12 WIND FARM MARINE MAMMALS

12.1 INTRODUCTION

1. This Section of the ES evaluates the likely significant effects of the Wind Farm on marine mammals in and around the Wind Farm Site, as characterised by their abundance and distribution across the Wind Farm Site and the Moray Firth. Reference is also made to cetacean and pinniped populations over a wider geographic area due to the highly migratory nature of marine mammals.

2. This Section describes the potential effects on marine mammals associated with the construction, operation and decommissioning phases of the Wind Farm. The assessment has been undertaken by RPS and includes an assessment of cumulative effects.

3. The following technical reports support the assessment within this Section:

- Annex 7A: Underwater Noise Modelling Technical Report;
- Annex 12A: Updated Technical Report Summarising Information on Marine Mammals Which Occur in the Moray Firth, including the following appendices:
  - Appendix 1: Thompson and Brookes (2011) Technical report on pre-consent marine mammal data gathering at the BOWL and MORL wind farm sites;
  - Appendix 2: Thompson (2012) Bottlenose dolphin densities across the Moray Firth;
  - Appendix 3: SMRU (2011) Grey seal usage maps for MORL/BOWL developments; and
- Annex 12B: Framework for Assessing the Impacts of Pile Driving Noise From Offshore Wind Farm Construction on Moray Firth Harbour Seal Populations.

4. This assessment has taken into account other relevant technical assessments presented in this ES, principally:

- Section 9: Wind Farm Physical Processes and Geomorphology;
- Section 11: Wind Farm Fish and Shellfish Ecology;
- Section 18: Wind Farm Shipping and Navigation; and
- Section 24: OfTW Marine Mammals (in respect of the cumulative assessment).

5. This Section includes the following elements:

- Assessment Methodology and Significance Criteria;
- Baseline Conditions;
- Development Design Mitigation;
- Assessment of Potential Effects;
- Mitigation and Monitoring;
- Residual Effects;
- Summary of Effects;
- Cumulative Assessment;
- Summary
- Statement of Significance; and
- References.

12.2 *ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA*

12.2.1 SCOPE OF ASSESSMENT

6. A number of cetacean species have been recorded regularly in the Moray Firth, including: bottlenose dolphin (*Tursiops truncatus*), harbour porpoise (*Phocena phocena*), minke whale (*Balaenoptera acutorostrata*), Atlantic white sided dolphin (*Lagenohynchus acutus*), white beaked dolphin (*Lagenorhynchus albirostris*), Risso's dolphin (*Grampus griseus*), and common dolphin (*Delphinus delphis*). Two resident populations of pinnipeds also occur within the Moray Firth: grey seals (*Halichoerus grypus*) and harbour (or common) seals (*Phoca vitulina*).

7. The scope of this assessment includes a description of all marine mammal species, from resident populations through to infrequent visitors, which occur within the Study Area. The assessment focuses on these key marine mammal species identified during the desktop review and site-specific studies as regularly occurring within the study area and therefore most likely to be affected by the Wind Farm. The potential for effects on European otter (*Lutra lutra),* which inhabits the nearshore marine environment will be considered as part of the OnTW ES.

8. Particular attention is paid to existing and proposed ecological conservation measures within the defined study area. Two SACs designated under the Habitats Directive (92/43/EEC) lie within the inner Moray Firth (Figure 8.1). The effects on the Moray Firth SAC (designated for bottlenose dolphins) and the Dornoch Firth and Morrich More SAC (designated for harbour seal) have been assessed with respect to the Habitat's Regulations in order to determine whether there is likely to be a significant effect on the integrity of these two sites. A site-specific assessment of effects upon these sites is provided in the Report to Inform an Appropriate Assessment document that will follow this ES. Finally, all of the key marine mammal species are listed as PMFs within Scottish territorial waters.

12.2.2 POLICY AND PLANS

9. This ES has been prepared in the context of key legislation and guidance documents related to marine mammals and offshore wind farm development. The assessment methodology will consider the following key guidance documents of relevance to marine mammals and offshore wind farms:

- IEEM (2010). Guidelines for Ecological Impact Assessment in Britain and Ireland. Marine and Coastal;
- Defra (2004). Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in respect of FEPA and CPA requirements. Version 2 June 2004. Prepared by CEFAS for MCEU;
- Defra (2005). Nature Conservation guidance on offshore wind farm development. Version 1.9;
- Transport Analysis Guidance (TAG): The Biodiversity Sub-Objective, TAG Unit 3.3.10, Department for Transport (2004);
- JNCC (2008). The deliberate disturbance of marine European Protected Species. Guidance for English and Welsh territorial waters and the UK offshore marine area;

- JNCC (2009). Statutory nature conservation agency protocol for minimising the risk of disturbance and injury to marine mammals from piling noise. JNCC June 2009; and
- JNCC (2010). The protection of marine European Protected Species from injury and disturbance. Guidance for the marine area in England and Wales and the UK offshore marine area.

10. Other receptor specific guidance includes:

- JNCC (2010). Corkscrew Seal Injuries – Draft Minutes of Meeting held on 5th July 2011.

12.2.3 CONSULTATION

11. This ES has been prepared taking consideration of the consultation that has been carried out to date and those opinions gathered from the key stakeholders in response to the Scoping Report prepared for the Wind Farm (BOWL, 2010). A number of meetings and workshops have been held to discuss the various issues that have arisen throughout the EIA process and are detailed in Table 12.1. A summary of the Scoping Opinion responses and how these have been addressed in this assessment is summarised in Table 12.2. The key consultees that provided responses relevant to marine mammals included MS, SNH, JNCC, WDCS and RSPB.

Table 12.1 Summary of Consultation Undertaken with Key Stakeholders

Consultee	Date	Meeting	Key issues discussed/outcomes
SNH	15/2/2010	Pre-scoping	SNH recommended BOWL provide two Marine Mammal Observers (MMOs) for boat-based survey work and that seal tagging be undertaken.
SNH/JNCC/MS	10/6/2011	Baseline data presentation	BOWL and MORL presented findings of baseline data collection. Request from SNH to include more data on grey seal usage of the area.
SNH/JNCC/MS	28/6/2011	Underwater noise MFOWDG methodology workshop	BOWL and MORL presented their underwater noise methodology to MS/SNH/JNCC in a workshop forum and demonstrated how the INSPIRE modelling works through interactive use of the inspire light model.
SNH/JNCC/MS	23/9/2011	Underwater noise workshop (led by MORL)	The seal framework paper and proposed revision to methodology for assessment presented to consultees.
WDCS	29/6/2011	Baseline data presented and assessment methodology	Key discussion focused around the proposed assessment methodology, the proximity of the WDCS wildlife centre to the OfTW cable landfall and minke whale distribution within the Moray Firth.

Consultee	Date	Meeting	Key issues discussed/outcomes
SNH/JNCC/MS	29/9/2011	Assessment methodology and initial outputs	BOWL presented the assessment methodology to consultees and also presented preliminary results of the assessment.
Offshore Wind Underwater Noise Working Group	Ongoing	Various meetings and workshops to consider the issue of underwater noise	BOWL are contributing to wider, industry-level, key discussions on underwater noise issues, including methodologies for assessment and scoping studies to widen the knowledge base.

Table 12.2 Summary of Responses from Consultees

Consultee	Summary of Consultation Response	Project Response
Marine Scotland	Noise assessment should take into consideration background noise, including vibration from ships' engines, piling hammers and auguring operations during construction of turbine foundations.	The underwater noise modelling study has presented an assessment of the noise sources associated with the construction activities and ranked these in order of severity of effect using the SPEAR (Simple Propagation Estimator and Ranking) programme for a number of species of interest (see Annex 7A). The outputs of this modelling indicated that impact piling is the dominant noise source and hence the activity that would have the greatest effect.
	Potential for longer term noise during operation.	The ranked SPEAR model includes a consideration of operational noise levels.
	Insufficient data presented in Scoping Report to assess adequacy of survey work or likely uncertainty in data.	Additional baseline survey data collected for marine mammals in the Moray Firth and Wind Farm were presented to statutory authorities following receipt of the Scoping responses. Survey data coverage and data uncertainties/limitations are detailed in Annex 12A: Technical report summarising information on marine mammals which occur in the Moray Firth
	We require a discussion of monitoring and assessment during operation and post decommissioning, in addition to how results of monitoring surveys will be assessed.	Proposed monitoring to be carried out during and post construction of the Wind Farm Site are presented in Section 12.6.
	Cumulative and in-combination impacts should consider SACs and SPAs that may be affected, taking into account other Offshore Wind Farms other developments (e.g. oil and gas operations) and activities (e.g. shipping and fishing industries).	The cumulative impact assessment (CIA) presented in this Section has considered the development of the Moray Firth Round 3 Zone alongside other relevant developments both within the Moray Firth and further afield (e.g. Firth of Forth proposed offshore wind farms).
	Cumulative impact will need to consider the possibility of all piling being undertaken concurrently for Moray Firth Round 3 Zone and Beatrice.	The underwater noise assessment has considered concurrent piling operations at both sites (Annex 7A).

Consultee	Summary of Consultation Response	Project Response
	In order to mitigate against corkscrew injuries to seals an MMO protocol will be required along with Environmental Management Plan (EMP) three months prior to construction.	Potential for corkscrew injuries is assessed in Section 12.5.1.2 and mitigation/monitoring is outlined in Section 12.6.
JNCC	Require detail presenting specifications on when and what activities require the use of DP vessels with ducted propellers.	These details are provided in Table 12.3Table 12.3 (Worst Case Scenario for Marine Mammals)
JNCC/SNH	Structure of ES (including Cumulative Impact Assessment) to address the requirements of HRA as well as EIA.	This assessment has considered effects on species associated with relevant SACs (i.e. bottlenose dolphins and harbour seals). Information to inform an appropriate assessment is provided in a separate document.
	In respect of seal licensing, we think it would be helpful if the telemetry study were to be extended to include any available records for grey seals.	Analysis of grey seal tracking data has been undertaken (Section 12.2.5.2 and Appendix 3 in Annex 12 A).
	It will be important to estimate the density of key marine mammal species not only at each wind farm site (i.e. within the Wind Farm Site and Moray Firth Round 3 Zone) but across the entire area of predicted effect from each wind farm individually and cumulatively (to be determined on a species by species basis).	The assessment has estimated marine mammal densities for bottlenose dolphins, harbour porpoise, harbour seal and grey seal for the whole of the inner and outer Moray Firth, and considered movement of these species between the Moray Firth and other sites outside the study area.
	Underwater noise generated from dredging activities/sea disposal as well as seismic survey work associated with the oil and gas licensing blocks in the Moray Firth (and not just the placement of any new infrastructure) is considered in the CIA. With regard to military activities, the MOD Joint Warrior exercises should also be considered.	As discussed above the noise modelling has presented a comparison of various noise sources in terms of area excluded for key species of interest (including bottlenose dolphins, harbour seals, harbour porpoises) (Annex 7A). This has concluded that pile driving is the dominant noise source and is discussed in the CIA. There are no planned or foreseeable seismic survey activities that will be undertaken simultaneously with the construction of the Wind Farm (Section 12.9.2.3). The MOD has been consulted regarding their Joint Warrior exercises in terms of location and timing (Section 12.9.2.1).

Consultee	Summary of Consultation Response	Project Response
	Consider that it is too early to suggest that long term avoidance of the wind farm site by marine mammals be scoped out of the assessment and that this issue should be considered in CIA.	The assessment deals with the issue of long term avoidance although emerging evidence from studies of Danish and Dutch wind farms suggest that harbour porpoises and seals do not show long term avoidance.
	Recommend undertaking field studies looking at impacts of construction noise on marine mammals due to the limited evidence available.	Monitoring data collected to investigate the responses of harbour porpoises to pile driving at the Horns Rev II Offshore Wind Farm and Beatrice demonstrator project has been used in the assessment of potential effects from noise from piling at the Wind Farm Site (and cumulatively) to marine mammals in the Moray Firth. Construction and operation related monitoring work is discussed in Section 12.6.
	Need to consider the full range of foundation types likely to be used at the wind farm for characterising noise impacts and not just monopiles as a worst case scenario. This information will be required for HRA, EIA and EPS licence applications.	The three foundation options being considered for each turbine are presented in Section 7: Project Description including the monopiles proposed for the meteorological masts. Noise modelling and assessment has presented the possible noise sources associated with the worst case scenario for each foundation option using the SPEAR programme, which concluded that impact piling is the dominant noise source (see Annex 7A).
	Further discussion is needed to define and agree the reference populations/ population scale at which it is relevant to consider noise impacts.	The assessment methodology has been presented to the statutory authorities for discussion and approval during a workshop on 29th September 2011. The methodology has been further refined, such as to include population modelling to determine population effects on harbour seals (Section 12.2.7.12).
	Need to consider future MPAs and species that are PMFs.	Refer to Section 12.3.1.6.
SNH	The assessment will need to consider features and potential impacts in relation to HRA.	This assessment has considered effects on species associated with relevant SACs (i.e. bottlenose dolphins and harbour seals). Information to inform an appropriate assessment will be provided in a separate document.
	Advise that harbour seal population is declining and overall UK status has been assessed as 'unfavourable-	Impacts were assessed with respect to the population status of harbour seals within the Moray Firth including their importance within a wider geographic frame of

Consultee	Summary of Consultation Response	Project Response
	inadequate'. Seals are vulnerable to impacts which could lead to further population decline.	reference.
	We need to agree a list of potential key receptors to underwater noise. Recommend that noise impacts are assessed using a zoned impact map for each species.	The list of potential key receptors to underwater noise was agreed with statutory authorities during presentation of the ES methodology in a workshop on 29th September 2011. These are bottlenose dolphin, harbour porpoise, harbour seal and grey seal.
	Further clarity is required in respect of noise 'trigger limits' – this issue requires consensus amongst the consenting authorities.	In the absence of consensus amongst the consenting authorities, the noise thresholds (trigger limits) that we have used in the assessment of potential death/injury, auditory injury and behavioural disturbance have been agreed with statutory authorities during presentation of the ES methodology in a workshop in September 2011. These thresholds are discussed in detail in Section 12.2.7 and Annex 7A.
	Proposed mitigation should consider full ranges of measures including alternative installation methods, seasonal restrictions, bubble curtains, jackets and vibro-piling. Zone of potential impacts should be defined from noise modelling for the range of construction activities.	Mitigation is presented in Section 12.6 Noise modelling has concluded that impact piling during construction is the dominant noise source in terms of potential impacts to key species (Annex 7A). Many of the alternative installation methods and foundation types are currently untested at the water depths of the Wind Farm Site. Based on current knowledge of technologies and sites, the feasibility of alternatives cannot be proven.
RSPB	The EIA process should take into account any potential marine SPAs or offshore SACs and any future MPAs.	Refer to Section 12.3.1.
WDCS	Military aviation should be included as an activity that could impact marine mammals.	Refer to CIA in Section 12.9.
	Long term avoidance should be included as a potential cumulative impact.	The assessment deals with the issue of cumulative avoidance including the likely duration of avoidance, Section 12.9.3.
	All modelling works should be ground-truthed with in-field data verification.	The INSPIRE noise model has been validated using actual measured data taken during the installation of a 1.8 m diameter pile at the Beatrice demonstrator project in the Moray Firth.

