated, include Arbroath Signal Tower (VP 7), Carnoustie (VP 8), St Andrews (VP 12), St Monans, North Berwick (VP 24), Dunbar (VP 18), and Cockburnspath. Again, moderate effects will only be experienced by high sensitivity receptors who currently have unobstructed open sea views.

96. Viewers looking out from closer settlements at night may experience significant effects as a result of visible aviation and navigation lighting on the turbines. This is most likely to be a significant effect in smaller settlements with fewer existing light sources.

97. No significant effects are predicted at more distant settlements or properties, or at non-coastal settlements, though minor effects may occur.

14.8.2.5.2 Recreational Receptors

98. Coastal recreational destinations within 22 km of the Offshore Wind Farm, where major (significant) effects may be anticipated, include the whole of the Isle of May, the 20-minute ferry crossing from Anstruther, Cambo Gardens and a number of golf courses and caravan parks along the Fife coast.

99. Open coastal locations within 35 km, where moderate (significant) effects may be anticipated, include cliff top sites such as Tantallon Castle (VP 25), Fast Castle and St Abb's Head (VP 21), and beaches at Pease Bay, Tentsmuir (VP 10) and Carnoustie (VP 8).

100. Recreational boat users within the outer Firth of Forth and Firth of Tay will view the Offshore Wind Farm at relatively close ranges, depending on their course. Boat users may view the turbines for prolonged periods. Up to major (significant) effects are predicted.

101. Recreational use outside of settlements is less likely to be taking place during the hours of darkness, though there will be receptors at caravan parks and coastal campsites, for example. Night views of the flashing aviation and navigation lights on the turbines will reduce the experience of relative remoteness that may be associated with such sites. Where these higher sensitivity receptors view the turbine lighting from dark coastlines within 30 km of the Offshore Wind Farm, effects may be up to moderate (significant).

14.8.2.5.3 Recreational Receptors on Routes

Walkers

102. Walkers following the Fife Coastal Path from the south will have more or less continuous views of the Offshore Wind Farm for around 20 km of the route along the East Neuk Coast from Earlsferry to Fife Ness (passing VP 14, VP 23 and VP 13). Similarly, walkers approaching from the north will have more or less continuous views of the turbines between St Andrews (VP 12) and Fife Ness, for around 15.5 km of the route. Views will be locally screened by topography, vegetation and buildings, but the route is often right on the coastal edge. Turbines would be seen in the direction of travel, at distances of 15 to 30 km. Up to major (significant) effects are predicted. Walkers on this route would also see the

turbines from the Tentsmuir area (VP 10), between the Eden estuary and Tayport, at distances of 30 to 35 km.

103. Walkers on the John Muir Way would pass through the ZTV of the Offshore Wind Farm for around 36 km between Eyebroughy and Dunglass. A number of assessment viewpoints are on or close to the route, including VP 18, VP 24 and VP26. Views of the turbines would be generally oblique to the direction of travel, whichever direction is followed. There may be some screening by topography, vegetation and buildings, but the route is often right on the coastal edge. Turbines would be visible at distances of 28 to 35 km. Up to moderate (significant) effects are predicted.

104. None of the other routes included in Scotland's Great Trails are within the ZTV of the Offshore Wind Farm, with the exception of a 2-3 km section of the Southern Upland Way near Cockburnspath, where no significant effects are predicted.

105. Walkers on other coastal footpaths within approximately 35 km of the Offshore Wind Farm, where open views are available towards the turbines, may experience significant effects on views. Walkers using inland footpaths are less likely to experience significant effects on views, for example in views from Largo Law (VP 15).

Cyclists

106. NCN Route 1 takes in Strathkinness (VP 11), Tentsmuir (VP 10), and follows the Angus coast passing VP 8, VP 7, VP 6 and VP 2. Various sections of the route are within the ZTV of the Offshore Wind Farm, particularly along the Angus coast, where the turbines will be a continuous feature on clear days. Moderate (significant) effects are anticipated over the Tentsmuir and south-east Angus sections of the route, which are within 35 km of the Offshore Wind Farm.

107. NCN Route 76 follows coastal roads between Eyemouth and Dunbar, passing through sections of the ZTV and close to VP 20 and VP 18. The Offshore Wind Farm will be seen in oblique views from around 20 km of the route, which is within 35 km and moderate (significant) effects may therefore be anticipated.

108. None of these recreational routes are likely to see substantial use during the hours of darkness, and no significant night-time effects are therefore predicted for this receptor group.

14.8.2.5.4 Other Travelling Receptors

Rail Routes

109. The East Coast Mail Line (ECML) railway follows the coastal edge between Cockburnspath and Dunbar. Over this stretch (around 15 km), there would be open views out to the Offshore Wind Farm, at around 28 to 30 km distance. Trains on this stretch are all high-speed long distance services, and sensitivity is low. Significant effects are not predicted.

Roads and Tourist Drives

110. The route of the A1 closely follows that of the ECML. People travelling in either direction would have oblique views of the Offshore Wind Farm from the 15 km section between Cockburnspath and Dunbar. Due to the high speed of travel, sensitivity is judged to be low. Significant effects are not predicted.

111. The East Lothian Coastal Trail/Scotland's Golf Coast Road (A198) is largely within the ZTV between Gullane and the A1, though actual visibility would be reduced by vegetation and other features. The turbines would be seen at 30 km or more, sometimes in open elevated views. VP 27 is on this road, east of North Berwick, and shows how the Offshore Wind Farm may be seen alongside the Bass Rock. As the viewer travels along the A198 the relationship of the Offshore Wind Farm, the Bass Rock and other features will change. The turbines will introduce a new focal feature of different form to the existing focal points of the Forth islands, with moderate (significant) effects on the most sensitive receptors.

112. The Fife Coastal Tourist Route includes the A917, which follows the East Neuk coast between Elie and St Andrews, and is generally within the ZTV. Although there is some roadside screening of views by vegetation and buildings, road users would see the Offshore Wind Farm in the direction of travel, at distances of 15 to 30 km. There would also be more limited or distant views from sections of the A955 and A914. Up to moderate (significant) effects are predicted.

113. The Angus Tourist Route mainly follows the A92, which often runs close to the coast and passes VP 7. Where the route is within the ZTV, views of the Offshore Wind Farm would be oblique or perpendicular to the direction of travel, at distances of up to 30 km. Up to minor (not significant) effects are predicted.

114. By night, the attention of road and rail users is less likely to be focused on the view, and the turbine lights are more likely to be viewed as a passing feature of interest rather than as an intrusion in views (e.g. VP N8). Significant effects are not anticipated.

Ferry Routes and Cruise Ships

115. For visitors accessing the Isle of May via boat trips from Anstruther harbour, the Offshore Wind Farm will be clearly visible at between 15 and 22 km to the east, over the whole course of this 20-minute trip. Major (significant) effects are predicted. It is also possible to visit the Isle of May from North Berwick. Over the course of the 30-minute outward trip, the Offshore Wind Farm will increase in visibility. From North Berwick (VP 24) the turbines will be a distant feature, partly behind the horizon. Heading northeast, more of the turbines will be revealed, and the Offshore Wind Farm will be continuously in view. Major (significant) effects are predicted. The island and the boat trips are not accessible at night.

116. Cruise ships entering and leaving the Firth of Forth may pass relatively close to the Offshore Wind Farm, depending on their precise route. Passengers may view the turbines as a feature of interest as they pass by, and would see the Offshore Wind Farm for a short period of their voyage. The presence of the turbines is unlikely to affect the overall experience of entering the Forth. Significant effects are not predicted.

14.8.3 Decommissioning Phase Impacts

117. Impacts from decommissioning are anticipated to be similar to those assessed during construction, as turbines are removed from the Wind Farm Area at the end of the Project's operational life. Effects on landscape and visual receptors resulting from decommissioning activities would be expected to be similar to those described during the construction phase.

118. Towards the end of the operational life of the Project, all decommissioning options will be considered. The potential decommissioning options will be presented to MS-LOT in a Decommissioning Programme for approval prior to construction. The Decommissioning Programme will then be reviewed and amended as required prior to the commencement of any decommissioning activities.

14.8.4 Cumulative Impacts

119. Cumulative effects refer to effects upon receptors arising from the Project when considered alongside other proposed developments and activities and any other reasonably foreseeable projects and proposals. In this context, the term 'projects' is considered to refer to any project with comparable effects and is not limited to offshore wind projects.

120. The aim of the cumulative SLVIA is to describe the ways in which the Project "would have additional impacts when considered together with other existing, consented or proposed windfarms" (SNH, 2012, paragraph 55). The cumulative assessment therefore focuses on the *additional* cumulative change which may result from the introduction of the Project. A cumulative assessment may also consider the potential interactions between different types of development (e.g. transmission

infrastructure, other energy generation stations or other built development) if these are likely to result in similar landscape and visual impacts.

14.8.4.1 Cumulative Baseline

121. Projects and activities considered within the cumulative impact assessment are set out in Table 14.22. There may be an element of uncertainty associated with the design envelope of proposed projects, therefore a judgement is made on the confidence associated with the latest available design envelope.

122. In assessing the cumulative impacts for the Project, the proposed Inch Cape and Seagreen projects as detailed in the Scoping Reports submitted to MS-LOT (ICOL, 2017; Seagreen, 2017) are considered to represent the 'worst case' (rather than the consented projects) in light of the proposed use of fewer but larger turbines. Design envelope information on these scoping proposals was exchanged by the developers, and they have been included in modelling and are discussed in the assessments.

123. Based on consideration of this assessment and the Original ES, it is judged that consideration of the consented Inch Cape and Seagreen projects as a further scenario would not lead to any different findings in relation to cumulative effects, as compared to the consideration of the scoping Inch Cape and Seagreen projects.

124. Other offshore wind farms in the area are included in Table 14.22, as are a selection of onshore wind farms, as set out in Appendix 14.1.

Table 14.22: Projects included in the cumulative SLVIA

Development Type	Project	Status	Data Confidence Assessment
Offshore Wind Farm	Inch Cape Offshore Wind Farm	Proposed	High: scoping opinion issued. Project information provided by Developer.
Offshore Wind Farm	Seagreen Phase I	Proposed	High: scoping opinion issued. Project information provided by Developer.[3]
Offshore Wind Farm	Forthwind Demonstration Array	Consented	High: two turbines consented. Published project information available in the public domain.
Offshore Wind Farm	Forthwind Demonstration Array Extension	Proposed	High: scoping opinion requested. Published project information available in the public domain.
Offshore Wind Farm	Kincardine Offshore Wind Farm	Consented	High. Published project information available in the public domain.
Onshore Wind Farms	Various (see Appendix 14.1)	Operational and consented	High. Published project information available in the public domain.
Onshore Wind Farms	Various (see Appendix 14.1)	Proposed	High. Published project information available in the public domain.

125. Cumulative ZTVs have been generated to illustrate the theoretical extent of visual interactions between the Project and the selected offshore and onshore wind farms, grouped by broad geographical areas. These show the number of wind farms theoretically visible from across various parts of the study area. Cumulative ZTVs are included in Figures 14.9 (Volume 3) to 14.17 (Volume 3),

[3] No layout information was initially provided for Seagreen Phase I, and ZTVs and visualisations are therefore based on an indicative layout devised by LUC, based on parameters supplied by Seagreen. Information subsequently received was not judged to make a material difference to ZTVs and visualisations, or to the assessments.

and discussed in detail in Appendix 14.1. The proposed Inch Cape and Seagreen offshore wind farms are illustrated in the visualisations in Figures 14.18 (Volume 3) to 14.57 (Volume 3).

126. Since it is considered highly unlikely that any of the other offshore wind farms will be under construction at the same time as the Project, and construction of onshore wind farms is unlikely to give rise to cumulative effects, only operational phase cumulative impacts are assessed.

14.8.4.2 Cumulative Impact Assessment

14.8.4.2.1 Cumulative effects on coastal character

127. Significant cumulative effects on coastal character are predicted to be limited to the eastern tip of Fife Ness, where the nearby presence of the Offshore Wind Farm, in addition to the likely presence of Inch Cape, would affect the perception of character along the coastal edge of two Regional Seascape Units (SA12 St Andrews to Fife Ness and SA13 East Neuk of Fife). The presence of the Offshore Wind Farm with the more distant Seagreen Phase I Project would be less likely to give rise to significant effects due to the separation between the two sites. The Offshore Wind Farm will also contribute to cumulative effects along the Angus coast (SA8 Arbroath to Monifieth), though it will be more distant than Inch Cape. Both Inch Cape and Seagreen Phase I are 50 km or more from the East Lothian Coast, so cumulative effects on character are highly unlikely in this area.

128. No significant cumulative effects on coastal character are predicted to occur as a result of interactions with any of the other projects listed in Table 14.22. ZTVs for other offshore wind farms overlap with that of the Offshore Wind Farm across small areas. With regard to onshore schemes, there are extensive overlaps of visibility, particularly across East Lothian where operational and proposed wind farms on the Lammermuirs are visible. However, none of the onshore wind farms assessed have strong influences on coastal character, with the exception of Drone Hill in the Scottish Borders, and potentially Kenly in Fife. There may be localised cumulative effects in relation to the latter, but Drone Hill is more distant. No significant cumulative effects are predicted.

14.8.4.2.2 Cumulative effects on landscape character

129. The landscape impact assessment has not identified any significant impacts upon landscape character areas from the Project. Due to its offshore location, there is no potential for the presence of the Offshore Wind Farm to transform any LCT into a ‘wind farm landscape’. Given the low magnitude of impact identified in the stand-alone assessment, and the limited potential for offshore development to give rise to cumulative impacts on landward character, it was judged that no significant effects would occur, and therefore no detailed assessment of cumulative effects on onshore landscape character, as represented by LCTs, has been undertaken.

130. There is an increasing number of single turbines or small clusters of turbines of varying size across the landscape of the study area, which has had some effect on landscape character in places. The additional presence of the Offshore Wind Farm is not considered likely to contribute significantly to such effects, due to its different scale, form and marine location.

14.8.4.2.3 Cumulative implications for landscape designations

131. The St Andrews to Fife Ness LLA and East Neuk LLA cover areas that, as noted above, are likely to experience significant cumulative effects on coastal character as a result of views of the Offshore Wind Farm and Inch Cape. This will lead to further effects on qualities related to outlook and remoteness, but will not further affect any of the other qualities for which the areas are designated. There may be more limited effects on the Tentsmuir LLA and St Andrews Links LLA.

14.8.4.2.4 Cumulative effects on visual amenity

132. Significant cumulative effects have been predicted for high-sensitivity viewers at several representative viewpoint locations. These are all located on the Fife coast, in locations where the Offshore Wind Farm will be clearly visible alongside the proposed Inch Cape Offshore Wind Farm. The

combined views of both offshore wind farms from these locations will result in a large sector of the seaward view being occupied by wind turbines. Similar effects would be anticipated if the consented Inch Cape scheme were present in place of the proposed scheme. This combination will not give rise to cumulative effects on views from East Lothian due to the greater distance of Inch Cape. Cumulative impacts arising from the combination of the Offshore Wind Farm and Seagreen Phase I are not anticipated to be significant, again due to the greater distance of the latter from shore.

133. The Forthwind turbines will be visible in successive views from locations in Fife and East Lothian, but the distances between them, and the developed coastal backdrop that these turbines are seen against, will reduce the potential for cumulative effects. There are very few locations where both the Offshore Wind Farm and the Kincardine Offshore turbines will be seen together, and any resulting effects will not be significant.

134. When considering onshore turbines, there are no coastal wind farms or proposals that are likely to be seen in combined views of the Offshore Wind Farm, with the exception of the consented Kenly Wind Farm in Fife that may be seen in more distant views from north and south, as well as local successive views. Other operational and consented wind farms are set back from the coast, in upland areas such as the Lammermuirs and Sidlaw Hills. Compared with the Offshore Wind Farm, they have distinctly different appearance and context in views, and significant cumulative effects are not anticipated.

135. At night, significant cumulative effects are predicted where aviation and/or navigation lights of more than one offshore wind farm are visible at relatively close range, and where the Offshore Wind Farm being closer is likely to have a greater additional effect. This is anticipated for high sensitivity receptors along the areas along the northeast Fife coast, including people in St Andrews and coastal settlements, campsites and caravan parks.

136. Onshore wind farms do not, generally, include lighting. Future proposals for larger turbines in the Lammermuirs may require lighting, but this will be distant from the Offshore Wind Farm, and cumulative effects are not anticipated.

137. Cumulative effects predicted at representative viewpoints are presented in Table 14.23, and at representative night-time viewpoints in Table 14.24.

Table 14.23 Cumulative Effects at Representative Viewpoints

No.	Viewpoint	Distance from Wind Farm Area (km)	Sensitivity	Magnitude of cumulative impact	Level of cumulative effect
2	Beach Road, Kirkton, St Cyrus	49.0	High	Low	Minor
5	Dodd Hill	43.9	Medium	Low	Minor
6	Braehead of Lunan	39.0	High	Low	Minor
7	Arbroath Signal Tower	30.8	High	Low	Minor
8	Carnoustie	31.7	High	Low	Minor
9	Dundee Law	44.9	Medium	Very low	Negligible
10	Tentsmuir	31.8	High	Medium	**Moderate**
11	Strathkinness	33.1	High	Low	Minor
12	St Andrews, East Scores	28.2	High	Medium	**Moderate**

No.	Viewpoint	Distance from Wind Farm Area (km)	Sensitivity	Magnitude of cumulative impact	Level of cumulative effect
13	Fife Ness, Lochaber Rock	15.5	High	High	**Major**
14	Anstruther Easter	21.8	High	Medium	**Moderate**
15	Largo Law	36.8	Medium	Low	Minor
16	Isle of May	16.3	High	High	**Major**
17	North Berwick Law	33.0	High	Low	Minor
18	Dunbar	28.0	High	Low	Minor
19	Innerwick	30.4	High	Low	Minor
20	Coldingham Moor	32.8	Medium	Low	Minor
21	St Abb's Head	33.0	High	Low	Minor
22	St Andrews, West Sands	29.9	High	Medium	**Moderate**
23	Crail	18.4	High	Medium	**Moderate**
24	Scottish Seabird Centre, North Berwick	32.4	High	Low	Minor
25	Tantallon Castle	29.3	High	Low	Minor
26	Broad Sands, North Berwick	34.9	High	Low	Minor
27	A198, North Berwick	30.2	High	Low	Minor
28	A199, East Linton	36.1	Medium	Low	Minor
29	Hopetoun Monument	42.0	High	Low	Minor

Table 14.24 Cumulative Effects at Representative Night Time Viewpoints

No.	Viewpoint	Distance from Wind Farm Area (km)	Sensitivity	Magnitude of impact	Level of effect
N1	King’s Road, Arbroath	30.1	High	Low	Minor
N2	Carmyllie	38.4	Medium	Low	Minor
N3	East Haven	31.7	High	Low	Minor
N4	St Andrews, East Scores	28.2	High	Medium	**Moderate**
N5	Crail	18.4	High	Low	Minor

No.	Viewpoint	Distance from Wind Farm Area (km)	Sensitivity	Magnitude of impact	Level of effect
N6	North Berwick Seabird Centre	32.4	High	Low	Minor
N7	Dunbar	28.0	High	Very low	Negligible
N8	A199, East Linton	36.1	Medium	Very low	Negligible

14.8.4.2.5 Sequential effects

138. Users of routes in East Lothian, including the coastal tourist route and John Muir Way, will have views of the Offshore Wind Farm, followed by views of the Forthwind turbines seen against a backdrop of development in Fife. Significant effects are not anticipated. Users of the Fife Coastal Tourist Route and Fife Coastal Path will have close views of the Forthwind turbines seen against the view to the Bass Rock and the outer Firth, followed by views towards the Offshore Wind Farm. Rounding Fife Ness, Inch Cape and Seagreen will be seen in sequence. Cumulative effects on views are predicted to be up to major (significant) for walkers on the Fife Coastal Path, and moderate (significant) for road users. Users of the Angus Tourist Route travelling north or south will have combined but oblique views of the Project and Inch Cape, and more distant Seagreen. Continuing on this route, Kincardine Offshore Wind Farm will also be seen, though separated from the Project by some distance. Significant cumulative effects are not anticipated.

14.8.5 Inter-relationships

139. Effects on visual amenity are related to effects on the setting of historic environment features (see Chapter 13: Cultural Heritage). Where significant effects on setting have been identified within 35 km of the Offshore Wind Farm, these may be combined with significant effects on visual amenity experienced by visitors to these sites.

14.9 Mitigation and Monitoring

140. The assessment of impacts, both in isolation and cumulatively, on landscape and visual receptors has predicted effects resulting from the presence of the Offshore Wind Farm ranging from negligible to major.

141. It is acknowledged that traditional methods of landscape and visual mitigation, such as screen planting, are ineffective for wind farm development. Mitigation for wind farms is generally limited to the reduction of potential direct effects through detailed siting, and the reduction in adverse aesthetic effects through wind farm design (see Annex 1 to Appendix 14.1).

142. As set out in Section 14.7.1, mitigation of landscape and visual effects relies on post-consent design processes that may help to reduce the levels of the identified effects. For the purposes of this SLVIA, the effects set out in Appendix 14.1, and summarised in this Chapter, are the residual effects of the Project.

14.10 Summary of Residual Effects

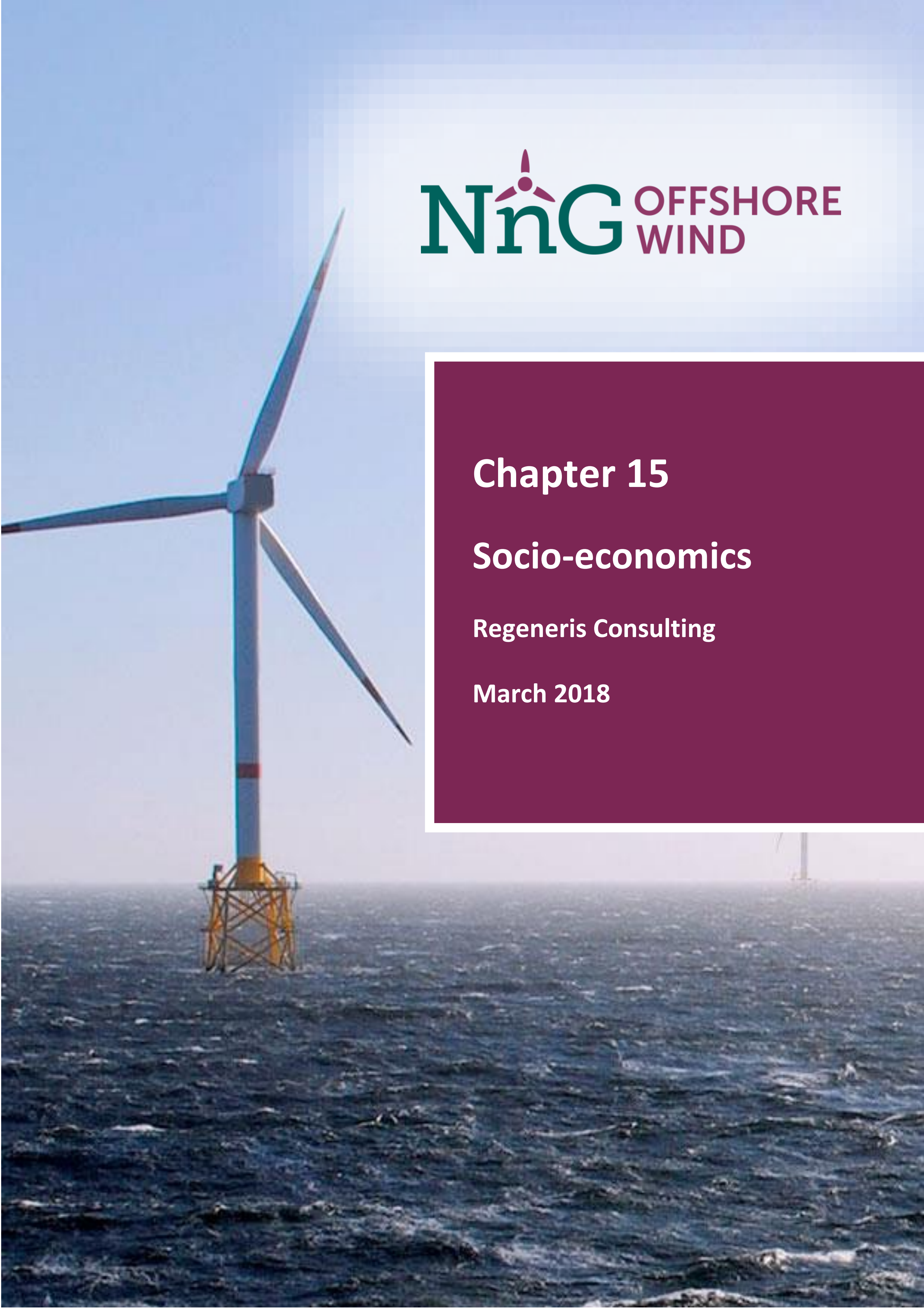
143. This chapter has assessed the potential effects on landscape and visual receptors of the construction, operation and decommissioning of the Project, both in isolation and cumulatively. Table 14.25 summarises the impact determinations discussed in this chapter and presents the post-mitigation residual significance.

