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Abbreviations and Acronyms

AC	Alternating Current
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
CBD	Convention on Biological Diversity
CMS	Convention on Migratory Species
DC	Direct Current
DECC	Department of Energy and Climate Change
ECMA	East Coast Management Area
EMF	Electromagnetic Field
EPS	European Protected Species
ES	Environmental Statement
FCS	Favourable Conservation Status
FTOWDG	Forth and Tay Offshore Wind Developers Group
HRA	Habitats Regulations Appraisal
ICOL	Inch Cape Offshore Limited
IMO	International Maritime Organisation
INSPIRE	Impulse Noise Sound Propagation and Impact Range Estimator
IWC	International Whaling Commission
JNCC	Joint Nature Conservation Committee
km	Kilometres
m	Metre
MARPOL	International Convention for the Prevention of Pollution from Ships
MHWS	Mean High Water Springs
ML	Most Likely
MORL	Moray Offshore Renewables Limited
MPA	Marine Protected Area
MS	Marine Scotland

NnG	Neart na Gaoithe
NPC	Natural Power Consultants
OfTW	Offshore Transmission Works
OnTW	Onshore Transmission Works
OSP	Offshore Substation Platform
OSPAR	The Convention for the Protection of the marine Environment of the North-East Atlantic
PAM	Passive Acoustic Monitoring
PBR	Potential Biological Removal
PTS	Permanent Threshold Shift
PVA	Population Viability Analysis
SAC	Special Area of Conservation
SCOS	Special Committee on Seals
SE	Standard Error
SEL	Sound Exposure Level
SMRU	Sea Mammal Research Unit
SNCB	Statutory Nature Conservation Bodies
SNH	Scottish Natural Heritage
SPEAR	Simple Propagation Estimator And Ranking
STW	Scottish Territorial Waters
TCE	The Crown Estate
TTS	Temporary Threshold Shift
UKBAP	UK Biodiversity Action Plan
WC	Worst Case

14 Marine Mammals

14.1 Introduction

1 This chapter presents the assessment of potential impacts on marine mammals predicted to arise from the Inch Cape Offshore Wind Farm and associated Offshore Transmission Works (OfTW) within the Firths of Forth and Tay.

2 This chapter details the potential impacts arising from the Wind Farm and OfTW, including cumulative impacts. Information to support a Habitats Regulations Appraisal (HRA) and an overview of the information which will be submitted in support of an application for a European Protected Species (EPS) licence at a later date, are provided in *Sections 14.13* and *14.14* respectively.

3 The following appendices and chapters should be read in conjunction with this chapter:

- *Appendix 14A: Marine Mammals Baseline;*
- *Appendix 14B: Marine Mammals Piling Impact Assessment;*
- *Appendix 14C: Piling Impact Assessment Figures;*
- *Appendix 14D: Harbour Seal Assessment Framework;*
- *Chapter 4: Process and Methodology;*
- *Chapter 7: Description of Development;*
- *Chapter 9: Designated Nature Conservation Sites;*
- *Chapter 11: Underwater Noise;*
- *Chapter 13: Natural Fish and Shellfish;*
- *Chapter 19: Shipping and Navigation;* and
- *Chapter 23: Summary of Effects.*

14.2 Consultation

4 Table 14.1 below provides a summary of the responses to the Wind Farm Environmental Impact Assessment (EIA) Scoping Report that are pertinent to marine mammals. These have been taken into consideration in the completion of this assessment, with all points being addressed. The table also summarises the responses received to the HRA Screening process undertaken by Inch Cape Offshore Limited (ICOL).

Table 14.1: Scoping Responses and Actions

Consultees	Scoping Responses	Project Responses
Marine Scotland (MS)	The Environmental Statement (ES) needs to show that the relevant wildlife legislation and guidance were taken into account. In terms of Scottish Government interim guidance, applicants must give serious consideration to meeting three fundamental tests (after scoping). It needs to be categorically established which species are present on and near the site, and where, before the application is considered for consent.	Relevant legislation and guidance has been taken into account including HRA legislation when conducting assessment (see *Sections 14.3.1 and 14.6.2*). A suite of survey techniques, including vessel based, aerial and passive acoustic monitoring (PAM), has been utilised to establish presence of marine mammal species in and around the Development Area and a four kilometre buffer.
	The presence of protected species such as EPS must be included and considered as part of the application process, not as an issue which can be considered at a later stage.	All cetaceans are EPS, therefore those cetaceans likely to be encountered in the vicinity of the Development Area and Offshore Export Cable Corridor are assessed accordingly.
Scottish Natural Heritage (SNH) (the response was joint with Joint Nature Conservation Committee (JNCC)	Sharp declines in harbour seal populations over recent years should be included in the assessment.	Based on the advice provided by SNH, an appropriate assessment will be required for the Inch Cape Offshore Wind Farm with respect to the listed Special Areas of Conservation (SACs). This assessment will include the Firth of Tay and Eden Estuary SAC for harbour seal, and will include population modelling that takes into account declines in the population over recent years. Details of modelling undertaken to inform the HRA are provided in *Appendix 14D. Chapter 14, Section 14.13* is designed to inform the HRA process that will be undertaken by Marine Scotland as competent authority. This section follows available relevant guidance in assessing potential impacts which may arise during the construction of the development.

Consultees	Scoping Responses	Project Responses
	A review of survey data should be conducted to assess methodologies for marine mammal data collection. SNH would also recommend further dialogue.	A review of survey data collected in year one resulted in additional studies being implemented in order to establish a robust baseline using all available data. These additional studies included a Forth and Tay Offshore Wind Developers Group (FTOWDG) commission to Sea Mammal Research Unit (SMRU) Ltd (see *Appendix 14A, Section 14A.2* and *Annex 14A.1* and *Annex 14A.2* for full details).
Scottish Natural Heritage (SNH) (the response was joint with Joint Nature Conservation Committee (JNCC)	SNH/JNCC – would welcome cumulative approach to noise study in particular.	With regards to the impacts of underwater noise on marine mammals, a cumulative noise modelling exercise has been undertaken by FTOWDG. The outputs of this noise modelling have informed the impact assessment undertaken by ICOL for the cumulative assessment.
	We recommend that the applicant assesses noise impacts in their ES using a zoned impact map for each species (illustrating the zones for injury, Permanent Threshold Shift (PTS), Temporary Threshold Shift (TTS) and displacement/disturbance). They can use these maps, combined with their baseline data in order to estimate how many individuals will be at risk from disturbance and/or injury.	The assessment presented in *Section 14.7* and *Appendix 14B* takes this recommendation into account.
	We highlight that rock dumping for scour protection may have noise impacts that need to be considered in respect of marine mammals.	A detailed methodology has been developed to assess the impacts of noise on marine mammals (*Section 14.7.1*). This assessment includes the direct impact of noise associated with rock placement for scour protection.
	SNH/JNCC welcomes collaborative work on cumulative impacts through the FTOWDG and is keen to maintain dialogue.	As described above, FTOWDG have undertaken both collaborative studies to establish a robust baseline for marine mammal use of the Firth of Forth and Tay, and cumulative noise studies. They have had joint meetings with Statutory Nature Conservation Bodies (SNCBs), and continue to liaise with regards to assessment methodologies adopted.

Consultees	Scoping Responses	Project Responses
	There is high value in coordinating various survey work, as well as necessary licence applications, to more effectively address the marine mammal impact assessment.	*Appendix 14A* details the coordinated approach taken by FTOWDG to establish baseline use of the area by marine mammals.
Marine Scotland Science (MSS)	MSS advises that the developer should assume that the (bottlenose) dolphins originate from the Moray Firth SAC as there is no evidence to suggest other populations are using the area.	As advised by the University of Aberdeen, and confirmed by available photo-id data by them, it has been assumed that all bottlenose dolphins observed in the Forth and Tay area are part of the population protected by the Moray Firth SAC.
Marine Scotland Science (MSS)	The scoping report has suggested that there is a data gap surrounding the extent to which harbour seals from the Firth of Tay and Eden Estuary SAC forage over the site during different seasons; and the potential impacts this might have on disturbance or change of habitat.	A review of all available tagging data has been undertaken to assess the usage of the Development Area and Offshore Export Cable Corridor by harbour seals.
	The potential for cumulative effects on species should be assumed to accumulate linearly, unless evidence to the contrary is found. Standard noise protocol should also be used to assess impacts. Barrier to movement should be viewed as both the result of the presence of vessels and foundations. Long term avoidance impacts should be considered in the context of post construction monitoring.	The potential impact of barrier to movement due to the presence of vessels and foundations has been assessed within *Sections 14.7, 14.8, 14.9* and *14.10* of this Chapter. All other points have been taken into consideration as part of the impact assessment process (for example, *Sections 14.7* and *14.8*).
	Potential impacts associated with disturbance and collision should be primary/direct impacts. Impacts on prey species, which are difficult to quantify should be viewed as secondary impacts.	Disturbance and collision have been assessed as direct impacts, and impacts upon prey species as indirect (secondary) impacts, within the assessment presented here in *Sections 14.7* and *14.8*.

	Impacts on marine mammals and fish should be assessed. Background noise and vibration from ships engines, piling hammers and auguring operations during the construction of foundations should be considered.	*Section 14.7.1* provides information on underwater noise recorded previously from ships, piling hammers and other construction related activities, and how this noise is expected to be transmitted through the water column. The extent of this transmitted noise is then interpreted with regards to disturbance impacts from various construction related activities.
	Cable route must be considered in the overall footprint of the development works.	The Offshore Export Cable Corridor has been assessed within *Section 14.8*. The cumulative impact of the Project has been assessed within *Section 14.10.1*.

Consultees	HRA Screening Responses	Project Responses
Marine Scotland, JNCC and SNH	Overall found the scoping report to be clearly laid out and informative. Agreed that the following SAC marine mammal interests be screened for likely significant effect (LSE): • Firth of Tay and Eden Estuary SAC: harbour seal; • Isle of May SAC: grey seal; • Berwickshire and North Northumberland Coast SAC: grey seal; • Moray Firth SAC: bottlenose dolphin.	Information to inform the Competent Authority's Appropriate Assessment on the four listed SACs is provided in *Section 14.13*.
	The ES would need to clearly set out the parameters used in impact assessment for marine mammals.	Parameters used for the impact assessment are detailed in *Section 14.4.*
	Marine Scotland and local authorities, with input from JNCC/SNH, will advise on the range of projects to consider under cumulative impact assessment.	The cumulative projects assessed are provided in Table 14.13.
	Noted that the Joint Cetacean Protocol (JCP) is another data source for bottlenose dolphins and that MS is currently considering modelling work undertaken by the Special Committee on Seals (SCOS) in respect of the Firth of Tay and Eden Estuary SAC harbour seal population.	The JCP analysis is not available. It is noted with interest that MS is considering modelling work on the harbour seal population. As this information is not yet available, it has not been included within this assessment.

5 In addition to the formal Scoping Opinion, further informal consultation has been undertaken in relation to the assessment of the impacts of the Wind Farm and OfTW with relevant stakeholders. ICOL has consulted regularly with Scottish Natural Heritage (SNH), Marine Scotland and the Joint Nature Conservation Committee (JNCC) throughout the assessment process. Where relevant consultation/discussions have taken place, these have been highlighted in the appropriate sections of this chapter.

6 The information received through this consultation, along with the formal Scoping Opinion and recognised best practice, has informed the methodology and scope for the assessment of the impacts on marine mammals presented in this chapter. Of particular note are agreement with SNH, JNCC and Marine Scotland on marine mammal reference populations, HRA screening, piling impact assessment criteria and a method for undertaking an HRA of a declining population.

14.3 Legislation and Policy

14.3.1 Legislation

7 Marine mammals in United Kingdom (UK) territorial waters are protected by international, European and national legislation and these are outlined below:

- *The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)*;
  - Since 1972, the OPSAR Convention has worked to identify threats to the marine environment through organised programs and measures to ensure national action. The OSPAR Commission assess which species and habitats require protection due to being threatened and/or experiencing a decline in population. This list includes harbour porpoise. Also contained within the Convention are a series of annexes dealing with pollution from anthropogenic sources, including underwater noise pollution.
- *Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas 1994 (ASCOBANS)*;
  - ASCOBANS entered into force in 1994 under the auspices of the Convention on Migratory Species (CMS or Bonn Convention), with additional areas (the north-east Atlantic and Irish Sea) included into the convention in 2008. The aim of the convention is to promote cooperation between parties with a view to maintaining the Favourable Conservation Status (FCS) of small cetaceans throughout the agreement area.
- *Council Directive 92/43/EEC on the Conservation of Natural Habitats and Wild Flora and Fauna 1992 (Habitats Directive)*;
  - Aim is to maintain or restore natural habitats and wild species (as listed on Annexes) to a Favourable Conservation Status. The Directive introduced a range of measures including the development of a network of protected sites (Special Areas of Conservation (SACs) for listed habitats (Annex I) and species (Annex II). In addition, strict protection is afforded to species listed on Annex IV of the Directive with all of these species whose natural range includes UK waters being known as European Protected Species (EPS). All cetacean species are listed on Annex IV of the Habitats Directive, and are therefore classed as EPS.
- The *Habitats Directive* has been transposed into Scottish law in territorial waters (within 12 nm) with the *Conservation (Natural Habitats, &c.) Regulations 1994* (as amended in Scotland) and in offshore waters via the *Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007*; and
- In relation to seal conservation, the *Marine (Scotland) Act 2010* replaces the *Conservation of Seals Act 1970* in Scottish waters. Under Part 6 of the new act, it is an offence to kill, injure or take a seal at any time of year, except to alleviate suffering or where a licence has been issued to do so by Marine Scotland. Under the Act is it also an

offence to harass seals at haul-out sites. A separate consultation is presently underway to identify haul-out sites that are to be given protection under the Act.

14.3.2 Policy

8 New systems of marine planning have been introduced across the UK via the UK *Marine and Coastal Access Act 2009* and the *Marine (Scotland) Act 2010*. These Acts enable the creation of Marine Protection Areas (MPAs) to protect features of conservation importance including species not previously covered by European legislation.

9 In 2011, the Scottish Government issued a pre–consultation *Draft National Marine Plan*, which must be drafted in conformity with the UK Marine Policy Statement. One aim of this policy is to turn Scotland's renewable energy resources into a fully developed industry while minimising the environmental impacts from the construction and operation of such developments.

10 Under Section 79 of the Marine (Scotland) Act 2010 and Section 123 of the Marine and Coastal Access Act 2009, the Scottish Government is required to develop a network of Marine Protected Areas (MPAs) that will contribute to the conservation or improvement of the marine environment in the UK by conserving a scientific selection of both marine diversity (species and habitats) and geo-diversity. The eventual aim is for all MPAs, including Special Areas of Conservation (SACs), to become part of this MPA network. In December 2012, the Scottish Government published a report detailing sites currently included within the MPA network. Thirty three Nature Conservation MPA proposals have been developed (in addition to existing SAC/Special Protection Areas (SPAs) that will become part of the network), one of which covers the Firth of Forth Banks (see Figure 9.3). This MPA, known as the Firth of Forth Banks Complex, comprises of three areas with ocean quahog aggregations, offshore subtidal sands and gravels, and shelf banks and mounds listed as protected biodiversity features. Although no marine mammals are listed as protected features for this MPA, their prey may indirectly benefit.

11 In addition to the above , the following plans or agreements also apply to marine mammals:

- UK Post-2010 Biodiversity Framework;
  - The *UK Biodiversity Action Plan* (UKBAP), published in 1994, was the UK Government's response to signing the Convention on Biological Diversity (CBD) at the 1992 Rio Earth Summit. The UKBAP describes the biological resources of the UK and provides detailed conservation plans for these resources. The new UK post-2010 Biodiversity Framework replaces the previous UK level Biodiversity Action Plan and forms the UK Government's response to the new strategic plan of the United Nations CBD, published in 2010 at the CBD meeting in Nagoya, Japan. The UK priority species list has been used to help draw up statutory lists of priorities within the devolved regions. This list includes 21 species of marine mammal including harbour porpoise, bottlenose dolphin and harbour (referred to as common seal within the list) seal. As part of this framework, a 25-year strategy to conserve and

enhance biodiversity in Scotland was published in 2004 (to be reviewed in 2013) to aid implementation of international commitments with regard to MPAs.

- Scottish Priority Marine Features;
  - Scottish Priority Marine Features (PMFs) are habitats and species considered to be marine nature conservation priorities in Scottish waters. The aim of this work is to produce a focussed list of marine habitats and species to help target future conservation work in Scotland. The list includes nine species of marine mammal including the bottlenose dolphin, harbour porpoise, harbour seal and grey seal.

14.4 Design Envelope and Embedded Mitigation

12 The Project potential development parameters and scenarios are defined as a Design Envelope and presented in *Chapter 7*. A precautionary assessment of potential impacts on marine mammals is presented in chapter 14, and is based upon the 'worst case scenario' as identified from this Design Envelope, and is specific to the potential impacts assessed in this chapter.

13 Key parameters for the worst and most likely case scenario for each potential impact are detailed in Table 14.2 below. Guidance received from Marine Scotland and SNH (in meetings) requested that a most likely scenario for construction noise should be considered for marine mammals, contextualised with a description of worst case.

14 For the assessments, the construction scenarios include:

- Duration of construction activities;
- Associated vessel activity;
- Type of offshore structure; and
- Extent of array.

Table 14.2: Design Envelope Parameters Used to Inform the Marine Mammal Assessment

Potential Impact	Design Envelope Scenario Assessed (Worst Case)*
• Disturbance/displacement. • Barrier to movement. In both cases from Wind Turbine Generator (WTG) numbers and layout.	213 WTGs with a minimum cross-wind and down-wind spacing of 820 x 820 m in either a grid or diamond layout. Up to three met masts. Up to five OSPs.
• Reduction in prey availability (indirect impact). • Barrier to movement. In both cases from foundation options and Export Cable protection with regards to habitat loss.	**Development Area** ***Construction***: Total seabed area disturbed is 5.54 km^2, equating to 3.69% of the Development Area (see *Chapter 12: Benthic Ecology, Table 12.2*). ***Operation***: Total loss of original habitat is 1.87 km^2, equating to 1.25% of the Development Area (see Table 12.2). **Offshore Export Cable Corridor** ***Construction***: Sub-tidal area of seabed disturbed across Offshore Export Cable Corridor is 3.02 km^2, equating to 3.0% of Offshore Export Cable Corridor (see Table 12.3). ***Operation***: Total area of original habitat loss is 0.6 km^2 (see Table 12.3).
• Lethal effects and physical injury. • Hearing damage. • Disturbance/Displacement. • Reduction in prey availability (indirect impact). In all cases from piling activities.	**Worst Case** Noise modelling based on four piles per 24 hour period. Modelling calculated on a pile diameter of 2438 mm[1]; maximum blow energy of 1080 kJ. Total duration, including soft start, 4.2 hours. This scenario is estimated to represent 30 per cent of the Development Area. ***Most Likely Case** Noise modelling based on two piles installed per 24 hour period. Modelling calculated on a pile diameter of 2438 mm[1]; maximum blow energy of 1080 kJ. Total duration, including soft start, 2.1 hours. This scenario is estimated to represent 70 per cent of the Development Area.

[1] Although the piles required for the offshore substations may be larger than those required for the WTGs and met masts (up to 3000 mm rather than 2438 mm), it is likely that an equivalent size of hammer will be used to install them on site. Because they will be installed during the same period as the WTGs and similar blow energies will be required, it is considered that their installation is included within the Design Envelope assessed.

Potential Impact	Design Envelope Scenario Assessed (Worst Case)*
• Lethal effects and physical injury. • Hearing damage. • Disturbance/Displacement. • Reduction in prey availability (indirect impact). In all cases from piling activities.	Total number of piles, 944 based on 213 WTGs (213 x 4), five OSPs (5 x 16) and three offshore met masts (3 x 4). This will take place over a two year period, approximately 11 per cent to 23 per cent of time (depending upon the number of vessels used and hardness of substrate encountered). Up to two piling vessels may operate simultaneously within the Development Area.
Toxic contamination: direct and indirect on prey from corrosion and anti-fouling protection.	Cathodic protection, anti-corrosion coatings, anti-fouling paints and mechanical removal of deposits. Potential for use of corrosion inhibitor chemicals inside J-tubes.
Disturbance from inter-array cabling.	AC cables. Maximum cabling length = 353 km. Trench width one metre, buried to a target depth of one metre[2] and protected where burial is not possible. Inter-array cable with maximum protection of 10% of the cables length covering 1.87 km^2 (equivalent to 1.25% of the Development Area).
Disturbance from Export Cable.	AC cables. Up to six trenches, maximum corridor width 1,400 m with individual trench width of one metre. Buried to a target depth of one metre and protected where burial is not feasible (20% of each of the cables with protection width of six metres).
• Collision risk. • Disturbance/displacement. • Toxic contamination. In all cases from vessel movement.	Construction (and Decommissioning): • Approximately 3,500 vessel movements (defined as a transit to and from the construction port and site centre) over total construction period (2016 - 2020). Operation and Maintenance: • A maximum average of six service trips per day.
• Potential bio-accumulation in liver, kidney, bone and fatty tissues. • Potential effect upon health and reproductive success of marine mammal species. From toxic contamination in both cases.	Construction (and Decommissioning): • Approximately 3500 vessel movements (defined as a transit to and from the construction port and site centre) over total construction period (2016-2020). Operation and Maintenance: • A maximum average of six service trips per day.

[2] Burial depth may be as great as three metres. This would be considered to exert a reduced effect upon marine mammal and fish receptors, as increased burial depth will increase shielding/distance to the receptors in the water column.

14.4.1 Embedded Mitigation

15 A range of Embedded Mitigation measures to minimise environmental effects are captured within the Design Envelope. This assessment of effects on marine mammals has taken account of the following Embedded Mitigation measures:

- A mitigation protocol has been developed by the Statutory Nature Conservation Bodies (SNCBs) in order to reduce risk of potential death/physical injury from noise sources to negligible levels (JNCC, 2010a) which will be implemented by ICOL. The Project specific protocol will be detailed in the final Environmental Management Plan (EMP) prior to construction and will reflect current guidance at the time of construction.
- Advances in technology may provide more effective means to aid, enhance or replace the Marine Mammal Observer (MMO) function. The feasibility of alternative approaches will be considered in consultation with regulatory authorities.
- Vessels and plant relating to construction, operation and decommissioning activities will follow best practice and guidance for pollution at sea, detailed in the final EMP, to reduce and coordinate response to pollution events if they were to occur. The final EMP will follow OSPAR, IMO and MARPOL guidelines, and industry best practices regarding pollution at sea. This includes provision for storage of pollutants, and identifies products suitable for use in the marine environment. The EMP will be finalised prior to construction.
- Defined navigational routes will be used by vessels. This will reduce the risk of collision with marine mammals.
- Alternative mitigation techniques will be investigated prior to the finalisation of the construction method statement. Approaches will be confirmed following consultation with regulatory organisations. Adoption of any mitigation measures will be subject to an assessment of technical and commercial feasibility.
- All materials used will be safe for use within the marine environment.
- Cables will be suitably buried or will be protected by other means when burial is not practicable, which will reduce the potential for impacts relating to Electromagnetic Field (EMF).

16 These measures will be delivered as part of the Project (see *Appendix 7A: Draft Environmental Management Plan*).

14.5 Baseline Environment

14.5.1 Baseline - Development Area

<u>**Background**</u>

17 The baseline characterisation has been compiled using existing (published) information, combined with the findings of the studies commissioned by ICOL, the Forth and Tay Offshore Wind Developers Group (FTOWDG) and The Crown Estate (TCE); summarised in Table 14.3. A full review of data utilised can be found in *Appendix 14A*.

Table 14.3: Summary of Data Sources Used for Impact Assessment

Species	Data source
Grey seal Harbour seal	• Seal baseline report (Sparling *et al*., 2012) • TCE aerial survey report (Grellier and Lacey, 2012) • Boat-based survey report (Canning, 2012) • SCOS report (2011) • Harbour seal haul-out data (Duck and Morris, 2012)
Bottlenose dolphin	• FTOWDG bottlenose dolphin report (Quick and Cheney, 2011) • Reid *et al*. (2003) • An integrated cetacean analysis for the three FTOWDG sites (Mackenzie *et al*., 2012)
Harbour porpoise Minke whale White-beaked dolphin	• Boat-based survey report (Canning, 2012) • TCE aerial survey report (Grellier and Lacey, 2012) • Reid *et al*. (2003) • An integrated cetacean analysis for the three FTOWDG sites (Mackenzie *et al*., 2012)

Cetaceans

18 The Firths of Forth and Tay are home to two resident cetacean species (harbour porpoise and bottlenose dolphin) and two species which occur seasonally (minke whale and white-beaked dolphin). Other species which occur on a more occasional basis include killer whale (e.g. in 2006 and 2007 and during commissioned studies), sperm whale (e.g. in 1997), humpback whale (e.g. in 2003 and 2006), long-finned pilot whale (e.g. during commissioned studies), common dolphin (e.g. during commissioned studies) and white-sided dolphin. A summary of the most frequently observed species can be found in Table 14.4 below.

Table 14.4: Summary of Most Commonly Observed Cetaceans in the Firths of Forth and Tay Area

Cetacean	Summary
Harbour porpoise (*Phocoena phocoena*)	Most commonly encountered cetacean in Firths of Forth and Tay. Observed all year round either singly or in small groups. Mating and calving in UK waters is estimated to occur between April and August with a peak in June/July. Important prey species include sandeel and whiting. FTOWDG-commissioned analysis of shared cetacean data estimated an absolute abundance[3] of 582 individuals (95% CI: 581-1235), distributed throughout the survey area (see Figure 14.1). See *Appendix 14A, Section 14A.2.2* for full review.
Bottlenose dolphin (*Tursiops truncatus*)	Bottlenose dolphins associated with the Moray Firth SAC are known to travel along the Scottish east coast, including the Firths of Forth and Tay. Their diet is diverse, with predominantly cod, saithe and whiting being important prey species. Their distribution is primarily coastal. The SAC population is currently estimated to contain 195 individuals, with between 42% and 73% known to use the coastal waters of St Andrews Bay and the Forth of Tay area throughout different periods of the year. Data collected at Arbroath and Fife Ness acoustically detected dolphins in all months of the year. For the purpose of this impact assessment, based on a review of available research data and through consultation with leading scientific experts in the field, it has been assumed that at any point in time, half of the bottlenose dolphin population of the Moray Firth SAC can be found within the Moray Firth and the remainder of the population will be spread out along the east coast in waters from Peterhead to Eyemouth in water less than 20 m deep (see Figure 14.2 for predicted densities). See *Appendix 14A, Section 14A.2.2* for full review.
White-beaked dolphin (*Lagenorhynchus albirostris*)	Commissioned surveys in the Forth and Tay area recorded sightings primarily in offshore waters with more observations during the summer months. A variety of prey species are taken with haddock and whiting identified as being important in Scottish waters. FTOWDG-commissioned integrated analysis of cetacean data estimated and absolute abundance of 293 individuals (95% CI: 267-1055; see Figure 14.3). See *Appendix 14A, Section 14A.2.2* for full review.
Minke whale (*Balaenoptera acutorostrata*)	This is the most commonly sighted whale species during boat surveys conducted in the Firths of Forth and Tay area, with most sightings occurring greater than 12 nm from the coast (approx. 85%). Sightings rate within 12 nm is 0.04 animals/100 km^2 compared to 0.13 animals per 100 km^2 outside. Greater numbers have been recorded during the summer months than at other times of the year. Diet is thought to consist mainly of sandeel and clupeids. FTOWDG-commissioned integrated analysis of cetacean data estimated an absolute abundance of 594 individuals although confidence in this estimate is low (95% CI: 483-2695; see Figure 14.4). See *Appendix 14A, Section 14A.2.2* for full review.

[3] Absolute abundance provides a population estimate expressed as number of individuals per unit area, in this case the combined survey area.

Figure 14.1: Estimated Harbour Porpoise Absolute Density Based on Corrected Count Data (MacKenzie *et al*., 2012)

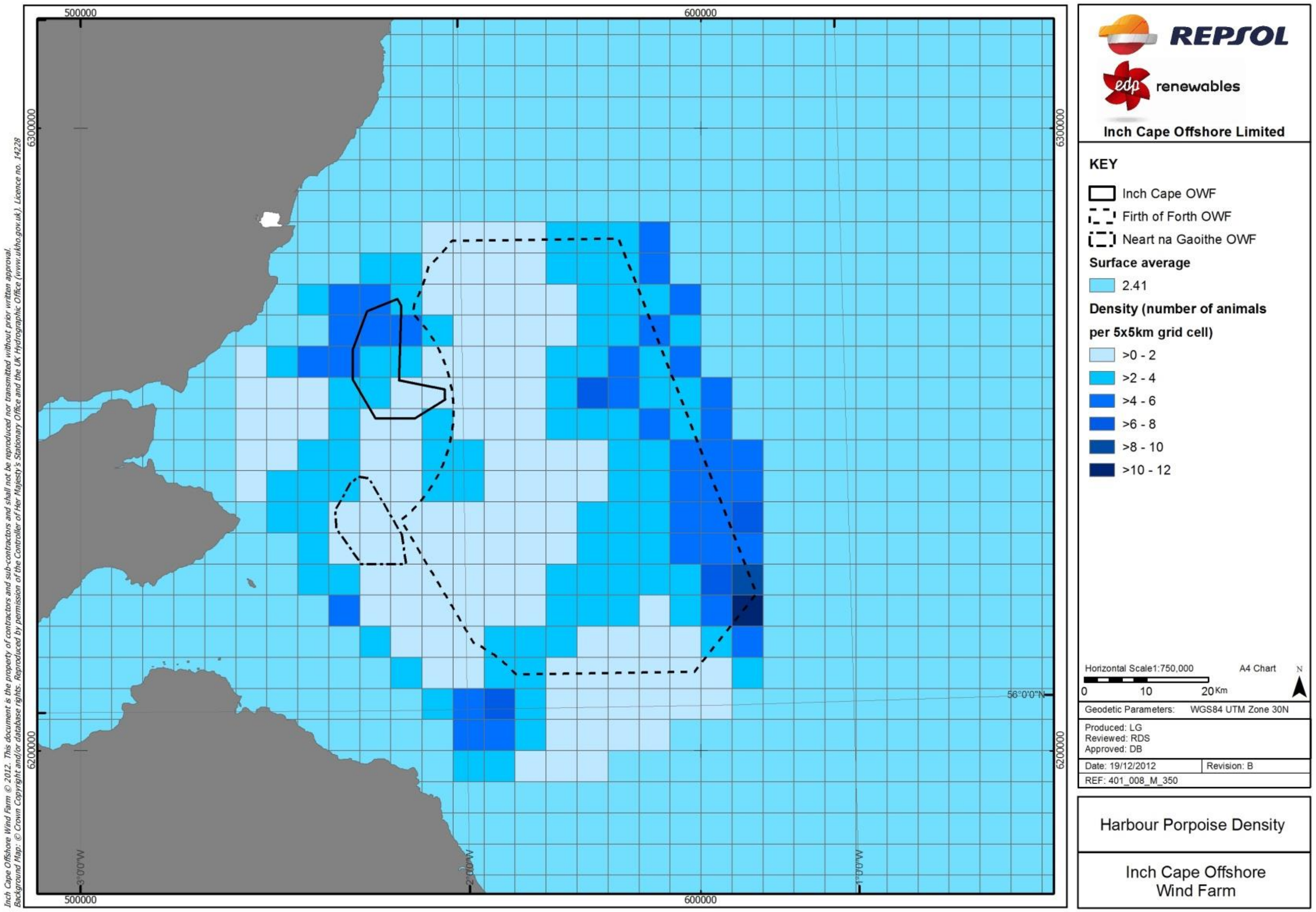


Figure 14.2: Predicted Bottlenose Dolphin Density in Coastal Waters Outside of the Moray Firth

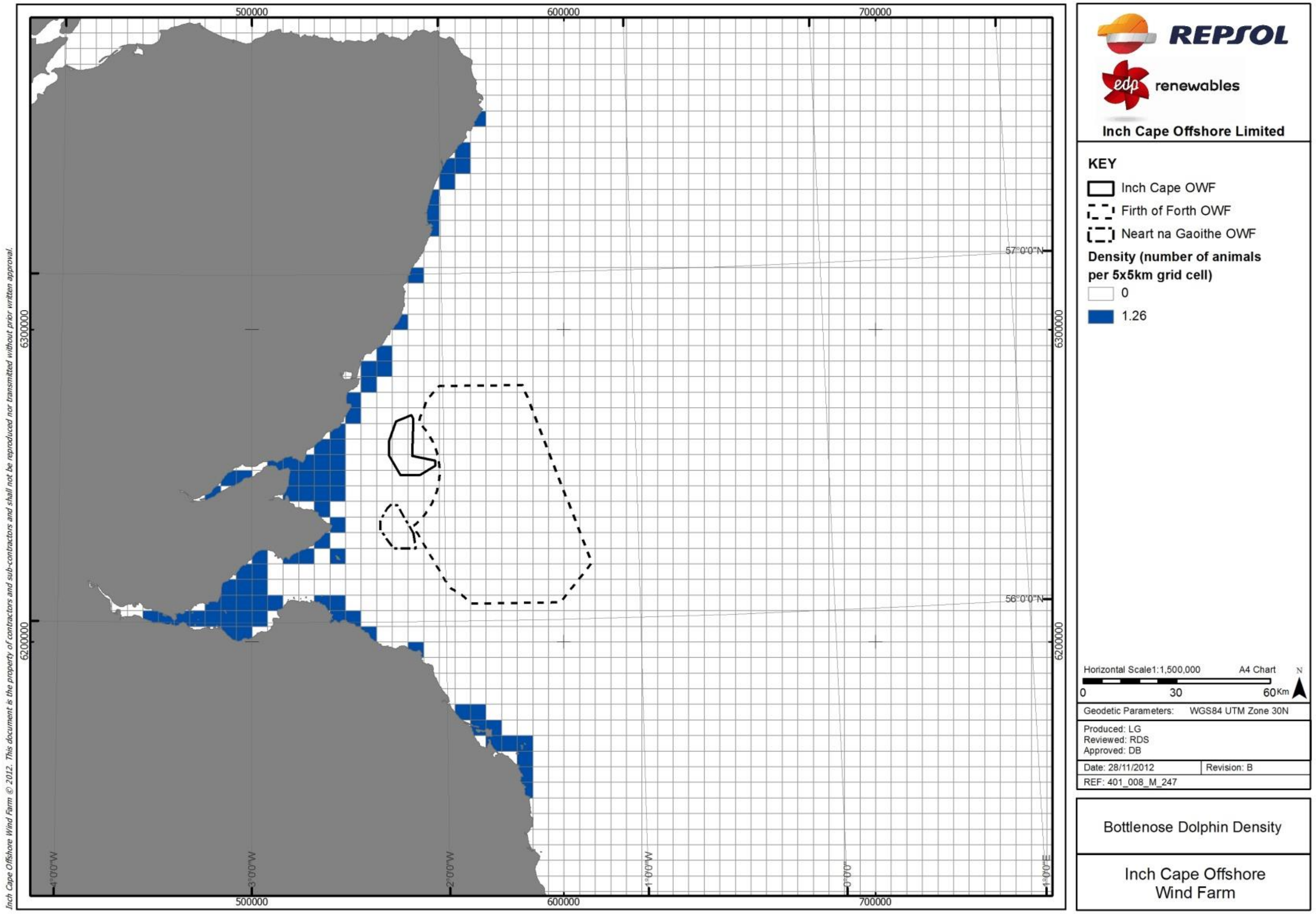


Figure 14.3: Estimated White-Beaked Dolphin Density Based on Corrected Count Data (Mackenzie *et al.*, 2012)