12. SNH provided details of the requirements for appraisal under the Habitats Directive. Information to inform an Appropriate Assessment is provided in a separate document that will follow this ES.

12.2.4 GEOGRAPHICAL SCOPE

13. The study area has been defined within an appropriate geographical frame of reference that encompasses the key areas for resident marine mammal populations and regular visitors to the Moray Firth. Baseline data were collected within an area extending from the shores of the inner Moray Firth to the seaward margin of the outer Moray Firth. The seaward margin has been approximately delineated between the headlands on the most easterly points of the north and south coasts of the Moray Firth (see Figure 12.1). The study area also considered the extent of noise impacts as predicted by the noise modelling undertaken for this project (Annex 7A).

12.2.5 DATA COLLECTION METHODS

12.2.5.1 Desktop Study

14. A comprehensive literature review for historical data and published studies was carried out for the Moray Firth region. Data on distribution and sightings was gathered as part of the site-specific surveys to provide a long-term baseline dataset (Annex 12A; see summary below). Further information on the ecology and health of species within the Moray Firth was gathered from peer-reviewed scientific literature (Robinson and Tetley, 2007; Robinson and Tetley, 2009; Robinson et al., 2007; Culloch and Robinson, 2008); SAC conservation objectives documentation (SNH, 2005a; SNH 2006) and commissioned reports (Thompson et al., 2004). Potential threats to marine mammals were investigated through reviews of other North Sea Offshore Wind Farm Environmental Statements (Galloper Wind Farm Ltd, 2011) and published reports on specific threats e.g. noise impact studies (Senior et al., 2008; Southall et al., 2007; Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals, 2003).

12.2.5.2 Site-Specific Surveys

15. University of Aberdeen (UA) in collaboration with the Sea Mammal Research Unit (SMRU) undertook a number of site-specific studies throughout 2009 and 2010 to characterise the marine mammal populations within the Wind Farm Site and Moray Firth Round 3 Zone (see Annex 12A). The key objectives of the surveys were:

1) To characterise the wind farm project areas with respect to the marine mammal species present; detail seasonality and year-to-year variability in occurrence;
2) To assess the density of animals at the proposed project sites; and
3) To assess the likelihood of exchange between local SACs and the proposed wind farm sites.

16. The Wind Farm surveys together with a number of previous surveys within the Moray Firth were used to inform the baseline with respect to Objectives 1 and 2. These surveys are described in detail in Annex 12A and summarised below:

- Boat-based and aerial visual surveys:
  - UA boat surveys in the Moray Firth SAC (2004, 2005);

- UA boat surveys in the Outer Moray Firth (2009);
- UA aerial surveys in the Outer Moray Firth (2010);
- Natural Power boat surveys of the Moray Firth Round 3 Zone (2011);
- Institute of Estuarine and Coastal Sciences, University of Hull (IECS) boat surveys of the Beatrice site (2011)[1]; and
- SMRU aerial surveys of grey and harbour seal haul-outs during the August moult in Scotland (1996-2009);
- SMRU fixed-wing aerial surveys for grey and harbour seals during August in the Moray Firth (1988-2009); and
- AU land-based counts of harbour seal haul-outs (1988-2010).

- Passive acoustic monitoring:
  - Echolocation detectors i.e. Timing Porpoise Detectors (T-PODs) for the Beatrice demonstrator project (2005-2007);
  - SNH and Scottish Executive Environment and Rural Affairs Department (SEERAD) funded study of the southern Moray Firth mostly using T-PODs except for the last year where C-PODs (i.e. the digital device superseding the T-POD) were used (2006-2008);
  - DECC funded study across the Moray Firth in 2009 and 2010 using C-PODs; and
  - SMRU surveys using Ecological Acoustic Recorders (EARs) in 2010 that were used to detect other noises made by cetaceans, such as whistles which were attributed to specific marine mammal species.

- Telemetry studies:
  - SMRU telemetry data for grey seals collected from 1995-2008.

17. Additional baseline data were collated to assess the likelihood of exchange between local SACs and the proposed wind farm sites. The species of concern within the local SACs include the bottlenose dolphin population within the Moray Firth SAC and the harbour seals within the Dornoch Firth and Morrich More SAC. Bottlenose dolphins were recorded within the study area using passive acoustic techniques together with specialised whistle classification software developed by SMRU to identify different dolphin species. Baseline data on harbour seals were collated using two decades worth of tracking data (recorded using VHF, Satellite and GSM telemetry) together with habitat association modelling to predict the occurrence of seals within the Wind Farm Site and the Moray Firth Round 3 Zone.

[1]Following a review of historic data for bottlenose dolphin within the Moray Firth and a review of the survey results is was agreed that there is likely to be a high degree of uncertainty associated with the observations for BND made within the Wind Farm study area. Following consultation with JNCC and SNH it was agreed that these sightings of BND within the Beatrice site should be removed from future analysis.

12.2.6 DATA ANALYSIS

12.2.6.1 Habitat Association Modelling and Density Estimations

Harbour Porpoise and Harbour Seal

18. Habitat association modelling has been carried out by UA (Thompson and Brookes 2011). Habitat characteristics (such as depth, slope, sediment type, etc.) were used to predict the distribution and density of harbour porpoises and harbour seals within the Moray Firth. These distribution maps are presented in the species accounts for harbour porpoise and harbour seal, which show the estimated number of each species in each 4 x 4 km grid square within the study area across the Moray Firth (see Figures 12.4 and 12.5).

Bottlenose Dolphin

19. There are several reasons why it is more difficult, and less appropriate, to produce equivalent maps for bottlenose dolphins. Firstly, bottlenose dolphin distribution is known to be much patchier, with high use areas in the coastal strip of the Moray Firth, and survey techniques have differed in these high and low density areas. Secondly, these animals are highly mobile, so an average density, based on studies over a large area (e.g. SCANS II data), are of more limited use when considering their likely presence in relatively small areas of interest around an offshore wind farm site.

20. Therefore, in order to determine bottlenose dolphin densities within the Wind Farm Site and Moray Firth in general, it is more appropriate to use metrics which account for temporal patterns of occurrence when considering bottlenose dolphin use of smaller areas. Work is currently underway for the Moray Firth funded by the DECC using a combination of Passive Acoustic Monitoring (PAM) data and classification tree analysis, to look at the potential impact of oil and gas exploration operations (particularly seismic surveys) on marine mammals in the Moray Firth. However, the results of this study are currently unavailable. In the meantime, sufficient analyses have been carried out to provide a more robust estimate of spatial variation in the probability of encountering bottlenose dolphins within the Moray Firth, which can be used with independent estimates of population size to provide average densities of bottlenose dolphins across this area (Thompson, 2012 (Annex 12A)). The resulting density map is provided in the bottlenose dolphin species account below, showing the estimated number of bottlenose dolphins in each 4 x 4 km grid square within the study area across the Moray Firth (see Figures 12.1 and 12.2).

21. Whilst this distribution map gives a useful indication of the more inshore distribution of bottlenose dolphin within the Moray Firth, it does not fully capture existing knowledge of the relative importance of different areas within the SAC and coastal waters. To gain a better understanding of bottlenose dolphin distribution in these inshore areas, historical C-POD data were used to provide an estimate of the spatial variation in the mean number of hours that animals were detected at different coastal sites within the Moray Firth (see Figure 12.3).

Grey Seal

22. A grey seal usage study was carried out using grey seal telemetry data from 1995-2008 combined with aerial survey data from 1996-2009 to produce maps of estimated total, at-sea, and hauled out usage in a 100 km radius of the Wind Farm Site (Annex 12A). The resulting density maps are provided in the grey seal species account below (Section 12.3.3.2), showing the estimated number of grey seals in each 4 x 4 km grid square within the study area across the Moray Firth. Further maps illustrating the upper and lower confidence intervals of the data were also produced and are discussed in the grey seal species account (see Figure 12.6).

12.2.7 ASSESSMENT OF EFFECTS

23. This Section describes the methodology used to assess potential effects on marine mammals from the construction, operation and decommissioning of the Wind Farm. This ES has been prepared in accordance with the Guidelines for Ecological Impact Assessment (IEEM, 2010) and other relevant guidelines.

12.2.7.1 Worst Case Scenario and Rochdale Envelope

24. The potential effects upon marine mammals will be assessed on the basis of the worst case scenario (the Rochdale Envelope) derived from the project parameters described in Section 7: Project Description.

25. The most significant potential for disturbance to marine mammals arises from the underwater noise associated with the installation of driven pile turbine foundations. Noise created during pile driving operations involves sound pressure levels that may cause behavioural responses in marine mammals from considerable distances (e.g. Thomsen et al., 2006, Thompson et al., 2010b; Bailey et al., 2010) as well as impair hearing and cause physical injury or fatality at close range (e.g. Madsen et al., 2006; Shepherd et al., 2006).

26. For marine mammals, the worst case scenario includes installation of 2.4 m pin piles (as part of a jacket structure) of up to two simultaneous installations, as this would result in the highest likely levels of noise during turbine installation (see Section 12.2.7.9). Noise from installation of 5 m meteorological mast monopiles and 3 m OSP pin piles were also considered in the Rochdale envelope. For the purposes of this assessment, it was assumed that a hammer with a blow force of up to 2300 kJ would be required through the Wind Farm Site, however, in reality this would only be needed for piling in the northern sections of the Wind Farm Site due to the harder material in this area. For all other areas a hammer blow force of 1800 kJ would be sufficient.

27. Table 12.3 provides a summary of the worst case scenario used for this assessment. Full details on the range of project design parameters for the Wind Farm are provided in Section 7: Project Description.

28. Wind farm construction is anticipated to occur continuously over a two year period. It should be noted that in reality pile driving is not likely to be continuous and that there will be significant gaps between piling events due to movement of vessel/equipment from one turbine to another, weather and other constraints.

However, although the piling itself may only last in the order of a number of hours there is the potential within the Rochdale Envelope for it to be immediately followed by another operation, therefore, in the worst case scenario, potentially constituting a continuous noise emission.

Table 12.3 Worst Case Scenario for Marine Mammals for the Wind Farm

Potential Effect	Worst Case Scenario Assessed
Construction / Decommissioning	
Physical injury, displacement and behavioural impacts resulting from pile driving.	Short-term typically up to five hours of actual pile driving for each pile; optimum blow force of 2300 kJ for a maximum of 277 turbines, with each foundation requiring four pin piles, each with a maximum of 2.4 m diameter. Total of 16,000 hammer strikes per pile with soft start procedures built in to the modelling. 3 x 5 m meteorological mast monopile and 3 x 3 m pin pile OSPs also modelled in noise assessment. Up to two piling vessels operating simultaneously at two locations at the western and south western most corners of the Wind Farm Site to represent the closest locations to the SACs (see Figure 12.7). Piling is assumed to occur continuously over a two year construction period. Noise from inter-array cable lay trenching - range of vessels using tools such rock cutter plough through to water jetting and standard ploughs.
Physical injury/mortality from vessels with ducted propellers and ship strike	A range of construction vessels is considered with some exceeding 100 m in length, and others with speeds of>25 kts.
Suspended solids impairing foraging efficiency	Dredging overspill (silts and clays) at 30 kg/s during gravity foundation base seabed preparation, 95 m pit diameter, 5 m pit depth, 3.6 MW layout. Drill arisings (sands, silts and clays) at 26 kg/s during installation of 277 pin piled jacket foundations (four pin piles, 2.4 m, requiring four holes of up to 3 m diameter, 60 m burial) plus burial of up to 325 km inter-array cable length. Elevation in SSC and bed load during installation of inter-array cable based on trenching by energetic means (e.g., jetting) as predicted by coastal processes studies (single trench with cross-section of disturbance 3 m deep by 2.5 m wide, 100 % of material resuspended); release of any associated pollutants into the water column.
Indirect effects due to loss of foraging area/ reduction of prey species	Reduction of prey species within Wind Farm Site over a period of up to four years based on gravity base foundations.
Operation	
Noise disturbance from turbine operation	Noise from 277 3.6 MW turbines
Noise disturbance from maintenance vessels	Maximum of 1760 number of maintenance vessels movements per annum over the operational lifespan of project with vessels of typically 18-20 m in length.
Collision risk from maintenance vessels	Maximum of 1760 number of maintenance vessels movements per annum over the operational lifespan of project with vessels of typically 18-20 m in length.

