4 Biological Environment

4.3 Marine Mammals

4.3.1 Baseline Information

Introduction

4.3.1.1 This section provides a brief summary of baseline marine mammal conditions for the Moray Firth for the proposed modified offshore transmission infrastructure (modified OfTI). Marine mammal considerations that are associated with the three consented wind farms are provided separately in MORL ES (2012) Chapter 4.4 (Marine Mammals).

4.3.1.2 This baseline study considers the following:

- The responses from key statutory and non-statutory stakeholders to MORLs scoping requests in relation to the modified OfTI;
- Information gathered from a desk top study of available data; and
- A summary of data collection and modelling (conducted by Aberdeen University and SMRU Ltd.) that has been undertaken to provide a baseline description of the use of the Moray Firth by marine mammals (MORL ES (2012) Chapter 4.4).

4.3.1.3 Additionally, Natural Power Consultants were commissioned for a two year boat-based study of the three consented wind farm sites to provide up-to-date, site specific data on marine mammal distribution and relative abundance. It should be noted that due to the mobile nature of the species in question, the ecological zone of impact is considered to be the entire Moray Firth for the impact assessment.

4.3.1.4 A more detailed account of this baseline information can be found in MORL ES (2012) Technical Appendix 4.4 A (Marine Mammals Baseline). The impact assessment undertaken for the construction, operation and decommissioning of the three consented offshore wind farms and modified OfTI is provided in the following sections:

- MORL ES (2012) Chapters 7.3 (Marine Mammals),
- Section 4.3.2 Impact Assessment and section 4.3.3 CIA for this modified OfTI impact assessment.

Consultations

4.3.1.5 Table 4.3-1 below summarises the consultation responses received with regards to marine mammals for the modified OfTI:

Table 4.3-1 Summary of Modified OfTI Consultation Responses

Organisation	Consultation Response	MORL Approach
Marine Scotland, JNCC (Joint Nature Concervation Committee) and SNH (Scottish Natural Heritage)	Recommend contacting the Cetacean Research and Rescue Unit and WDC regarding minke whales in the area due to the potential MPA. States that the coast is important to bottlenose dolphin especially within 3 km of the shore. Agree with the scope of impacts considered for marine mammals. Highlight the likelihood of cumulative impacts on marine mammals and will need to be addressed for the OfTI.	MORL welcome agreement of the scope of the impact assessment proposed.
WDC	Overall agree with what has been 'scoped in' for the marine mammal assessment. Recommend including corkscrew injuries Suggests including developments outside the Moray Firth in the Cumulative Impacts Assessment section which include: Aberdeen harbour, Neart na Gaoithe OWF, Inch Cape OWF, Seagreen OWF.	MORL welcome agreement of the scope of the impact assessment proposed. MORL agree to include cumulative assessments for the projects listed.

Baseline Characteristics

4.3.1.6 At least 14 species of cetacean (whale, dolphin and porpoise) have been recorded within the Moray Firth along with two species of seals. For a full review of all the species recorded in the Moray Firth area, see MORL ES (2012) Technical Appendix 4.4 A (Marine Mammals Baseline).

4.3.1.7 Table 4.3-2 provides a summary of species commonly recorded within the Moray Firth.

Table 4.3-2 List of Marine Mammals Commonly Recorded within the Moray Firth, Adapted From a Variety of Sources including Reid *et al.*, (2003), Robinson *et al.*, (2007) and Thompson *et al.*, (2010)

Species	Latin Name	Occurrence
Pinnipeds		
Harbour (common) seal	*Phoca vitulina*	Common, all year
A number of haul-out sites for harbour seals are located within the Moray Firth, primarily in the Beauly, Cromarty and Dornoch Firths (Thompson *et al.*, 1996b; SCOS, 2010). The harbour seal population in the Moray Firth has declined by 40 % compared to numbers recorded in the mid 1990s, with the population being relatively stable in recent years (SCOS, 2010). Harbour seals occur throughout the year in these areas, with peak numbers at haul-out sites between June and August when they are used as breeding sites (Thompson & Miller, 1990; Thompson *et al.*, 1996a). Seals within the Moray Firth are found to forage in waters of 10 to 50 m deep over areas with predominantly sandy sea beds. Tagging studies within the Firth have found that harbour seals generally travel no more than 60 km from their haul-out sites (Thompson *et al.*, 1996b), with a tendency to forage slightly further afield in the winter and with seasonal differences in the areas used (Thompson *et al.*, 1996a).		
Grey seal	Halichoerus grypus	Common, all year
Grey seals within the Moray Firth are predominantly observed during the summer although smaller numbers are present throughout the year. Non-breeding grey seals have been observed at intertidal sites within the Firth, also used by harbour seals. Breeding grey seals are mostly found at the rocky beaches and caves to the north of the Moray Firth (Thompson *et al.*, 1996b). It is thought that grey seals travel into the Moray Firth from different breeding sites (such as Orkney, Firth of Forth and Farne Islands) and use the area for food and non-breeding haul-out (Thompson *et al.*, 1996b). Tagging studies within the Moray Firth have identified grey seals foraging over a much wider area than the harbour seal, with great variation between individuals (Thompson *et al.*, 1996b).		
Cetaceans		
Harbour porpoise	*Phocoena phocoena*	Common, all year
Harbour porpoises are distributed throughout the Moray Firth (Hastie *et al.*, 2003b; Robinson *et al.*, 2007; Thompson *et al.*, 2010). Although the original SCANS surveys (Small Cetaceans in the European Atlantic and North Sea) did not encompass the Moray Firth, estimates of porpoise density for the closest surveyed regions were 0.36 and 0.78 animals / km2 (Hammond *et al.*, 2002) with spatially smoothed predictions of porpoise density suggesting relatively high densities within the Moray Firth (1.2 animals / km2). The SCANS II survey did include the Moray Firth (Hammond *et al.*, 2013) which estimated harbour porpoise densities within the ranges of the original SCANS estimates but lower than the smoothed prediction for the Moray Firth (0.4 to 0.6 animals / km2). Data collected from the outer Moray Firth through a DECC and Industry funded project conducted by Aberdeen University assessing the impact of seismic surveys on marine mammals, supports the relatively high occurrence of porpoises throughout the Firth with high detection rates of porpoises using autonomous passive acoustic detectors (CPODs)(Bailey *et al.*, 2010; Thompson *et al.*, 2010).		
Bottlenose dolphin	*Tursiops truncatus*	Common, all year
The most recent population estimate of dolphin abundance around the northeast coast of Scotland is 195 individuals (95 % probability interval 162 to 245; Thompson *et al.*, 2011). Although the majority of the population (71 to 111 individuals) appear to regularly utilise the Moray Firth SAC (95 % CI: 66 to 161), it is clear that a relatively high number of individuals also frequently utilise areas outside the SAC (Thompson *et al.*, 2006; 2009). The distribution of bottlenose dolphin sightings within the Moray Firth appear to be coastal, with the majority occurring in the inner Moray Firth and along the southern coast, generally in waters of less than 25 m deep (Hastie *et al.*, 2003a; Robinson *et al.*, 2007). Parts of the population exhibit movement patterns between the Moray Firth and other areas. For example bottlenose dolphins from the Moray Firth SAC are regularly sighted in the Tay (Thompson *et al.*, 2011) and the Firth of Forth and Tay Offshore Wind Developers Group (FTOWDG) commissioned a piece of work from SMRU Ltd that confirmed this connectivity, using the most up-to-date photography records of bottlenose dolphins known to be residing in the Moray Firth that have also been recorded within the Firth of Tay. (Quick and Cheney, 2011).		

Common dolphin	*Delphinus delphis*	Common, seasonal
Predominantly found in the continental shelf waters in the Celtic Sea and the western approach to the English Channel. They have been frequently seen in the Sea of Hebrides during the summer and occasionally in the North Sea, primarily in the Moray Firth region, with sightings becoming regular here during the summer months since 2006 (Robinson *et al*., 2010). No common dolphins were recorded in the North Sea during the SCANS II surveys (Hammond *et al*., 2013).		
White-Beaked dolphin	*Lagenorhynchus albirostris*	Common, seasonal
UK sightings predominantly recorded from around Scotland and the east coast of England (Northridge *et al*., 1995; Reid *et al*., 2003), although sightings within the Moray Firth are low compared to other areas. They have been recorded in UK waters all year round, with an increase in sighting frequency in coastal waters during the summer months when the animals appear to move inshore (Evans, 1992; Northridge *et al*., 1995; Weir *et al*., 2007). The SCANS II Survey (2007) gave an overall abundance estimate for white-beaked dolphins of 22,664 (95 % CI = 10,341 to 49,670) and a density estimate for the Moray Firth, Orkney and Shetland areas combined of 0.018 animals per km2 (0.86 CV).		
Minke whale	*Balaenoptera acutorostrata*	Common, seasonal
Minke whales are the most abundant baleen whale species within the Moray Firth, with sightings being reported throughout the area (Reid *et al*., 2003; Robinson *et al*., 2007; Thompson *et al*., 2010). Much of the research has concentrated on the southern coast and deeper trench waters, with observations most commonly occurring in deeper waters further from the shore (Robinson *et al*., 2007; Eisfeld *et al*., 2009). Data indicates that minke whales visit the Moray Firth in late summer in order to forage (Bailey & Thompson, 2009). Hammond *et al.* (2013) gave an overall abundance estimate for minke whale of 18,614 (95 % CI = 10,445 to 33,171) and a density estimate for the Moray Firth, Orkney and Shetland areas combined of 0.022 animals per km2 (1.02 CV).		

4.3.1.8 In addition further information is available in Figures 4.3-1 and 4.3-2 to illustrate key information on grey seal distribuition.

Summary

Harbour Seal

4.3.1.9 Harbour seal is the most common seal species observed within the Moray Firth, with parts of the Inner Moray Firth designated a SAC for their protection. Counts made during the breeding season indicate a decline in numbers within the SAC in recent years but an increase in numbers across the Moray Firth as a whole. Tagging studies found the highest rates of occurrence for the harbour seal were within 30 km of their haul-out sites. Habitat association models highlighted areas of preferred habitat, primarily within the inner Firth, plus some areas close to the consented developments (MORL and BOWL) in the north-eastern part of the Firth. Some preference was also shown for small areas of the south-east Firth in the vicinity of the proposed cable land-fall site at Inverboyndie. Modelling suggests some areas may contain up to 0.5 animals per km^2.

Grey Seal

4.3.1.10 Telemetry studies showed that grey seals regularly travel between the Moray Firth and haul-out sites outside the area. Areas with the highest usage within the Moray Firth included the Dornoch Firths. Lower levels of usage (between one and five animals per 4 km grid square) were estimated for the three consented wind farm sites. Areas of low usage are also predicted for the proposed land-fall site.

Harbour Porpoise

4.3.1.11 Passive acoustic monitoring indicates that harbour porpoise can be found throughout the Moray Firth. Harbour porpoise habitat models showed a preference for intermediate depths with increasing levels of sand and gravel, such as the Smith Bank. The boat-surveys supported this modelling, with the highest numbers of porpoises recorded in the south-east part of the survey area. Numbers predicted in the models for coastal areas were low.

4.3.1.12 There are relative density estimates available from boat-based surveys undertaken at the three consented wind farm sites combined (Technical Appendix 4.4 A of MORL ES (2012), SCANS (I and II) for the wider Moray Firth, and the aerial surveys. These density estimates are 0.72 animals / km^2, 0.4 to 0.6 animals / km^2 and 0.81 animals /km^2 respectively. It should be noted, however, that these aerial surveys coincide with the months during which the highest number of porpoise were recorded during the boat-based surveys (refer to Figure 5.31 in MORL ES (2012) Technical Appendix 4.4 A (Marine Mammals Baseline)).

Bottlenose Dolphins

4.3.1.13 A resident population of bottlenose dolphins can be found within the Moray Firth, for which an SAC has been designated. Passive acoustic monitoring (which cannot differentiate between dolphin species) indicates that dolphins can be found throughout the Moray Firth. The EARs data (which does allow differentiation between species) suggest that t this species being restricted to coastal waters.

4.3.1.14 The most recent estimate of the abundance of bottlenose dolphins along the whole of the east coast of Scotland is based on co-ordinated photo-identification studies in 2006 and 2007, which produced an estimate of 195 (95 % highest posterior density intervals (HPDI): 162 to 253) (Cheney *et al.,* 2013). More detailed annual surveys within the Moray Firth SAC between 2002 and 2010, indicate that around 50 % of these animals use the SAC in each year, with estimates ranging from 68 to 114 individuals; (mean = 93.3) but with overlapping confidence limits (Cheney *et al.,* 2012).

Other Cetacean Species

4.3.1.15 Of the other cetacean species observed within the Moray Firth, the minke whale is the most abundant. They have been shown to prefer sandbanks, as was shown by their distribution recorded during the boat-based surveys. The SCANS II surveys estimated 0.022 animals per km2 for the Moray Firth, Orkney and Shetland combined, higher than the 0.01 animals per km2 calculated from the boat-based surveys, although the small sample size needs to be taken into account when interpreting these results.

4.3.1.16 White-beaked and common dolphins have been recorded within the Moray Firth but detailed information on their abundance is lacking. Both species were recorded during the boat-based surveys but in low numbers.

Legislative and Planning Framework

4.3.1.17 Marine mammals in UK territorial waters are protected by both European and National Legislation (see MORL ES (2012) Chapter 4.1: Designated Sites). All cetaceans are listed on Annex IV of Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive') and therefore classed as European Protected Species and are fully protected under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended).

4.3.1.18 Four species of marine mammal relevant to this development are also listed on Annex II of the Habitats Directive which requires the designation of Special Areas of Conservation:

- Bottlenose dolphin (*Tursiops truncatus*);
- Harbour porpoise (*Phocoena phocoena*);
- Grey seal (Halichoerus grypus); and
- Harbour seal (*Phoca vitulina*).

4.3.1.19 Two SACs have been designated within the Moray Firth for marine mammals (Figure 4.3-3, and Table 4.3-3 below):

- Moray Firth SAC – designated for bottlenose dolphin; and
- Dornoch Firth and Morrich More SAC – designated for harbour seals.

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

- UK Biodiversity Action Plan (UK BAP);
- Marine (Scotland) Act 2010;
- Scottish Priority Marine Feature List;
- Draft Scottish Planning Policy (SPP), 2013;
- Wildlife and Countryside Act 1981 (Amendment) (Scotland) Regulations 2004;
- Nature Conservation Act 2004;
- Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention);
- OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic; and
- Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas 1994 (ASCOBANS).

4.3.1.21 The three consented wind farm sites and much of the remaining modified OfTI area are outwith the 12 nm limit, and thus potentially impacted marine mammal populations are protected under Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (Amendment) 2012. The inshore modified export cable route corridoor and modified export cable landfall are within Scottish Territorial Waters, and thus potential impacted marine mammal populations are covered by Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) legislation).

Table 4.3-3 Designated Areas within the Moray Firth Listing Marine Mammals as Qualifying Interest Features

	Status	Area (ha)	Relevant Notified Feature (s)
Dornoch Firth and Morrich More	SAC	8,700.53	Harbour seal and otter[1]
Moray Firth	SAC	151,347.17	Bottlenose dolphin

[1] Otters forage in inshore waters, out to approximately 10 m water depth. They are not considered further within the assessment as the OfTI cable corridor does not pass within proximity to the SAC.