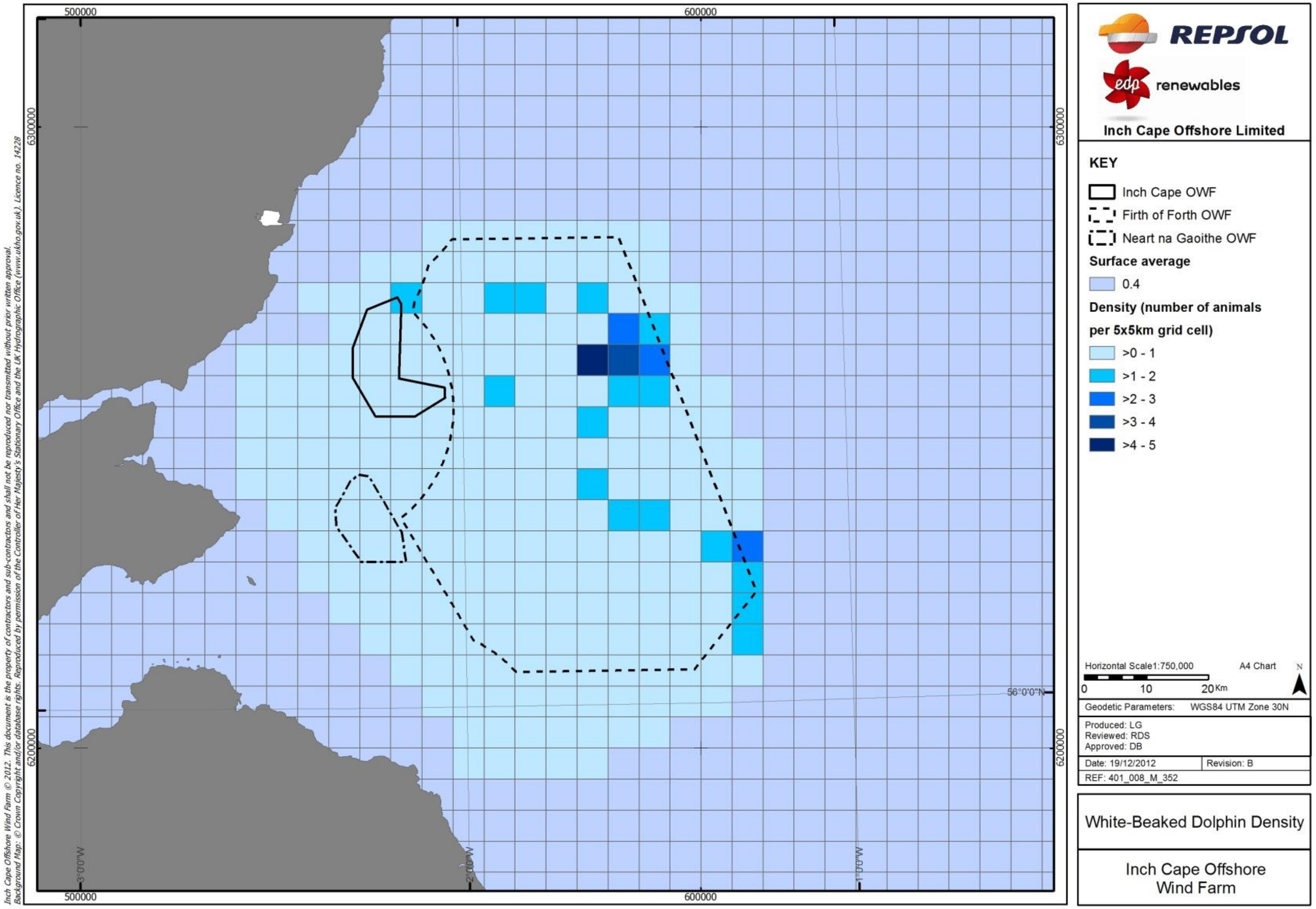
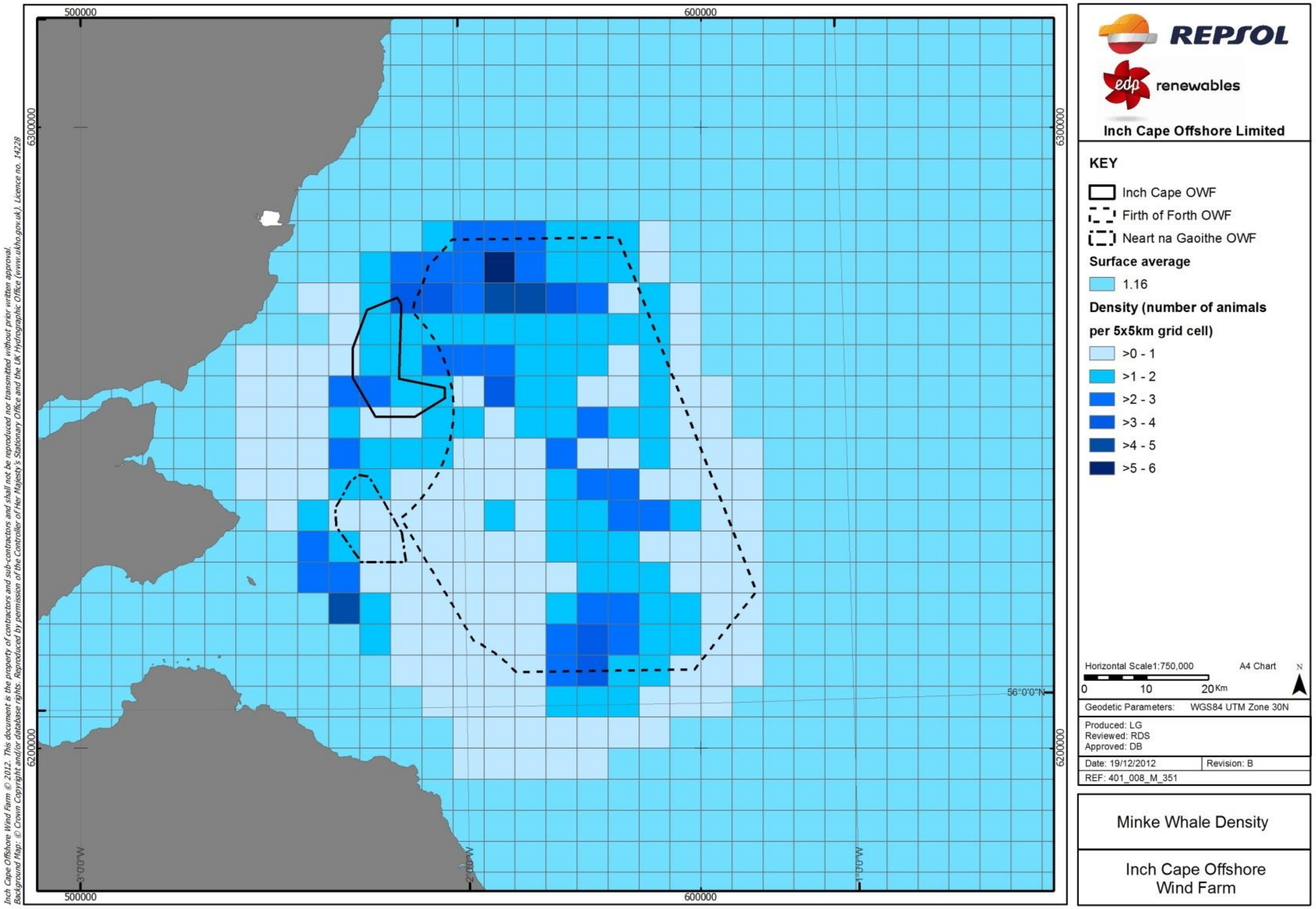


Figure 14.4: Estimated Minke whale Absolute Density Based on Corrected Count Data (Mackenzie *et al.*, 2012)



Pinnipeds

19 Two pinniped species are found in the Firths of Forth and Tay, namely grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*). Table 14.5 below provides a summary of the detail provided in *Appendix 14A, Section 14A.2.3*.

Table 14.5: Review Summary of Most Commonly Observed Pinniped Species in the Firths of Forth and Tay Area

Pinniped	Summary
Harbour seal (*Phoca vitulina*)	Harbour seals haul out along the Angus, Fife and Lothian coasts, with counts in these areas declining dramatically since the early 2000s. They are present in the Tay and Eden estuaries throughout the year, with greater numbers observed during the summer months coinciding with pupping (June - July) and moult (July - September). Tracking studies suggest harbour seals regularly travel through the Firth of Forth and Tay area when foraging. Figure 14.5 below shows the density surface for harbour seal. For the purpose of this assessment, the reference population is assumed to be 638 seals based on SMRU survey data (2007) for the East Coast Management Area (ECMA) corrected for animals at sea. See *Appendix 14A, Section 14A.2.3* for full review.
Grey seal (*Halichoerus grypus*)	Non-breeding grey seals can be found hauled out at a number of sites along the east coast of Scotland including the Firths of Forth and Tay. The nearest breeding colony to the Development Area can be found on the Isle of May, an area designated as an SAC for grey seals. Pupping occurs here between September and December. Lower counts have been made at a number of other small islands within the Firth of Forth and at Fast Castle, on the southern edge of the Firth. Grey seals were recorded in all months of the year during commissioned surveys with peak occurrence within the Development Area occurring in July. Tracking studies demonstrate that at least a proportion of seals hauled out in the St Andrews Bay area will travel through the Development Area in order to reach foraging grounds. Figure 14.6 below shows the density surface for grey seal. For the purpose of this assessment, the reference population is given to be 7,112 seals based on SMRU survey data (2007) of the ECMA corrected for animals at sea. See *Appendix 14A, Section 14A.2.3* for full review.

Figure 14.5: Harbour Seal Density

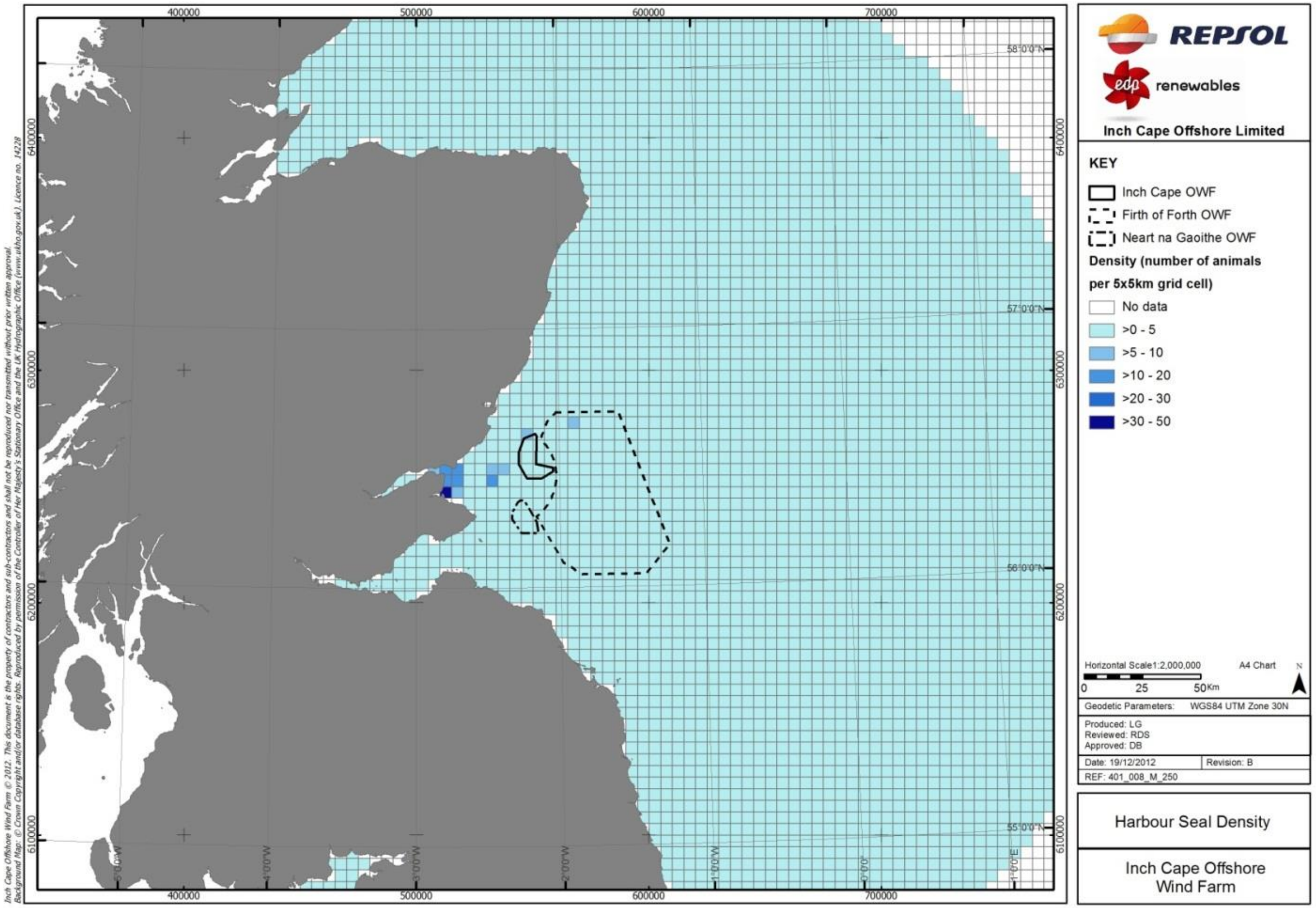
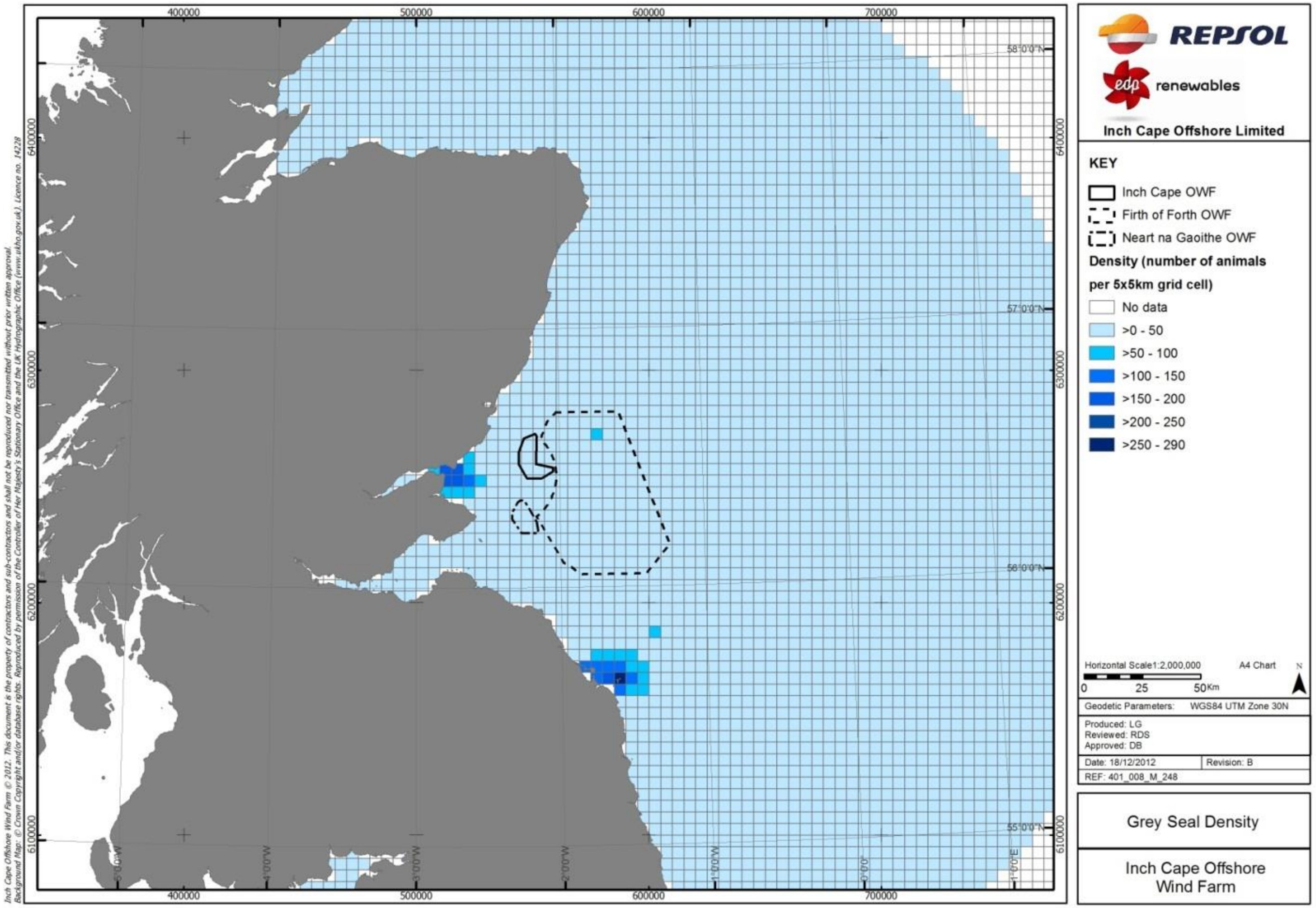


Figure 14.6: Grey Seal Density



14.5.2 Baseline - Offshore Export Cable Corridor

20 The Offshore Export Cable Corridor exits the south side of the Development Area, passing to the south of the Isle of May, coming ashore at either Seton Sands or Cockenzie (see Figure 7.1) on the southern side of the Firth of Forth. Of the marine mammal species discussed in the previous section, grey seal and bottlenose dolphin are of particular relevance with regard to the Offshore Export Cable Corridor.

21 The Offshore Export Cable Corridor passes relatively close to the south-west of the Isle of May (approximately 5.5 km at the nearest point), an area designated as an SAC for grey seal. Around 2,000 pups are born each year on the island, with lower numbers recorded on smaller islands in the southern half of the Firth of Forth. A fast-growing colony can also be found at Fast Castle, on the southern outer reaches of the Forth.

22 Bottlenose dolphins in Scottish waters are primarily coastal, generally observed in waters of less than 25 m deep. Survey effort in the Forth and Tay area has primarily covered the Firth of Tay and St Andrews Bay area. An acoustic study on the northern side of the Forth (Fife Ness) recorded 'dolphins' in every month between 2006 and 2009. The length of time dolphins appeared to stay in the area was low compared to the Moray Firth, suggesting that the dolphins may have been travelling through the Firths of Forth and Tay (see *Appendix 14A, Section 14A.2.2*). While there appears to be no reports of bottlenose dolphins near to Seton Sands or Cockenzie, they have been recorded to the south of the Firth of Forth along the Northumberland coast suggesting they cross the Offshore Export Cable Corridor.

14.5.3 Baseline without the Project

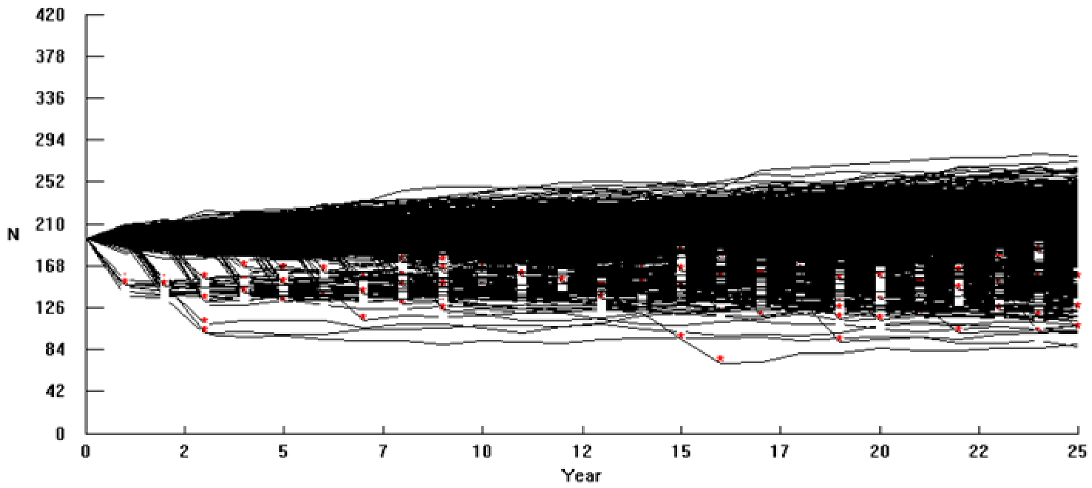
<u>Cetaceans</u>

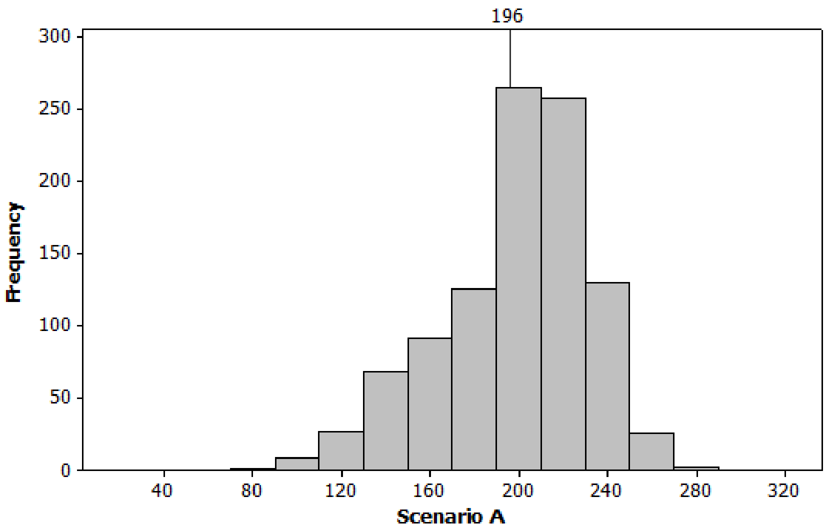
23 The ranging behaviour and population structure of harbour porpoise, minke whale and white-beaked dolphins in the North Sea remains unclear due to a lack of data. This coupled with the wide ranging nature of these animals, means that predicting future trends in populations is challenging, and any assessment based on these predictions will have an inherent uncertainty associated with them. However, the best data available has been used in this assessment ensuring the level of uncertainty is minimised. The UK conservation status assessment for all three species is considered "favourable" (JNCC, 2007).

24 The conservation status of the bottlenose dolphin in UK waters is also considered to be "favourable", with abundance estimates remaining relatively stable during the years studied to date. Population modelling has been undertaken for bottlenose dolphin (*Appendix 14B, Section 14B.3.5*). A baseline scenario (Scenario A) was run 1,000 times to provide a distribution of final population sizes after 25 years, in the absence of the Project, the results of which are presented below (Figure 14.7). Each line in the upper graph represents a different model run, each predicting how the number of dolphins in the population will change over the 25 year period. The histogram below represents the number of times (frequency) each outcome was predicted at the end of the 25 year period (195 is the present estimated population size). The outputs from this model suggest that the bottlenose dolphin population will remain stable over the next 25 years in the absence of the Project (because

the majority of model runs are in the same bin (or population group size, shown in Figure 14.7), as the current population estimate).

Figure 14.7: Bottlenose Dolphin Population Modelling Scenario A: Baseline (PTS: None, Displacement: None)



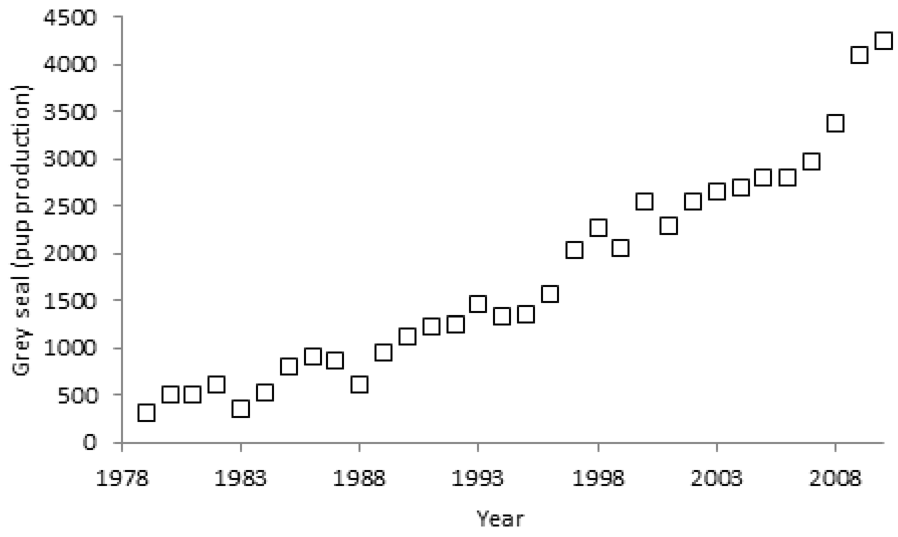


Pinnipeds

25 Grey seal pup production has been increasing during recent years in many areas including the North Sea, and their conservation status is considered "favourable".

26 Figure 14.8 below illustrates grey seal pup production at the Fast Castle, Isle of May and Inchkeith breeding colonies in the Firth of Forth.

Figure 14.8: Increase in Grey Seal Pup Production at Colonies in the Firth of Forth (Redrawn Using Data Provided in SCOS, 2011)



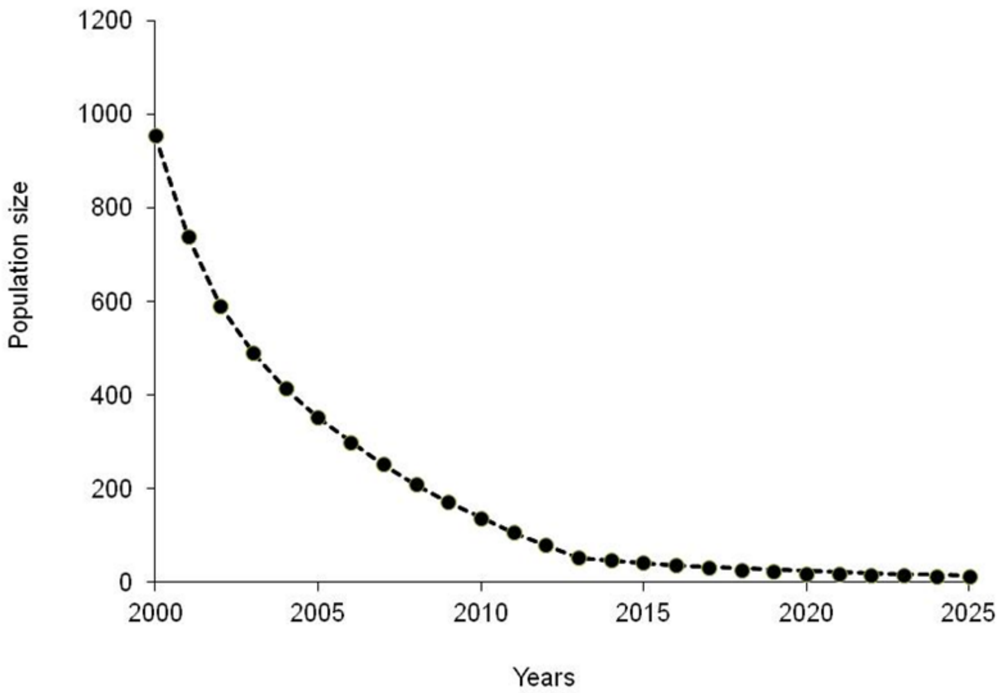
27 Some harbour seal populations, including those found in the Firths of Forth and Tay, have been decreasing since the mid-1990s where others have been increasing, e.g. the Moray Firth. The future prospect for their conservation status is stated as being "unknown" in the last UK assessment (JNCC, 2007).

28 Population modelling has been undertaken for harbour seals for the Firth of Tay and Eden Estuary SAC. Full details are presented in *Appendix 14D*. To establish a baseline, it was assumed that the population trend (18 per cent decline per annum based on Lonergan and Thompson, 2012) of the Firth of Tay and Eden Estuary SAC was similar across the whole East Coast Management Area (ECMA). The cause of this population decline is currently unknown, but a number of harbour seal carcasses have been recovered on the coast of the east of Scotland that had experienced traumatic 'corkscrew' injury. The cause of this injury is also unknown, but the current hypothesis is centred around the animals being pulled through a cowling or channel containing a rotating blade (a ducted propeller in use on numerous vessel types).

29 The models produced suggest a continuation in the current trend of decline for the Forth of Tay and Eden Estuary SAC population, with the species effectively disappearing within the next 20 years. Random variations in the sex-ratio of births and the timings of natural deaths in the model suggest this would occur much sooner than 20 years (Lonergan and Thompson, 2012). Figure 14.9 below illustrates the predicted harbour seal population trend assuming 18

per cent decline per annum continues but that corkscrew injury death is resolved (to allow modelling against a baseline to take place). If the cause of the decline were to be identified and rectified immediately and fully, recovery of the population to the same abundance levels as when the SAC was designated is predicted to take at least 40 years (Lonergan and Thompson, 2012).

Figure 14.9: Harbour Seal Population Baseline Scenario Modelling. Assuming that the Corkscrew Seal Death Issue is solved in 2013 (and Therefore there is No Further Removal from the Population due to Mortality from this Cause)



14.6 Assessment Methodology

14.6.1 Methodology

30 The aim of this assessment is to describe and assess the magnitude of impact that specific activities associated with the Wind Farm and OfTW may have on marine mammals both on the individual, and at the population level. Potential impacts are either direct or indirect, with the latter defined as an impact that effects a receptor that marine mammals rely on (i.e. prey species) as opposed to affecting the marine mammal directly.

31 The methodology described below is of relevance to all subsequent assessment sections. *Sections 14.7 and 14.8* consider potential impacts associated with Wind Farm and OfTW (within the Development Area and Offshore Export Cable Corridor respectively), with *Section 14.10* (Cumulative Impacts) discussing potential impacts associated with the different elements of the Project cumulatively, and the Project cumulatively with other developments both within the Forth of Tay and in the wider coastal and offshore area that may have the potential to impact marine mammals. Details of how the outputs from these methods have been utilised for HRA can be found in *Section 14.13.*

32 The assessment process used for marine mammals is based on methodologies recommended by the Institute of Ecology and Environmental Management (IEEM, 2010) and those set out in *Section 4.4*. Expert opinion has been used to develop assessment criteria for predicting significance of impacts (see Table 14.8) and some additional definitions are provided by Wilhelmsson *et al*. (2010) in a review of potential impacts of offshore wind developments.

33 The basic assessment steps are as follows:

- Identification of potential receptors and description of baseline conditions;
- Predict activities during the different stages of the project development that may result in potential impacts;
- Characterisation of potential impacts including likelihood of occurrence;
- Assess whether impacts are significant and the geographical scale at which they may occur;
- Assess cumulative impacts;
- Propose mitigation if applicable; and
- Assess whether residual impacts (after mitigation) are significant.

34 Table 14.6 defines some key terms used in this assessment.

Table 14.6: Definition of Terms Used in Assessment

Term	Definition
Magnitude	Size of potential impact e.g. number of individuals predicted to be affected.
Extent	Area over which the impact is predicted to occur.
Duration	Time period over which an impact is predicted to occur e.g. short-term (occur over a few days); medium term (occur over construction years); long term (occurring for up to 25 years) (Wilhelmsson *et al*., 2010).
Reversibility	Is the potential impact predicted to be reversable (either though natural processes or mitigation)?
Timing	Period of the year the activity would need to occur, to result in a potential impact.
Frequency	Frequency of activity leading to potential impact.
Risk	Likelihood the potential impact will occur.

35 Certainties in predictions for this assessment follow the criteria described in Table 14.7, based on IEEM guidance (IEEM, 2010) with the exception of the term “probable”. Instead of probable, this assessment uses the term “possible” to reflect the uncertainty surrounding estimation of impact on marine mammals acknowledged throughout academia and industry.

Due to these degrees of uncertainty, the assessment incorporates a series of conservative assumptions about the potential impacts of noise on marine mammals (see *Appendix 14B*, Table 14B.11). Thus the predicted impacts are thought to be overly conservative and thus 'possible' and not 'probable'.

36 The EIA regulations require an assessment of 'likely effects'. For the purpose of this assessment, if these conservative assumptions used throughout this assessment are shown to be correct, the assessment represents 'likely' predictions of effects and thus impacts.

Table 14.7: Criteria Used for Predicting Certainty in Predictions During the Assessment

Term	Definition
Certain	Interactions are well understood and documented, i.e. receptor sensitivity investigated in relation to potential impact, data have comprehensive spatial coverage/resolution and predictions relating to effect magnitude modelled and/or quantified. Probability estimated at >95%.
Possible	Interactions are understood using some documented evidence, i.e. receptor sensitivity is derived from sources that consider the likely effects of the potential impact, data have a relatively moderate spatial coverage/resolution, and predictions relating to effect magnitude have been modelled but not validated. Probability estimated at 50% - 95%.
Uncertain	Interactions are poorly understood and not documented, i.e. predictions relating to effect magnitude have not been modelled and are based on expert interpretation using little or no quantitative data. Probability estimated at <50%.

37 The geographical scale at which the significance of a potential impact may occur is defined as:

- Local – receptors of local importance.
- Regional – receptors of regional importance.
- National – receptors are a feature of a UK designated site or UK Biodiversity Action Plan (UKBAP species).
- International – receptors are a feature of European designated sites (e.g. SACs).

38 To determine the significance of potential impacts on marine mammal species, an impact significance matrix has been utilised throughout the impact assessment (Table 14.8), to ensure consistency. This is based on the duration and magnitude of the potential impact upon marine mammal species, using the criteria for predicting certainty (Table 14.7 above) and the definitions outlined in Table 14.6 above.

39 Given the level of legal protection afforded to all of the marine mammals likely to be encountered within the Firth of Forth and Tay, all species of marine mammal (both cetaceans and pinnipeds) are considered to be of high sensitivity in this assessment. Magnitude has been assessed using a scale that experts consider to be measurable if change is within a population size (Moray Offshore Renewables Limited, 2012 (marine mammals

chapter)). Due to the large confidence intervals of population size estimates for marine mammals within UK waters, a change of 20 per cent was considered measurable.

40 The long term duration criteria used in Table 14.8 (25 years) is considered appropriate due to the potential for one to two generations of marine mammal species to be affected during the impact period, therefore long term impacts with respect to population change (if any) will be evident during this time. It is considered that if potential impacts from construction activity are not evident after a 25 year modelling period, they would not be evident over a greater period of time. This long term duration criteria also concurs with conservation assessments, including those used by the International Union for Conservation of Nature (IUCN) where a 25 year time scale is applied when considering conservation status. This will be relevant to all marine mammal species considered in this assessment.

Table 14.8: Criteria Used for Predicting Significance of Impacts

	Duration of Impact		
Magnitude	**Short Term (Days)**	**Medium Term (Construction Years)**	**Long Term (detectable after 25 years)**
High (>20% of population)	Moderate/Major	Major	Major
Medium (10-20% of population)	Minor	Moderate	Moderate
Low (<10% of population)	Negligible	Minor	Minor

41 For the purposes of this assessment those residual positive and negative effects indicated as Major and Moderate/Major are considered significant.

14.6.2 Guidance and Methods

42 The following guidance documents have been taken into account as part of the marine mammal assessment process:

- *The deliberate disturbance of marine European Protected Species. Guidance for English and Welsh territorial waters and the UK offshore marine area* (JNCC, 2008)[4];
- *The protection of marine European Protected Species from injury and disturbance*, JNCC (2010b);

[4] While we believe that DEFRA have adopted this guidance as it currently stands, the guidance has been amended to reflect slight changes in legislation and is currently under review.

- *Methodologies for measuring and assessing potential changes in marine mammal behaviour, abundance or distribution arising from the construction, operation and decommissioning of offshore wind farms* (Diederichs *et al*., 2008);
- *Assessment and costing of potential engineering solutions for the mitigation of the impacts of underwater noise arising from the construction of offshore wind farms*, BioConsult SH (2008);
- *Guidelines for Ecological Impact Assessment in Britain and Ireland: Marine and Coastal Institute of Ecology and Environmental Management* (IEEM, 2010);
- *Greening Blue Energy: Identifying and managing the biodiversity risks and opportunities of offshore renewable energy* Wilhelmsson *et al*. (2010); and
- *Framework for assessing the impacts of pile-driving noise from offshore wind farm construction on Moray Firth harbour seal populations* (Thompson *et al*., 2011a).

14.7 Impact Assessment – Development Area

14.7.1 Effects of Construction

43 Table 14.9 below summarises the key risks to marine mammals which are associated with construction activities.

Table 14.9: Summary of the Key Risks to Marine Mammals Associated with Construction Activities

Risk	Associated Activity	Impact
Hearing damage (temporary and permanent)	Increased noise levels particularly during piling operations.	Potential for immediate distress, disturbance and displacement; Potential for long-term reduction in individual survival; Potential reduction in ability to find prey, avoid predators and to socially interact.
Temporary disturbance/ displacement	Increased vessel movements; Elevated noise levels from activities such as piling.	Restricted access to food sources, breeding grounds or migration routes leading to reduced fitness; Potential for increased competition for resources elsewhere (in areas where displacement has resulted in a localised increase of marine mammal activity).
Collision	Vessel movement, including those with ducted propellers.	Physical injury and reduced viability, potentially leading to long-term incapacity/death.
Toxic Contamination	Any offshore activity that may cause a pollution incident i.e. diesel spillage from vessels, oil leakage from equipment.	Potential for non-toxic and toxic contamination through accidental spillages and pollution incidents could lead to death or physiological injury.

Risk	Associated Activity	Impact
Changes in prey availability	Indirect impact resulting from increased noise and/or habitat disturbance.	Changes in prey availability may result in reduction in fitness and breeding success.

Increased Underwater Noise (Non-piling Construction Activities)

Overview of Impact

44 Marine mammals have very good underwater hearing and as a consequence are sensitive to increased underwater noise (Koschinski *et al*., 2003, Thomsen *et al*., 2006, Madsen *et al*., 2006). Cetaceans rely heavily on sound to feed, navigate and to interact socially. Sound travels much further underwater than in air, and anthropogenic noise has the potential to affect marine mammals at relatively large distances from the source. The propagation of noise through the water column is dependent on a number of factors including the depth of the water, with noise travelling further through deeper water.

45 Reported responses by marine mammals to increased noise (Weilgart, 2007) include the following:

- Changes in foraging/diving behaviour, swim speed, respiration or vocalisation, stress levels;
- Displacement/avoidance;
- Hearing damage (temporary and permanent); and
- Stranding/death.

46 Some of these responses can be subtle and difficult to detect, and there are many documented cases of apparent tolerance of noise (for example: Richardson *et al*., 1995; 1999; Madsen *et al*., 2002; Croll *et al*., 2001). Although the consequences of the more direct impacts (such as mortality) are relatively clear, it is more difficult to assess the biological consequences of behavioural responses and auditory injury. Nevertheless, these have the capacity to lead to higher energetic demands on the individual, higher predation risk, or decreased reproduction; potentially impacting both the individual and the population as a whole.