Potential Effect	Worst Case Scenario Assessed
Behavioural effects arising from EMF	Magnetic field strength of 1.7μT immediately adjacent to cable and 0.61 μT up to 2.5m from cable for a typical 33 core 33 kV array cable. Maximum length of cable (350 km) will be used and buried to a minimum depth of 0.6 m or protected by means of rock placement or cable mattressing.
Changes in prey resources and tidal regimes due to presence of turbine structures	277 3.6 MW gravity bases, three meteorological masts, two AC OSP, one DC converter and up to 487 500 m^2 of cable protection will lead to a total habitat loss/gain of approximately 3.8 km^2 (Section 11: Fish and Shellfish Ecology) and the same scenario will lead to the greatest effect on coastal processes
Cumulative	
Cumulative effect	The Wind Farm Site and OfTW Corridor have been assessed as a single project against cumulative impacts from other projects/activities in the study area and wider region.
Cumulative effect	Moray Firth Round 3 Zone worst case scenario of up to six simultaneous pin pile jacket foundations with a maximum pile diameter of 3 m and optimum blow force of 1800 kJ. A range of piling scenarios were assessed with the shortest timescale, but greatest magnitude, being for cumulatively piling at eight locations over two years and the longest timescale, smallest magnitude, being at two piling locations over six years.

12.2.7.2 Potential Effects on Marine Mammals

29. On the basis of available data and literature, and consultation with regulatory bodies and stakeholders, the main potential effects to marine mammals resulting from offshore wind farm development are considered to be those presented in Table 12.4. For each of the potential effects identified there may be indirect effects on the habitats/prey used by marine mammals or direct effects on the marine mammals themselves.

Table 12.4 Potential Effects to Marine Mammals from Offshore Wind Farm Construction, Operation and Decommissioning

Construction / Decommissioning	Operation
Pile driving noise - Death, auditory injury, displacement, behavioural response	Operational noise – Displacement, interruption of natural behaviour
Noise from vessels, other construction noise – Displacement, interruption of natural behaviour	Noise from vessels and other maintenance activity – Displacement, interruption of natural behaviour
Increased turbidity and re-suspension of polluted sediments – Displacement, loss of foraging efficiency	Collision risk (from O&M vessels), ducted propellers– Potential for injury/death
Collision risk (from construction vessel traffic) - ducted propeller injuries – Potential for injury/death	Electromagnetic emissions – Unknown potential displacement/disturbance of mammals
Indirect effects, e.g. effects on prey from pile	Indirect effects, e.g. changes in food webs,

Construction / Decommissioning	Operation
driving/increased turbidity - Displacement/habitat abandonment	changes in tidal regimes affecting formation of tidal races (harbour porpoise only) – Displacement/habitat abandonment
Potential for spillages of polluting/hazardous materials e.g. due to operation of work boats, platforms other vessels and plant – Potential *toxicity*	Presence of structures – Potential barrier effect – scoped out as marine mammals are frequently recorded around wind farm sites and can navigate around structures

30. Potential effects were assessed using the following approach (IEEM, 2010):

- Proposed activity, duration of activity, biophysical change and relevance to receptor in terms of ecosystem structure and function;
- Characterisation of unmitigated impact on the feature;
- Rationale for prediction of effect on integrity (of a site or ecosystem) or conservation status (of a habitat or population);
- Significance (at population and individual level);
- Mitigation, enhancement and compensation; and
- Residual significance.

31. According to the IEEM guidelines (2010), the likelihood that a change or activity will occur as predicted is best expressed as a 'probability of occurrence'. This probability is based on statistical significance in common scientific practice. The four-point scale employed is:

- Certain/near certain: probability estimated at 95% chance or higher;
- Probable: probability estimated above 50% but below 95%;
- Unlikely: probability estimated above 5% but less than 50%; and
- Extremely unlikely: probability estimated at less than 5%.

32. Potential effects on marine mammals are discussed for each of the potential environmental changes (Table 12.4) that may arise as a result of the construction, operation and decommissioning activities. A quantitative or semi-quantitative assessment of the environmental changes and resulting ecological effects is presented in order to understand the significance of any effects that may occur. Ecological effects are broadly characterised and described as discussed in Section 4: EIA Process and Methodology.

12.2.7.3 Marine Mammals and Noise

33. Marine mammals rely on their hearing to locate prey, for communication, reproduction, detection of predators and navigation. Therefore, these animals are sensitive to anthropogenic noise sources introduced into their environment. Underwater noise from other offshore activities, such as seismic surveying, have been noted as having the capacity to cause behaviour changes, such as avoidance by marine mammals and fish (Richardson, 1995; Turnpenny and Nedwell, 1994). At sufficiently high levels of exposure to sound, for instance during an underwater explosive blast, physical injury, such as deafness, may also occur.

34. Dolphins and porpoises generally produce sounds over some of the widest frequency banks (150 Hz to 180 kHz), with specialised clicks used in echolocation for prey detection and navigation generated at the highest frequency end of the spectrum (>100 kHz) (Southall et al., 2007). Pinnipeds produce sound over a generally lower and more restricted bandwidth (75 Hz to 75 kHz) and are considered to use sound primarily for social and reproductive interactions (Southall et al., 2007). The sensitivity of marine mammals to noise is based on this frequency range and also their threshold of hearing i.e. the level of sound at which they perceive noise. For example, harbour porpoise are highly sensitive as they hear over a broad bandwidth of frequencies and also their range of perception will start at a much lower sound pressure level (dB re. 1 Pa) than for other species (Annex 7A). Pile driving activities (associated with Wind Farm construction) are therefore of special concern as they generate very high sound pressure levels and are relatively broad-band (i.e. across a wide range of frequencies), (20 Hz to >20 kHz; Madsen et al., 2006). In addition to pile driving noise, it is recognised that noise sources associated with wind farm operation and decommissioning could also contribute to the potential effect to marine mammals in a given area. Whilst this low-level noise is considered unlikely to impair hearing, the area of affect is dependent upon the hearing abilities of the marine mammals in the area, sound propagation and presence of other noise sources e.g. shipping (Madsen et al., 2006).

35. The following Sections provide a discussion of the effects of underwater sound on marine mammals and are described under three categories: physical (non-auditory) injury and mortality, auditory injury (either permanent or temporary) and behavioural responses. A full discussion of the potential effects to marine mammals and their associated noise levels is presented in Annex 7A.

12.2.7.4 Physical Injury/Death

36. Lethal effects (i.e. death) and/or physical (non-auditory) injury may occur in marine mammals in extreme cases from noise exposure. Noise levels required to produce these effects are measured as peak to peak pressure waves as the amount of noise does not relate to how the animal perceives noise or may respond to it (Annex 7A). Lethal effects occur at a peak to peak level of 240 dB re. 1 μPa, while physical injury occurs at 220 dB re. 1 μPa (Parvin et al., 2007).

12.2.7.5 Auditory Injury

37. Auditory injury may initially occur as a temporary, but recoverable, change in hearing threshold, or Temporary Threshold Shift (TTS) following noise exposure. Effects include temporary hearing loss but no permanent injury. Recovery of normal hearing function may occur quickly. If hearing does not return to normal after a relatively long interval (i.e. in the order of weeks), then a Permanent Threshold Shift (PTS) has occurred. Therefore the distinction between TTS and PTS depends on whether there is a complete recovery of the individual’s hearing following noise exposure, however the relationship between the two thresholds is complex (Southall et al., 2007). Chronic sound exposure may also give rise to PTS. Effects of PTS include destruction of receptor hair cells in the ear, rupture of middle/inner ears.

38. Southall et al., (2007) proposed noise exposure criteria for levels at which PTS is caused for different functional groups of marine mammals. The criteria for PTS proposed for cetaceans and pinnipeds are presented in Table 12.8 and Table 12.9. These levels are in fact termed PTS-onset criteria, as they are defined as the levels at which PTS starts to occur. Given that PTS cannot be experimentally induced in animals to determine the threshold, noise exposure criteria for PTS-onset are based on the relationship between the relative levels of noise likely to cause TTS and PTS (Thompson et al., 2012).

12.2.7.6 Behavioural Responses

39. Behavioural responses of marine mammals to noise are highly variable and dependent on a number of factors (Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals, 2003):

- Internal factors:
  - individual hearing sensitivity, activity patterns and behavioural state/motivation at time of exposure;
  - past exposure of the animal to noise which may have led to habituation or sensitisation;
  - individual noise tolerance; and
  - demographic factors such as age, sex, presence of calves.
- External factors:
  - whether noise source is stationary or moving;
  - environmental factors that influence sound transmission;
  - habitat characteristics e.g. confined;
  - location, e.g. proximity to a shoreline.

40. These behavioural responses can include changes in surfacing and breathing patterns, cessation of vocalisations and/or active avoidance or escape from the ensonified area. Behavioural disturbance or displacement may be particularly important for seals, where both harbour and grey seals have been shown to demonstrate high levels of site-fidelity to their haul-out sites (e.g. Cordes et al., 2011). Foraging ranges may thereby become concentrated around their breeding and haul-out sites creating increased competition for food. For those individuals displaced; this could lead to greater energetic costs of foraging or reduced foraging (Thompson et al., 2012 (Annex 12B)).

41. Both Southall et al., (2007) and Subacoustech Environmental Ltd. (Subacoustech) have proposed noise thresholds at or over which an animal exhibits a behavioural effect to noise exposure. However, Southall et al., (2007) only provide criteria for a single pulse exposure, due to the lack of sufficient data to identify appropriate criteria for multiple pulse or continuous noise (Annex 7A). Subacoustech's dB_{ht} approach suggests that animals will show a strong avoidance reaction to levels at and above 90 dB_{ht} and milder reactions to levels of 75 dB_{ht} and above. Noise levels giving rise to behavioural disturbance and/or displacement and development of these thresholds for the noise modelling are described in more detail later in this Section.

12.2.7.7 Noise Modelling and Assessment

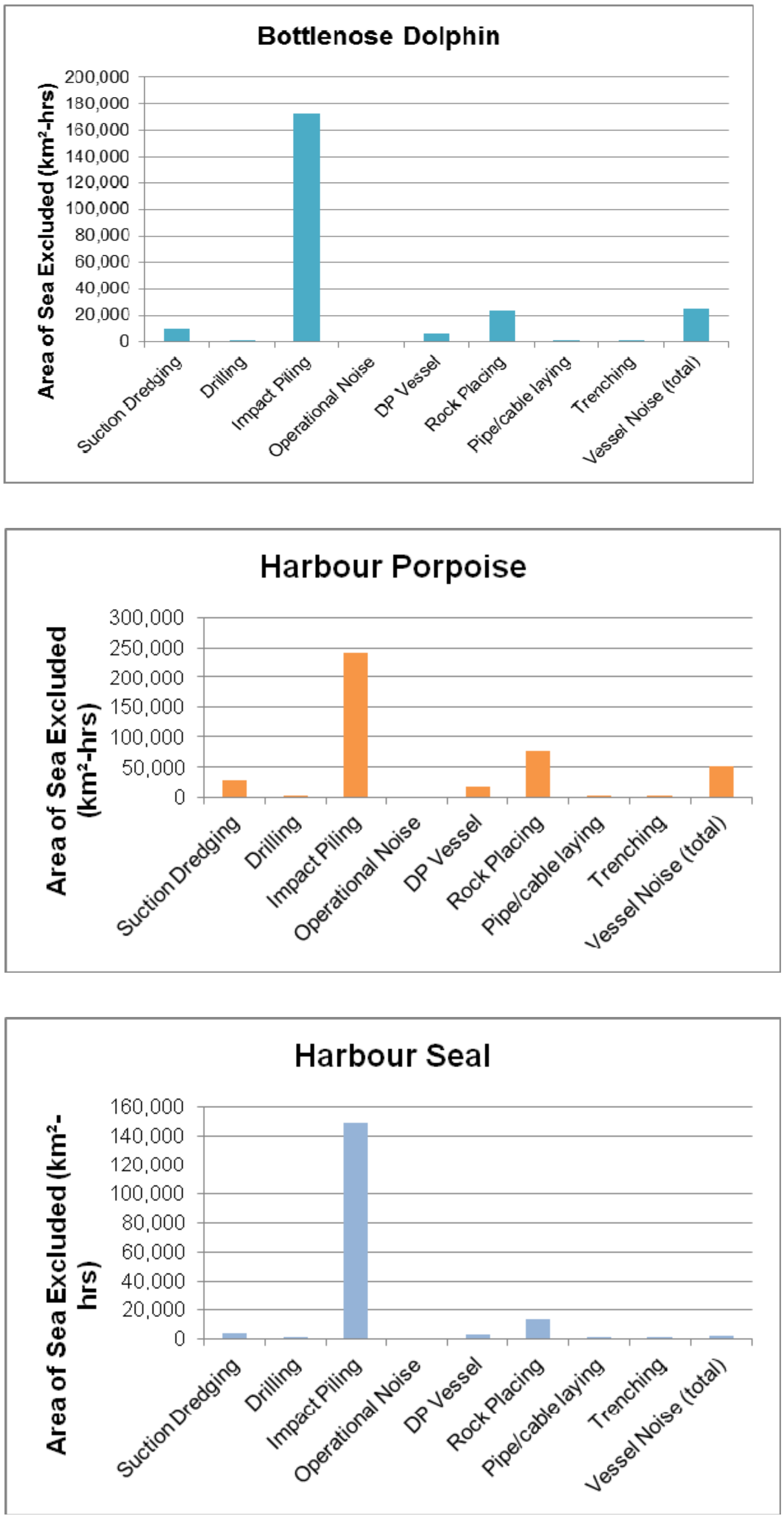
42. Subacoustech has undertaken a study of the potential effects of underwater noise from impact pile driving operations in the Wind Farm Site on marine mammals (see Annex 7A). The assessment is supported by a review of available literature and empirical data relating to the effects of impulsive sound on marine mammals, drawing particularly on findings from operational offshore wind farm sites. This work was undertaken in conjunction with MORL.