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

- Seal Assessment Framework Document (Thompson *et al.,* 2011) (This document is provided in MORL ES (2012) Technical Appendix 7.3 B (Marine Mammals Environmental Imapact Assessment));
- The deliberate disturbance of marine European Protected Species. Guidance for English and Welsh territorial waters and the UK offshore marine area (2008) (http://jncc.defra.gov.uk/PDF/consultation_epsGuidanceDisturbance_all.pdf);
- The protection of Marine European Protection Species from injury and disturbance. Guidance for Scottish Inshore Waters. Marine Scotland, March 2014 (http://www.scotland.gov.uk/Resource/0044/00446679.pdf);

- The protection of marine European Protected Species from injury and disturbance, JNCC (2010);
- 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, by 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, by BioConsult SH (2008);
- Guidelines for Ecological Impact Assessment in Britain and Ireland: Marine and Coastal Institute of Ecology and Environmental Management, 2010; and
- Greening blue energy: Identifying and managing the biodiversity risks and opportunities of offshore renewable energy (Wilhelmsson *et al.,* 2010).

4.3.2 Impact Assessment

Summary of Effects and Mitigation

4.3.1.23 Effects on marine mammal receptors have been assessed during the construction, operation and decommissioning phases of the modified OfTI.

4.3.1.24 Significant medium term effects on marine mammal receptors are predicted from piling noise associated with Offshore Substation Platform (OSP) foundations, but no long term population level effects are assessed to be likely. No other significant effects are predicted.

4.3.1.25 The assessment process has used noise propagation and impact analysis to quantify the risks of physical injury and displacement due to piling noise for all species potentially effected, and used population analysis to assess the potential effects at the population level for harbour seals. The assessment incorporates a series of conservative assumptions about the potential impacts of noise on marine mammals. If these assumptions are confirmed, the assessment represents likely significant effects.

4.3.1.26 The assessment also considers current guidelines from the Joint Nature Conservation Committee (JNCC) regarding the use of ducted propellers and potential risk of corkscrew injury to seals. Likely effects are considered small due to distance to nearest breeding seal colony.

Summary of Effects

4.3.1.27 The effects on marine mammals that have been assessed include:

- Temporary displacement caused by increased noise levels during construction, in particular during piling activity for the two OSPs;
- Permanent hearing damage resulting from increased noise levels, in particular during piling activity;
- Risk of collision with vessels and ducted propellers;
- Long term avoidance resulting from operation and maintenance activity;
- Secondary effects associated with changes to prey availability;
- Risk of stranding associated with electromagnetic field (EMF) generation; and
- Impacts of non-toxic and toxic contamination.

Summary of Mitigation Measures and Residual Effects

4.3.1.28 Primary mitigation during construction will include adherence to the JNCC protocol for minimising the risk of injury to marine mammals from piling noise. Currently, this protocol involves the use of marine mammal observers and 'soft start' piling procedures. All effects assessed within this chapter assume these best practice guidelines are implemented. In addition, to minimise the risk of collision with vessels involved in the construction, operation and decommissioning of the OfTI infrastructure, all vessels will operate within designated routes, ensuring predictable vessel movement. This has also been assumed for the purposes of the assessments in this chapter.

4.3.1.29 Table 4.3-4 below summarises the predicted residual effects on marine mammal receptors.

Table 4.3-4 Impact Assessment Summary

Effect	Receptor	Pre-mitigation Effect	Mitigation	Post-mitigation Effect
Construction				
Hearing Damage	Harbour seal Grey seal Harbour porpoise Bottlenose dolphin Minke whale	The modelling on which the assessment is based has been undertaken including mitigation measures (JNCC protocol and designated vessel routes) and therefore pre-mitigation effects are not separately identified)	None additional to JNCC protocol for minimising the risks to marine mammals. Designated vessel routes	No significant long term impact
Displacement/Disturbance				No significant long term impact
Collision Risk (including risk of corkscrew injury from ducted propellers)				No significant long term impact
Reduction in Prey Sources				No significant long term impact
Reduction in Foraging Ability				No significant long term impact
Toxic Contamination				No significant long term impact
Operation				
Collision Risk (including risk of corkscrew injury from ducted propellers)	Harbour seal Grey seal Harbour porpoise Bottlenose dolphin Minke whale	Not significant	Designated vessel routes	Not significant
Stranding due to Electromagnetic Fields		Not significant		Not significant
Long Term Changes in Prey Availability		Not significant		Not significant
Toxic Contamination		Not significant		Not significant

Decommissioning				
Hearing Damage	Harbour seal Grey seal Harbour porpoise Bottlenose dolphin Minke whale	The modelling on which the assessment is based has been undertaken including mitigation measures (JNCC protocol and designated vessel routes) and therefore pre-mitigation effects are not separately identified)	None additional to JNCC protocol for minimising the risks to marine mammals. Designated vessel routes	Not significant
Displacement/Disturbance				Not significant
Collision Risk (including risk of corkscrew injury from ducted propellers)				Not significant
Reduction in Prey Sources				Not significant
Reduction in Foraging Ability				Not significant

Introduction to Impact Assessment

4.3.1.30 The aim of this assessment is to describe the potential significant effects that specific activities associated with the installation of the modified OfTI may have on marine mammal populations within the Moray Firth. It concentrates on the connection between the three consented offshore wind farm sites and the modified export cable landfall site at Inverboyndie, including the construction of two offshore OSPs which will be located within the area of the three consented wind farms.

4.3.1.31 A full review of potential significant effects on marine mammals and the methodologies used in this assessment can be found in the following technical appendices (MORL ES, 2012):

- Technical Appendix 7.3 A (Marine Mammals: Environmental Impact Assessment);
- Technical Appendix 7.3 B (Framework for assessing the impacts of pile-driving noise from offshore wind farm construction on Moray Firth harbour seal populations);
- Technical Appendix 7.3 C (MORL SAFESIMM noise impact assessment for seals and cetaceans);
- Technical Appendix 7.3 D (A comparison of behavioural responses by harbour porpoise and bottlenose dolphins to noise implications for wind farm risk assessments);
- Technical Appendix 7.3 E (Identification of appropriate noise exposure criteria for assessing auditory injury for pinnipeds using offshore wind farm sites);
- Technical Appendix 7.3 F (Noise propagation and SAFESIMM model outputs);
- Technical Appendix 7.3 G (Habitat Regulations Appraisal: Marine Mammals – Two SAC's listing marine mammals as qualifying features can be found within the Moray Firth. For the purpose of Appropriate Assessment, an appraisal under the Habitats Regulations is presented within this appendix); and
- Technical Appendix 7.3 H (EPS Assessment: Supplementary Information – All cetaceans present within the Moray Firth are European Protected Species (EPS)). MORL recognises that an EPS licence will be required during the construction phase of the modified OfTI works. A preliminary assessment is presented, which will be revised once construction parameters have been finalised.

4.3.1.32 Additional supporting information on underwater noise modelling activities can be found in MORL ES (2012) Chapter 3.6: Underwater Noise and Technical Appendix 3.6 A (Underwater Noise Technical Report).

4.3.1.33 The marine mammal assessment interacts with assessments for the following receptors and where relevant, linkages have been made:

- Chapter 4.2 (Fish and Shellfish Ecology);
- Chapter 4.1 Benthic Ecology); and
- Chapter 5.2 (Shipping and Navigation).

4.3.1.34 The species assessed in this section are:

- Grey seal;
- Harbour seal;
- Harbour porpoise;
- Bottlenose dolphin; and
- Minke whale.

4.3.1.35 Key effects on marine mammals assessed are summarised in Table 4.3-5 below.

Table 4.3-5 Summary of the Potential Key Impacts on Marine Mammals Assessed within this Chapter

Risk	Associated Activity	Effect
Permanent Hearing Damage	Increased noise levels, associated with piling.	Reduction in ability to find prey, avoid predators and socially interact.
Temporary Disturbance / Displacement	Increased vessel movements; Increased noise levels, associated with piling and non-piling activities.	Restricted access to food sources, breeding grounds or migration routes leading to reduced fitness.
Collision	Vessel movements, including those with ducted propellers.	Physical injury and reduced viability.
Long Term Avoidance	Disturbance related to OSPs and cable installation; Operation and Maintenance related vessel movement.	Habitat disturbance leading to reduction in prey source; restricted access to food sources, breeding grounds or migration routes leading to reduced fitness.
Reduction in Prey Availability	Secondary effect resulting from increased noise and / or vibration (including electromagnetic fields), habitat disturbance or the physical presence of the turbines.	Reduction in fitness.
Toxic / Non-Toxic Contamination	General construction activities leading to increased sediment; sacrificial anodes and antifouling paints.	Contamination of food chain leading to reduced fitness.

Rochdale Envelope Parameters Considered in the Assessment

4.3.1.36 Full details of the Rochdale Envelope for the modified OfTI are provided in Chapter 2.2 (Project Description) of this ES. The key components of the project design for this marine mammal impact assessment are described in Table 4.3-6 below.

4.3.1.37 Key components of the modified OfTI design relevant for this impact assessment on marine mammals are:

- Duration and timing of construction activities;
- Associated vessels;
- Number of OSPs and type of foundation structures; and
- Extent and route of export cable route to Inverboyndie.

Table 4.3-6 Rochdale Envelope Parameters Relevant to the Marine Mammal Impact Assessment

Potential effect	Rochdale Envelope Scenario Assessed
Construction	
Permanent Threshold Shift (PTS – hearing damage)	Greatest potential cause of auditory damage will be from piling noise during construction. Worst case (as modelled) is 32 x 3 m piles from two substations (16 piles per OSP for jack-up foundation type).
Disturbance/Displacement	Greatest potential cause of disturbance / displacement will be increased noise, in particular from piling, created during construction. Worst case (as modelled) is 32 x 3 m piles from two substations (16 piles per OSP for jack-up foundation type).
Collision Risk	An assessment will be undertaken with respect to anticipated increased vessel traffic around the offshore transmission works, taking account of the use of standard vessel routes which will help to localise effects. A separate review of ducted propeller related injury from vessel movement near haul-out sites will be undertaken as part of the impact assessment as described below. It is assumed for this assessment that all vessels associated with the installation of the cable and OSPs will utilise ducted propellers.
Risk of Corkscrew Injury from use of Ducted Propellers	The Rochdale Envelope scenario assessed assumes that vessels with ducted propellers will be used.
Reduction in Prey Availability	Secondary impacts as a result of changes in prey distribution or density. Worst case, maximum 70 km of cable for inter platform cables and cabling up to the boundary of the three consented wind farms. Corridor length from the boundary of the three consented wind farms of 52 km; maximum of four trenches; maximum corridor width 1,200 m, 1 m width per trench with associated loss of habitat and impacts of piling on prey availability (32 x 3 m piles for two substations). Refer to Chapter 2.2: Project Description of this ES for details.
Reduction in Foraging Ability	Secondary effect due to increased suspended sediment associated with construction activities i.e. piling or trenching. Refer to Chapter 3.1: Hydrodynamics, Sedimentary and Coastal Processes of this ES for details.
Toxic Contamination	Potential for non-toxic and toxic contamination through accidental spillages and pollution incidents. It is assumed all offshore vessels/installations will use sacrificial anodes and/or anti fouling coatings.
Operation	
Increased Vessel Use - Collision Risk and Barrier to Movement	Increased vessel movements associated with maintenance of the cable and OSPs.
Increased Vessel Movement – Ducted Propellers	The Rochdale Envelope scenario assessed assumes that vessels with ducted propellers will be used.
Electromagnetic Fields	70 km of 220 kV HVAC cable for inter-platform cables and cabling up to the boundary of the three consented wind frams; and a maximum of 52 km of 220 kV HVAC export cable corridor length from the boundary of the three consented wind farms. Target trench depth of 1 m.

Potential effect	Rochdale Envelope Scenario Assessed
Changes in Prey Availability (habitat loss)	Secondary impacts due to changes in prey distribution or density as a result of loss or gains in habitat (refer to Chapter 4.1: Benthic Ecology and 4.2: Fish & Shellfish Ecology of this ES for details) due to presence of EMF. Maximum 70 km of cable for interplatform cables and cabling up to the boundary of the three consented wind farms. Corridor length from the boundary of the three consented wind farms of 52 km from the boundary of the three consented wind farms; maximum of four trenches; maximum corridor width 1,200 m, 1 m width per trench.
Toxic Contamination	Potential for non-toxic and toxic contamination through accidental spillages and pollution incidents. It is assumed all offshore vessels/installations will use sacrificial anodes and/or anti fouling coatings.
Decommissioning	
The decommissioning programme has not yet been finalised, therefore a detailed assessment is not possible at this stage. The decommissioning of the OSPs and export cable may involve the use of cutting tools and / or other methods if appropriate. Impacts from decommissioning are prediceted to be broadly similar to or less than those from construction. The greatest impact is likely to be due to increased anthropogenic noise associated with removal of the OSP's.	

EIA Methodology

4.3.1.38 The assessment methodology used for marine mammals is based on methodologies recommended by the Chartered Institute of Ecology and Environmental Management (IEEM, 2010). Some additional definitions are provided by Wihelmsson *et al.* (2010) in a review of potential effects of offshore wind developments. For full details of methodology used in this assessment, including details of modelling undertaken to assess the impacts of piling and the conservatism in the assessment, refer to MORL ES (2012) Chapter 7.3 (Marine Mammals) and Technical Appendix 7.3 A: Marine Mammals Environmental Impact Assessment (MORL ES, 2012).

4.3.1.39 The basic assessment steps are as follows:

- Identification of potential receptors and description of baseline conditions;
- Prediction of activities during the different stages of the development that may result in potential effects;
- Characterisation of potential effects including likelihood of occurrence;
- Assessment of whether effects are ecologically significant and the geographical scale at which they may occur;
- Proposed mitigation if applicable;
- Assessment of whether residual effects (after mitigation) are ecologically significant; and
- Assessment of cumulative / in-combination effects.

4.3.1.40 A list of defining terms used in this assessment can be found in Table 4.3-7 below. The geographical scale at which the ecological significance of a potential effect 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, i.e. Site of Special Scientific Interest (SSSI), UK Biodiversity Action Plan (UK BAP) species or Marine Protected Areas; and
- **International**: receptors are a feature of European designated sites, i.e. Special Area of Conservation (SAC).

4.3.1.41 Certainties in predictions for this assessment follow the criteria described below in Table 4.3-8, based on IEEM guidance (IEEM, 2010).

4.3.1.42 Given the level of legal protection afforded all of the marine mammals likely to be encountered within the Moray Firth, all species of marine mammal are considered to be of high sensitivity in this assessment.