Table 14.25: Summary of predicted impacts of the Project

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Construction			
Impact of landfall construction activities on landscape receptors at Thorntonloch Beach	Minor	N/A	Minor
Impact of landfall construction activities on visual receptors at Thorntonloch Beach	Minor	N/A	Minor
Operation			
Impact of the Offshore Wind Farm on coastal character	**Moderate** in east Fife and north-east East Lothian, minor or negligible elsewhere.	None identified.	**Moderate** in east Fife and north-east East Lothian, minor or negligible elsewhere.
Impact of the Offshore Wind Farm on landscape character	Minor or negligible.	N/A	Minor or negligible.
Impact of the Offshore Wind Farm on visual amenity	Up to **major** within 22 km, up to **moderate** within 35 km, no more than minor beyond 35 km.	None identified.	Up to **major** within 22 km, up to **moderate** within 35 km, no more than minor beyond 35 km.
Impact of aviation and navigation lighting on coastal character	Up to **moderate** along the eastern Fife coast, minor or negligible elsewhere.	None identified.	Up to **moderate** along the eastern Fife coast, minor or negligible elsewhere.
Impact of aviation and navigation lighting on landscape character	Minor or negligible.	N/A	Minor or negligible.
Impact of aviation and navigation lighting on visual amenity	Up to **moderate** within 30 km, minor or negligible beyond.	None identified.	Up to **moderate** within 30 km, minor or negligible beyond.
Cumulative Effects			
Cumulative impacts on coastal character arising from the additional presence of the Offshore Wind Farm	**Moderate** in east Fife and south-east Angus, minor or negligible elsewhere.	N/A	**Moderate** in east Fife and south-east Angus, minor or negligible elsewhere.
Cumulative impacts on landscape character arising from the additional presence of the Offshore Wind Farm	None.	N/A	None.
Cumulative impacts on visual amenity arising from views of the Offshore Wind Farm in addition to other wind farms	Up to **major** where both Neart na Gaoithe and Inch Cape viewed at closer range. Minor or negligible elsewhere.	N/A	Up to **major** where both Neart na Gaoithe and Inch Cape viewed at closer range. Minor or negligible elsewhere.

14.11 References

- Aberdeenshire Council (2016) *Aberdeenshire LDP Supplementary Guidance 9: Aberdeenshire Special Landscape Areas.* Available at https://www.aberdeenshire.gov.uk/media/16358/special-landscape-areas-consultation-01-april-2016.pdf
- ASH Consulting (1998a) *The Lothians Landscape Assessment.* Scottish Natural Heritage Review No 112.
- ASH Consulting (1998b) *The Borders Landscape Character Assessment.* Scottish Natural Heritage Review No 91.
- Countryside Commission (1996) *Countryside Character of England: Volume 1* (North East England)
- David Tyldesley and Associates (1998) *Analysis of National Landscape Character Types in Scotland.* (SNH)
- David Tyldesley and Associates (1999) *Fife Landscape Character Assessment* (SNH Review No 113)
- East Lothian Council (2016) *Proposed Local Development Plan Technical Note 9: Local Landscape Designation Review.*
- Environmental Resources Management (1998) *South and Central Aberdeenshire Landscape Character Assessment.* (SNH Review No 102)
- Enviros (2005) *Guidance on the Assessment of the Impact of Offshore Wind Farms: Seascape and Visual Impact Report* (Prepared for the DTI)
- HES (1987-2017) *An Inventory of Gardens and Designed Landscapes in Scotland.* Available at [http://portal.historicenvironment.scot/designations]
- The Landscape Institute and Institute of Environmental Management and Assessment (2013) *Guidelines for Landscape and Visual Impact Assessment, 3rd Edition*
- Landscape Institute (2011) *Photography and photomontage in landscape and visual impact assessment. Advice Note 01/2011.* Available at https://www.landscapeinstitute.org/PDF/Contribute/LIPhotographyAdviceNote01-11.pdf
- Land Use Consultants (1999) *Tayside Landscape Character Assessment.* (SNH Review No 122)
- Land Use Consultants, Carol Anderson and STAR Group (2009) *Fife Local Landscape Designation Review.* (Fife Council)
- Scottish Borders Council (2012) *Supplementary Planning Guidance: Local Landscape Designations.*
- SNH (2017a) *Siting and designing wind farms in the landscape. Version 3*.
- SNH (2017b) *Visual Representation of Wind Farms: Good Practice Guidance. Version 2.2.*
- SNH (2017c) *Guidance Note: Coastal Character Assessment.*
- SNH (2012a) *Offshore Renewables: Guidance on assessing the impact on coastal landscape and seascape.*
- SNH (2012b) *Assessing the cumulative impact of onshore wind energy developments.*
- SNH (2008) *Guidance on Landscape/Seascape Capacity for Aquaculture*.



Chapter 15

Socio-economics

Regeneris Consulting

March 2018

Table of Contents

Table of Figures

Table of Illustrations

Table of Tables

15 Socio-economics

15.1 Introduction

1. This chapter of the EIA Report presents an assessment of the potential socio-economic impacts arising from the construction, operation and decommissioning of the Project, as detailed in Chapter 4: Project Description.

2. The socio-economic assessment focuses only on the impacts related to the offshore elements of the Project, excluding commercial fisheries subject to a more focussed assessment in chapter 10. All onshore activities were assessed in a separate EIA which accompanied the planning application for the onshore transmission works (NnGOWL, 2012).

3. The assessment is based upon a combination of the understanding of the Project in terms of the potential for impact and the resultant effects on receptors in the identified study areas (as detailed in Section 15.3).

4. This chapter is comprised of the following elements:

- A summary of relevant guidance, policy and legislation;
- Details of the data sources used to characterise the Local Study Area;
- A summary of the relevant consultations with stakeholders;
- A description of the methodology for assessing the impacts of the Project, including details of the receptors and study areas, and approach to the assessment of potential effects;
- A review of the baseline conditions;
- A description of the worst case design scenario relevant to the socio-economic receptors;
- An assessment of the likely significant effects for the construction, operation and decommissioning phases of the Project, including cumulative effects;
- Identification of any further mitigation measures in respect of any significant effects; and
- A summary of the residual impact assessment determinants taking account of any additional mitigation measures identified.

15.2 Legislation, Guidance and Policy Review

15.2.1 Legislation and Guidance

5. There is no specific Scottish Government legislation relevant to the assessment of the socio-economic impacts of offshore wind developments in Scotland.

6. HM Treasury guidance as set out in the Green Book (HM Treasury, 2013) will be used to assess the economic impacts resulting from the development of the Project.

7. The importance of economic benefit is identified in Scottish Planning Policy (Scottish Government, 2014a, P40) which states proposals for energy infrastructure development will need to consider *"net economic impact; including local and community socio-economic benefits such as employment, associated business and supply chain opportunities".*

15.2.2 National Strategic Policy Context

15.2.2.1 Scottish Planning Policy (Scottish Government, 2014d)

8. One of the core values of the Scottish Planning Policy (SPP) is *"to play a key role in facilitating sustainable economic growth, particularly the creation of new jobs and the strengthening of economic capacity and resilience within communities"* (Scottish Government, 2014d). The Scottish Government's vision is to achieve sustainable, distributable and fair growth without compromising *"the quality of environment, place and life"*, with an emphasis on reducing emissions.

9. Within the document, there are four planning outcomes, which underpin the vision. Two of which are of direct relevance to this chapter:

- **Outcome 1: A successful, sustainable place** - Supporting sustainable economic growth and regeneration, and the creation of well-designed, sustainable places.
- **Outcome 2: A low carbon place** - reducing our carbon emissions and adapting to climate change.

10. Sustainable development is widely encompassing, including infrastructure that focuses on net economic benefits but of most relevance to this chapter, those that support climate change mitigation and adaptation.

15.2.2.2 National Planning Framework (NPF) 3 (Scottish Government, 2014c)

11. One of NPF3's aims is to support the diversification of the energy sector and identifies "a low carbon place" as one of four strategic objectives which define its vision for Scotland. The spatial strategy intends to reduce greenhouse gas emission and assist in adapting to climate change. This is in line with the Climate Change (Scotland) Act 2009, which targets a reduction of Scotland's emissions by 42% by 2020, and 80% by 2050.

12. The role of offshore renewables in delivering this objective is recognised throughout NPF3, including:

- The promotion of Scotland as a 'world leader' in offshore renewable energy;
- Offshore renewables-related electricity transmission infrastructure development given the highest-tier 'national development' designation, recognising the national need for, and significance of, such development;
- Similar national development designation for development at Dundee Waterfront, including that relating to a low carbon economy;
- Cockenzie and the forth coast to Torness identified as an area of co-ordinated action with significant potential for renewables-related investment; and
- Identification of the Fife Energy Corridor between Methil and Longannet as having potential for significant investment in energy-related business development.

15.2.2.3 Scottish Energy Strategy: The future of energy in Scotland (Scottish Government, 2017)

13. The vision, set out in the strategy, is one that focuses on the development of renewable energy to bring about socio-economic benefits: *"A strong low carbon economy – sharing the benefits across our communities, reducing social inequalities, and creating a vibrant climate for innovation, investment and high value jobs".* A key part of the vision is delivering inclusive growth from secure, reliable, and affordable energy.

14. Specifically, with regard to the future development of offshore wind, there is a stated commitment to *"continue to support innovation and cost-reduction, through our Enterprise Agencies and partners".*

15.2.2.4 Low Carbon Economic Strategy (Scottish Government, 2010a)

15. Similar to the Scottish Energy Strategy, the Low Carbon Economic Strategy also aims to deliver on the promises made in the Climate Change Act (Scotland) 2009, to attain sustainable growth, and to transition to a low carbon Scotland.

16. Offshore wind is highlighted as an area of strong potential to attract large investment and create jobs – *"The large scale development of offshore wind represents the biggest opportunity for sustainable economic growth in Scotland for a generation"* (P47) To enable the sector, the Scottish Government will aim to reduce barriers, change regulation, outline route maps, advocate innovation, and market the sector.

15.2.2.5 National Renewables Infrastructure Plan 1 - 2 (Scottish Enterprise & Highlands and Islands Enterprise, 2010b)

17. The National Renewables Infrastructure Plans' aims are to develop an actionable framework to deliver on the growing offshore renewables sector.

18. The Stage 1 report maps out the existing and potential locations for renewable infrastructure, and highlights spatial areas of expertise (Scottish Enterprise & Highlands and Islands Enterprise, 2013a).

19. The Stage 2 report builds on this and explores an investment plan to deliver on the first phase, involving local community, enterprise and planning authority engagement, investment propositions, and identification of funding streams (Scottish Enterprise & Highlands and Islands Enterprise, 2013b).

15.2.2.6 2020 Routemap for Renewable Energy in Scotland (Scottish Government, 2011a) and Electricity Generation Policy Statement (Scottish Government, 2013)

20. The Routemap, an update on the Scottish Renewables Action Plan 2009, outlines a set of actions to meet 100% gross annual electricity consumption from renewable energy by 2020, with an interim target of 50% by 2015. As of 2014, nearly 50% of electricity consumption came from renewables (The Scottish Government, 2015). The Scottish Government's 2020 Routemap and Electricity Generation Policy Statement note that, between 2010 and 2020, renewable energy in Scotland could provide:

    - Up to 40,000 jobs (Skills Development Scotland, 2011) and £30 billion investment to the Scottish economy; and
    - A transformational opportunity for local ownership and benefits.

21. Further, offshore wind represents the biggest opportunity for sustainable economic growth in Scotland for a generation, potentially supporting up to 28,000 directly related jobs and a further 20,000 indirect jobs and generating up to £7 billion for the Scottish economy by 2020.

22. Recent ONS (2017) estimates found there were approximately 31,000 direct jobs and 27,500 indirect jobs, totalling 58,500, in 2015, related to low carbon and renewable energy group activity.

15.2.2.7 Low Carbon Scotland: Meeting the Emissions Reduction Targets 2010-2022 (Scottish Government, 2011b)

23. The report outlines actions that can be taken to achieve greenhouse gas emission reduction targets as set out in the Climate Change (Scotland) Act 2009. It draws together existing policies and interventions and highlights those that will play a major role in driving Scotland to its carbon reduction target.

24. The potential economic benefits are as follows:

    - In 2008-09, Scotland's low carbon market was worth around £8.8 billion and was forecast to rise to around £12 billion by 2015-16; and

- Jobs in the low carbon sector in Scotland could grow by 4% a year to 2020, rising by 70,000 jobs, which would account for over 5% of the Scottish workforce.

25. ONS (2017) estimated, in 2015, the total direct turnover in low carbon and renewable energy group activity within Scotland was worth £5.5bn and indirect turnover £5bn, in total £10.5bn.

26. It must be noted the majority of the Project impacts are likely to be realised beyond the target period as stated in the report; however the Project will affect successor policies.

15.2.2.8 Scotland's Offshore Wind Route Map (Offshore Wind Industry Group, 2013)

27. The Route Map highlights the aim of the Offshore Wind Industry Group, in partnership with the Scottish Government, national representative bodies and enterprises, to develop the industry to its full economic potential. It explains that since the publication of the 2010 road map, significant progress has been made on areas such as infrastructure, investment and innovation. However, the Route Map notes concerns that progress has been limited because of unclear sector-wide signals from the UK government and uncertainty surrounding key policies such as the electricity market reform.

15.2.2.9 2015-2018 Business Plan: Building Scotland's International Competitiveness (Scottish Enterprise, 2015)

28. The business plan contains a framework built around creating sustainable growth, the purpose of which is to create opportunities for all and, by doing so, reduce inequality. Scottish Enterprise will attempt to assist key sectors, including offshore wind, in taking advantage of global opportunities.

15.2.2.10 Oil and Gas 'Seize the Opportunity' Guide – Offshore Wind (Scottish Enterprise, 2016)

29. The guide's aim is to encourage diversification within the oil and gas industry into the offshore wind sector. Many of the infrastructure and resources used in oil and gas are similar to that used in offshore wind, whilst the skills developed are also transferrable.

15.2.3 Regional Strategic Policy Context

15.2.3.1 SESplan (and Proposed SESplan) (Strategic Development Planning Authority for Edinburgh and South East Scotland, 2013)

30. The Strategic Development Plan for South East Scotland ('SESplan') sets out strategic planning policy for South East Scotland, including City of Edinburgh, Fife (in part) and East Lothian Council areas. Sustainable economic development is a key component of the SESplan Vision.

31. At a number of points throughout the document, SESplan identifies the potential of the region to support the offshore wind sector, with ports and harbours including Leith and Rosyth identified as potential manufacturing locations. Furthermore, Policy 10 specifically identifies the role of offshore wind as part of a sustainable energy future, whilst also highlighting the potential economic development significance of associated supply chain developments.

32. The process to replace SESplan is underway, with consultation on a Proposed Strategic Development Plan ('Proposed SESplan') undertaken in October 2016. Proposed SESplan identifies the strategic role of a low carbon economy in the future of the areas, whilst also identifying *"serviceable ports to support offshore renewables"* as a specific economic development opportunity. At the time of writing, an Examination into Proposed SESplan is currently underway.

15.2.3.2 TAYplan (Strategic Development Planning Authority for Dundee, Angus, Perth and North Fife, 2017)

33. The TAYplan Strategic Development Plan for ('TAYplan') sets out strategic planning policy for the Dundee City Region, including Dundee City, Fife (in part) and Angus Council areas. As is the case with SESplan, the promotion of sustainable economic growth is fundamental to the delivery of TAYplan objectives.

34. TAYplan expects Dundee and Montrose Ports to contribute significantly towards the UK's east coast energy cluster and encourages such a role though the identification of strategic energy opportunities, including a series of hubs for development and investment in renewable energy. Policy 10 compels Local Development Plans to encourage and facilitate economic growth in offshore-renewables related ports and harbours development.

15.2.4Local Policy Context

15.2.4.1 Angus Council

35. The Angus Local Development Plan (LDP) (Angus Council, 2016) supports the national and regional strategic policy vision of a low carbon economy. A specific policy, PV9, within the plan, emphasises the council's support for the development of renewable energy infrastructure.

36. Within Angus' Economic Development Strategy 2013-2020 (Angus Council, 2013), the council highlights the sector as one of three opportunity industries. Not only does the area have many local strengths, transferrable from the oil and gas industry, it has a strong potential to form supply chain clusters within the region. To fully realise the opportunity, the council plans to work with relevant stakeholders to develop awareness within the sector.

15.2.4.2 City of Edinburgh Council

37. Edinburgh's LDP (City of Edinburgh Council, 2016) sets out the policies guiding development in the area, in accordance with the SESplan Vision. It supports the Climate Change (Scotland) Act 2009 agreements and highlights Leith Docks as a prime location for the offshore renewable industry.

38. Edinburgh's first Sustainable Energy Action Plan (City of Edinburgh Council, 2015) has a clear aim of achieving a 42% reduction in carbon emissions by 2020, in line with the national target under the Climate Change (Scotland) Act 2009. The plan involves five programmes, which target a range of factors from energy efficiency to district heating. The renewables programme aims to increase the use of renewable energy across the economy. The council intends to publish new policies on renewables, and assess the potential for growth in the sector; however, the focus is on smaller scale projects.

39. The council's Economic Strategy for 2012-17 (City of Edinburgh Council, 2012) aims to generate growth and create jobs alongside improving quality of life. It envisions a strong, sustainable and prosperous future for the area, which can be achieved by tapping into the job potential in the renewable energy sector. One of their priority outcomes, for the 2012-17 period, is for Edinburgh and Fife to be established among Scottish centres of excellence in renewable energy and to support innovation from higher education spin-outs in the sector.

40. The Edinburgh and South East Scotland City Region Deal is a key component of Edinburgh's medium / long-term economic development strategy. As part of the City Region Deal, investment in infrastructure is recognised as an essential contributor towards a successful economy.

15.2.4.3 Dundee City Council

41. Pursuant to TAYplan, the Dundee City LDP (Dundee City Council, 2013) establishes a spatial strategy underpinning future development across the city to 2024. The LDP identifies renewable energy sector

as a key growth sector for the local authority, with a strong emphasis on developing and growing the offshore wind sector.

42. In the LDP, the Port of Dundee is defined as a Principal Economic Development Area, which is identified as being of city wide importance and safeguarded for specific development. The plan explicitly expresses the council's support for the production of energy from wind turbines.

43. A replacement Dundee LDP, Dundee LDP2, has reached Proposed Plan stage, with community consultation undertaken from August 2017. Dundee LDP2 is similarly supportive of investment in the renewable energy sector and continues to promote the Port of Dundee as a strategically significant location for the industry.

44. Dundee Partnership's (2013) Action Plan sets out its programme for development for the 2013-17 period. Outcome 1H of the report aims to make Dundee a leading centre for the offshore renewables industry in the UK.

15.2.4.4 East Lothian Council

45. The East Lothian Local Plan (East Lothian Council, 2008) is aged and pre-dates much of the offshore renewables-related activity which has taken place in the area over recent years. Notwithstanding, the economic development credentials of the Local Plan are underpinned by the promotion of sustainable economic development as one of three primary objectives.

46. A replacement plan, the East Lothian LDP, is currently being prepared pursuant to SESplan. Consultation on the Proposed LDP was undertaken in late-2016 and the Plan is currently the subject of Examination by Scottish Government Reporters. The Proposed LDP (East Lothian Council, 2016) identifies an Area of Co-ordinated Action between Cockenzie and Torness, which is considered to have significant potential to support the offshore renewables sector.

47. East Lothian Council's Economic Development Strategy for 2012-22 (University of Glasgow, 2012) aims to identify areas of strength and opportunity which can drive sustainable economic competitiveness. Within the document, it highlights renewable energy as a key sector and an area of opportunity. In total, there are six strategic projects, which will be used to achieve their goals. Strategy Project 1 is to agree and resource implementation plans for all key sectors. The renewables implementation plan will detail how best to work with South East Scotland local authorities and East Coast Renewables to develop an interlinked approach.

15.2.4.5 Fife Council

48. Fife Council's LDP, FIFEplan (Fife Council, 2017), outlines its support for investment in the Fife Energy Corridor, a series of coastal locations considered to have potential for future roles as part of the offshore renewables manufacturing and supply chains. FIFEplan recognises the regional significance of the Fife Energy Corridor to the offshore renewables sector and also the significance of the sector to the sustainable growth of the Fife economy.

49. Fife's Economic Strategy (Fife Council *et al.*, 2017) lists the renewable energy industry as a key sector to the local economy, a sector considered as important in achieving their vision for sustainable growth. The council plans to focus its efforts on internationalising, investing and encouraging innovation in the industry to continue building on Fife's competitive advantage.

15.3 Data Sources

50. The assessment considers the potential interaction between the Project, as described in Chapter 4: Project Description, and socio-economics receptors within the Local Study Area.

51. The Local Study Area under analysis in this chapter refers to those areas surrounding the Development Area that will be impacted by the construction, operations and maintenance, and decommissioning of

the Project. The Local Study Area in consideration is the combined local authorities of Angus, City of Edinburgh, Dundee, East Lothian and Fife, shown in Figure 5.1.

52. Impacts in a National (Scotland) Study Area for Scotland have also been assessed.

53. Baseline characterisation and model data has been collated combining a thorough desk-based study of extant data supplemented with a series of consultations with the various impacted local authorities and relevant enterprise organisations.

Table 15-1 Data Sources for Baseline

Data Source	Data Name	Overview
Office for National Statistics	Annual population survey (APS)	A UK household survey covering a range of socio-economic variables such as employment, housing, ethnicity, religion, health and education.
	Annual survey of hours and earnings, workplace and residence based	Data on levels and distribution of earnings and hours worked for UK employees in all industries and occupations.
	Business register and employment survey	Data on office based employee and employment estimates by geography and industry.
	Business demography	Annual publication covering business births and deaths, survival rates and stock.
	Claimant count by sex and age	Monthly measure of the number of people claiming unemployment related benefits.
	Mid-year population estimate	Annual population estimates for the UK by sex and age down to local authority levels.
	Regional GVA (Gross Value Added) (income approach) at current basic prices	Primary measure of GVA – value of the economy due to the production of goods and services.
Scottish Government	Scottish index of multiple deprivation	An index that identifies deprivation levels across a number of domains such as barriers to employment or access to local amenities.

15.4 Relevant Consultations

54. As part of the EIA process, NnGOWL has undertaken a number of consultations with various statutory and non-statutory stakeholders. A formal scoping opinion was requested from MS-LOT following submission of the Scoping Report. Ongoing consultation with stakeholders continued post-scoping

and responses have been used to develop an appropriate methodology and parameters for assessment.