12.2.7.8 SPEAR Modelling – Ranking of Noise Sources

43. Given the high noise levels resulting from pile driving in comparison with other sources of noise during construction, operation and/or decommissioning, the potential effects of greatest concern to marine mammals from noise have been identified as effects associated with noise during piling. The noise modelling assessment therefore focuses on those potential effects arising from construction noise, however Subacoustech have modelled and ranked other noise sources associated with Wind Farm development as described below.

44. The SPEAR model was used to rank order a wide range of activities associated with the development of offshore wind that generate sources of underwater noise (Annex 7A). This step was taken in order to identify those noise sources that are significant in affecting the species of marine mammal considered in this assessment. This ranking of noise sources thereby allows activities which cause negligible adverse effect to be eliminated from further consideration in the assessment. The activities considered included impact piling, ducted propeller vessels, trenching, cable laying, drilling, rock placing, dredging, operational noise and other vessel noise. The SPEAR model outputs identified areas of the marine environment that are rendered unusable by a particular species of concern (i.e. in the case of this assessment bottlenose dolphin, harbour porpoise and harbour seal), as a result of that particular activity. From the results, it was evident that impact piling is the dominant noise source and therefore the activity that will have the greatest effect (Plate 12.1).

Plate 12.1 Relative Importance of the Effect of Development Activities on Key Species



12.2.7.9 INSPIRE Modelling – Impact Piling

45. The INSPIRE (Impulse Noise Sound Propagation and Impact Range Estimator) model predicts the propagation of impulsive broad band underwater noise in shallow waters. This model has been used in this assessment to model a number of construction scenarios as described within the turbine piling scenarios in Table 12.5 and summarised below.

46. The potential effects of pile driving for different diameter pin piles were modelled to determine which represented the worst case scenario in terms of magnitude of potential noise effects. In addition, the 5 m meteorological mast monopiles and 3 m substation pin piles were also modelled. The pile driving for the meteorological mast monopiles will be carried out singly and it was found that the noise effect was less than that for the two simultaneous pile driving events for installation of the pin piles. Initial modelling runs by Subacoustech also found that the pinpiled 3 m OSP foundations were negligibly different to the 2.4m pin piles for turbines and, given the limited number of OSPs on the site (two to three), these were not assessed any further. Therefore, the pile driving of the 2.4 m pin piles for 277 turbines was taken forward in the Rochdale envelope for the assessment.

Table 12.5 Summary of Turbine Piling Scenarios Modelled for the Wind Farm

Pile Location	Pile Diameter	Blow Force	Species	Potential Effect
Wind Farm A	2.4 m 2.4 m	2300 kJ 1800 kJ	Bottlenose dolphin, harbour porpoise, harbour seal, grey seal	Death/physical injury, PTS (Sound Exposure Levels) (SELs)), dBht for behavioural responses (see Table 12.8 and Table 12.9)
Wind Farm B	2.4 m 2.4 m	2300 kJ 1800 kJ	Bottlenose dolphin, harbour porpoise, harbour seal, grey seal	As above
Wind Farm A+B	2.4 m 2.4 m	2300 kJ 1800 kJ	Bottlenose dolphin, harbour porpoise, harbour seal, grey seal	As above

Note: there were no data available to model noise thresholds for minke whale.

Development of Noise Thresholds

47. Noise modelling was undertaken using methods and threshold criteria described in Southall et al., (2007) (M-weighted SELs) and those developed by Subacoustech (dB_{ht} method). Both methods are summarised below and described in detailed in Annex 7A.

48. The method proposed by Southall et al., (2007) considers the SEL over a given period, thereby accounting for both the Sound Pressure Level (SPL) at sound source and the duration the sound is present in the acoustic environment. The M-weighted SEL metric is based on filtering underwater noise data using a generalised frequency weighting function, designed to match the frequency response of different groups of marine mammals –high, mid and low frequency

cetaceans, and pinnipeds in water or in air (see Table 12.6). Each group has an assigned frequency range of hearing based on known audiogram data, where available, or inferred from auditory morphology and ambient noise levels in the frequency ranges they use.

Table 12.6 Functional Marine Mammal Hearing Groups and Auditory Range Over Which Each Group Hears Underwater (Southall et al., 2007)

Functional hearing group	**Estimated auditory bandwidth**	**Species in the Moray Firth**	**Frequency-weighting code**
Low frequency cetaceans	7 Hz - 22 kHz	Minke whale	M_{lf}
Mid frequency cetaceans	150 Hz - 160 kHz	Bottlenose dolphin Common dolphin White beaked dolphin Risso's dolphin Killer whale	M_{mf}
High frequency cetaceans	200 Hz - 180 kHz	Harbour porpoise	M_{hf}
Pinnipeds in water	75 Hz – 75 kHz	Harbour seal Grey seal	M_{pw}

49. For the low, medium and high frequency cetaceans the criteria for the onset of behavioural effects is given as an SEL of 183 dB re 1 µPa^2/s and 15 dB more (i.e. 198 re 1 µPa^2/s) for the onset of PTS. For the pinnipeds in water the SEL criteria is 171 dB re 1 µPa^2/s for behavioural effects and 186 dB re 1 µPa^2/s for PTS. The PTS threshold for pinnipeds has subsequently been revised due to insufficient evidence to support Southall's (2007) proposal for different criterion for pinnipeds and cetaceans (Thompson et al., 2011). It has therefore been proposed that an M-weighted PTS-onset threshold of 198 dB re. 1 µPa^2/s be used, which reflects the only studies available to Southall et al., (2007) in which exposure to pulsed noise induced TTS in marine mammals.

50. The Subacoustech dB_{ht} metric is based on a frequency weighting system related to the hearing threshold of the species under consideration (Nedwell et al., 2007a). The dB_{ht}(species) level is estimated for a specific species by passing the sound through a filter that mimics the hearing ability of the species, and then measuring the level of the sound after the filter (Nedwell et al., 2007b). This produces a level that is different for each species. Levels specific to those used in this assessment are presented in Table 12.7.

Table 12.7 Assessment Criteria Proposed for db$_{ht}$ (Species) used in this Study to Predict the Potential Behavioural Effect of Underwater Noise on Marine Species

Level in dB$_{ht}$ (species)	Effect
0	None
0-75	Mild reaction in minority of individuals, probably not sustained.
75-90	Significant avoidance reaction by up to 50% of individuals although habituation will limit the response
90 and above	Strong avoidance reaction by virtually all individuals with potential for TTS over prolonged exposure.
Above 110	Tolerance limit of sound: unbearably loud and causing TTS from a single event.
Above 130	Possibility of traumatic hearing damage (causing PTS) from a single event.

51. Table 12.8 and Table 12.9 presents the noise exposure thresholds investigated for each type of potential effect on marine mammals from noise generated during pile driving at the Wind Farm Site. Discussion with statutory authorities has highlighted the uncertainties in these thresholds for PTS, TTS and behavioural responses. Following on from these discussions an assessment framework has been developed to assess effects to the Moray Firth harbour seal (Thompson et al., 2012 (Annex 12B)).The development of thresholds for PTS and behavioural responses as presented in the assessment framework is further described below.

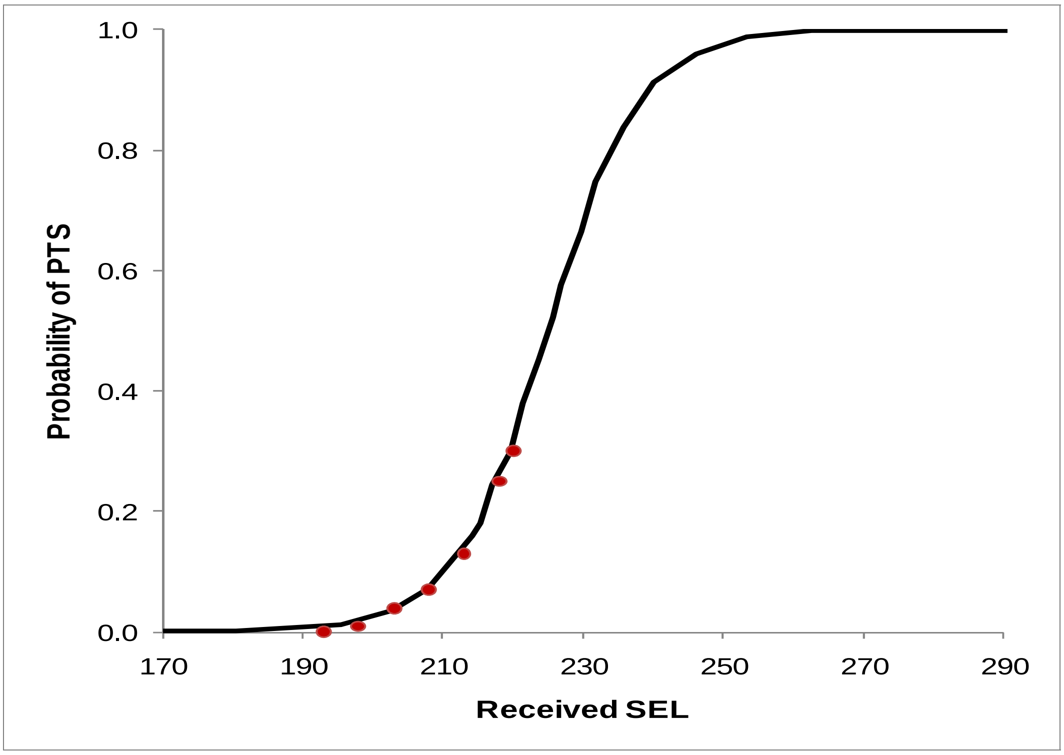
52. The assessment framework developed by Thompson et al., 2012 (Annex 12B) has been adopted for the harbour seals assessment. Its applicability to cetaceans is described in Section 12.2.9.4.

PTS-onset

53. PTS is not likely to occur at the same noise threshold for all individuals and/or during all circumstances of noise exposure. Therefore, it is expected that there is an increasing likelihood of PTS in relation to the noise dose received (Thompson et al., 2012 (Annex 12B). It has been a common assumption in ESs to date that all animals within the PTS threshold will experience PTS. However, a model developed by the University of St Andrews as part of their Environmental Risk Management Capability assessment framework, called SAFESIMM, uses a theoretical dose-response curve for PTS, scaled from a TTS dose-response curve developed by Finneran et al., (2005). This predicts the probability of animals experiencing PTS increases from a SEL of 198 dB up to 250 dB, the latter being the level at which all animals are predicted to experience PTS (Thompson et al., 2012 (Annex 12B)). Thompson et al., (2011) have proposed a PTS dose-response relationship based upon the SAFESIMM approach as described in detail in their framework assessment. This assessment provides an estimate of the number of animals within the PTS threshold that are affected based on this dose response (Plate 12.2).

Plate 12.2 Proposed PTS Dose-Response Curve For A PTS-Onset of 198 dB (Based on SAFESIMM Model).

Note: red points correspond to SEL contours generated using INSPIRE.



Behavioural Response

54. As discussed above with regard to the PTS-onset criteria, individuals are unlikely to respond to noise exposure at consistent received levels, and it is more appropriate to consider responses in terms of a curve that describes the relationship between sound level and the proportion of animals predicted to respond rather than a simple step-change threshold (e.g. 75 or 90 dB_{ht}) (Thompson et al., 2012 (Annex 12B)). Therefore as part of the framework assessment proposed by Thompson et al., (2011), a dose-response curve relationship has also be developed to predict responses to varying levels of noise across a wide range of dB_{ht} levels (Plate 12.3). Data on the proportional change, (i.e. difference between baseline period and data collected after piling), in the detection of porpoises on C-PODs moored at different distances from a piling event was taken from the Horns Rev II monitoring studies (Brandt et al., 2011) and used to estimate the variation in the level of behavioural response (displacement). This ES has also adopted this relationship for behavioural responses to noise exposure in calculating the numbers of animals affected using predicted noise contours generated by the noise modelling.

Plate 12.3 Proposed Relationship Between dBht for Harbour Porpoise and the Predicted Proportion of Animals Excluded from the Area.