Table 4.3-7 Definitions of terms used in assessment

Term	Definition
Magnitude	Size of potential effect (e.g. number of individuals predicted to be affected). For the purposes of this impact assessment, low has been termed as < 10 % of the reference population considered, medium as between 10 to 20 %, and high as over 20 % of the reference population considered.
Extent	Area over which effect predicted to occur. For this assessment, the extent has been considered as the Moray Firth.
Duration	Time period over which effect predicted to occur. For example: short term (occur over days or weeks within the construction phase); medium term (occur over complete construction phase); or long term (detectable after 25 years).
Reversibility	Likelihood of effect to be reversed (either though natural processes or mitigation).
Timing	Period of the year that activity would need to occur to result in potential effect. It has been assumed for this assessment that construction activities occur throughout the year and do not exhibit seasonality.
Frequency	Frequency of activity leading to potential effect.
Risk	Likelihood potential effect will occur.

Table **4.3-8 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 effect, data have comprehensive spatial coverage / resolution and predictions relating to effect magnitude modelled and / or quantified. Probability estimated at > 95 %.
Probable	Interactions are understood using some documented evidence, i.e. receptor sensitivity is derived from sources that consider the likely effects of the potential effect, data have a relatively moderate spatial coverage / resolution, and predictions relating to effect magnitude have been modelled but not validated. Probability estimated at 50 to 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 %.

4.3.1.43 A magnitude scale (see Table 4.3-9 below) was determined through consultation with scientific experts, and guided by comparison of predicted changes in population size against likely baseline trends. This also considered whether predicted change could be detected in these marine systems. A high magnitude change in distribution or population size should be measureable within the Moray Firth given the robust baseline information for this area. Medium or low magnitude change may remain undetected due to high levels of background variation and sampling variability. The duration of effect described has been agreed through consultation with Marine Scotland, SNH and JNCC.

4.3.1.44 Technical Appendix 7.3 B (MORL ES, 2012) provides the rationale for using a 25 year period to predict the long term consequences of these construction activities. In this context, it is suggested that “long term” be considered to be a 25 year time-scale. First, this is the time-scale typically considered by the International Union for Conservation of Nature (IUCN) when assessing conservation status. Second, it is equivalent to approximately one to two times the generation time for key marine mammal receptors, and thus seems an appropriate period for assessing longer term population change.

Table 4.3-9 Criteria used for predicting significance from magnitude of effect and duration

	Duration		
Magnitude	**Short term (days)**	**Medium Term (construction years)**	**Long Term (25 years)**
High (>20% of population)	Major significance	Major significance	Major significance
Medium (>10% pf population)	Minor significance	Moderate significance	Moderate significance
Low (<10% of population)	Negligible significance	Minor significance	Minor significance

Impact Assessment

4.3.1.45 All marine mammal species that may be encountered in the vicinity of the proposed works are considered target species due to the fact that all cetaceans are listed on Annex IV of the Habitats Directive and the bottlenose dolphin, harbour porpoise, harbour seal and grey seal are listed on Annex II. This assessment will concentrate on the key species highlighted in the Baseline Information section 4.3.1 above, (and associated MORL ES (2012) Technical Appendix 4.4 A) (Marine Mammals Baseline). The key species to be discussed are:

- Grey seal;
- Harbour seal;
- Harbour porpoise;
- Bottlenose dolphin; and
- Minke whale.

Construction

Increased Anthropogenic Noise (Non-Piling Activities)

4.3.1.46 Ambient noise in the ocean is sound that is always present and cannot be attributed to an identifiable localised source. Anthropogenic (man-made) noises which are now a constant in the marine environment, for example shipping, come from all directions, but will vary in magnitude, frequency, direction and depth. 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. 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.

4.3.1.47 As piling is generally accepted as providing the greatest potential for impact to marine mammals, increases in anthropogenic noise due to piling are discussed separately (see next section which is titled “Increased anthropogenic noise (piling)”). During periods when no impact piling is occurring, marine mammals may react to other sources of construction noise such as vessel noise, trenching, cable laying, dredging or rock placement.

4.3.1.48 Simple Propagation Estimator and Ranking (SPEAR) modelling was conducted by Subacoustech Environmental Ltd. to demonstrate the level of noise produced by different construction activities. Underwater measurements of background noise taken within the Moray Firth suggest that levels of background noise within the Moray Firth are typical for UK waters (see MORL ES (2012) Section 7 of Technical Appendix 3.6 (Underwater Noise Technical Report) for details).

4.3.1.49 The results showed that the primary source of noise during installation of the OfTI infrastructure (and therefore the greatest effect on marine mammals) will be from piling for the OSPs. This is illustrated below in Plate 4.3-1, and explored in detail in MORL ES (2012) Technical Appendix 7.3 A (Marine Mammals Environmental Impact Assessment). Plate 4.3-1 below illustrates the range at which noise from different OfTI construction related activities reaches 90 dBht for harbour porpoises from the noise source. It should be noted that the Y-axis of this graph is plotted using a log scale, illustrating that the impact range of piling associated noise is several orders of magnitude larger than other construction related activities.

4.3.1.50 As shown in Table 4.3-10 below, SPEAR modelling for other marine mammal species shows very similar impact ranges from the modelled construction activities to those of harbour porpoises (see MORL ES (2012) Section 4.1.2 of Technical Appendix 7.3 A (Marine Mammals Environmental Impact Assessment) full details of SPEAR modelling undertaken).

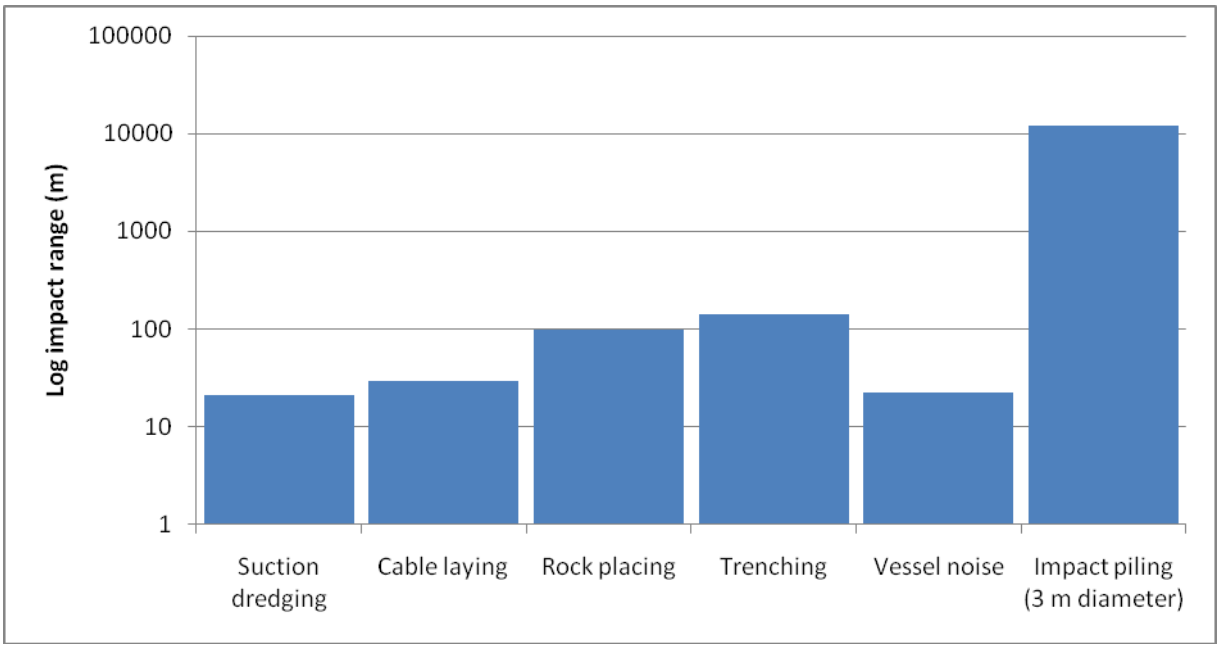

Plate 4.3-1 Extent of effect of various construction activities (90 dB_{ht}) on harbour porpoise

Table 4.3-10 Numerical Output from SPEAR Model Predicting and Comparing the Modelled Noise Effects of the Different Construction Activities on Marine Mammals

Construction Activity	Effect Range (m)							
	Minke Whale		Bottlenose Dolphin		Harbour Porpoise		Harbour Seal	
	90 dB_{ht}	75 dB_{ht}	90 dB_{ht}	75 dB_{ht}	90 dB_{ht}	75 dB_{ht}	90 dB_{ht}	75 dB_{ht}
Suction Dredging	16	180	21	72	21	200	2	26
Cable Laying	18	180	9	75	29	220	2	29
Rock Placing	70	390	31	170	99	550	17	99
Trenching	59	390	81	350	140	640	12	87
Vessel Noise	6	130	12	110	22	200	<1	11
Impact Piling (3 m diameter)	12,000	24,000	7,700	15,000	12,000	21,000	5,400	14,000

4.3.1.51 The results of this study showed that the primary source of noise during construction (and therefore exerting the greatest potential effect on marine mammals) will be from piling.

4.3.1.52 Based on the SPEAR model outputs above, it was concluded that the effects of these additional non-piling construction activities associated with the modified OfTI would be minimal due to their local influence and the fact that more distant effects would be masked by the noise produced from piling of the OSPs. During periods when no piling is occurring, strong reactions to the activities modelled are unlikely to occur at distances of greater than 140 m (Table 4.3-10 above) from the source and so any impacts effects would be of low magnitude.

4.3.1.53 Disturbance to animals due to non-piling related Works associated with the OfTI installation or decommissioning is deemed to constitute a direct negative impact on animals, for a short duration (months) and of a temporary nature (for the period of construction and decommissioning and only within a very small distance from the activity), and is therefore considered to be of minor significance (see Table 4.3-11). As the number of OSPs has been reduced from eight to two this will decreases the potential short term effects compared to the MORL ES (2012) assessment.

Increased Anthropogenic Noise (Piling)

4.3.1.54 It is generally accepted that underwater noise associated with piling generates the most noise compared to other construction activities. The level of noise produced is related to blow energies required to pile the foundation, with the required blow energy dependent on a number of factors including pile design and diameter, seabed characteristics and water depth (Diederichs *et al.* 2008). The propagation of noise produced through the water column is also dependent on a number of factors including the depth of the water.

4.3.1.55 Marine mammals are sensitive to increased underwater noise (e.g. Koschinski *et al.,* 2003; Thomsen *et al.,* 2006; Madsen *et al.,* 2006; Skeate *et al.,* 2012; Kastelein *et al.,* 2013). They have good underwater hearing and rely heavily on sound to feed, navigate, and conduct social interactions.

4.3.1.56 Impacts of pile driving noise on marine mammals can be broadly categorised into three effects:

- Lethal Effects and Physical Injury;
- Auditory Injury/PTS onset; and
- Behavioural avoidance/displacement.

4.3.1.57 For the modified OfTI, the proposed infrastructure will include two AC OSPs. A number of foundation types are currently under consideration including jackets and jack ups (platform with jack-up legs) secured with pin piles, which would require piling (see Chapter 2.2: Project Description for more details). The maximum number of piling events envisaged are 32 pin piles for the two OSPs in total at 260 minutes per pile. This is a conservative estimate as it is based on the longest estimated piling duration.

4.3.1.58 The OSPs are predicted to be installed during the overall offshore wind farm turbine installation phase of the three consented wind farms and have therefore been assessed as part of the marine mammal impact assessment MORL ES (2012) Chapter 7.3 (Marine Mammals). Location 2 to the southeastern corner of the three consented wind farms (see Figure 01 in Technical Appendix 7.3 F of MORL ES (2012)) represented the closest location to the offshore export cable route corridor assessed in the MORL ES (2012) and thus the most representative for the proposed OSPs. While it is recognised that for the modified OfTI the OSPs can be located in multiple locations within the EDA, and so closer to the seal haul out sites, this piling will be undertaken within the same periods as that of the wind turbine foundations, as described above, and so has been assessed in this context. Location 2 is still considered to represent an appropriate worst case scenario with regards to proximity to the bottlenose dolphins travelling along the southern Moray Firth coast.

4.3.1.59 Modelling was undertaken for 3 m pin piles in the MORL ES (2012), in which the parameters have remained the same for the modified OfTI. This includes area affected by PTS and behavioural displacement. However, since the consent of the wind farm, the number of OSPs have been reduced from eight to two, which has significantly reduced the piling duration and will therefore likewise reduce the potential piling impact.

4.3.1.60 The OfTI assessed as part of the MORL ES (2012) has been awarded a Marine Licence based on eight OSPs. The new Rochdale envelope now has only two OSPs. As eight OSPs are deemed aceptable (due to being consented), two OSPs have been deemed to be acceptable and have therefore been assessed qualitatively in this assessment.

4.3.1.61 The assessment above indicates that the potential for PTS and displacement effects on minke whale and bottlenose dolphin is low to medium magnitude respectively; for harbour porpoise and grey seal the potential effects have the potential to be low to high magnitude and for harbour seal to be medium to high magnitude effects during the period of piling of OSPs.

4.3.1.62 Given the very short duration (weeks) of the proposed OSP installation, the potential effect of piling two OSPs on all marine mammal species is considered to be of **minor significance**.

Table 4.3-11 Summary of Potential Effects from Piling Noise during OSP Construction on Relevant Marine Mammal Receptors

Species	Predicted Effect
Harbour Seal	Major significance over short duration (piling phase each year) with minor significance for long term effects.
Grey Seal	Major significance over short duration (piling phase each year) with minor significance for long term effects.
Harbour Porpoise	Major significance over short duration (piling phase each year) with minor significance for long term effects.
Bottlenose Dolphin	Moderate significance over short duration (piling phase each year) with minor significance for long term effects.
Minke Whale	Moderate significance over short duration (piling phase) with minor significance for long term effects.

Changes in Prey Availability

4.3.1.63 Sources of anthropogenic noise that may affect marine mammal behaviour may also alter the behaviour of potential prey species (e.g. fish). As for marine mammals, the primary source of such disturbance is predicted to be from piling associated with the installation of the OSPs.

4.3.1.64 Noise modelling (based on a 3 m diameter pile at Location 2 to the southeastern corner of the three consented wind farms; Figure 01 in MORL ES (2012) Technical Appendix 7.3 F) was conducted to predict impact ranges from piling noise associated with the OSPs on key fish species (see Chapter 4.2 (Fish and Shellfish Ecology) of this ES and Chapter 3.6 (Underwater Noise) of MORL ES (2012)). Impact ranges were found to be similar to those derived from the worst case scenarios for the three consented wind farm sites (e.g. 90 dB_{ht} impact range of within 40 km for hearing specialist species, herring).

4.3.1.65 Though the potential impact on prey species is predicted to be up to 40 km for hearing specialists such as herring, the significance of impact is predicted to be minor or no significance for all fish species assessed overall, therefore the potential impact on marine mammals is predicted to be of **low** magnitude.

4.3.1.66 The potential effects from piling noise were predicted to be of minor or no significance for all fish species assessed (Chapter 4.2 (Fish and Shellfish Ecology)).