Characterisation of Impact

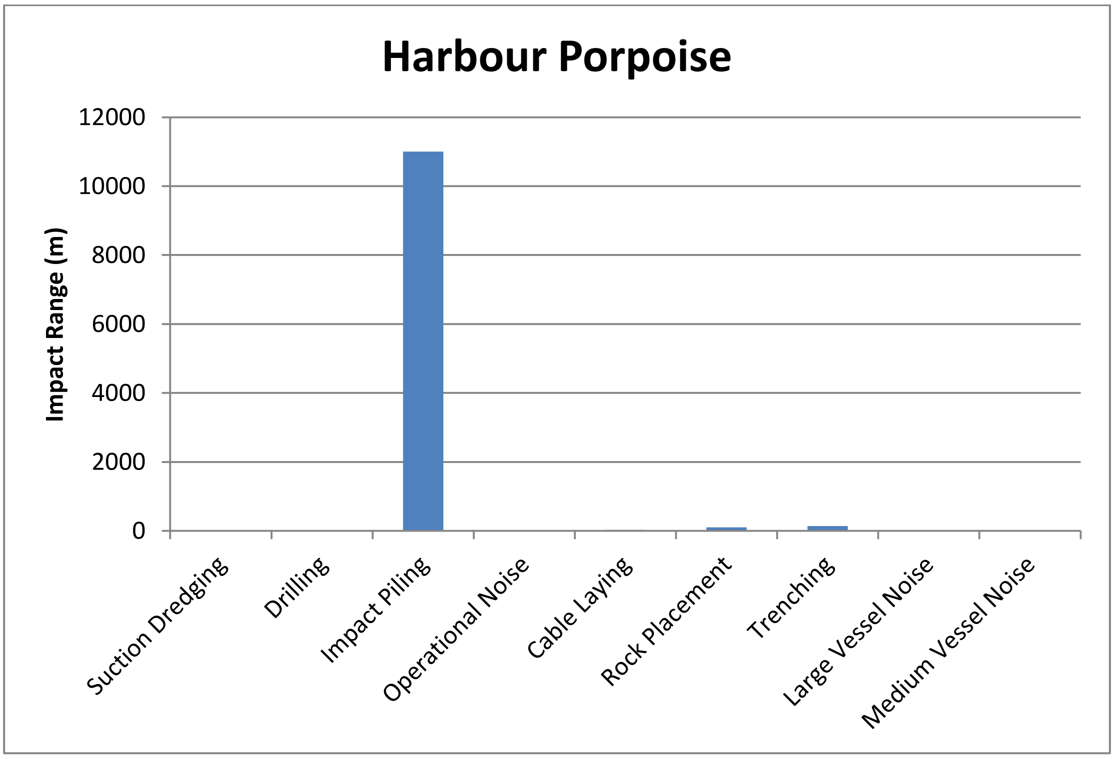
47 Details regarding the proposed construction activities are presented in Table 7.12. During periods when no impact piling is occurring, marine mammals may react to other sources of construction noise such as trenching, rock placing, cable laying, dredging and vessel noise.

48 Figure 14.10 and Figure 14.11 below are based on the Simple Propagation Estimator And Ranking (SPEAR) modelling outputs for harbour porpoise (see *Section 11.6.1* for details of the SPEAR modelling and parameters used), and provide an indication of the perceived underwater noise range for various construction related activities.

49 The results presented below are for harbour porpoise, a species with a hearing range considered representative of, or conservative for, other marine mammal species likely to encounter the construction works within the Development Area (details of ranges for other species modelled can be found in *Section 11.6.1*. The perceived noise ranges of construction activities for marine mammal species other than harbour porpoise (as detailed in *Section 11.6.1*) shows a similar pattern of audibility ranges to those of harbour porpoise.

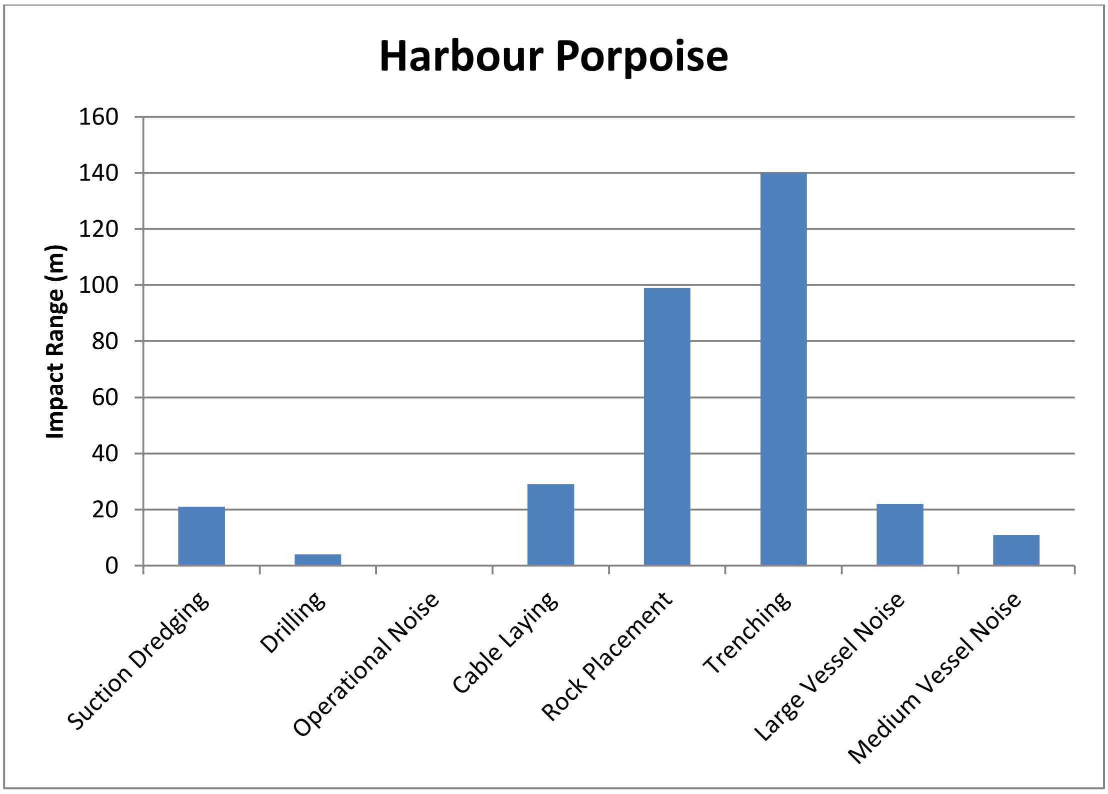
50 Figure 14.10 illustrates the range at which noise from different construction related activities reaches 90 dB_{ht} (harbour porpoise) from the point of noise source, as predicted by SPEAR modelling. The figure also provides a 90 dB_{ht} (harbour porpoise) range for an operational 3.6 MW offshore WTG (which is the largest operational WTG within the Subacoustech Ltd database). 90 dB_{ht} (species) is the level at which the perceived noise level is predicted to cause a strong avoidance reaction in virtually all marine mammal individuals (Nedwell, 2007). Rank ordering of the noise levels showed that the majority of construction activities had very small ranges in which perceived noise reached 90 dB_{ht} levels (within 100 m of activity), with the greatest levels of noise produced by impact piling. Impact piling noise was modelled in detail using the Impulse Noise Sound Propagation and Impact Range Estimator (INSPIRE) model. Further details of this INSPIRE modelling can be found in *Section 11.6.2*. How this prediction of noise propagation has been utilised with respect to prediction of impacts from piling related noise and can be found in the proceeding section and *Appendix 14B*, *Section 14B.3* and illustrated in *Appendix 14C*.

Figure 14.10: Spatial Extent of Noise Range for Various Construction and Operation Related Activities at 90 dB_{ht} (Harbour Porpoise)



51 Figure 14.10 shows that, for 90 dB_{ht} (harbour porpoise), noise produced during impact piling is of a much greater magnitude than that produced by any of the other construction activities, with an range of 11 km at 90 dB_{ht} (harbour porpoise). Trenching has the greatest potential 90 dB_{ht} (harbour porpoise) range of non-piling activities (140 m; Figure 14.11). Rock placement has a likely 90 dB_{ht} (harbour porpoise) range of approximately 100 m. All other non-piling construction activities have potentially only very localised noise ranges of less than 30 m at 90dB_{ht} (harbour porpoise).

Figure 14.11: Spatial Extent of Noise Ranges for Various Construction and Operation Related Activities (Excluding Piling) at 90 dB_{ht} (Harbour Porpoise)



52 These results show that the primary source of underwater noise during construction (and therefore the greatest impact on marine mammals) is likely to be from impact piling. The potential impacts of piling noise are discussed in greater detail in the proceeding subsection and *Appendix 14B*. While occurring, piling noise is considered likely to mask audible noise levels related to other construction activities within the vicinity of the Development Area, and thus it is considered that there would be no detectable difference between the impacts of piling on its own and in conjunction with other activities.

53 Construction of the Wind Farm will involve an increase in vessel traffic for the transportation of materials and installation activities throughout the duration of the construction phase (see *Chapter 19*). As outlined in *Section 14.7.1*, an increase in vessel noise is expected during the construction phase, however at the time of writing, only a broad assessment of an increase in vessel noise has been possible. SPEAR modelling has shown that for large vessels travelling at 10 knots, the perceived underwater noise range at which significant displacement is predicted will be approximately 20 m (harbour porpoise). The frequency and

sound levels produced by an increase in vessel movement will be dependent on vessel size, type and speed of vessel movements, which may vary throughout the construction phase (see *Chapters 19* and *11*). Potential for impact on marine mammal species will be dependent upon the vessel transport routes taken. Potential construction ports are yet to be confirmed and, therefore, potential transport routes remain uncertain. However, it is likely that during the construction phase, background noise and vibrations from vessel engines will increase in the surrounding environment, both within the Development Area and from commuting vessels (travelling to and from the Development Area). Modelling predicts that 90 dB_{ht} (harbour porpoise) noise level ranges from individual large vessels are predicted to be no greater than 22 m, with ranges for other species being smaller.

54 Coastal species such as bottlenose dolphins have been shown to both use (Sini *et al*., 2005) and avoid (Polacheck and Thorpe, 1990; Bristow, 2004) areas with a high frequency of vessel traffic. Marine mammal responses to vessel traffic will likely vary according to the vessel size, activity and speed (Sini *et al*., 2005). It is therefore possible that some species have the potential to be excluded from supporting habitat. However, acclimatisation to vessel presence and noise has also been observed in some species (Koschinski and Culik, 1997; Richardson *et al*., 1995; Laist, 2001; Sini *et al*., 2005; Leung and Leung, 2003). It is therefore uncertain how marine mammal species will respond to an increase in construction-related vessel traffic and in this respect the above disturbance represents a conservative assessment.

Significance of Impact

55 The results of the SPEAR modelling suggest that potential effects of increased noise from non-piling activities will be localised (within 140 m; see Figure 14.11). The magnitude of effect of increased underwater noise from non-piling construction activities on all marine mammal species likely to be encountered in the vicinity of the Development Area is considered to be low. Thus, combined with a temporary (medium term) duration, a minor impact is predicted.

Increased Underwater Noise (Piling During Construction)

Overview of Impact

56 As discussed in the previous sub-section, marine mammals are sensitive to increased underwater noise (Koschinski *et al*., 2003; Thomsen *et al*., 2006; Madsen *et al*., 2006) and SPEAR modelling has demonstrated that the greatest source of noise will be impact piling.

Characterisation of Impact

57 A thorough assessment of potential noise impacts on marine mammals from piling is presented in *Appendix 14B* with accompanying figures presented in *Appendix 14C*. A summary of the modelling carried out and the main conclusions drawn are presented here.

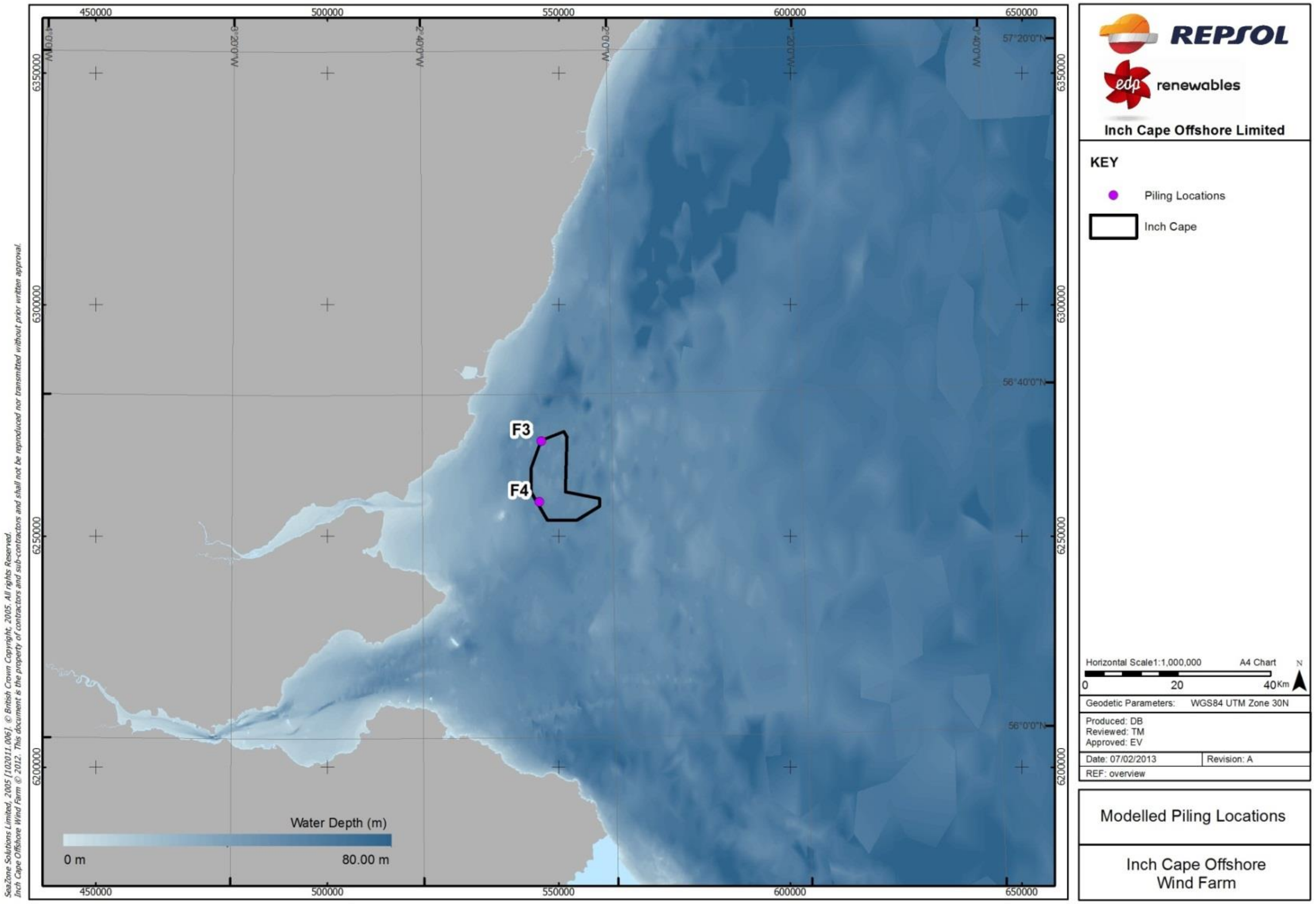
58 As discussed above, underwater noise modelling was undertaken by Subacoustech Environmental Ltd to predict the exposure of marine mammals to piling noise (see *Section 11.6.2*). This modelling has indicated that during piling operations, physical injury and lethal impacts to marine mammals are in the order of 40 and 6 metres respectively from the pile

(see *Appendix 11A: Underwater Noise, Section 11A.6.1* and *Appendix 14B, Section 14B.5.1*). It is very unlikely that marine mammals will be exposed to noise levels which have the potential to cause death/physical injury because a mitigation protocol has been developed by the SNCBs in order to reduce this risk to negligible levels (JNCC, 2010a) and which ICOL will implement. This is detailed in *Section 14.4.1*. Therefore death/physical injury is not discussed further within this chapter.

59 Potential impacts modelled also used the criteria dB_{ht} (*species*) and Sound Exposure Levels (SELs). The dB_{ht} (species) criteria have been used to quantify potential behavioural impacts and SELs have been used to quantify potential auditory injury. The predicted SELs were modelled assuming a level of noise exposure produced within a 24 hour period, and represent the SEL which has the potential to cause the onset of Permanent Threshold Shift (PTS) in the species group considered.

60 Noise modelling was carried out at two different locations within the Development Area, F3 and F4 (see Figure 14.12 below for modelled piling locations). The 'most sensitive' location (that closest to areas of greatest animal density) was used for each species. This was location F3 for harbour porpoise, bottlenose dolphin and minke whale and location F4 for white-beaked dolphin, harbour seal and grey seal.

Figure 14.12: Modelled Piling Locations



61 Piling scenarios modelled, including blow energies modelled for Most Likely (ML) and Worst Case (WC), are detailed in *Appendix 14B*. Six scenarios were modelled relating to the Development Area only. Table 14.2 provides the parameters and Table 14.10 details of the scenarios modelled. Noise modelling locations (F3, F4) are shown in Figure 14.12 above.

Table 14.10: Details of the Scenarios Used for Predicting the Impacts of Piling Noise on Marine Mammals

Scenario	Location	Species modelled	ML or WC	Numbers of piles per 24 h
1a	F3	Minke whale Bottlenose dolphin Harbour porpoise	ML (2.1 hours per pile)	Two piles
1b	F4	White-beaked dolphin Harbour seal Grey seal		
2a	F3	Minke whale Bottlenose dolphin Harbour porpoise	WC (4.2 hours per pile)	Four piles
2b	F4	White-beaked dolphin Harbour seal Grey seal		
3	F3 + F4	All	ML (2.1 hours per pile)	Four piles
4			WC (4.2 hours per pile)	Eight piles

62 Underwater noise modelling to predict SELs from pile driving multiple, consecutive pin piles in one 24 hour period showed that, due to the fact that the animals were modelled to swim away from the noise source, the majority of the noise exposure for animals leading to modelled onset of PTS occurred during the first piling event. In addition to the noise arising from piling which utilises a single construction vessel, modelling was also undertaken to represent two piling vessels in operation simultaneously. The use of two construction vessels is likely to reduce the total number of months in which piling impacts are experienced, but it may not be possible to deploy two vessels concurrently. Piling activity may be concentrated within summer months in order to reduce weather downtime that is likely to be experienced during winter months.

63 The numerical outputs and details from this modelling process can be found in *Appendix 14B, Section 14B.4*, and the summaries for each species are provided below. In addition to the modelling to estimate the potential PTS and displacement arising from the piling activities, effects at population level were examined for the three SAC species – harbour seal, grey seal and bottlenose dolphin. This was undertaken to inform the HRA for the Forth of Tay and Eden Estuary (harbour seal), Isle of May and Berwickshire and north Northumberland coast (grey seal) and Moray Firth (bottlenose dolphin) SACs.

Harbour Seals

64 Current advice from regulators is that the ECMA should be used as the reference population for harbour seals. The most recent count of the ECMA (of 459 harbour seals) was made in 2007 (Sea Mammal Research Unit (SMRU), unpublished data). When multiplied by a correction factor in order to take into account the number of seals which were at sea when the count was made (the proportion hauled out was estimated at 0.72; Lonergan *et al.*, 2011a), the reference population for the ECMA is 638 harbour seals.

65 The number of harbour seals predicted to be affected by PTS onset falls within a range of 47 individuals which is equivalent to 7.4 per cent of the reference population for the most likely scenario for one construction vessel (2.1 hours per pile and two piles in a 24 hour window; Scenario 1b) and 78 individuals (12.2 per cent of the population) for the worst case for two construction vessels (4.2 hours per pile and four piles in a 24 hour window; Scenario 4 (see Table 14.10)).

66 The number of harbour seals predicted to exhibit some form of behavioural response out to 50 dB_{ht} (harbour seal) is 322 individuals during the use of one construction vessel, and 340 individuals if two vessels are used at any one time.

67 The percentage of the reference population predicted to be affected ranges from 7.4 to 12.2 per cent for PTS (low to medium magnitude of impact) to up to 53.3 per cent for some form of behavioural displacement (high magnitude of impact).

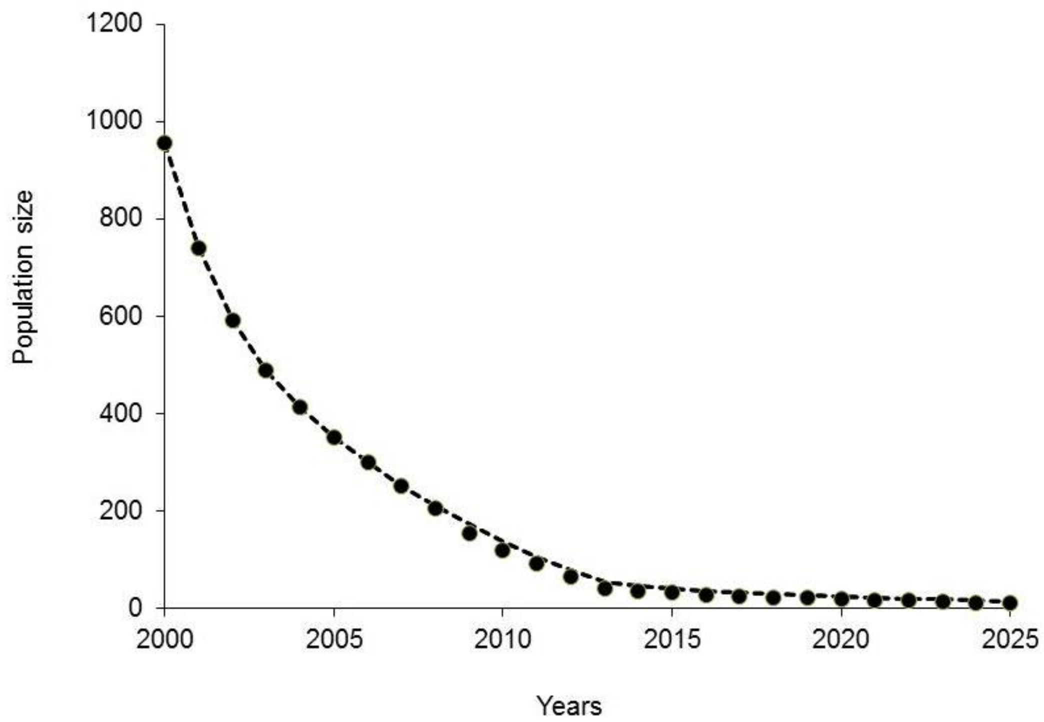
68 The potential impact of auditory injury on harbour seals is assessed as low (<10 per cent of the population) to medium (10 to 20 per cent of the population) magnitude and of medium duration. Thus a minor (one vessel, most likely piling duration) to moderate (two vessels, worst case piling duration) impact is predicted in the medium term.

69 The potential impact of exhibiting some form of behavioural response out to 50 dB_{ht} (harbour seal) on harbour seals is assessed as high magnitude (>20 per cent) and of medium duration (construction years). Thus a major impact is predicted over the medium term.

70 However, piling is likely to occur for a relatively low percentage of the total construction time (11 to 23 per cent of the two year piling phase detailed in Table 14.2 above). Therefore, actual potential for impacts due to behavioural displacement are likely to be less than stated.

71 As described above in *Section 14.5.3*, the models produced suggest that if the current levels of decline for the Forth of Tay and Eden Estuary SAC population continue, the species will effectively disappear within the next 20 years. By 2016, when piling at the Development Area is due to commence, the harbour seal population is likely to be of negligible size (details can be found in *Appendix 14D*). The baseline scenario was developed by adjusting vital rates to mimic the 18 per cent decline identified by SMRU, and imposing an eight seal per annum mortality from unexplained traumatic deaths. In order to model the consequence of piling impacts upon a population, a baseline scenario was run in which current population trends of 18 per cent adult mortality per annum were halted in 2013. This assumption of reduced adult mortality, although unlikely, was made so that there were more than zero animals in the baseline scenario in 2016 which may not be the case if the current mortality trends continue. In the construction scenario, the two year piling period was also shifted from 2016 - 2017 to 2008 - 2009 because, from the modelling outputs, the harbour seal population will already be of negligible size at the start of the actual piling period. There is little difference between the baseline and construction scenarios (Figure 14.13 below for summary, and *Appendix 14B,* Figure 14B.9 for the detailed modelling methodology) therefore it is concluded that impacts from piling on harbour seals at the population level are likely to be minor in the long term. It is considered that if potential impacts from construction activity are not evident after a 25 year modelling period, they would not be evident over a greater period of time.

Figure 14.13: Harbour Seal Population Modelling – Comparison of Baseline (dashed line) and Construction (solid dots) Scenarios



Grey Seals

72 The number of grey seals predicted to be affected by PTS onset, range between 478 individuals for the most likely scenario (one construction vessel, 2.1 hours per pile and two piles per a 24 hour window, Scenario 1b) and 822 individuals for the worst case scenario (two construction vessels, 4.2 hours per pile and four piles per a 24 hour window, Scenario 4).

73 The number of grey seals predicted to exhibit some form of behavioural response out to 50 dB_{ht} (harbour seal) is 3,058 individuals during the use of one piling vessel, and 3,212 individuals if two piling vessels are used at any one time.

74 Current advice from regulators is that the ECMA should be used as the reference population for grey seals. The most recent count of the ECMA (of 2,347 grey seals) was made in 2007 (SMRU, unpublished data). When multiplied by a correction factor in order to take into account the number of seals which were at sea when the count was made (the proportion hauled out was estimated to be 0.33; Lonergan *et al*., 2011b), the reference population for the ECMA is calculated as 7,112 grey seals. The percentage of the reference population predicted to be affected ranges from 6.7 to 11.6 per cent for PTS onset (low to medium magnitude of impact) to up to 45.2 per cent for a behavioural response if two construction vessels are used (high magnitude of impact).

75 The potential impact of auditory injury on grey seals is assessed as low to medium magnitude (<12 per cent of the reference population) and of medium duration. Combined, this provides a minor to moderate impact in the medium term.

76 The potential impact of behavioural response on grey seals is assessed as high magnitude (>20 per cent) for the total number of animals to exhibit some form of behavioural response out to 50 dB_{ht} (*species*) for the medium term (two years). This combines to predict a major impact in the medium term.

77 The 2012 Potential Biological Removal (PBR; i.e. the number of animals that can be removed from the population within any one year, without causing a decline) for grey seals in the ECMA is 277 (The Scottish Government, 2013). If it is assumed that 25 per cent of the animals predicted to develop PTS are lost from the population or ‘harvested’, as has been assumed when predicting population level effects for bottlenose dolphins (see *Appendix 14B*), this would equate to removal of 120 individuals (most likely case for one construction vessel, Scenario 1b). This is equivalent to 44 per cent of the current PBR. For a worst case for piling at two locations at the Development Area, this would equate to removal of 206 individuals (Scenario 4) which is equivalent to 74 per cent of the current PBR. Therefore, for all of the ranges of potential piling scenarios, the potential impact of PTS at the population level is within the allowed ‘take’ (PBR) so no population modelling was undertaken.

78 Due to the conservative approach taken to modelling potential impacts, these numbers are considered to be highly conservative and are likely to represent an over-estimation of the number of animals affected. The grey seals which have the potential to be displaced due to piling at the Development Area may not breed in the Firth of Forth. In addition, grey seals

travel extensively and use a wide range of habitats including multiple foraging areas and haul out sites. Displacement is therefore not expected to have the same effect on grey seals as it might have on a species which do not travel so extensively. Given that the grey seal population in the ECMA is thought to be increasing (see *Appendix 14A, Section 14A.2.3*), there is likely to be suitable alternative habitat for feeding and hauling out and it is likely that animals will become habituated to the lower levels of piling noise, it is considered unlikely that behavioural displacement will have a long-term impact at the population level and impact will therefore be minor in the long term.

Harbour Porpoise

79 The number of harbour porpoises predicted to be affected by PTS onset is low for both the most likely (Scenario 1a, a single piling vessel, two piles which take 2.1 hours each per 24 hour period; 16 individuals) and the worst case (Scenario 4, two piling vessels each carrying out four piles which take 4.2 hours each per 24 hour period; 30 individuals) scenarios (see Table 14B.24 in *Appendix 14B*). A much larger number (486 individuals) are predicted to exhibit some form of behavioural response out to 50 dB_{ht} (harbour porpoise) during piling activities using a single construction vessel piling at the most likely piling durations, while 556 individuals are predicted to exhibit some form of behavioural response out to 50 dB_{ht} (harbour porpoise) by two vessels piling for the worst case durations.

80 Current advice from regulators is that the ‘national population’ should be used as the reference population for harbour porpoises. In the absence of a definition of a ‘national population’, ICOL has used the sum of the abundance estimates for the SCANS II North Sea Blocks. The percentage of the national/reference population predicted to be affected ranges from < 0.1 per cent for PTS (low magnitude of impact) to 0.3 per cent for behavioural displacement (low magnitude of impact).

81 The number of harbour porpoises predicted to be affected through temporary displacement is large and the duration of the effect is medium term (effects predicted to occur over the two years of piling activity). However, the percentage of the reference population predicted to be affected is low (<10 per cent). Therefore the impact at the population level for PTS onset and behavioural displacement is deemed to be minor.

Bottlenose Dolphin

82 The number of bottlenose dolphins predicted to be affected by PTS onset is low for both the most likely (Scenario 1a, 1.2 individuals) and worst case (Scenario 4, 2.9 individuals) scenarios. A larger number (15 individuals) are predicted to have the potential to exhibit some form of behavioural response out to 50 dB_{ht} (bottlenose dolphin) from a single piling noise source (19 individuals from two piling noise sources).

83 These numbers were derived using an inferred density surface which was created using the best available information. However, it should be noted that bottlenose dolphins differ from some of the other species in the area because they are generally either absent from a particular location, or are present there as part of a group, i.e. assuming that half the east coast population is spread *evenly* along the coast from Peterhead to the Farne Islands is not

very realistic. This means that the number of bottlenose dolphins predicted to experience PTS onset and/or be displaced is likely to be an overestimate if they are actually absent at a given point in time, or an underestimate if they are present at that point in time but are there as part of a group.

84 The 'reference population' for bottlenose dolphin used in this assessment is the East Coast population which numbers 195 individuals (95 per cent highest posterior density intervals 162 - 253; Cheney *et al.*, 2012). For the purposes of this assessment it has been assumed that the population is split 50:50 between the Moray Firth and the east coast (from Rattray Head south) at any point in time. Therefore, for the purposes of this impact assessment, the reference population against which numbers of animals affected by the Wind Farm piling noise have been compared is 98 individuals. Calculated against this reference population, the percentage of the reference population predicted to be affected ranges from 1.2 (most likely for one construction vessel, Scenario 1a) to 2.9 per cent (worst case for two construction vessels, Scenario 4) for PTS (low magnitude of impact) to 15.3 per cent for some form of behavioural response out to 50 dB_{ht} from the piling activity of a single construction vessel (Scenario 1a) and 19.4 per cent for two construction vessels (Scenario 4; medium magnitude of impact).

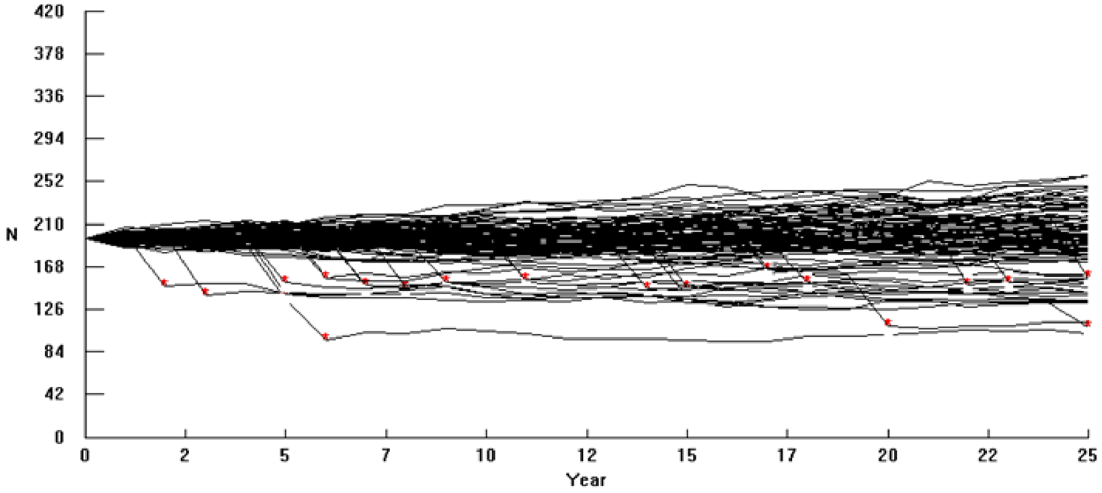
85 The number of animals predicted to be affected by PTS onset is small (percentage of the population is three or less) and the duration of the effect is medium term (two years of piling activity). Combined, this is a minor impact.

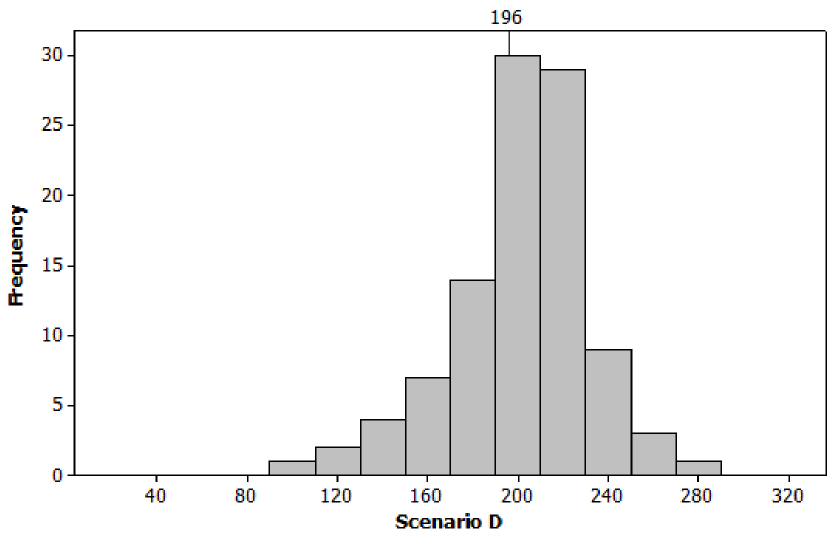
86 The percentage of the reference population of bottlenose dolphins predicted to exhibit some form of behavioural response out to 50 dB_{ht} (bottlenose dolphin) is medium (between 15 and 20 per cent) and of medium duration. Therefore, a moderate impact for the duration of the piling activities is predicted (medium term).

87 The population modelling undertaken indicates that it is likely that there will be no discernible population level effects of piling activity on the size of the east coast bottlenose dolphin population over a period of 25 years. It is considered that if potential impacts from construction activity are not evident after a 25 year modelling period, they would not be evident over a greater period of time. Details of the modelling can be found in *Appendix 14A, Section 14B.4.3*. In summary, four different scenarios were modelled; a single vessel piling at one location at the Development Area, (most likely (1a) and worst case (2a)), and piling two locations at the Development Area, (most likely (3) and worst case (4)). The most likely and worst case values for PTS from piling at a single location were 1.2 and 1.7 individuals, and 1.9 and 2.9 individuals from piling at two locations simultaneously. The best estimate of the number of dolphins predicted to exhibit some form of behavioural displacement out to 50 dB_{ht} (bottlenose dolphin) is 15 for piling at one location at the Development Area or 19 if piling two locations at the Development Area was modelled. These numbers were implemented in the model by harvesting one female calf and one adult female from the population in each scenario (to simulate the effects of behavioural

displacement[5] and PTS[6]). Figure 14.14 below shows the worst case piling scenario for two piling vessels operating simultaneously.

Figure 14.14: Bottlenose Dolphin Population Modelling Scenario D: F3 IC + F4 IC (PTS WC, Displacement Best Estimate)





88 When compared to the baseline scenario without construction related impacts shown in Figure 14.7, population level modelling indicates that impacts of PTS onset and behavioural displacement are unlikely to cause a decline at the population level in the long term (25 years). The majority of model runs had a final population size of 200 individuals after a 25

[5] Modelled as a reduction in reproduction (assuming four female and four male calves produced in each year) proportional to the proportion of the population that was displaced in each construction (piling) year – always worst case (rounding up numbers of calves and taking more females if there were an odd number).

[6] Modelled by harvesting 25 per cent of the animals modelled to be exposed to SELs sufficient to induce PTS onset in each construction (piling) year – always worst case (assuming all animals were adults and biasing towards females).

year period. Therefore, impact at the population level is deemed to be minor in the long term.