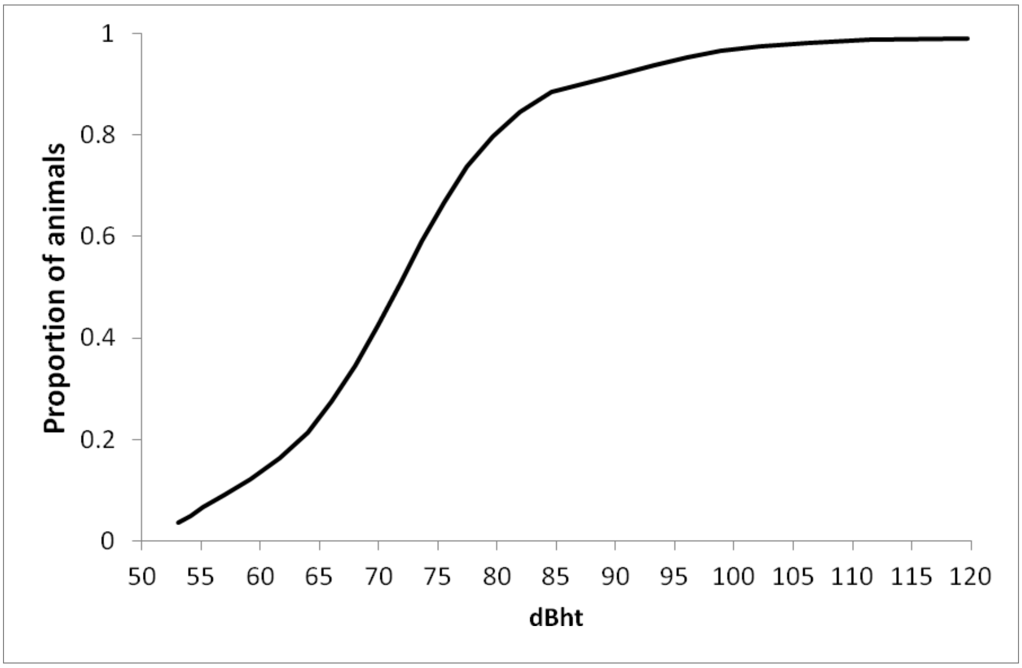


Table 12.8 Summary of Thresholds Considered in Noise Modelling – Harbour Porpoise and Bottlenose Dolphin

Species	Potential effect	Method of assessment	Threshold calculated	Assumptions
Harbour Porpoise/ Bottlenose Dolphin	Permanent physical injury/death	Subacoustech (Nedwell et al., 2007)	240 and 220 dB re. 1 µPa (Unweighted) for lethal and physical injury, respectively	Following Parvin et al., (2007) and based on data in the studies of Yelverton et al., (1975), Turnpenny et al., (1994), Hastings and Popper (2005).
		Southall et al., 2007	No given criteria	Not applicable.
Harbour Porpoise/ Bottlenose Dolphin	PTS	Subacoustech	130 dBht	Possibility of traumatic hearing damage from a single event.
		Southall	198 dB re. 1 µPa2/s for Mid and High Frequency Cetaceans	PTS on-set criteria (i.e. level at which PTS starts to occur). Cumulative (long-term) injury; uses mid and high frequency cetacean level from Southall (fleeing and stationary).
Harbour Porpoise/ Bottlenose Dolphin	TTS	Subacoustech	110, 120, 130 dBht	Refer to Table 12.7.
		Southall	No given criteria	TTS data used in development of PTS criteria – insufficient data to use in assessments
Harbour Porpoise/ Bottlenose Dolphin	Behavioural effect	Subacoustech	50, 55, 60, 65, 70, 75, 80, 85, 90, 100, 110, 120 dBht	90 dBht - Strong avoidance reaction by virtually all individuals. 75 dBht (precautionary) – Some avoidance, about 50% of individuals will react to the noise, although the effect will probably be limited by habituation.
		Southall	183 dB re. 1 µPa2/s for Mid and High Frequency Cetaceans	Tentative criteria for single blows - recognised as tentative by authors. Southall model does not propose behavioural response criteria for multiple pulses i.e. piling. Therefore not used in assessments.

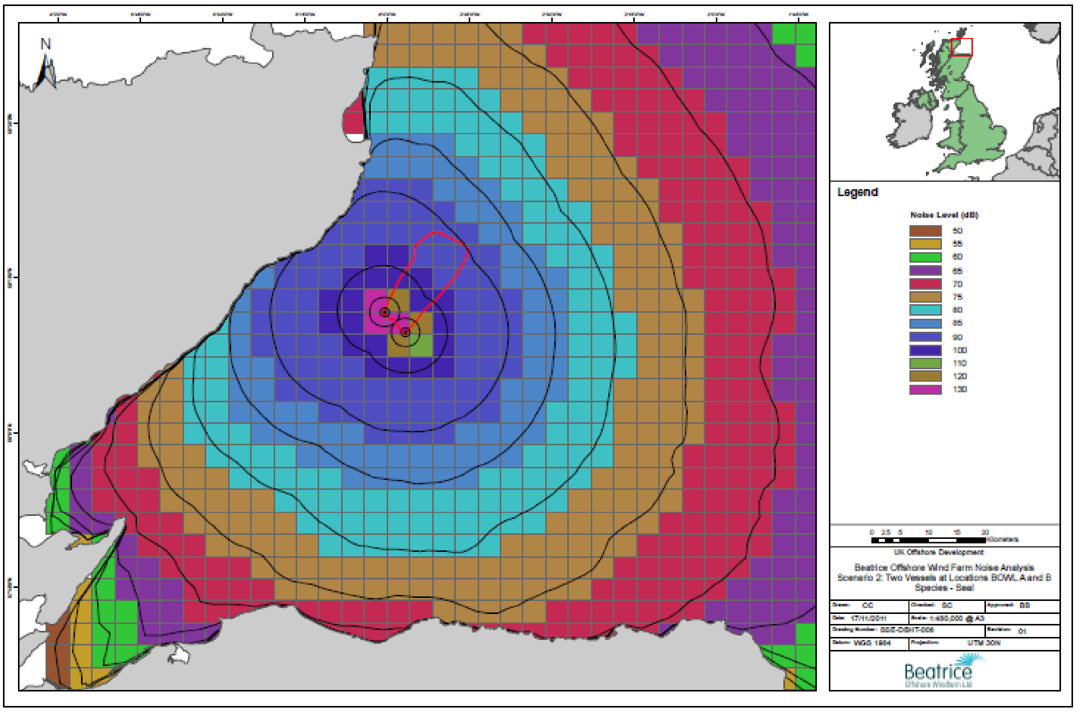
Table 12.9 Summary of Thresholds Considered in Noise Modelling – Harbour Seal and Grey Seal

Species	Potential effect	Method of assessment	Threshold calculated	Assumptions
Harbour Seal/ Grey Seal	Permanent physical injury/death	Subacoustech	240 and 220 dB re. 1 µPa (Unweighted) for lethal and physical injury, respectively	Following Parvin et al., (2007) and based on data in the studies of Yelverton et al., (1975), Turnpenny et al., (1994), Hastings and Popper (2005).
		Southall	No given criteria	Not applicable.
Harbour Seal/ Grey Seal	PTS	Subacoustech	130 dB_{ht}	Possibility of traumatic hearing damage from a single event
		Southall	198 dB re. 1 µPa²/s for Pinnipeds (in water)	Uses mid and high frequency cetaceans from Southall revised from pinnipeds in water threshold (see explanation in *para*0), as agreed with statutory authorities
Harbour Seal/ Grey Seal	TTS	Subacoustech	110, 120, 130 dB_{ht}	Refer to Table 12.6.
		Southall	No given criteria	TTS data used in development of PTS criteria – insufficient data to use in assessments.
Harbour Seal/ Grey Seal	Behavioural effect	Subacoustech	50, 55, 60, 65, 70, 75, 80, 85, 90, 100, 110, 120 dB_{ht}	90 dBht - Strong avoidance reaction by virtually all individuals. 75 dBht (precautionary) – Some avoidance, about 50% of individuals will react to the noise, although the effect will probably be limited by habituation.
		Southall	171 dB re. 1 µPa²/s for Pinnipeds (in water)	Tentative criteria for single blows - recognised as tentative by authors. Southall model does not propose behavioural response criteria for multiple pulses i.e. piling – therefore not used in assessments.

12.2.7.10 Spatial Model of Received Noise Levels

55. The INSPIRE model outputs of predicted received noise levels in different parts of the Moray Firth as a result of piling were used within ARC GIS to assess the maximum received levels in each of the 4 x 4 km grid squares for which there were predictions of densities for marine mammal species. It was assumed that if any point of a 4 x 4 km grid square reached a particular threshold, the whole of the square was assigned that value. This work was carried out by SeaRoc for SEL levels and dB_{ht} levels for each potential effect. An example of the outputs of this exercise is presented in Plate 12.4 below, which shows the resulting noise levels for each grid square for the dB_{ht} metric. Outputs from this analysis for each species are discussed in Section 12.5).

Plate 12.4 Example Map Showing the Variation in Received Noise Levels in each 4 X 4 km Grid Square in the Study Area



12.2.7.11 Estimation of Numbers of Affected Individuals

56. The next step of the process to determine the potential effect on marine mammals due to physical injury/death, auditory injury and displacement was to estimate the number of individuals of each species that would be exposed to each of these potential effects. It should be noted that this was only possible for harbour and grey seals and harbour porpoise, as comparable density distribution were not available for bottlenose dolphin. The proposed thresholds for each of these potential effects were discussed previously (see Table 12.8 and Table 12.9), and are summarised below:

- Death - 240 dB re. 1 µPa (unweighted);
- Physical injury – 220 dB re. 1 µPa (unweighted);
- PTS – refer to dose response curve shown on Plate 12.2; and

- Behavioural disturbance – refer to behavioural response curve shown on Plate 12.3.

57. The proportion of each species in each grid square that would be displaced by the received noise level in that square was predicted using the relationships already described for PTS and behavioural disturbance. The total number of individuals affected in the study area was calculated by summing the proportions from each grid square. These estimates are presented in the discussion of potential effects for each species assessed and are expressed in terms of the relevant population for that species.

12.2.7.12 Population Modelling

58. When considering estimates of numbers of individuals affected by piling, population modelling is required to determine the long-term population level effects for harbour seals, population modelling would need to be undertaken as part of the ES. UA were appointed to develop the population model for the Moray Firth harbour seal population as part of the assessment framework developed by Thompson et al., 2012 (Annex 12B).

59. The model incorporated each of the potential effects described previously (Paras 36 to 41) including: lethality and physical injury, auditory injury, and behavioural responses. For each potential effect the framework identified the most appropriate approach (Southall et al., 2007 or Subacoustech dB_{ht}), the justification behind each selection and the limitations of using each approach (Thompson et al., 2011).

12.2.7.13 Linking Individual Effects to Demographic Parameters

60. As part of the model development, a number of assumptions were required to be made regarding demographic/biological parameters and how these could be affected by each type of potential effect. A conservative approach was deemed appropriate in the development of these assumptions in order to provide a worst case scenario (see Table 12.10). In addition, the model assumed that seals typically spend 75% of their time at sea, but this value is known to be much lower during the breeding season.

61. A combination of the Southall et al., (2007) and Subacoustech dB_{ht} approaches were used to model potential effects and the thresholds for each are given in Paragraph 56.

Table 12.10 Worst Case Fitness Consequences for Individual Harbour Seals with regard to Potential Effects from Noise Exposure due to Pile Driving (adapted from Thompson et al., 2012 (Annex 12B)

Potential Effect	**Consequence**		**Assumptions**	**Confidence Level*** **
	Intermittent exposure*	**Constant exposure**		
Death	Immediate mortality	Immediate mortality	Major impacts at close range <50 m; mitigated against using standard procedures e.g. soft start.	High
Physical injury	Immediate mortality	Immediate mortality	As above.	High
PTS	25% risk of mortality**	25% risk of mortality** Remaining 75% risk of behavioural disturbance (see below)	Harbour seals less sensitive to changes in hearing sensitivity from PTS than cetaceans; potential reduction in foraging competition for individuals with PTS that remain at foraging areas; risk of increased predation from killer whales due to reduced hearing is low due to rare encounters of killer whales in the Firth; other reproductive cues exist e.g. visual, geographic for males to attract females.	Very Low
Behavioural disturbance	Proportional reduction in reproductive success and/or juvenile survival	100% reproductive failure	Fitness consequences expressed as a reduction in fecundity. Direct linear relationship between amount of year individuals displaced from foraging areas and consequent reduction in reproductive success.	Low Very Low

Notes: *Intermittent exposure e.g. due to periodic or seasonal piling
**PTS fitness consequences expressed as 25% mortality during the year of exposure
***Confidence in the consequences for intermittent and constant exposure

12.2.8 SIGNIFICANCE CRITERIA

62. The significance of potential effects has been based upon the value, sensitivity and importance within the study area of each marine mammal receptor combined with the magnitude of the likely effect. All marine mammals are generally considered to be high value receptors due to their conservation and protection status but their sensitivity to a given effect may vary (e.g. different species have different hearing sensitivities) and their importance within the study area also differs (e.g. SAC population of one species compared with a few irregular sightings of another species). Therefore, for a given magnitude of effect (small, medium or large) the effect will differ between species and so too will the significance of that effect (Section 4: EIA Process and Methodology). Whilst effects are broadly categorised as 'negligible', 'minor', 'moderate' and 'major' there is also the potential for an effect to fall in between these categories.

63. Potential effects were not just assessed on an individual basis, instead the magnitude of the effect upon individuals was compared to the wider population such that the potential tolerance of the population and its recoverability were taken into consideration in the assessment. In the context of SAC populations (i.e. those of bottlenose dolphins and harbour seals within the Moray Firth), potential losses of individuals through either lethal effects, injury or PTS were assessed in terms of the percentage increase over and above natural mortality levels. The thresholds for calculating potential losses arising from each of these potential effects are presented in Table 12.8 (bottlenose dolphin and harbour porpoise) and Table 12.9 (harbour and grey seal) above. For each potential effect, the noise modelling study gave an area over which each effect occurs for each species. In addition, the effect was also expressed as the area of sea excluded over a particular timescale allowing comparisons between different activities at any one time e.g. short piling operation compared to all-day dredging activity. This was expressed as km^2 times hours of sea excluded (see Annex 7A for further description of this calculation).

64. In terms of the EIA Regulations, only major or moderate effects are considered to be significant and therefore requiring mitigation. Minor and negligible effects are not considered to be significant in terms of the EIA Regulations.

12.2.9 ASSESSMENT LIMITATIONS

65. This assessment is based upon the best available information on marine mammal populations within the Moray Firth at the time of writing. However, a number of assumptions have been made at various stages of the assessment process. These assumptions and limitations have been presented and discussed in the relevant Sections of this assessment and are summarised here. It should also be noted that all assumptions are conservative and are therefore in accordance with the precautionary principle.

12.2.9.1 Marine Mammal Distribution

66. The data collected for cetaceans generally represents a snapshot of their usage and distribution within the study area, particularly where for species that are highly mobile and wide ranging i.e. bottlenose dolphins, and therefore more difficult to

survey. However, for species that may be surveyed via telemetry studies such as harbour and grey seals, there is a greater degree of confidence in the distribution/movements and densities of animals and the data for harbour seals, in particular, can be viewed as representative of the Moray Firth population (Thompson et al., 2012 (Annex 12B)).