55. In response to NnGOWL's request, MS-LOT issued a Scoping Opinion identifying a number of receptors that could not be scoped out of the assessment at this stage following review of the Scoping Report. The comments to be considered further within this EIA, in respect of the socio-economics assessment, are summarised in Table 15-2.

Table 15-2 Summary of consultations related to socio-economics

Date and consultation phase / type	Key Stakeholder comments	Section where comment addressed
Scoping Opinion (September 2017)	The Scoping Report recommended the socio-economic impact on tourism be scoped out as the baseline from the Original EIA remained valid and any effects from the Project, for up to 54 turbines, compared to up to 125 turbines in the previous application, would be lessened as a result. The Scottish Ministers agree that the effect on tourism can be scoped out.	This comment does not need to be addressed further – the baseline and impacts on tourism have been scoped out
Scoping Opinion (September 2017)	Scottish Ministers agree with the proposed approach to assessing the potential effects on GVA and employment.	This comment is addressed in Section 15.5 'Impact Assessment Methodology'
Consultation with Angus Council (July 2017)	Angus Council representative feels that the area possesses a port and a strong civil engineering core, which can assist in and benefit from the development of the Project. Distance from Development Area may mean local supply chain may not be engaged, many of whom are sceptical and unaware of the opportunities that are available. History of wind farm development in the North Sea have not seen many opportunities realised. The Project is a positive for the environment and is a strong contributor to meeting carbon emission targets. It further acts as an opportunity for skills and sector development.	This comment is addressed in Section 15.7.1 'Embedded Mitigation'.
Consultation with City of Edinburgh Council	NnGOWL, and their technical consultants, were unable to schedule a consultation with a representative of the strategy team from the City of Edinburgh Council after initial contact was made through email.	N/A

Date and consultation phase / type	Key Stakeholder comments	Section where comment addressed
Consultation with Dundee City Council (August 2017)	Dundee City Council's representative stated that Dundee is an ideal location from which to centre development. There is the port, which already services the wider energy sector; strong history in engineering; local to higher and further education institutions providing strong future labour supply and R&D; and proximity to other developing wind farms. With the gradual downturn in oil and gas industry, the effects of which have impacted Dundee, the wind farm sector is well received and supported, with many local skills gained in the traditional energy sector transferrable to renewables. There are schemes such as Energy Training East and Tayside Engineering network, which are readily identifying the future skills needs and addressing these gaps to meet future demand and support local growth. There are a host of businesses ready to seize on the potential opportunities arising from the Project. Recent supply chain events, hosted by Mainstream Renewable Power (MRP), have raised awareness of the availability of opportunities but more can be done to engage the local supply chain (tier three) in specifically outlining where they can support the higher tier firms.	This comment is addressed in Section 15.7.1 'Embedded Mitigation'.
Consultation with East Lothian Council (July 2017)	East Lothian is predominantly comprised of small and medium sized enterprises (SME). There are some growing companies, which would be interested in partaking in the development of the Project. The Council is keen to take advantage of the growing number of opportunities in the offshore wind sector – the sector plays a major role in local plans. There is a need to make businesses more aware of these opportunities and provide support in the tender process to improve success rate of winning contracts. Developers can assist in this process by hosting supply-chain events. More work can be done to align the needs of the sector with the skills and education taught at schools and universities in the local area.	This comment is addressed in Section 15.7.1 'Embedded Mitigation'.

Date and consultation phase / type	Key Stakeholder comments	Section where comment addressed
Consultation with Fife Council (August 2017)	Fife is the home of many large energy companies, which have a supply chain ready to play a part at every stage of a wind farm's lifecycle. Many of these have already won contracts and are in a good position for future contract winning. It follows that the renewable energy sector is of significant importance to Fife. There are several schemes in Fife aimed at delivering a strong labour supply including delivery of offshore wind apprenticeships. Challenges faced by local firms in securing contracts include knowing where the opportunities are and obtaining the opportunity to showcase their capabilities. Developers can assist by improving the contact between tier-one suppliers and the local supply chain.	This comment is addressed in Section 15.7.1 'Embedded Mitigation'.
Consultation with Scottish Enterprise (July 2017)	Concerned with supply chain companies not investing in technology because it is not effective to do so when the pipeline of wind farm work is so intermittent. Developers are more risk averse in the wind farm industry and as a result spread risk further down the supply chain, which inversely affects supply chain willingness to engage. More feedback to local supply chain is felt to be required from the developer. Otherwise, there is strong support from Scottish Enterprise, consistent with their desire to encourage innovation in the renewable energy sector. Scotland has specialisms across the board of activities in the energy sector; many businesses have diversified from the traditional oil and gas sector to renewables. The Project is seen as very beneficial to Scotland.	This comment is addressed in Section 15.7.1 'Embedded Mitigation'.

15.5 Impact Assessment Methodology

56. This assessment considers the potential impacts associated with the construction, operation (including maintenance) and decommissioning of the Project and the effects on socio-economic receptors in the study area. The impact assessment process and methodology follows the principles and general approach outlined in Chapter 6: EIA Methodology. The methodology and parameters assessed have also taken into account issues identified through consultation with stakeholders as detailed in Section

15.4 and the understanding of baseline conditions informed by the data sources referenced in Section 15.3.

57. The Project Description (Chapter 4) and the project activities for all stages of the project life cycle (construction, operation and decommissioning) have been assessed against the environmental baseline to identify the potential interactions between the Project and the environment. These are known as the potential impacts and are then assessed to determine a level of significance of effect upon the receiving environment.

15.5.1 Receptors

58. Table 15-3 lists the receptors under assessment and the study areas within which they will be assessed.

Table 15-3 Study area for each of the receptors identified for the Project

Receptors	Study Area(s)
Direct and indirect employment creation in the construction, O&M and decommissioning supply chain	▪ **Local Study Area** - combined local authorities ▪ Scotland study area
Direct and Indirect GVA creation in the construction, O&M, and decommissioning supply chain	

15.5.2 Methodology for Assessing Employment and GVA Impact

59. The absolute scale of economic impacts were calculated using an approach consistent with the methods for economic impact assessment as set out in HM Treasury's Green Book (2013).

60. The analysis of employment and GVA impacts focuses on direct and indirect economic impacts at each lifecycle phase, outlined below:

- **Construction –** the direct economic impacts relate to the direct employees of NnGOWL and the jobs and GVA associated with the first round of capital expenditure (i.e., what NnGOWL will spend directly with its supplier). The indirect economic impacts refer to the jobs and GVA generated within the chains of suppliers of goods and services to the direct activities; and
- **Operation and Maintenance –** the direct economic impacts relate to the direct employees of NnGOWL and the jobs and GVA associated with the first round of operational expenditure (i.e. what NnGOWL will spend directly to operate and maintain the Project). The indirect economic impacts refer to the jobs and GVA generated within the chains of suppliers of goods and services to the direct activities.

61. In addition to direct and indirect effects, there will be additional employment and wealth creation arising from the expenditure of personal income by those whose jobs are supported directly or indirectly by the Project. However, compared with the direct and indirect economic impacts, there is typically greater uncertainty about the scale, sectoral distribution and geographical spread of these impacts, so these have not been included in this assessment.

62. Direct employment and GVA impacts are estimated using costing and sourcing assumptions. Based on the cost and geographic sourcing assumptions for each of the development scenarios (outlined below), benchmark figures (from Regeneris Consulting's in-house Input-Output model, based on UK Input-Output tables, 2005) have been applied to estimate the number of jobs and associated GVA that would be created in each study area.

63. To assess indirect employment and GVA impacts, Regeneris's Input-Output model has been used to model the way in which the direct expenditure with tier-one suppliers would lead to indirect employment and GVA effects further down the supply chain.

64. Temporary employment supported during the construction period is assessed and presented in terms of full-time equivalent (FTE) person years of employment. Average annual FTE impacts during the construction phase have also been estimated to allow for the magnitude of potential change against baseline levels of employment to be assessed.

65. Job creation arising from O&M activity is presented as direct and indirect FTE jobs and GVA effects presented as annual impacts.

15.5.2.1 Scenario Analysis

66. The assessment of potential socio-economic effects is subject to various sources of uncertainty, in particular:

- There is greater certainty for constructions costs rather than costs further in the future, for example decommissioning will be undertaken using best practice at the time;
- The likelihood of ports in the local and Scotland study areas being selected for the construction, and the range of functions they might serve; and
- The location of the main tier-one and tier-two suppliers, which will be used, and their associated supply chains, and therefore the extent to which this influences the retention of supply chain expenditure within the Local and Scotland Study Areas.

67. In light of these uncertainties, the methodology has involved estimating construction and O&M costs using sector benchmarks from The Crown Estate (2012), and three scenarios to demonstrate the likely range of geographical sourcing patterns, including different assumptions about the location of the construction port base.

68. Note that no estimate is made for costs and impact of decommissioning, as this activity is considered too difficult to forecast with accuracy and too far into the future to allow for meaningful analysis. The assessment of employment and GVA impacts for this phase is therefore dealt with qualitatively.

69. The sourcing assumptions for each scenario have been informed by:

- A review of published studies examining the economic impact of offshore wind farms in Scotland;
- An analysis of the economic sectors in which the study areas have particular strengths; and
- Discussions with NnGOWL concerning the procurement process and the potential for local and Scottish suppliers to secure supply chain opportunities.

15.5.2.1.1 Construction Phase Scenarios

70. The scenarios below show the sourcing assumptions under low, medium and high sourcing scenarios for the construction phase. The categories of expenditure include:

- Design and development – the pre-construction phase including activities associated with the development of the Project such as sea bed surveys, engineering / design studies, ecology surveys, wind measurement surveys, environmental impact assessments and coastal processes surveys;
- Wind turbine manufacture;
- Balance of plant activities (i.e. all components of the Project except the turbines), so including manufacture of cables, foundations and substations; and
- Installation and commissioning.

71. The high scenario is based on the assumption that where there are suitably qualified firms in Scotland or the Local Study Area that could secure tier-one contracts, these firms would be successful. It is therefore an upper bound of expected impact.

72. The low scenario is based on an assumption that the majority of tier one contracts would not be secured by Scottish firms, however that various lower tier contracts would still be won, being highly unlikely that such lower tier contracts could be won competitively by a firm outside of Scotland or the local area. This therefore represents a lower bound of expected impact.

73. The medium scenario assumes some but not all tier one contracts would be won by firms from Scotland or the Local Study Area.

74. The actual impact will depend on the procurement decisions made. The impacts assessed in this chapter are separate to those set out in the analysis by the Fraser of Allander Institute at University of Strathclyde (2017). In terms of overall jobs and economic impact, the figures from the University of Strathclyde match most closely with the medium scenario for construction.

Low Impact Construction Scenario

75. Under the low impact scenario, it is assumed that the construction port for the Project would be outside Scotland and that no large contract would be won by Scottish supply chain firms and is therefore considered as the worst case scenario.

76. The main impacts would be in the design and development phase and lower tier contracts relating to balance of plant and installation. These assumptions are summarised in Table 15-4.

Table 15-4 Sourcing assumptions under the low impact construction scenario (Source: Regeneris Consulting)

Phase	Estimated value (£ million)	% of total value sourcing from the Local Study Area	% of total value sourced from within Scotland
1. Design and development	£100.5	18%	51%
2. Wind turbine manufacture	£500.0	0%	0%
3. Balance of plant	£473.0	4%	4%
4. Installation and commissioning	£365.0	0%	10%
Total	**£1,438.5**	**2%**	**7%**

Medium Impact Construction Scenario

77. Under the medium impact scenario, it is assumed that the construction port would be within Scotland but not in the Local Study Area. This is considered to be a more reasonable set of assumptions as it is likely that some of the larger contracts will be won by local or at the minimum Scottish firms.

78. The main impacts would be in design and development and some more substantial contracts won relating to wind turbine towers, balance of plant items and installation. These assumptions are summarised in Table 15-5.

Table 15-5 Sourcing assumptions under the medium impact construction scenario (Source: Regeneris Consulting)

Phase	Estimated value (£ million)	% of total value sourcing from the Local Study Area	% of total value sourced from within Scotland
1. Design and development	£100.5	18%	75%
2. Wind turbine manufacture	£500.0	0%	5%
3. Balance of plant	£473.0	37%	37%
4. Installation and commissioning	£365.0	0%	46%
Total	**£1,438.5**	**14%**	**31%**

High Impact Construction Scenario

79. Under the high impact scenario, it is assumed that a construction port within the Local Study Area is used and many large contracts won by Scottish firms. The main impacts would be in major contracts won relating to the supply of wind turbine towers, foundations, array cables, substations and installation. These assumptions are summarised in Table 15-6.

80. This scenario assumes that the contracts, for which Scotland has appropriate capabilities, are won by Scottish firms. As such, this scenario represents a maximum scenario for Scotland based on its current supply chain.

Table 15-6 Sourcing assumptions under the high impact construction scenario (Source: Regeneris Consulting)

Phase	Estimated value (£ million)	% of total value sourcing from the Local Study Area	% of total value sourced from within Scotland
1. Design and development	£100.5	18%	84%
2. Wind turbine manufacture	£500.0	0%	10%
3. Balance of plant	£473.0	75%	75%
4. Installation and commissioning	£365.0	14%	100%
Total	**£1,438.5**	**29%**	**59%**

15.5.2.1.2 Operation and Maintenance Phase Scenarios

81. The scenarios below show the sourcing assumptions under low, medium and high sourcing scenarios for the O&M phase. The categories of expenditure include:

- Technician and component replacements – incorporating turbine supply contract and post warranty activity;
- Professional services, business rates, insurances, administrative overheads;
- Port and travel costs; and
- Other costs, including Crown Estate lease costs.

82. As with the construction phase, the high scenario is based on the assumption that where there are suitably qualified firms in Scotland or the Local Study Area that could secure major contracts, these firms would be successful. It is therefore an upper bound of expected impact.

83. The low scenario is based on an assumption that the majority of major contracts would not be secured by Scottish firms, however that various lower tier contracts would still be won at this level. This therefore represents a lower bound of expected impact.

84. The medium scenario assumes some but not all major contracts would be won by firms from Scotland or the Local Study Area.

85. The medium scenario can be considered as the most likely scenario; however, the actual impact will depend on the procurement decisions made. The impacts set out under all three scenarios are considered to be realistic estimates.

86. The impacts assessed in this chapter are separate to those set out in the analysis by the Fraser of Allander Institute at University of Strathclyde. In terms of overall jobs and economic impact, the figures from the University of Strathclyde match most closely with the low scenario for O&M.

Low Impact O&M Scenario

87. Under the low impact scenario, considered as the minimum to be expected, it is assumed that the O&M port would be in Scotland, but not in the Local Study Area. As such, the overall sourcing in the Local Study Area would be limited, with the main impacts at national level being related to activity at the O&M port. These assumptions are summarised in Table 15-7.

Table 15-7 Sourcing assumptions under the low impact O&M scenario (Source: Regeneris Consulting)

Phase	Estimated value (£ million)	% of total value sourcing from the Local Study Area	% of total value sourced from within Scotland
1. Technician and Component Replacements	£568.2	0%	19%
2. Professional services, business rates, insurances, administrative overheads.	£363.8	2%	40%
3. Port and Travel Costs	£19.7	55%	91%
4. Other	£105.6	54%	54%
Total	**£1,057.3**	**7%**	**31%**

Medium Impact O&M Scenario

88. Under the medium impact scenario, it is assumed that the O&M port will be within the Local Study Area. As such, the overall sourcing in the Local Study Area would be larger, relating to O&M technicians, transportation and port related activity. These assumptions are summarised in Table 15-8.

Table 15-8 Sourcing assumptions under the medium impact O&M scenario (Source: Regeneris Consulting)

Phase	Estimated value (£ million)	% of total value sourcing from the Local Study Area	% of total value sourced from within Scotland
1. Technician and Component Replacements	£568.2	19%	21%
2. Professional services, business rates, insurances, administrative overheads.	£363.8	55%	60%
3. Port and Travel Costs	£19.7	91%	91%
4. Other	£105.6	54%	54%
Total	**£1,057.3**	**36%**	**39%**

High Impact O&M Scenario

89. Under the high impact scenario, it is assumed that the O&M port will be within the Local Study Area. As well as technician, transportation and port related activity, this scenario assumes a higher proportion of other O&M supporting contracts would be captured in the Local Study Area. These assumptions are summarised in Table 15-9.

Table 15-9 Sourcing assumptions under the high impact O&M scenario (Source: Regeneris Consulting)

Phase	Estimated value (£ million)	% of total value sourcing from the Local Study Area	% of total value sourced from within Scotland
1. Technician and Component Replacements	£568.2	19%	26%
2. Professional services, business rates, insurances, administrative overheads, etc.	£363.8	75%	80%
3. Port and Travel Costs	£19.7	91%	91%
4. Other	£105.6	54%	54%
Total	**£1,057.3**	**43%**	**49%**

15.5.3 Assessment and Assignment of Significance

90. The sensitivities of the receptors are defined by their potential vulnerability to an impact from the Project, their recoverability and the value or importance of the receptor. Definitions of terms relating to the receptors are detailed in Table 15-10. The method for determining the sensitivity of each of the receptors takes account of the importance attached to each receptor in local and national economic development and regeneration policy, together with professional judgement relating to the scale of socio-economic challenges.

Table 15-10 Sensitivity/ importance of the socioeconomic receptors

Receptor sensitivity / importance	Description / justification
High	The receptor is identified as a policy priority (as a result of economic potential and/or need). There is evidence of sizable socio-economic challenges, underperformance and vulnerability for the receptor in the study area.
Medium	The receptor is not identified as a policy priority (as a result of economic potential and/or need). There is evidence of considerable socio-economic challenges or underperformance and vulnerability for the receptor in the study area.
Low	The receptor is not identified as a policy priority (as a result of economic potential and/or need). There is evidence that the receptor is resilient and there are few weaknesses or challenges for the receptor in the study area.
Negligible	The receptor is not identified as a policy priority (as a result of economic potential and/or need). There is evidence that the receptor is resilient and no particular weaknesses or challenges for the receptor in the study area.

91. The magnitude of impact is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact. Definitions of the levels of magnitude used in this assessment in respect of the receptors are described in Table 15-11.

Table 15-11 Magnitude of the impact of the socio-economic receptors

Magnitude of Impact	Description
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (adverse). Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality (beneficial).
Medium	Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements (adverse). Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (beneficial).
Low	Some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements (adverse). Minor benefit to or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (beneficial).

Magnitude of Impact	Description
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements (adverse). Very minor benefit to, or positive addition of, one or more characteristics, features or elements (beneficial).
No change	No loss or alteration or characteristics, features or elements; no observable impact in either direction.

92. The assessment of the magnitude of the impacts is underpinned by an analysis of the potential economic impacts supported by the construction and O&M of the Project. The magnitude of impact on most receptors is primarily driven by the increased level of economic activity in the area as a result of the Project going ahead.

93. The assessment considers the potential economic impact of the Project in light of the cost of constructing and operating the Project, the location of the development, and the expected geography of the Project's supply chain.

94. The magnitude of the impact is correlated against the sensitivity of the receptor to provide a level of significance. For the purposes of this assessment any effect that is considered major or moderate in Table 15-12, is considered significant in EIA terms.

Table 15-12 Significance of potential effects

		Magnitude			
		High	Medium	Low	Negligible
Sensitivity	**High**	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

15.5.4 Uncertainty and Technical Difficulties Encountered

95. As outlined in the methodology at Section 15.5, the main areas of uncertainty in undertaking the technical assessment of socio-economic impacts are around longer term costs, construction and O&M port to be used, and geographic sourcing of goods and services.

96. Section 15.5.2.1 details how this uncertainty has been dealt with in our methodology through the use of high, medium and low impact scenarios, to provide a range of likely potential impacts.

15.6 Baseline Description

97. This section presents an overview of the key social and economic indicators within the local and Scotland study areas. The key sources of data used to assess the baseline environment in the Local Study Area include relevant national datasets from the ONS, which provide intelligence on population, labour market and employment base conditions.

98. The analysis draws on the most up-to-date sources of data available in July 2017 for all key socio-economic indicators, although the year that the data relates to varies according to the release calendar for each dataset. The baseline year will therefore vary slightly across the indicators considered in the baseline. This is referenced throughout this report.

15.6.1GVA

99. The Local Study Area's GVA in 2015 was £31.8bn, equating to 25% of total GVA in Scotland. Within the Local Study Area, the highest GVA generating district was the City of Edinburgh with £18.4bn, with the lowest being East Lothian with £1.5bn. This disparity is reflected in the productivity levels, GVA per head has been used as a proxy, of each district at £40,000 and £14,800 per head, once again representing the highest and lowest with the Local Study Area.

Table 15-13GVA performance, 2015 (Source: ONS, 2017, Regional gross value added (income approach) at current basic prices. Accessed July 2017)

Relevant geographical areas	Gross value added (£m)	GVA per head (£)
Local Study Area	£31,849	£25,788
Angus	£1,969	£16,844
City of Edinburgh	£18,437	£36,963
Dundee City	£3,230	£21,795
East Lothian	£1,528	£14,827
Fife	£6,685	£18,162
Scotland	£127,260	£23,685

15.6.2Population Structure

100. As summarised in Table 15-14, the Local Study Area is home to a population of around 1.25 million people, of which 785,000 (or approximately 63%) are of working age (WAP - refers to males aged 16 to 64 and females aged 16 to 59); a larger proportion than national levels (62%).

Table 15-14 Total and working age population (WAP), 2016 (Source: ONS (2016), 'Mid-Year Population Estimates'. Accessed July 2017).

Relevant geographical areas	Total population (000s)	WAP (000s)	% WAP
Local Study Area	1,246	785	63.0%
Angus	117	67	57.2%
City of Edinburgh	507	342	67.3%
Dundee City	148	95	63.8%
East Lothian	104	61	59.0%
Fife	370	221	59.6%
Scotland	5,405	3,325	61.5%

15.6.3Labour Market Indicators

101. Table 15-15 below highlights the performance of the study area's labour market in comparison with the national average. Overall, the Local Study Area has slightly fewer economically active working age individuals - i.e. either in employment or actively looking for work – with 76% of working age individuals active, compared to the national rate of 77%.

Table 15-15 Headline performance on key labour market indicators, 2017 (Source: ONS (Apr 2016 -Mar 2017), 'Annual Population Survey'. Accessed July 2017).

Relevant geographical areas	Economically active		In employment		Economically inactive[1]	
	No. (000s)	% WAP	No. (000s)	% WAP	No. (000s)	% WAP
Local Study Area	608	75.8%	583	72.7%	194	24.2%
Angus	55	79.5%	53	76.8%	14	20.5%
City of Edinburgh	260	75.4%	251	72.8%	85	24.6%
Dundee City	66	68.6%	63	65.4%	30	31.4%
East Lothian	50	78.8%	48	75.0%	14	21.2%
Fife	177	77.4%	168	73.7%	52	22.6%
Scotland	2,626	76.9%	2,505	73.4%	787	23.1%

102. Despite an unemployment rate that is below the national average (4.1% compared to 4.6%), Table 15-16 indicates, there are still around 25,000 unemployed residents across the Local Study Area.

Table 15-16 Unemployment rate, 2016 (Source: ONS (Apr 2016 - Mar 2017), 'Annual Population Survey'. Accessed July 2017).

Relevant geographical areas	Number unemployed (000s)	Unemployment rate
Local Study Area	25	4.1%
Angus	2	3.4%
City of Edinburgh	9	3.4%
Dundee City	3	4.7%
East Lothian	2	4.8%
Fife	9	4.8%
Scotland	121	4.6%

103. Illustration 15-1 shows the number of people claiming benefits (principally for the reason of being unemployed), and includes all out of work Universal Credit claimants as well as all Job Seeker's Allowance claimants. It shows that overall, the claimant rate in the Local Study Area has been consistently below or level to the national claimant rate. The claimant rate in the study area has declined by around half over the past four years, from 4.0% in June 2013 to 2.2% by June 2017.