4.3.1.67 The effects from noise during construction on potential marine mammal prey species within the OfTI area are therefore considered to be of low magnitude of short duration and therefore of **minor significance.**

Increased vessel use - Collision Risk and Barrier to Movement

4.3.1.68 While vessel strikes are a known cause of mortality in marine mammals (Pace *et al.* 2006, Laist *et al*. 2001,) the extent of vessel strike related mortality is likely to be under-recorded (David 2006). A review reported that vessel strikes accounted for between 12 and 47% of reported marine mammal deaths (Carter 2007). Reported collisions between vessels and large whales are generally lethal (Laist *et al.* 2001). However, non-lethal collisions have also been documented in both large and small cetaceans species, based on observations of individuals with injuries or scars characteristic with vessel strikes (Van Waerebeek *et al.* 2007) suggesting that cetaceans can survive such collisions. Most published data regarding collision risk have focused on large whale species (Knowlton and Kraus 2001, Jensen and Silber 2004, Douglas *et al.* 2008, Panigada *et al.* 2006) as injuries to smaller species are less likely to be noticed or reported (International Whaling Commission: http://iwc.int/ship-strikes).

4.3.1.69 Marine mammals will show some degree of habituation to additional vessel movements. Though there will be some response to additional vessel movement associated with the modified OfTI construction, this is likely to be of short duration and restricted due to vessels using a pre-defined vessel corridor, therefore effect magnitude is predicted to be **low**.

4.3.1.70 Based on the Shipping and Navigation Impact Assessment (Chapter 5.2 of this ES), it was concluded that any vessel traffic would be slow moving in a predictable manner (along a predefined corridor). As a result, the effects of increased vessel traffic on marine mammals (of all species) are considered probable in the immediate vicinity of the vessel but, overall, effects would be of low magnitude, short duration, direct and temporary and of **minor significance**, which is consistent with the MORL ES (2012).

Increased Vessel Movement – Ducted Propellers

4.3.1.71 Ducted propellers are propellers with non-rotating nozzles which are encased by a duct or passageway. These are used for the dynamic positioning enabling vessels to maintain their position by repeatedly starting or reversing. This may increase the opportunity for animals to approach and be drawn into propellers (Thompson *et al.,* 2010). Their use has been prevalent in the shipping industry since the 1930s and such propellers are common to a wide range of vessels including tugs, self-propelled barges, rigs, offshore support vessels and research boats.

4.3.1.72 Fatal injuries to seals that are consistent with animals potentially being pulled through ducted propellers have been observed on carcasses washed up in eastern Scotland, along the north Norfolk coast and around Strangford Lough in Northern Ireland (Bexton *et al.,* 2012; Thompson *et al.,* 2013a). Harbour seals appear to be predominantly affected with 88% of carcasses to date identified as this species. The phenomenon is commonly referred to as 'corkscrew seal injury'

4.3.1.73 The JNCC (endorsed by the Statutory Natural Conservation Bodies, SNCBs) has provided advice relating to potential for corkscrew injury and proposed developments as a result of the concerns over the potential for corkscrew injury from the use of ducted propellers, details of which can be found in Table 4.3-12 below. There is currently some commissioned work to investigate potential causes of 'corkscrew seal injury' fatalities, in particular work being undertaken by the Sea Mammal Research Unit (SMRU). However, results are not expected to be available until later in 2014 and are therefore not available for use in this assessment.

Table 4.3-12 JNCC Advice in Relation to Potential for Corkscrew Injury Associated with the Use of Ducted Propellers (from JNCC 2012)

Risk	Activity	Recommendations
High	Activity proposed to take place within 4 nm of a harbour seal SAC and areas where the harbour seal population is in significant decline.	- Consider alternatives to using ducted propellers or, - Avoid the breeding season; and - (If avoiding the breeding season or using alternatives to ducted propellers are not possible then a Seal Corkscrew Injury Monitoring Scheme should be considered).
Medium	Activity proposed to take place between 4 and 30 nm of a harbour seal SAC and not covered above.	- Consider alternatives to using ducted propellers. - Avoid the breeding season if possible.
	Activity proposed to take place within 4 nm of a grey seal SAC.	- Consider alternatives to using ducted propellers. - Avoid the breeding season if possible.
Low	Activity proposed to take place beyond 30 nm distance from a harbour seal SAC.	None
	Activity proposed to take place beyond 4 nm distance from a grey seal SAC.	None

4.3.1.74 The Dornoch Firth and Morrich More SAC is approximately 43 nm away from the proposed land-fall site at Inverboyndie, and therefore seals associated with these haul-out sites are considered to be at low risk from ducted propellers on vessels associated with installing the offshore transmission cables. A smaller number of harbour seals are known to haul-out in the vicinity of Peterhead (SCOS, 2011; Duck *et al.,* 2011), approximately 36 nm away from the modified export cable landfall site, suggesting these individuals are also at a low risk from activities relating to the offshore transmission cables. As a result, the risk to harbour seals from vessels equipped with ducted propellers associated with the installation of the offshore export cables and OSPs is considered to be of **low**.

4.3.1.75 A number of grey seal haul-out sites have been identified around the Fraserburgh area (approximately 20 nm from Inverboyndie) and south towards Cruden Bay (SCOS, 2011; Duck, 2012). Based on the JNCC guidance, grey seals associated with these haul-out sites are considered to be at low risk from ducted propellers on vessels associated with installing the offshore transmission cables and OSPs.

4.3.1.76 As effects are predicted to be of low magnitude, of short duration, direct, permanent and negative should they occur, and following JNCC guidance as detailed in Table 4.3-12 above, overall significance of effect is deemed to be **minor significance**.

Reduction in Foraging Ability (Increased Suspended Sediment)

4.3.1.77 Increased turbidity (suspended sediment) as a result of construction activities could affect foraging or social interactions of marine mammals. Chapter 3.1 Hydrodynamics, Sedimentary and Coastal Processes of this ES discusses the effects construction activities may have on local sedimentary processes.

4.3.1.78 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.

4.3.1.79 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 sea bed. This may result in increased turbidity, particularly in habitats located in close proximity to the modified OfTI. Given the footprint of the disturbance expected within the context of the available habitat of the Moray Firth, the magnitude of effect is considered to be **low** and of a short duration.

4.3.1.80 Marine mammals are often recorded foraging in areas where sediment suspension levels are high, such as in estuaries and may in fact target such areas for foraging. It is therefore expected that marine mammals will continue to forage in areas of increased 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.

4.3.1.81 Increased suspended sediment concentration is predicted to be of minor significance to mobile fish species (see Chapter 3.1 Hydrodynamics, Sedimentary and Coastal Processes of this ES) and therefore the secondary effects to marine mammals (in the context of effects on prey species) is also considered to be unlikely, of low magnitude, short duration and **negligible significance**, which is less than what was found within MORL ES (2012) due to the reduction in the number of OSPs and construction time.

Toxic Contamination

4.3.1.82 Leaching of compounds (in particular heavy metals) from sacrificial anodes or antifouling paints on OSPs and associated vessels has the potential to contaminate marine mammals and their food supply.

4.3.1.83 Given that such systems are likely to be present on most (if not all) shipping vessels already present within the Moray Firth and taking into account the tidal regime around the consented sites (see MORL ES (2012) Chapter 3.4 (Hydrodynamics – Wave Climate and Tidal Regime), it is not considered there will be any detectable increase in metal concentrations within the Moray Firth should these systems be applied.

4.3.1.84 The change from using DC to AC cabling will have no significance to the above assessment. As a result of the above, effects on marine mammals are considered to be unlikely and **not significant**.

Operation

4.3.1.85 A summary of the consideration of these effects on marine mammals are provided below. For more details on the predicted effects during operation, see MORL ES (2012) Technical Appendix 7.3 A (Marine Mammals Impact Assessment). Publicly available information was reviewed with respect to the potential impacts to marine mammals.

Changes in Prey Availability (Habitat Loss)

4.3.1.86 The effects of habitat loss due to the OfTI are considered very low in the context of fish habitat (see Table 4.3-6 Rochdale Envelope Parameters above) and therefore have not been considered in detail in Chapter 4.2 of this ES (Fish and Shellfish Ecology). As a result, the indirect effects of habitat loss (leading to a reduction in available prey species) upon marine mammals are considered of low magnitude, of long term duration and therefore of **minor significance**, which is in line with findings from the MORL ES (2012).

Increased Vessel Movement - Collision Risk and Ducted Propellers

4.3.1.87 Vessel movement associated with the maintenance programme of the OSPs could also potentially affect marine mammals during the operational phase of the consented developments.

4.3.1.88 The potential impacts from an increase in vessel traffic have been detailed above in section 4.3.2.46 and 4.3.2.59 (construction impacts from increased vessel movement), and have not been reiterated here. In summary, it is likely that marine mammals will show some degree of habituation to existing levels of vessel movement within the wider area, particularly major transit routes where there is a lot of activity. Though some response is possible, habituation is likely to reduce impact level from vessels. Assessment of the potential effects of increased vessel traffic (collisions and behavioural responses) undertaken on marine mammals is combined, rather than being carried out on a species by species basis as, for the purpose of this assessment, as it is considered that individuals of all of the species under discussion are at an equal risk of collision or exhibiting a behavioural response.

4.3.1.89 Marine mammals will show some degree of habituation to additional vessel movements. The number and type of vessels to be utilised in the OSP operation and maintenance is yet to be decided but is unlikely to represent a significant increase in existing vessel activity within the Firth (see Chapter 5.2: Shipping and Navigation of this ES). Though there will be some response to additional vessel movement associated with operation and maitanence, this is likely to be of short duration and restricted due to vessels using a pre-defined vessel corridor, therefore effect magnitude is predicted to be **low**.

4.3.1.90 It is likely that the maintenance of the two OSPs would constitute only a small part of the increase in vessel traffic. Based on JNCC's advice (also endorsed by the SNCBs) relating to potential for corkscrew injury (details of which can be found in Table 4.3-12 above), the effects on marine mammals are predicted to be of low magnitude (for the OSPs) and of **minor significance**, which is in line with findings from the MORL ES (2012).

Electromagnetic Fields

4.3.1.91 The primary effect relating to the export cable during the operational phase of the developments will be from Electromagnetic Fields (EMF) produced by transmission cables.

4.3.1.92 Transmission of electricity through subsea cables (e.g. from offshore wind farms to shore) leads to the generation of both electric (E-fields) and magnetic (B-fields) fields (Gill et al. 2009). The type and strength of the fields produced will depend on the voltage and current which is passing along the cable. Both electric and magnetic fields increase in strength with increasing current or voltage (Portier & Wolfe 1998). The potential effects of these fields on the surrounding environment depends on the type of cable used and its insulation, orientation and configuration.

4.3.1.93 Magnetic fields can induce secondary electric fields (iE-fields) in nearby conductors; the strength of induced (secondary) fields will depend on the distance of the conductor from the cable, the strength of the magnetic field and the speed, direction of flow and chemical composition of the surrounding water. Such iE fields are also dependent on the current within the cable, the rate of change of the AC current, and the orientation and bundling of the cables.

4.3.1.94 Cetaceans are capable of sensing geomagnetism and 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 & Wiltschko 2005, Luschi et al. 2007, Gould 2008, Lohmann et al. 2008).

4.3.1.95 A number of live stranding events have been linked with local geomagnetic anomalies or disruptions to normal patterns of daily geomagnetic fluctuations, with fields of less than 50nT having the potential to influence the stranding of some species (Kirschvink et al., 1986; Klinowska, 1990). EMF created by transmission cables at offshore wind farms can be 30-50μT (Hoffman et al. 2000). It is therefore possible that they could affect animals (such as cetaceans and bony fish) which use geomagnetic cues as an aid to navigation (Wiltschko & Wiltschko, 2005; Luschi et al., 2007; Gould, 2008; Lohmann et al., 2008).

4.3.1.96 There is, however, no evidence to date suggesting a change (positive or negative) in marine mammal activity / behaviour relating to magnetic fields from cables associated with offshore wind farms. Harbour porpoises continue to migrate in and out of the Baltic Sea over subsea HVDC cables (Basslink, 2001). It is thought that magnetic fields from cables are likely to be detected by cetaceans as a new, localised addition to the heterogeneous pattern of geomagnetic anomalies in the surrounding area. Gill and Bartlett (2010) concluded that the iE-field will also dissipate to one or two microvolts per meter within a distance of approximately 10m from the 33kV cable.

4.3.1.97 At present there is no indication that seals are sensitive to EMF (Faber, Maunsell and Metoc 2007) and they are not discussed further in this assessment.

4.3.1.98 Where possible, export cables will be buried to a target depth of 1 m. In areas where this is not possible, cables will be protected by a layer of rock or concrete Although unproven, it is considered unlikely that magnetic fields will affect cetaceans and the magnitude is therefore considered to be low, which is in line with findings from the MORL ES (2012).

4.3.1.99 The change from using DC to AC cabling will have no significance to the above assessment. In conclusion, the effects of electromagnetic fields on marine mammals are uncertain, but are considered to be unlikely and of low magnitude and are therefore considered not significant.

Toxic Contamination

4.3.1.100 Leaching of compounds (in particular heavy metals) from sacrificial anodes or antifouling paints on OSPs and associated vessels has the potential to contaminate marine mammals and their food supply.

4.3.1.101 Given that such systems are likely to be present on most (if not all) shipping vessels already present within the Moray Firth and taking into account the tidal regime around the consented sites (see Chapter 3.1 Hydrodynamics, Sedimentary and Coastal Processes of this ES), it is not considered there will be any detectable increase in metal concentrations within the Moray Firth should these systems be applied.

4.3.1.102 As a result of the above, effects on marine mammals are considered to be unlikely and **not significant**.

Decommissioning

4.3.1.103 The decommissioning programme has not yet been finalised, therefore a detailed assessment is not possible at this stage. The decommissioning of the OSPs and export cable may involve the use of cutting tools and / or other methods if appropriate.

4.3.1.104 Current cutting techniques include mechanical and abrasive cutting. No data is available at this time on noise levels produced by cutting mechanisms underwater but it would be expected to be lower or equivalent to the noise levels created during the installation of the OSP foundations and the export cables. There may also be disturbance from vessels associated with the decommissioning but, as with the construction phase, the associated effects are considered to be of low magnitude and therefore considered **not significant**.

Proposed Mitigation

4.3.1.105 The information below summarises mitigation measures proposed to be applied during the different stages of the modified OfTI. The suggested mitigation is consistent with that detailed in MORL ES (2012).

Construction

4.3.1.106 The primary effect on marine mammals during the construction phase of the modified OfTI is predicted to be from piling noise from the installation of the OSP foundations. MORL is working with The Crown Estate and other developers with regards to investigating and developing best practice for mitigation measures that may be implemented to reduce either the level of noise at the source or noise propagation. These investigations have shown that while such mitigation measures (such as bubble curtains and piling sleeves) have been relatively successful in low-tidal regimes such as German waters in depths of 8.5 m, they are either unviable in the deeper, tidal conditions of the Moray Firth (bubble curtains) or at the concept design or early prototype testing stage for deeper water (piling sleeves and other designs), and thus not commercially viable for large scale deployment at present.

4.3.1.107 Existing JNCC guidelines require the presence of a marine mammal observer prior to piling commencing and the instigation of a "soft start" procedure once piling starts. Typically this involves a 30 minute visual watch being conducted prior to all piling operations in parallel with a 30 minute acoustic survey. If a marine mammal is observed (visually or acoustically) within 500 m of the piling vessel during this period, piling is delayed until the animal has moved away from the area (outside of the 500 m buffer) or has not been sighted for 20 minutes.