67. There are several reasons why it is more difficult, and less appropriate, to produce equivalent maps for bottlenose dolphins. First, bottlenose dolphin distribution is known to be much patchier, with high use areas in the coastal strip of the Moray Firth, and survey techniques have differed in these high and low density areas. Second, these animals are highly mobile, so an average density based on studies over a large area (e.g. SCANS II data) are of more limited use when considering their likely presence in relatively small areas of interest around an offshore wind farm site.

68. There is also an element of uncertainty associated with extrapolating field data to predict marine mammal numbers using habitat-association modelling. For example, in some 4 x 4 km grid cells there were no habitat data available and therefore these had to be removed from the analyses. A description of the approach to habitat association modelling and its caveats is given in Thompson and Brookes (2011) (see Appendix 1 in Annex 12A).

12.2.9.2 Noise Modelling

69. INSPIRE calculates noise exposures on straight line transects, and so when a limit of bathymetry data is reached before a result is calculated, the model leaves a gap in the contour. A complete contour can still be approximated however, and so the missing section was completed by hand based on the bathymetry along that transect and the expected behaviour of an animal as it reached the limit. For example, where the data limit is as a result of meeting a beach, a seal would probably haul-out, reducing its overall exposure. The assessment was therefore based on this approximation of the complete noise contour.

70. Noise modelling represents a prediction of the zones in which marine mammals experience different effects. The noise levels at which species respond is based on audiograms of a particular animal and there is lack of empirical evidence to aid understanding of how different species react to noise threshold and indeed different animals within a species. For example, in the Southall et al., (2007) assessment the TTS onset data for bottlenose dolphins exposed to pulsed noise was based on the study of a single beluga whale. This has been overcome to some extent by the use of a dose-response curve, but this itself is based on harbour porpoise only and there is no evidence to support the shape of the response curve for other species.

71. In terms of behavioural responses the use of the dB_{ht} approach was the most suitable as there was no comparable behavioural threshold in Southall et al., (2007). The Subacoustech dB_{ht} approach is also widely used and accepted by MS and SNH/JNCC. In order to adopt a precautionary approach the 75 dB_{ht} noise contour was therefore considered as the outmost threshold for potential behavioural effects.

72. Assumptions for each of the noise thresholds is given in Table 12.8 above and further discussed in Annex 7A.

12.2.9.3 Assessment of effects on individuals and populations

73. There is limited knowledge of the sensitivity of many marine mammal species to noise effects in particular and therefore in some instances species assumed to have similar sensitivities, and for which more detailed information is available, have been used as surrogates. The use of surrogates to undertake the noise assessment is detailed in Annex 7A.

74. There are also limitations in terms of the scientific understanding of responses of marine mammals to noise effects. In the first instance, the biological significance of an individual's response to a given noise level is poorly understood and therefore assumptions have had to be made as to the possible effect of displacement on, for example, fitness. Secondly, there is a high-level of uncertainty as to the population-level effects of excluding marine mammals from a large proportion of their potential range. If animals respond by moving to other areas to feed and do not suffer consequences such as reduced fitness (which may be expressed as reduced fecundity), then it can be assumed that there are unlikely to be long-term effects on the viability of the population. For harbour seals, this has been answered through population modelling (Thompson et al., 2012 (Annex 12B), but this framework could not be applied in the same way to bottlenose dolphin since the underlying data is not as robust.

75. In the assessment for bottlenose dolphins, a semi-quantitative approach was employed which combined distribution data together with expert knowledge on distribution ecology and behaviour of bottlenose dolphins in the Moray Firth and considered this information in the context of the noise impact areas (see Section 12.5.1.1).

76. Whilst a fully quantitative approach might have been possible by using independent data on population size (e.g. Cheney et al., 2011) to estimate the number of individuals that might fall with the noise contour bands, this is not considered appropriate for mobile schooling species, such as bottlenose dolphin (see Section 12.3.2.1 and discussion in Harbour Seal Framework paper, Thompson et al., 2012 (Annex 12B)).

77. The strengths of the quantitative and semi-quantitative approaches are due to be explored when the results of this modelling work is presented as a case study at a regulator workshop currently scheduled for 2012 that aims to develop procedures for assessing population level effects of renewable energy developments in the future (Thompson pers. comm).

12.2.9.4 Population modelling framework and applicability to cetaceans

78. The assessment framework developed by Thompson et al., (2011) has been adopted for the Wind Farm for the harbour seals assessment and to some degree for cetaceans. The assumptions made to develop the framework for seals are given in Table 12.10 above. A number of assumptions have also been made in applying this

framework assessment to cetaceans. The framework discusses the suitability of its application to cetaceans, and emphasises that there are key differences in considering population effects. One such difference is the underlying data on animal distribution and how it is typically collected for cetaceans, i.e. through larger-scale visual surveys rather than through telemetry studies. This means that the cetacean data is restricted in terms of access to areas during a survey and therefore may not adequately gain information on all areas visited by a particular species (Thompson et al., 2012 (Annex 12B)).

79. Another key difference is the species difference in ranging patterns, as harbour seals tend to spend considerable time in the same foraging areas in relation to their travel to/from haul-out sites. However, bottlenose dolphins are highly mobile and wide ranging animals, with individuals from the Moray Firth population often occurring in large groups, both within the Moray Firth and further away such as the Firth of Forth (Thompson et al., 2012 (Annex 12B)). Therefore density estimations for bottlenose dolphins can prove a poor representation of the actual population at any one time in any one area due to the extremely mobile nature of this species.

80. Conversely, application of the framework assessment for harbour porpoises is likely to be more suitable than for bottlenose dolphins as this species are often seen as individuals or small groups and at high densities across the Moray Firth. Also importantly, the framework assessment proposed approach to assessing behavioural responses was derived from data from studies of porpoises in similar habitats, such as at Horns Rev II (Thompson et al., 2012 (Annex 12B)).

12.3 BASELINE CONDITIONS

12.3.1 DESIGNATIONS AND LEGISLATION

12.3.1.1 Cetaceans

81. Cetaceans are protected under Annex IV of the EC Habitats Directive (92/42/EEC) because they are endangered, vulnerable or rare (Table 12.11). Harbour porpoise and bottlenose dolphins are Annex II (Habitats Directive) species for which SACs are designated by member states to ensure their protection and for the conservation of habitats that are essential to their life and reproduction. The Habitats Directive is transposed into UK law through the Conservation (Natural Habitats & c) Regulations 1994 (as amended in 2007) (referred to as the 'Habitats Regulations'). All species of cetaceans are listed in Schedule 2 of these Regulations as European Protected Species (EPS), which are protected by law from deliberate capture, injury or killing, deliberate disturbance, or damage to a resting place. Licensing for inshore activities (within 12 nm) is the responsibility of Marine Scotland, whilst licensing for offshore activities is undertaken by Defra.

82. Whales and dolphins are also fully protected under schedule 5 of the Wildlife and Countryside Act 1981 (WCA) (as amended), which makes it an offence to kill, injure, or disturb them in their places of shelter or rest (i.e. the seas in which they live). In addition, Schedule 6 (Part 3) of the Nature Conservation (Scotland) Act

2004 amends the WCA, making it an offence to intentionally or recklessly disturb a dolphin, porpoise or whale (collectively known as cetaceans) or basking shark.

12.3.1.2 Seals

83. Seals are listed on Annex V of the Habitats Directive and as such are legally protected by regulations on the number that can be taken from the wild. Under the Marine Scotland Act 2010, this protection has been strengthened such that it is an offence to kill or take a seal at any time, unless under licence or for animal welfare reasons. This Act supersedes all existing seal legislation e.g. the Conservation of Seals Act 1970 and the Conservation of Seals (Scotland) Order 2004. In addition, it is now an offence under the Marine (Scotland) Act 2010 to disturb seals at designated haul out sites in Scotland. Although not afforded the protection given to EPS, both harbour and grey seals are listed on Annex II of the EU Habitats Directive and therefore, where included as a feature, receive a level of protection under certain SAC designations.

12.3.1.3 International Agreements

84. The Bonn Convention on the Conservation of Migratory Species of Wild Animals (1979) provides protection for migratory animals (listed on Appendix II) over all or part of their natural range through international cooperation, including strict protection for endangered species (Appendix I). In order to achieve this, a number of legally binding agreements have been made by contracting parties, one of which is the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS). Under this agreement, provision is made for the protection and management of cetaceans through research, monitoring, pollution control, raising public awareness and reducing problems such as by-catch and disturbance.

85. The Bern Convention on the Conservation of European Wildlife and Natural Habitats (1979) ensures protection of wild animals species and their habitats (listed in Appendices I and II) and to regulate exploitation of some species (Appendix III). The Convention for the Protection of the Marine Environment of the Northeast Atlantic (OSPAR, 1998) aims to maintain and improve the biodiversity of the Northeast Atlantic through a number of key measures which includes identification of species and habitats that are in threat of decline and require protection.

86. The Convention on International Trade in Endangered Species (CITES) regulates the commercial trade in species listed on Appendix I or II of the convention. Those cetaceans and pinnipeds known from the Moray Firth and which are listed on Appendix II are detailed in Table 12.11. These species are not necessarily threatened with extinction but may become so and therefore are strictly regulated.

87. Species were also checked against the IUCN Red List of Threatened Species to determine their current threat status and all species were listed as Least Concern (LC) (IUCN, 2010).

Table 12.11 Summary of Legislation and Nature Conservation relevant to the Protection of Cetaceans and Pinnipeds Considered in this Assessment

Species	Wildlife and Countryside Act 1981	EC Habitats Directive (Annex)	Bonn Convention (Appendix)	Bern Convention (Appendix)	CITES (Appendix)	Conservation of Seals Act 1970	OSPAR (annex)	ASCOBANS	Section 74 CRoW Act 2000	UK Biodiversity Action Plan*
Bottlenose dolphin	5 & 6	II&IV	II	II	II	-	-	yes	yes	SD
Harbour porpoise	5 & 6	II&IV	II	II	II	-	V	yes	yes	HP
Atlantic white-sided dolphin	5	IV	II	II	II	-	-	yes	yes	SD
White-beaked dolphin	5	IV	II	II	II	-	-	yes	yes	SD
Risso's dolphin	5	IV	II	II	II	-	-	yes		
Common dolphin	5 & 6	IV	II	II	II	-	-	yes	yes	SD
Minke whale	5	IV	-	III	I	-	-		yes	BW
Harbour seal	-	II & V	II	III	-	yes	-	-	-	-
Grey Seal	-	II & V	II	III	-	yes	-	-	-	-

88. Abbreviations used in Table 12.11 are as follows:

- SD – small dolphins grouped plan
- HP – harbour porpoise species plan
- BW – baleen whales grouped plan

12.3.1.4 Natura 2000 sites

Moray Firth SAC

89. Species listed on Annex II of the EU Habitats Directive are those for which strict protection is required through the designation of Natura 2000 sites, such as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

90. Bottlenose dolphins are an Annex II species that are a primary reason for designation of the Moray Firth SAC (Figure 8.1). This is the only known resident population of bottlenose dolphins in the North Sea, with approximately 195 individuals (95% CI 162-253) present in the Moray Firth all year round, although there natural variability in the proportion of the population that are present in the Moray Firth (Cheney et al., in press a). Whilst estimates of the SAC population have varied over the years, a substantial proportion (~50%) of the total Moray Firth population regularly use the SAC suggesting that this is an important area for the resident population and therefore the total Moray Firth population of 195 individuals is also taken as the size of the SAC population (Cheney *et al.* in press b). For the purposes of the assessment the density of bottlenose dolphins has been estimated based on the data collected from the Moray Firth and presented in Annex 12A and in Thompson and Brookes 2011.

91. The SAC extends from the inner firths to Helmsdale on the north coast and Lossiemouth on the south coast (Figure 8.1). As a result of this designation, SNH has a responsibility to report on the condition of the SAC for the conservation status of the bottlenose dolphin population every six years.

92. The current condition status assessment of the population is "Unfavourable (recovering)" and is based on a number of conservation targets for the interest feature (i.e. bottlenose dolphins) for this SAC, for example, maintaining or increasing population of dolphins using the SAC (Thompson et al, 2006; Thompson et al., 2009). Previous work showed that there was a reduction in the use of the SAC by dolphins during the late 1990s, followed by a slight increase during the previous 2002-2004 reporting period(SNH, 2006).

Dornoch Firth and Morrich More SAC

93. The Dornoch Firth and Morrich More SAC is an estuarine environment with a diverse range of estuarine and coastal habitats from mud and sand flats through to coastal sand dunes and heath (Figure 8.1). There are 12 Annex I habitats that are primary reasons for designation and two Annex II species, namely otter *Lutralutra* and common (or harbour) seal *P. vitulina*. The Dornoch Firth supports a breeding population of common seals that represents almost 2% of the UK population (JNCC, 2011).

94. The condition of the Dornoch Firth and Morrich More SAC has been assessed three times during the last reporting cycle. There were 405 seals in 2000, 220 seals in 2002 (although this is considered an undercount because the survey was undertaken more than two hours after low tide), and 290 seals in 2003. These data, along with previous counts made in 1992 (662), 1994 (542) and 1997 (593), indicate that the number of harbour seals within the SAC during the moulting season has decreased over the reporting cycle. Conversely, over this same time period there has been a gradual increase in the number of harbour seals recorded in Loch Fleet (albeit not as steep as the opposing decrease) suggesting a slight shift in the population to favouring the Loch Fleet area (Cordes et al., 2011). Indeed, seals from these two areas forage in the same location (Cordes et al., 2011). The population of harbour seals within this SAC is considered to be "Unfavourable (recovering)"(SNH, 2005a) based on a number of conservation targets (e.g. a stable or increasing population of common seals within the SAC during the moulting season and no loss in extent or distribution of habitat suitable for use by breeding and moulting common seals in the SAC), and a management plan is now in place which is addressing the one of the reasons believed to be behind the decline (shooting of seals mainly to protect salmon and sea trout fisheries).