[1] Economically Inactive – *"consists of people aged 16 and over without a job who have not sought work in the last 4 weeks and/or are not available to start work in the next 2 weeks. The main economically inactive groups are students, people looking after family and home, long-term sick and disabled, temporarily sick and disabled, retired people and discouraged workers."* - https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/methodologies/aguidetolabourmarketstatistics

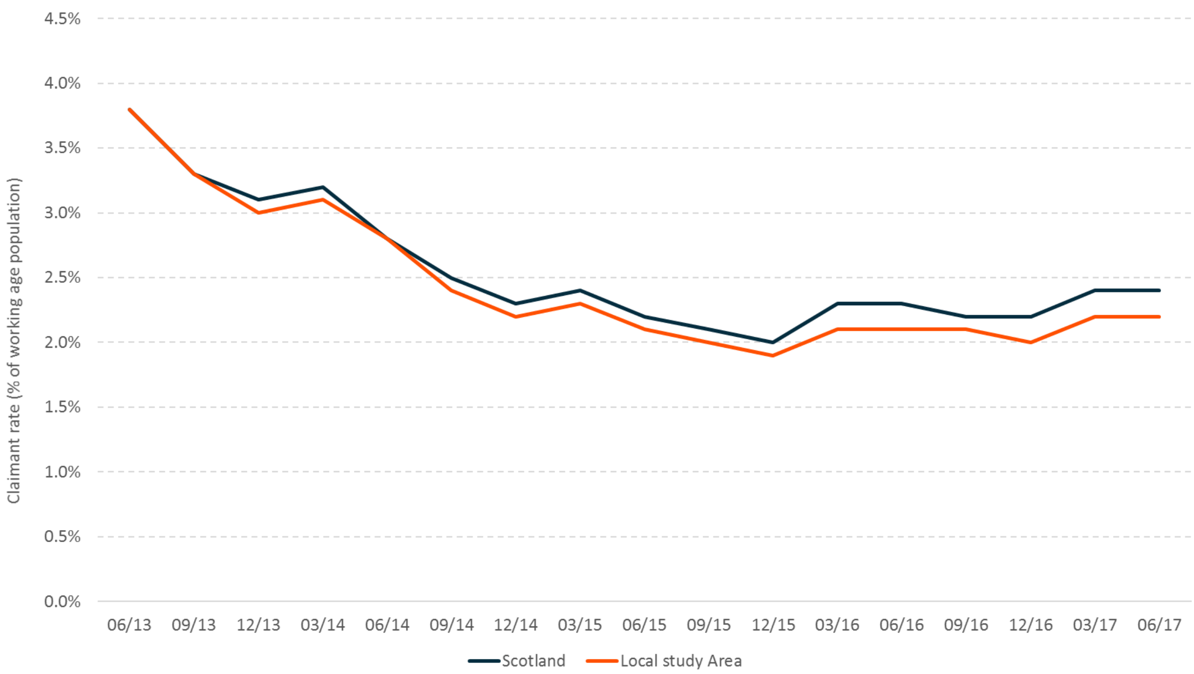


Illustration 15-1: Change in claimant rate for the study area and Scotland, 2013-17 (Source: ONS (Jun 2013 – Jun 2017), 'Claimant count by sex and age'. Accessed July 2017).

104. The study area's skills profile performs strongly against the national average. Table 15-17 shows that around half of the areas working age population have Scottish Vocational Qualifications (SVQ) level four or above qualifications, whilst nationally this stands at 44%. This aggregate performance across the Local Study Area masks variations amongst the local authority areas making up the Local Study Area however, with Dundee City below the national equivalent.

105. The proportion of working age residents with no qualifications in the Local Study Area (7.6%) is significantly below that seen nationally (at 9.9%).

Table 15-17 Education qualifications of working age adults by SVQ level, other and no qualifications, 2016 (Source: ONS (Apr 2016 -Mar 2017), 'Annual Population Survey'. Accessed July 2017).

Relevant geographical areas	NVQ 4 and above[2]		Other qualifications[3]		No qualifications	
	No. (000s)	%	No. (000s)	%	No. (000s)	%
Local Study Area	400	50.0%	39	4.9%	61	7.6%
Angus	29	42.0%	4	5.4%	6	7.9%
City of Edinburgh	203	59.2%	16	4.6%	19	5.5%
Dundee City	39	40.9%	6	6.0%	12	12.2%
East Lothian	29	46.0%	3	3.9%	5	7.4%
Fife	100	43.6%	12	5.0%	20	8.7%
Scotland	1,488	43.7%	207	6.1%	336	9.9%

106. The above average qualifications performance of the Local Study Area is reflected in the type of occupations the area's residents are engaged in. From Table 15-18 below, it can be seen there is a

[2] Level 4 NVQ are: certificate of higher education, higher apprenticeship, higher national certificated for a complete list of NVQ levels see - http://www.gov.scot/Topics/Statistics/Browse/Lifelong-learning/StudyLevels
[3] Those with entry level qualifications, for more information see http://www.gov.scot/Topics/Statistics/Browse/Lifelong-learning/StudyLevels

relatively higher representation of employment in higher managerial and professional occupations (Group 1-3) in the area than what is seen nationally. Again, however, there is variation across the five local authorities with significantly fewer in Dundee City and Angus.

Table 15-18 Employment by standard occupation classification, 2017 (Source: ONS (Apr 2016-Mar 2017), 'Annual Population Survey'. Accessed July 2017).

Relevant geographical areas	Group 1 - 3 (Management)		Group 4 – 5 (Administration)		Group 6 – 7 (Support workers)		Group 8 – 9 (Elementary occupations)	
	No.	%	No.	%	No.	%	No.	%
Local Study Area	286	47.3%	117	19.4%	107	17.7%	91	15.0%
Angus	22	38.3%	13	23.2%	10	17.9%	12	20.4%
City of Edinburgh	145	56.2%	41	15.8%	37	14.4%	34	13.1%
Dundee City	25	37.9%	13	19.3%	16	24.2%	12	18.3%
East Lothian	23	46.4%	11	22.9%	10	20.0%	5	10.7%
Fife	72	41.0%	39	22.4%	34	19.4%	29	16.3%
Scotland	1,105	42.6%	543	20.9%	479	18.4%	455	17.5%

15.6.4Sectoral Structure of the Employment Base

107. Data from the ONS indicates that, in 2015, there were just under 600,000 people employed within the Local Study Area. The City of Edinburgh accounts for more than half of total employment in the Local Study Area, and together with Fife, they represent over three-quarters of all employment.

108. Employment density (i.e. the number of jobs per 1,000 working age residents) can be used to compare the Local Study Area's performance with that of the nation. At 761 jobs per 1,000 working age residents, job density in the area is marginally lower than the national average of 764. Employment density ranges from around 460 jobs per 1,000 working age residents in East Lothian to around 950 jobs per 1,000 working age residents in the City of Edinburgh.

Table 15-19 Total employment and employment density in the Local Study Area (Source: ONS (2016), 'Business Register and Employment Survey'. Accessed July 2017).

Relevant geographical areas	Total employment (000s)	Employment density (jobs per 1,000 WAP residents)
Local Study Area	597	761
Angus	35	524
City of Edinburgh	324	949
Dundee City	75	793
East Lothian	28	462
Fife	135	613
Scotland	2,541	764

109. Concentrations of employment in key sectors that exist in the Local Study Area (compared with the national employment base) are highlighted in Illustration 15-2 below. Like Scotland, the Local Study Area's employment base is heavily reliant on service sector activities.

110. Location quotients (LQs) measure the industrial specialisation relative to Scotland, where a LQ greater than 1.0 means the Local Study Area has a higher concentration of a particular sector than that of Scotland, using ONS' BRES data. With around 35,000 jobs, manufacturing is the 9th largest sector across the Local Study Area and represents just under six percent of all jobs in the Local Study Area. In

comparison, the manufacturing sector employs around seven percent of all jobs In Scotland. This means that the Local Study Area has a lower concentration (or LQ of 0.8) of manufacturing jobs when compared with the national average. There are around 6,000 jobs in the transport and storage sector, representing just over three percent of all jobs across the Local Study Area, resulting in a low LQ of 0.8 (ONS, 2016: Business Register and Employment Survey).

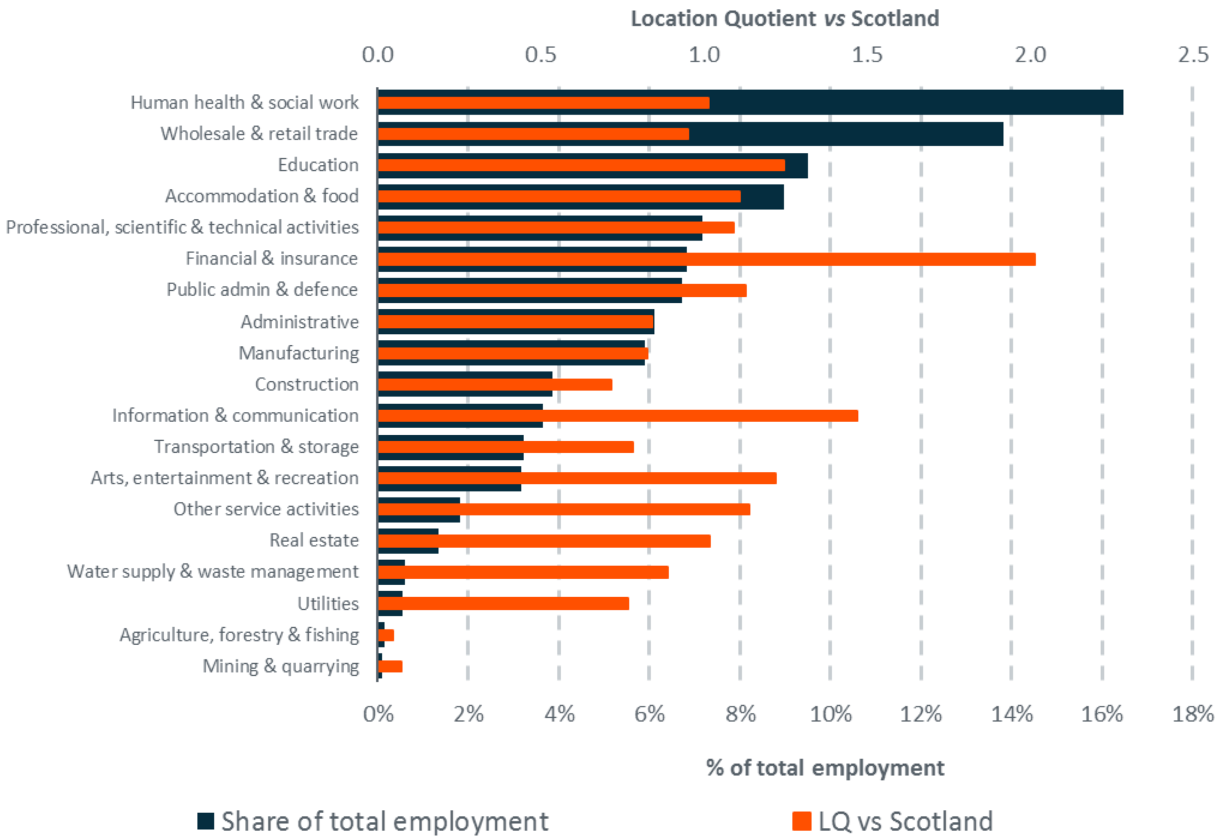


Illustration 15-2 Sectoral employment profile in the Local Study Area, 2015 (Source: ONS (2016), 'Business Register and Employment Survey'. Accessed July 2017).

15.6.5Business Births and Deaths

111. Illustration 15-3 plots a time-series of the difference between enterprises births and deaths each year. The net number of enterprises in the Local Study Area between 2010 and 2015 has grown, but at a slower rate to that of Scotland as a whole. This peaked in 2013 with around 1,800 enterprises but growth slowed to 1,200 net new enterprises in 2015.

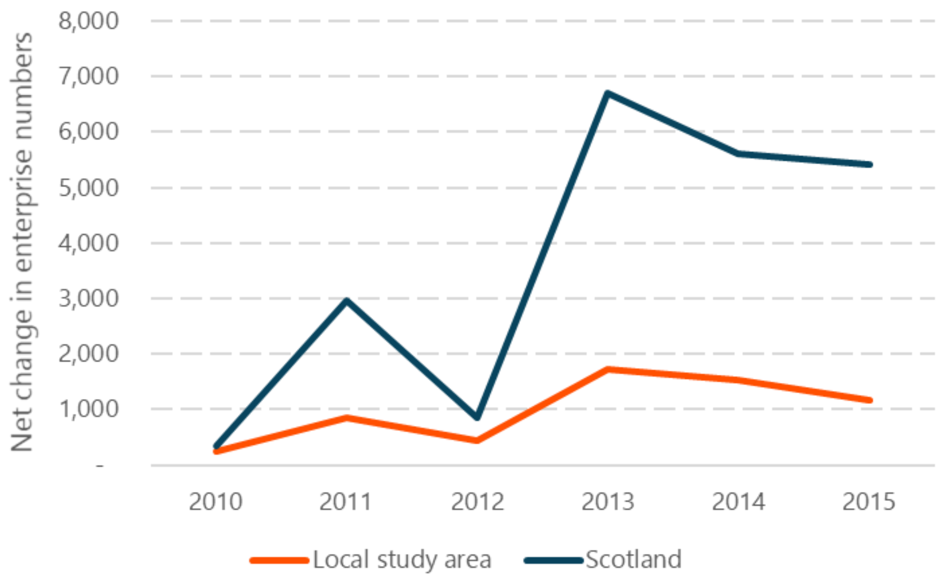


Illustration 15-3 Net change in enterprise births and deaths (Source: ONS (2016), 'Business demography'. Accessed July 2017).

15.6.6Earnings and Wealth Generation

112. Table 15-20 highlights the gap that exists between the average yearly earnings of those employed in the Local Study Area and Scotland as a whole. There are large differences within the Local Study Area, with the average salary ranging from £28,200 in Angus to £39,300 in the City of Edinburgh, compared to the national average of £33,400.

Table 15-20 Annual average gross pay for full time employees and residents for the LAs that make up the Local Study Area, 2017 (Source: ONS (2017), 'Annual Survey of Hours and Earnings, Workplace and Residence Based'. Accessed July 2017).

Relevant geographical areas	Workplace resident's average annual gross pay
Angus	£28,200
City of Edinburgh	£39,300
Dundee City	£30,800
East Lothian	£30,800
Fife	£30,200
Scotland	£33,400

113. Table 15-21 below shows that in 2015 the Local Study Area had an overall GVA output of just under £32 billion. GVA per head for the Local Study Area is around £25,800. Within this area only the City of Edinburgh outperforms the national average, and significantly so, at around £37,000 GVA per head.

Table 15-21 Total GVA and GVA per head, 2015 (Source: ONS (2016), 'Regional GVA (income approach) at current basic prices'. Accessed July 2017).

Relevant geographical areas	Total GVA (£ million)	GVA per head (£)	GVA per head index (UK = 100)
Study area	31,849	25,788	101.7
Angus	1,969	16,844	66.4
City of Edinburgh	18,437	36,963	145.8
Dundee City	3,230	21,795	86.0
East Lothian	1,528	14,827	58.5
Fife	6,685	18,162	71.6
Scotland	127,260	23,685	93.4

15.6.7 Quality of Life

114. The Scottish Index of Multiple Deprivation (SIMD) ranks all local authorities' data zones by different domains, which include income, employment, health, education, housing, access to services, and crime.

115. Compared to Scotland, as a whole, Edinburgh has more areas among the most deprived, while for the Local Study Area as a whole, levels of deprivation are similar to those for Scotland as a whole.

116. All of the local authorities in the Local Study Area score relatively highly on income and most on the employment domain, while some score relatively low on housing and crime domains.

15.6.8 Key Supply Chain Sectors

117. The table below provides a more detailed breakdown of the current level of employment in the sectors (and sub-sectors) which would be more likely to benefit from construction, O&M and decommissioning of the proposed development. The main sector benefits can be summarised as follows:

- **Manufacturing and engineering sectors**: in particular, the manufacture of fabricated metal products (for example as part of the supply chain for the turbine towers and foundations), electric wires and cables, electric motors, generators (for example to supply components for substations) and turbines;
- **Construction sectors**: the more specialist construction sectors, and those relating to construction of floating structures, ships and boats are most likely to be affected by the development of the Project;
- **Land and marine-based transport sectors**: sea and coastal water transport as well as ancillary services will be key sectors along with other land-based forms of transport;
- **Accommodation and food services**: these sectors are likely to experience an increase in demand to cater for workers coming into the area from elsewhere, during the construction period in particular; and
- **Professional services**: a range of technical consultancy services will be required throughout the construction, O&M and decommissioning of the development (which includes remotely monitoring the Project once completed).

Table 15-22 Individuals in employment in sectors which would most likely benefit from the construction, O&M, and decommissioning of the Project (Source: ONS (2016), 'Business Register and Employment Survey'. Accessed July 2017).

Individuals in Employment			
	Scotland (000s)	Local Study Area (000s)	LQ Study area vs Scotland
Key manufacturing sectors listed below	10.3	3.0	1.2
259: Fabricated metal products	2.5	0.7	1.1
271: Motors, generators, transformers, etc.	1.4	0.1	0.2
273: Wiring and wiring devices	1.4	0.9	2.8
281: General purpose machinery	5.0	1.4	1.2
Key construction sectors listed below	19.0	3.0	0.7
301: Building of ships and boats	6.5	2.0	1.3
429: Other civil engineering projects	12.5	1.0	0.3
Key transport sectors listed below	38.9	6.2	0.7
494: Freight transport by road	17.5	2.1	0.5
502: Sea and coastal freight water transport	0.4	0.1	0.5
522: Support activities for transportation	21.0	4.0	0.8
Key professional services listed below	19.0	4.9	1.1
702: Management consultancy activities	5.0	1.0	0.8
711: Architectural and engineering consultancy	11.5	3.5	1.3
749: Other professional, scientific and technical	2.5	0.5	0.8
Other sectors listed below	101.2	25.3	1.1
55: Accommodation	89.0	23.5	1.1
56: Food and beverage service activities	0.2	0.1	2.6
351: Electric generation, transmission and distribution	12.0	1.6	0.6
Total	**188.4**	**42.3**	
Total excluding "other" sectors	**87.2**	**4.7**	

15.6.9Transport and Infrastructure

118. In total, there are six main ports within the Local Study Area, each of which are owned by Forth Ports, these are located in Leith, Dundee, Methil, Rosyth, Burntisland, and Kirkcaldy. There are also two commercial airports located in the Local Study Area: Edinburgh, and Dundee.

119. Three ports have been identified as potential construction port options for the Project (Department of Energy and Climate Change (DECC) 2015). Only one of these (the port of Dundee) sits within the Local Study Area, with Nigg Energy Park (owned by Global Energy Solutions) and ABLE Seaton Port (owned by Able Ports) making up the remaining two options. There are a number of O&M port options available and a tendering exercise will select the preferred port. Port of Dundee and Eyemouth Harbour have been assessed in the past, but new entrants are not precluded from assessment. Characteristics of each of these ports are outlined below:

- **Port of Dundee** – the port's portfolio already consists of energy sector work. Currently it provides services in inspection, repair and maintenance of jack-up and semi-submersible drilling rigs and support vessels for the North Sea oil and gas industry. Construction has begun on a £10 million re-development to create a new quayside for berthing and land capacity with industry-leading 'heavy lift' capabilities, coupled with a significant onshore operational area at the port. This is expected to be completed by the end of 2017, before commencement of Project works, if approved. In 2010, Scottish Enterprise identified the Port of Dundee as one of Scotland's top locations for renewable manufacturing (Scottish Enterprise & Highlands and Islands Enterprise, 2013). Furthermore, it is located in the Scottish Government's Low Carbon Renewables East Enterprise Area.
- **Nigg Energy Park** – is the Moray Firth's largest port facility. With over 900m of deep-water quayside, it is capable of hosting some of the largest vessels available, and with 700,000m^2 of laydown and storage, it is able to manage the erection, assembly and installation of wind turbines.
- **ABLE Seaton Port** – possesses one of the world's largest dry docks at 10 hectares. The infrastructure and planning consents are in place for offshore wind manufacturing activities and is suitable for a wide range of activities from blade manufacturing and testing to offshore wind turbine component pre-assembly.
- **Eyemouth Harbour** – is located near a number of offshore wind development sites. For the purposes of O&M, the port offers a wind range of facilities, including 24/7 access and unrestricted access to deep-water berths, alongside a host of support services, such as boat builders and marine engineers. If required there is also land to expand upon including 1 hectare of quayside and port land, and 8.5 hectares of other land near the main harbour building.

15.7 Realistic Worst Case Scenario

120. The worst case scenario for NnG is considered to be that with the worst effect on the receptor in question. In relation to socio-economic effects, the receptors are: *Direct and indirect employment creation in the construction, O&M and decommissioning supply chain* for both the Local and National (Scotland) Study Areas.

121. Three scenarios have been considered for potential socio-economic effects i.e. Low, Medium and High Impact Scenarios. The low scenario, whilst beneficial, has the least benefit to the above receptors and is therefore the worst case. However, it is not considered to be a realistic outcome of the Project. The Medium Scenario is considered to be a realistic worst case scenario and it is therefore the basis for the socio-economic impact assessment.

15.7.1 Embedded Mitigation

122. Unlike other topics within this EIA Report, expected consent conditions are not anticipated in relation to socio-economic effects and therefore these are not considered as embedded mitigation here. Embedded mitigation measures that have been identified and adopted into the Project design as the design envelope has evolved and that are relevant to socio-economics are set out below.

123. For the purposes of socio-economic assessment, as many of the receptors relate to positive impacts (such as employment and GVA creation), mitigation can be more usefully interpreted as enhancement of positive impacts.

124. NnGOWL has interacted with the supply chain in the Local Study Area. They have done this by:

- **Encouraging a competitive procurement process** - To ensure strong local supply is fully informed, NnGOWL has hosted numerous engagement events in partnership with local enterprise agencies.
- **Support new entrants -** NnGOWL have sought to engage many new entrants to the offshore wind farm sector. Nearly one in two contractors who were approached for wind turbine generation and balance of plant procurement have been newcomers.
- **Improve awareness –** NnGOWL have attempted to engage with local suppliers through a variety of events and partnerships:
- Since 2010, NnGOWL have undertaken an extensive programme of public exhibitions with attendance at 30 public community events;
- In collaboration with Scottish Enterprise, they have hosted three supply chain events with tier-one contractors in Dunbar, Fife, and Dundee. There are plans to re-run such events in the near future alongside diversification events for the local fisherman and ex-RAF. They have also conducted regional roadshow events to promote opportunities; and
- NnGOWL are engaged with the Offshore Renewables Catapult, Universities and Skills Development Scotland to explore greater opportunities to engage with the local supply chain.

15.8 Impact Assessment

15.8.1 Construction Phase Impacts

125. The impacts resulting from the construction of the Project have been assessed on socio-economic receptors identified within the local and Scotland study areas. A discussion of the likely significance of each effect resulting from each impact is presented below.

15.8.1.1 Direct and indirect construction related employment creation

126. The assessment of this receptor focuses on the potential impacts of the construction phase on employment in the construction supply chain in each study area.

15.8.1.1.1 Scotland Study Area

Sensitivity of Receptor

127. Job creation is a central strategic priority in national and local economic policies and strategies. It is a vital component in the government’s plan to create sustainable and equitable growth. As highlighted in the strategic policy review (Section 15.2.3), there is an emphasis on opportunity sectors, one of which is the renewable energy sector.

128. In light of the continued strategic importance attached to the creation of employment, this receptor is deemed to be of high value. The sensitivity of the receptor is therefore considered to be high.

Magnitude of Impact

129. Table 15-23 below sets out the predicted levels of direct and indirect employment that the Project would deliver across Scotland during the construction phase, based on the methodology and assumptions as set out in Section 15.5.

Table 15-23 Summary of predicted levels of employment during construction of the Project for the Scotland Study Area (Source: Socio-economic impact calculations by Regeneris Consulting, 2017. Please note, job figures have been rounded to the nearest 5 jobs. Totals might not add up due to rounding).