White-Beaked Dolphin

89 The number of white-beaked dolphins predicted to be affected by PTS onset is low for both the most likely scenario (using one construction vessel, Scenario 1b, seven individuals) and the worst case scenario (from two construction vessels, Scenario 4, 13 individuals). A larger number of individuals (43 most likely, 51 worst case) are predicted to exhibit some form of behavioural response out to 50 dB_{ht} (bottlenose dolphin).

90 Because white-beaked dolphin is a wide-ranging species, the reference population, which numbers of animals affected have been compared against, is that in European Atlantic continental shelf waters. The percentage of the reference population predicted to be affected ranges from < 0.1 per cent for PTS (low magnitude of impact) to 0.2 per cent for behavioural displacement (low magnitude of impact).

91 The percentage of the reference population of white-beaked dolphins predicted to be affected is low (<10 per cent) and the duration is medium (two years of piling activity), and therefore the impact is deemed to be minor.

Minke Whale

92 The number of minke whales predicted to have the potential to develop PTS onset is low for both the most likely scenario using one construction vessel (Scenario 1a; 13 individuals) and the worst case scenario using two construction vessels (Scenario 4; 24 individuals). A much larger number (500 individuals) are predicted to exhibit some form of behavioural response out to 50 dB_{ht} (humpback whale) from a single piling event (Scenario 1a), with this number increasing to 543 if two construction vessels encounter the worst case piling scenario (Scenario 4).

93 Because minke whale is a wide-ranging species, the reference population against which numbers of animals affected have been compared is the North-East Atlantic stock. The percentage of the reference population predicted to be affected ranges from < 0.1 per cent for PTS (low magnitude of impact) to 0.3 per cent for behavioural displacement (low magnitude of impact).

94 The percentage of the reference population of minke whales predicted to be affected by PTS onset and behavioural response is low (<1 per cent) and the duration is medium (up to two years of piling activity), and therefore the impact is deemed to be minor.

95 Table 14.11 below summarises the level of significance of potential impacts from piling at the Development Area.

Table 14.11: Summary of Potential Impacts from Construction Piling Noise at the Development Area on Relevant Marine Mammal Receptors

Receptor	Potential Impact: Piling at the Development Area
Harbour seal	Minor to Moderate (PTS onset) and Major (behavioural avoidance) in the medium term but minor impact at the population level in the long term.
Grey seal	Minor to Moderate (PTS onset) and Major (behavioural avoidance) in the medium term but Minor impact at the population level in the long term.
Harbour porpoise	Minor (PTS onset and behavioural avoidance).
Bottlenose dolphin	Minor (PTS onset) and Moderate (behavioural avoidance) in the medium term but Minor impact at the population level in the long term.
White-beaked dolphin	Minor (PTS onset and behavioural avoidance).
Minke whale	Minor (PTS onset and behavioural avoidance).

Vessel Movement – Increased Collision Risk and Barrier Effect

Overview of Impact

96 Vessel strikes are known to be a cause of mortality for marine mammals (Pace *et al*., 2006; Laist *et al*., 2001). A review of studies on stranded carcases reported that vessel strikes accounted for between 12 and 47 per cent of these reported marine mammal deaths (Carter, 2007). A number of responses to vessel traffic have been reported in marine mammal species, including avoidance, displacement and changes in vocalisation. Whale species may become habituated to vessel noise (Richardson *et al*., 1995; Terhune and Verboom, 1999; Laist *et al*., 2001; Nowacek *et al*., 2004), only responding once the vessel is very close. Some experiments using alerting devices on right whales found they responded strongly, but some of the responses had the potential to put the animals at greater risk from ship strikes rather than a reduction, for example the whale swam towards the vessel or remained at the surface (Nowacek *et al*., 2004).

97 An increase in vessel use may also result in a temporary barrier effect throughout the construction phase due to marine mammal avoidance of construction traffic, potentially preventing marine mammals from moving through the waters within the regions of the Development Area, in which construction is taking place. This may cause disturbance to marine mammals, especially those which may be transecting or foraging in waters local to the Development Area.

Characterisation of Impact

98 Much of the data published regarding collision risk has focused on large whale species (Knowlton and Kraus, 2001; Jensen and Silber, 2003; Douglas *et al.*, 2008; Panigada *et al.*,

2006) rather than small cetaceans and seals, as injuries to these smaller species are more likely be go unnoticed or unreported (International Whaling Commission (IWC), 2013). An assessment of increased collision risk has therefore been undertaken with respect to the degree of increased vessel movement within the Firth of Forth and Tay as a consequence of the Wind Farm construction, rather than a species specific assessment.

99 The number and severity of marine mammal strikes is likely to be influenced by vessel type, speed and underwater background noise. Vessels travelling at speeds of 14 knots or over appear to cause the most severe injuries, with sick or juvenile animals being the most vulnerable (Laist *et al*., 2001). Some behaviour (for example social behaviours) may increase risk of collision (IWC, 2006).

100 The precise nature of the vessels to be used during construction of the Project is still to be determined. It is likely that a number of vessels will be used, including; jack-up platforms, barges, dredgers, cable laying vessels and tugs. During the construction phase, approximately 3,500 vessel movements (where a movement is defined as a transit to and from the construction port development area (centre)) will be made from the construction port to the Development Area (see *Chapter 19*). As outlined in *Chapter 19*, construction vessels will be slow moving and predictable for safety and operational reasons, therefore it is likely that construction vessels will pose little risk of collision or increased barrier effects to marine mammals already used to a medium level of vessel movement occurring throughout the Firths of Forth and Tay area.

101 An SNH commissioned report (Lusseau *et al*., 2011) attempted to predict the consequences of disturbance from increased vessel traffic associated with renewable developments in the Moray Firth. It was considered unlikely that the predicted increase in the time bottlenose dolphins would encounter vessel traffic would result in negative impacts on the local population.

Significance of Impact

102 The level of shipping and vessel traffic within the Firths of Forth and Tay is judged as moderately busy compared to other regions of UK waters. The current use of the Development Area varies considerably throughout the year, with a maximum of 25 different vessels recorded within one day and a minimum of two vessel movements per day. The vessels recorded included tankers, fishing vessels, cargo vessels, recreational traffic and passenger vessels (see *Chapter 19*). In addition to existing vessel traffic, approximately 3,500 vessel movements are anticipated throughout the duration of the construction phase. This additional construction related traffic will be confined to pre-defined traffic corridors as defined in *Section 14.4.1* above.

103 The magnitude of effect of collision risk from an increase in construction vessel traffic is therefore considered of a low magnitude. Thus, combined with a temporary (medium term) duration, a minor impact is predicted.

104 The magnitude of a barrier effect resulting from avoidance of increased vessel traffic associated with construction is considered of a low magnitude. Thus, combined with a temporary (medium term) duration, a minor impact is predicted.

Increased Vessel Movement - Use of Ducted Propellers

Overview of Impact

105 Ducted propellers are propellers with non-rotating nozzles which are encircled by a duct or passageway. Their use is prevalent in the shipping industry and they have been in use since 1931.

106 Recently, concern has been raised by SNCBs about the potential impacts on seal species from the use of vessels with ducted propellers. Since 2008, a number of seal carcasses have been found with a characteristic single smooth edge spiral cut down the length of the body on beaches in south-eastern Scotland, the north Norfolk coast and around Strangford Lough in Northern Ireland (Thompson *et al*., 2010). Since 2008, 27 seal carcasses with spiral lacerations have been found on beaches in eastern Scotland (St Andrews Bay, Tay and Eden Estuaries, Firth of Forth, Moray Firth and Montrose), 42 along the North Norfolk coast in England (centred on the Blakeney Point National Nature Reserve), and several within and around Strangford Lough in Northern Ireland (JNCC *et al*., 2012). In all cases examined, the wound was fatal. Although the link with ducted propellers has not been proven, injuries were consistent with the animals being pulled through a ducted propeller common to a wide range of vessels, including tugs, self-propelled barges, rigs, offshore support vessels and research boats (Thompson *et al*., 2010). Seals with similar injuries have also been reported in Canada for at least 15 years (Thompson *et al*., 2010).

107 The potential impact of the use of ducted propellers on the UK harbour seal population is unknown, but regulators have raised particular concern in relation to declining harbour seal populations such as the Firth of Tay and Eden Estuary SAC. A further concern is that adult females comprise a large proportion of carcasses and without sufficient females of breeding age it is not possible to maintain or recover a population of seals. In areas where harbour seal numbers have declined over recent years, this is of particular concern (JNCC *et al*., 2012). ICOL is aware of some commissioned work to investigate potential causes of these fatalities, in particular work being undertaken by SMRU. However, results of this research are not expected to be published within 2013 and are therefore not available to use in this assessment.

Characterisation of Impact

108 As noted, the precise nature of the vessels to be used during construction of the Project is yet to be determined. It is highly likely that a number of vessels will use a ducted propeller system for dynamic positioning, maintaining position and travelling at slow speeds. A worst case scenario for this impact assessment is therefore that a number of vessels using ducted propellers will be commuting between the Development Area and the construction port on a daily basis (with approximately 3,500 additional vessel movements anticipated during the construction phase).

109 As a result of concern over potential for corkscrew injury from the use of ducted propellers, JNCC (endorsed by SNCBs) has provided advice relating to potential for corkscrew injury and proposed developments such as the Inch Cape Offshore Wind Farm (Table 14.12).

Table 14.12: From JNCC Advice in Relation to Risk from Potential for Corkscrew Injury Associated with the Use of Ducted Propellers (from JNCC *et al*., 2012).

Risk level	Proximity to Seal Haul Out
High	Activity proposed to take place within four nautical miles of a harbour seal SAC and areas where the harbour seal population is in significant decline.
Medium	Activity proposed to take place between four and 30 nautical miles of a harbour seal SAC and not covered above.
Medium	Activity proposed to take place within four nautical miles of a grey seal SAC.
Low	Activity proposed to take place beyond 30 nautical miles distance from a harbour seal SAC.
Low	Activity proposed to take place beyond four nautical miles distance from a grey seal SAC.

Significance of Impact

110 It is possible that vessels using ducted propellers will be travelling within four nautical miles of a harbour seal haul out. Using the above guidance, and because the harbour seal population within the Firth of Tay and Eden Estuary SAC and the wider ECMA is experiencing a severe decline (see *Appendix 14A, Section 14A2.3*), the risk of corkscrew injury to harbour seal is deemed to be high. There are, however, such low numbers of harbour seals associated with the Firth of Tay and Eden Estuary SAC that the number of animals at risk of exposure to corkscrew injury is innately very low.

111 The activity associated with the vessels commuting to and from the Development Area to grey seals is considered to be low (activity proposed to take place beyond four nautical miles distance from a grey seal SAC, Table 14.12 above).

112 The impact of increased risk of injury to harbour seals from the use of ducted propellers is considered to be of medium term duration and medium magnitude (worst case due to number of vessels commuting to and from the Development Area). Therefore a moderate impact is predicted in the medium term (construction years).

113 In order to contextualise this predicted moderate impact over a medium duration with the long term impacts modelled for piling related impact, comparison can be made to the magnitude of predicted medium term impacts. Population modelling of the long term effects of combined moderate (PTS onset) and major (behavioural impacts) in the medium term predicts likely minor impact at the population level in the long term. PTS is modelled as an increase in adult mortality, while behavioural displacement is modelled as failure to

breed. Thus, a moderate impact from the increased risk of corkscrew injury from ducted propellers (especially given the very small numbers of animals predicted to remain in the population and thus the small numbers of animals available to be affected) is considered to represent a minor impact at a population level in the long term.

114 The impact of increased risk of injury to grey seals from the use of ducted propellers is considered to be minor in the medium term during construction and thus minor in the long term (as above).

Toxic contamination

115 The potential for toxic contamination is deemed to be similar for all phases of the Project (construction, operation and maintenance, decommissioning) as it is mainly related to vessel movement and general offshore construction activities. Therefore, the assessment presented here relates to all phases of the Project and will not be reiterated in subsequent sections in this chapter.

Overview of Impact

116 Marine mammals can be exposed to contaminants directly through their skin and indirectly through the consumption of contaminated prey, potentially causing illness and/or death. As apex predators, marine mammals are particularly at risk from bio-accumulation of contaminants in the food chain. To date, most research in this area has concentrated on heavy metals, persistent organic pollutants (POPs) and polycyclic aromatic hydrocarbons (PAHs).

117 Accidental incidents involving the release of chemicals into the marine environment may include vessel collisions and accidental spillages. Once a wind farm is operational, there is the potential for leaching of toxic compounds from sacrificial anodes, leaking of corrosion inhibitors, antifouling paints, vessel fuel or the loss of hydraulic fluids, which may result in toxic contamination of the water column.

118 The heavy metals of greatest importance to marine mammals species are cadmium, lead, zinc and mercury, all of which bio-accumulate and are frequently found in high concentrations in the liver, kidney and bone. Marine mammals produce proteins (metallothioneins) which are involved in the homeostasis of essential metals (zinc and copper) and detoxification of non-essential metals (cadmium and mercury); therefore, marine mammals can tolerate relatively high levels of some metals in their diet (Das *et al.*, 2000). Heavy metal contamination has been associated with POP build up in fatty tissues, which are often resistant to metabolic degradation, resulting in high levels being found in the blubber of marine mammals. POPs are thought to affect the immune and hormonal systems, thereby have the potential to impact reproductive success.

Characterisation of Impact

119 An increase in vessel traffic may result in an increased risk of accidental vessel collision, within the Development Area and Offshore Export Cable Corridor, and within the surrounding environment (see *Chapter 19*). Vessel collision, both with other vessels and with

WTGs/offshore infrastructure being constructed, may result in the accidental release of chemicals such as fuel. Additionally, accidental spillage of polluting chemicals such as lubricants and anti-corrosion agents may occur due to human error or technical failure and without the involvement of a vessel collision.

120 Should an accidental incident occur where chemicals are released into the marine environment, emergency procedures will be in place to minimise environmental effects where possible. This may include the use of spill kits to enable containment and treatment of spillages. Procedures specific to the protection of the environment, including mitigation for accidental pollution incidents, will be developed further in the EMP and implemented during construction and operation.

121 In a worst case scenario where a vessel collision may result in the release of significant volumes of pollutants, potential impacts to marine mammals may include illness and death from ingestion and direct contact with chemicals, or indirect effects through the consumption of contaminated prey species.

Assessment of Significance

122 All materials used in the construction, operation and maintenance, and decommissioning of the Project, will be certified as safe for use within the marine environment. It is likely that antifouling paints, amongst other potential contaminants, are widely used by existing marine infrastructure and vessels in the Firth of Forth and Tay; therefore detectable increases in potential contaminants from the Project are considered unlikely.

123 Vessels will use predefined routes and will travel at slow speeds to reduce risk of accidental vessel collision where possible.

124 The probability of such an event occurring is deemed highly unlikely. As the greatest increase in vessel movements will be during the construction phase, the increased risk of toxic contamination will predominantly be during the construction phase and therefore of a temporary nature (see *Chapter 19*).

125 The magnitude of effect of increased risk of accidental pollution incidents to marine mammal species is considered low. Thus, combined with a temporary (medium term) duration, a minor impact is predicted.

Indirect Impacts - Changes in the Availability of Prey Species

Overview of Impact

126 Construction activities resulting in increased underwater noise may cause disturbance and potential displacement to fish species important to marine mammals (refer to *Chapter 13*), therefore potentially reducing the availability of prey species to marine mammals. Throughout the construction phase, several activities such as trenching, dredging and cable laying may result in an increase of suspended sediments throughout the water column, primarily due to disturbance of the seabed (refer to the *Chapter 10*: *Metocean and Coastal*

Processes for further details). This may result in increased turbidity, particularly in habitats located in close proximity to the Development Area.

Characterisation of Impact

127 *Appendix 14A, Section 14A.2*, details what is known about the fish species which constitute prey sources to each marine mammal species. For the purposes of this assessment, fish species for which noise modelling was conducted were considered to be representative of common prey species and other similar fish species that may constitute small components of marine mammal diet.

128 In addition to marine mammals, SPEAR modelling was carried out for several fish species, including cod, dab, herring, salmon, and sand lance (proxy for sandeel) which may be taken by marine mammals as prey (refer to *Chapters 11* and *13* for further detail). Several fish species are sensitive to underwater noise, particularly clupeid species such as herring (*Clupea harengus*) and sprat (*Sprattus sprattus*).

129 Noise modelling identified piling as the most significant construction activity likely to impact fish species, with the Natural Fish and Shellfish assessment presented in *Chapter 13* (*Section 13.6, 13.7 and 13.8*) concluding that avoidance of non-piling related construction noise would be limited to 100 m for hearing specialists such as cod, herring and sprat, with less impact on other fish species. It is therefore likely that potential impacts to fish species from non-piling construction activities will be very localised.

130 Increased turbidity may disturb and displace mobile marine mammal prey species, however cetaceans do not rely on visual cues to hunt (they use echolocation) and seals are sensitive to hydrodynamic stimuli through their whiskers (Dehnhardt *et al.,* 1998; 2001) rather than relying solely on sight and sound. Due to the natural dispersal of sediments in the marine environment, it is likely that this impact will be localised and of a temporary nature, with fast dispersal of suspended sediments.

Significance of Impact

131 In UK waters, marine mammals are recorded foraging in areas where sediment suspension levels are high, such as estuaries. Marine mammals may in fact target such areas for foraging. Generally therefore, it is expected that marine mammals will continue to forage in areas of high sediment load, relying on sensory cues other than visual ones. Changes in suspended sediment levels are therefore considered unlikely to result in a change in prey availability.

132 *Section 13.8.1* concludes that impacts during general construction activities will have negligible to minor impacts on fish species that are potential prey for marine mammals e.g. cod, dab, herring, salmon and sandeels. Noise disturbance from piling was predicted to be a moderate impact to hearing specialist fish species such as cod and herring, but of minor impact to other prey species for marine mammals (dab, salmon and sandeels). While large areas are affected by perceived noise levels, only mild behavioural responses are expected to occur.

133 As a result, the impact of changes in availability of prey species from non-piling and piling effects on marine mammals is deemed to be of a low magnitude, of a temporary (medium term) duration and is therefore minor.

14.7.2 Effects of Operation and Maintenance

Background

134 Primary impacts to marine mammals, with the potential to occur during the operational phase of the Wind Farm, have been identified as follows:

- Displacement or disturbance of marine mammals from the Development Area and surrounding environment due to underwater WTG operating noise;
- Habitat loss;
- Increased collision risk and use of ducted propeller from maintenance vessels;
- Disturbance from EMF produced by inter-array cables
- Toxic contamination of prey from antifouling paints and corrosion inhibitors; and
- Accidental pollution events.

135 Unlike the other marine mammal species, bottlenose dolphin is a coastal species and therefore is very unlikely to occur within the vicinity of the Development Area and will therefore be unlikely to be exposed to the effects listed above. It is considered that due to their absence from waters in and around the Development Area, bottlenose dolphins are not likely to be susceptible to offshore operational impacts and may have potential to be affected by an increase in vessel traffic from maintenance ports only. This potential effect is discussed further in *Section 14.7.1*.

Underwater Wind Turbine Generator (WTG) Noise

Overview of Impact

136 Operational offshore WTGs produce low frequency noise and vibrations that pass into the water column (Ingemansson Technology, 2003). While operational noise may be of a far lower frequency than that produced during the construction and decommissioning phases of an offshore wind farm, the duration of noise is much longer.

137 Operational noise from offshore WTGs may affect marine mammal behaviour but is very unlikely to result in hearing damage (Betke *et al*., 2004; Koschinski *et al*., 2003; Tougaard *et al*., 2009). Previous studies show marine mammal responses to operational WTG noise of avoidance and increased echolocation (Koschinski *et al*., 2003); however, avoidance by harbour porpoises was less than that observed during pinger experiments (Culik *et al*., 2001). Harbour porpoise can appear cautious when confronted with a new stimulus (in this case, the noise vibrating from the WTG foundation), exploring the sound source with their sonar (Koschinski *et al*., 2003). Notably, masking of communication cues by WTG noise is thought to be insignificant for both harbour seals and harbour porpoises (Tougaard *et al*., 2009).

138 Evidence from existing offshore wind farms, for example Nysted and Rødsand II, suggest that behavioural responses by marine mammals to operational WTG noise is unlikely, although it should be noted that existing data is from smaller WTGs.

139 Marine mammals have been observed in close proximity to other fixed, noise emitting features, such as drilling rigs and oil platforms.

Characterisation of Impact

140 Recordings at Barrow offshore wind farm (eastern Irish Sea, Cumbria) indicated a marginal increase in low frequency underwater noise, compared to background noise from three megawatt WTGs (Edwards *et al*., 2007). The increase in low frequency noise was distinguishable up to a distance of 600 m from the WTGs. Marine mammals observed in the area included harbour seal, harbour porpoise and bottlenose dolphin and it was concluded that operational noise was unlikely to cause a behavioural response in these species.

141 For harbour seals, the zone of audibility from a two megawatt WTG has been estimated at between 2.5 and 10 km (Tougaard *et al.*, 2009).

142 Larger WTGs have the potential to produce louder noise or peak energies at higher frequencies than those reported here. Harbour porpoise have poor hearing capabilities within the noise frequency range produced by a two megawatt WTG, but a higher frequency noise may result in an increased response zone (Tougaard *et al*., 2009). SPEAR modelling utilising measured data on operational wind farms (3.6 MW machines, which is the largest operational WTG within the Subacoustech Ltd database) estimates WTGs noise to not exceed 75 dB_{ht}(*Species*) at the point of emission at the WTG tower for any of marine mammal species (*Section 11.6.1*). As such, while audible levels of noises from operational WTGs are likely, the impact range in which animals have the potential to be disturbed is likely to be less than 100 m for all marine mammals.

143 Previous studies show no local effects with regards to harbour or grey seals, from the Horns Rev I (80 WTGs, monopiles) and Nysted (72 WTGs, gravity foundations) offshore wind farms (Teilmann *et al*., 2006a; Tougaard *et al*., 2006). Notably, the seal population at Rødsand (haul-out site near Nysted Wind Farm) increased during the operational years 2004 and 2005 (Teilmann *et al*., 2006b); however, it is unclear at this stage whether this is related to the presence of the wind farm. Additionally, harbour seals have been observed in waters within Horns Rev Wind Farm, with no evidence of avoidance or changes in dive behaviour (Tougaard *et al*., 2006).

144 An increase in harbour porpoise was observed within and around the Egmond aan zee Wind Farm (36 WTGs, monopiles) during the first two years of operation, in line with a general increase observed in Dutch waters during the last decade (Hammond *et al*., 2002; SCANS II, 2008; Scheidat *et al*., 2011). The increase within the wind farm was more pronounced compared to reference areas, although the reasons for this are unclear (Scheidat *et al*., 2011) with increases in prey (artificial reef effect) and shelter from disturbance (no fishing zones) suggested as potential reasons for the localised increase in harbour porpoises. Weak negative effects on harbour porpoise were observed during the construction phase at Horns

Rev I and II but impacts were temporary (Tougaard *et al*., 2006; Brandt *et al*., 2011). In contrast, the decline in porpoise activity observed during the construction of the Nysted offshore wind farm (gravity foundations) is still evident ten years after the wind farm became operational (Teilmann and Carstensen, 2012). The reasons for this are unclear but one possible explanation is that the Nysted area was less important to harbour porpoises prior to the wind farm being present than other areas, so there was less of an incentive for porpoises to be tolerant of disturbance and change (Teilmann and Carstensen, 2012).

Significance of Impact

145 It is expected that marine mammals will not suffer adversely from WTG operating noise. Behavioural reactions are likely to occur only in the immediate vicinity of the foundations (i.e. within 100 m). Harbour porpoise have relatively poor hearing in the frequency ranges previously recorded from offshore WTGs (Tougaard *et al*., 2009) and while seals have better hearing, they are more tolerant to underwater noise (Southall *et al*., 2007).

146 A Marine Scotland funded review (2012) concluded that WTG noise is unlikely to cause permanent hearing damage in seals, porpoises or bottlenose dolphins, even at close proximity to the WTGs. It was also concluded, after a review of telemetry studies, that operational wind farms do not appear to affect harbour seal movement patterns.

147 In conclusion, the impact of the operating noise from up to 213 WTG is predicted to be of low magnitude (less than 10 per cent of the relevant population, as per Table 14.8 above). It is anticipated that marine mammals will quickly habituate to the presence of WTGs in the water and that there will be sufficient distance between WTGs (820 m) to allow movement of animals between foundations.

148 The impact of operational underwater WTG noise on marine mammals is considered to be of low magnitude, of long term duration, and is therefore minor.

Long Term Presence of Wind Turbine Generators

Overview of Impact

149 The physical presence of WTG foundations has the potential to result in habitat loss for prey species which is an indirect impact for marine mammals. Scoping responses from Marine Scotland in 2010 requested barrier to movement to be considered as the result of the presence of foundations. As detailed above, a number of recent studies report the presence of marine mammals within wind farm footprints. In addition, a Marine Scotland funded report concludes that there is no evidence for displacement of harbour porpoise and grey seals from the operational Robin Rigg Offshore Wind farm (Walls *et al*., 2012). Harbour porpoise and grey seals were the only marine mammals present in high enough numbers pre- and post-construction to enable robust analysis. Displacement as a consequence of the physical presence of foundations is therefore not considered further.

Characterisation of Impact

150 It is considered that offshore wind farms are unlikely to result in significant loss of marine habitat. Habitat loss will vary depending on the type and size of the installation, the location,

whether it is situated in degraded or pristine habitat, and the life cycle stage of the installation (Inger *et al*., 2009). The potential route to impact upon marine mammals is considered to be one of changes in availability of prey species resulting from habitat loss.

151 Habitat loss leading to a reduction in prey species is a potential indirect impact from the Wind Farm and is discussed further in *Chapter 13*. *Section 13.7.2.* This provides an assessment of impact on fish species within a range of negligible/minor (mobile prey species) to minor/moderate (sandeel) and of a localised scale. Potential for indirect impacts to marine mammals is therefore considered of a low magnitude.

152 Subsea infrastructure, particularly WTG foundations, may have potential to act as an artificial reef (Linley *et al*., 2007); thus increasing the amount of available habitat for some marine taxa, including prey species of marine mammals. Man-made structures positioned on the seabed are naturally colonised by marine organisms and may also act as fish aggregating structures; therefore subsea infrastructure is often used to enhance fisheries and rehabilitate local habitat (Clark and Edwards, 1999; Jensen, 2002). The presence of subsea infrastructure may provide new habitat capable of supporting epibiota and fish; it has been shown that artificial reefs created from subsea infrastructure can increase density and biomass of fish species compared to surrounding habitats (Bohnsack *et al*., 1994; Wilhelmsson *et al*., 1998; Wilhelmsson and Malm, 2008).

153 Additionally, it has been reported that marine organisms can be attracted to piers and oil platforms (Rilov and Benayahu, 1999; Love *et al*., 1999; Helvey, 2002). A greater abundance of fish has also been found in the vicinity of WTGs compared to surrounding areas (Wilhelmsson *et al*., 2006), with little difference in species richness and diversity.

Significance of Impact

154 Table 14.2 provides the maximum total loss of original habitat during the operational phase of the Inch Cape Offshore Wind Farm to be 1.87 km^2, equating to 1.25 per cent of the Development Area (see Table 12.2 for more details). This potential loss of habitat would be localised to the Development Area, therefore although the duration of this potential impact is considered long term, the magnitude of impact is considered low, due to the wide availability of habitat in the surrounding environment.

155 In conclusion, the impact of habitat loss due to the long term presence of WTGs and potential presence of protection to inter-arraying cabling is considered to be of a low magnitude, of long term duration, and is therefore minor.

156 Conversely, potential for positive impacts, such as the indirect creation of reef habitat from subsea infrastructure (with the possibility of increasing the abundance of fish species within the Development Area) is likely to occur at a localised scale. This potential effect may be beneficial to marine mammals.

157 The potential impact of an increase in marine mammal prey species from the indirect creation of an artificial reef/fish aggregating structure is considered uncertain, of low magnitude, of long term duration, and is therefore minor.

Increased Vessel Traffic during Maintenance Operations (Collision Risk and use of Ducted Propellers)

Overview of Impact

158 The potential impacts associated with vessel movements have been detailed in *Section 14.7.1* "Effects of Construction – Increased Vessel Movement– Use of Ducted Propellers" and have not been re-iterated here.

Characterisation of Impact

159 During the operational phase, it is anticipated that there will be an average of six vessel movements per day. As described above in *Section 14.7.1*, the level of shipping and vessel traffic within the Firths of Forth and Tay is judged as moderately busy compared to other regions of UK waters. It is considered that the presence of low levels of maintenance vessels specific to the Wind Farm will not substantially increase the number of vessels utilising the Development Area or the levels of vessel traffic currently encountered within the Firth of Forth and Tay area.

160 Table 14.12 provides the JNCC advice in relation to risk for potential for corkscrew injury associated with the use of ducted propellers.

Assessment of Significance

161 It is considered unlikely that vessel use during the operational phase of the Wind Farm, predominantly for maintenance activities, will significantly increase from the number of vessels already utilising the Firth of Forth and Tay with an average increase of six vessel movements a day.

162 The impact of increased collision risk from increased vessel traffic is therefore considered of a low magnitude, of long term duration, and thus minor.

163 While the vessels involved in operation and maintenance activities have the potential to pass within four nautical miles of a harbour seal SAC (and thus carry a high risk for corkscrew injury), as described above, the numbers of vessels likely to involved is likely to be low. In addition there are such low numbers of harbour seals associated with the Firth of Tay and Eden Estuary SAC that the number of animals at risk of exposure to corkscrew injury is innately very low. Therefore, the impact of increased risk of injury to harbour seals from the use of ducted propellers during operation and maintenance activities is considered to be of minor magnitude over the long term, and therefore minor.

164 The risk of corkscrew injury to grey seals from the vessels commuting to and from the Wind Farm during operation and maintenance activities is considered to be low (activity proposed to take place beyond four nautical miles distance from a grey seal SAC, Table 14.12 above). Thus the impact of increased risk of injury to grey seals from the use of ducted propellers is considered to be minor in the long term.

Presence of Electromagnetic Fields

Overview of Impact

165 Transmission of electricity through subsea cables will lead to the generation of electric and magnetic fields, both of which have been associated with the Export Cables to shore from offshore wind farms (Gill *et al*., 2009). It has been suggested that magnetic fields could affect animals such as marine mammals. Marine mammals may use geomagnetic cues as an aid to navigation; however, the importance of these cues, and the potential impact on the detection of geomagnetic fields from local cable induced fields, remains unclear (Wiltschko and Wiltschko, 2005; Luschi *et al*., 2007; Gould, 2008; Lohmann *et al*., 2008). There are currently no indications in the literature that seals are sensitive to magnetic fields (Fauber *et al*., 2007).

Characterisation of Impact

166 For the purposes of this assessment, AC has been identified as representing the worst case for EMF potential. *Chapter 13* provides a description of potential causes and sources of EMF, including subsea transmission cables, in *Section 13.6.2*.

167 The number and length of inter-array cables will be determined by the number of WTGs (up to 213) and WTG arrangement/spacing. It is anticipated that the inter-array cables will comprise of a maximum of 353 km of 66 kV AC cables (*Table 14.2*). *Section 13.6.2* details that B fields (magnetic fields) from 66 kV cables would be 15 µT at the seabed and will dissipate to negligible levels within a few metres. As detailed within *Chapter 13* this is well below the strength of the Earth's natural geomagnetic field which is assumed to be 50 µT around the central North Sea, *Section 13.6.2*).

168 *Section 13.6.2* also details research that indicates that there would be maximum iE-field (induced electrical field) of approximately 2.5 µV/m in seawater above the point of cable burial of 33 kV cables (assuming burial to 1.5 m) (Gill *et al*., 2005). Gill and Bartlett (2010) concluded that the iE-field will also dissipate to one or two microvolts per metre within a distance of approximately 10 m from the 33 kV cable. The study presented in *Section 13.6.2* also suggests that strengths within the potentially 66 kV inter-array cables would be expected to be comparable in strength to those presented by Gill *et al.* (2005).

169 Table 14.2 details that cables will be buried to a target depth of one metre (within a burial range of zero to three metres) or protected where burial is not feasible. Burial will provide a physical barrier that reduces exposure to the highest EMF fields found at the cable 'skin.' As such the assessment considers values at the seabed and beyond when considering impact on marine mammal species.

170 A number of live cetacean strandings have been linked with local geomagnetic anomalies (Kirschvink *et al.,* 1986) or with disruptions in the normal patterns of daily geomagnetic fluctuations (Klinowska, 1990), suggesting that cetaceans are capable of sensing geomagnetism and of using geomagnetic cues for navigation.

171 Geomagnetic fields of less than 50 nT are thought to be of a level to influence the stranding of some cetacean species (Kirschvink *et al*., 1986). Magnetic fields created by transmission cables at offshore wind farms of around 15 µT may influence the navigation of marine mammals (Hoffmann *et al*., 2000).

172 It is likely that potential for impact on marine mammals is limited, with effects likely to occur only when animals are located in close vicinity to cabling.

Assessment of Significance

173 Information on the influence of EMF on marine mammals is very limited, with much of the available evidence concentrating on fish species. There is no evidence to date suggesting a change (positive or negative) in marine mammal activity related to magnetic fields from cables associated with offshore wind farms. Harbour porpoises continue to migrate in and out of the Baltic Sea over sub-sea High Voltage DC cables (Basslink, 2001). It is thought that magnetic fields from cables are likely to be detected by cetaceans as a new localised addition to a heterogeneous pattern of geomagnetic anomalies in the surrounding area (Basslink, 2001).

174 Where possible, cables within the Development Area will be buried to a target depth of one metre (burial range of zero to three metres). If the cable is buried any deeper than one metre, predicted impacts will be reduced due to additional shielding/distance from potential receptors. It is anticipated that it will not be possible to bury up to 10 per cent of the inter-array cables, and these lengths will require protection in the form of rock placements, concrete matting, or equivalent. References provided above suggest that magnetic fields may only be detectable above background levels in the immediate vicinity of the cable, and will dissipate rapidly with distance from the cable.

175 The impact of EMF on marine mammals within the Development Area is uncertain, but is considered to be of low magnitude in very close proximity to the cables themselves. Combined with a long term duration, a minor impact is predicted.

14.7.3 Effects of Decommissioning

176 The potential effects of decommissioning are considered to be equivalent to and potentially lower than the worst case effects assessed for the construction phase. It is expected that underwater noise levels would be substantially lower than during the construction phase as decommissioning will not involve pile driving activities. The approach to decommissioning is described in *Section 7.12*. A decommissioning plan will be prepared in accordance with the requirements of the *Energy Act 2004* (see *Section 3.2.5*) and will be subject to approval from the Department of Energy and Climate Change (DECC) prior to implementation.

14.8 Impact Assessment - Offshore Export Cable Corridor

14.8.1 Background

177 The Offshore Export Cable Corridor is shown in Figure 7.1 and includes the transmission cable and associated cable protections, up to Mean High Water Springs (MHWS).

178 In a worst case scenario (detailed in Table 14.2 above), the maximum number of cable trenches required will be six (with individual trench width of one metre each), within a maximum cable corridor width of 1,400 m. In addition to the cable installation vessel itself, various other vessels may be involved in the cable installation. Potential exists for several impacts to occur in relation to the installation, operation and maintenance and decommissioning of the Offshore Export Cable. These have been identified as follows:

- Displacement or disturbance of marine mammals during construction and decommissioning from the Offshore Export Cable due to an increase in disturbance from underwater noise and vessel presence;
- Increased collision risk, underwater noise and risk of ducted propeller injury from Offshore Export Cable installation and maintenance vessels;
- Risk of stranding due to an increase in EMF emissions – operational phase;
- Indirect effects associated with changes in prey availability; and
- Toxic contamination.

179 It is notable that grey seals and bottlenose dolphins may be particularly susceptible to the impacts associated with the installation, operation and decommissioning of the Offshore Export Cable as these species are known to cross the area traversed by the Offshore Export Cable Corridor, to access foraging grounds.

Other Mammals

180 Ecology surveys have indicated that otter may pass through the intertidal area as some indications of otter were found at the extreme eastern edge of the Seton Sands landfall option.

181 Otter (*Lutra lutra*) is protected under European and UK law including by the *Conservation (Natural Habitats &c.) Regulations 1994* (as amended) and under Schedules 5 and 6 of the *Wildlife and Countryside Act 1981* (as amended). It is also listed on Appendix 2 of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) 1979 and as a globally threatened species on The World Conservation Union (IUCN) Red Data List. It is a UK Biodiversity Action Plan species.

182 Any works which could impact on otter may require an EPS licence (see *Section 3.3.3*). Based on current survey data and assessment of likely impacts, this would not be necessary for the OfTW. Mitigation which will be included in the application for the onshore works will include the requirement for further otter surveys if it is more than six months since the surveys were undertaken. If it was found that the OnTW could directly affect an otter holt or disturb otter,

the potential impacts would be discussed with SNH and, if necessary, an EPS licence would be applied for from SNH in advance of construction.