Grey seal SACs

95. There are six grey seal SACs in Scotland: the Trenhish Isles (Strathclyde), the Monach Isles (Outer Hebrides), North Rona (Outer Hebrides), Faray and Holm of Faray (Orkney), the Isle of May (Firth of Forth) and the Berwickshire and North Northumberland Coast (which crosses the border between Scotland and England on the east coast). None of these lie within the study area, however, due to the

long-range movements of grey seals, the links between these SACs and the study area have been considered in this assessment (Para 1511).

12.3.1.5 Loch Fleet NNR

96. Loch Fleet National Nature Reserve is designated for a variety of coastal habitats, (sand dunes, sand flats, saltmarsh, and eelgrass), but has also become increasingly important as a breeding site for harbour seals over the last decade (SNH, 2005b). Fifty to one hundred harbour seals typically haul-out at this site throughout the year (Cordes et al., 2011), and grey seals are also occasionally present during the winter months.

12.3.1.6 Priority Marine Features

97. A list of draft PMFs have been identified for Scottish territorial waters, and for which future conservation action will be required. Of the marine mammals included on the list, the minke whale has been identified as an important species within the outer Moray Firth. A non-statutory proposal by the Whale and Dolphin Conservation Society (WDCS) for the establishment of a Marine Protected Area (MPA) for minke whale off the Fraserburgh coast was set out in a document published in 2010 (WDCS, 2010). Although this proposed MPA does not feature in the list of sites currently being considered by MS it may be considered for inclusion in the future.

12.3.2 CETACEAN POPULATIONS IN THE STUDY AREA

98. The outer Moray Firth is an important area for cetaceans (whales, dolphins and porpoises) as either resident populations or seasonal visitors. Cetacean species known to regularly occur within the study area include: bottlenose dolphin, harbour porpoise, minke whale, common dolphin, white-beaked dolphin, and Risso's dolphin. Other infrequent visitors include long-finned pilot whale (*Gloicephala melas*), killer whale (*Orcinus orca*), humpback whale (*Megaptera novaeangliae*), and fin whale (*Balaenoptera physalus*) however these species have been scoped out of the assessment as the likelihood of significant effects on these species is extremely low due to their very low frequency of occurrence within the study area (*Annex 12A*).

99. In the outer parts of the Moray Firth, in which the Wind Farm Site is located, the most abundant species were harbour porpoise and minke whale (Thompson and Brookes, 2011). In contrast the number of sightings of white-beaked dolphin, minke whale, common dolphin, and Risso's dolphin were comparatively low, and bottlenose dolphins extremely rare. Most individuals of bottlenose dolphins were seen in the inner part of the Moray Firth SAC, within 15 km of the coast, along the coastal strip of the southern Moray Firth coast.

100. The species summaries below are presented for the five key marine mammal species in the outer Moray Firth most likely to be affected by development of the Wind Farm. A full account of each species is given in Annex 12A.

12.3.2.1 Bottlenose Dolphin

Distribution

101. UA's review of cetacean observation data from the last 30 years showed that almost all bottlenose dolphin sightings within the Moray Firth were along coastal areas in the inner Moray Firth and that sightings in the outer Moray Firth were uncommon (Thompson and Brookes, 2011) (Plate 12.5). This was supported by the results of the UA aerial surveys conducted in 2010 in which no bottlenose dolphins were encountered offshore in the Moray Firth (Thompson and Brookes, 2011). More specifically no bottlenose dolphins were encountered within the Wind Farm Site during these surveys (Plate 12.6).

Plate 12.5 Sightings of Dolphins in the Moray Firth Over the Last 30 Years (Thompson and Brookes, 2011)

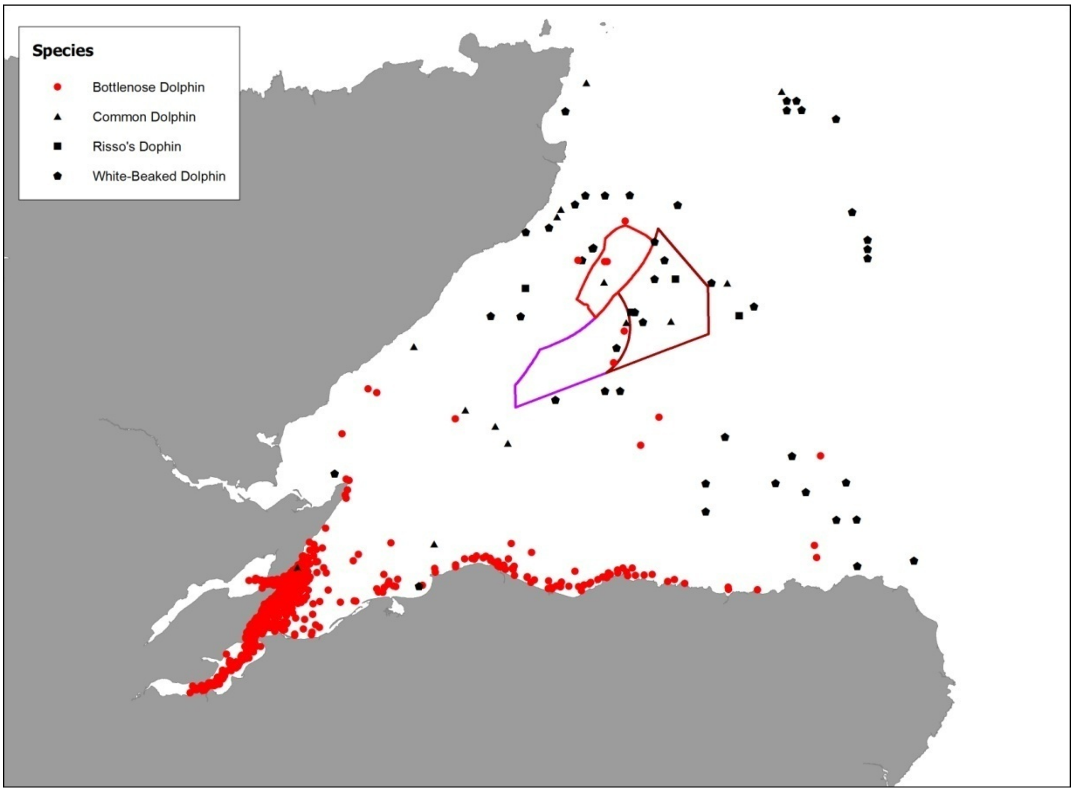
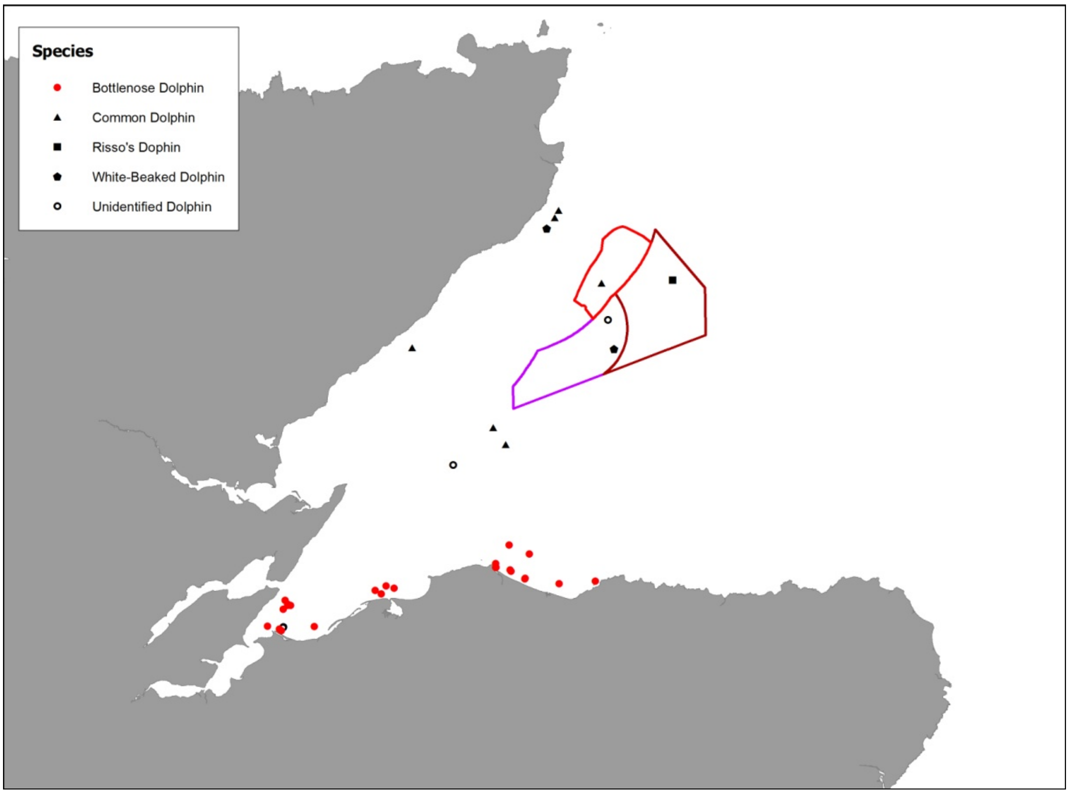


Plate 12.6 Sightings of Dolphins Made During the University of Aberdeen's 2010 Aerial Surveys of the Outer Moray Firth (Thompson and Brookes, 2001)



102. An assessment of the likely dolphin species to be encountered in different parts of the Moray Firth, undertaken by UA, demonstrated that dolphins encountered along the coastal strip of the Moray Firth are most likely to be bottlenose dolphins, but those encountered in offshore areas are, in general, more likely to be other species (Plate 12.6) (Thompson and Brookes, 2011). The results of sightings made during the IECS boat surveys in the Wind Farm Site were excluded from these assessments due to uncertainties over the reliability of species identification from these surveys (Thompson and Brookes, 2011). This decision was discussed with statutory authorities during presentation of the baseline data at a workshop in June 2011.

103. The UA POD data, combined with the visual survey data described above, showed that the coastal strip of the Moray Firth, particularly the inner and southern Moray Firth coast were a key area for dolphins, and bottlenose dolphins in particular (Annex 12A, Appendix 1, Figure 3.9). In contrast, the north coast of the Moray Firth and the central parts (including the Wind Farm Site) show very low detection rates of bottlenose dolphin.

104. In addition, broadband sound recordings using EARs were made at the Wind Farm Site and a whistle-classifier system was constructed to distinguish bottlenose dolphins from other dolphin species that may be encountered at the site. The data showed that none of the recordings made over the 88 day survey period were attributed to bottlenose dolphins, supporting the evidence that bottlenose dolphins are generally not present at the Wind Farm Site, at least during the July-October sampling period used in the acoustic study (Booth et al., 2011).

Seasonal variation

105. Bottlenose dolphins are sighted in all months of the year in the Inner Moray Firth but numbers are lower in winter and peak in summer and autumn (Wilson, 1997); similar seasonal fluctuations have been observed in the outer Moray Firth study area (Cheney et al., 2011). Eastern coasts to the south of the Moray Firth also appear to be used less in the winter; this is discussed in Section 24: OfTW Marine Mammals. Cheney et al., (2011) also found that bottlenose dolphins use their entire known summer range in winter but with lower occupancy rates (Cheney et al., 2011). The most likely explanation for this is that bottlenose dolphins extend their range to other unknown areas over winter. However, there is also a possibility that their behaviour changes in the winter making them less detectable than during summer months. For example, in winter they may increase their group sizes, which would produce lower visual sighting rates and lower rates of dolphin-positive days on the POD recorders (Booth et al., 2011). Acoustic data acquired by the UA from PODs deployed at five sites within the Wind Farm Site, although not differentiated to species, did not identify any seasonal pattern in overall dolphin detections which remained relatively low over the survey period (generally dolphins were detected on less than 30% of days per month) (Thompson and Brookes, 2011).

Abundance

106. The Scottish east coast bottlenose dolphin population is small and isolated. There have been several estimates of the population but the most reliable figures come from a 2006 study using data from every research group that carries out photo-identification work (Cheney et al., 2011). This study suggested that the population is around 193 individuals (95% Probability Interval 162-245). The study was subsequently updated with a further year of photo-identification work and the estimate was very similar with 195 individuals (95% Highest Posterior Density Intervals 162 – 253) (Cheney et al., in press a). This estimate is higher than annual estimates of the number of animals using the Moray Firth SAC population indicating that not all of the animals of the east coast population use the Moray Firth (Cheney et al., 2011).

107. Mark-recapture analysis of bottlenose dolphin abundance in the southern Moray Firth estimated that between 32% and 56% of the east coast population used the southern Moray Firth between 2001 and 2004 (Culloch and Robinson, 2008). This highlights that both the southern Moray Firth and the Moray Firth SAC are important areas for this population.

Density

108. For many species, habitat association modelling can provide robust estimates of spatial variation in density. However, as discussed in Section 12.2.9.1 this was problematic for bottlenose dolphin due to the patchiness of their distribution and highly mobile nature. There is currently ongoing discussion amongst regulators over the best way to overcome this when assessing effects of wind farm construction on bottlenose dolphin populations. In the meantime, the best available data on occurrence in different areas (from C-PODS, see Figure 12.1) have been

integrated with the best available data on dolphin species identification (using the classification tree analysis). This provides an indication of spatial variation in the probability of encountering bottlenose dolphins across the Moray Firth (Figure 12.2). The resulting map clearly shows that there is very low likelihood of bottlenose dolphins occuring in the central Moray Firth in the vicinity of the Wind Farm Site.