	Person years of employment			Average annual employment impact during construction period (FTEs)		
Impact type	**Low scenario**	**Medium scenario**	**High scenario**	**Low scenario**	**Medium scenario**	**High scenario**
Direct	1,005	3,000	5,360	335	1,000	1,785
Indirect	630	2,215	4,120	210	740	1,375
Total	**1,635**	**5,215**	**9,480**	**545**	**1,740**	**3,160**

130. At the Scotland-level, the potential employment impact, taking into account direct and indirect effects ranges from 1,635 person years of employment for the lowest impact scenario to 9,480 person years of employment for the highest impact scenario.

131. The average annual number of FTEs supported during the construction phase is a more useful figure to use to assess the magnitude of impacts on baseline conditions. The annual average can be readily compared to the current baseline level of employment in the Scotland study area. It should, however, be noted that while the average annual figures are helpful, the actual level of employment supported is likely to fluctuate across the construction activity required at any one time.

132. On average, during the construction period, it is estimated that the Project would support an average annual employment impact of between 545 FTEs per year under the lowest scenario to 3,160 FTEs under the highest impact scenario.

133. As outlined in the baseline section of this chapter, the direct employment effects can reasonably be expected to be concentrated in a relatively small number of employment sectors, namely:

- **Manufacturing and engineering sectors:** particularly the manufacture of fabricated metal products, electric motors, wiring, and general-purpose machinery;
- **Construction sectors:** particularly the building of ships and boats, and civil engineering projects;
- **Transport sectors:** particularly freight transport by road, sea and coastal freight, and support activities for transportation;
- **Professional services:** notably management consultancy activities, architectural and engineering consultancy, and other professional, scientific and technical sectors; and
- **Other sectors:** which include accommodation, food and beverage service activities, as well as electric generation, transmission and distribution.

134. As set out in the baseline section of this chapter, there are currently 188,400 individuals in employment within these sectors nationally. During the construction period, the maximum average annual direct employment impact in these sectors would be 1,785 (under the high impact scenario) which would represent 0.9% of the current baseline level of employment in these sectors nationally.

135. The indirect effects would be spread across a much wider set of sectors. Under the highest impact scenario, the indirect employment effects (1,375 FTEs per year on average) would represent less than 0.1% of national employment.

136. Given the small percentage changes that the direct and indirect effects would stimulate, even under the highest impact scenario, the construction of the Project is expected to result in little overall change in baseline conditions within the Scotland study area. The impact is predicted to be of a national spatial extent, medium term duration and temporary. The magnitude is assessed to be low for all scenarios.

Significance

137. With sensitivity assessed as high, but magnitude of impact as low, the effect will therefore be of moderate beneficial significance which is considered significant in EIA terms.

15.8.1.1.2 Local Study Area

Sensitivity of Receptor

138. Sub-regionally (i.e. local authority strategies within the Local Study Area), all emphasise the ambition for new jobs to be created in their own local authority boundaries. The socio-economic baseline shows in absolute terms, that there remains capacity in the labour market. Furthermore, the claimant rate in the study has been gradually increasing, since it reached its low of 1.9% towards the end of 2015.

139. In light of the strategic importance attached to the creation of employment in regional and local strategy, the construction employment receptor is deemed to be of high value. The sensitivity of the receptor is therefore considered high.

Magnitude of Impact

140. Table 15-24 below sets out the predicted levels of direct and indirect employment that the proposed development would deliver across the Local Study Area during the construction phase, based on the methodology and assumptions set out in Section 15.5.2.1.

Table 15-24 Summary of predicted levels of employment during construction of the Project at the Local Study Area level (Source: Socio-economic impact calculations by Regeneris Consulting, 2017. Please note, job figures have been rounded to the nearest 5 jobs. Totals might not add up due to rounding).

	Person years of employment			Average annual employment impact during construction period (FTEs)		
Impact type	Low scenario	Medium scenario	High scenario	Low scenario	Medium scenario	High scenario
Direct	255	1,230	2,895	85	410	965
Indirect	45	180	400	15	60	135
Total	**300**	**1,410**	**3,295**	**100**	**470**	**1,100**

141. Across the Local Study Area, the total potential employment impact, taking into account the direct and indirect effects, ranges from 300 person years under the lowest impact scenario to 3,295 person years under the highest impact scenario.

142. To assess the magnitude of the impact on baseline conditions for this receptor, the average annual number of FTEs supported during the construction phase is a more useful figure, as this can be readily compared to the current baseline level of employment in the study area. It should however be noted that, while the average annual figures are helpful, the actual level of employment support is likely to fluctuate across the construction period in accordance to the scheduling of the programme and the intensity of construction activity required at any one time.

143. During the construction period, the development would support an average annual direct and indirect employment of between 100 FTEs per year under the lowest impact scenario and 1,100 FTEs per year under the highest impact scenario.

144. As with the Scotland level impact assessment, we would expect the direct employment effects to be concentrated in the following sectors:

- Manufacturing and engineering sectors;
- Construction sectors;
- Transport sectors;
- Professional services; and
- Other sectors: such as the accommodation, food and beverage service activities; and electric generation, transmission and distribution.

145. The uplift on the baseline level of employment in these sectors will differ across the three scenarios (i.e., 85 FTEs under the low scenario, 410 FTEs under the medium scenario, and 965 FTEs under the high scenario). With approximately 42,300 individuals in employment in these sectors, this would represent an uplift on the current baseline of between 0.2% under the low impact scenario to 2.3% under the high impact scenario.

146. The indirect effects would be spread across a much wider set of sectors than the direct effects, so the most appropriate benchmark against which to measure the magnitude of impact is total employment across the whole economy in the Local Study Area. Under all scenarios assessed, the overall impact of employment generated during the construction period will be less than 0.03% of the total employment in the Local Study Area (i.e., 597,500 jobs in 2015).

147. For all scenarios, the combined direct and indirect effects on employment are expected to result in a small change in baseline conditions within the Local Study Area. The impact is predicted to be of local spatial extent, medium term duration and temporary (i.e., only throughout the expected 3-year construction period). In the context of the current level of employment in relevant sectors in the Local Study Area, the magnitude is considered low for all scenarios.

Significance

148. With sensitivity assessed as high, but magnitude of impact low, the effect will therefore be of moderate beneficial significance which is significant in EIA terms.

15.8.1.2 Direct and indirect construction related GVA creation

15.8.1.2.1 Scotland Study Area

Sensitivity of Receptor

149. Nationally, GVA is an important measure of the amount of wealth that economic activity is creating. The latest evidence available shows that Scotland-wide GVA for 2015 was around £127.3 billion.

150. In light of the strategic importance attached to the creation of wealth and economic growth as set out in the baseline section, the GVA receptor is deemed to be of high value. The sensitivity of the receptor is therefore considered high.

Magnitude of Impact

151. Table 15-25 below sets out the predicted levels of GVA impacts of construction activity on Scotland for the three impact scenarios during the construction phase of the Project, based on the methodology and assumptions set out in Section 15.5.

Table 15-25 Summary of construction impacts on GVA at the Scotland level (Source: Socio-economic impact calculations by Regeneris Consulting, 2017. Please note GVA figures have been rounded to the nearest £0.1m. Totals might not add up due to rounding).

	Low scenario (£ million)	Medium scenario (£ million)	High scenario (£ million)
Direct	£50.3	£197.0	£371.7
Indirect	£29.4	£132.3	£255.2
Total	**£79.7**	**£329.3**	**£626.9**

152. Construction activity on the Project is expected to deliver GVA impact of between £79.7 million under the low scenario and £626.9 million under the high scenario. The annual estimated GVA impact is a more useful means of assessing the magnitude of impact on baseline conditions, as this can be used to estimate the percentage uplift in annual GVA that the impact would represent. This is presented below in Table 15-26, along with the percentage uplift on national GVA that it would represent.

Table 15-26 Summary of construction impact on annual GVA at the Scotland level (Source: Socio-economic impact calculations by Regeneris Consulting, 2017.

	Low scenario	Medium scenario	High scenario
Estimated annual GVA impact (£ million)	£26.6	£109.8	£209.0
% of 2015 Scotland GVA (£127.3 billion)	0.02%	0.09%	0.16%

153. Under the high scenario, the GVA impact is expected to be around 0.16% of 2015 Scotland GVA baseline.

154. The impact is predicted to be of national spatial extent, medium term duration and temporary (i.e. through the construction period). The magnitude is therefore, considered to be negligible for all impact scenarios.

Significance

155. With sensitivity assessed as high, but magnitude of impact negligible, the effect will therefore be of minor beneficial significance which is not significant in EIA terms.

15.8.1.2.2 Local Study Area

Sensitivity of Receptor

156. At the Local Study Area level, economic growth is identified as a key ambition. In light of the strategic importance attached to the creation of economic growth and GVA, and the lagging performance on this indicator behind the national average, the GVA receptor is deemed to be of high value. The sensitivity of the receptor is therefore, considered to be high.

Magnitude of Impact

157. Table 15-27 below sets out the predicted levels of cumulative GVA impacts of construction activity on the Local Study Area for the three impact scenarios during the construction phase of the proposed development, based on the methodology and assumptions set out in Section 15.5.

Table 15-27 Summary of construction impacts on GVA at the Local Study Area level (Source: Socio-economic impact calculations by Regeneris Consulting, 2017. Please note GVA figures have been rounded to the nearest £0.1m. Totals might not add up due to rounding).

	Low scenario (£ million)	Medium scenario (£ million)	High scenario (£ million)
Direct	£16.2	£82.2	£178.9
Indirect	£2.3	£12.3	£26.9
Total	**£18.5**	**£94.5**	**£205.9**

158. Construction activity on the Project is expected to deliver a GVA impact in the Local Study Area of between £18.5 million under the low scenario and £205.9 million under the high scenario. The GVA impact data presented in the table below has been used to estimate annual average GVA impacts during the construction period as well as the uplift on the Local Study Area's GVA.

Table 15-28: Summary of construction impact on annual GVA at the Local Study Area level (Source: Socio-economic impact calculations by Regeneris Consulting, 2017.

	Low scenario	Medium scenario	High scenario
Estimated annual GVA impact (£ million)	£6.2	£31.5	£68.6
% of 2015 Local Study Area GVA (£31.8 billion)	0.02%	0.10%	0.22%

159. Even under the high scenario, the GVA impact is expected to be only around 0.22% of the 2015 GVA baseline for the Local Study Area.

160. The impact is predicted to be of local spatial extent, medium term duration and temporary (during the construction period). The magnitude is therefore considered negligible.

Significance

161. With sensitivity assessed as high, but magnitude of impact negligible, the effect will therefore be of minor beneficial significance which is not significant in EIA terms.

15.8.2 Operational Phase Impacts

15.8.2.1 Direct and indirect O&M related employment creation

15.8.2.1.1 Scotland Study Area

Sensitivity of Receptor

162. The evidence underpinning the assessment of the sensitivity of the receptor is as for the construction phase (see Section 15.8.1). The O&M employment receptor is deemed to be of high value, and as a result is considered high.

Magnitude of Impact

Table 15-29 Summary of predicted levels of Scotland-based employment during O&M phase of the Project (Source: Socio-economic impact calculations by Regeneris Consulting, 2017. Please note, job figures have been rounded to the nearest 5 jobs. Totals might not add up due to rounding).

	Person years of employment			Average annual employment impact during operational period (FTEs)		
Impact type	**Low scenario**	**Medium scenario**	**High scenario**	**Low scenario**	**Medium scenario**	**High scenario**
Direct	2,345	2,490	2,645	95	100	105
Indirect	1,565	2,130	2,735	65	85	110
Total	**3,910**	**4,620**	**5,380**	**155**	**185**	**215**

163. At the Scotland-level, the potential employment impact ranges from 155 FTE posts each year for the lowest impact scenario to 215 FTE posts each year for the highest impact scenario.

164. There are currently 12,000 jobs in Scotland in the electric power generation sector (see Table 15-22, SIC 351). The addition of 95 to 105 FTE posts across Scotland would have a small impact on the level of employment in this sector nationally (the percentage increase would be between 0.8% and 0.9%).

165. It can reasonably be expected that the indirect employment effects would be focussed on a smaller number of sectors than during the construction phase, as activities would be related primarily to (i) manufacture and installation of spare components, (ii) engineering activities associated with maintenance, and (iii) land and marine transport of components. The main sectors considered in this assessment have therefore been limited to the following:

- Relevant manufacturing and engineering sectors;
- Specialist construction sectors;
- Marine and land transport sectors; and
- Professional services.

166. Together these sectors support around 87,200 positions nationally (see Table 15-22). Under the highest impact scenario, the annual indirect employment impact of 110 FTE posts would represent around 0.1% of the employment in these sectors nationally, and therefore would have no discernible impact on overall levels of employment.

167. In light of this, the impact is predicted to be of a national spatial extent, long term duration and permanent. The magnitude on employment is therefore considered negligible.

Significance

168. With sensitivity assessed as high, but magnitude of impact negligible, the effect will therefore be of minor beneficial significance which is not significant in EIA terms.

15.8.2.1.2 Local Study Area

Sensitivity of Receptor

169. The evidence underpinning the assessment of the sensitivity of the receptor is the same as for the construction phase (see Section 15.8.1). The O&M employment receptor is deemed to be of high value, and as a result, the sensitivity of the receptor in the Local Study Area is considered high.

Magnitude of Impact

170. Table 15-30 below sets out the predicted levels of employment that the proposed development would deliver in the Local Study Area during the O&M phase. The total potential employment impact during the O&M phase of the Project is between 30 to 120 FTE posts each year.

Table 15-30 Summary of predicted levels of the Local Study Area based employment during O&M phase of the Project (Source: Socio-economic impact calculations by Regeneris Consulting, 2017. Please note, job figures have been rounded to the nearest 5 jobs. Totals might not add up due to rounding).

Impact type	Person years of employment			Average annual employment impact during operational period (FTEs)		
	Low scenario	Medium scenario	High scenario	Low scenario	Medium scenario	High scenario
Direct	595	2,315	2,460	25	95	100
Indirect	80	450	560	5	20	20
Total	**675**	**2,765**	**3,025**	**30**	**110**	**120**

171. As with the Scotland-level impact assessment, the direct employment impact would be focussed on the electric power generation sector, which supports around 1,600 jobs within the Local Study Area (see Table 15-22, SIC 351). Direct employment resulting from the operation and maintenance of the Project is expected to create 25 to 100 direct FTEs. This would add an additional 1.6% to 6.3% jobs to the sector.

172. Indirect employment would be focussed on the same sectors outlined under the assessment of the receptor for Scotland. Within the Local Study Area, these sectors support around 4,700 jobs (see Table 15-22). Under the high scenario, the maximum increase of 20 FTEs would represent an increase of 0.4% on the current baseline.

173. The employment generated by O&M activity within the local impact study area is expected to have a minor level of impact. The impact of O&M activity is predicted to be of local spatial extent, long-term in duration and permanent, and the magnitude of the impact is considered low.

Significance of effect

174. With sensitivity assessed as high and the magnitude of impact as low, the effect will therefore be of moderate beneficial significance which is significant in EIA terms.

15.8.2.2 Direct and indirect O&M related GVA creation

15.8.2.2.1 Scotland Study Area

Sensitivity of Receptor

175. The evidence underpinning the assessment of the sensitivity of the receptor is as for the construction phase (see Section 15.8.1). The O&M GVA receptor is deemed to be of high value. The sensitivity of the receptor is therefore considered high.

Magnitude of Impact

176. Table 15-31 sets out the predicted levels of annual GVA impacts of O&M activity on Scotland for the three scenarios assessed. Annually, O&M activity is predicted to support between £10.7 million GVA under the low scenario and £17.0 million GVA under the high scenario.

Table 15-31 Summary of predicted levels of Scotland-based GVA impact during O&M phase of the Project

	Annual GVA impact during O&M phase		
	Low scenario (£ million)	Medium scenario (£ million)	High scenario (£ million)
Direct	£5.2	£6.6	£8.1
Indirect	£5.5	£7.1	£8.9
Total	**£10.7**	**£13.7**	**£17.0**

177. The most recent estimate of the Scotland's GVA is £127.3 billion. This means that the annual GVA created across Scotland as a result of O&M activity even in the high scenario would be no more than 0.01%.

178. The impact is predicted to be of national spatial extent, long-term duration and permanent. The magnitude is therefore considered negligible for all impact scenarios.

Significance

179. With sensitivity assessed as high, but magnitude of impact negligible, the effect will therefore be of minor beneficial significance which is not significant in EIA terms.

15.8.2.2.2 Local Study Area

Sensitivity of Receptor

180. The evidence underpinning the assessment of the sensitivity of the receptor is as for the construction phase (see Section 15.8.1). The O&M GVA receptor is deemed to be of high value, and the sensitivity of the receptor is therefore considered high.

Magnitude

181. Table 15-32 below sets out the predicted levels of annual GVA impacts of O&M activity in the Local Study Area. Annually, O&M activity is predicted to generate between £1.6 million GVA under the low scenario and £8.9 million GVA under the high scenario.

Table 15-32 Summary of predicted levels of the Local Study Area-based GVA impact during O&M phase of the Project. (Please note GVA figures have been rounded to the nearest £0.1m. Totals might not add up due to rounding)

	Annual GVA impact during O&M phase		
	Low scenario (£ million)	Medium scenario (£ million)	High scenario (£ million)
Direct	£1.3	£5.9	£7.1
Indirect	£0.2	£1.6	£1.9
Total	**£1.6**	**£7.5**	**£8.9**

182. The most recent estimate for the Local Study Area's GVA is £31.8 billion. It is expected that even in the high scenario the annual GVA created across the Local Study Area as a result of O&M activity would deliver an additional 0.03% GVA.

183. The impact is predicted to be of local spatial extent, long term duration and permanent. The magnitude is therefore considered negligible.

Significance

184. With sensitivity assessed as high, but magnitude of impact negligible, the effect will therefore be of minor beneficial significance which is not significant in EIA terms.

15.8.3 Decommissioning Phase Impacts

185. The impacts of the decommissioning phase of the Project have been assessed on the socio-economics of the Study area and Scotland. There is considerable uncertainty with regards to the potential effects of the decommissioning process of the proposed development. This is because the approach to decommissioning the Project, the available technology, which could be used, and the associated costs are not yet known.

186. A description of the significance of impacts upon socio-economic receptors caused by each identified impact is given below.

187. Towards the end of the operational life of the Project, all decommissioning options will be considered. It may be deemed that removal of certain pieces of infrastructure may have a greater environmental impact than leaving in-situ. The potential decommissioning options will be presented to MS-LOT in a Decommissioning Programme for approval prior to construction. The Decommissioning Programme will then be reviewed and amended as required prior to the commencement of any decommissioning activities.

15.8.3.1 Direct and indirect decommissioning related employment creation

Sensitivity of receptor: Scotland study area

188. As for the construction and O&M phases, the sensitivity of the employment receptor is based on current policy and socio-economic conditions, and is considered high.

Magnitude of impact: Scotland study area

189. Given the unknown nature of the decommissioning phase and position of the Scotland sector at that point in time, it is not possible to estimate the employment impacts associated with the decommissioning phase.

190. However, it can be assumed that these will be of a similar nature but lower than the impacts relating to the construction phase.

191. On that basis, it is concluded that the magnitude of impact is expected to be negligible.

Significance of effect: Scotland study area

192. With sensitivity assessed as high, but magnitude of impact negligible, the effect will therefore be of minor beneficial significance which is not significant in EIA terms.

Sensitivity of receptor: Local Study Area

193. As for the construction sector, the employment receptor is deemed to be of high value and high vulnerability. The sensitivity of the receptor is therefore considered high.

Magnitude of impact: Local Study Area

194. As above, given the unknown nature of the decommissioning phase and position of the Local Study Area sector at that point in time, it is not possible to estimate the employment impacts associated with the decommissioning phase.

195. However, it can be assumed that these will be of a similar nature but lower than the impacts relating to the construction phase.

196. On that basis, we can conclude that the magnitude of impact is expected to be negligible.

Significance of effect: Local Study Area

197. With sensitivity assessed as high, but magnitude of impact negligible, the effect will therefore be of minor beneficial significance which is not significant in EIA terms.

15.8.3.2 Direct and indirect decommissioning-related GVA creation

Sensitivity of receptor: Scotland study area

198. As for the construction and O&M phases, the sensitivity of the GVA receptor, based on the current policy context, and socio-economic conditions, is considered high.

Magnitude of impact: Scotland study area

199. Given the unknown nature of the decommissioning phase and position of the Scotland sector at that point in time, it is not possible to estimate the employment impacts associated with the decommissioning phase.

200. However, it can be assumed that these will be of a similar nature but significantly lower than the impacts relating to the construction phase.

201. On that basis, we can conclude that the magnitude of impact is expected to be negligible.

Significance of effect: Scotland study area

202. With sensitivity assessed as high, but magnitude of impact negligible, the effect will therefore be of minor beneficial significance which is not significant in EIA terms.

Sensitivity of receptor: Local Study Area

203. As for the construction and O&M phases, the sensitivity of the GVA receptor, based on the current policy context and socio-economic conditions, is considered high.

Magnitude of impact: Local Study Area

204. Given the unknown nature of the decommissioning phase and position of the Local Study Area sector at that point in time, it is not possible to estimate the employment impacts associated with the decommissioning phase.

205. However, it can be assumed that these will be of a similar nature but significantly lower than the impacts relating to the construction phase.

206. On that basis, we can conclude that the magnitude of impact is expected to be negligible.

Significance of effect: Local Study Area

207. With sensitivity assessed as high, but magnitude of impact negligible, the effect will therefore be of minor beneficial significance which is not significant in EIA terms.

15.8.4 Cumulative Impacts

208. Cumulative effects refer to effects upon receptors arising from the Project when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals. In this context, the term 'projects' is considered to refer to any project with comparable effects and is not limited to offshore wind projects.

209. Project and activities considered within the cumulative impact assessment are set out in Table 15-33. There may be an element of uncertainty associated with the design envelope of proposed projects, therefore a judgement is made on the confidence associated with the latest available design envelope.

210. In assessing the cumulative impacts for the Project, two scenarios are considered to take into account the consented design envelopes of the Inch Cape Offshore Wind Farm and the Seagreen Phase 1 Wind Farm Project and forthcoming applications which were the subject of requests for scoping opinions in 2017. Scenario one incorporates the design envelopes for the proposed Inch Cape, Seagreen, and Moray West projects as detailed in the Scoping Reports submitted to MS-LOT (ICOL, 2017; Seagreen, 2017; and Moray, 2017). Scenario two incorporates the consented design envelopes as detailed in the respective project consents (The Scottish Government, 2014e, 2014f, and 2014g)

Table 15-33 Projects for cumulative assessment

Development Type	Project	Status	Data Confidence Assessment / Phase
Offshore Wind Farm	Inch Cape Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Inch Cape Offshore Wind Farm	Proposed	High – Scoping report publicly available.
Offshore Wind Farm	Moray Offshore East Development	Consented	High – Consented project details available.

Development Type	Project	Status	Data Confidence Assessment / Phase
Offshore Wind Farm	Moray West Offshore Wind Farm	Proposed	High – Scoping report publicly available.
Offshore Wind Farm	Seagreen Alpha Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Seagreen Bravo Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Seagreen Phase 1 Wind Farm	Proposed	High – Scoping report publicly available.

211. Under a cumulative impact assessment, the worst-case scenario is less relevant than for other chapters as all socio-economic impacts assessed will be positive, as detailed in Table 15-34.