183 Otter has not been considered further in this chapter.

14.8.2 Construction

184 As noted above in *Section 14.8.1*, the methodology for the Offshore Export Cable installation has yet to be finalised and, as a consequence, this impact assessment considers the various techniques that may be employed for Offshore Export Cable burial. These methodologies include; ploughing, jetting, use of a mechanical rock wheel cutter, horizontal directional drilling (HDD), and open cut trenching (see *Section 7.9.3*). Where it is not possible to bury the Offshore Export Cable due to the absence of sufficiently stable sediment, grout bags, concrete tunnels, concrete mattresses and/or rock placement may be used to protect the Offshore Export Cable. It is anticipated that up to 20 per cent of the Offshore Export Cable length may require protection. Impacts associated with these activities are discussed below.

Increased Underwater Noise

Overview of Impact

185 A thorough review of non-piling related anthropogenic noise sources that are likely to occur during the construction activities in the Development Area is provided above in *Section 14.7.1.*

Characterisation of Impact

186 The noise relating to the activities described in *Section 14.7.1* above are also considered appropriate for the construction activities likely to occur during the installation of the Offshore Export Cable. SPEAR modelling outputs for 90 dB_{ht} (harbour porpoise) (Figure 14.11) provide ranges for noise levels likely to illicit a strong behavioural response from a variety of different construction related activities. As described in *Section 14.7.1* above, modelling for harbour porpoise is considered representative for marine mammal species likely to be present within the Firth of Forth and Tay. Activities of relevance to the assessment of likely avoidance of works associated to the Offshore Export Cable installation are cable laying, rock placement, trenching and large and medium sized vessel noise.

187 Trenching has the greatest potential 90 dB_{ht} (harbour porpoise) range of non-piling activities (140 m; Figure 14.11). Rock placement has a likely 90 dB_{ht} (harbour porpoise) range of approximately 100 m. All other non-piling construction activities have potentially only very localised noise ranges of less than 30 m at 90 dB_{ht} (harbour porpoise).

Significance of Impact

188 The results of the SPEAR modelling suggest that potential effects of increased noise from construction related activities for the installation of the Offshore Export Cable will be localised (within 140 m) and therefore of low magnitude. Thus, combined with a medium term duration, a minor impact is predicted.

Increased Vessel Movement

189 It is anticipated that there will be an increase in local vessel traffic and general vessel presence along the Offshore Export Cable Corridor during the construction phase. The overview and characterisation of potential impacts of increased collision risk as a consequence of increased vessel traffic have been detailed in *Section 14.7.1* "Effects of Construction – Vessel Movement – Increased Collision Risk and Barrier Effect". The potential impact is predicted to be very similar for installation of the Offshore Export Cable.

190 Precise details of vessels and routes to be employed for construction of the Offshore Export Cable have yet to be confirmed. It is anticipated however that the increase in vessel traffic specific to the construction of the Offshore Export Cable will not substantially increase the levels of vessel traffic currently encountered within the Firth of Forth and Tay area.

191 The impact of collision risk from an increase in construction vessel traffic for the Offshore Export Cable installation is therefore considered of a low magnitude. Thus, combined with a temporary (medium term) duration, a minor impact is predicted.

Use of Ducted Propellers

192 Potential impacts of using ducted propellers have been fully assessed in *Section 14.7.1* "Effects of Construction – Increased Vessel Movement – Use of Ducted Propellers" and have not been re-iterated here. The precise nature of vessels to be used for the installation of the Offshore Export Cable has yet to be determined but a worst case scenario would be that a number of vessels using ducted propellers would be commuting to the Offshore Export Cable and construction port on a daily basis during construction, approximately 30 vessel movements per cable. It is considered that the likely impact will be very similar to that for construction of the Wind Farm but for a much shorter period of time (months rather than years).

193 It is possible that vessels using ducted propellers will be travelling within four nautical miles of a harbour seal haul out. Using the JNCC advice relating to potential for corkscrew injury associated with the use of ducted propellers (JNCC *et al.,* 2012), and because the harbour seal population within the Firth of Tay and Eden Estuary SAC and the wider ECMA is experiencing a severe decline (see *Appendix 14A, Section 14A2.3*), the risk of corkscrew injury is deemed to be high. However, the activity will occur for a shorter period of time, and as there are such low numbers of harbour seals associated with the Firth of Tay and Eden Estuary SAC, the number of animals at risk of exposure to corkscrew injury is innately very low.

194 The potential for impact associated with the vessels commuting to and from the Offshore Export Cable Corridor on grey seals is considered to be low (activity proposed to take place beyond four nautical miles from a grey seal SAC, Table 14.12 above).

195 The impact of increased risk of injury to harbour and grey seal species from the use of ducted propellers for the installation of the Offshore Export Cable is considered to be of low

magnitude. Thus, combined with a temporary (medium term) duration, a minor impact is predicted. Long term impacts are also considered to be minor for both species.

<u>Indirect Impacts: Changes in the Availability of Prey Species</u>

<u>Overview of Impact</u>

196 Installation of the Offshore Export Cable may involve trenching and dredging activities, therefore disturbance of the seabed and water column will be likely. This may affect the distribution of fish and benthic fauna within the construction footprint, potentially causing disturbance and displacement of marine mammal prey species. Construction activities may also temporarily increase levels of suspended sediment in the water column, also affecting prey species distribution and potentially minimising the detectability of prey species to foraging marine mammals.

<u>Characterisation of Impact</u>

197 Disturbance of the seabed will occur within the Offshore Export Cable Corridor only, which at the widest point will be 1,400 m. Each Offshore Export Cable trench depth is anticipated to be approximately one metre (burial range zero to three metres); however along some sections it may not be possible to bury the Offshore Export Cable and protection measures such as rock placement and use of concrete mattresses may be necessary. It is anticipated that up to 20 per cent of the cable length may require such protection. Trench width affected by construction of the Offshore Export Cable is likely to be up to six metres (per cable); the area of seabed affected by the installation of the Offshore Export Cable is considered small and very localised in comparison to the available surrounding habitat. It is anticipated that disturbance and displacement of potential prey species will occur within the footprint (3.02 km^2 across the Offshore Export Cable Corridor, see Table 14.2) of the Offshore Export Cable works only.

198 Potential for increased levels of suspended sediment is low, with affected areas likely to be within the footprint of the construction works only and with fast dispersal of sediment into surrounding waters expected, due to the dynamic nature of the marine environment.

<u>Significance of Impact</u>

199 Due to the dynamic environment where the works are occurring, the temporary nature of the proposed works and the availability of prey in other foraging habitats, the impact of changes in the availability of marine mammal prey species during the construction of the Offshore Export Cable is deemed to be of low magnitude, of temporary duration, and therefore minor.

14.8.3 Operation and Maintenance

<u>Increase in Electromagnetic Fields</u>

<u>Overview of Impact</u>

200 The potential impacts associated with cabling have been detailed in *Section 14.7.1* above and has not been reiterated here.

Characterisation of Impact

201 It is anticipated that in the worst case, the Offshore Export Cables will comprise of up to six 275 kV AC cables each of approximately 83 km in length. As described in *Section 13.7.2,* modelling conducted in support of an application for a wind farm in the Moray Firth indicated that B fields from 220 kV (800 mm^2 at 775 A) cables would be 21 µT at the seabed (based on one metre burial) and dissipate to approximately 0.80 µT at five metres above the seabed (MORL , 2012). Magnetic field strength increases, with a linear relationship, based on the size and current of the cable, however values are unlikely to be significantly greater than those reported by MORL (2012). This is below the strength of the Earth's natural geomagnetic field which is assumed to be 50 µT.

202 The Offshore Export Cable(s) will also produce iE-fields that are likely to be greater than 33 kV inter array cabling. The strength of the iE field will be dependent on the current within the cable, the rate of change of the AC current, and the orientation and bundling of cables. It is therefore difficult to determine general values of iE-fields to apply to the current assessment. However, it should be noted that high voltage subsea cabling is prevalent in UK waters and internationally, with numerous interconnections between countries and islands at analogous voltages in proximity to the Development Area and Offshore Export Cable Corridor and beyond.

203 Although the B-fields associated with the Offshore Export Cable are greater than those for the inter-array cabling, the field strength will dissipate to levels below the earth's natural geomagnetic field at the seabed and to negligible levels within five metres. This is only slightly beyond those expected within inter-array cables.

204 Table 14.2 details that the Offshore Export Cables will be buried to a target depth of one metre (burial range of zero to three metres) or protected where burial is not feasible (up to 20 per cent of the length). Burial will provide a physical barrier that reduces exposure to the highest iE and B fields found at the cable 'skin.' As such the assessment considers values at the seabed and beyond when considering impact on natural fish and shellfish species.

205 It is considered that potential for impact to marine mammals is limited, with effects likely to occur only when animals are located in close vicinity to the Offshore Export Cables.

206 An increase in EMF may affect the distribution of fish species in benthic habitats along the Offshore Export Cable Corridor, particularly elasmobranch species such as dogfish, shark, skates and rays, which use EMF for detecting prey and therefore are particularly sensitive to this impact. Although it is not thought that elasmobranchs make up a large part of marine mammal species diet, this may influence the distribution of a minor portion of marine mammal prey species within the immediate vicinity of the Offshore Export Cable throughout the Wind Farm operation and power transmission.

Significance of Impact

207 Information on the influence of EMF on marine mammals is very limited, with much of the available evidence concentrating on fish species. There is no evidence to date suggesting a change (positive or negative) in marine mammal activity related to magnetic fields from cables associated with offshore wind farms. It is anticipated that an increase in EMF from the Offshore Export Cable are likely to be detected by cetaceans as a new localised addition to a heterogeneous pattern of geomagnetic anomalies in the surrounding area (Basslink, 2001). It is considered highly unlikely that a small increase in EMF from the Offshore Export Cable will be strong enough to interfere with the navigation system of marine mammals; therefore the potential to increase the risk of stranding is considered low.

208 It is anticipated that an increase in EMF from the Offshore Export Cable may be detectable by sensitive fish species (*Section 13.6.2*) although the magnitude of any effect is considered to be low. Any potential effect would occur within the immediate vicinity of the Offshore Export Cable only, therefore in the context of the wider environment, this impact is considered localised and likely to affect only a very small proportion of marine mammal prey species (if any). Therefore, the impacts of EMF on the prey species of marine mammals and the marine mammals themselves are considered to be of a low magnitude and will be very temporary due to animals only being exposed to effects in close proximity to the cables/sea floor as they pass, and are therefore minor.

Disturbance during Maintenance Operations

Overview of Impact

209 Maintenance operations associated with the Offshore Export Cable will include monitoring of Offshore Export Cable condition and maintenance of cable protection (e.g. rock placement or cement mattresses). This may result in increased vessel presence and associated underwater noise, which has the potential to cause disturbance to marine mammal species.

Characterisation of Impact

210 It is likely that throughout Wind Farm operation, maintenance requirements of the Offshore Export Cable will be limited. Should maintenance be required, works are likely to be localised and of short-term duration, and applicable to short sections of the Offshore Export Cable only.

Significance of Impact

211 The presence of maintenance vessels specific to the Offshore Export Cable is likely to be infrequent and of short term duration throughout the operation of the Offshore Export Cable. The potential impact from increased disturbance or risk of injury to marine mammals is therefore considered to be minor.

14.8.4 Disturbance during Decommissioning Operations

212 The potential effects of decommissioning are considered to be equivalent to and potentially lower than the worst case effects assessed for the construction phase. The approach to decommissioning is described in *Section 7.12*. A decommissioning plan will be prepared in accordance with the requirements of the *Energy Act 2004* (see *Section 3.2.5*) and will be subject to approval from the DECC prior to implementation.

14.9 Impact Interactions

14.9.1 Introduction

213 The impact interactions associated with the Project are considered to be:

- Total increased underwater noise from construction and decommissioning activities such as piling, vessel movements and cable installation activities;
- Total increased collision risk – vessel movement and ducted propellers; and

14.9.2 Indirect changes in prey availability. Overview of Impact

214 It is possible that the above impact interactions could combine to cause an increased level of impact on marine mammals throughout the Project area and Project lifecycle. Impacts during construction and decommissioning phases are considered likely to have the greatest potential for impact interactions due to the number and extent of impact, of activities taking place during these phases.

215 Impact interactions during the operational phase are likely to be limited to total increased collision risk – vessel movement and ducted propellers. Though there will also be increased levels of noise from vessel movement during the operational phase, *Section 14.7.2* – Effects of Operation has shown that noise increase is localised (10 - 20 metres from source) and therefore is not considered to have the potential to interact with other impacts during the operational phase.

14.9.3 Characterisation of Impact

216 During construction and decommissioning, indirect changes in prey availability are considered to have the potential for very localised and temporary (medium term) impacts on marine mammals due to displacement/disturbance of prey species. Increased underwater noise is likely to cause animals to avoid areas of active construction such as piling, installation of the OfTW, and vessel movement, and it is considered that these areas of displacement are likely to overlap with changes in prey availability due to construction related noise. There is alternative supporting habitat on the east coast available to animals displaced from the area during construction, therefore no further impacts of changes in prey availability are predicted. Animals displaced due to total increased underwater noise are also likely to be at reduced risk of collision with construction vessels as they are less likely to be in the vicinity of these potential impacts. In addition, animals displaced from the area impacted by construction noise will be at reduced collision risk as the Firths of Forth and Tay

have relatively high existing vessel traffic compared to other areas of the Scottish east coast, therefore any displacement to alternative supporting habitat is likely to reduce the risk of collision. Thus there is a potential reduced collision risk associated with displacement due to increased underwater noise.

217 During operation there is the potential that animals that have potentially experienced PTS onset from construction related noise may be at increased risk of collision with vessels associated with operations and maintenance. However, marine mammals, in particular pinnipeds, also use alternative means for detecting underwater noise, such as vibrissae. This will compensate to some extent for any potential impact of PTS on hearing ability, by providing alternative cues for detection of vessels. In addition, as animals in the area are already accustomed to relatively high levels of vessel use, any additional increased risk of collision with vessels associated with the Offshore Wind Farm and OfTW due to PTS induced by piling activity is considered to be minor.

14.9.4 Assessment of Significance

218 It is likely that during the construction phase, marine mammals (due to the direct impacts of increased underwater noise and disturbance) will spend an increased proportion of time foraging out with the Development Area and therefore be at reduced collision risk, and unaffected by changes in prey availability within the Development Area and Offshore Export Cable Corridor. The impact interaction overall of the three impacts identified is therefore considered unlikely to increase the potential impact on marine mammals. The effect of impact interactions throughout the project lifecycle are considered to be of low magnitude and long term, therefore effects are minor.

14.10 Cumulative Impact

14.10.1 The Project

219 Within this section, cumulative impacts of the Wind Farm and OfTW have been considered with regards to the works within the Development Area and the Offshore Export Cable Corridor. The impacts identified and assessed above in *Sections 14.7* and *14.8* have the potential to impact cumulatively. The potential cumulative impacts regarding marine mammals have been identified as follows:

- Total increase in underwater noise from construction, operation and maintenance, and decommissioning activities, and increased vessel traffic during these phases of the Project;
- Total increased collision risk - vessel movement and ducted propellers; and
- Indirect impacts from changes in the availability of prey species.

Total Increased Underwater Noise

Overview of Impact

220 It is considered possible that increased levels of underwater noise from construction, operation and maintenance, and decommissioning activities, combined with an increase in underwater noise from increased vessel traffic (both during construction and operational phases) may result in a combined impact on marine mammals with implications for levels of disturbance.

221 The cumulative effect of greatest potential impact in relation to marine mammals is identified as auditory injury and behavioural disturbance due to piling activities.

222 It is considered very unlikely that marine mammals will be exposed to noise levels which have the potential to cause death or physical injury. As described above in *Section 14.7.1* - Increased Underwater Noise (Piling during Construction), a mitigation protocol has been developed by the SNCBs to reduce this risk to negligible levels (JNCC, 2010a) and this mitigation protocol will be applied throughout relevant, noisy activities, such as piling. Death and physical injury has therefore not been considered further within this cumulative section.

Characterisation of Impact

223 It is anticipated that increases in vessel traffic will not be significantly greater than the levels of marine traffic currently experienced in the Firth of Forth and Tay (*Chapter 19*), with the Wind Farm and OfTW vessels using defined transit routes and speeds thereby limiting potential impacts to particular areas. The use of defined transit routes will also maximise predictability of vessel use by marine mammals and serve to localise any displacement associated to vessel noise.

224 Construction activities other than piling (such as rock placement and dredging) have been predicted (*Sections 14.7.1*, Figures 14.10 and 14.11) to have a localised impact (up to 140 m from source) and to be of low magnitude, medium duration and thus be a minor impact.

225 Potential impacts of piling have been assessed as of minor to major significance in the medium term (during construction) and, although are predicted to be minor in the long term (operation), are likely to have the greatest potential impact of all the construction related noise. Potential impacts of piling due to construction of the Wind Farm and OfTW have been considered in detail in *Sections 14.7.1* and *14.8.2* and *Appendix 14B*.

226 A decommissioning plan will be prepared in accordance with the requirements of the *Energy Act 2004* (see *Section 3.2.5*) and will be subject to approval from the DECC prior to implementation. However, it is expected that underwater noise levels will be substantially lower during decommissioning than during the construction phase, as decommissioning will not involve pile driving activities. It is expected that noise produced during decommissioning activities will be substantially lower than noise levels created during piling. There may also be disturbance from vessels associated with the WTG removal, but as with the construction phase, the associated impacts are considered to be of low magnitude.

227 Animals may be temporarily displaced or may leave the area for periods of time due to 'noisy' activities during construction. However, animals are already habituated to a relatively high level of noise in the Firth of Forth and Tay area, and cumulative noise impacts of the offshore grid cabling works with those piling related impacts of the Development Area are predicted to be low level.

Significance of Impact

228 As described in *Section 14.7*, marine mammals of all species have the potential to suffer PTS and to be displaced from the vicinity of the Development Area and surrounding area during piling activities. The summary of these potential impacts are provided in Table 14.11. There are no proposed PTS impacts from the cable laying activities within the Offshore Export Cable Corridor, and predicted very localised and minor displacement impacts. Thus cumulative impacts can be considered equivalent to those of the Development Area, namely minor to all species in the long term for both PTS and behavioural displacement impacts.

229 The potential for cumulative impact due to increased underwater noise from both vessel traffic and non-piling activities, during construction and operations and maintenance activities, is deemed to be low magnitude, very local to the vessels themselves, of long term (operation and maintenance) and therefore of minor impact for all species.

Total Increased Vessel Movement - Collision Risk and Barrier Effects

Overview of Impact

230 A cumulative effect of the construction and the operation and maintenance phases of the Project may result in increased vessel traffic across the region, in both coastal and offshore waters, leading to potentially higher risk of collision both with vessels hulls and potential barrier effects. It is likely that the greatest vessel use will be during the construction of the Wind Farm and OfTW, particularly during piling operations.

Characterisation of Impact

231 It is predicted that vessels used for construction, and operation and maintenance activities, will use a pre-defined corridor and will move in a slow and predictable manner thereby maximising predictability and detection by marine mammals. Potential to impact individuals is highest when animals move into close proximity with vessels, which is considered unlikely.

232 It is expected that the cumulative effect of increased construction and maintenance vessel traffic will not be markedly above the existing levels of vessel traffic currently using waters to the east of Scotland. Therefore, although of a long-term duration, impacts to marine mammals are expected to be of a low magnitude.

Significance of Impact

233 The cumulative effect of increased collision risk and barrier effects due to increased vessel movements through construction activities within the Development Area and Offshore Export Cable Corridor, is not considered to be greater than that of the Development Area only, due to the small number of vessels involved with the installation of the Offshore Export

Cables and the limited duration of the associated works. The cumulative impact for all marine mammal species is therefore considered to be of medium duration and minor.

234 The cumulative effect of increased collision risk and barrier to movement from increased vessel movements is considered to be localised, of low magnitude (effecting less than 10 per cent of the population), of long term duration and thus be minor for all marine mammal species.

<u>Increased Vessel Movement – Use of Ducted Propellers</u>

<u>Overview of Impact</u>

235 As described above with regards to collision risk and barrier effects, cumulative effect of the construction and the operation and maintenance phases of the Project may result in increased vessel traffic across the region, in both coastal and offshore waters, leading to potentially higher risk of corkscrew injury from ducted propellers. It is likely that the greatest vessel use will be during the construction of the Wind Farm and OfTW infrastructure, particularly during piling operations.

<u>Characterisation of Impact</u>

236 As discussed in *Section 14.7.1*, the precise nature of the vessels to be used for the construction/maintenance and decommissioning of the offshore aspects of the Project has yet to be determined. It is possible, and likely, that a number of vessels used will employ a ducted propeller system for dynamic positioning, maintaining position and travelling at slow speeds. A worst case scenario would be that vessels using ducted propellers would be commuting between the Project and their respective construction ports on a daily basis.

237 As described above, commuting vessels have the potential to pass within four nautical miles of a harbour seal SAC (defined as posing a high risk of corkscrew injury by JNCC, see Table 14.12) and are of low risk to grey seals, as activity will be out with four nautical miles from a grey seal SAC. As described in *Section 14.7*, the Development Area itself is more than four nautical miles off the harbour seal SAC, but within 30 nm and thus represents medium risk of injury. However, it is possible that vessels using ducted propellers will be travelling within four nautical miles of a harbour seal haul out during commuting to and from the activity site and therefore animals inhabiting the area are at a high risk of injury.

<u>Significance of Impact</u>

238 The JNCC (endorsed by SNCBs) have provided advice relating to the potential for corkscrew injury to seals and proposed developments (JNCC *et al.*, 2012, Table 14.12 above). Precise details of vessels to be used and construction ports for the Project are yet to be determined. However, as the harbour seal population in the ECMA is so low (and declining) the number of individual animals at risk is also considered to be low as there are few animals to have the potential to interact with a ducted propeller. The risk to grey seals is defined as low using the JNCC guidance.

239 The cumulative effect of increased collision risk due to increased vessel movements and potential for corkscrew injury through construction activities within the Development Area

and Offshore Export Cable Corridor, is not considered to be greater than that of the Development Area only, due to the small number of vessels involved with the installation of the Offshore Export Cables and the limited duration of the associated works. The cumulative impact for harbour seals is therefore considered of medium magnitude, medium term and thus moderate. As described in *Section 14.7.1* above, by comparing the magnitude of predicted medium term impacts from the increased risk of corkscrew injury due to the use of ducted propellers, with those related to piling noise, and consideration of the parameters used in the population modelling undertaken for the later to predict long term impacts, corkscrew injury is likely to pose a minor impact in the long term upon the harbour seal population of the ECMA.

240 The cumulative impact for grey seals is considered to be of low magnitude, medium term and thus a minor impact.

241 The cumulative effect of increased potential for corkscrew injury through operation and maintenance activity is considered to be localised and of a low magnitude (less than 10 per cent of the population due to the low numbers of vessels involved in the activities). Combined with the long term duration (construction followed by operation and maintenance activities), the impact is predicted to be minor for both grey and harbour seals.

Indirect Impacts from Changes in Prey Availability

Overview of Impact

242 Indirect impacts of habitat disturbance, increased underwater noise, and EMF, may have an impact on the availability of marine mammal prey species. The distribution and abundance of these species may change throughout the lifecycle of the Project. It is considered likely that changes in the distribution and abundance of marine mammal prey species will be localised to the Development Area and Offshore Export Cable Corridor only and most likely to occur during the construction phase.

Characterisation of Impact

243 Fish species occurring within the Development Area will likely experience localised disturbance and displacement during the construction phase, potentially locally affecting fish distribution and abundance. During the Wind Farm operation, changes in EMF may also influence fish behaviour, in addition to WTG presence which may attract fish species, resulting in increased aggregation. It is anticipated that any effects on fish species will be localised and occur predominantly during the construction phase.

Assessment of Significance

244 It is likely that during the piling phase, marine mammals (due to the direct impacts of increased underwater noise and disturbance) will spend an increased proportion of time foraging outwith the Development Area and Offshore Export Corridor. Additional disturbance and displacement from the Offshore Export Cable Corridor is therefore likely to be limited to localised regions of the inshore areas of the Firth of Forth through which the Offshore Export Cable will be routed.

245 The potential for cumulative impacts to marine mammals from changes in the distribution and abundance of prey species as a result of the construction activities in the Development Area and Offshore Export Cable Corridor is deemed of a low magnitude. Thus, combined with a temporary (medium term) duration, a minor impact is predicted.

14.10.2 The Project and Other Projects

Background

246 The geographic scope of the cumulative assessment is primarily focused on the Firths of Forth and Tay; however it is recognised that as mobile species, marine mammals may spend considerable periods of time outside this area. There is therefore the potential for these species to be affected by other offshore developments, more remote to the Development Area. To identify potential cumulative impacts, ICOL worked collaboratively with other offshore developers in the Firths of Forth and Tay region through the FTOWDG, and with the regulatory community.

247 The offshore projects and plans identified as having potential cumulative effects on marine mammals throughout the lifecycle of the Wind Farm and OfTW are presented below in Table 14.13.

Table 14.13: Offshore Projects and Plans Considered in the Cumulative Impact Assessment

Project	Location	Status	Details	Potential effects
Offshore wind farms and associated infrastructure				
Methil (Fife Energy Park) Offshore Demonstration Wind Turbine	Methil, Fife	Consented	One WTG and one met mast; foundation design to be determined (probable requirement for piling).	Underwater noise from piling of foundations; Noise propagation from a single WTG and met mast in very shallow, inshore waters is considered likely to have limited extent and result in a very localised impact zone. The connectivity of animals using this area and the Project is considered to be very low. Therefore, the potential for cumulative impact on all marine mammal species is considered to be negligible.
Neart na Gaoithe Offshore Wind Farm (NnG)	Firth of Forth and Tay	Decision pending	75 to 125 WTGs, 3.6 MW to 7 MW.	Underwater noise from piling of foundations. Increased vessel usage. Reduction in prey availability. Construction timescales may overlap.
Firth of Forth Phase 1 (Project Alpha and Bravo) (FoF)	Firth of Forth and Tay	Decision pending	Two proposed wind farms within zone, each with a maximum capacity of 525 MW and accommodate up to 75 WTGs with supporting infrastructure (subsea cables, OSPs and met masts).	Underwater noise from piling of foundations. Increased vessel usage. Reduction in prey availability. Construction timescales may overlap.
European Offshore Wind Deployment Centre	Aberdeen	Consent awarded, March 2013	11 WTGs; five foundation type options (monopile, gravity base, tripod, steel jacket, suction caisson/bucket); installation estimated to start in 2014.	Underwater noise from construction of any piled foundations; 75 dB_{ht} noise impact contours for some species may overlap but timescales unlikely to overlap so no cumulative impact with underwater noise, increased vessel movement or prey availability.

Project	Location	Status	Details	Potential effects
Beatrice Offshore Wind Farm	Moray Firth	Decision pending	Up to 277 WTGs, up to three OSPs and up to three Met Masts; three foundation type options (monopile (met mast only), pin piles, gravity base and suction piles); up to five years construction period commencing 2014.	Potential cumulative effects assessed in *Appendix 14B* for bottlenose dolphins (*Section 14B.5*). 75 dB_{ht} (species) noise impact contours for other marine mammal species unlikely to overlap.
Firth of Forth Phase 1 Meteorological Mast	Firth of Forth	Decision pending	Suction caisson foundation due to be installed during 2013.	Short term displacement from non-piling related foundation, timescales unlikely to overlap and therefore not assessed further (scoped out).
Moray Firth R3 Zone 1 (Eastern Development Area (EDA))	Moray Firth	Decision pending	EDA – 189 to 339 WTGs, five to eight OSPs plus max two met masts; three foundation type options (gravity base, pin piles or suction caissons); up to six years construction period commencing 2015.	Potential cumulative effects assessed in *Appendix 14B* for bottlenose dolphins (*Section 14B.5*). 75 dB_{ht} (*species*) noise impact contours for other marine mammal species unlikely to overlap.
Hywind Demonstration Site	Near Aberdeen	No scoping yet available	Three to five floating WTGs.	No underwater noise from piling because WTGs will be attached to the seabed using a three-point mooring.

Project	Location	Status	Details	Potential effects
Tidal Energy				
Montrose Tidal Array (GlaxoSmithKline Tidal Energy Project)	Montrose	Refused on current application. Applicant considering alternative technology.	15 tidal turbines with gravity foundations, installed over 14 months.	Slow moving blades may reduce risk of collision, and absence of a gearbox will reduce underwater noise and may reduce disruption to marine mammals. The proposed array does not use the whole width of channel such that a clear passage for fish, mammals and birds remains at all times. Potential cumulative effect is increased vessel movements (ducted propellers). As current application has been refused, this project is now scoped out of the cumulative assessment.
Biomass				
Grangemouth Renewable Energy Plant	Grangemouth	Decision pending	Biomass fulled steam boiler plant. 36 month construction period. Fuel delivered by ship. Cooling water to be extracted from Forth estuary and returned up to 10°C warmer.	Activities associated with this develoment are predicted to produce either no or negligible levels of underwater noise or other potentially disturbing effect, and therefore are considered unlikely to have any impact on marine mammals. This project is therefore not assessed further (scoped out of the cumulative assessment).
Rosyth Renewable Energy Plant	Rosyth	Decision pending	Biomass fulled steam boiler plant. 36 month construction period. Fuel delivered predominantly by ship. Cooling water to be extracted from Forth estuary and returned at outfall in same location.	Activities associated with this develoment are predicted to produce either no or negligible levels of underwater noise or other potentially disturbing effect, and therefore are considered unlikely to have any impact on marine mammals. This project is therefore not assessed further (scoped out of the cumulative assessment).

Project	Location	Status	Details	Potential effects
Dundee Renewable Energy Plant	Dundee	Decision pending	Biomass fulled steam boiler plant. 36 month construction period, operational by 2015. Fuel delivered predominantly by ship. Cooling water extracted from Forth estuary and returned up to 10° C warmer.	Construction timescales are unlikely to overlap. This project is therefore not assessed further (scoped out of the cumulative assessment).
Power plants				
Cockenzie Combined Cycle Gas Turbine Power Station	Cockenzie, East Lothian	Consented	Replace coal fired power station with gas station. Existing power station due to close by end March 2013.	Activities associated with this develoment are predicted to produce either no or negligible levels of underwater noise or other potentially disturbing effect, and therefore are considered unlikely to have any impact on marine mammals. This project is therefore not assessed further (scoped out of the cumulative assessment).
Captain Clean Energy Project (Caledonia Clean Energy Project)	Grangemouth	EIA submission expected 2013	Proposed construction January 2015, commencement of operation 2018. Cooling water likely to be abstracted from the River Forth, returned via pipeline 0.8 - 1 km from shore at elevated temperature.	Activities associated with this develoment are predicted to produce either no or negligible levels of underwater noise or other potentially disturbing effect, and therefore are considered unlikely to have any impact on marine mammals. This project is therefore not assessed further (scoped out of the cumulative assessment).
Other offshore activities				
Forth Replacement Crossing	Firth of Forth	Construction started (Autumn 2011)	Completion due 2016. Onshore piling required, using bored piles appose to driven, removing vibration issues normally associated with piling.	Construction timescales are unlikely to overlap. This project is therefore not assessed further (scoped out of the cumulative assessment).

Project	Location	Status	Details	Potential effects
Coastal Improvement Works at the Mouth of the Barry Burn	Carnoustie	Approved	Replacement of existing tank traps and blocks with a retaining wall and provision of rock amour along beach head.	Activities associated with this develoment are predicted to produce either no or negligible levels of underwater noise or other potentially disturbing effect, and therefore are considered unlikely to have any impact on marine mammals. This project is therefore not assessed further (scoped out of the cumulative assessment).
Rosyth International Container Terminal Project	Rosyth	Decision pending	Creation of tidal basin within current void to bedrock. Anticipated that piling will be required in construction of quay walls. Maintenance dredging will be necessary to maintain channel access.	Activities associated with this develoment are predicted to produce either no or negligible levels of underwater noise or other potentially disturbing effect, and therefore are considered unlikely to have any impact on marine mammals. This project is therefore not assessed further (scoped out of the cumulative assessment).
Victoria and Albert Museum at Dundee (Dundee Waterfront Development)	Dundee	Proposal of application notice	Construction of building on quayside. Anticipated to be completed 2015.	Activities associated with this develoment are predicted to produce either no or negligible levels of underwater noise or other potentially disturbing effect, and therefore are considered unlikely to have any impact on marine mammals. This project is therefore not assessed further (scoped out of the cumulative assessment).
Port of Dundee Expansion	Dundee	EIA underway	Reclamation of 30 acres from river to form additional industrial land.	The details of this project are unknown, and therefore the assessment has been undertaken on a broad scale.

Project	Location	Status	Details	Potential effects
Edinburgh Harbour Master Plan (Edinburgh Waterfront Development)	Leith	Unknown Outline planning application approved August 2008. Master Plan for first two villages at The Harbour and Leith Docks submitted December 2008.	Creation of commercial, leisure and retail hub at waterfront, including creation of two new piers and cruise liner terminal. Construction phase will include reclamation of land in Western Harbour and drive piling in water.	Activities associated with this develoment are predicted to produce either no or negligible levels of underwater noise or other potentially disturbing effect, and therefore are considered unlikely to have any impact on marine mammals. The assessment has been undertaken on a broad scale.

248 It is recognised that the RAF Leuchars air base is located in close proximity to the Eden Estuary and is approximately central to the Firths of Forth and Tay. Low flying aircraft may produce an increase in underwater noise, especially when passing directly overhead. It is likely that an increase in noise would be very brief in duration, and unless located directly overhead (which is deemed unlikely), the sound produced by passing aircraft is likely to be inaudible or weakly audible to a submerged marine mammal (Richardson *et al.,* 1995) and has therefore been scoped out of this assessment.

Increased Noise (Non-piling)

Overview of Impact

249 Marine mammals have very good underwater hearing and as a consequence are sensitive to increased underwater noise (Koschinski *et al*., 2003; Thomsen *et al*., 2006; Madsen *et al*., 2006). Cetaceans rely heavily on sound to feed, navigate and to interact socially. Sound travels much further underwater than in air, and anthropogenic noise has the potential to affect marine mammals at relatively large distances from the source.

250 Reported responses by marine mammals to increased anthropogenic noise (Weilgart, 2007) include the following:

- Changes in foraging/diving behaviour, swim speed, respiration or vocalisation, stress levels;
- Displacement/avoidance;
- Hearing damage (temporary and permanent); and
- Stranding/death.

Characterisation of Impact

251 As noted in Table 14.13, there are proposed waterfront developments located at both Edinburgh and Dundee (Port of Dundee Expansion and Edinburgh Harbour Master Plan). These developments, along with the Neart na Gaoithe (NnG) and Firth of Forth Phase 1 (Alpha and Bravo) (FoF) offshore wind farms construction, maintenance and operation, and decommissioning, may have implications for vessel traffic in both the Firths of Tay and Forth, particularly during construction when vessel activity local to these areas may increase. Use of pleasure craft may also increase due to the presence of these developments, potentially increasing collision risk and disturbance impacts to marine mammals. The frequency and sound levels produced by an increase in vessel movement will be dependent on vessel size, type, and the speed of vessel movements (see *Chapters 19* and *11*). Modelling for the Inch Cape Project only (*Section 14.7.1*) predicts that 90 dB_{ht} (harbour porpoise) noise level ranges from individual large vessels are predicted to be no greater than 22 m, with ranges for other species being smaller. Acclimatisation to vessel presence and noise has been observed in some species (Koschinski and Culik, 1997; Richardson *et al*., 1995, Laist, 2001; Sini *et al*., 2005; Leung and Leung, 2003). It is predicted that other offshore projects will utilise vessels of a similar nature to the above.

252 With regards to the Edinburgh Waterfront Development, new facilities will be installed at Leith Docks, Western Harbour and Granton Harbour. It is likely that the construction works associated with these developments will have the potential to disturb marine mammals using coastal waters, such as seals and bottlenose dolphins. However, it is expected that disturbance to the marine environment will be localised and temporary. Other developments are considered to be of a sufficiently long distance from the Development Area and Offshore Export Cable Corridor, or there are no noisy or otherwise disturbing activities that may impact on marine mammals predicted to occur in relation to the Project (see Table 14.13), for there to be a cumulative effect on marine mammals.

253 It is considered possible that increased levels of underwater noise from non-piling construction activities such as dredging and rock placement may result in a combined impact on marine mammals with implications for levels of disturbance. Figure 14.11 (*Section 14.7.1* – Effects of Construction) has shown that rock placement and trenching are the most likely non-piling activities to cause disturbance (associated with development of an offshore wind farm) with potential impact zones out to 140 m from the source of the noise.

254 The cumulative potential range of impact from activities other than piling associated with the offshore projects and plans listed for cumulative impact assessment consideration are considered likely to be very restricted.

Significance of Impact

255 It is possible that during the construction and operation phases of the projects listed in Table 14.13, marine mammals may be temporarily disturbed. However, as this disturbance is likely to be temporary, and there is likely to be suitable alternative supporting habitat during periods of disturbance, it is concluded that the potential for cumulative impacts on marine mammals from increased underwater noise (non-piling) is of a low magnitude, of a temporary (medium term) duration and thus a minor impact.

Increased Noise (Piling) during Construction of the Inch Cape, Firth of Forth Phase 1 and Neart na Gaoithe Offshore Wind Farms

Overview of Impact

256 Piling has the potential to lead to physical injury or lethal effects, auditory injury and/or displacement of marine mammals. Noise propagation (INSPIRE modelling) has been used to quantify which projects have the potential for cumulative risks of physical injury and displacement, and a population level assessment has been carried out to assess the long term effects on harbour seals, grey seals and bottlenose dolphins.