4.3.1.108 Recent developments in passive acoustic monitoring technology promises to improve the potential to detect cetaceans in low light or poor weather conditions. Similarly, more effective acoustic deterrents are being developed to exclude seals from potential impact areas. It is anticipated that these developments may lead to more effective mitigation procedures within the lifetime of the modified OfTI. The use of alternative approaches will be investigated prior to construction commencing and their use decided upon after consultation with regulatory bodies.

4.3.1.109 Typical response distances from pile driving activity range from 10 m for lethal injury (240 dB) and 60 m for non-auditory physical injury (220 dB) for marine mammal species (see MORL ES (2012) Chapter 3.6 (Underwater Noise)). Given the small radii predicted to cause physical injury to marine mammals, mitigation will focus on ensuring that marine mammals are outside a 500 m buffer zone to reduce such impacts. Once piling begins, the power will be ramped up in stages thus giving the majority of marine mammals inside of this area the opportunity to move away from the area prior to the piling hammer reaching full power (and maximum noise generation).

4.3.1.110 The soft start procedure will involve the ramping up of power over a 20 minute period until the hammer reaches optimal force. This procedure has already been factored into the noise propagation models discussed in MORL ES (2012) (Chapter 3.6 (Underwater Noise)) and utilised within the assessment presented here. Therefore residual effects after the consideration of these mitigation measures have already been included in the impact assessment.

4.3.1.111 The risk to marine mammals of collision with construction vessels is predicted to be negligible and of low significance. Although mitigation is not considered a necessity, the designation of a navigational route for construction vessel traffic will aid marine mammals to predict vessel movement and reduce potential impacts.

4.3.1.112 For the purpose of this assessment it has been assumed that vessels with ducted propellers will be used. JNCC guidance (2012) recommends that no additional mitigation measures are required for activities greater than 30 nm from seal SACs. As the proposed works are at a greater distance than this from the Dornoch Firth and Morrich More SAC for harbour seals, and at least 20nm from grey seal haul-out sites that have been identified around the Fraserburgh area and south towards Cruden Bay, no additional mitigation measures are proposed.

4.3.1.113 As described in Table 4.3-4, the modelling on which the construction and decommissioning assessment is based has been undertaken including the mitigation measures described above.

Operation

4.3.1.114 The risk to marine mammals of collision with operational and maintenance vessels is predicted to be negligible and of low significance. Although mitigation is not considered a necessity, the designation of a navigational route for operation and maintenance vessel traffic will aid marine mammals to predict vessel movement and reduce potential effects.

Decommissioning

4.3.1.115 The decommissioning programme has not yet been finalised and will be dependent on the choice of foundation structure, therefore a detailed mitigation proposal is not possible at this stage. The most likely scenario would involve the use of cutting equipment and is predicted to be of low to medium magnitude of effect to marine mammals. Once the decommission programme has been decided upon, a review of mitigation requirements will be undertaken and instigated as required based on the best available procedures at the time.

Residual Effects

4.3.1.116 Much of the mitigation and management measures described above are standard procedure for such developments. For example, the use of a soft start procedure has already been incorporated into the noise modelling. The marine mammal observer / PAM survey (and subsequent soft start) is designed to ensure that no marine mammals are within a certain radius of the piling event thus reducing the potential for physical injury. This has already been incorporated into the impact assessments and so residual effects are the same.

4.3.1.117 The use of designated navigational routes, although primarily a management tool, will also help reduce risks to marine mammals from collision and is therefore an indirect form of mitigation. This has already been incorporated into the impact assessments present here and therefore included residual effects are the same. The assessment of effects of piling incorporates a series of conservative assumptions about the potential impacts of this noise on marine mammals. If all the assumptions detailed in Table 7.3-11 of Chapter 7.3 Marine Mammals (MORL ES (2012)), are confirmed, the assessments presented above are assessed as likely significant effects.

4.3.3 Cumulative Impact Assessment

4.3.1.118 This section presents the results of assessment of the potential significant cumulative effects upon marine mammals arising from the OfTI in conjunction with other existing or reasonably foreseeable marine and coastal developments and activities. MORL's approach to the assessment of cumulative impacts is described in MORL ES (2012) Chapter 1.3 (Environmental Impact Assessment). It should be noted Marine Licences together with Section 36 consents have now been granted for the three MORL windfarms and the BOWL wind farm. The CIA presented below updates the effects of the assessments presented in support of these licence applications but does not change the conclusion of the original assessments.

Summary of Effects

4.3.1.119 The cumulative effects on marine mammals that have been assessed are:

- Increased anthropogenic noise from piling activities;
- Changes in prey availability;
- Increased vessels use – collision risk; and
- Increased vessel use – ducted propellers.

4.3.1.120 The following activities / effects have not been considered within this cumulative assessment as their potential effects were considered not significant in assessment for the modified OfTI:

- Risk of stranding from EMF generated by transmission cables;
- Long term avoidance resulting from the presence of offshore structures; and
- Prey contamination due to toxic (heavy metal) contamination from use of sacrificial anodes and antifouling paints.

4.3.1.121 The receptors identified for consideration in this cumulative impact assessment are as detailed above under section 4.3.1 Baseline Information.

Summary of Residual Effects and Mitigation

4.3.1.122 Temporary, significant effects on marine mammal receptors from piling noise are predicted during the construction phases of the MORL and BOWL wind farm projects with associated OfTI, but no cumulative long term population level effects are predicted. No other significant cumulative effects are predicted.

4.3.1.123 No additional mitigation measures to those outlined in section 4.3.2 are proposed.

4.3.1.124 A summary of the potential cumulative effects is provided in Table 4.3-13.

Table 4.3-13 Cumulative Impact Summary

Effect/Receptor	Residual Significance Level for Modified TI	Whole Project Assessment: Modified TI + Stevenson, Telford and MacColl	Mitigation Method
Construction & Decomissioning			
Harbour Seal (increased anthropogenic noise from piling activities, changes in prey , increased vessel use – collision risk and ducted propellers)	No significant long term effect	No significant long term effects	None additional to those detailed in MORL ES (2012) Chapter 7.3 (Marine Mammals) and section 4.3.2.
Total Cumulative Impact Assessment ***(Whole project plus those developments listed in Section 4.3.3.11)***	Major significance over medium term for individuals during construction phase with minor significance in the long term at the population level for all construction scenarios modelled.		
Grey Seal (increased anthropogenic noise from piling activities, changes in prey , increased vessel use – collision risk and ducted propellers)	No significant long term effect	No significant long term effects	None additional to those detailed in MORL (2012) Chapter 7.3 (Marine Mammals) and section 4.3.2.

Effect/Receptor	Residual Significance Level for Modified TI	Whole Project Assessment: Modified TI + Stevenson, Telford and MacColl	Mitigation Method
Total Cumulative Impact Assessment ***(Whole project plus those developments listed in Section 4.3.3.11)***	Major significance over medium term for individuals during construction phase with minor significance in the long term at the population level for all construction scenarios modelled.		
Harbour Porpoise (increased anthropogenic noise from piling activities, changes in prey , increased vessel use – collision risk and ducted propellers)	No significant long term effect	No significant long term effects	None additional to those detailed in MORL (2012) Chapter 7.3 (Marine Mammals) and section 4.3.2.
Total Cumulative Impact Assessment ***(Whole project plus those developments listed in Section 4.3.3.11)***	Major significance over medium term for individuals during construction phase with minor significance in the long term at the population level for all construction scenarios modelled.		
Bottlenose Dolphin (increased anthropogenic noise from piling activities, changes in prey , increased vessel use – collision risk and ducted propellers)	No significant long term effect	No significant long term effects	None additional to those detailed in MORL (2012) Chapter 7.3 (Marine Mammals) and section 4.3.2.
Total Cumulative Impact Assessment ***(Whole project plus those developments listed in Section 4.3.3.11)***	Medium significance over medium term for individuals during construction phase with minor significance in the long term at the population level for all construction scenarios modelled.		
Minke Whale (increased anthropogenic noise from piling activities, changes in prey , increased vessel use – collision risk and ducted propellers)	No significant long term effect	No significant long term effects	None additional to those detailed in MORL (2012) Chapter 7.3 (Marine Mammals) and section 4.3.2.
Total Cumulative Impact Assessment ***(Whole project plus those developments listed in Section 4.3.3.11)***	Major significance over medium term for individuals during construction phase with minor significance in the long term at the population level for all construction scenarios modelled.		
Operation			
Harbour Seal (reduction in prey availability, increased vessel usage – collision risk and ducted propellers)	No significant long term effect	Minor significance	None additional to those detailed in MORL (2012) Chaptes 7.3 (Marine Mammals) and section 4.3.2.
Total Cumulative Impact Assessment ***(Whole project plus those developments listed in Section 4.3.3.11)***	Low magnitude, long term duration and minor significance		
Grey Seal (reduction in prey availability, ducted propellers)	No significant long term effect	Minor significance	None additional to those detailed in MORL (2012) Chapter 7.3 (Marine Mammals) and section 4.3.2.

Effect/Receptor	Residual Significance Level for Modified TI	Whole Project Assessment: Modified TI + Stevenson, Telford and MacColl	Mitigation Method
Total Cumulative Impact Assessment ***(Whole project plus those developments listed in Section 4.3.3.11)***	Low magnitude, long term duration and minor significance		
Harbour Porpoise (reduction in prey availability, ducted propellers)	No significant long term effect	Minor significance	None additional to those detailed in MORL (2012) Chapter 7.3 (Marine Mammals) and section 4.3.2.
Total Cumulative Impact Assessment ***(Whole project plus those developments listed in Section 4.3.3.11)***	Low magnitude, long term duration and minor significance		
Bottlenose Dolphin (reduction in prey availability, ducted propellers)	No significant long term effect	Minor significance	None additional to those detailed in MORL (2012) Chapter 7.3 (Marine Mammals) and section 4.3.2.
Total Cumulative Impact Assessment ***(Whole project plus those developments listed in Section 4.3.3.11)***	Low magnitude, long term duration and minor significance		
Minke Whale (reduction in prey availability, ducted propellers)	No significant long term effect	Minor significance	None additional to those detailed in MORL (2012) Chapter 7.3 (Marine Mammals) and section 4.3.2.
Total Cumulative Impact Assessment ***(Whole project plus those developments listed in Section 4.3.3.11)***	Low magnitude, long term duration and minor significance		

Assessment of Cumulative Effects

4.3.1.125 The geographical scope of the cumulative assessment is principally focused on the Moray Firth area. It is, however, recognised that some mobile species may spend varying periods of time outside the Moray Firth and, as a result, there is potential for these to be affected by other activities / developments further afield.

Projects Assessed

Whole Project Assessment

4.3.1.126 A whole project assessment has been done for the likely significant cumulative effects of the modified TI in conjunction with the three consented wind farms (Telford, Stevenson and MacColl).

4.3.1.127 MORL has been consented with a reduced size of 186 turbines and the MORL OfTI has been modified from that initially assessed reducing the number of OSP's from eight to two.

Other Developments

4.3.1.128 The following developments were considered in the total cumulative impact assessment for the whole Project:

- MORL Western Development Area (WDA);
- BOWL wind farm and associated OfTI;
- Forth & Tay Offshore windfarms;
- Meygen Tidal Stream Project;
- Ports & harbours within the Moray Firth (Nigg, Invergordon, Ardersier);
- Oil and Gas activity;
- MOD activities;
- Aberdeen harbour; and
- European offshore wind deployment centre.

Western Development Area (WDA)

4.3.1.129 There are no significant geographical variations in the density of key marine mammal receptors (harbour seal, grey seal, harbour porpoise, bottlenose dolphin and minke whale) between the area of the three consented wind farms and the WDA (Baseline Information section 4.3.1).

4.3.1.130 The connection between the WDA and the three consented wind farms necessitates a slightly different approach to assessment, as the effects arising from the "worst case" for the modified Project cannot simply be added to the "worst case" scenario for the WDA. The potential capacity of the WDA (500 MW) when added to the consented capacity of the three MORL consented wind farms (1,116 MW) exceeds the overall target capacity of the MORL Zone (1,500 MW). It is not proposed that the target capacity for the MORL Zone will be exceeded. 500MW represents the maximum development on the WDA, but in the event that MORL successfully constructs in excess of 1,000 MW in the three consented wind farm sites then the development in the WDA will be restricted accordingly to ensure the MORL Zone capacity is not exceeded.

4.3.1.131 This restriction of the total capacity of the MORL Zone means that the effects from development in the three consented wind farms and WDA combined will be restricted also. In the MORL ES, effects were assessed on the basis of a potential capacity of 1,500 MW (3 x 500 MW) from the three MORL consented wind farms alone. So the predicted effects of a 1500MW offshore wind farm within the MORL Zone have been assessed and reported in the MORL ES. Where it is considered relevant and can be justified on the basis that conditions across the Zone are consistent, the conclusions from that assessment have been assumed in this ES to be representative of the effects of the three MORL consented wind farms and the WDA combined.

BOWL wind farm and Associated OfTI

4.3.1.132 A detailed cumulative assessment was undertaken with the BOWL site and OfTI. BOWL has been consented with a reduced size, of 125 turbines as per consents conditions for but with the potential for up to 140 turbines (see summary of worst case scerario Rochdale Envelope parameters assessed for BOWL in Table 4.3-16 below).

Firth of Forth and Tay Offshore Wind Farm Projects

4.3.1.133 The proposed Firth of Forth and Tay offshore wind projects (Neart na Gaoithe, SeaGreen (Alpha and Bravo) and Inch Cape offshore wind farms) have the potential for cumulative impact with the construction of the OfTI through cumulative impacts from piling (see Table 4.3-14 below).

Table 4.3-14 Details of Firth of Forth and Tay offshore wind farm projects included in the cumulative impact assessment

Renewable project	Details
Neart na Gaoithe offshore wind farm	Proposed scheme of up to 450 MW at Neart na Gaoithe, within the Firth of Forth, for which a Marine Licence Application was submitted within Quarter two 2012. Onshore Planning consent was received in June 2013 and the offshore windfarm is expected to reach financial close in 2014. Offshore consent is expected in 2014 with construction starting in 2015.
Firth of Forth offshore wind farm (Seagreen offshore wind farm)	Up to three phases of development within the Round 3 Zone outside the 12 nm boundary within the Firth of Forth and Tay. The offshore application for Phase 1 totaling 1,050 MW (Project Alpha and Bravo) was submitted in September 2012 but an addendum was submitted in October 2013. Consent is expected during 2014 and construction has been described in the ES to commence in the 4th quarter of 2015. Onshore application was submitted in June 2013 and was granted in November 2013.
Inch Cape offshore wind farm	Proposed wind farm with grid connection agreement for 1,050 MW at Inch Cape which is scheduled to begin construction in 2016. Consent application was submitted in July 2013, and consent is expected during 2014.

4.3.1.134 At the time of the MORL ES assessment (MORL, 2012), insufficent information on the Firth of Forth and Tay Projects was available to enable a meaningful assessment. However, all three projects now have active Marine Licence applications, and sufficent information is avaiable to update the cummulative assessment.