Table 15-34 Cumulative worst-case design envelope scenarios

Impact	Worst Case Design Scenario	Justification
Scenario 1 – Development of Neart na Gaoithe and the proposed versions of Inch Cape, Seagreen Phase 1 Offshore Wind Farm Projects, and Moray West		
Direct and indirect employment creation in the supply chain (Local and Scotland study areas).	The worst case design scenario would involve low impact scenarios for the Project alongside similarly low impact scenarios for other wind farms (as outlined in Table 15-33).	The low impact scenario could be thought of as the worst case design scenario insofar as the Local Study Area and Scotland-based benefits are at their lowest.
Direct and indirect GVA creation in the supply chain (Local and Scotland study areas).		
Scenario 2 – Development of Neart na Gaoithe and the consented versions of Inch Cape, Seagreen Phase 1 Offshore Wind Farm Projects, and Moray East		
Direct and indirect employment creation in the supply chain (Local and Scotland study areas).	The worst case design scenario would involve low impact scenarios for the Project alongside similarly low impact scenarios for other wind farms (as outlined in Table 15-33).	The low impact scenario could be thought of as the worst case design scenario insofar as the Local Study Area and Scotland-based benefits are at their lowest.
Direct and indirect GVA creation in the supply chain (Local and Scotland study areas).		

212. Although the precise size and spend relating to proposed offshore wind farms incorporated in the cumulative assessment is not fully known, it is assumed for the purposes of this assessment that under scenario one, the size and spend relating to proposed offshore wind projects may be slightly smaller than under scenario two. This is based on the evidence available, as follows.

213. The originally consented project (relating to Scenario 2) for Inch Cape Offshore Wind Farm was for 784 MW and up to 110 turbines whilst the current application (relating to Scenario 1) is for 784 MW and up to 72 turbines (The Scottish Government, 2014a & Inch Cape Offshore Limited, 2017).

214. Similarly, whilst Seagreen Alpha and Bravo were originally consented (relating to Scenario 2) for 1,050 MW and up to 150 turbines the current application (relating to Scenario 1) is for up to 120 turbines with a maximum capacity of 15 MW per turbine (The Scottish Government, 2014b & Seagreen Wind Energy, 2017). With fewer proposed turbines for both developments, in scenario 1 than 2, it is expected that the capital costs would be lower.

215. Information on jobs and GVA generated by the respective proposed and consented wind farms listed in Table 15-34, are not in the public domain and therefore the impacts can only be assessed qualitatively below. As it is not possible to assess these impacts quantitatively, the assessment below considers both scenarios together.

15.8.4.1 Direct and indirect employment and GVA creation in the supply chain

216. For either scenario, it is not possible to confidently predict the level of cumulative impact on employment within the supply chain. This depends on several factors, which are, at this time, unknown, including the overall costings and geographical sourcing of goods and services for the construction and O&M of other wind farms. As this is not yet known, it is impossible to provide a quantitative assessment of the potential cumulative effects.

217. Though the scale of local expenditure associated with the developments in Table 15-34 is unknown, as noted in section 15.5.2.1, Scotland supply chain for offshore wind farm components is significant. With the exception of the nacelle and rotor for the wind turbine, there are suppliers within the local area and / or Scotland, which have the capabilities to supply the main tier-one contracts. As such, it is reasonable to assume that some degree of local and national sourcing would occur during the construction, O&M and decommissioning phases in either scenario. The construction of multiple windfarms alongside the Project would also increase the probability of local firms securing contracts.

218. This would lead to a further increase in employment and GVA creation in the local and Scotland study areas, thereby generating additional positive socio-economic impacts.

15.8.5 Inter-relationships

219. Inter-relationships are considered to be the impacts and associated effects of different aspects of the Project on the same receptor. These are considered to be the following:

15.8.5.1 Project Lifetime Effects

220. An assessment has been undertaken of the scope for effects that occur throughout more than one phase of the project (construction, O&M and decommissioning) to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three key project stages.

221. Table 15-35 shows the total GVA impacts across the development, construction and O&M phases of the Project, drawing on the analysis from Section 15.8. This shows a cumulative GVA impact across these phases of between £58m and £430m in the Local Study Area, and between £347m and £1.05bn in the Scotland study area.

Table 15-35 Summary of total GVA impact resulting from the Project (Source: Socio-economic impact calculations by Regeneris Consulting, 2017) (Please note GVA figures have been rounded to the nearest £0.1m. Totals might not add up due to rounding)

	Total GVA (£m)		
Local Impact Study	**Low**	**Medium**	**High**
Direct	£49.4	£229.9	£355.3
Indirect	£8.3	£51.4	£74.2
Total	£57.6	£281.4	£429.5
Scotland	Low	Medium	High
Direct	£179.9	£361.2	£573.9
Indirect	£167.3	£310.7	£477.2
Total	£347.2	£671.8	£1051.0

15.8.5.2 Onshore Transmission Works (OnTW) Effects

222. This chapter considered the offshore activities of the Project, whilst the onshore activities had already been assessed in the EIA which accompanied the planning application for the OnTW (NnGOWL, 2012). The combined effects on employment and GVA will be larger than either application in isolation.

223. Within the OnTW planning application, the socio-economic chapter assumes employment benefits are to be predominantly realised within the study area, East Lothian district. Whilst the wider supply chain benefits may be generated in Edinburgh, Fife, Angus, and Dundee and the rest of Scotland. This chapter's Local Study Area, includes East Lothian along with districts outlined in Section 15.3, but assumes the accruement of benefits will be dependent on the level of local area supply chain sourcing.

224. The socio-economic analysis for the OnTW covers employment effects resulting from the construction and operation of the OnTW, as shown in Table 15-36. These figures include induced impacts, which have been excluded from the employment figures set out in this chapter at Section 15.8, so are not directly comparable. However, these figures demonstrate the additional employment benefits arising from the OnTW alongside the offshore works described in this chapter.

Table 15-36 Employment Effects from the Onshore Transmission Works

	Study Area			Scotland		
	Direct	Indirect + Induced	Total	Direct	Indirect + Induced	Total
Construction/Installation	59	40	99	108	99	207
Operation	1	4	5	N/A	N/A	N/A

225. There are not anticipated to be any significant inter-relationships with other receptors assessed under other chapters.

15.9 Mitigation and Monitoring

226. The effects, both in isolation and cumulatively, on socio-economic receptors as a result of the construction, operation and decommissioning of the Project are predicted to be of beneficial moderate and minor significance. None of the impacts on the receptors are adverse. Based on the predicted effects it is concluded that no specific mitigation is required beyond the embedded mitigation set out in Section 15.7.1.

15.10 Summary of Residual Effects

227. This chapter has assessed the potential effects on socio-economics of the construction, operation and decommissioning of the Project, both in isolation and cumulatively. Table 15-37 summarises the impact determinations discussed in this chapter and presents the post-mitigation residual significance.

Table 15-37 Summary of residual impacts of the Project

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Construction			
Impact of construction activity on direct and indirect employment creation in the construction supply chain	Scotland: **moderate positive** Local Study Area: **moderate positive**	No additional mitigation required.	Scotland: **moderate positive** Local Study Area: **moderate positive**
Impact of construction activity on direct and indirect GVA creation in the construction supply chain	Scotland: **minor positive** Local Study Area: **minor positive**	No additional mitigation required.	Scotland: **minor positive** Local Study Area: **minor positive**
Operation			
Impact of operation activity on direct and indirect employment creation in the construction supply chain	Scotland: **minor positive** Local Study Area: **moderate positive**	No additional mitigation required.	Scotland: **minor positive** Local Study Area: **moderate positive**
Impact of operation activity on direct and indirect GVA creation in the construction supply chain	Scotland: **minor positive** Local Study Area: **minor positive**	No additional mitigation required.	Scotland: **minor positive** Local Study Area: **minor positive**
Decommissioning			
Impact of decommissioning activity on direct and indirect employment creation in the construction supply chain	Scotland: **minor positive** Local Study Area: **minor positive**	No additional mitigation required.	Scotland: **minor positive** Local Study Area: **minor positive**
Impact of decommissioning activity on direct and indirect GVA creation in the construction supply chain	Scotland: **minor positive** Local Study Area: **minor positive**	No additional mitigation required.	Scotland: **minor positive** Local Study Area: **minor positive**
Cumulative Effects			
Impact of cumulative activity on direct and indirect employment and GVA creation in the construction supply chain	Not possible to quantify, however would be positive.	No additional mitigation required.	Not possible to quantify, however would be positive.

Potential Impact	Significance of Effect	Mitigation Measures	Residual Significance of Effect
Impact of cumulative activity on direct and indirect employment and GVA creation in the operation and maintenance supply chain	Not possible to quantify, however would be positive.	No additional mitigation required.	Not possible to quantify, however would be positive.

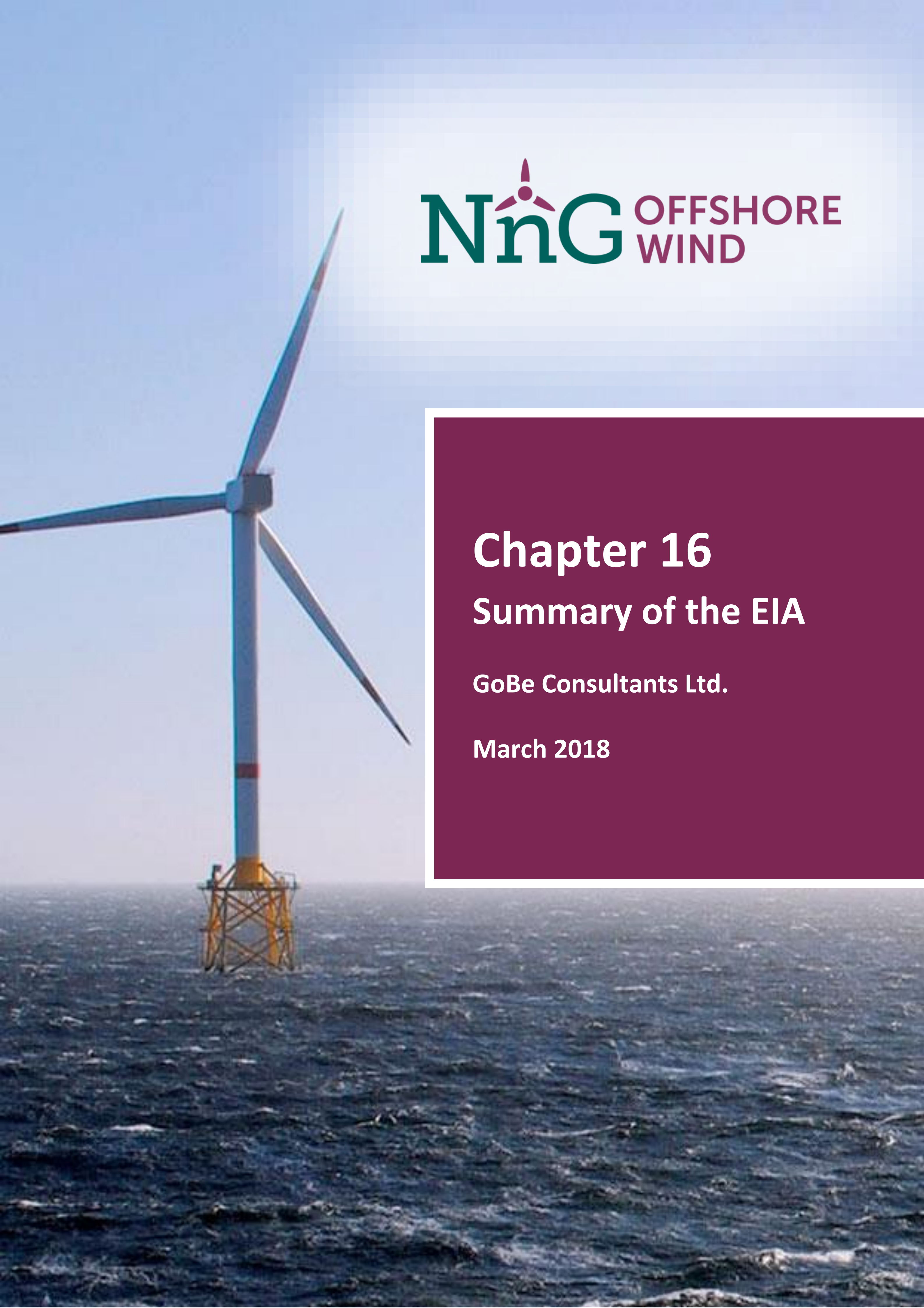
15.11 References

- Angus Council (2016), *Angus Local Development Plan.* Available from: http://www.angus.gov.uk/sites/angus-cms/files/Angus%20local%20development%20plan%20adopted%20September%202016.pdf [Accessed 25th July 2017]
- Angus Council (2013), *Angus Economic Development Strategy.* Available from: http://www.angus.gov.uk/sites/angus-cms/files/Angus_Economic_Development_Strategy_2013_2020.pdf [Accessed 25th July 2017]
- The Crown Estate (2012), *A guide to an Offshore Wind Farm.* Available from: https://www.thecrownestate.co.uk/media/5408/ei-km-in-sc-supply-012010-a-guide-to-an-offshore-wind-farm.pdf [Accessed 26th July 2017]
- Department of Energy & Climate Change (2015), *Neart na Gaoithe offshore wind farm supply chain plan*. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/429410/UK02-1701-005-MRP-SUPPLY_CHAIN_PLAN-RPT-A2_-_final_redaction_applied.pdf [Accessed 19th July 2017]
- Dundee Partnership (2013), *Economic Strategy and Action Plan.* Available from: http://www.dundeepartnership.co.uk/sites/default/files/Dundee%20Partnership%20Economic%20Strategy%20&%20Action%20Plan%20Final.pdf [Accessed 25th July 2017]
- East Lothian Local Plan (East Lothian Council, 2008)
- East Lothian Local Development Plan 2016
- Edinburgh Council (2016), *Edinburgh Local Development Plan.* Available from: http://www.edinburgh.gov.uk/downloads/file/9065/edinburgh_local_development_plan [Accessed 25th July 2017]
- Edinburgh Council (2015), *Sustainable Energy Action Plan.* Available from: http://www.edinburgh.gov.uk/info/20220/economic_development/544/sustainable_economy/2 [Accessed 25th July 2017]
- Edinburgh Council (2012), *A strategy for jobs.* Available from: http://www.edinburgh.gov.uk/info/20220/economic_development/385/a_strategy_for_jobs [Accessed 25th July 2017]
- Fife Council (2017), *FIFEplan*. Available from: http://lpconsult.fife.gov.uk/portal/fife_ldp/fifeplan_-_adopted_plan_13/adopted_fifeplan?pointId=4395822 [Accessed 15th December 2017]
- Fife Council *et al* (2017b), *Fife's Economic Strategy 2017-2027.* Available from: http://wordpress.fifedirect.org.uk/fifeeconomypartnership/wp-content/uploads/sites/10/2016/10/Fifes-Economic-Strategy-Final.pdf [Accessed 26th July 2017]
- Fife Economic Strategy (Fife et al, 2017)
- HM Treasury (2013), *The Green Book.* Available from: https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent [Accessed 26th July 2017]
- Inch Cape Offshore Limited (2017), *Offshore Scoping Report 2017.* Available from: http://www.gov.scot/Resource/0051/00517517.pdf [Accessed 22nd November 2017]
- Legislation.gov.uk. (2009), *Climate Change (Scotland) Act 2009*. Available from: http://www.legislation.gov.uk/asp/2009/12/pdfs/asp_20090012_en.pdf [Accessed 24th July 2017]
- Marine Management Organisation (2011), *Maximising the socio-economic benefits of marine planning for English coastal communities.* Available from: https://www.gov.uk/government/publications/marine-planning-socio-economic-study [Accessed 27th July 2017]

- Moray Offshore Windfarm Limited (2017), *Scoping Report*. Available from: http://www.gov.scot/Resource/0052/00520771.pdf [Accessed 29th November 2017]
- Offshore Wind Industry Group (2013), *Scotland's Offshore Wind Route Map.* Available from: http://www.gov.scot/Publications/2013/01/5856/0 [Accessed 24th July 2017]
- ONS (2017), *Low carbon and renewable energy economy indirect estimates dataset*. Available from: https://www.ons.gov.uk/economy/environmentalaccounts/datasets/lowcarbonandrenewableenergyeconomyindirectestimatesdataset [Accessed 15th December 2017]
- ONS (Jun 2013 – Jun 2017), 'Claimant count by sex and age'. Accessed July 2017
- ONS (2016), 'Business Register and Employment Survey'. Accessed July 2017
- ONS (2016), 'Business demography'. Accessed July 2017
- ONS, 2017, *Regional gross value added (income approach) at current basic prices.* Accessed July 2017
- ONS (2016), '*Mid-Year Population Estimates'.* Accessed July 2017
- ONS (Apr 2016 -Mar 2017), '*Annual Population Survey*'. Accessed July 2017
- ONS (2017), 'Annual Survey of Hours and Earnings, Workplace and Residence Based'. Accessed July 2017
- ONS (2016), 'Regional GVA (income approach) at current basic prices'. Accessed July 2017
- NnGOWL (2012), *Socioeconomic Effects.* Available from: http://nngoffshorewind.com/files/onshore-environmental-statement/Chapter-17---Socioeconomic-Effects.pdf [Accessed 22nd November 2017]
- Scottish Enterprise (2016), *Oil and Gas 'Seize the Opportunity' Guides.* Available from: www.nsri.co.uk/uploads/Oil-and-gas-diversification-guide-offshore-wind.pdf [Accessed 24th July 2017]
- Scottish Enterprise (2015), *2015 – 2018 Business Plan Building Scotland's International Competitiveness.* Available from: https://www.scottish-enterprise.com/~/media/se_2013/corporate%20site/documents/scottish%20enterprise%20business%20plan%202017-18.pdf?la=en [Accessed 24th July 2017]
- Scottish Enterprise & Highlands and Islands Enterprise (2013a), *National Renewables Infrastructure Plan – Stage 1.* Available from: https://www.scottish-enterprise.com/knowledge-hub/articles/guide/national-renewables-infrastructure-plan-stage-1 [Accessed 19th July 2017]
- Scottish Enterprise & Highlands and Islands Enterprise (2013b), *National Renewables Infrastructure Plan – Stage 2.* Available from: https://www.scottish-enterprise.com/knowledge-hub/articles/guide/national-renewables-infrastructure-plan-stage-2 [Accessed 26th July 2017]
- Seagreen Wind Energy (2017), *Seagreen Phase 1 Scoping Report Round 3: Firth of Forth*. Available from: http://www.gov.scot/Resource/0046/00460524.pdf [Accessed 26th September 2017]
- Sea Energy Renewables (2010), Inch Cape Offshore Wind Farm Environmental Impact Assessment Scoping Report. Available from: http://www.gov.scot/Resource/0046/00460548.pdf [Accessed 26th September 2017]
- Skills Development Scotland (2011), *Skills Investment Plan For Scotland's energy sector (2nd Edition).* Available from: http://www.skillsdevelopmentscotland.co.uk/media/35691/sds_energy_sip_digital.pdf [Accessed 24th July 2017]
- Strategic Development Planning Authority for Edinburgh and South East Scotland (2013), *Strategic Development Plan June 2013.* Available from: http://www.sesplan.gov.uk/assets/SESplan%20Strategic%20Development%20Plan%20Approved%2027%20June%202013.pdf [Accessed 15th December 2017]

- Strategic Development Planning Authority for Dundee, Angus, Perth and North Fife (2017), *TAYplan Strategic Development Plan.* Available from: http://www.tayplan-sdpa.gov.uk/system/files_force/publications/Approved%20Plan2017_FINAL_Oct2017WebVersion_V4%20KK.pdf?download=1 [Accessed 15th December 2017]
- The Scottish Government (2017), *Scottish Energy Strategy: The future of energy in Scotland.* Available from: http://www.gov.scot/Publications/2017/01/3414/0 [Accessed 24th July 2017]
- The Scottish Government (2015), *2020 Routemap for Renewable Energy in Scotland – Update.* Available from: http://www.gov.scot/Resource/0048/00485407.pdf [Accessed 22nd November 2017]
- The Scottish Government (2014a), *Marine Works (Environmental Impact Assessment) Regulations 2007 (Regulation 22) Environmental Impact Assessment Consent Decision – Inch Cape Offshore Wind Farm*. Available from: http://www.gov.scot/Resource/0046/00460544.pdf [Accessed 26th September 2017]
- The Scottish Government (2014b), *Marine Works (Environmental Impact Assessment) Regulations 2007 (Regulation 22) Environmental Impact Assessment Consent Decision – Seagreen Alpha Offshore Wind Farm, Seagreen Bravo Offshore Wind Farm and the transmission Asset Project*. Available from: http://www.gov.scot/Resource/0046/00460526.pdf [Accessed 26th September 2017]
- The Scottish Government (2014c), *National Planning Framework 3.* Available from: http://www.gov.scot/Publications/2014/06/3539/0 [Accessed 24th July 2017]
- The Scottish Government (2014d), *Scottish Planning Policy.* Available from: http://www.gov.scot/Resource/0045/00453827.pdf [Accessed 24th July 2017]
- The Scottish Government (2014e), *Inch Cape Offshore Windfarm Environmental Impact Assessment Consent Decision.* Available from: http://www.gov.scot/Resource/0046/00460544.pdf [Accessed 29th November 2017]
- The Scottish Government (2014f*), Seagreen Alpha Offshore Wind Farm, Seagreen Bravo Offshore Wind Farm and the transmission Asset Project Environmental Impact Assessment Consent Decision.* Available from: http://www.gov.scot/Resource/0046/00460526.pdf [Accessed 29th November 2017]
- The Scottish Government (2014g*), Telford / Stevenson / MacColl Offshore Winfarm Environmental Impact Assessment Consent Decision.* Available from: http://www.gov.scot/Topics/marine/Licensing/marine/scoping/Moray3 Accessed 29th November 2017]
- The Scottish Government (2013), *Electricity Generation Policy Statement.* Available from: http://www.gov.scot/Publications/2013/06/5757/0 [Accessed 24th July 2017]
- The Scottish Government (2011a), *2020 Routemap for Renewable Energy in Scotland.* Available from: http://www.gov.scot/Publications/2011/08/04110353/0 [Accessed 24th July 2017]
- The Scottish Government (2011b), *Low Carbon Scotland: Meeting the Emissions Reduction Targets 2010-2020.* Available from: http://www.gov.scot/Resource/Doc/346760/0115345.pdf [Accessed 24th July 2017]
- The Scottish Government (2010a), *Low Carbon Economic Strategy.* Available from: http://www.gov.scot/resource/doc/331364/0107855.pdf [Accessed 24th July 2017]
- The Scottish Government (2010b), *National Renewables Infrastructure Plan 1 and 2.* Available from: http://www.hie.co.uk/growth-sectors/energy/n-rip.html [Accessed 25th July 2017]
- University of Glasgow (2012), *East Lothian Economic Development Strategy 2012-2022.* Available from: http://www.eastlothian.gov.uk/downloads/file/5873/east_lothian_economic_development_strategy [Accessed 26th July 2017]

- University of Strathclyde Fraser of Allander Institute (2017), *Economic Impact of the proposed Neart na Gaoithe offshore windfarm.* Available from: https://www.sbs.strath.ac.uk/economics/fraser/201708/NNG-Impact-Report.pdf [Accessed 29th November 2017]



NnG OFFSHORE WIND

Chapter 16

Summary of the EIA

GoBe Consultants Ltd.

March 2018

Table of Contents

Table of Tables

16 Summary of the EIA

16.1 Introduction

1. This chapter of the EIA Report presents a tabulated summary of the outcomes of the technical assessments that are presented within Chapters 7 to 15 (Table 16-1). Each potential impact source, pathway and receptor is described, along with the findings of the assessment in terms of the significance of the effect, any mitigation requirements and the residual effect once the mitigation is implemented. The cumulative significance is also summarised.
2. With the application of identified mitigation measures to the potential significant effects that have been identified, the majority of the effects will be reduced to a level not significant level in EIA terms. However, some significant residual effects do remain for seascape, landscape and visual impact, as well as cumulative impacts relating to shipping and navigation and cultural heritage.
3. The significant effects relating to seascape, landscape and visual will be sought to be reduced during the post-consent design development stage, through consideration of appropriate final layout and siting design.
4. With regards to shipping and navigation, there are significant cumulative residual impacts relating to collision and allision risks for all vessel types. NnGOWL will engage with MCA and NLB to explore further mitigation, where required, to manage navigational risk.
5. For cultural heritage, a residual significant cumulative impact remains on the setting of the Isle of May Priory Scheduled Monument. As per effects on seascape, landscape and visual, a reduction in this effect will be sought during the post-consent design development stage, through consideration of appropriate final layout and siting design.