257 Analysis of the 75 dB_{ht} (*species*) contours identified the projects which have the potential to cause a cumulative impact to marine mammals utilising the waters of the Firth of Forth and Tay through increased underwater noise due to piling at the Inch Cape, Firth of Forth Phase 1 and Neart na Gaoithe offshore wind farms.

258 According to the proposed construction timelines of the three FTOWDG offshore wind farms (Inch Cape, Firth of Forth Phase 1 and Neart na Gaoithe Offshore Wind Farms) (summarised

in Table 14.14 below), piling has the potential to be carried out at two of the three projects in 2015 (Neart na Gaoithe and Firth of Forth Phase 1) and at the three projects in 2016. To ensure that this cumulative impact assessment is inclusive of a potential slip in project timelines of any or all of the three projects, the impact assessment has been undertaken assuming piling activity on all three projects for five years from 2014 to 2018. It is recognised that piling activity on all three projects in all five years is extremely unlikely, and thus this assessment is very likely to over-estimate cumulative impacts. However, displacement has the potential to occur over relatively large areas for each project and thus the impact radii from piling at locations within two or three projects will overlap. It is considered that the complexity of attempting to model distinct piling phases of individual projects is not warranted when considered against the uncertainties detailed in *Appendix 14B,* Table 14B.11.

Table 14.14: Construction Timelines of the FTOWDG Projects

Offshore Wind farm	**Year**				
	2014	**2015**	**2016**	**2017**	**2018**
Neart na Gaoithe					
Firth of Forth Phase 1					
Inch Cape					
Potential for programme slippage					

259 It is recognised that the European Offshore Wind Deployment Centre (Aberdeen Bay) and offshore wind projects in the Moray Firth will also use piling, and could contribute to a cumulative impact for bottlenose dolphin due to the known movement patterns of the east coast population. This potential impact to bottlenose dolphins has been assessed through population impact modelling scenario J - 'Extreme to include 100 per cent breeding failure' (see *Appendix 14B, Section 14B.5.5*).

Characterisation of Impact

260 A detailed assessment of the potential cumulative impact of piling at the Inch Cape, Firth of Forth Phase 1 and Neart na Gaoithe offshore wind farms is presented in *Appendix 14B* and illustrated in *Appendix 14C*.

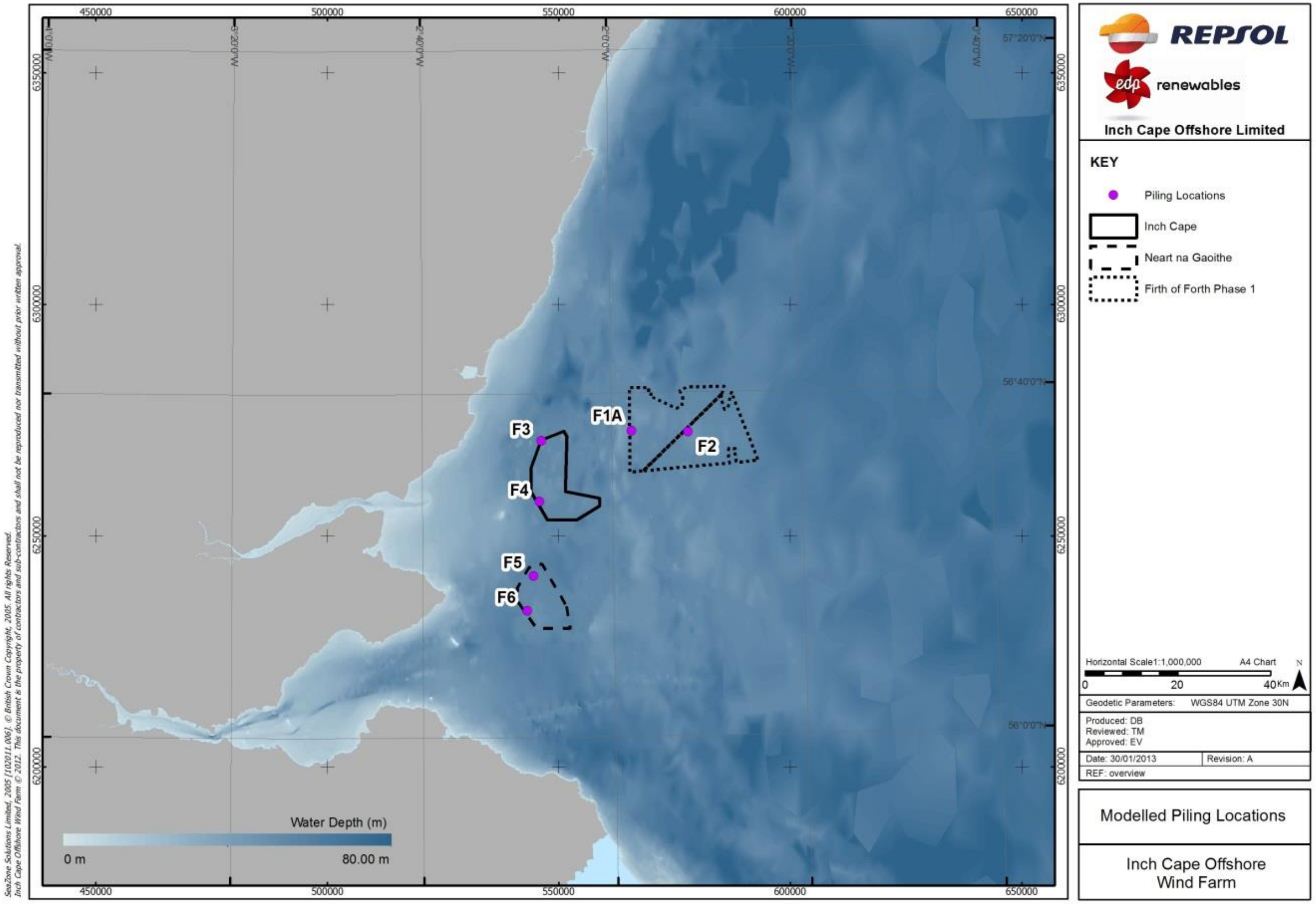
261 Noise modelling was undertaken by Subacoustech Environmental Ltd to predict the exposure of marine mammals to piling noise from the three FTOWDG offshore wind farms (see *Chapter 11*). dB_{ht} (*species*) and SEL contours were modelled. Details of how the piling impact assessment has been undertaken and the detailed impact assessment are provided in *Appendix 14B* and illustrated in *Appendix 14C*.

262 As described in *Section 14.7* above, predicted noise contours at 5 dB_{ht} (*species*) increments out to 50 dB_{ht} (*species*) were generated for piling activity during construction at the Development Area to inform the assessment of displacement of marine mammal species (presented below in Table 14.18 as in column 'Number of animals predicted to exhibit some form of behavioural response out to 50 dB_{ht} (*species*) from piling at the Inch Cape Project only (Scenario 1a to Scenario 4)'). However, these contours were not available to inform the equivalent displacement assessment for the Neart na Gaoithe and Firth of Forth Phase 1 projects. For these latter two projects, only 130, 90 and 75 dB_{ht} (*species*) contours were available, with no 5 dB_{ht} increments and no further contours after 75 dB_{ht} (*species*).

263 In order to undertake comparative cumulative modelling, the assessment for the Inch Cape Project only was conducted using only the 130, 90 and 75 dB_{ht} (species) contours. The results of using this methodology are presented in Table 14.18 below in column 'Number animals predicted to exhibit up to mild behavioural avoidance (75 dB_{ht} (standardised)) at the Inch Cape Project only (Scenario 1a to Scenario 4)'. The difference in the numbers of individuals with the potential to be affected reflect the curtailment of behavioural response predicted to 75 dB_{ht} (*species*), and assigning all behavioural response between 90 and 75 dB_{ht} (*species*) a displacement value predicted from 75 dB_{ht} (*species*). It is expected that fewer animals will be predicted to respond in this latter case as 75 dB_{ht} (*species*) and 90 dB_{ht} (*species*) lie at either end of the steepest part of the dose response curve (see *Appendix 14B*, Figure 14B.6). The modelling to inform the cumulative assessment was therefore carried out using the 'standardised' methodology reflecting the availability of 130, 90 and 75 dB_{ht} (*species*) contours (see *Appendix 14B* for full details of methodology).

264 Noise modelling was undertaken at two different locations within each of the three FTOWDG offshore wind farms (see Figure 14.15 below for modelled piling locations). The most sensitive location (that closest to areas of greatest animal density) was used for each species.

Figure 14.15: Noise Modelling Locations for Cumulative Assessment



265 The following piling scenarios, detailed in Table 14.15, were modelled at the most sensitive piling locations for each species (see *Appendix 14B*, *Section 14B.5*). The most likely piling duration at each piling location was used for the cumulative impact modelling.

Table 14.15: Details of the Scenarios Used for Predicting Cumulative Impacts of Piling Noise on Marine Mammals

Scenario	Location	Number of piles per 24 h	Species modelled
5a	F3 IC + F5 NnG + F1A FoF	Two piles at Inch Cape (IC), one pile at NnG, one pile at FoF	Bottlenose dolphin Minke whale
5b	F4 IC + F5 NnG + F1A FoF		Harbour seal Grey seal
5c	F3 IC + F5 NnG + F2 FoF		Harbour porpoise
5d	F4 IC + F5 NnG + F2 FoF		White-beaked dolphin
6	F3 IC + F4 IC + F5 NnG + F6 NnG + F1A FoF + F2 FoF	Two piles at F3, two piles at F4, two piles at NnG (one at F5, one at F6), two piles at FoF (one at F1A, one at F2) location	All

266 Scenario 5 is thought to represent the most likely cumulative piling scenario (one piling vessel per project). Noise contours were generated as part of the FTOWDG package of works discussed previously (see Table 14.1) from piling two piles at one location at the Inch Cape Development Area, one pile at Firth of Forth Phase 1 and one pile at Neart na Gaoithe within one 24 hour period (Scenario 5a to 5d in Table 14.15).

267 Scenario 6 is thought to represent the worst case cumulative piling scenario (two piling vessels per project). Noise contours were generated from piling four piles at the Inch Cape Development Area (two at each of two locations) and one pile at each Firth of Forth Phase 1 and Neart na Gaoithe location within one 24 hour period (Scenario 6 in Table 14.15).

268 All marine mammals are predicted to have the potential to experience lethal effects at a maximum of six metres from each piling operation, and physical injury up to a maximum of 40 m from each piling operation. It is very unlikely that marine mammals will be exposed to noise levels which have the potential to cause death/physical injury because a mitigation protocol has been developed by the SNCBs in order to reduce this risk to negligible levels (JNCC, 2010a), and which will be implemented by ICOL. Therefore cumulative death/physical injury is not discussed further within this chapter.

269 The number of each species predicted to have the potential to be exposed to SELs sufficient to induce the onset of PTS and to have the potential to be displaced for Scenario 5 and 6 are provided in Table 14.16 and 14.17 below. These numbers were generated through the use of

SAFESIMM from SEL data files provided by Subacoustech and thus, unlike the behavioural displacement predictions, do not reflect a difference in methodology from that used for the Inch Cape Project alone.

Table 14.16: Scenario 5: Number of Individuals and Proportion of Reference Population (%) Predicted to Develop PTS or Exhibit Behavioural Displacement (up to 75 dB_{ht} (*species*)) for Species as a Result of Piling Noise in the Cumulative Construction

Species	PTS		Displacement (75 dB_{ht} (*species*))[7]	
	n	%	n	%
Harbour seals	72	11.3	287	45.0
Grey seals	737	10.4	2546	35.8
Harbour porpoise	22	<0.1	555	0.3
Bottlenose dolphin	4.3	4.4	15	15.3
White-beaked dolphin	11	<0.1	59	0.3
Minke whale	17	<0.1	467	0.3

Table 14.17: Scenario 6: Number of Individuals and Proportion of Reference Population (%) Predicted to Develop PTS or Exhibit Behavioural Displacement (up to 75 dB_{ht} (*species*)) for Species as a Result of Piling Noise in the Cumulative Construction

Species	PTS		Displacement (75 dB_{ht} (*species*))[13]	
	n	%	n	%
Harbour seals	90	14.1	298	46.7
Grey seals	969	13.6	2867	40.3
Harbour porpoise	32	<0.1	577	0.4
Bottlenose dolphin	4.8	4.9	17	17.3
White-beaked dolphin	16	0.1	67	0.3
Minke whale	24	<0.1	545	0.3

Significance of Impact

270 Potential significance of the impacts described above was also investigated at the population level for the SAC species – harbour seal, grey seal and bottlenose dolphin.

[7] Numbers calculated using the 'standardised' method from 130, 90 and 75 dB_{ht} (*species*) contours only

Harbour Seal

271 Population modelling (detailed in *Appendix 14D* and summarised in *Section 14.7.1* above for Inch Cape Development Area only) indicates that there is little difference between baseline and construction scenarios (Figure 14.13 above) therefore it was concluded that the long term impacts from piling on harbour seals at the population level are likely to be minor. Illustrative modelling has been undertaken, with impacts starting in 2008 in order to address the declining harbour seal population to allow modelling to be undertaken against a population (see *Appendix 14B* for details). This modelling takes into account a potential cumulative five year period of piling activity.

272 It should be noted that it may not be possible to measure any added loss that activities at the FTOWDG offshore wind farm developments might have on the population in the long-term because by the time piling is due to commence the harbour seal population is likely to be of negligible size (*Appendix 14D*). In conclusion, based on the assumptions above, impacts on the harbour seal population are likely to be minor in the long term.

Grey Seal

273 The 2012 PBR (i.e. the number of animals that can be removed from the population in that year without causing a decline) for grey seals in the ECMA is 277 (The Scottish Government, 2013) If it is assumed that 25 per cent of the animals predicted have the potential to be exposed to SELs sufficient to induce the onset of PTS are lost from the population, or 'harvested', this would equate to removal of 184 (Scenario 5) and 242 (Scenario 6) individuals from the population depending on the scenario (*Appendix 14B, Section 14B.5.2*). This is equivalent to 67 - 87 per cent of the current PBR. Therefore, the potential impact of PTS onset at the population level is within the allowed 'take' (PBR) for both cumulative construction scenarios, and therefore is not predicted to cause a decline in the ECMA population.

274 Modelling undertaken has predicted 35.8 to 40.3 per cent of the grey seal reference population may exhibit behavioural responses to piling noise out to 75 dB_{ht} (harbour seal); This equates to a major impact at 75 dB_{ht} (harbour seal) in the medium term which could have the potential to impact population size in the long term due to a reduction in breeding success for the duration of piling activities.

275 Due to the conservative approach taken to modelling potential impacts, these numbers of animals exhibiting behavioural responses are considered to be highly conservative and are likely to represent an over-estimation of the number of animals affected.

276 Displacement is not expected to have the same effect on grey seals as it might have on a species which does not travel so extensively, and thus the reduction in breeding success is expected to be lower than for a species such as harbour seal. Given that the grey seal population in the ECMA is thought to be increasing (*Appendix 14A*, *Section 14A.2.3*), there is likely to be suitable alternative habitat for feeding and hauling out therefore it is considered unlikely that behavioural impacts will have a long-term impact at the population level.

Therefore the overall assessment of long term significance at a population level on grey seals for behavioural effect and PTS onset is likely to be minor.

Bottlenose Dolphin

277 Outputs of the cumulative effects population modelling presented in *Appendix 14B, Section 14B.5.4* ('Auditory Injury and Displacement for Cetaceans') indicate that it is likely that there will be no population level effects of cumulative piling activity from Scenario 5 and 6 on the size of the east coast bottlenose dolphin population over a period of 25 years, and therefore in the long term, including after the 25 year modelled period. The majority of the model runs had final population sizes after 25 years in the 200 individuals bin, i.e. the same population size as the baseline scenario. Therefore, significance at the population level in the long term is predicted to be minor.

278 An additional 'extreme' cumulative scenario in which all calves were harvested following each year of construction was also modelled to attempt to illustrate the potential impact of concurrent piling at both the FTOWDG, Moray Firth (Beatrice Offshore Wind Farm and the Moray Firth R3 Zone 1 (Eastern Development Area)) and Aberdeen Bay (European Offshore Wind Deployment Centre) offshore wind farm developments. All five cumulative projects lie within range of the east coast of Scotland bottlenose dolphin population. This is presented as Scenario J - 'Extreme to include 100 per cent breeding failure' in *Appendix 14B, Section 14B.5.5*. The construction years used included 2014 to 2018. The outputs indicate that it is possible that the cumulative piling activity described may result in a small effect at the population level (the majority of the model runs had final population sizes after 25 years of 160 individuals). Whether this would be detectable given the likely confidence interval associated with any population estimate (e.g. the 95 per cent highest posterior density intervals associated with the current population estimate of 195 individuals are 162-253; Cheney *et al*., 2012) is unclear.

279 When compared to the baseline scenario without construction related impacts shown in Figure 14.7, *Section 14.5.3* above, population level modelling indicates that the impact of PTS onset (minor impact, medium duration) and behavioural displacement (moderate impact, medium duration) are unlikely to cause a decline at the population level in the long term (25 years). The overall impact on the bottlenose dolphin population is therefore considered to be minor in the long term.

280 Potential effects on the non-SAC species (harbour porpoise, white-beaked dolphin and minke whale) are predicted to be of low magnitude (less than 10 per cent of the population will be affected) for both PTS onset and behavioural response. Thus, combined with the medium term duration (piling years), the predicted impacts are minor for all species.

281 Table 14.18 below shows a summary of the level of significance of potential behavioural impacts occurring as a result of piling at the Inch Cape Development Area, Firth of Forth Phase 1 and Neart na Gaoithe Wind Farms. Table 14.19 provides a summary of the potential PTS onset impacts from the same cumulative projects.

Table 14.18: Summary of Predicted Impacts of Displacement from Piling at the Inch Cape Development Area and Cumulatively with Neart na Gaoithe and Firth of Forth Phase 1 Offshore Wind Farms

European Protected Species	Number of animals predicted to exhibit some form of behavioural response out to 50 dB_{ht} from piling at Inch Cape Development Area only (Scenario 1 to Scenario 4)	Predicted impact –at Inch Cape Development Area at population level	Number animals predicted to exhibit up to mild behavioural avoidance (75 dB_{ht} (standardised)) at Inch Cape Development Area only (Scenario 1a to Scenario 4)	Predicted impact –at Inch Cape Development Area at population level	No. animals predicted to exhibit up to mild behavioural avoidance (cumulative - 75 dB_{ht} (standardised)) for cumulative scenarios (5 and 6)	Predicted impact – cumulative at population level
Harbour seal	322-340	Major (medium term) but minor at population level in the long term	239-257	Major (medium term) but minor at population level in the long term	287-298	Major (medium term) but minor at population level in the long term
Grey seal	3,058-3,212	Major (medium term) but minor at population level in the long term	2,380-2,507	Major (medium term) but minor at population level in the long term	2,546-2,867	Major (medium term) but minor at population level in the long term
Harbour porpoise	486-556	Minor	266-326	Minor (medium term)	555-577	Minor
Bottlenose dolphin	15-19	Moderate (medium term) but minor at the population level in the long term	10-13	Moderate (medium term) but minor at the population level in the long term	15-17	Moderate (medium term) but minor at the population level in the long term

European Protected Species	Number of animals predicted to exhibit some form of behavioural response out to 50 dB_{ht} from piling at Inch Cape Development Area only (Scenario 1 to Scenario 4)	Predicted impact –at Inch Cape Development Area at population level	Number animals predicted to exhibit up to mild behavioural avoidance (75 dB_{ht} (standardised)) at Inch Cape Development Area only (Scenario 1a to Scenario 4)	Predicted impact –at Inch Cape Development Area at population level	No. animals predicted to exhibit up to mild behavioural avoidance (cumulative - 75 dB_{ht} (standardised)) for cumulative scenarios (5 and 6)	Predicted impact – cumulative at population level
White-beaked dolphin	43-51	Minor	20-27	Minor (medium term)	59-67	Minor
Minke whale	500-543	Minor	327-361	Minor (medium term)	467-545	Minor

Table 14.19: Summary of Potential PTS Onset Impact from Piling at the Inch Cape Development Area and Cumulatively with Neart na Gaoithe and Firth of Forth Phase 1 Offshore Wind Farms

European Protected Species	Number of animals modelled to exhibit PTS onset from piling at the Inch Cape Development Area only (Scenario 1 to Scenario 4)	Predicted impact – at the Inch Cape Development Area at population level	Number of animals modelled to exhibit PTS onset for cumulative scenarios (5 and 6)	Predicted impact – cumulative at population level
Harbour seal	47-78	Minor (47) to Moderate (78) (medium term) but minor at population level in the long term	72-90	Moderate (medium term) but minor at population level in the long term
Grey seal	478-822	Moderate (medium term) but minor at population level in the long term	737-969	Moderate (medium term) but minor at population level in the long term
Harbour porpoise	16-30	Minor (medium term)	22-32	Minor
Bottlenose dolphin	1.2-2.9	Minor (medium term) and minor at the population level in the long term	4.3-4.8	Minor (medium term) and minor at the population level in the long term
White-beaked dolphin	7-13	Minor (medium term)	11-16	Minor
Minke whale	13-24	Minor (medium term)	17-24	Minor

Table 14.20: Summary of Potential Impacts Occurring as a Result of Cumulative Construction Scenario Piling Noise on the Relevant Marine Mammal Receptors

Receptor	Potential Impact: Piling at IC, FoF and NNG
Harbour seal	Moderate (PTS onset) and Major (behavioural avoidance) in the medium term but likely Minor impact in the long term (illustrative modelling has been carried out because current population projections predict that the harbour seal population will be of negligible size at the start of the actual piling period).
Grey seal	Moderate (PTS onset) and Major (behavioural avoidance) (medium term). Population comparisons to current PBR predicts Minor impacts (long term).
Harbour porpoise	Minor for both PTS onset and behavioural avoidance.
Bottlenose dolphin	Minor (PTS onset) and Moderate (behavioural avoidance) (medium term) but population modelling predicts Minor impact at the population level (long term). A potentially un-measurable reduction in population size may occur if piling schedules of the FTOWDG, Aberdeen Bay and Moray Firth projects coincide and the combined impacts result in complete failure of the entire population to raise young for five years. Given the highly precautionary nature of the population modelling (detailed in Table 14B.11), it is considered highly unlikely that this degree of breeding failure would occur.
White-beaked dolphin	Minor for both PTS onset and behavioural avoidance.
Minke whale	Minor for both PTS onset and behavioural avoidance.

Increased Vessel Movement - Collision Risk and Barrier Effect

Overview of Impact

282 Cumulative construction, maintenance and operation, and decommissioning phases of offshore developments in the east of Scotland may result in increased vessel traffic across the region, in both coastal and offshore waters. This could lead to potentially higher risk of collision and potential barrier effect. A generic assessment of impact of increased vessel use is presented here. It is likely that the greatest vessel use will be during the construction and decommissioning phases of offshore wind projects, particularly during the installation, and removal, of foundation structures. The potential effects of decommissioning are considered to be equivalent to and potentially lower than the worst case effects assessed for the construction phase. Non-offshore wind projects listed in Table 14.13 are not predicted to cause a significant increase in vessel movement or vessel movement will be very locally restricted. Offshore wind projects outwith the Firth of Forth and Tay are considered to be sufficiently distant from the Inch Cape Project not to constitute a potential cumulative impact. The focus has therefore been on FTWODG projects.

Characterisation of Impact

283 It is likely that FTOWDG construction periods will overlap, therefore it can be assumed that increased vessel traffic use will overlap. Table 14.14 illustrates predicted overlap of construction activities of the FTOWDG offshore wind farms starting in 2014 (likely foundation installation years shaded grey, to start in 2015).

284 It is predicted that vessels used for construction, operation and maintenance, and decommissioning activities for the FTOWDG offshore wind farms will use a pre-defined corridor, and will move in a predictable manner thereby maximising predictability and detection by marine mammals. Increased vessel use is therefore considered likely to have a limited effect on marine mammals either as a barrier to movement, or increased collision risk. Potential to impact individuals is highest when animals move into close proximity with vessels. This is considered unlikely.

285 It is expected that the cumulative effect of increased construction and maintenance vessel traffic will not be markedly above the existing levels of vessel traffic currently using waters to the east of Scotland. Therefore, although of a long-term duration, impacts to marine mammals are expected to be of a low magnitude.

Significance of Impact

286 The cumulative effect of increased collision risk and barrier to movement from increased vessel movements and presence, particularly during the construction phase of offshore developments throughout the region, is considered to be localised, of a low magnitude (effecting less than 10 per cent of the population), of a medium duration for construction vessels and long term for operation and maintenance vessels. Thus the impact is minor overall.

Increased Vessel Movement – Use of Ducted Propellers

Overview of Impact

287 Cumulative construction, maintenance and decommissioning phases of the FTOWDG offshore wind farms in the east of Scotland may result in increased vessel traffic across the region, in both coastal and offshore waters, leading to a potentially higher risk of corkscrew injury to marine mammals from ducted propellers. It is likely that the greatest vessel use will be during the construction and decommissioning phases of the FTOWDG offshore wind farms, particularly during installation of foundation structures, and that these vessels will use ducted propellers. Offshore wind farm projects out with the Firth of Forth and Tay are considered to be sufficiently distant from the Project not to constitute a potential cumulative impact. Construction of non-wind farm developments along the coast, detailed in Table 14.13 above, are unlikely to require the use of vessels utilising ducted propellers.

288 The focus has therefore been on offshore wind farm projects within the Firths of Forth and Tay area. Cumulative construction and maintenance phases of offshore developments may result in increased vessel traffic across the region (see assessment for collision risk and barrier effect directly above). This increase is likely to occur in both coastal and offshore waters and therefore increase risk of exposure of harbour and grey seals to corkscrew injury.

Characterisation of Impact

289 As discussed in *Section 14.7.1*, the precise nature of the vessels to be used for the construction, operation and maintenance and decommission phases of the offshore wind farms has yet to be determined. It is possible and likely that a number of vessels used will employ a ducted propeller system for maintaining position and travelling at slow speeds. A worst case scenario would be that a number of vessels using ducted propellers would be commuting between the FTOWDG offshore wind farms and their respective construction ports on a daily basis. Other projects listed in Table 14.13 are not predicted to cause a significant increase in vessel movement (using ducted propellers) as they are more restricted in nature, therefore the focus has been on offshore wind projects.

290 As with the previous assessments presented within this chapter, the species considered to be at particular risk is harbour seal.

Significance of Impact

291 The JNCC (endorsed by SNCBs) has provided advice (Table 14.12) relating to the potential for corkscrew injury to seals and proposed offshore developments (JNCC *et al*., 2012). They consider that if an activity is to take place within 30 nm of a harbour seal SAC, animals inhabiting the area are at a medium risk of injury. Most cumulative sites are within 30 nm. However, vessels commuting to and from the sites have the potential to pass within four nautical miles of the SAC boundary and therefore have the potential to pose a high risk. Precise details of vessels to be used and construction ports for the projects being assessed are yet to be determined but it is likely that some will involve travel within this distance. However, as the number of seals associated with the Firth of Tay and Eden Estuary SAC are so low (and declining) the number of individual animals at risk is also considered to be low as there are few animals to have the potential to interact with a ducted propeller.

292 The cumulative effect of increased risk to harbour seals from increased exposure to ducted propellers of the offshore developments construction throughout the region is therefore considered to be uncertain, of a likely medium magnitude (reflecting the number of construction vessels passing within four nautical miles), of a medium duration (construction years) and impact is therefore considered to be moderate. As described in *Section 14.7.1*, by comparison of the magnitude of predicted medium term impacts from the increased risk of corkscrew injury due to the use of ducted propellers with those from piling related noise, and consideration of the parameters used in the population modelling undertaken for the later to predict long term impacts, corkscrew injury is likely to pose a minor impact in the long term upon the harbour seal population of the ECMA.

293 For the operational phases, the number of vessels involved will be less, and so of likely low magnitude, long term duration and therefore minor impact.

294 The vessels commuting to and from the offshore developments, will not pass within four nautical miles of a grey seal SAC and therefore present a low risk of cork screw injury to grey seals according to JNCC guidance (Table 14.12). The cumulative impact for grey seals is therefore considered to be of low magnitude, medium term and thus be minor. The long

term, population level impact of this increased risk during construction is also considered to be minor.

Toxic Contamination

Overview of Impact

295 Marine mammals can be exposed to contaminants directly through their skin and indirectly through the consumption of contaminated prey, potentially causing illness and/or death. As apex predators, marine mammals are particularly at risk from bio-accumulation of contaminants in the food chain. To date, most research in this area has concentrated on heavy metals, POPs and PAHs.

296 Accidental incidents involving the release of chemicals into the marine environment may involve vessel collisions and accidental spillages. Once an offshore project is operational, leaching of toxic compounds from sacrificial anodes, leaking of corrosion inhibitors, antifouling paints, vessel fuel or the loss of hydraulic fluids may result in toxic contamination of the water column.

297 The heavy metals of greatest importance to marine mammals species are cadmium, lead, zinc and mercury, all of which bio-accumulate and are frequently found in high concentrations in the liver, kidney and bone. Marine mammals produce proteins (metallothioneins) which are involved in the homeostasis of essential metals (zinc and copper) and detoxification of non-essential metals (cadmium and mercury); therefore, marine mammals can tolerate relatively high levels of some metals in their diet (Das *et al*., 2000). Heavy metal contamination has been associated with POP build up in fatty tissues, which are often resistant to metabolic degradation, resulting in high levels being found in the blubber of marine mammals. POPs are thought to affect the immune and hormonal systems, thereby having the potential to impact reproductive success.

Characterisation of Impact

298 An increase in vessel traffic from cumulative offshore projects may result in an increased risk of accidental vessel collision within the Firths of Forth and Tay area. In general, vessel collision, both with other vessels and with offshore installations, may result in the accidental release of chemicals such as fuel. Additionally, accidental spillage of polluting chemicals such as lubricants and anti-corrosion agents may occur due to human error or technical failure and without the involvement of a vessel collision.

299 Should an accidental incident occur where chemicals are released into the marine environment, it is environmental best practice for emergency procedures to be in place to minimise environmental effects where possible; this may include the use of spill kits to enable containment and treatment of spillages.

300 In a worst case scenario where a vessel collision may result in the release of significant volumes of pollutants, potential impacts to marine mammals may include illness and death from ingestion and direct contact with chemicals, or indirect effects through the consumption of contaminated prey species.

Assessment of Significance

301 All materials used in the construction, operation and decommissioning of cumulative projects listed in Table 14.13 are likely to be certified as safe for use within the marine environment. It is likely that antifouling paints, amongst other potential contaminants, are already widely used by existing marine infrastructure and vessels in the Firth of Forth and Tay; therefore detectable increases in potential contaminants cumulatively are considered unlikely.

302 Vessels will use predefined routes and will travel at slow speeds to reduce this risk where possible.

303 The probability of such an event occurring is deemed highly unlikely. As the greatest increase in vessel movements will be during the construction phase, the increased risk of toxic contamination will predominantly be during the construction phase and therefore of a temporary nature (see *Chapter 19*).

304 The impact of increased risk of accidental pollution incidents to marine mammal species is considered of a low magnitude (effect <10 per cent reference population), of a temporary (medium term) duration (highest during construction years), and therefore is predicted to be minor.

Indirect Impacts from Changes in Prey Availability - EMF and Subsea Infrastructure Associated with the Offshore Developments within the Forth of Tay Area

Overview of Impact

305 Indirect impacts of prey species habitat disturbance and EMF may have an impact on the availability of marine mammal prey species. These potential impacts are considered to be most relevant to cumulative wind farms within the Firth of Forth and Tay, and not the other projects identified within Table 14.13. The distribution and abundance of these species may change throughout the lifecycle of the Inch Cape, Neart na Gaoithe and Firth of Forth Phase 1 offshore wind farms. It is considered that changes in the distribution and abundance of marine mammal prey species due to changes in habitat (due to subsea infrastructure) are likely to be local to the Development Areas only and most likely to occur during the construction and decommissioning phases. Impacts due to EMF are likely to occur only during the operational phase.

Characterisation of Impact

306 Fish species occurring within the Development Areas will likely experience localised disturbance and displacement during the construction phases, potentially locally affecting fish distribution and abundance.

307 During proposed operation of the wind farms within the Firth of Forth and Tay, changes in EMF may also influence fish behaviour within very close proximity of the operational cables. However WTG presence may attract fish species and act as a fish aggregating device.

Assessment of Significance

308 It is likely that during the impact piling phases of the cumulative offshore wind projects within the Firth of Forth and Tay, marine mammals will forage outwith the wind farm sites due to the direct impacts of increased underwater noise and disturbance. Additional disturbance and displacement from the export cable route due to cable laying/protection is therefore likely to be limited to localised regions of the inshore areas of the Firth of Forth and Tay through which the export cables will be routed. It is also predicted to be of a temporary nature.

309 *Section 14.7.1* "Effects of Construction Indirect Impacts - Changes in the Availability of Prey Species" has set out the predicted impact associated with changes in prey availability and it is considered these conclusions are likely to hold true for other offshore wind development in the Firths of Forth and Tay area.

310 Animals are likely to forage outwith the development footprints during construction (piling) years and the mobile nature and large foraging range of marine mammals and prey species, in addition to the availability of alternative marine mammal foraging habitat located elsewhere within the North Sea, have been taken into account in the assessment of significance of effect. The potential for cumulative impacts to marine mammals from changes in the distribution and abundance of prey species from offshore wind projects in the Firth of Forth and Tay is deemed to be of a low magnitude (<10 per cent reference population), of a medium (changes in prey species habitat) to long (potential impacts from EMF) term duration, and therefore predicted to be minor.

311 Consideration of the potential impact arising from EMF has taken the mobile nature and large foraging range of marine mammals and prey species into account, in addition to the availability of alternative marine mammal foraging habitat located elsewhere within the North Sea.

312 Given the very small potential impact range from EMF emanating from cables predicted for this potential impact in *Section 14.7.1* "Effects of Construction – Indirect Impacts: Changes in the Availability of Prey Species", it is considered these conclusions are likely to hold true for other offshore wind development in the Firths of Forth and Tay area.

313 The cumulative impacts of EMF on marine mammal as a consequence of impact upon prey species are considered to be of low magnitude, of long-term duration, of a localised nature and are therefore to be of minor.

14.11 Mitigation

314 The marine mammal assessment has assessed worst case scenario impacts of the Project in isolation and cumulatively. This assessment has concluded that the long term impacts to the marine mammal within the Development Area and Offshore Export Cable Corridor from the Project related activities will be of no more than minor. For the purposes of this assessment, only effects indicated as Major and Moderate/Major are considered to be significant (see *Section 14.6*).

315 Based on the outputs from this impact assessment, it has been concluded that the Embedded Mitigation detailed in *Section 14.4.1* is appropriate. No Addition Mitigation is proposed for the Project. It should be noted that alternative mitigation techniques will be investigated prior to the finalisation of the construction method statement. Approaches will be confirmed following consultation with regulatory organisations. Adoption of any mitigation measures will be subject to an assessment of technical and commercial feasibility.

Monitoring

316 Recent developments in the use of passive acoustic monitoring may enable deployment of effective mitigation, management and monitoring measures throughout the construction period of the Wind Farm and OfTW and associated infrastructure. Employment of alternative mitigation techniques will be investigated prior to the finalisation of the construction method statement and commencement of construction; management and monitoring approaches will be confirmed following consultation with regulatory organisations.

317 It is anticipated that pre-, during and post-construction monitoring will provide valuable data regarding the predicted to actual effects of the Project on marine mammal species. Throughout the duration of offshore wind farm lifecycle, ICOL will work with Marine Scotland, TCE and FTOWDG to share marine mammal data, to inform and further develop best practice measures.

14.12 Conclusions and Residual Impacts

14.12.1 Development Area

318 All Embedded Mitigation identified in Tables 11.22 and 11.23 has been included within the assessments above, and therefore in all cases the pre- and post-mitigation effects are the same and only the Post-Mitigation Effects (Residual Effects) have been presented in Table 14.21 below.

Table 14.21: Development Area: Summary of Effects

Effect	Receptor	Residual Effects
Construction		
Disturbance from increased Noise (non-piling)	All marine mammals	Minor
Displacement/PTS from piling	All marine mammals	Minor to major in the medium term, minor in the long term
Collision risk and barrier effect from increased vessel movement	All marine mammals	Minor

Effect	Receptor	Residual Effects
Construction		
Use of ducted propellers leading to risk of corkscrew injury	Seals	Moderate (harbour seals) in the medium term, minor in the long term Minor (grey seals)
Accidental pollution events	All marine mammals	Minor
Changes in availability of prey species	All marine mammals	Minor
Operation		
Disturbance from increased Anthropogenic Noise (non-piling)	All marine mammals	Minor
Collision risk and barrier effect from increased vessel movement	All marine mammals	Minor
Use of ducted propellers leading to risk of corkscrew injury	Seals	Minor for both harbour and grey seals
Loss of habitat	All marine mammals	Minor
Creation of habitat	All marine mammals	Minor
Effects of EMF	Cetaceans	Minor
Toxic contamination	All marine mammals	Minor

14.12.2 Offshore Export Cable Corridor

319 All Embedded Mitigation identified above has been included within the assessments, and therefore in all cases the pre- and post-mitigation effects are the same and only the Post-Mitigation Effects (Residual Effects) have been presented in Table 14.22 below.