4.3.1.135 Marine Scotland have confirmed that they, and SNH and JNCC, agree with the conclusion of the cumulative population level impact assessment undertaken for bottlenose dolphin by Inch Cape Offshore Ltd, in support of the Inch Cape Project (Inch Cape ES, 2013). This assessment considered the cumulative impact on the east coast population of the construction timelines of BOWL, MORL, Inch Cape, Neart na Gaoithe and the Firth of Forth Alpha and Bravo Projects. The assessment concluded that the impact was minor in the long term (Appendix 14B, Inch Cape ES, 2013). No further assessment has therefore been undertaken for bottlenose dolphin in relation to Firth of Forth and Tay projects. A cumulative assessment on harbour porpoise, harbour and grey seals and minke whale is presented below.

Meygen Tidal Stream Project

4.3.1.136 The MeyGen tidal stream project covers an area of 3.5 km^2 in the channel between the island of Stroma and the north-eastern tip of the Scottish mainland. The Agreement for Lease is for 398 MW of installed capacity and will be consented in two separate phases. Phase 1 will involve the installation of up to 86 tidal turbines, with a maximum capacity of 86 MW.

4.3.1.137 The appropriate assessment (Scottish Government 2014c) carried out by Marine Scotland concluded that there will be no long term significant effects on the Moray Firth SAC and Dornoch Firth and Morrich Moore SAC. In addition, the impact assessment concluded that less than 10% of the harbour seal population will encounter the turbines annually, and no regional effects to grey seal populations are excpected (Meygen ES 2012).

Ports and Harbours within the Moray Firth

Ardersier Port

4.3.1.138 Port Ardersier has been given consent for onshore works by the Highland council and is still awaiting a decision from the Scottish government and regulators Marine Scotland and Transport Scotland for the offshore elements. Piling is considered to have potential cumulative impacts with the MORL OfTI works. However, piling is expected to take approximately two to three months. Therefore, due to the short duration of the piling from the ports construction works the impact is considered minor in the long term.

Nigg Port

4.3.1.139 The consented development will comprise of an extension to the south quayside harbour and berthing facilities at the Nigg Yard. Piling is considered to have the potential for cumulative impacts with the modified OfTI. Piling works are to be completed in one phase between October 2013 to April 2014 as stated in their ES (Nigg, 2013). Therefore, as construction is completed Nigg Energy Park has not been assessed.

Invergordon Service Base

4.3.1.140 The environmental statement and application was submitted to Marine Scotland for the new berth. Consultation period for the application ended on the 30th May 2014. Construction will be carried out in three stages and is projected to start in the spring / summer of 2014. The three stages of construction include: berth construction (including piling), containment bund and reclamation of laydown area.

4.3.1.141 The proposed development has the potential for cumulative impact with the construction of the modified OfTI through cumulative impacts from piling. Piling will be used to support the berth and moorings, which may utilise percussion piling initially to pile through the infill material after which it is suggested that vibro-piling will be used. Pile diameter has been proposed to be 914 mm in diameter with 90 vertical piles 65 m long and 16 raked piles of 68.5 m long. Piling has been estimated to take approximately 18 weeks.

4.3.1.142 The appropriate assessment (Scottish Government 2014b) conducted has concluded that there will be no significant long term effects on the the Moray Firth SAC and Donrnoch Firth and Morrich More SAC. In addition, due to the short term duration of construction and the expected construction finish date by 2015 piling is unlikely to occur during the construction works of the modified OfTI it is therefore considered that the impact will be minor in the long term.

Oil and Gas Activity

4.3.1.143 License blocks acquired by Suncor are within the modified boundaries of the modified OfTI. Suncor are known to be planning geophysical surveys in block 12/27 (see Figure 5.7-2) in 2014 and an installation of a well in 2015. Existing oil platforms in the Moray Firth include the Beatrice and Jacky oil platforms. Beatrice and Jacky oil platforms are located to the north-west of the development area. Access to these platforms does not pass through the eastern development area.

Other developments

- MoD activities - The Royal Air Force (RAF) use part of the outer Moray Firth as practice areas. Activities include flying, gunnery and subsurface exercises.
- Aberdeen harbour - Port upgrades (~£24 million) for the infrastructure and port facilities in 2012. Nigg Bay expansion project. Wildlife surveys to commence in second quarter of 2014.
- European offshore wind deployment centre - Proposed demonstrator site comprising 11 turbines. Consent was granted in March 2013. Offshore construction to be commenced.

Methodology

4.3.1.144 The detailed assessment process for cumulative impacts of projects within the Moray Firth has used noise propagation and impact analysis to quantify the potential risks of physical injury and displacement due to piling noise associated with the installation of the OfTI OSPs, MORL and BOWL offshore wind farms, and has used population modelling to assess the potential long term effects on harbour seal and bottlenose dolphin.

4.3.1.145 The assessment methodology has followed that outlined in the Moray Firth Offshore Wind Developers Group Discussion Document (ERM, 2011; see Technical Appendix 1.3 D of MORL ES, 2012).

4.3.1.146 A summary of the methodologies used within this assessment can be found in MORL ES (2012) Chapter 7.3 (Marine Mammals). A full review of likely significant effects on marine mammals and the methodologies used can be found in the following technical appendices (MORL ES 2012):

- Technical Appendix 7.3 A (Marine Mammals: Environmental Impact Assessment);
- Technical Appendix 7.3 B (Framework for assessing the impacts of pile-driving noise from offshore wind farm construction on Moray Firth harbour seal populations);
- Technical Appendix 7.3 C (SAFESIMM impact assessment for seals and cetaceans);
- Technical Appendix 7.3 D (A comparison of behavioural responses by harbour porpoise and bottlenose dolphins to noise: Implication for wind farm noise assessments);
- Technical Appendix 7.3 E (Identification of appropriate noise exposure criteria for assessing auditory injury for Pinnipeds using offshore wind farm sites);
- Technical Appendix 7.3 F (Noise propagation and SAFESIMM model outputs for marine mammal risk assessment);
- Technical Appendix 7.3 G (Habitat Regulations Appraisal: Marine Mammals - Two SAC's listing marine mammals as qualifying features can be found within the Moray Firth. For the purpose of Appropriate Assessment, an appraisal under the Habitats Regulation is presented within is appendix); and
- Technical Appendix 7.3 H (EPS Assessment: Supplementary Information - All cetaceans present within the Moray Firth are European Protected Species (EPS). MORL recognises that an EPS license is likely to be required for construction related disturbance to cetaceans. A preliminary assessment is presented, which will be revised once construction parameters have been finalised).

4.3.1.147 Additional supporting information on underwater noise modelling activities can be found in Chapter 3.6: Underwater Noise and Technical Appendix 3.6 A (Underwater Noise Technical Report) (MORL ES 2012).

4.3.1.148 Data was shared between MORL and BOWL to allow for a detailed cumulative assessment (including construction scenarios and predicted blow energy profiles to drive pin piles used in noise modelling).

Worst Case Scenario for Projects within the Moray Firth

4.3.1.149 A summary of the worst case parameters of wind farm design for the three MORL wind farms and the BOWL project, in terms of marine mammals and as modelled for the original impact assessment, is provided in Table 4.3-15 and 4.3-16 respectively. However as stated above in section 4.3.3.10 and 4.3.3.15, this provides a highly conservative worst case as overall number of turbines have reduced for both projects in addition to a reduction in MORL's OSPs associated with the modified OfTI. Results presented are therefore a conservative worst case.

Table 4.3-15 Summary of MORL worst case parameters

Worst Case Parameters	**Scenario Assessed**		
Construction Noise			
Installation 339 turbines (186 turbines consented)	Four pin piles (2.5 m diameter) per foundation		
Max, number of simultaneous piling events	Two		
Predicted blow energy profile as being required to drive a 2.5 m diameter pin into the soils of the MORL site	**Impact Energy (kJ)**	**No of blows**	**Time**
	170	260	15 mins
	450	2,400	45 mins
	890	1,000	15 mins
	1,080	7,000	2 hrs
	170	260	15 mins
Increased Suspended Sediment Concentration and Sediment re-Deposition			
Installation 339 turbines (186 turbines consented)	Drilling to facilitate pin pile installation and seabed preparation for installation of gravity bases. Inter array cable and export cable burial by energetic means.		
Loss of Habitat and Introduction of New Habitat			
Installation 339 turbines (186 turbines consented)	Use of tubular jackets and gravity bases		

Table 4.3-16 Summary of BOWL Worst Case Parameters

Worst case Parameters	Scenario Assessed		
Construction Noise			
Installation of 277 turbines (125 turbines consented as per conditions but with the potential for up to 140 turbines)	Four pin piles (2.4 m diameter) per foundation		
Max, number of simultaneous piling events	Two		
Predicted blow energy profile provided by BOWL as being required to drive a 2.4 m diameter pin into the soils of the BOWL site	**Impact Energy (kJ)**	**No of blows**	**Time**
	280	1,200	20 mins
	920	3,700	1 hr
	1,380	3,700	1 hr
	1,840	3,700	1 hr
	2,300	3,700	1 hr
Increased Suspended Sediment Concentration and Sediment re-Deposition			
Installation of 277 turbines (125 turbines consented as per conditions but with the potential for up to 140 turbines)	Drilling to facilitate pin pile installation and seabed preparation for installation of gravity bases. Inter array cable and export cable burial by energetic means.		
Loss of Habitat and Introduction of New Habitat			
Installation of 277 turbines (125 turbines consented as per conditions but with the potential for up to 140 turbines)	Use of tubular jackets and gravity bases		

Cumulative Assessment

Increased Anthropogenic Noise from Piling Activities

4.3.1.150 It is considered possible that increased levels of underwater noise from construction, operation and decommissioning activities may result in a combined impact on marine mammals with implications for levels of disturbance.

4.3.1.151 The use of the SPEAR model presented in MORL ES (2012) Chapters 7.3 (Marine Mammals) and in the 'Increased Anthropogenic Noise (Non-Piling Activities) section above has provided evidence that the greatest source of noise during the construction period will be from impact piling. The INSPIRE noise propagation modelling discussed in Chapter 7.3, and explained in detail in Technical Appendix 7.3 A (MORL, 2012), was extended to include the additional wind farm foundation piling activities of the now consented BOWL Project. For the purposes of this assessment, the installation of the three OSPs within the BOWL Rochdale Envelope are considered to occur within the construction period and footprint of the offshore generation station, and thus are included within the effects assessed with MORL ES (2012) Technical Appendix 7.3 A (Marine Mammals Environmental Impact Assessment).

4.3.1.152 As with the three consented wind farms of Telford, Stevenson and MacColl, jackets with pin piles are considered to be the worst case foundation technology within the BOWL Rochdale Envelope with regards impacts upon marine mammals (Table 4.3-16). The details of the noise propagation modelling undertaken are provided within Chapter 3.6 and Technical Appendix 3.6 A (Underwater Noise) (MORL, 2012). The outputs were used to predict the number of individuals of the key marine mammal species within the Moray Firth which fell within the criteria for PTS onset or could be displaced due to noise related disturbance (see Technical Appendices 7.3 A: Marine Mammals Environmental Impact Assessment and 7.3 B: Framework for assessing the impacts of pile-driving noise from offshore wind farm construction on Moray Firth Harbour Seal populations of the MORL ES, 2012 for full methodology).

4.3.1.153 Details of the inherent conservatism that is purposefully adopted in the assessment methodology can be found in Table 7.3-11 in Chapter 7.3 (MORL ES, 2012). A number of cumulative scenarios were assessed in the MORL ES (ES). The numerical outputs from the modelling process of Scenario E are presented in Table 4.3-17 below. This senario assumes a three year build out programme for BOWL and a five year build out programme for the three MORL wind farms with a year of overlap in which both sites are under construction. The years in the Table were those used in the MORL ES, 2012. The construction years are used in this cumulative assessment as indicative duration of construction activities only. The figures in brackets within the table represent the number of individuals expressed as a percentage of the Moray Firth populations or SCANS II Block J for minke whales[1]. The seal PTS values were modelled using 186 dB SELs and cetaceans using 198 dB SELs. The number of individual harbour seals and bottlenose dolphins estimated to experience displacement and PTS were then used in population modelling, the results of which are presented within Plates 4.3-2 and 4.3-3 below (see Technical Appendices 7.3 A and 7.3 B of the MORL ES (2012) for full details on both methodologies).

Table 4.3-17 Predicted Number of Individuals (and Percentage of Population Size) Affected by Piling Noise Each Year of Construction for Each Project

Scenario E - BOWL, overlapping for one year with MORL, followed by MORL[2]					
	Harbour Seal	**Grey Seal**	**Harbour Porpoise**	**Bottlenose Dolphin**	**Minke Whale**
PTS					
2014 to 2015 (BOWL)	168.6 (14.6 %)	236.5 (7.5 %)	8.2 (0.1 %)	0.07 (< 0.1 %)	35.4 (2.4 %)
2016 to 2016 (BOWL + MORL)	210.1 (18.1 %)	300 (9.5 %)	11.5 (0.2 %)	0.1 (0.1 %)	24.2 (1.7 %)
2017 to 2020 (MORL)	120.9 (10.4 %)	170 (5.4 %)	6.4 (0.1 %)	0.06 (<0.1 %)	12.3 (0.8 %)
Behavioural Displacement Each Year for the Total Spread of the Construction Vessels (Best Fit)					

[1] The details of these population estimates for each species can be found in Chapter 4.4 (Marine Mammals) of the MORL ES, 2012. The population of minke whales potentially subject to the effects of the Project construction phase was taken to be 1,462, based upon SCANS II model estimates for block J (which includes the Moray Firth)

[2] The years in this table were those used in the MORL ES, 2012, based on the construction programme information available at the time. Since then the indicative construction programmes for MORL and BOWL have been revised (please see current indicative construction programme for MORL in Chapter 2.2 of this ES). The construction years are used in this cumulative assessment as indicative duration of construction activities only.