Table 16-1: Summary of the potential impacts and likely significant effects as detailed within each technical assessment.

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
Fish and Shellfish					
Construction					
Disturbance or injury as a result of particle motion arising from pile driving	Group 1,2,3 and 4 fish species	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	All shellfish species	Minor, adverse (Not significant	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
Disturbance from noise and particle motion arising from the HDD pipe site works	All fish and shellfish	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
Operation					
Disturbance resulting from particle motion arising from turbine operation	All fish and shellfish	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
Marine Mammals					
Construction					
Pile driving noise	Harbour porpoise	Minor, adverse (Not significant)	Use of MMOs, PAM systems, ADDs and soft-start procedures will be considered and agreed with MS-LOT, to further mitigate any risk of residual effect.	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	White-beaked dolphin	Negligible, adverse (Not significant)		Negligible, adverse (Not significant)	Minor, adverse (Not significant)
	Bottle nose dolphin	Minor, adverse (Not significant)		Minor, adverse (Not significant)	Major, adverse (Not significant)

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
	Minke whale	Minor, adverse (Not significant)		Minor, adverse (Not significant)	Moderate, adverse (Not significant)
	Grey seal	Negligible, adverse (Not significant)		Negligible, adverse (Not significant)	Major, adverse (Not significant)
	Harbour seal	Minor, adverse (Not significant)		Minor, adverse (Not significant)	Minor, adverse (Not significant)
Drilling noise	All receptors	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Negligible, adverse (Not significant)
Noise from pre-construction geophysical survey work	All receptors	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Not considered cumulatively.
Disturbance from noise and particle motion from the HDD site pipe works	All receptors	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Not considered cumulatively.
Operation					
Aircraft and helicopter disturbance	All receptors	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Not considered cumulatively.
Ornithology					
Construction (and decommissioning)					
Impacts of installation of Export cables	All receptors	Minor, adverse	Embedded mitigation	Minor, adverse	Not considered cumulatively
Direct impacts of construction activities	All receptors	Negligible	Embedded mitigation	Negligible	Not considered cumulatively

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
Indirect impacts of construction activities	All receptors	Minor, adverse	Embedded mitigation	Minor, adverse	Not considered cumulatively
Operation					
Displacement and barrier impacts	Puffin All other species considered:	Minor, adverse Negligible, adverse	Embedded mitigation	Minor, adverse Negligible, adverse	Minor, adverse Negligible, adverse
Collision impacts	Gannet Kittiwake All other species considered:	Minor, adverse Minor, adverse Negligible, adverse	Embedded mitigation, Collision reduction technologies will be explored post-consent in consultation with FTRAG,	Minor, adverse Minor, adverse Negligible, adverse	**Scenario 1** (Project, in combination with Inch Cape and Seagreen 2017) – Gannet and Kittiwake: Minor, adverse All other species considered: negligible, adverse. **Scenario 2** (Project, in combination with the Inch Cape and Seagreen 2014) – Moderate effects predicted for kittiwake collisions in the non-breeding season, and by association, throughout the year[1]. Gannet: Minor, adverse All other species considered: negligible, adverse.

[1] It is considered highly unlikely that Inch Cape and Seagreen A & B will be built to the maximum extent of their consented envelopes, therefore the outcome of this assessment is considered to be highly precautionary and unrealistic.

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
Commercial Fisheries					
Construction					
Wind Farm Area construction activities and physical presence of constructed Offshore Wind Farm leading to reduction in access to, or exclusion from established fishing grounds.	Potters	Moderate, adverse (Significant)	With respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.	Minor, adverse (Not significant)	Initially moderate, adverse (Significant) Following mitigation: minor, adverse (not significant)
	Demersal trawl	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Initially moderate, adverse (Significant) Following mitigation: minor, adverse (not significant)
	Scallop dredge	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	All others	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Minor, adverse (Not significant)
Offshore Export Cable construction activities leading to reduction in access to, or exclusion from, established fishing grounds.	Potters & other dredge	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Initially moderate, adverse (Significant) Following mitigation: minor, adverse (not significant)
	Demersal trawl	Moderate, adverse (Significant)	With respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW	Minor, adverse (Not significant)	Minor, adverse (Not significant)

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
			guidance documents (2014 and 2015), will be followed wherever possible.		
	Scallop dredge	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Negligible to Minor, adverse (Not significant)
Displacement from Neart na Gaoithe Wind Farm Area leading to gear conflict and increased fishing pressure on adjacent grounds.	Potters and demersal trawl	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Initially moderate, adverse (Significant) Following mitigation: minor, adverse (not significant)
	All others	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Minor, adverse (Not significant)
Displacement from the Offshore Export Cable Corridor leading to gear conflict and increased fishing pressure on adjacent grounds.	Potters	Moderate, adverse (Significant)	With respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.	Minor, adverse (Not significant)	Initially moderate, adverse (Significant) Following mitigation: minor, adverse (not significant)
	Demersal trawl	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Initially moderate, adverse (Significant) Following mitigation: minor, adverse (not significant)
	All others	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Minor adverse

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
Wind Farm Area and Offshore Export Cable construction activities leading to displacement or disruption of commercially important fish and shellfish resources.	Potters and demersal trawl	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Not considered cumulatively as impacts likely to be highly localised and temporary as per Chapter 7: Fish and Shellfish Ecology.
	All others	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Not considered cumulatively as impacts likely to be highly localised and temporary as per Chapter 7: Fish and Shellfish Ecology.
Wind Farm Area and Offshore Export Cable construction activities leading to additional steaming to alternative fishing grounds for vessels that would otherwise be fishing within the Wind Farm Area and Offshore Export Cable Corridor.	All receptors	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Minor, adverse (Not significant)
Increased vessel traffic within fishing grounds as a result of changes to shipping routes and construction vessel traffic from Wind Farm Area and Offshore Export Cable Corridor leading to	Potters	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	All other gear	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Negligible, adverse (Not significant)

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
interference with fishing activity.					
Operation and Maintenance (and Decommissioning)					
Physical presence of Wind Farm Area leading to reduction in access to, or exclusion from established fishing grounds.	Potters	Moderate, adverse (Significant)	With respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	Demersal trawl & scallop dredge	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor or negligible, adverse (Not significant)
	All others	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Minor or negligible, adverse (Not significant)
Physical presence of Offshore Export Cable leading to reduction in access to, or exclusion from established fishing grounds.	Demersal trawl	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	All others	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Minor or negligible, adverse (Not significant)
Displacement from Neart na Gaoithe Wind Farm Area leading to gear conflict and increased fishing pressure on adjacent grounds.	Potters and demersal trawl	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	All others	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Minor or negligible, adverse (Not significant)
Displacement from the Offshore Export Cable Corridor leading	All receptors	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Negligible, adverse (Not significant)

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
to gear conflict and increased fishing pressure on adjacent grounds.					
Physical presence of Wind Farm Area leading to gear snagging.	All receptors	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Not considered cumulatively
Physical presence of the Offshore Export Cable leading to gear snagging	All receptors	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Not considered cumulatively
Physical presence of Wind Farm Area and Offshore Export Cable leading to additional steaming to alternative fishing grounds for vessels that would otherwise be fishing within these areas	All receptors	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Negligible, adverse (Not significant)
Increased vessel traffic within fishing grounds as a result of changes to shipping routes and maintenance vessel traffic from Wind Farm Area and Offshore Export Cable leading to	All receptors	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Negligible, adverse (Not significant)

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
interference with fishing activity.					
Shipping and Navigation					
Construction					
All impacts relevant to the construction phase have been scoped out of this EIA Report during the Scoping stage					
Operation					
Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased collision risk (vessel-to-vessel)	Commercial vessels Fishing vessels Recreational vessels	Minor, adverse (Not significant)	To be considered in consultation with MCA and NLB. May include additional aids to navigation to assist with navigation and additional means of communication to assist third parties.	Minor, adverse (Not significant)	Moderate, adverse (Significant)
Physical presence of Offshore Wind Farm structures leading to a loss of navigable sea room and deviations around structures resulting in an increased allision risk (vessel-to-structure)	Commercial vessels Fishing vessels Recreational vessels	Minor, adverse (Not significant)	To be considered in consultation with MCA and NLB. May include additional aids to navigation to assist with navigation and additional means of communication to assist third parties.	Minor, adverse (Not significant)	Moderate, adverse (Significant)

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
Military and Civil Aviation					
Operation					
Wind turbines causing permanent interference as a result of reflected turbine signals	Leuchars PSR, Leuchars PAR, RRH Brizlee Wood and RRH Buchan ADRs	Major, adverse (Significant)	Regulator approved TMZ and associated radar RAG blanking for the Leuchars PSR RDDS until an enduring mitigation solution is established Removal of wind turbine infrastructure including overlap from rotation of turbine blades from the Leuchars PAR Safeguarded Area NAIZ (subject to stakeholder approval) for the Brizlee Wood and Buchan ADR systems. If this mitigation solution is not suitable NnGOWL will consult with MoD regarding other technical mitigation solutions prior to construction. .	Minor, adverse (Not significant)	Initially major, adverse (Significant)[2] Following mitigation: minor, adverse (not significant)
Effects on Activities carried out in military PEXA	All receptors	Major (significant)	Removal of wind turbine induced clutter through NAIZ mitigation on the ADRs. If this mitigation solution is not applicable a technical mitigation	Minor (not significant)	Not considered cumulatively

[2] The cumulative assessment relates to Leuchars PSR, Brizlee Wood ADR and RRH Buchan ADR only. Effects on Leuchars PAR were not considered cumulatively.

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
			solution will be agreed with the MOD before construction.		
Use of helicopters for O&M of the Wind Farm Area	All receptors	Minor (not significant)	N/A	Minor (not significant)	Not considered cumulatively
Archaeology and Cultural Heritage					
Construction					
All potential impacts during construction have been scoped out of the EIA Report during the Scoping stage.					
Operation					
Presence Offshore Wind Farm, Met Masts and OSP(s) on the setting of onshore cultural heritage and archaeology receptors	Tentsmuir coastal defences	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	Crail Airfield	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	Crail Airfield pillbox	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	St Andrews Castle	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	St Andrews Cathedral	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	Isle of May Old Lighthouse	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	Isle of May Priory	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Moderate, adverse (Significant)

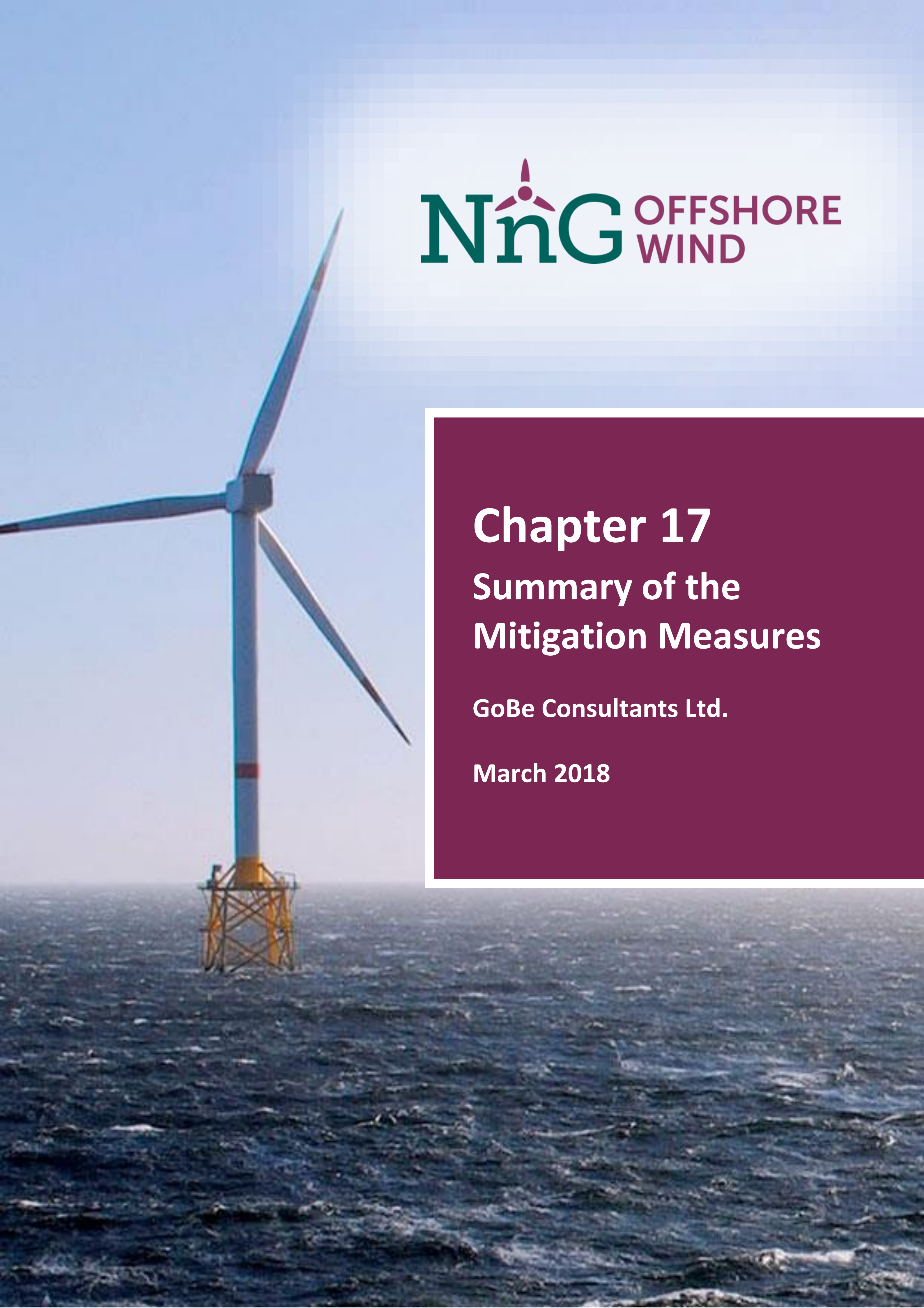
Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
	Dunbar Castle	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	Tantallon Castle	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	North Berwick Law	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	Doon Hill Forts	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	St Andrews Harbour	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	Bell Rock Lighthouse	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	Arbroath Signal Tower	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	Minor, adverse (Not significant)
	Dunbar Battery	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Negligible, adverse (Not significant)
	St Andrews Links	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Negligible, adverse (Not significant)
	Cambo Estate	Negligible, adverse (Not significant)	N/A	Negligible, adverse (Not significant)	Negligible, adverse (Not significant)
Seascape, Landscape and Visual Amenity					
Construction					
Impact of landfall construction activities	Thorntonloch Beach	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	N/A

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
on landscape receptors					
Impact of landfall construction activities on visual receptors	Thorntonloch Beach	Minor, adverse (Not significant)	N/A	Minor, adverse (Not significant)	N/A
Operation					
Impact of offshore wind farm on coastal character	East Fife and south-east Angus	Moderate, adverse (Significant)	None identified	Moderate, adverse (Significant)	Moderate, adverse (significant) in east Fife and south-east Angus, minor or negligible, adverse (not significant) all other receptors. Mitigation will rely on post-consent design processes
	All other receptors	Negligible to Minor, adverse (Not significant)	N/A	Negligible to Minor, adverse (Not significant)	
Impact of offshore wind farm on landscape character	All receptors	Negligible to Minor, adverse (Not significant)	N/A	Negligible to Minor, adverse (Not significant)	None
Impact of offshore wind farm on visual amenity	Within 22 km	Major, adverse (Significant)	None identified – will rely on post-consent design processes	Major, adverse (Significant)	Up to major, adverse (significant) where both Neart na Gaoithe and Inch Cape can be viewed at close range. Negligible or Minor, adverse (not significant) elsewhere. Mitigation will rely on post-consent design processes
	Within 35 km	Moderate, adverse (Significant)	None identified - – will rely on post-consent design processes	Moderate, adverse (Significant)	
	Beyond 35 km	Negligible to Minor, adverse (Not significant)	N/A	Negligible to Minor, adverse (Not significant)	

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
Impact of aviation and navigation lighting on coastal character	Eastern Fife coast	Moderate, adverse (Significant)	None identified - – will rely on post-consent design processes	Moderate, adverse (Significant)	Moderate, adverse (significant) in east Fife and south-east Angus, minor or negligible, adverse (not significant) all other receptors. Mitigation will rely on post-consent design processes
	All other receptors	Negligible to Minor, adverse (Not significant)	N/A	Negligible to Minor, adverse (Not significant)	
Impact of aviation and navigation lighting on landscape character	All receptors	Negligible to Minor, adverse (Not significant)	N/A	Negligible to Minor, adverse (Not significant)	None
Impact of aviation and navigation lighting on visual amenity	Within 30 km	Moderate, adverse (Significant)	None identified	Moderate, adverse (Significant)	Up to major, adverse (significant) where both Neart na Gaoithe and Inch Cape can be viewed at close range. Negligible or Minor, adverse (not significant) elsewhere. Mitigation will rely on post-consent design processes
	Beyond 30 km	Negligible to Minor, adverse (Not significant)	N/A	Negligible to Minor, adverse (Not significant)	
Socioeconomics					
Construction					
Impact of construction activity on direct and indirect employment creation in the construction supply chain	Scotland	Moderate, beneficial (Significant)	Not required as beneficial effect	Moderate, beneficial (Significant)	Not possible to quantify, however would be positive
	Local study area	Moderate, beneficial (Significant)	Not required as beneficial effect	Moderate, beneficial (Significant)	

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
Impact of construction activity on direct and indirect GVA creation in the construction supply chain	Scotland	Minor, beneficial (Significant)	Not required as beneficial effect	Minor, beneficial (Significant)	Not possible to quantify, however would be positive
	Local study area	Minor, beneficial (Significant)	Not required as beneficial effect	Minor, beneficial (Significant)	
Operation					
Impact of operation activity on direct and indirect employment creation in the construction supply chain	Scotland	Minor, beneficial (Significant)	Not required as beneficial effect	Minor, beneficial (Significant)	Not possible to quantify, however would be positive
	Local study area	Moderate, beneficial (Significant)	Not required as beneficial effect	Moderate, beneficial (Significant)	
Impact of operation activity on direct and indirect GVA creation in the construction supply chain	Scotland	Minor, beneficial (Significant)	Not required as beneficial effect	Minor, beneficial (Significant)	Not possible to quantify, however would be positive
	Local study area	Minor, beneficial (Significant)	Not required as beneficial effect	Minor, beneficial (Significant)	
Decommissioning					
Impact of decommissioning activity on direct and indirect employment creation in the construction supply chain	Scotland	Minor, beneficial (Significant)	Not required as beneficial effect	Minor, beneficial (Significant)	Not possible to quantify, however would be positive
	Local study area	Minor, beneficial (Significant)	Not required as beneficial effect	Minor, beneficial (Significant)	
Impact of decommissioning activity on direct and indirect GVA creation	Scotland	Minor, beneficial (Significant)	Not required as beneficial effect	Minor, beneficial (Significant)	Not possible to quantify, however would be positive
	Local study area	Minor, beneficial (Significant)	Not required as beneficial effect	Minor, beneficial (Significant)	

Potential Impact	Receptor	Significance of Effect	Mitigation Measures	Residual Effect	Cumulative Effect
in the construction supply chain					



Chapter 17

Summary of the Mitigation Measures

GoBe Consultants Ltd.

March 2018

Table of Contents

17 Summary of the Mitigation Measures

17.1 Introduction

1. This chapter of the EIA Report presents a summary of the mitigation measures identified within each of the technical assessment chapters (Chapters 7 to 15). Mitigation has been suggested for those impacts considered to be of moderate or major significance (refer to Chapter 6: EIA Methodology). For these significant effects, appropriate mitigation is identified in order to reduce the potential effect to a not significant level. Where, with the application of mitigation, this does not result in a not significant effect, further proposals are made to address this.

2. Three levels of mitigation are established:

- Embedded mitigation – Through the iterative EIA process and in light of the findings of the Original EIA and subsequent consent determination process, NnGOWL has identified a variety of measures that have been 'embedded' into Project design;
- Anticipated consent condition commitments – Various conditions were applied to the Originally Consented Project. NnGOWL recognises that MS-LOT may wish to apply similar conditions to the new consents and expects these to reflect the main requirements of the conditions attached to the Originally Consented Project; and
- In some instances, the EIA process may identify effects that are considered significant and for which additional mitigation measures are required.

3. Where relevant on a chapter-by-chapter basis, the three levels of mitigation are summarised in the following sections.

4. For additional information on the impact assessment criteria, each of the impact assessments and additional detail on the suggested mitigating measures and conclusions, refer to the appropriate chapter within this EIA Report.

5. Certain potential effects have been minimised through the adoption of embedded mitigation measures during the design stage for a number of topics, for example the use of scour protection to minimise potential impacts on physical processes. Further information on embedded mitigation is provided both in this chapter and in the individual technical assessments within this EIA Report. Where appropriate, monitoring recommendations are also described below.

17.2 Fish and Shellfish Ecology

17.2.1 Mitigation

6. The assessment of impacts, both in isolation and cumulatively, on Fish and Shellfish receptors as a result of the construction, operation and decommissioning of the Project are predicted to be of minor or negligible significance and therefore not significant in EIA terms. Based on the predicted effects it is concluded that no specific mitigation is required beyond the embedded mitigation.

7. The embedded mitigation has included:

- Inter-array, interconnector and Offshore Export Cables will be suitably buried (to a maximum of 3 m) or will be protected by other means when burial is not practicable. This will reduce the potential for effect and exposure of electromagnetically sensitive species to the strongest electromagnetic fields (EMF);

- To minimise the extent of any unnecessary habitat disturbance, material displaced as a result of cable burial activities will be back filled, where necessary, in order to promote recovery; and
- Cable specifications will be used that reduce EMF emissions as per industry standards and best practice such as the relevant IEC (International Electrotechnical Commission) specifications.

8. A number of consents conditions were applied to the Originally Consented Project and NnGOWL anticipate similar conditions relating to:

    - Piling Strategy - Setting out, for approval, the pile driving methods, in accordance with the Application and detailing associated mitigation incorporating data collected as part of pre-construction survey work to demonstrate how the risk to species will be managed;
    - Cable Plan – Setting out, for approval, in accordance with the application and detailing routing considerations, including environmental sensitivities based on pre-construction survey data, and any relevant mitigation ensure all relevant environmental risks associated with cable installation and operation are managed in respect of fish receptors;
    - Environmental Management Plan – Setting out, for approval, the over-arching environmental management procedures that will be implemented across the Project to minimise the risk to environmental receptors from, for example, potential pollution, introduction of non-native species, and dropped objects;
    - Project Environmental Monitoring Programme – Setting out, for approval, the proposed environmental monitoring programme, to include as relevant and necessary the monitoring of sandeels, marine fish and diadromous fish;
    - Participation in the Forth and Tay Regional Advisory Group (FTRAG) – Participation in the FTRAG with respect to monitoring and mitigation of diadromous and commercial fish;
    - Participation in the Scottish Marine Environment Group (SSMEG) – Participation in the SSMEG with respect to monitoring and mitigation of diadromous and commercial fish; and
    - Participation in the ‘National Research and Monitoring Strategy’ for Diadromous Fish - Engage with and participate in the delivery of the strategic salmon and trout monitoring strategy at a local level (the Forth and Tay).

9. No additional mitigation measures are applicable in the context of fish and shellfish ecology.

17.2.2 Monitoring

10. Within Chapter 7: Fish and Shellfish Ecology there are a number of acknowledged uncertainties in the understanding of the particle motion component of underwater noise and the effects of particle motion arising from activities such as pile driving on fish and shellfish species and the lack of standardised modelling techniques or clear thresholds of effects for key species inevitably means that uncertainties remain.