Table 14.22: Offshore Export Cable Corridor: Summary of Effects

Effect	Receptor	Residual Effects
Installation		
Disturbance from increased Noise	All marine mammals	Minor
Collision risk from increased vessel movement	All marine mammals	Minor
Use of ducted propellers leading to risk of corkscrew injury	Seals	Minor for both harbour and grey seals
Accidental pollution events	All marine mammals	Minor
Operation		
Collision risk from increased vessel movement	All marine mammals	Minor
Use of ducted propellers leading to risk of corkscrew injury	Seals	Minor for both harbour and grey seals
Changes in availability of prey species	All marine mammals	Minor
Effects of EMF	Cetaceans	Minor

14.12.3 Cumulative Impacts

320 All Embedded Mitigation for the Project with other cumulative projects have been included within the assessments, and therefore in all cases the pre- and post-mitigation effects are the same and only the post mitigation effects have been presented in Table 14.23 below.

Table 14.23: Cumulative Impacts: Summary of Effects

Effect	Receptor	Post-Mitigation Effect
Construction		
Total increased underwater noise (non-piling)	All marine mammals	Minor
Total increased underwater noise (piling)	All marine mammals	Minor to Major in the medium term, minor in the long term
Collision risk and barrier to movement from increased vessel movement	All marine mammals	Minor
Use of ducted propellers leading to risk of corkscrew injury	Seals	Moderate (harbour seals) in the medium term, minor in the long term Minor (grey seals)
Toxic contamination	All marine mammals	Minor
Operation		
Total increased underwater noise (non-piling)	All marine mammals	Minor
Collision risk and barrier to movement from increased vessel movement	All marine mammals	Minor
Use of ducted propellers leading to risk of corkscrew injury	Seals	Minor for both harbour and grey
Indirect impacts from changes in prey availability (including EMF)	All marine mammals	Minor
Toxic contamination	All marine mammals	Minor

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14.13 Habitats Regulations Appraisal

14.13.1 Background

<u>Introduction</u>

321 The purpose of this section is to provide information to inform an Appropriate Assessment, following available and relevant guidance in assessing potential impacts which may arise during the construction, operation and decommissioning of the Project by:

a) Identifying relevant Natura sites which include marine mammals as notified interest features and for which there is potential connectivity from activities associated with the Project.

b) Identifying potential opportunities for these designated sites to be affected by activities associated with the Project 'routes to impact' associated with the construction, operation and decommissioning of the Project.

c) Considering potential impacts in relation to notified interest features of identified Natura sites in relation to their conservation objectives.

322 This section has been prepared following the process described in *Section 4.8* and has been prepared to inform an Appropriate Assessment to be carried out by the Scottish Ministers, acting through Marine Scotland, in respect of the Project.

<u>In-combination Effects</u>

323 In addition to assessing impacts of the Project, the HRA assessment also assesses potential in-combination effects which may arise from other, existing (or foreseeable) developments/activities. The developments considered are listed in *Section 14.10*; Table 14.13.

324 However, SNH/JNCC advised in their response to the screening exercise (see Table 14.1) that "details of projects considered in assessing cumulative and in combination impacts - Marine Scotland and the local authorities will advise on the range of projects to consider under cumulative impact assessment for marine mammal species, with input from ourselves. We note that seal conservation and seal licensing is now legislated for under the *Marine (Scotland) Act 2010*. Shooting is still possible under licence from Marine Scotland, but there is no longer a 'netsmen's defence' to protect fishing nets or catches". ICOL has taken the killing of seals under licence into account in the in-combination assessment for HRA through the consideration of PBR.

325 Because the primary impact during construction of the Project will be from piling (see *Section 14.7.1*), in-combination effects other than piling have been assessed qualitatively rather than being assessed quantitatively as per piling impacts.

326 The EU council directive 92/43/EEC on the *Conservation of Natural Habitats and Wild Flora and Fauna* (the *Habitats Directive*) requires member states to implement management measures to maintain or restore natural habitats and wild species listed on the Annexes of the directive.

Protected Areas

327 A number of SACs have been designated for marine mammals which are within travelling distance (by the animal) of the Development Area and Offshore Export Cable Corridor (see *Section 9.3.3*). Movement of animals between the Forth and Tay area and these SACs is known to occur.

328 Early consultation with Marine Scotland, JNCC and SNH identified potential SACs (with marine mammal notified interests) to be considered further (through the HRA screening exercise, see Table 14.1). SACs identified and agreed for further consideration are (see Figure 14.16 below):

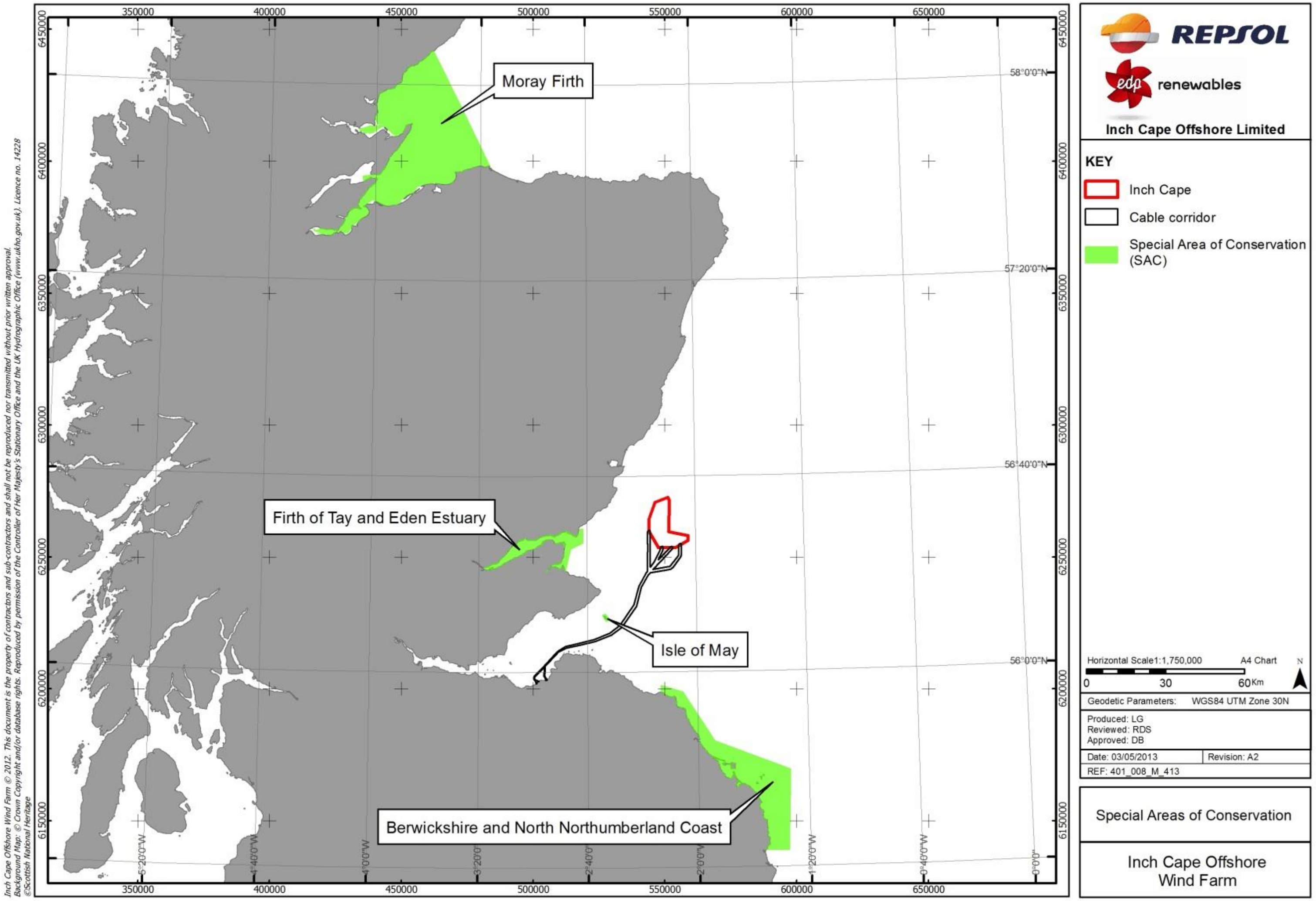
- Firth of Tay and Eden Estuary SAC – Common seal[8] (*Phoca vitulina*);
- Isle of May SAC – Grey seal (*Halichoerus grypus*);
- Berwickshire and North Northumberland Coast SAC – Grey seals (*Halichoerus grypus*); andMoray Firth SAC – Bottlenose dolphin (*Tursiops truncatus*).

329 The conservation objectives for each site under consideration are generic/the same and are provided below:

- To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving FCS for each of the qualifying features; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within the site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

[8] Harbour seal is the most frequently used common name for *Phoca vitulina*. In site qualifying interest lists (otherwise known as QUILS) the species is referred to as Common Seal. Common Seal must therefore be used in relation to the legislation (HRA and Conservation Objectives).

Figure 14.16: Marine Mammal SACs



Screening for Likely Significant Effect

330 Screening for potential LSE has been undertaken in consultation with Marine Scotland, SNH and JNCC and the scope of the HRA agreed – as detailed in the screening document (Inch Cape Marine Mammal Screening Report – issued to regulators on the 28 August 2012). Table 14.24 below details the conclusions of the screening stage for the relevant SACs.

Table 14.24: European Sites which are within the Potential Impact Zone of the Project for Marine Mammals, and Considered Would Suffer a LSE

Special Area of Conservation	Distance to the Inch Cape Development Area (km)	Relevant Qualifying interest	Status[9]	Reason for Selection[10]	Additional information	Potential impact of the Project alone or in combination.
Firth of Tay and Eden Estuary	25	Common seal (*Phoca vitulina*)	Unfavourable Declining	The Firth of Tay and Eden Estuary supports a nationally important breeding colony of common seal (*Phoca vitulina*), part of the east coast population of common seals that typically utilise sandbanks. Around 600 adults haul-out at the site to rest, pup and moult, representing around 2% of the UK population of this species.	Only 77 harbour seals were counted in August 2011. This was the lowest ever count for the Firth of Tay and represents 11% of the mean count (670) between 1991 and 2002 (Duck and Morris, 2012). There is no apparent recovery of the dramatic decline in harbour seal numbers in the Firth of Tay and Eden Estuary SAC. Harbour seals normally feed within 40-50 km of their haul-out sites (SCOS, 2011). The northern tip of the Development Area is used by harbour seals for foraging (as are areas between the coast and the Development Area; Sparling *et al.*, 2012).	The primary impact is considered to be displacement from foraging areas and transit routes due to increased underwater noise from piling. This displacement is likely to occur for the duration of the piling activity, but is likely to be reversible once piling has stopped. Piling related noise could potentially cause the onset of PTS, however, lethal effect and physical injury are not predicted as Embedded Mitigation will allow animals to move outwith the range of potential injury. The use of ducted propellers in the inshore areas could potentially impact the population through potential corkscrew injury. Changes in habitat distribution and structure may also affect the distribution and abundance of harbour seal prey species in the medium term.

[9] Taken from http://gateway.snh.gov.uk/sitelink/index.jsp on 24/05/2012
[10] Taken from http://jncc.defra.gov.uk/protectedsites/sacselection/SAC_searchpage.asp

Special Area of Conservation	Distance to the Inch Cape Development Area (km)	Relevant Qualifying interest	Status[9]	Reason for Selection[10]	Additional information	Potential impact of the Project alone or in combination.
Isle of May	32	Grey seal (*Halichoerus grypus*)	Favourable Maintained	The Isle of May, lying at the entrance to the Firth of Forth on the east coast of Scotland, supports a breeding colony of grey seals. The site is the largest east coast breeding colony of grey seals in Scotland and the fourth-largest breeding colony in the UK, contributing approximately 4.5% of annual UK pup production.	SCOS tend to combine the Isle of May SAC pup production estimate with those from Fast Castle and the Firth of Forth islands colonies. This is presented as a 'Firth of Forth colonies' estimate (SCOS, 2011). Pup production in the Firth of Forth colonies was 4,249 in 2010, a 5% increase on 2009 (SCOS, 2011). Grey seals forage in the open sea and return regularly to haul out on land. They may range widely to forage and frequently travel over 100 km between haul-out sites. Foraging trips can last anywhere between one and 30 days (SCOS, 2011). The whole of the proposed Development Area is used by grey seals for foraging (as are several other areas both between the coast and the Development Area and also offshore and to the south of the Development Area; Sparling *et al.*, 2012).	The primary impact is considered to be displacement from foraging areas and transit routes due to increased underwater noise from piling. This displacement is likely to occur for the duration of piling activity but is likely to be reversible once piling has stopped. Piling related noise could potentially cause the onset of PTS. The use of ducted propellers in the inshore areas could potentially impact the population through potential corkscrew injury. Because the grey seal population at this SAC is increasing (based on pup production estimates), viability of this population is unlikely to be affected by the Project in the long term (see *Section 14.10.1* for assessment of the potential impacts of the Project). Changes in habitat distribution and structure may also affect the distribution and abundance of grey seal prey species in the medium term.

Special Area of Conservation	Distance to the Inch Cape Development Area (km)	Relevant Qualifying interest	Status[9]	Reason for Selection[10]	Additional information	Potential impact of the Project alone or in combination.
Berwickshire and North Northumberland Coast	52	Grey seal (*Halichoerus grypus*)	Favourable Maintained	This is an extensive and diverse stretch of coastline in north-east England and south-east Scotland. There is variation in the distribution of features of interest along the coast. The north-east England coastal section is representative of grey seal breeding colonies in the south-east of its breeding range in the UK. It is the most south-easterly site selected for this species, and supports around 2.5% of annual UK pup production.	The 'Firth of Forth colonies' estimate is made up of the Isle of May, Fast Castle and the Firth of Forth islands estimates combined (SCOS, 2011). Pup production was 4,249 in 2010, a 5% increase on 2009 (SCOS, 2011). Grey seals forage in the open sea and return regularly to haul out on land. They may range widely to forage and frequently travel over 100 km between haul-out sites. Foraging trips can last anywhere between one and 30 days (SCOS, 2011). The whole of the Development Area is used by grey seals for foraging (as are several other areas both between the coast and the Development Area and also offshore and to the south of the Development Area; Sparling *et al.*, 2012).	The primary impact is considered to be displacement from foraging areas and transit routes due to increased underwater noise from piling. This displacement is likely to occur for the duration of piling activity but is likely to be reversible once piling has stopped. Piling related noise could potentially cause the onset of PTS. The use of ducted propellers in the inshore areas could potentially impact the population through potential corkscrew injury. Because the grey seal population at this SAC is increasing (based on pup production estimates), viability of this population is unlikely to be affected by the Project in the long term. Changes in habitat distribution and structure may also affect the distribution and abundance of grey seal prey species in the medium term.

Special Area of Conservation	Distance to the Inch Cape Development Area (km)	Relevant Qualifying interest	Status[9]	Reason for Selection[10]	Additional information	Potential impact of the Project alone or in combination.
Moray Firth	142	Bottlenose dolphin (*Tursiops truncatus*)	Unfavourable Recovering	The Moray Firth in north-east Scotland supports the only known resident population of bottlenose dolphin in the North Sea. The population is estimated to be around 130 individuals (Wilson *et al.*, 1999). Dolphins are present all year round, and, while they range widely in the Moray Firth, they appear to favour particular areas.	The most recent (2006) estimate of the size of the east coast population is 195 individuals (95% highest posterior density intervals: 162-253; Cheney *et al.*, 2012). A Bayesian capture-recapture assessment of the total abundance of the east coast bottlenose dolphin population suggests, with a high probability (>99%), that this population is stable or increasing (Cheney *et al.*, 2012). The number of dolphins using the SAC between 1990 and 2010 appears to be stable. However, because the overall east coast population size appears to have increased, the actual proportion of the population using the SAC may have declined. Nevertheless, at least 60% of the population has been seen within the SAC in 16 of the 21 years of photo-identification effort (Cheney *et al.*, 2012.	The primary impact is considered to be displacement from the coastal strip due to increased underwater noise from piling and potential barrier to movement between the Firth of Forth and Tay and the Moray Firth. Changes in distribution are likely to be moderate in the medium term but minor at the population level.

Special Area of Conservation	Distance to the Inch Cape Development Area (km)	Relevant Qualifying interest	Status[9]	Reason for Selection[10]	Additional information	Potential impact of the Project alone or in combination.
					Although these animals have a coastal distribution (Reid *et al.*, 2003), they are wide-ranging. The most southerly confirmed sighting of individuals from this population was made in 2007 in the mouth of the River Tyne (Thompson *et al.*, 2011b).	

331 As detailed in above, the designated species of the four SACs considered in this assessment are bottlenose dolphin, harbour seal and grey seal. As a consequence, these species will be the focus of the HRA assessment presented here. A summary of the potential impacts on these species resulting from the construction, operation or decommissioning of the Project alone or in-combination with other plans or projects is provided in Table 14.25 below.

Table 14.25: Summary of Potential Effects from Project Related Activities from EIA Assessment, Alone or In-Combination with Other Projects

Potential Effect	Predicted effect
Increased anthropogenic noise from construction activities other than piling.	Minor impact in the medium and long term.
Impacts of piling noise.	**Harbour seal**: Moderate (PTS onset) and Major (behavioural impacts) in the medium term but population modelling predicts Minor in the long term. **Grey seal**: Moderate (PTS onset) and Major (behavioural impacts) in the medium term but population modelling predicts Minor in the long term. **Bottlenose dolphin**: Minor (PTS onset) and Moderate (behavioural impacts) in the medium term, but population modelling predicts Minor in the long term.
Increased vessel movement, collision risk and barrier effect.	Minor impact in the medium and long term.
Increased vessel movement – use of ducted propellers.	**Harbour seal**: Moderate impact in the medium term and minor impact in the long term. **Grey seal**: Minor impact in the medium and long term.
Toxic contamination.	Minor impact in the medium and long term.
Indirect Impacts from changes in prey availability - EMF and subsea infrastructure associated with the offshore developments within the Forth of Tay area.	Minor impact in the medium and long term.

14.13.2 Information to Inform an Appropriate Assessment

Addressing Uncertainty

332 As requested by JNCC, SNH and Marine Scotland, terminology used in this assessment is based on that suggested by the IPCC. Definitions provided by the IPCC for levels of confidence in an assessment can be found in Table 14.26 and Table 14.27 below.

Table 14.26: Quantitatively Calibrated Levels of Confidence Used in this Assessment as Defined by the IPCC

Terminology	Degree of confidence in being correct
Very high confidence	At least 9 out of 10 chance
High confidence	About 8 out of 10 chance
Medium confidence	About 5 out of 10 chance
Low confidence	About 2 out of 10 chance
Very low confidence	Less than 1 out of 10 chance

Table 14.27: Definition for the Likelihood of a Defined Outcome Having Occurred or Occurring in the Future, as Defined by the IPCC

Terminology	Likelihood of Occurrence/Outcome
Virtually certain	>99% probability of occurrence
Very likely	>90% probability of occurrence
Likely	>66% probability of occurrence
About as likely as not	33-66% probability of occurrence
Unlikely	<33% probability of occurrence
Very unlikely	<10% probability of occurrence
Exceptionally unlikely	<1% probability of occurrence

333 Assignation of these confidence and likelihood values within the context of this assessment takes into account the conservative assumptions made throughout this assessment. Table 14B.11 in *Appendix 14B* provides details on these assumptions and why they represent the most conservative approach possible in each case. As described above in *Section 14.6*, it is considered that the sum of all these assumptions represents an overly conservative model, and that predicted impacts to the level of those described in the assessments are possible and not probable. Confidence that 'likely' impacts (Table 14.27 above) are within the ranges

predicted by the models used is therefore 'high' or 'very high' (Table 14.26 above) for the assessment undertaken below.

334 As part of the EIA for designated sites and to provide information to the competent authority in order to undertake appropriate assessment, the following tables (Tables 14.28 to 14.31) summarise the effects the Project alone and in-combination with other plans and projects (see Table 14.13) are predicted to have on the four SACs detailed in Table 14.24.

335 The following assessment tables use the same definition of magnitude and significance that are provided in Table 14.8 in order to ensure consistency of terminology.

Table 14.28: Assessment of the Conservation Objectives of the Firth of Tay and Eden Estuary SAC (Qualifying Feature: Common Seal (*Phoca vitulina*)) for the Project and In-combination with Other Projects

Conservation Objective	Assessment (taken from the EIA presented above)
1: Distribution and extent of habitats supporting the species	Increased anthropogenic underwater noise may change the availability of sea as a habitat for animals within the SAC. This may affect the distribution of harbour seals. This impact when considered for the Project alone and in-combination with other projects, is considered to be likely in the medium term, but a minor impact in the long-term (see *Sections 14.10.1* and *14.10.2*). All other potential impacts were predicted to be minor. Even when considered in-combination with other projects it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause a change in habitat distribution within the SAC. Changes in habitat distribution are considered to be likely (medium term) and minor in the long term. Confidence level: High.
2: Structure, function and supporting processes of habitats supporting species	Changes in sea habitat structure due to temporary increased levels of anthropogenic noise may affect the distribution and abundance of harbour seal prey and therefore distribution of animals within the SAC. This indirect impact both for the Project alone and in combination with other projects, is considered to be possible, of low magnitude and therefore a minor impact in the long term. All other potential impacts were predicted to be minor. Even when considered in combination with other projects, it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF and toxic contamination will cause a change in habitat structure within the SAC. Using predictions made within the ES and due to the fact that the SAC does not fall within the Development Area and Offshore Export Cable Corridor, changes in habitat structure are considered to be exceptionally unlikely and therefore a no impact in the long term. Confidence level: Very High.

Conservation Objective	Assessment (taken from the EIA presented above)
3: No significant disturbance to species	The primary impact is considered to be increased noise from piling – both from the Project alone and in-combination with other FTOWDG projects. This has the potential to displace some seals during the piling activities for the construction period. This impact, when considered for the Project alone and in-combination with other projects, is considered to be likely, moderate (PTS onset) and major (behavioural displacement) in the medium term but minor **in the long-term.** As the SAC and ECMA population is undergoing a severe decline, and the population is currently not viable, it is considered unlikely that potential impacts of piling on harbour seals will be detectable at a population level over the long term and are therefore minor. A detailed harbour seal assessment has been presented in *Appendix 14D* and summarised in *Section 14.7.1* and *14.10.2*. All other potential impacts were predicted to be minor. Even when considered in combination it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF, toxic contamination will cause significant disturbance to species. Therefore no significant disturbance to common seal is predicted in the long-term. Confidence level: High.
4: Distribution of the species within the site	The primary impact is considered to be displacement from foraging areas and transit routes due to increased noise from piling. This is considered to be, for the Project alone and in-combination with other projects, possible but of low magnitude and minor in the long term. All other potential impacts were predicted to be minor. Even when considered in combination it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF and toxic contamination will cause changes in species distribution. It is likely that seals displaced during piling operations will find suitable alternative habitat within the Firths of Forth and Tay area and within the ECMA. Therefore changes in distribution of the species within the site are considered to be likely but of a temporary nature and **minor** in the long term. Confidence level: High.

Conservation Objective	Assessment (taken from the EIA presented above)
5: Population of the species as a viable component of the site	All potential impacts other than piling were predicted to be minor. Even when considered in-combination with other projects, it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF and toxic contamination will adversely affect site integrity of the SAC. The primary impact is considered to be increased noise from piling and, based on observations from operational wind farms (Horns Rev I & II), this is not considered a long term impact. As detailed in *Appendix 14B* and *Appendix 14D,* and the EIA assessment, because the harbour seal population within the area is severely declining due to factors unknown but not relating to potential impacts from piling, the modelled potential impact at the population level in the long-term is considered to be minor. Therefore the long-term viability of the population is considered unlikely to be adversely affected. Confidence level: High.

336 It is predicted that the Project, alone or in-combination with other plans or projects, will not cause deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features in the long term.

Table 14.29: Assessment of the Conservation Objectives of the Isle of May SAC (Qualifying Feature: Grey Seal)

Criterion	Assessment
1: Distribution and extent of habitats supporting the species	The potential for piling activity, either associated with the Project alone or in-combination with other projects to directly impact the distribution of habitat within the SAC is considered very unlikely as modelled noise contours do not extend to the Isle of May SAC. Other project related activities either for the Project alone or in-combination with other projects, do not enter or pass in close proximity to the SAC therefore potential effects on habitat distribution are considered to be highly unlikely. All other potential impacts were predicted to be minor. Even when considered in-combination it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause a change in habitat distribution with the SAC. Changes in distribution and extent of habitats supporting the species are considered unlikely and minor in the long term. Confidence level: High.
2: Structure, function and supporting processes of habitats supporting the species	The potential for any activity, either associated solely with the Project alone or in-combination with other projects, to directly impact the structure and functioning of habitat processes within the SAC is considered very unlikely as modelled noise contours do not extend to the Isle of May SAC. Other project related activities either for the Project alone or in-combination with other projects, do not enter or pass in close proximity to the SAC therefore potential effects on habitat structure are considered to be highly unlikely. All other potential impacts were predicted to be minor. Even when considered in-combination with other projects it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause a change in habitat structure within the SAC. Changes in the structure, function and supporting processes of habitats supporting the species is considered highly unlikely and no impact in the long term. Confidence level: High.
3: No significant disturbance of the species	The primary impact is considered to be increased noise from piling. This is assessed, for the Project alone or in-combination with other projects, as moderate to major impacts (medium term), but minor in the long-term (based on consideration of PBR and increased grey seal numbers in the ECMA). All other potential impacts were predicted to be minor. Even when considered in-combination with other projects it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause significant disturbance to species. Some grey seals will potentially experience major impact (displacement) during piling operations, however the effects of this impact are considered to be temporary in nature and to have a minor impact at the population in the long term.

Criterion	Assessment
	Therefore no significant disturbance to grey seal is predicted in the long-term. Confidence level: High.
4: Distribution of the species within the site	The primary impact is considered to be displacement from foraging areas and transit routes due to increased noise from piling. This is considered, for the Project alone or in-combination with other projects, to be a minor impact in the long term. All other potential impacts were predicted to be minor. Even when considered in-combination it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause changes in species distribution within the site. It is likely that seals displaced during piling operations will find suitable alternative habitat within the Firths of Forth and Tay area and within the ECMA. Therefore changes in distribution of the species within the site are considered to be likely but of a temporary nature and minor in the long term. Confidence level: High.
5: Population of the species as a viable component of the site	The primary impact is considered to be increased noise from piling and, based on observations from operational wind farms (Horns Rev I & II), this is not considered to be an impact in the long term. Because the grey seal population within the area is stable to increasing (based on pup production estimates), viability of this population is unlikely to be affected by the Project alone or in-combination with other projects in the long-term. All potential impacts other than piling were predicted to be minor. Even when considered in-combination with other projects it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will adversely affect site integrity of the SAC. The long-term viability of the population is considered unlikely to be adversely affected. Confidence level: High.

337 It is predicted that the Project, alone or in-combination with other plans or projects, will not cause deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features in the long term.

Table 14.30: Assessment of the Conservation Objectives of the Berwickshire and North Northumberland Coast SAC (Qualifying Feature: Grey Seal).

Criterion	Assessment
1: Distribution and extent of habitats supporting the species	The potential for piling activity, either associated with the Project alone or in-combination with other plans and projects, to directly impact the distribution or extent of habitat within the SAC, is considered very unlikely as modelled noise contours do not extend to the Berwickshire and North Northumberland Coast SAC. Other Project related activities either for the Project alone or in-combination with other projects, do not enter or pass in close proximity to the SAC therefore potential effects on habitat distribution are considered to be highly unlikely. All other potential impacts were predicted to be minor. Even when considered in-combination it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause a change in habitat distribution with the SAC. Changes in distribution and extent of habitats supporting the species are considered unlikely and minor in the long term. Confidence level: High.
2: Structure, function and supporting processes of habitats supporting the species	The potential for any activity, either associated with the Project alone or in-combination with other plans and projects, to directly impact the structure, function and supporting processes of habitat within the SAC is considered very unlikely as modelled noise contours do not extend to the Berwickshire and North Northumberland Coast SAC. Other Project related activities either for the project alone or in-combination with other projects, do not enter or pass in close proximity to the SAC therefore potential effects on habitat structure are considered to be highly unlikely. All other potential impacts were predicted to be minor. Even when considered in-combination it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause a change in habitat structure with the SAC. Changes in the structure, function, and supporting processes of habitats supporting the species is considered highly unlikely and no impact in the long term. Confidence level: High.
3: No significant disturbance of the species	The primary impact is considered to be increased noise from piling. This is assessed, for the Project alone or in-combination with other plans and projects, as major in the medium term, but minor in the long-term (based on consideration of PBR and increased grey seal numbers in the ECMA). All other potential impacts were predicted to be minor. Even when considered in-combination it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause significant disturbance to species. Some grey seals will potentially experience a major impact (displacement) during piling operations, however the effects of this impact are considered to be temporary in nature and to have a minor impact at the population in the

Criterion	Assessment
	long term. Therefore no significant disturbance to grey seal is predicted in the long-term. Confidence level: High.
4: Distribution of the species within the site	The primary impact is considered to be displacement from foraging areas and transit routes due to increased noise from piling. This is considered for the Project alone or in-combination with other plans and projects, to be minor in the long term. All other potential impacts were predicted to be minor. Even when considered in-combination it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause changes in species distribution within the site. It is likely that seals displaced during piling operations will find suitable alternative habitat within the Firths of Forth and Tay area and within the ECMA. Therefore changes in distribution of the species within the site are considered to be likely but of a temporary nature and minor in the long term. Confidence level: High.
5: Population of the species as a viable component of the site	The primary impact is considered to be increased noise from piling and, based on observations from operational wind farms (Horns Rev I and II), this is considered to be reversible. Because the grey seal population within the ECMA is stable to increasing (based on pup production estimates), viability of this population is unlikely to be affected by the Project alone or in-combination with other plans and projects in the long-term. All potential impacts other than piling were predicted to be minor. Even when considered in-combination with other projects it is considered highly unlikely that increased vessel movement (including ducted propellers), accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will adversely affect site integrity of the SAC. The long-term viability of the population is considered unlikely to be adversely affected. Confidence level: High.

338 It is predicted that the Project, alone or in-combination with other plans or projects, will not cause deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features in the long term.

Table 14.31: Assessment of the Conservation Objectives of the Moray Firth SAC (Qualifying Feature: Bottlenose Dolphin)

Criterion	Assessment
1: Distribution and extent of habitats supporting the species	The potential for piling to directly impact the distribution of habitat with the SAC is considered very unlikely for the Project alone or in-combination with other plans and projects, as modelled noise contours do not extend to the Moray Firth SAC. All other potential impacts were predicted to be minor. Even when considered in-combination it is considered highly unlikely that increased vessel movement, accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause a change in habitat distribution with the SAC. The potential impact is therefore considered to be exceptionally unlikely, of minor magnitude and in the long term. Confidence Level: Very high.
2: Structure, function and supporting processes of habitats supporting the species	The potential for any activity related to the Project alone, or in-combination with other plans and projects to directly impact the distribution of habitat with the SAC is considered very unlikely as modelled noise contours do not extend to the Moray Firth SAC. All other potential impacts were predicted to be minor. Even when considered in-combination it is considered highly unlikely that increased vessel movement, accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause a change in habitat structure with the SAC. The potential impact is therefore considered to be unlikely and no impact in the long term. Confidence Level: Very High.
3: No significant disturbance of the species	The primary impact is considered to be increased noise from piling. The Project alone and in-combination with other plans and projects have predicted impacts of piling to be of moderate during the piling operations in the medium term, but of minor at the population level in the long term. All other potential impacts were predicted to be of minor. Even when considered in combination it is considered highly unlikely that increased vessel movement, accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause significant disturbance to species. Therefore no significant disturbance to bottlenose dolphin is predicted in the long-term. Confidence level: High.
4: Distribution of the species within the site	The primary impact is considered to be displacement from the coastal strip due to increased noise from piling. The Project alone and in-combination with other plans and projects have predicted impacts of piling to be of moderate during the piling operations in the medium term, but minor at the population level in the long term. All other potential impacts were predicted to be minor. Even when considered in-combination it is considered highly unlikely that increased vessel movement,

Criterion	Assessment
	accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will cause changes in species distribution. It is likely that bottlenose dolphins forage all along the east coast, therefore temporary changes in prey species distribution or temporary reduction in access habitat due to piling at the Firth of Forth and Tay offshore wind farms is unlikely to have an adverse effect on species distribution in the long term. Therefore changes in distribution of the species within the site are considered to be unlikely. Confidence level: High.
5: Population of the species as a viable component of the site	The primary impact is considered to be increased noise from piling and, based on observations from operational wind farms; this is considered to be reversible. The Project alone and in-combination with other projects have predicted impacts of piling to be of moderate in the medium term, but minor at the population level in the long term. All potential impacts other than piling were predicted to be minor. Even when considered in combination it is considered highly unlikely that increased vessel movement, accidental pollution events, indirect impacts on prey availability, operation noise, EMF or toxic contamination will adversely affect site integrity of the SAC. The long-term viability of the population is considered unlikely to be adversely affected. Confidence level: High.

339 It is predicted that the Project, alone or in-combination with other plans or projects, will not cause deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features in the long term.

14.14 European Protected Species

14.14.1 Background

340 This section aims to set out the legislative requirements relating to EPS that have been considered for the Project.

341 The *Habitats Directive* and UK Offshore Marine Regulations[11] prohibit the deliberate capture, injury, killing or disturbance of any wild individual of a EPS, as listed on Annex IV of the *Habitats Directive*. In addition, the Habitats Regulations 1994 (as amended in Scotland) included the offence of disturbance or harassment of a wild animal or group of wild animals of an EPS, including during migration. It is possible to carry out certain activities which would otherwise be illegal, under licence.

342 All cetaceans are listed on Annex IV of the *Habitats Directive* and are therefore classed as EPS and are fully protected under these items of legislation.

343 The purpose of this section is to provide a summary of potential effects to EPS from activities associated with the construction, operation and maintenance or decommissioning of the Project.

344 ICOL recognises that an EPS license may be required during the construction and decommissioning phases of the Project. A preliminary assessment is presented here, which will be revised once construction and decommissioning parameters have been finalised.

14.14.2 Project Details

345 Key parameters for the worst and most likely case scenario for each potential impact are detailed in Table 14.2.

346 The assessment of effects on marine mammals has taken account the Embedded Mitigation measures in *Section 14.4.1*.

14.14.3 Legislation

347 The need to consider effects upon EPS in waters off Scotland comes from two pieces of legislation which transposes the requirements of the *Habitats Directive* (Council Directive 92/43/EEC on the conservation on natural habitats and of wild fauna and flora) – the *Conservation (Natural Habitats &c.) Regulations 1994* (as amended in Scotland), and the *Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007* (as amended).

348 Draft guidance produced by the JNCC, Natural England and the Countryside Council for Wales *The Protection of Marine European Protected Species from Injury and Disturbance* (JNCC *et al.*, 2010b) has been utilised as a resource when considering this appraisal. This guidance considered certain activities that produce increased noise levels in areas where an EPS may be present to have the potential to result in an injury or disturbance offence unless

[11] Conservation (Natural Habitats &c.) Regulations 1994 (as amended in Scotland) and the Offshore Marine Conservation (Natural Habitats &c.) Regulations 2009 (as amended)

appropriate mitigation measures are implemented. This risk of causing an offence is dependent on a number of factors including:

- Duration of noise associated with the activity;
- Presence/absence of semi-resident populations of EPS;
- Frequency of occurrence of EPS;
- Density of occurrence of EPS; and
- Length of stay of individuals in a given area.

349 The guidance considers that the potential for disturbance from some activities can be considered trivial, including those that lead to "sporadic disturbances without any likely negative impact on the species". For an activity to be considered non-trivial, the report states that "the disturbance to marine EPS would need to be likely to at least increase the risk of certain negative impacts on the FCS".

350 The tests for an EPS licence are given below:

- Test 1 - The licence application must demonstrably relate to one of the purposes specified in Regulation 44(2) (as amended). For development proposals, the relevant purpose is likely to be Regulation 44(2)(e) for which Scottish Government is currently the licensing authority. This regulation states that licences may be granted by Scottish Government only for the purpose of "preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment".
- Test 2 - Regulation 44(3)(a) states that a licence may not be granted unless the licensing authority (Scottish Government) is satisfied "that there is no satisfactory alternative".
- Test 3 - Regulation 44(3)(b) states that a licence cannot be issued unless the licensing authority (Scottish Government) is satisfied that the action proposed "will not be detrimental to the maintenance of the population of the species concerned at a FCS in their natural range".

351 The FCS of an EPS is defined in the *Habitats Directive* by:

- Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable element of its 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 population on a long-term basis.