Scenario E - BOWL, overlapping for one year with MORL, followed by MORL[2]					
2014 to 2015 (BOWL)	582 (49.2 %)	966 (26.9 %)	3,191 (52.2 %)	19 (9.6 %)	177 (12.1 %)
2016 to 2016 (BOWL + MORL)	609 (51.4 %)	995 (27.7 %)	3,312 (54.1 %)	21 (10.7 %)	179 (12.2 %)
2017 to 2020 (MORL)	522 (44.1 %)	739 (20.5 %)	2,933 (47.9 %)	17 (8.9 %)	168 (11.5 %)

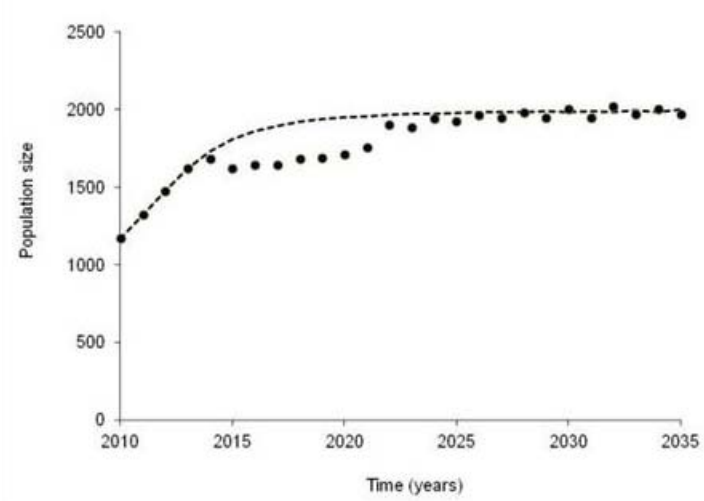

Plate 4.3-2 **Scenario E (BOWL, overlapping for one year with MORL, followed by MORL) - Population modelling for the harbour seal population in the Moray Firth. Data based on 186 dB SAFESIMM model outputs. The dashed line indicates the baseline trend, while the circles indicate the impact scenario on the population.**

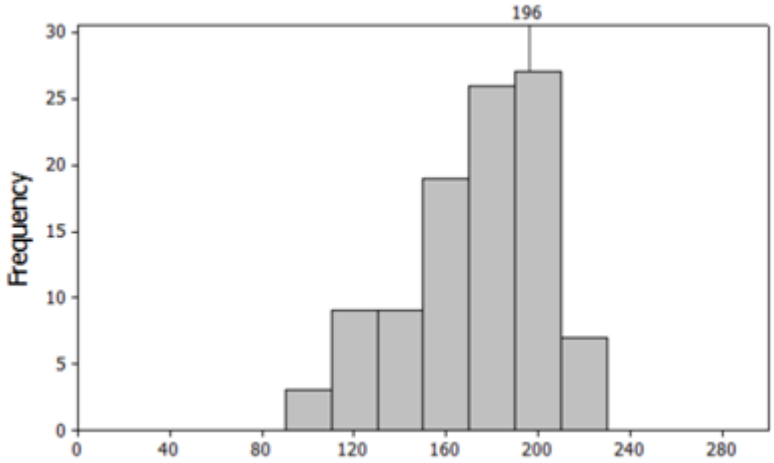

Plate 4.3-3 **Scenario E - Population Modelling for the Bottlenose Dolphin Population in the Moray Firth. Data Based on 198 dB SAFESIMM Model Outputs. Figures Represent the Frequency Distribution of Predicted Population Size after 25 Years**

4.3.1.154 The potential significance on receptor species is detailed below in Table 4.3-18.

Table 4.3-18 Summary of potential effects of piling noise during construction on relevant marine mammal receptors using precautionary modelling criteria

	Scenario E (BOWL, overlapping for one year with MORL, followed by MORL)
Harbour Seal	
Predicted Effect	Major significance over medium term for individuals during construction phase with minor significance long term effects on the population.
Grey seal	
Predicted Effect	Major significance over medium term for individuals during construction phase with minor significance long term effects on the population.
Harbour Porpoise	
Predicted Effect	Major significance over medium term for individuals during construction phase with minor significance long term effects on the population.
Bottlenose Dolphin	
Predicted Effect	Medium significance over medium term for individuals during construction phase, with minor significance for long term effects on the population level.
Minke Whale	
Predicted Effect	Major significance over medium term for individuals during construction phase with minor significance long term effects on the population.

4.3.1.155 It can be seen from Table 4.3-17 that the increase in simultaneous piling activity between the three consented MORL wind farms and the BOWL wind farm leads to an increase in modelled noise related displacement and the potential for individual animals to experience PTS.

4.3.1.156 The levels of displacement below were modelled on the intial pre-consented wind farm number of turbines, OSPs and cable route. However, the now consented wind farms have a reduced maximum number of turbines (now 186 turbines and two OSPs for MORL and 125 turbines but with the potential for up to 140 turbines for BOWL). This will reduce potential impacts from piling from those modelled and consented.

Harbour Seals

4.3.1.157 As discussed in Baseline Information section 4.3.1, results from harbour seals tagged at Moray Firth haul-out sites demonstrate that they remain in the area when foraging.

4.3.1.158 Population modelling undertaken for the original number of piles and OSPs demonstrated no significant long term population level impact. Therefore a reduced number of piles associated with both the OSPs and the wind farms will have lower level of potential impact, therefore no significant long term population level impact is predicted.

4.3.1.159 Displaced seals are likely to use alternative foraging areas within the Moray Firth where there are lower levels of disturbance. As seen during periods of natural changes in prey availability, these changes may also lead to temporary changes in the use of different Moray Firth haul-out sites (Thompson *et al.,* 1996). Harbour seals are not expected to be displaced to areas outside of the Moray Firth, and so would not suffer cumulative impact with projects occurring within the Firths of Forth and Tay or Pentland Firth and Orkney waters.

Grey Seals

4.3.1.160 Grey seals will travel over much larger areas than harbour seals, with tracking studies showing that many of the grey seals tracked within the Moray Firth originated from haul-out sites further afield. A number of the seals tracked within the Moray Firth were tagged on the Isle of May, confirming connectivity between the Moray Firth and the Firths of Forth and Tay.

4.3.1.161 Construction activities for the wind farms of the Firths of Tay and Forth are predicted to coincide with those of the Moray Firth over the period of 2014 to 2020. Precautionary modelling conducted for the MORL ES (2012) predicts that between 20.5 to 27.7 % of grey seals currently using the Moray Firth may be displaced from the area during construction, depending on the phase of the construction scenario E. Tracking studies demonstrate that should foraging areas close to piling events become less preferable to grey seals, they are capable of travelling to alternative areas. The large foraging range of this species will ensure that feeding areas outside of the noise influence from construction of the Firth of Forth and Tay, and Pentland Firth and Orkney waters should the construction phases of these projects coincide, is likely. Grey seals are therefore not expected to suffer cumulative impact with projects occurring within the areas of Firth and Forth and Tay, or Pentland Firth and Orkney waters.

Harbour Porpoise

4.3.1.162 Using the most conservative assumptions, between 47.9 to 54.1 % of harbour porpoise within the Moray Firth may be displaced during the piling activities within the Moray Firth. Harbour porpoise exhibit widespread distributions and are not tied to specific feeding or breeding grounds within the Moray Firth or elsewhere in the North Sea or North Atlantic. A population structure workshop held in 2007 under the aegis of the Agreement on the Conservation of Small Cetaceans of the Baltic, North-East Atlantic, Irish and North Seas (ASCOBANS) and the Helsinki Commission (HELCOM) concluded that there was some population structure within the North Sea, but the evidence was insufficient to define boundaries between any (sub-) populations at the time (ASCOBANS, 2009). Consequently, for the purposes of conservation, harbour porpoise in the North Sea are considered to represent a single population.

4.3.1.163 Relatively large numbers of harbour porpoise may be displaced from the Moray Firth and, from analysis of the ESs of the submitted Firth of Forth and Tay Projects are likely to include at least some piling, it can be assumed that significant numbers may be displaced from the Forth and Tay due to piling associated with developments. Although the local effects from piling will be significant on this species in the areas surrounding specific construction activities, the generalised distribution of this species suggests that the cumulative effects across such a wide area will be relatively low and that alternative foraging areas in the North Sea for harbour porpoises are likely to be available.

Bottlenose Dolphins

4.3.1.164 The most precautionary models discussed within the MORL ES (2012) predict that between 8.9 to 10.7 % of the population could be disturbed within the Moray Firth as a result of piling noise. Predicted noise levels within those parts of the Moray Firth frequented by bottlenose dolphins are not expected to be sufficient to exclude animals from these areas. Nevertheless, the coastal nature of this population suggests that should piling lead to some individuals moving outside the Moray Firth, they could be further exposed to piling activities along the eastern coast, in particular in the Forth and Tay region. Piling activities at Aberdeen are predicted to be short in duration and completed prior to construction activities beginning at either the three MORL consented wind farm sites, BOWL, or in the Forth and Tay region. Population Viability Analysis (PVA) carried out for the Inch Cape Project to assess cumulative impacts on bottlenose dolphin predict that there will be no significant long term impact on bottlenose dolphin utilising the east coast of Scotland. Marine Scotland (and SNH and JNCC) have confirmed that they accept the Inch Cape cumulative impact assessment.

Minke Whale

4.3.1.165 Using the precautionary fit, between 11.5 to 12.2% of minke whales of the reference population could be displaced during the piling activities. As with harbour porpoise, minke whales exhibit generalised distributions throughout the North Sea or North Atlantic. It is unclear whether minke whales in UK waters move slightly offshore during the winter months or migrate further afield. If population differentiation between North Atlantic minke whales from different regions exists, it seems present only at low levels (Árnason & Spilliaert, 1991; Daníelsdóttir *et al.,* 1992; Bakke *et al.,* 1996; Martinez & Pastene, 1999; Andersen *et al.,* 2003; Anderwald *et al.,* 2011). Sightings within the Moray Firth are most common between April and September, as has been reported for other areas (see MORL ES (2012) Technical Appendix 4.4 A (Baseline Marine Mammals)).

4.3.1.166 The impact assessments for the Forth and Tay offshore wind projects (Neart na Gaoithe, Firth of Forth and Inch Cape) are available. Although the local effects from piling may be significant in the medium term on this species in the areas surrounding specific construction activities, the generalised distribution of this species suggests that the cumulative effects across such a wide area of coastline will be minimal and that alternative areas in the northeast Atlantic for minke whales to forage are likely to be extensive. If all the assumptions detailed in Table 7.3-11 (Chapter 7.3: Marine Mammals) of the MORL ES (2012) are confirmed, the assessments presented above are assessed as likely significant effects.

Changes in Prey Availability

4.3.1.167 The potential for impact from changes in prey availabilty are presented above and have not been re-iterated here.

4.3.1.168 Noise modelling was conducted to predict impact ranges from piling noise produced by the MORL and BOWL projects simultaneously on key fish species (see MORL ES (2012) Chapters 14.2 (Fish and Shellfish Ecology) and 3.6 (Underwater Noise)).

4.3.1.169 Impact ranges were found to be similar to those derived from the worst case scenarios for the three MORL wind farm sites alone suggesting limited cumulative effects with the BOWL development and other projects. Cumulative effects of noise are therefore considered to be of **low** magnitude.

4.3.1.170 The indirect cumulative effects from changes in prey availability on potential marine mammal prey species are therefore considered to be of low magnitude, for a medium duration, negative and therefore of **minor significance**.

Increased Vessel Movement - Collision Risk and Barrier to Movement

4.3.1.171 There are no significant changes in the assessment of the three consented wind farms plus the modified OfTI on its own when considered cumulatively with the WDA with regards increased collision risk from vessels. Projects out with the Moray Firth are considered to be sufficiently distant not to constitute a potential cumulative impact. There are no significant changes in the assessment of the three consented wind farms plus the modified OfTI on its own when considered cumulatively with the WDA and BOWL.

4.3.1.172 Therefore no additional cumulative impact due to OfTI construction, decommissioning or operation is predicted and is therefore considered to be of **minor significance**.

Increased Vessel Use – Ducted Propellers

4.3.1.173 Section 4.3.2.49 to 4.3.2.54 outlines the concerns regarding ducted propellers and guidance from the JNCC for potential corkscrew injuries. The modified OfTI is greater than 30 nm away from the Dornoch Firth SAC.

4.3.1.174 Vessels use pre-defined corridors for movement to and from port, thereby moving in a predictable manner and maximising predictability and detection by marine mammals.

4.3.1.175 Following JNCC guidance (Table 4.3-12) cumulative impacts with projects listed in section 4.3.3.11 associated with OfTI works are deemed to be of low risk (over 30 nm from a harbour seal SAC and over 4 nm from a grey seal SAC). The impact is therefore considered to be of low magnitude.

4.3.1.176 Considering the uncertainty over the mechanism of the potential injury, and the low magnitude considered in the context of cumulative vessel activities, the impact of ducted propellers is considered to be uncertain, of low magnitude, a direct negative impact, but non-reversible should it occur, and therefore of **minor significance**.

Habitats Regulations Appraisal

4.3.1.177 No changes to the conclusions of the HRA as presented in Chapter 10, section 10.3.9 (OfTI HRA assessment) of the MORL ES (2012) are predicted. The piling locations for the OSPs are within the Rochdale Envelope assessed within the original ES (MORL ES, 2012), and the only change that could result from the modification to the OfTI route is that of the proximity of cable landing point to seal haul-outs and bottlenose dolphin feeding/transit habitat. The cable landing point remains out with the 30 nm and 4 nm for harbour seals and grey seals respectively, as outlined in Table 4.3-12, and the assessment against potential disturbance to bottlenose dolphin remains as described in the MORL ES (2012). Therefore the MORL Appropriate Assessment which has stated this development will not adversely affect the integrity of any SAC (Scottish Government, 2014) should be referred to.

4.3.4 References

Aarts, G., MacKenzie, M., McConnell, B., Fedak, M., & Matthiopoulos, J. (2008). Estimating space-use and habitat preference from wildlife telemetry data. Ecography, 31: 140-160.

Andersen, L.W., Born, E.W., Dietz, R., Haug, T., Oien, N. & Bendixen, C. (2003). Genetic population structure of minke whales Balaenoptera acutorostrata from Greenland, the North East Atlantic and the North Sea probably reflects different ecological regions. Marine Ecology Progress Series, 247: 263-280.

Anderwald, P., Daníelsdóttir, A.K., Haug, T., Larsen, F., Lesage, V., Reid, R.J., Víkingsson, G.A. & Hoelsel, A.R. (2011). Possible cryptic stock structure for minke whales in the North Atlantic: implications for conservation and management. Biological Conservation, 144: 2479-2489.

Árnason, A. & Spilliaert, R. (1991). A study of variability in minke whales (Balaenoptera acutorostrata) in the North Atlantic using a human hypervariable region probe, alpha-globin 3'HVR. Report to the International Whaling Commission, 41: 439-443 (SC/42/NHMi23).

ASCOBANS, (2009). Report of ASCOBANS/HELCOM small cetacean population structure workshop held on 8-10 October 2007 at UN Campus, Hermann-Ehlers-Str. 10, 53113 Bonn, Germany. Available at: http://www.service-board.de/ascobans_neu/files/MOP6_5_08_PopulationStructureWorkshopReport.pdf

Bailey, H. & Thompson, P.M. (2009). Using marine mammal habitat modelling to identify priority conservation zones within a marine protected area. Marine Ecology Progress Series, 378: 279-287.

Bailey, H., Clay, G., Coates, E.A. Lusseau, D., Senior, B. & Thompson, P.M. (2010). Using T-Pods to assess variations in the occurrence of coastal bottlenose dolphins and harbour porpoise. Aquatic Conservation – Marine and Freshwater Ecosystems, 20: 150-158.

Bailey, H., Shillinger, G., Palacios D., Bograd, S., Spotila, J., Paladino, F. & Block, B. (2008). Identifying and comparing phases of movement by leatherback turtles using stat-space models. Journal of Experimental Marine Biology and Ecology, 356: 128-135.

Bakke, I., Johansen, S., Bakke, Ø. & El-Gewely, M.R. (1996). Lack of population subdivision among the minke whales (Balaenoptera acutorostrata) from Icelandic and Norwegian waters based on mitochondrial DNA sequences. Marine Biology, 125: 1-9.