11. Many of the uncertainties with particle motion relate to the fundamental understanding of the effects on fish and shellfish, which require ongoing academic research initiatives, which would lie out with the role of monitoring in a project-specific licensing context. However, where the Project is able to make some contribution to the broader strategic understanding of the issue it will seek to do so and through ongoing discussions with key stakeholders.

17.3 Marine Mammals

17.3.1 Mitigation

12. The embedded mitigation is as follows:

- Pile driving - Pile driving will be undertaken using the lowest possible hammer energy. This will reduce the area of potential impact from noise on marine mammals and their prey. Pile driving will commence by using a lower hammer energy and slowly, over a period of time, ramp-up to a maximum hammer energy (soft-start procedures).

13. This reduces the duration at which marine mammals will be impacted by potentially significant levels of noise and provides time for them to leave the area in order to avoid possible risk of physical injury; and

14. In terms of consent condition commitments, a number of those relating to fish and shellfish ecology apply equally to marine mammals, namely:

- A Construction Method Statement (CMS) will provide details of the finalised construction methods and set out the construction procedures and god working practices to be used. The CMS will be submitted for approval at least six months prior to the commencement of works.
- Prior to any activities an Environmental Management Plan (EMP) will be submitted to the Scottish Ministers within which details of the planned mitigation and monitoring to be undertaken will be presented. The mitigation measures identified within the PEMP will be developed and agreed with Marine Scotland and SNH prior to the start of construction activities.
- Piling Strategy;
- Project Environmental Monitoring Programme; and
- Participation in SSMEG and FTRAG.

15. In addition, the following consent condition commitments are anticipated:

- Noise registry - Prior to the commencement of piling activities the proposed date(s), location(s) and nature of the piling activities undertaken must be reported. In the event piling is to be carried out for more than 10 consecutive days, submit quarterly noise registry reports; and
- Vessel Management Plan - Requires details of the vessels to be used and working practices to reduce the use of ducted propellers.

16. No significant likely significant effects have been identified and require defined mitigation measures, however potential additional mitigation measures that could be included to reduce not significant, potential effects further and their likely effectiveness are described below:

- Use of a Marine Mammal Observer(MMOb) and of Passive Acoustic Monitoring (PAM) are recognised to be suitable mitigation in ensuring marine mammals are not present in an area where they could be at risk of traumatic physical injury and, in the case of dolphins, PTS;
- The use (and operating requirements) of any Acoustic Deterrent Device (ADD) will be discussed with MS-LOT and SNH to determine whether this will need to be deployed or not. If ADD are required, it will be operated at the pile driving location for a period of time, typically approximately 20 minutes prior to the start of pile driving. It will be turned off once pile driving has started.

17.3.2 Monitoring

17. A detailed monitoring programme will be developed through consultation with MS-LOT and SNH. NnGOWL will also participate in regional and national fora such as the Forth and Tay Regional Advisory Groups (FTRAG) and the Scottish Strategic Marine Environment Group (SSMEG), through which a strategic monitoring plan will be developed.

18. At least six months prior to the start of the development a PEMP will be submitted to the Scottish Ministers within which details of the planned monitoring to be undertaken will be presented. A Marine Mammal Monitoring Plan (MMMP) will be developed and agreed with MS-LOT and SNH prior to the start of construction activities.

19. Details of the monitoring that could be undertaken are yet to be confirmed. However, potential monitoring could include:

- Measuring sound levels during pile driving activities. This would help improve our understanding of the sound levels produced from pile driving.
- Monitoring the responses of marine mammals to pile driving noise. The species that effective monitoring could be undertaken and the methods to be used will be agreed with MS-LOT and SNH. However, it is envisaged that monitoring the responses to pile driving on bottlenose dolphins and harbour porpoise could be undertaken through the use of passive acoustic monitoring. This could improve our understanding of the potential impacts on marine mammals and confirm the predictions made within the EIA Report.

20. The final monitoring programmes will be developed following consultation with stakeholders and subject to approval with MS-LOT.

17.4 Ornithology

17.4.1 Mitigation

21. Embedded mitigation comprises the following:

- Number of turbines:
  - The number of turbines was reduced from a maximum of 125 at the time of the Original Application to a maximum of 90 at the time of the addendum and 75 for the Original Consents. The reduced turbine numbers and increased spacing was anticipated to reduce the risk of collision, displacement and barrier effects on birds; and
  - The design evolution of the Project has continued and the number of turbines has been further reduced to a maximum of 54 turbines for the Project EIA Report.
- Rotor Height:
  - Increasing the turbine rotor height reduces the risk of collision for a number of seabirds, many of which rarely fly above about 25m but occur regularly at around 20m. Therefore an increase in turbine height can cause a reduction in the number of predicted collisions; and
  - Minimum rotor height was increased from 26m above LAT in the Original Application to 30.5m above LAT in the Addendum. The design evolution of the Project has continued and the minimum rotor height has been further increased to a minimum rotor height of 35m above LAT and the assessments are on this basis.

22. No specific consent condition commitments are made, nor are any additional mitigation measures proposed.

17.4.2 Monitoring

23. Following consent, a Project Environmental Monitoring Plan (PEMP) will be developed and agreed with MS-LOT, in discussion with the Forth and Tay Regional Advisory Group (FTRAG). Monitoring will be required to validate the findings of the EIA.

24. To date, there have been some high level discussions regarding future monitoring requirements for NnG. An ornithology sub-group for the FTRAG has been established, comprising representatives from NnG, Inch Cape, Seagreen, Marine Scotland, SNH, JNCC and RSPB. Initial discussions considered where monitoring should focus, in terms of research questions, key species, SPAs and effects to be addressed.

25. The above discussions will continue and will inform the selection of the most appropriate monitoring methods. Methods selected will be subject to regular review, as technologies improve and as information from monitoring programmes at other offshore projects is published, together with results from industry-led research projects such as the Offshore Renewables Joint Industry Programme (ORJIP).

26. At this stage it is considered likely that monitoring will focus on collision/avoidance, displacement/barrier, as well as population-level effects. Various methods and technologies are available to monitor displacement/barrier, including GPS tagging, radar, boat-based and digital aerial surveys. For monitoring collision/avoidance, there is the potential to use turbine mounted cameras, radar, human observers and laser range finders. In addition, if looking at population effects, it would be beneficial to have a better understanding of survival and productivity rates for breeding adults at these SPA colonies.

27. The different potential methods are still being considered, and a future decision on a monitoring system will be determined depending on the most appropriate technology available at the time of selection. There is the potential for collaboration with other developers, government and NGOs, which could be progressed via the PEMP or separate studies.

17.5 Commercial Fisheries

17.5.1 Mitigation

28. Embedded mitigation is included as follows:

- Establishment of and participation in a working group to assist with the following:
  - Dissemination of Project information;
  - Application of safety zones and advisory safe passing distances and implications for fisheries;
  - Navigation of Project construction and maintenance works vessels to and from the site (i.e., agreement of transit lanes to minimise interference to fishing activities, agreement for ‘holding’ areas for vessels in the event of bad weather);
  - Procedures in the event of interactions between Project construction and fishing activities (i.e. claims for lost and/or damaged gear);
  - Burial and protection of inter-array and Offshore Export Cables;
  - Removal of seabed obstacles during and post-construction; and
  - Post-construction surveys and seabed rectification procedures.
- All infrastructure installed during the construction phase will be marked and lit, in line with standard industry practice, and relevant information will be distributed to fishermen through the agreed channels.

- Cables will be buried to a maximum depth of 3 m where it is reasonably practicable to do so. In instances where adequate burial cannot be achieved then the developers will seek to install cable protection.
- Over trawl surveys will be carried out on the Offshore Export Cable and inter-array cables where cable protection has been required to ensure that the protection scheme has been successful.

29. A number of consent conditions were attached to the Consents to manage the environmental risk associated with the Originally Consented Project. Those consent condition commitments that are relevant to the potential impacts on commercial fisheries comprise:

- Commercial Fisheries Mitigation Strategy - Setting out, for approval, the mitigation strategy for each commercial fishery in the area that the Scottish Ministers agree may be adversely affected by the Project;
- Fisheries Liaison Officer – Appointment of a Project Fishing Liaison Officer (FLO) to establish and maintain effective communications with fishery industry;
- Cable Plan – Setting out, for approval, the following measures to manage the risk to commercial fisheries:
  - Details of the location and cable laying techniques for the cables;
  - The results of survey work (including geophysical, geotechnical and benthic surveys) which help inform cable routing;
  - Technical specifications of cables, including a desk based assessment of attenuation of electro-magnetic field strengths and shielding;
  - A burial risk assessment to ascertain burial depths and, where necessary, alternative suitable protection measures;
  - Methodologies for over trawl surveys of the cables through the operational life of the wind farm where mechanical protection of cables laid on the sea bed is deployed; and
  - Methodologies for cable inspections with measures to address and report any cable exposure.
- Commercial Fisheries Working Group – Continued membership of, and participation in the Forth & Tay Commercial Fisheries Working Group to assist with the following:
  - Dissemination of Project information;
  - Application of safety zones and implications for fisheries;
  - Navigation of Wind Farm Area construction and works vessels to and from the site (i.e., agreement of transit lanes to minimise interference to fishing activities, agreement for ‘holding’ areas for vessels in the event of bad weather);
  - Procedures in the event of interactions between Wind Farm Area construction and fishing activities (i.e. claims for lost and/or damaged gear);
  - Burial and protection of inter-array, inter-connector and export cabling;
  - Removal of seabed obstacles during and post-construction; and
  - Post-construction surveys and seabed rectification procedures.
- Navigational Safety Plan – Navigational Safety Plan: Setting out, for approval, the navigational safety measures to mitigate navigational risk to commercial fisheries operating in the area;
- Lighting and Marking Plan – Lighting and Marking Plan: Setting out, for approval, the navigational lighting strategy to be installed at the site to ensure safe marking of the structures and Development Area to mitigate the navigational risk to commercial fisheries operating in the area; and
- Monitoring and Mitigation - Monitoring and mitigation:

- Participation in the Forth and Tay Regional Advisory Group (FTRAG) established by the Scottish Ministers for the purposes of advising the Scottish Ministers on monitoring and mitigation of, among other things, commercial fish.
- Participation in the Scottish Strategic Marine Environment Group (SSMEG) established by the Scottish Ministers for the purposes of advising the Scottish Ministers on monitoring and mitigation of, among other things, commercial fish.

30. Significant effects have been identified in relation to potential loss of earnings and loss of the ability to carry out normal working procedures, through reduced access to or exclusion from established fishing grounds or displacement leading to gear conflict and increased fishing pressure on adjacent grounds. These are economic issues and therefore the appropriate means to address them is through commitment to disturbance payments. With respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015), will be followed wherever possible.

17.5.2 Monitoring

31. No monitoring in relation to commercial fisheries is proposed within this EIA Report.

17.6 Shipping and Navigation

17.6.1 Mitigation

32. Embedded mitigation is as follows:

- Appropriate liaison to ensure information on the construction, operation and decommissioning of the Offshore Wind Farm is circulated in Notice to Mariners, Kingfisher Bulletin, Navigation Information Broadcasts and other appropriate media. As part of the Notice to Mariners process the information will be supplied to Imray publications;
- While construction work is in progress, Admiralty Charts will provide a note over the Wind Farm Area stating as such including position of construction buoyage;
- The Project construction, operation and decommissioning works will be marked in line with IALA-O136, and as agreed with NLB, MCA and the Civil Aviation Authority (CAA);
- Compliance with relevant MCA Guidance (MGN 543 and Annexes);
- Creation of an ERCoP based on the MCA template and Project Safety Management Systems (SMS), in consultation with the MCA. Procedures will be followed in the event of an emergency situation during the construction phase;
- The onshore operations base will also serve as a Marine Control Centre that will monitor vessel activity;
- Construction safety zones of 500 m around major activities will be in place to exclude vessels not associated with the construction works for the Offshore Wind Farm;
- The Project will be marked on admiralty charts;
- Lowest point of rotor sweep is a minimum of 35m above LAT which is in line with the MCA and RYA recommendations; and
- Cables will be protected appropriately from fishing and anchoring and monitored to ensure burial / protection and seabed stability is maintained.

33. A number of consent conditions were attached to the Consents to manage the environmental risk associated with the Originally Consented Project. NnGOWL anticipate that any future consents issued to the Project may incorporate conditions similar to the following to manage the risk to shipping and navigation commensurate with the Project design envelope where it remains necessary to do so:

- Construction Method Statement - Requires the final construction methods to be set out for approval to ensure that they remain consistent with the methods assessed in the Project ES and to ensure appropriate construction management taking into account mitigation measures to protect the environment and other users of the marine area;
- Development Specification and Layout Plan – Setting out, for approval, the final design and layout of the Project to ensure it remains consistent with the design assessed in the ES as relevant to shipping and navigation;
- Vessel Management Plan – Setting out, for approval, the number and types of vessels, vessel management practices, port and harbour locations, and transit routes relevant to the Project;
- Navigational Safety Plan – Setting out, for approval, the navigational safety measures to mitigate navigational risk of other marine users operating in the area;
- Cable Plan – Setting out, for approval, the location and installation methods for the cables (including burial) to ensure they remain consistent with the installation process assessed in the ES, as relevant to Shipping and Navigation;
- Lighting and Marking Plan – Setting out, for approval, the navigational lighting strategy to be installed at the site to ensure safe marking of the structures and Development Area to mitigate the navigational risk to other marine users;
- Navigational Safety (Construction):
  - Notify the UKHO prior to the commencement of construction to facilitate the promulgation of maritime safety information and updating of nautical charts and publications through the national Notice to Mariners System.
  - Issue local Notice to Mariners to ensure local mariners, fishermen's organisations and HM coastguard are aware of the Licensable Marine Activity.
  - Consult with local harbour masters as appropriate.
  - Ensure that details of the works are promulgated in the Kingfisher Fortnightly Bulletin [KIS-ORCA], prior to the commencement of the works to inform the Sea Fish industry of vessel routes, timings and the locations of Project Activities
- Markings, lighting and signals of the Works (Construction, Operation and Maintenance) – Ensure that the Project is lit in accordance with the requirements of the relevant statutory stakeholders including marking of the site with appropriate construction buoyage during construction and continued lighting of the site following completion of construction as required by the MCA and NLB;
- Markings, lighting and signals of the Works (Construction) – Ensure that any vessels engaging in the work are marked in accordance with the International Rules for the Prevention of Collisions at Sea if under way and in accordance with the UK Standard Marking Schedule for Offshore Installations if secured to the seabed;
- Navigational Safety (Operation):
  - Ensure appropriate notifications are made following completion of the works to all relevant stakeholders including UKHO, the Maritime Rescue and Coordination Centre Aberdeen and all mariners and fishermen's organisations;
  - Ensure appropriate notifications are made through the Kingfisher Fortnightly Bulletin to inform the Sea Fish Industry;
- Marine Pollution Contingency Plan - Setting out, for approval, relevant management measures to mitigate risk of accidental spills and subsequent remedial action, response measures relating to spills and collision incidents and practices used to refuel vessels at sea if relevant.

34. NnGOWL propose to consult with the MCA and NLB and other stakeholders to identify appropriate further mitigation as required. Further mitigation may include additional aids to navigation to assist internal navigation and additional means of communication to assist third parties throughout the

operational phase of the Project, such as, marine coordination facilities, offshore VHF aerials and AIS transceivers/receivers.

17.6.2 Monitoring

35. Rerouting has been identified as potentially occurring as a result of the Project, however it is proposed that marine traffic is monitored via AIS post-construction to ensure actual changes in shipping behaviour resulting from the Wind Farm Area can be fully understood. This will serve to confirm any deviated routeing and will also provide an indication of any vessel activity occurring within the Wind Farm Area.

17.7 Military and Civil Aviation

17.7.1 Mitigation

36. Embedded mitigation has been included as follows:

- Appropriate liaison to ensure information on the construction of the wind farm is circulated in Notice to Airman (NOTAM) and other appropriate media;
- Aviation Chart Marking;
- Regulation and Control (AIRAC) system;
- Lighting and Marking Plan, including operational lighting in line with CAP 393 (CAA, 2017) and CAP 437 (CAA, 2016a), and as agreed with the CAA;
- The Project will be designed as per MGN 543, including Annex 5;
- Information will be circulated to relevant military and aviation stakeholders including NATS and MOD; and
- Creation of an Emergency Response Co-operation Plan (ERCoP) based on the Maritime and Coastguard Agency (MCA) template and site Safety Management Systems (SMS).

37. Consent conditions relating to the following are anticipated, reflecting the issues considered in the Original Consents:

- Lighting and Marking Plan – Setting out for approval, the final lighting and marking of structures to ensure aviation safety at the Offshore Wind Farm;
- Air Traffic Control Mitigation (ATC) Scheme – Setting out, for approval, an ATC scheme to mitigate the adverse impacts of the Project on the air traffic control radar at Leuchars Station and the operations of the MOD; and
- Provision of Turbines and Construction Equipment above 150 m LAT - Provide the positions and maximum heights of the turbines and construction equipment above 150 m LAT and any offshore substation platform to the United Kingdom Hydrographic Office (UKHO) for aviation and nautical charting purposes to ensure aviation and navigational safety.

38. A number of additional mitigation measures have been identified to further reduce or manage significant effects:

- Implementation of an agreed mitigation strategy for Leuchars Station PSR. This involves an Airspace Change Proposal for the introduction of a TMZ over the Wind Farm Area. The Airspace Change occurs in two stages; stage one includes radar blanking of the Leuchars Station PSR; stage two is the introduction of the TMZ covering the Wind Farm Area. A TMZ will also be in place for Inch Cape Offshore Wind Farm and is also anticipated to be required for the Seagreen offshore wind farms. The TMZ will remain in place until an enduring technical solution is agreed. A long term 'in-fill' solution may involve the removal of PSR data where radar clutter is anticipated in the vicinity of the

wind turbines, and replacing it with an alternate radar source which is not affected by radar clutter;
- For the Leuchars Station PAR, NnGOWL has committed to not siting any wind turbines within the PAR 'Protection Zone' (Safeguarded Area), including turbine blades, to remove the potential for radar detectability of any element of a turbine;
- Engagement in discussions with the MOD (DIO) regarding the implementation of a NAIZ for RRH Brizlee Wood and RRH Buchan ADRs; and
- Implementation of similar mitigation identified for RRH Brizlee Wood and RRH Buchan ADRs to remove radar impact upon military PEXA activity within TRA 007A.

17.7.2 Monitoring

39. No monitoring in relation to military and civil aviation is proposed within this EIA Report.

17.8 Cultural Heritage

17.8.1 Mitigation

40. Embedded mitigation is incorporated and includes:

- Analysis of pre-construction survey data to refine the identified potential marine archaeology assets at infrastructure locations. Appropriate micro-siting allowance for identified assets will be agreed in consultation with HES;
- Micro-siting allowance and exclusion zones will be detailed in the WSI. This will reduce any potential impacts on marine archaeology;
- Mitigation relating to effects of the Offshore Wind Farm on the setting of cultural heritage receptors will include:
  - Turbines will all be of similar dimensions for hub height and blade tip level subject to turbine and substructure design and installation specification;
  - Turbines will all be pale grey in colour (Light Grey RAL 7035) with a semi-matt finish; and
  - The design analysis undertaken as part of the SLVIA assessment provides 'design objectives' will be used to refine the appearance of the final wind farm layout. Detailed post-consent siting of the offshore turbines will be driven by a range of physical and environmental constraints including localised geological conditions, ecology, aviation, navigation, wind resource and marine archaeology.

41. Conditions relating to the following were attached to the Original Consents and NnGOWL anticipate similar conditions in respect of the Project:

- Environmental Management Plan - Setting out, for approval, an EMP detailing a WSI to be followed in the event of an archaeological discovery; and
- Marine Archaeology Reporting Protocol - Setting out, for approval, procedures to follow on discovery any marine archaeology during the construction, operation, maintenance and monitoring of the Project.

42. Only one significance effect on one receptor has been identified and this relates to cumulative effects upon the Isle of May Priory (turbine height and layout in relation to the setting of onshore receptors). Setting-related cultural heritage impact can dealt with in a similar way to landscape and visual effects, where mitigation relies on post-consent design processes that may help to reduce the levels of the identified effects, and it is at this point that mitigation to reduce the impact should occur.

17.8.2 Monitoring

43. The monitoring and enforcing of AEZs around archaeology and cultural heritage receptors will be an important part of the mitigation strategy for all phases of construction, operation and decommissioning of the Project.

17.9 Seascape, Landscape and Visual Impact Assessment

17.9.1 Mitigation

44. Significant effects resulting from the presence of the Offshore Wind Farm and from aviation and navigation lighting have been predicted, particularly in relation to coastal character and visual amenity in certain areas of east Fife, north-east Lothian and in the wider area.

45. Traditional methods of landscape and visual mitigation, such as screen planting, are ineffective for offshore wind farm development. Mitigation for wind farms is generally limited to the reduction of potential direct effects through detailed siting, and the reduction in adverse aesthetic effects through wind farm design. For the significant effects identified, mitigation of landscape and visual effects will rely on post-consent design processes that may help to reduce the levels of the identified effects.

46. Detailed design of the aviation and navigation lighting will also take place post-consent, in line with the requirements of the relevant statutory authorities. It is possible that the lights installed may be less bright than those modelled and assessed in this EIA Report.

47. Embedded mitigation has included an analysis of alternative layouts which has provided 'design objectives' that can be considered in order to refine the appearance of the final layout.

48. Consent conditions are expected to relate to:

- Development Specification and Layout Plan - Setting out, for approval, the final design and layout of the Project to ensure it remains consistent with the design assessed in the ES as relevant to SLVIA;
- Design Statement - Providing representative visualisations of the Offshore Wind Farm based on the final Development Specification and Layout Plan. The requirements for the design statement will be discussed with MS-LOT and relevant stakeholders following award of consent; and
- Lighting and Marking Plan - Setting out, for approval, how the Offshore Wind Farm will be lit and marked in accordance with the current aviation and navigation policy and guidance.

49. No additional mitigation measures are proposed.

17.9.2 Monitoring

50. No monitoring in relation to seascape, landscape and visual impacts is proposed within this EIA Report.

17.10 Socioeconomics

17.10.1 Mitigation

51. The effects on socio-economic receptors as a result of the construction, operation and decommissioning of the Project are predicted to be of beneficial moderate and minor significance. As none of the effects are adverse no specific mitigation is required in addition to the embedded mitigation already incorporated. The embedded mitigation is as follows:

- NnGOWL has interacted with the supply chain in the local study area. They have done this by:
  - Encouraging a competitive procurement process - To ensure strong local supply inclusion, NnGOWL has hosted numerous engagement events in partnership with local enterprise agencies;
  - Support new entrants - NnGOWL has sought to engage many new entrants to the offshore wind farm sector. Nearly one in two contractors who were approached for wind turbine generation and balance of plant procurement have been newcomers;
  - Improve awareness - NnGOWL has attempted to engage with local suppliers through a variety of events and partnerships:
- Since 2010, NnGOWL has undertaken an extensive programme of public exhibitions with attendance at 30 public community events;
- In collaboration with Scottish Enterprise, NnGOWL has hosted three supply chain events with tier-one contractors in Dunbar, Fife, and Dundee. There are plans to re-run such events in the near future alongside diversification events for the local fisherman and ex-RAF. They have also conducted regional roadshow events to promote opportunities; and
- NnGOWL are engaged with the Offshore Renewables Catapult, Universities and Skills Development Scotland to explore greater opportunities to engage with the local supply chain.

52. Unlike other topics within this EIA Report, expected consent conditions are not anticipated in relation to socio-economic effects. Similarly, no additional mitigation measures are proposed.

17.10.2 Monitoring

53. No monitoring in relation to socioeconomics is proposed within this EIA Report.