14.14.4 EPS within the Firths of Forth and Tay Area

352 Two species of cetacean can be observed in the Firths of Forth and Tay throughout the year (harbour porpoise and bottlenose dolphin) and two species occur seasonally (minke whale and white-beaked dolphin). Other species which occur on a more occasional basis include killer whale (e.g. in 2006 and 2007 and during commissioned studies), sperm whale (e.g. in 1997), humpback whale (e.g. in 2003 and 2006), long-finned pilot whale (e.g. during commissioned studies), common dolphin (e.g. during commissioned studies) and white-sided dolphin.

353 This information presented below will focus on the following species, being the most abundant EPS species in the project area:

- Harbour Porpoise;
- Bottlenose Dolphin;
- Minke Whale; and
- White-beaked Dolphin.

354 **Harbour porpoises** are distributed throughout the North Sea (Reid *et al*., 2003; SCANS II, 2008) and were the most frequently observed cetacean species observed during surveys conducted in the Forth and Tay area (see *Appendix 14A, Section 14A.2.2*). The SCANS II abundance for Block V (north central North Sea, incorporating the Development Area) was 47,131 animals with a density estimate 0.29 animals per km^2 (CV = 0.37). FTOWDG-commissioned analysis of shared cetacean data estimated an absolute abundance[12] of 582 individuals (95 per cent CI: 581-1235; 1.2 per cent of SCANS estimate), distributed throughout the survey area of the Firth of Forth and Tay (Mackenzie *et al*., 2012).

355 The most recent population estimate of **bottlenose dolphin** abundance around the north-east coast of Scotland is 195 individuals (95 per cent probability interval 162-253; Cheney *et al*., 2012). Although the majority of the population appear to regularly utilise the Moray Firth SAC, a relatively high proportion of the population also frequently utilise areas outside the SAC (Thompson *et al*., 2006; 2009). The distribution of bottlenose dolphin sightings appear to be coastal, with the majority occurring generally in waters of less than 25 m deep (Hastie *et al*., 2003; Robinson *et al*., 2007). For the purpose of the impact assessment, it has been assumed that at any point in time, half of the bottlenose dolphin population of the Moray Firth SAC can be found within the Moray Firth and the remainder of the population will be spread out along the east coast in waters from Peterhead to Eyemouth of less than 20 m deep as detailed in *Appendix 14A, Section 14A.2.2*.

356 The **white-beaked dolphin** is the most abundant dolphin species in the North Sea (Reid *et al*., 2003; SCANS II, 2006) although they were less abundant than harbour porpoise in surveys conducted in the Forth and Tay area (see *Appendix 14A, Section 14A.2.2*), during which white-beaked dolphins were primarily recorded in offshore waters and during the

[12] Absolute abundance provides a population estimate expressed as number of individuals per unit area, in this case the combined survey area.

summer months. The Block V SCANS II abundance estimate for white-beaked dolphin is 7,862 animals (CV = 0.37; SCANS II, 2006) and FTOWDG-commissioned integrated analysis of cetacean data estimated an absolute abundance of 293 individuals (95 per cent CI: 267-1055; four per cent of SCANS estimate; Mackenzie *et al*., 2012).

357 **Minke whales** are the most abundant baleen whale species within the North Sea (Reid *et al*., 2003) and the most commonly sighted whale species during surveys conducted in the Firths of Forth and Tay area, with most sightings occurring greater than 12 nm from the coast (approx. 85 per cent). The SCANS II abundance estimate for Block V is 4,449 (CV=0.45; SCANS II, 2006) and FTOWDG-commissioned integrated analysis of cetacean data estimated an absolute abundance of 594 individuals although confidence in this estimate is low (13 per cent of SCANS estimate; 95 per cent CI: 483-2695; Mackenzie *et al*., 2012).

14.14.5 Summary of Potential Impacts

358 A summary of predicted effects associated with piling during construction, and activities associated with the operation of the Project, can be found in Table 14.20 and have not been re-iterated here. The impact which has the greatest potential to have a significant effect on EPS is piling during construction as shown in *Section 14.7.1* above.

359 Definitions used in this assessment are the same as presented in Table 14.8.

360 Noise modelling was undertaken to predict the potential impact of piling on cetaceans present within the Firths of Forth and Tay, and has been presented in detail in *Appendix 14B* and in *Section 14.10.1* above. Other non-piling noise related potential impacts are also assessed in *Section 14.10.1* above.

361 As described in *Section 14.10.1* above, while predicted noise contours at 5 dB_{ht} (*species*) increments out to 50 dB_{ht} (*species*) were generated for piling activity during construction at the Development Area to inform the assessment of displacement of marine mammal species (presented in Table 14.32 below as column 'Number of animals predicted to exhibit some form of behavioural response out to 50 dBht (*species*) from piling at the Inch Cape Project only (Scenario 1a to Scenario 4)'), these contours were not available to inform the equivalent displacement assessment for the Neart na Gaoithe and Firth of Forth Phase 1 projects. For these latter two projects, only 130, 90 and 75 dB_{ht} (*species*) contours were available, with no 5 dB_{ht} (*species*) increments and no further contours after 75 dB_{ht} (*species*).

362 In order to undertake cumulative modelling across comparative modelling methodology, the assessment for the Inch Cape Project only was conducted using only the 130, 90 and 75 dB_{ht} (species) contours. The results of using this methodology are presented in Table 14.32 below as column 'Number animals predicted to exhibit up to mild behavioural avoidance (75 dB_{ht} (standardised)) at the Inch Cape Project only (Scenario 1a to Scenario 4)'. The difference in the numbers reflect the curtailment of behavioural response predicted to 75 dB_{ht} (*species*), and that by assigning all behavioural response between 90 and 75 dB_{ht} (*species*) a displacement value predicted from 75 dB_{ht} (*species*) fewer animals would be predicted to respond as 75 dB_{ht} (*species*) and 90 dB_{ht} (*species*) lie at either end of the steepest part of the dose response curve (see *Appendix 14B,* Figure 14B.6). The modelling to inform the

cumulative assessment was therefore carried out using the 'standardised' methodology reflecting the availability of 130, 90 and 75 dB_{ht} (*species*) contours.

363 A summary of potential impacts of piling at the Development Area either alone or in-combination with other offshore wind farms in the Firths of Forth and Tay area is provided in Table 14.32 below.

Table 14.32: Summary of Predicted Impacts of Displacement from Piling at the Inch Cape Development Area and Cumulatively with Neart na Gaoithe and Firth of Forth Phase 1

European Protected Species	Number of animals predicted to exhibit some form of behavioural response out to 50 dB_{ht} (*species*) from piling at Inch Cape only (Scenario 1a to Scenario 4)	Predicted impact –at Inch Cape at population level	Number animals predicted to exhibit up to mild behavioural avoidance (75 dB_{ht} (standardised)) at Inch Cape only (Scenario 1a to Scenario 4)	Predicted impact – at Inch Cape at population level	No. animals predicted to exhibit up to mild behavioural avoidance (cumulative - 75 dB_{ht} (standardised)) for cumulative scenarios (5 and 6)	Predicted impact – cumulative at population level
Harbour porpoise	486-556 (0.31 – 0.35% ref pop)	Minor	266-326 (0.17 – 0.21% ref pop)	Minor	555-577 (0.3 – 0.4% ref pop)	Minor
Bottlenose dolphin	15-19 (15.3 – 19.4% ref pop)	Moderate (medium term) but minor at the population level in the long term	10-13 (10.2 – 13.3% ref pop)	Moderate but minor at the population level in the long term	15-17 (15.3 – 17.3 % ref pop)	Moderate (medium term) but minor at the population level in the long term
White-beaked dolphin	43-51 (0.19 – 0.23% ref pop)	Minor	20-27 (0.1% ref pop)	Minor	59-67 (0.3% ref pop)	Minor
Minke whale	500-543	Minor	327-361 (0.2% ref pop)	Minor	467-545 (0.3% ref pop)	Minor

364 The potential impact of piling (behavioural avoidance) on harbour porpoise, white beaked dolphin and minke whale is considered to be minor.

365 Predicted impacts on bottlenose dolphin are minor to moderate (behavioural avoidance) in the medium term, but population modelling predicts minor impacts in the long term, at the population level.

366 Other potential routes to disturbance of cetacean species (total increased collision risk – vessel movement and ducted propellers); is considered to have a minor impact in the long term.

367 In support of an EPS licence application to disturb, the following information on potential auditory injury is provided as supplementary information. As with all the information presented within this section, it will be up-dated in the final EPS licence application supporting information once the construction method statement has been finalised.

Table 14.33: Summary of Potential PTS Onset Impact from Piling at the Development Area and Cumulatively with Neart na Gaoithe and Firth of Forth Phase 1

European Protected Species	Number of animals modelled to exhibit PTS onset from piling at Inch Cape only (Scenario 1 to Scenario 4)	Predicted impact – at Inch Cape at population level	Number of animals modelled to exhibit PTS onset for cumulative scenarios (5 and 6)	Predicted impact – cumulative at population level
Harbour porpoise	16-30 (0.01 – 0.02% ref pop)	Minor	22-32 (0.01 – 0.02% ref pop)	Minor
Bottlenose dolphin	1.2-2.9 (1.2 – 3.0% ref pop)	Minor (medium term) and minor at the population level in the long term	4.3-4.8 (4.4 – 4.9% ref pop)	Minor (medium term) and minor at the population level in the long term
White-beaked dolphin	7-13 (0.03 – 0.06% ref pop)	Minor	11-16 (0.05 – 0.07% ref pop)	Minor
Minke whale	13-24 (0.007 – 0.01% ref pop)	Minor	17-24 (0.009 – 0.01% ref pop)	Minor

368 The potential impact of piling (PTS) on harbour porpoise, bottlenose dolphin, white beaked dolphin and minke whale is considered to be minor in the long term.

14.14.6 Mitigation

369 The marine mammal assessment has assessed worst case scenario impacts of the Project in isolation and cumulatively. This assessment has concluded that the long term impacts to the marine mammal within the study area from Project related activities will be of no more than Minor.

370 Based on the outputs from this impact assessment, it has been concluded that the Embedded Mitigation detailed in *Section 14.4.1* is appropriate to reduce any potential impacts relating directly to marine mammals to an acceptable level. No Additional Mitigation is proposed for the Project. It should be noted that alternative mitigation techniques will be investigated prior to the finalisation of the construction method statement. Approaches will be confirmed following consultation with regulatory organisations. Adoption of any mitigation measures will be subject to an assessment of technical and commercial feasibility.

14.14.7 Monitoring

371 Recent developments in the use of passive acoustic monitoring may enable deployment of effective mitigation, management and monitoring measures throughout the construction period of the Wind Farm and OfTW. Employment of alternative mitigation techniques will be investigated prior to the finalisation of the construction method statement and commencement of construction; management and monitoring approaches will be confirmed following consultation with regulatory organisations.

372 It is anticipated that pre-, during and post-construction monitoring will provide valuable data regarding the predicted to actual effects of the Project on marine mammal species. Throughout the duration of the Wind Farm lifecycle, ICOL will work with Marine Scotland, TCE and FTOWDG to share marine mammal data, to inform and further develop best practice measures.

14.14.8 Summary and Conclusion

373 The primary activity associated with the construction and operation of the Project that is likely to cause disturbance to EPS is considered to be piling during construction.

374 It is clear from Table 14.32 above that EPS of cetacean, namely harbour porpoise, bottlenose dolphin, white-beaked dolphin and minke whale, could have the potential to be disturbed by activities, particularly piling, associated with the Project.

375 Therefore a licence to disturb may be required for the period of construction.

376 However, modelling has shown that there is unlikely to be an impact at the population level in the long term from piling activities and therefore test three for an EPS licence is passed because:

- White-beaked dolphin, harbour porpoise and minke whale all have large viable reference populations. Bottlenose dolphin present within the Firths of Forth and Tay are from a stable or possibly increasing population. Therefore, potential impacts from piling at the Project will not significantly affect the longer-term viability or population dynamics of the species concerned;
- The natural range of the species concerned will not be reduced in the medium to long term; and
- There is, and will probably continue to be, a sufficiently large habitat to maintain each species reference population on a long-term basis.

377 It is therefore concluded that a licence to disturb for cetacean species listed, while necessary for the duration of piling activity at the Development Area, will not be detrimental to the maintenance of the population of the species concerned at FCS in their natural range.

References

Betke, K., Schultz-von Glahn, M. and Matuschek, R. 2004*. Underwater Noise Emissions from Offshore Wind Turbines.* Paper presented on CFA/DAGA 2004, 2pp.

BioConsult SH (2008). *Assessment and Costing of Potential Engineering Solutions for the Mitigation of the Impacts of Underwater Noise Arising from the Construction of Offshore Wind Farms*.

Bohnsack, J.A., Harper, D.E., McClellan, D.B. and Hulsbeck, M. (1994). *Effects of Reef Size on Colonisation and Assemblage Structure of Fishes at Artificial Reefs off South-eastern Florida, USA*. Bulletin of Marine Science, 55: 796–823.

Brandt, MJ., Diederichs, A., Betke,K., and Nehls,G. (2011) *Responses of Harbour Porpoises to Pile Driving at the Horns Rev II Offshore Wind Farm in the Danish North Sea.*

Bristow, T. (2004). *Changes in Coastal Site Usage by Bottlenose Dolphin (Tursiops truncatus) in Cardigan Bay, Wales*. Aquatic Mammals, 30: 398 – 404.

Canning, S. (2012). *Inch Cape OWF: Year two Analysis of Boat-based Marine Mammal Surveys*. Natural Power report 401_R_NPC_2222_3 to ICOL.

Carter, C. (2007). *Marine Renewable Energy Devices: a Collision Risk for Marine Mammals?* MSc Thesis, University of Aberdeen. 131 pages.

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. (2012). *Integrating Multiple Data Sources to Assess the Distribution and Abundance of Bottlenose Dolphins Tursiops Truncatus in Scottish Waters*. Mammal Review.

Clark, S. and Edwards, A.J. (1999). *An evaluation of Artificial Reef Structures as Tools for Marine Habitat Rehabilitation in the Maldives.* Aquatic Conservation: Marine and Freshwater Ecosystems, 9: 5–21.

Croll, D.A., Clark, C.W., Calambokidis, J., Ellison, W.T., and Tershy, B.R. (2001). *Effect of Anthropogenic Low-frequency Noise on the Foraging Ecology of Balaenoptera whales.* Animal Conservation, 4: 13-27.

Culik, B.M., Koschinski, S., Tregenza, N. and Ellis, G. (2001). *Reactions of Harbour Porpoises (Phocoena phocoena) and Herring (Clupea harengus) to Acoustic Alarms*. Mar Ecol Pr g Ser 211: 255–260.

Das, K., Lepoint, G., Loizeau, V., Debacker, V., Dauby, P. and Bouquegneau, J. (2000). *Tuna and Dolphin Associations in the North-east Atlantic: Evidence of Different Ecological Niches from Stable Isotope and Heavy Metal Measurements.* Marine Pollution Bulletin 40(2): 102-109.

Defra (2011). *UK Marine Policy Statement: Habitats Regulations Assessment report*. Available at: http://archive.defra.gov.uk/environment/marine/documents/interim2/mps-habitats-appraisal.pdf

Dehnhardt, G., Mauck, B. and Bleckmann, H. (1998). *Seal Whiskers Detect Water Movements*. Nature 394: 235-236.

Dehnhardt, G., Mauck, B., Hanke, W. and Bleckmann, H. (2001). *Hydrodynamic Trail Following in Harbour Seals*. Science 293: 102-104.

Diederichs, A., Nehls, G., Dahne., M., Alder, S., Koschinski, S. and Verub, U. (2008). *Methodologies for Measuring and Assessing Potential Changes in Marine Mammal Behaviour, Abundance or Distribution Arising from the Construction, Operation and Decommissioning of Offshore Windfarms*. Commissioned by COWRIE Ltd.

Douglas, A.B., Calambokidis, J., Raverty, S., Jeffries, S.J., Lambourn, D.M. and Norman, S.A. (2008). *Incidence of Ship Strikes of Large Whales in Washington State*. JMBA, 88:1121-1132

Duck, C., and Morris, C. (2012). *Surveys of harbour (common) and Grey Seals in the Outer Hebrides and the Moray Firth in August 2011*. Scottish Natural Heritage Commissioned Report No. 518.

Edwards B., Brooker, A., Workman, R., Parvin, S.J. & Nedwell, J.R. (2007). S*ubsea Operational Noise Assessment at the Barrow Offshore Wind Farm Site.* Subacoustech Report No. 753R0109. Subacoustech Ltd., Bishops Waltham, Hants.

Fauber Maunsell and Metoc, (2007). *Scottish Marine Renewables SEA: Environmental Report Section C*; Chapter C18: EMF.

Gill, A.B. and Bartlett, M. (2010). *Literature Review on the Potential Effects of Electromagnetic Fields and Subsea Noise from Marine Renewable Energy Developments on Atlantic Salmon, Sea Trout and European Eel.* Scottish Natural Heritage Commissioned Report No.401

Gill, A.B., Huang, Y., Gloyne-Philips, I., Metcalfe, J., Quayle, V., Spencer, J. and Wearmouth, V. (2009). COWRIE 2.0 Electromagnetic Fields (EMF) *Phase 2: EMF-sensitive Fish Response to EM Emissions from Sub-sea Electricity Cables of the Type Used by the Offshore Renewable Energy Industry*. Commissioned by COWRIE Ltd (project reference COWRIE-EMF-1-06).

Gill, A.B., Gloyne-Phillips, I., Neal, K.J. and Kimber, J.A. (2005). COWRIE 1.5 Electromagnetic Fields Review. *The potential Effects of Electromagnetic Fields Generated by Sub-sea Power Cables Associated with Offshore Wind Farm Developments on Electrically and Magnetically Sensitive Marine Organisms – a Review.* Final Report

Gould, J.L. (2008). *Animal navigation: the Evolution of Magnetic Orientation*. Current Biology, 18: R482–R484.

Great Britain Parliament (1994). *The Conservation (Natural Habitats, &c.) Regulations 1994*. Available at: http://www.legislation.gov.uk/uksi/1994/2716/contents/made

Great Britain Parliament (2007). *The Offshore Marine Conservation (Natural Habitats, etc.) Regulations 2007 .*

Great Britain Parliament (2009). *Marine and Coastal Access Act 2009.*

Great Britain Parliament (2010). *The Conservation of Habitats and Species Regulations 2010*. Available at: http://www.legislation.gov.uk/uksi/2010/490/contents/made

Grellier, K. and Lacey, C. (2012). *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.

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M., Heimlich, S., Hiby, A., Leopold, M. and Øien, N. (2002). *Abundance of Harbour Porpoise and other Cetaceans in the North Sea and Adjacent Waters*. Journal of Applied Ecology 39(2): 361-376.

Hastie, G.D., Wilson, B. & Thompson, P.M. (2003). *Fine-scale Habitat Selection by Coastal Bottlenose Dolphins: Application of a New Land-based Video-montage Technique*. Canadian Journal of Zoology, 81: 469–478.

Helvey, M. (2002). *Are southern Californian Oil and Gas Platforms Essential Fish Habitat?* ICES Journal of Marine Science, 59: 266–271.

Hoffmann, E., Astrup, J., Larsen, F. and Munch-Peterson, S. (2000). *Effects of Marine Windfarms on the Distribution of Fish, Shellfish and Marine Mammals in the Horns Rev Area.* Danish Institute for Fisheries Research report to ELSAMPROJEKT A/S.

IEEM. (2010). *Guidelines for Ecological Impact Assessment in Britain and Ireland, Marine and Coastal.* Institute of Ecology and Environmental Management.

International Maritime Organization(IMO) (1996). *Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972*. Available at: http://www.imo.org/ourwork/environment/pollutionprevention/pages/1996-protocol-to-the-convention-on-the-prevention-of-marine-pollution-by-dumping-of-wastes-and-other-matter,-1972.aspx [Accessed 5 September 2012].

International Whaling Commission (IWC) (2006). *58th Annual Meeting of the International Whaling Commission. Ship strikes working group*. First progress report to the conservation committee. Report No. IWC/58/CC3.

International Whaling Commission (IWC) (2013) .*Whales and Ship Strikes: A problem for Both Whales and Vessels*. [Online]. Accessed at: http://iwc.int/ship-strikes

Ingemansson Technology. (2003). *Utgrunden Offshore Wind Farm - Measurements of Underwater Noise.* Report 11-00329-03012700. Ingemansson Technology, Gothenburg.

Inger, R., Attrill, M.J., Bearhop, S., Broderick, A.C., Grecian, W.J., Hodgson, D.J., Mills, C., Sheehan, E, Votier, S.C., Witt, M.J. and Godley, B.J. (2009). *Marine Renewable Energy: Potential Benefits to Biodiversity? An Urgent Call for Research*. Journal of Applied Ecology 2009, 46: 1145–1153

Jensen, A.S. and G.K. Silber. (2003). *Large Whale Ship Strike Database*. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR- , 37 pp.

JNCC. (2007). *Second Report by the UK under Article 17 on the Implementation of the Habitats Directive from January 2001 to December 2006*. Peterborough, UK. Available at: www.jncc.gov.uk/article17.

JNCC. (2008). *The Deliberate Disturbance of Marine European Protected Species. Guidance for English and Welsh Territorial Waters and the UK Offshore Marine Area.* Available at: http://jncc.defra.gov.uk/PDF/consultation_epsGuidanceDisturbance_all.pdf

JNCC (2010a). *Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals from Piling Noise*. Available at: http://jncc.defra.gov.uk/page-4274

JNCC, Natural England and Countryside Council for Wales (2010b). *The Protection of Marine European Protected Species from Injury and Disturbance. Guidance for the Marine Area in England and Wales and the UK Offshore Marine Area.*

JNCC, Natural England, Countryside Council for Wales and SNH (2012). *Guidance for Staff Advising on the Potential Risk of Seal Corkscrew Injuries April 2012*.

JNCC and Defra (on behalf of the Four Countries' Biodiversity Group) (2012). *UK Post-2010 Biodiversity Framework*. July 2012. Available at: http://jncc.defra.gov.uk/page-6189.

Klinowska, M. (1990). *Geomagnetic Orientation in Cetaceans: Behavioural Evidence*. In: "*Sensory Abilities of Cetaceans*". J.A. Thomas & R.A. Kastelein (Eds.). Plenum Press, New York.

Kirschvink, J.H., Dizon, A.E. and Westphal, J.A. (1986). *Evidence from strandings for geomagnetic sensitivity in cetaceans.* Journal of Experimental Biology, 120: 1-24.

Knowlton, A.R. and Kraus, S.D. (2001). *Mortality and Serious Injury of Northern Right Whales (Eubalaena glacialis) in the Western North Atlantic Ocean*. Journal of Cetacean Research and Management (Special Issue), 2:193-208

Koschinski, S., Culik, B. (1997). *Deterring Harbor Porpoises (Phocoena phocoena) from Gillnets: Observed Reactions to Passive Reflectors and Pingers.* Report of the International Whaling Commission, 47: 659-668

Koschinski, S. Culik, B.M., Damsgaard Henriksen, O., Tregenza, N., Ellis, G., Jansen, C. and Kathe, G. (2003). *Behavioural Reactions of Free-ranging Porpoises and Seals to the Noise of a Simulated 2MW Windpower Generator*. Marine Ecology Progress Series, 265: 263-273.

Laist , D.W., Knowlton, A.R., Mead, J.G. Collet, A.S., Podesta, M. (2001). *Collisions Between Ships and Whales.* Marine Mammal Science. 17 (1): 35-75.

Leung Ng, S. and Leung, S. (2003). *Behavioural Response of Indo-pacific Humpback Dolphin (Sousa chinensis) to Vessel Traffic.* Marine Environmental Research, 56: 555-567.

Linley, E.A.S., Wilding, T.A., Black, K., Hawkins, A.J.S. and Mangi, S. (2007). *Review of the Reef Effects of Offshore Wind Farm Structures and their Potential for Enhancement and Mitigation*. Report from PML Applications Ltd and the Scottish Association for Marine Science to the Department for Business, Enterprise and Regulatory Reform (BERR), Contract No: RFCA/005/0029P.

Lohmann, K.J., Lohmann, M.F. and Endres, C.S. (2008). *The Sensory Ecology of Ocean Navigation*. The Journal of Experimental Biology, 211: 1719–1728.

Lonergan, M., Duck, C., Moss, S., Morris, C. and Thompson, D. (2011a). *Harbour Seal Abundance has declined in Orkney: an Assessment Based on Using ARGOS Flipper Tags to Estimate the Proportion of Animals Ashore during Aerial Surveys in the Moult*. SCOS Briefing Paper 11/08 in *Scientific Advice on Matters Related to the Management of Seal Populations: 2011.* Available at: http://www.smru.st-andrews.ac.uk/pageset.aspx?psr=411

Lonergan, M., McConnell, B., Duck, C. and Thompson, D. (2011b). An E*stimate of the Size of the British Grey Seal Population Based on Summer Haulout Counts and Telemetry Data.* SCOS Briefing Paper 11/06 in *Scientific Advice on Matters Related to the Management of Seal Populations: 2011*. Available at: http://www.smru.st-andrews.ac.uk/pageset.aspx?psr=411

Lonergan, M. and Thompson, D. (2012). *Harbour Seal Abundance within the Firth of Tay and Eden Estuary Special Area of Conservation: Recent Trends and Extrapolation to Extinction*. SCOS Briefing Paper 12/05.

Love, M.S., Caselle, J.E. and Snook, L. (1999). *Fish Assemblages on Mussel Mounds Surrounding Seven Oil Platforms in the Santa Barbara Channel and Santa Maria Basin.* Bulletin of Marine Science, 65: 497–513.

Luschi, P., Benhamou, S., Girard, C., Ciccione, S., Roos, D., Sudre, J. and Benvenuti, S.(2007). *Marine Turtles Use Geomagnetic Cues during Open-Sea Homing*. Current Biology, 17: 126–133.

Lusseau, D., New, L., Donovan, C., Cheney, B., Thomson, P.M., Hastie, G. and Harwood, J. (2011). *The Development of a Framework to Understand and Predict the Population Consequences of Disturbances for the Moray Firth Bottlenose Dolphin Population*. SNH Commissioned Report No 468.

Mackenzie, M.L., Kidney, D. and Donavan, C.R. (2012). *Forth and Tay Offshore Wind Developers Group: Cetacean Survey Data Analysis Report*. DMP Stats.

Madsen, P.T., Møhl, B., Nielsen, B.K., & Wahlberg, M. (2002*). Male Sperm Whale Behaviour During Exposures to Distant Seismic Survey Pulses*. Aquatic Mammals, 28: 231-240.

Madsen, P.T., Wahlberg, M., Tougaard, J., Lucke, K. and Tyack, P. (2006). *Wind Turbine Underwater Noise and Marine Mammals: Implication of Current Knowledge and Data Needs*. Marine Ecology Progress Series, 309: 279-295.

Marine Scotland, (2012). *Offshore Renewables Research Work Package 3: Request for Advice about the Displacement of Marine Mammals Around Operational Offshore Windfarms*. Available at: http://www.scotland.gov.uk/Resource/0040/00404921.pdf

MARPOL (1973*). International Convention for the Prevention of Pollution From Ships*, *1973, as Modified by the Protocol of 1978 Relating Thereto* (MARPOL 73/78).

Moray Firth Offshore Renewables Ltd. (MORL) (2012). *Environmental Statement for Telford, Stevenson, MacColl Wind Farms and Associated Transmission Infrastructure*.

Nedwell, J.R., Turnpenny, A.W.H., Lovell, J., Parvin, S.J., Workman, R., Spinks, J.A.L. and Howell, D. (2007). *A Validation of the dB$_{ht}$ as a Measure of the Behavioural and Auditory Effects of Underwater noise*. Subacoustech Report Reference 534R1231. Published by the Department for Business, Enterprise and Regulatory Reform.

Nowacek,* Douglas P. , Mark P. Johnson, Peter L. Tyack (2003) North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alerting stimuli.

NSR Environmental Consultants. (2001). Basslink: Draft Integrated Impact Assessment Statement. Hawthorn East, Vic., Australia (http://trove.nla.gov.au/work/20564639?versionId=41222357)OSPAR (1998). *Convention for the Protection of the Marine Environment of the North-east Atlantic (OSPAR Convention)*. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:21998A0403(01):EN:HTML

Pace, D.S., Johnson, M.P. and Tyack, P.L. (2006). *Vessels and Dolphins: Scars that Tell Stories*. Fins: 19-20.

Panigada, S., Pesante, G., Zanardelli, M., Capoulade, F., Gannier, A. and Weinrich, M.T. (2006). *Mediterranean Fin Whales at Risk from Fatal Ship Strikes*. Marine Pollution Bulletin, 52:1287-1298.

Polacheck, T.; Thorpe, L. (1990). The Swimming Direction of Harbor Porpoise in Relationship to a Survey Vessel. *Rep. Int. Whaling Comm*. 40:463-470.

Quick, N. and Cheney, B. (2011). *Cetacean Baseline Characterisation for the Firth of Tay Based on Existing Data: Bottlenose dolphins.* SMRU Ltd report to FTOWDG.

Reid, J. B., Evans, P.H. and Northridge, S.N. (2003). *Atlas of Cetacean Distribution in North-west European Waters*. ISBN 1 86107 550 2.

Richardson, W.J., Greene, Jr., C.R., Malme C.I., Thomson D.H. (1995). *Marine Mammals and Noise.* Academic Press, San Diego CA, 579pp.

Richardson, W.J., Miller, G.W., and Greene, C.R. (1999). *Displacement of Migrating Bowhead Whales by Sounds from Seismic Surveys in Shallow Waters of the Beaufort Sea*. Journal of the Acoustical Society of America, 106: 2281.

Rilov, G. and Benayahu, Y. (1999). *Rehabilitation of Coral Reef Fish Communities: Importance of Artificial-reef Relief to Recruitment Rates*. Bulletin of Marine Sciences, 70: 185–197.

Robinson, K.P., Eisfeld, S.M. Baumgartner, N., Tetley, M.J. Clark, N.M., Culloch, R.M., Whaley, A.R. and Haskins, G.N. (2007). *Summer Distribution and Occurrence of Cetaceans on the Coastal Waters of the Outer Southern Moray Firth in NE Scotland.* Lustra, 50: 13-26.

SCANS-II (2008). *Small cetaceans in the European Atlantic and North Sea.* Final Report to the European Commission under project LIFE04NAT/GB/000245, SMRU, Gatty Marine Laboratory, University of St Andrews, St Andrews, Fife KY16 8LB, UK.

SCOS. (2011). *Scientific Advice on Matters Related to the Management of Seal Populations: 2011*. Available at: http://www.smru.st-andrews.ac.uk/documents/678.pdf

Scheidat, M., Tougaard, J., Brasseur, S., Carstensen, J., van Polanen Petel, T., Teilmann, J. and Reijnders, P. (2011). *Harbour Porpoises (Phocoena phocoena) and Wind Farms: A Case Study in the Dutch North Sea*. Environmental Research Letters 6: 025102 (10pp).

Scottish Parliament (2010). *Marine (Scotland) Act 2010*. Available at: http://www.legislation.gov.uk/asp/2010/5/pdfs/asp_20100005_en.pdf

Sini, M.I., Canning, S.J., Stockin, K.A. and Pierce, G.J. (2005). *Bottlenose Dolphins around Aberdeen Harbour, North-east Scotland: A Short Study of Habitat Utilization and the Potential Effects of Boat Traffic*. J Mar Biol Assoc UK 85: 1547–1554.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr. C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack, P. (2007). *Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations.* Aquatic Mammals 33: 411-521.

Sparling, C., Russell, D., Lane, D., Grellier, K., Lonergan, M., McConnell, B., Matthiopoulos, J. and Thompson, D. (2012). *Baseline seal Information for the FTOWDG Area*. SMRU Ltd report to FTOWDG Project reference: 29.08.10.FDG – FTOWDG Seals.

Teilmann, J., Tougaard, J. and Carstensen, J. (2006a). *Summary on Harbour Porpoise Monitoring 1999-2005 around Nysted and Horns Rev Offshore Wind Farms.* Technical report to Energi E2 A/S and Vattenfall A/S.

Teilmann, J., Carstensen, J., Dietz, R., Edrén, S.M.C. and Andersen, S.M. (2006b). *Final Report on aerial Monitoring of Seals Near Nysted Offshore Wind Farm*. Technical report to Energi E2 A/S.

Teilmann, J. and Carstensen, J. (2012). *Negative Long Term Effects on Harbour Porpoises from a Large Scale Offshore Wind Farm in the Baltic – evidence of slow recovery*. Environmental Research Letters 7: 045101 (10pp).

Terhune, J. M. and W. C. Verboom.(1999). *Right Whales and Ship Noise*. Marine Mammal Science 15: 256-258

The Council of the European Communities (1992). *Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive) as Amended*. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1992L0043:20070101:EN:HTML [Accessed September 2012].

The Scottish Government (2011). *Scotland's National Marine Plan: Pre-Consultation Draft*. Available at: http://www.scotland.gov.uk/Resource/Doc/346796/0115349.pdf

The Scottish Government(2013). *Seal Licensing*. [Online]. Accessed at: http://www.scotland.gov.uk/Topics/marine/Licensing/SealLicensing

Thompson, P.M., Cheney, B., Ingram, S., Stevick, P., Wilson, B. and Hammond, P.S. (Eds). (2011b). *Distribution, Abundance and Population Structure of Bottlenose Dolphins in Scottish waters.* Scottish Government and Scottish Natural Heritage funded report. Scottish Natural Heritage Commissioned Report No. 354.

Thompson, P.M, Cheney, B., Cândido, A.T. and Hammond, P.S. (2009). *Site Condition Monitoring of Bottlenose Dolphins within the Moray Firth Special Area of Conservation: Interim report 2005-2007.* Scottish Natural Heritage Commissioned Report.

Thompson, P.M., Corkrey, R., Lusseau, D., Lusseau, S.M., Quick, N., Durban, J.W., Parsons, K.M. and Hammond, P.S. (2006). *An Assessment of the Current Condition of the Moray Firth Bottlenose Dolphin Population.* Scottish Natural Heritage Commissioned Report No. 175 (ROAME No. F02AC409).

Thompson, P.M., Brookes, K., Cheney, B., Cândido, A., Bates, H., Richardson, N. and Barton, T. (2010). *Assessing the Impact of Seismic Surveys on Cetaceans in the Moray Firth.* First year report for DECC, Scottish Government, COWRIE and Oil & Gas UK.

Thompson, P.M., Hastie, G.D., Nedwell, J., Barham, R., Brooker, A., Brookes, K.L., Cordes, L.S., Bailey, H. and McLean.(2011a). *Framework for Assessing the Impacts of Pile-driving Noise from Offshore Wind Farm Construction on Moray Firth Harbour Seal Populations.*

Thomsen, F., Laczny M. and Piper, W. (2006). *A Recovery of Harbour Porpoises (Phocoena phocoena) in the Southern North Sea? A Case Study off Eastern Frisia, Germany.* Helgoland Marine Research 60: 189-195. doi: 10.1007/s10152-006-0021-z

Tougaard, J., Tougaard, S., Jensen, R.C., Jensen, T., Teilman, J., Adelung, D., Liebsch, N. and Müller, G. (2006). *Harbour Seals at Horns Reef Before, During and After Construction of HornsRev Offshore Wind Farm*. Final report to Vattenfall A/S.

Tougaard, J., Henriksen, O.D. and Miller, L.A., (2009). *Underwater Noise from Three Types of Offshore Wind Turbines: Estimation of Impact Cones for Harbour Porpoises and Harbour Seals*. Journal of the Acoustical Society of America, 125: 3766-3773.

Walls, R., Canning, S., Lye,G., Givens,L., Garrett, C. and Lancaster,J. (2012). *Analysis of Marine Environmental Monitoring Plan Data from the Robin Rigg Offshore Wind Farm, Scotland (Operational Year 1).* Executive Summary and Non-Technical Report. Available at: http://www.scotland.gov.uk/Resource/0041/00413017.pdf

Weilgart, L.S. (2007). *A Brief Review of Known Effects of Noise on Marine Mammals.* International Journal of Comparative Psychology, 20: 159-168.

Wilhelmsson, D., Öhman, M.C., Stáhl, H. and Shlesinger, Y. (1998). *Artificial Reefs and Dive Ecotourism in Eilat, Isreal*. Ambio, 27: 764–766.

Wilhelmsson, D., Malm, T. and Öhman, M.C. (2006). *The Influence of Offshore Wind Power on Demersal Fish.* ICES Journal of Marine Science, 63: 775–784.

Wilhelmsson, D. and Malm, T. (2008). *Fouling Assemblages on Offshore Wind Power Plants and Adjacent Substrata*. Estuarine Coastal and Shelf Science, 79: 459–466.

Wilhelmsson, D., Malm, T., Thompson, R., Tchou, J., Sarantakos, G., McCormick, N., Luitjens, S., Gullström, M., Patterson Edwards, J.K., Amir, O. and Dubi, A. (eds.). (2010). *Greening Blue Energy: Identifying and Managing the Biodiversity Risks and Opportunities of Offshore Renewable Energy.* IUCN, Gland, Switzerland. 102 pp.

Wiltschko, W. and Wiltschko, R. (2005). *Magnetic Orientation and Magnetoreception in Birds and other Animals.* Journal of Comparative Physiology A ‐ Neuroethology and Sensory Neural and behavioural Physiology, 191: 675‐693.