Basslink. (2001). Draft Integrated Impact Assessment, June 2001

Camphuysen, C. J., Fox, A. D., Leopold, M. F. & Peterson, I. K. (2004). Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the UK. Report commissioned by the Collaborative Offshore Wind Research into the Environment (COWRIE). The Netherlands: Royal Netherlands Institute for Sea Research.

Canning, S.J. (2007). Cetacean distribution and habitat use along the east coast of Scotland. PhD Thesis. University of Aberdeen.

Canning, S.J. (2007). Cetacean distribution and habitat use along the east coast of Scotland. PhD Thesis. University of Aberdeen.

Cheney, B., Thompson, P.M., Ingram, S.N., Hammond, P.S., Stevick, P.T., Durban, J.W., Culloch, R.M., Elwen, S.H., Mandlebreg, 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. & Wilson, B. (2013) Integrating multiple data sources to assess the distribution and abundance of bottlenose dolphins Tursiops truncatus in Scottish waters. Mammal Review, 43: 71-88

Cheney, B, Corkrey, R, Quick, NJ, Janik, VM, Islas-Villanueva, V, Hammond, PS & Thompson, PM (2012) Site Condition Monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation: 2008 - 2010. Scottish Natural Heritage Commissioned Report No. 512.

Cordes, L.S., Duck, C.D., Mackey, B.L., Hall, A.J., & Thompson, P.M. (2011). Long-term patterns in harbour seal site-use and the consequences for managing protected areas. Animal Conservation, 14(4): 430-438. DOI: 10.1111/j.1469-1795.2011.00445.x

Cordes, L.S., Duck, C.D., Mackey, B.L., Hall, A.J., & Thompson, P.M .(2011) Long-term patterns in harbour seal site-use and the consequences for managing protected areas. Animal Conservation 14, 430-438.

Daníelsdóttir, A.K., Duke, E.J. & Árnason, A. (1992). Genetic variation at enzyme loci in North Atlantic minke whales, Balaenoptera acutorostrata. Biochemical Genetics, 30: 189-202. ERM, 2011. Moray Firth Offshore Wind Developers Group Cumulative Impacts Assessment Discussion Document.

De'ath, G, & Fabricius, K.E. (2000). Classification and regression trees: a powerful yet simple technique for ecological data analysis. Ecology, 81: 3178–3192.

Eisfeld, S., Keith, S., Pope, A., Still, D., Dolman, S. & Simmond, M. (2009). Outer Moray Firth cetacean research 2008: project report for the BBC Wildlife Fund. Whale & Dolphin Conservation Society.

Evans, P.G.H. (1992). Status review of cetaceans in British and Irish waters. UK Mammal Society, Cetacean Group, Oxford.

Gaskin, D.E., Yamamoto, S. & Kawamura, A. (1993). Phocoena phocoena (L.) in the coastal waters of northern Japan. Fisheries Bulletin, 91: 440-454.

Gill, A.B. & 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

Gillespie, D., Gordon, J., McHugh, R., McLaren, D., Mellinger, D., Redmond, P., Thode, A., Trinder, P. and Deng, X.Y. (2008). PAMGUARD: Semi-automated, open source software for real-time acoustic detection and localisation of cetaceans. Proceedings of the Institute of Acoustics, 30(5): 9pp.

Gullström, M., Patterson Edwards, J.K., Amir, O. & Dubi, A. (eds.) (2010) Greening Blue Energy: Identifying and managing the biodiversity risks and opportunities of off shore renewable energy. Gland, Switzerland: IUCN. 102pp.Wilson, B., Thompson, P.M. & Hammond, P.S. (1997). Habitat use by bottlenose dolphins: seasonal distribution and stratified movement patterns in the Moray Firth, Scotland. Journal of Applied Ecology, 34: 1365–1374.

Hammond, P.S., Macleod, K., Berggren, P., Borchers, D.L., Burt, L., Cañadas, A., Desportes, G., Donovan, G.P., Gilles, A., Gillespie, D., Gordon, J., Hiby, L., Kuklik, I., Leaper, R., Lehnert, K., Leopold, M., Lovell, P., Øien, N., Paxton, C.G.M., Ridoux, V., Rogan, E., Samarra, F., Scheidat, M., Sequeira, M., Siebert, U., Skov, H., Swift, R., Tasker, M.L., Teilmann, J., Van Canneyt, O. and Vázquez, J.A. (2013). Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological Conservation 164: 107–122.

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich, S., Hiby, A.R. & Leopold, M.F. (2002). Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology, 39: 361-376.

Hastie, G.D., Barton, T.R., Grellier, K., Hammond, P.S., Thompson, P.M., Wilson, B. (2003b). Distribution of small cetaceans within a candidate Special Area of Conservation: implications for management. Journal of Cetacean Research Management, 5: 261 – 266.

Hastie, G.D., Barton, T.R., Grellier, K., Hammond, P.S., Thompson, P.M., Wilson, B. (2003). Distribution of small cetaceans within a candidate Special Area of Conservation: implications for management. Journal of Cetacean Research Management, 5: 261–266.

Hastie, G.D., Wilson, B. & Thompson, P.M. (2003a). Fine-scale habitat selection by coastal bottlenose dolphins: application of a new land-based video-montage technique. Canadian Journal of Zoology, 81: 469–478.

JNCC. (2012). Guidance for staff on the potential risk of seal corkscrew injuries. April 2012. The Countryside Council for Wales, the Joint Nature Conservation Committee, Natural England and Scottish Natural Heritage.

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

JNCC. (2010a). The protection of marine European Protected Species from injury and disturbance. Guidance for the marine area in England and Wales and the UK marine offshore area. JNCC, NE and CCW.

JNCC. (2008). The deliberate disturbance of marine European Protected Species. Guidance for English and Welsh territorial waters and the UK offshore marine area. JNCC.

Jonsen, I.D., Myers, R.A. & James, M.C. (2007). Identifying leatherback turtle foraging behaviour from satellite-telemetry using a switch state-space model. Marine Ecology Progress Series, 337: 255-264.

Lusseau, D., New, L., Donavan, C., Cheney, B., Thompson, P.M., Hastie, G. & Harwood, J. (2011). The development of a framework to understand and predict the population consequences of disturbances for the Moray Firth bottlenose dolphins. Scottish Natural Heritage Commissioned Report.

Maclean, I.M.D., Wright, L.J., Showler, D.A. and Rehfisch, M.M. (2009). A review of assessment methodologies for offshore windfarms. A report for COWRIE.

Martinez, I. & Pastene, L.A. (1999). RAPD-typing of Central and Eastern North Atlantic and Western North Pacific minke whales, Balaenoptera acutorostrata. ICES Journal of Marine Science, 56: 640-651.

McConnell, B.J., Fedak, M.A., Lovell, P. & Hammond, P.S. (1999). Movements & foraging areas of grey seals in the North Sea. Journal of Applied Ecology, 35: 573-590.

MORL (2012) Moray Offshore Wind Farm Environmental Statement. Moray Offshore Renewables Ltd.

Naud, M.J., Long, B., Brêthes, J.C. & Sears, R. (2003). Influences of underwater bottom topography and geomorphology on minke whale (Balaenoptera acutorostrata) distribution in the Mingan Islands (Canada). JMBA UK 83: 889-896.

Nigg (2013). Nigg Energy Park Environmental Statement. Global Energy Nigg Ltd.

Northridge, S.P., Tasker, M.L., Webb. A. & Williams, J.M. (1995). Distribution and relative abundance of harbour porpoise (Phocoena phocoena L.), white-beaked dolphins (Lagenorhynchu alnirostris Gray) and minke whales (Balaenoptera acutorostrata Lacepède) around the British Isles. ICES Journal of Marine Science, 52: 55-66.

Pierce, G.J., Thompson, P.M., Miller, A., Diack, J.S.W., Miller, D. & Boyle, P.R. (1991). Seasonal variation in the diet of common seals (Phoca vitulina) in the Moray Firth area of Scotland. Journal of Zoology, 223: 641-652.

Pirotta, E., Brookes, K.L., Graham, I.M., Thompson, P.M., (2014) Variation in harbour porpoise activity in response to seismic survey noise. Biol. Lett. 10: 20131090. http://dx.doi.org/10.1098/rsbl.2013.1090

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.

Read, A.J. & Westgate, A.J. (1997). Monitoring the movements of harbour porpoise (Phocoena phocoena) with satellite telemetry. Marine Biology, 130: 315 – 322.

Read, A.J. (1999). Harbour porpoise Phocoena phocoena (Linnaeus, 1758). In "Handbook of marine mammals, Volume 6". Academic Press. p323–355.

Reid, J.B., Evans, P.G.H., & Northridge, S.P. (Eds). (2003). Atlas of Cetacean Distribution in North-west European Waters. Joint Nature Conservation Committee, Peterborough. 76pp.

Robinson, K.P., Eisfeld, S.M. Baumgartner, N., Tetley, M.J. Clark, N.M., Culloch, R.M., Whaley, A.R. & 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.

Robinson, K.P., Eisfeld, S.M. Baumgartner, N., Tetley, M.J. Clark, N.M., Culloch, R.M., Whaley, A.R. & 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 (2007). Hammond, P.S. Small cetaceans in the European Atlantic and North Sea (SCANS II). Life Project Number: LIFE04NAT/GB/000245.

Scottish Government (2014a) Telford, Stevenson and MacColl Appropriate Assessment. Available from http://www.scotland.gov.uk/Topics/marine/Licensing/marine/scoping/Moray3/TelfordAppropriateAssessment [accessed 06/06/2014].

Scottish Government (2014b) CFPA Appropriate Assessment. Available from http://www.scotland.gov.uk/Resource/0044/00441709.pdf [accessed 17/06/2014].

Scottish Government (2014c) Meygen Tidal Stream Project Appropriate Assessment. Available from http://www.scotland.gov.uk/Resource/0043/00434041.pdf [accessed 23/06/2014].

SCOS (2010). Scientific advice on matters related to the management of seal populations: 2010. Sea Mammal Research Unit, St Andrews, Scotland.

SCOS. (2011). Scientific advice on matters related to the management of seal populations: 2011. Sea Mammal Research Unit, St Andrews, Scotland.

SMRU Ltd. (2011). Development and implementation of automatic classification of odontocetes within PAMGUARD. Authors: Gillespie, D., White, P., Caillat, M. and Gordon, J.

Stockin, K.A., Weir, C.R. & Pierce, G.J. (2006). Examining the importance of Aberdeenshire (UK) coastal waters for North Sea bottlenose dolphins (Tursiops truncatus). Journal of the Marine Biological Association of the UK, 86: 201-207.

Tetley, M.J., Mitchelson-Jacob, E.G. & Robinson, K.P. (2008). The Summer distribution of coastal minke whales (Balaenoptera acutorostrata) in the southern outer Moray Firth, NE Scotland, in relation to co-occurring mesoscale oceanographic features. Remote Sensing of the Environment, 112: 3449-3454.

Thomas, L., Buckland, S. T., Rexstad, E. A., Laake, J. L., Strindberg, S., Hedley, S. L., *et al.*, (2010). Distance software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology, 47: 5–14.

Thompson, P.M. & Miller, D. (1990). Summer foraging activity and movements of radio tagged common seals (Phoca vitulina) in the Moray Firth, Scotland. Journal of Applied Ecology, 27: 492-501.

Thompson, P.M. & Wheeler, H. (2008). Photo-ID based estimates of reproductive patterns in female harbor seals. Marine Mammal Science, 24: 138-146.

Thompson, P.M., Brookes, K., Cheney, B., Cândido, A., Bates, H., Richardson, N. & 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., Brookes, K.L., Graham, I.M., Barton, T.R., Needham, K., Bradbury, G., Merchant, N.D., (2013) Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises. Proc R Soc B 280: 20132001. http://dx.doi.org/10.1098/rspb.2013.2001

Thompson, P.M., Cheney, B., Cândido, A.T. & Hammond, P.S. (2009). Site condition monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation: Interim report 2005-2007. SNH Commissioned Report.

Thompson, P.M., Cheney, B., Ingram, S., Stevick, P., Wilson, B. & Hammond, P.S. (2011). Distribution, abundance and population structure of bottlenose dolphins in Scottish waters. Scottish Government and SNH funded report. SNH Commissioned Report No 354.

Thompson, P.M., Corkrey, R., Lusseau, D., Lusseau, S., Quick, N., Durban, J.W., Parsons, K.M. & Hammond, P.S. (2006a). An assessment of the current condition of the Moray Firth bottlenose dolphin population. SNH Commissioned Report No 175.

Thompson, P.M., Mackay, A., Tollit D.J., Enderby S., Hammond P.S. (1998). The influence of body size and sex on the characteristics of harbour seal foraging trips. Canadian Journal of Zoology 76: 1044-1053.

Thompson, P.M., McConnell, B.J., Tollot, D.J., MacKay, A., Hunter, C. & Racey, P.A. (1996b). Comparative distribution, movements and diet of harbour and grey seals from the Moray Firth, NE Scotland. Journal of Applied Ecology, 33: 1572-1584.

Thompson, P.M., Miller, D., Cooper, R. & Hammond, P.S. (1996a). Changes in the distribution and activity of harbour seals during the breeding season: implications for their lactation strategy and mating patterns. Journal of Animal Ecology, 63: 24-30.

Thompson, P.M., Pierce, G.J., Hislop, J.R.G., Miller, D. & Diack, J.S.W. (1991). Winter foraging by common seals (Phoca vitulina) in relation to food availability in the inner Moray Firth, NE Scotland. Journal of Animal Ecology, 60: 283-294.

Thompson, P.M., Pierce, G.J., Hislop, J.R.G., Miller, D. & Diack, J.S.W. (1991). Winter foraging by common seals (Phoca vitulina) in relation to food availability in the inner Moray Firth, NE Scotland. Journal of Animal Ecology, 60: 283-294.

Thompson, P.M., Tollit, D.J., Wood, D., Corpe, H.M., Hammond, P.S. & Mackay, A. (1997). Estimating harbour seal abundance and status in an estuarine habitat in north-east Scotland. Journal of Applied Ecology 34: 43-52.

Tollit, D.J., Black, A.D., Thompson, P.M., MacKay, A., Corpe, H.M., Wilson, B., van Parijs, S.M., Grellier, K. & Parlane, S. (1998). Variations in harbour seal Phoca vitulina diet and dive-depths in relation to foraging habitat. Journal of Zoology, 244: 209-222.

Tougaard, J., Tougaard, S., Jensen, R.C., Jensen, T., Teilman, J., Adelung, D., Liebsch, N. & Müller, G. (2006) Harbour seals at Horns Reef before, during and after construction of Horns Rev Offshore Wind Farm. Final report to Vattenfall A / S.

Weir, C.R., Stockin, K.A. & Pierce, G.J. (2007). Spatial and temporal trends in the distribution of harbour porpoise, white-beaked dolphins and minke whales off Aberdeenshire (UK), northwestern North Sea. Journal of Marine Biological Association of the UK, 87: 327-338.

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.