109. In contrast, bottlenose dolphins are much more likely to be encountered along the Moray Firth coast (Figure 12.2). However year-round POD data from coastal sites highlight that inshore distribution of dolphins is likely to be more clustered than suggested by these broad scale analyses (Annex 12A, Appendix 2, Figure 3). As recognised from a variety of previous studies, key areas for bottlenose dolphin are within the inner reaches of the Moray Firth at Sutors and Chanonry and along the south coast at Spey Bay (Figure 12.3). Furthermore, dolphins were detected over a greater number of hours at these sites on the days that they were recorded by the T-PODs corroborating previous studies that these may be key foraging areas(Hastie et al., 2004; Bailey and Thompson, 2009),. Comparison of these data with the POD data from across the study area further demonstrates that the north coast and central parts of the Moray Firth (including the Wind Farm Site) are not key areas for bottlenose dolphin (see Para 103).

Movement between the Wind Farm Site and the Moray Firth SAC

110. Based on the distributional information presented above, bottlenose dolphin outside the SAC, are most likely to be encountered in coastal areas of the Moray Firth, particularly along the southern coastline (Figure 12.2). Therefore, the most significant movement for bottlenose dolphins from the Moray Firth SAC is likely to be along this southern coastline.

12.3.2.2 Harbour Porpoises

Distribution

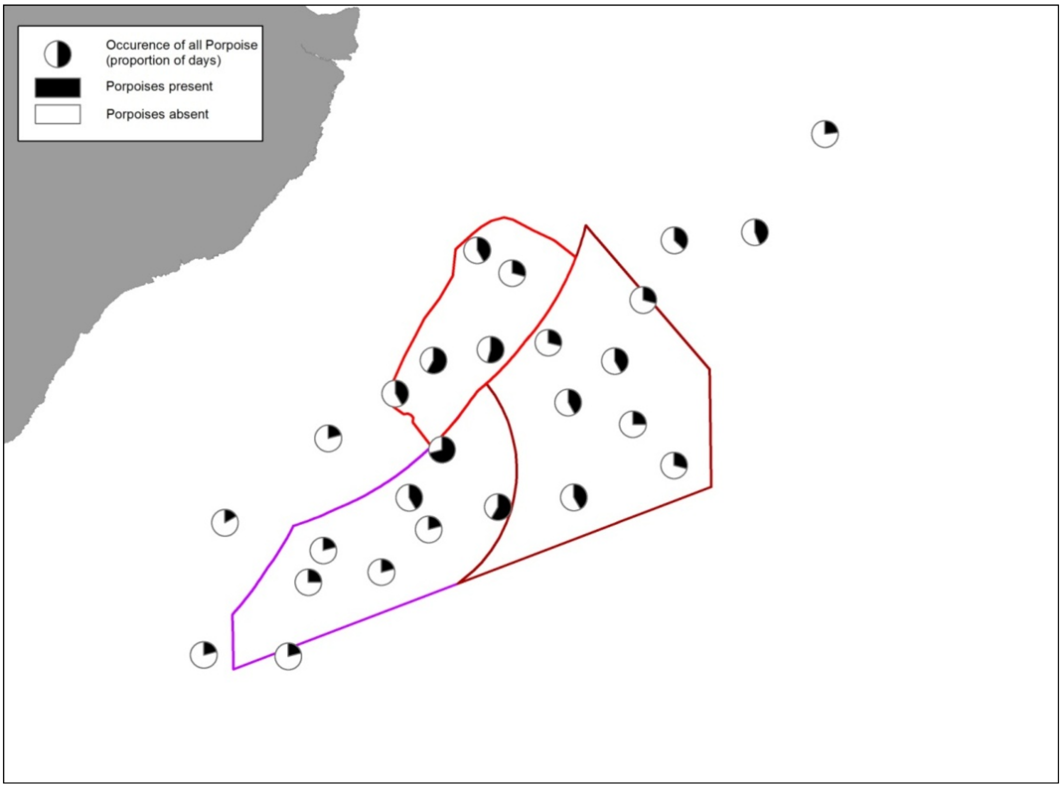
111. Harbour porpoises are the most numerous of the cetaceans found in north-western European continental shelf waters and are widespread around UK waters (Reid, 2003). Harbour porpoise were historically the most commonly encountered species in all the Moray Firth studies, both inshore and offshore (Thompson and Brookes, 2011). The UA POD data for April-October 2009 and 2010 showed that harbour porpoises were present at offshore deployment sites on almost all sampling days (Plate 12.7) while detection rates were lowest in the coastal areas where dolphins occurred more commonly (Thompson and Brookes, 2011).

112. Fine scale information from the POD deployments relating specifically to the Wind Farm Site showed that harbour porpoises were present for around a quarter of each day at 14 locations, half of the day at nine locations and three quarters of the day at three locations (Plate 12.7) (Thompson and Brookes, 2011). Similar results were obtained from passive acoustic monitoring data from within the Wind Farm Site (2009-2011), which showed that harbour porpoise were present in the site on an almost daily basis, for up to 12-15 hours a day. Long-term passive accoustic monitoring data available from PODs deployed at the Beatrice demonstrator project

(August 2005 - December 2007 and May 2009 – 2011) also detected harbour porpoises on most (>93%) days. On the days that harbour porpoises were detected, they were recorded for a median of four hours (Interquartile Range = 2-7).

113. Harbour porpoise are commonly sighted along the southern Moray Firth coast but less frequently than in offshore regions and in the Wind Farm Site. The UA POD data shows that they are present on a relatively high proportion of days (>75% of days at 65% of POD sites)(Thompson and Brookes, 2011).

Plate 12.7 Spatial Variation in the Occurrence of Harbour Porpoises in and around the Wind Farm Site and Moray Firth Round 3 Zone (April-October 2009 and 2010) (Thompson and Brookes, 2011)



Note: Fine-scale variation in the occurrence of harbour porpoises in the vicinity of the Wind Farm Site and Moray Firth Round 3 Zone. Pie charts represent the median number of hours on days on which harbour porpoises were detected (coloured black) at POD sites during the summers (April-October) of 2009 and 2010 (Thompson et al., 2011).

Seasonal Variation

114. Harbour porpoises occur year-round in the Moray Firth and as discussed above the POD data suggests that they are present at the Wind Farm Site on an almost daily basis. However, the median number of hours that harbour porpoise were detected appeared to vary seasonally, with peaks in the winter and late summer.

115. Seasonal peaks were observed by the Cetacean Research and Rescue Unit (CRRU) in the southern Moray Firth between May and July, consistent with the known calving period for this species in the North Sea. The seasonal pattern in distribution and abundance along the southern Moray Firth is discussed in Section 24: OfTW Marine Mammals.

Abundance

116. During the site specific surveys, a total of 863 animals were estimated from the aerial line transect surveys in blocks A and B and along the coast. In block B, which covered the Wind Farm Site, a total of 508 individuals were estimated. Harbour porpoise abundances for SCANS Block J (Moray Firth, Orkney and Shetland) were estimated as 24,335 in 1994 and 10,254 in 2005. In the wider North Sea the population was estimated as 280,000 individuals (JNCC, 2003) and in the Regional SEA area 1, the population was recorded as 169,294 in 2005 (DECC, 2011).

Density

117. The UA aerial survey data for the offshore survey block B, which incorporated the Wind Farm Site, estimated a density of 0.812 harbour porpoises per km^2 (Thompson and Brookes, 2011), which is similar to the SCANS I density estimate of 0.783 harbour porpoises per km^2 (Hammond, 2002). The UA density estimate for harbour porpoise equates to an estimated 98 harbour porpoises present in the Wind Farm Site (Figure 12.4). In comparison, the aerial data harbour porpoise density estimates for the coasts of the Moray Firth were lower at 0.265 harbour porpoises per km^2 (Thompson and Brookes, 2011).

118. Habitat association modelling was also used to predict numbers across the Moray Firth (see Annex 12A). The resulting map (Figure 12.4) shows the predicted number of harbour porpoises in each 4 x 4 km grid square. For the majority of grid square in the outer Moray Firth the density is in the range 0 to 5 individuals per grid square but for the majority of grid squares in the Wind Farm Site the estimated numbers of harbour porpoise exceeds 15 individuals per grid square and in a few, numbers are in the range of 20-30 individuals per grid square (Figure 12.4).

12.3.2.3 Minke Whale

Distribution

119. Minke whales are distributed along the central and northern North Sea and along the Atlantic seaboard of Britain and Ireland (Reid, 2003). Minke whales were the second most commonly sighted species during field surveys (after harbour porpoise) in offshore waters of the outer Moray Firth, although this is a more recent finding as there were comparatively fewer sightings in earlier datasets (Thompson and Brookes, 2011).

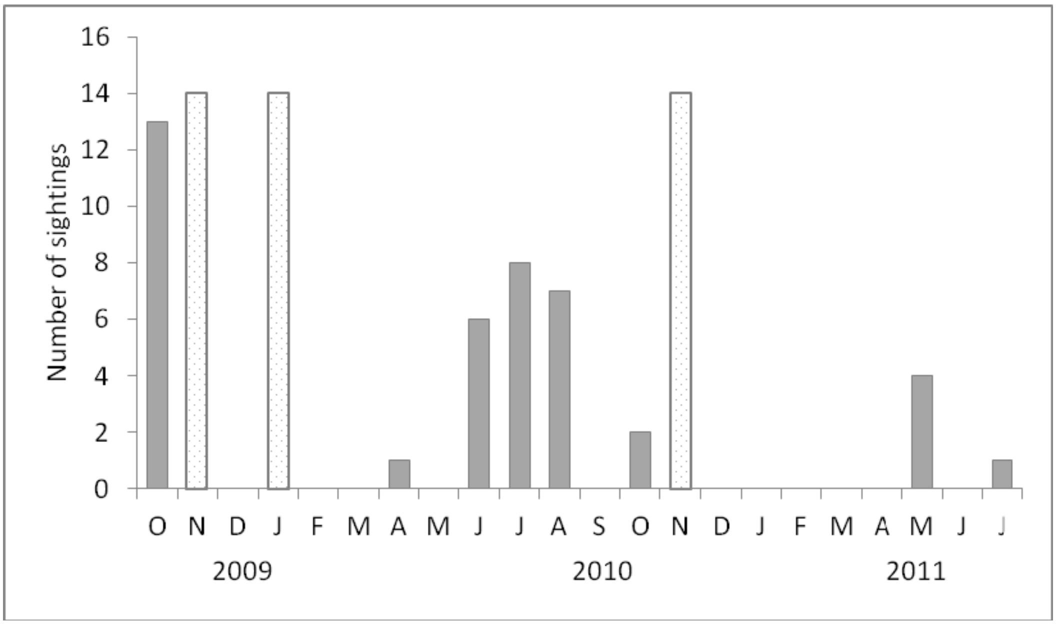
120. In the Moray Firth, minke whales are known to occur in offshore areas in the outer Moray Firth, with individuals commonly sighted around the Wind Farm Site based on UA surveys (see Figure 36, Annex 12A). CRUU surveys along the southern Moray coast, further showed a significant distribution of minke whale along this coast which is also discussed in Section 24: OfTW Marine Mammals.

Seasonal Variation

121. Minke whale presence in the Moray Firth shows seasonal variation, most sightings in the outer Moray Firth have been made between May and September, with fewer sightings between October and April(Reid et al., 2003). This finding is supported by the Wind Farm boat survey data collected in the Wind Farm Site in 2009-2011

which recorded minke whales predominantly between April and October (Plate 12.8). Minke whales along the southern Moray Firth coast are recorded from mid-June onwards but are absent during the winter and spring months (Robinson and Tetley, 2007).

Plate 12.8 The Number of Minke Whale Sightings Made per Month During the Wind Farm Boat Surveys



Note: Filled bars = Wind Farm unpublished data. Unfilled bars = months in which no surveys were carried out. The amount of survey effort per month is similar

Abundance

122. The most recent estimate of minke whale abundance was from SCANS II Block J (Moray Firth, Orkney and Shetland) data which gave an abundance of 835 animals, equating to a density of 0.0223 animals per km² (SCANS-II, 2008). This is not significantly different from the earlier SCANS survey (1994) data density estimate of 0.0286 animals per km² (Hammond et al., 2002).

123. Along the southern Moray Firth coast the CRRU data gave abundance estimates of between 0.011 animals per km effort on the inshore route rising up to 0.044 animals per km effort at the outermost route (Robinson, 2007).

12.3.2.4 Other Cetaceans

124. All dolphins encountered in offshore regions during the UA aerial surveys were common, white-beaked and Risso's dolphins (Plate 12.5).

Common Dolphin

125. In the North Atlantic all common dolphins appear to be *D. delphis*, the short beaked common dolphin. In the UK, common dolphins are more regularly sighted in waters off the west coast than in the North Sea (Reid, 2003). In recent years, there have been regular reports of this species in the Moray Firth (Robinson et al., 2010). The classification tree analysis carried out for BOWL and MORL (Thompson and Brookes, 2011) indicated that this species could be seen across the southern, central

and outer Moray Firth, and may occur in the Wind Farm Site. However, the combined site-specific data used in this analysis showed that abundance was fairly low, with only 15 sightings of 241 individuals in total. Of the sightings that have been made in the Moray Firth the majority have been around the coast and offshore on the north side of the Moray Firth in water depths of 51 to 209 m (mean depth 88.6 ± 42.2 m) and at distances from shore of 5 to 32 km (mean distance 16.6 ± 8.0 km) (Robinson et al., 2010).

126. Seasonal variation in the presence of common dolphins in the Moray Firth is unknown as sightings of the species have been too few. However, seasonal peaks may occur along the southern Moray Firth coast in June and July due to the birth of newborn calves (Robinson et al., 2010).

127. Densities of common dolphins in the Moray Firth and at the Wind Farm Site was not estimated as there were too few sightings; however it will be less than the estimate of 0.018 animals per km^2 in the Outer Moray Firth for all dolphin species combined (Thompson and Brookes, 2011).

White-beaked Dolphin

128. White-beaked dolphins are recorded most frequently in the western part of the central and northern North Sea and off the north and west coasts of Scotland (Reid, 2003). They are the most commonly sighted dolphin species in the outer Moray Firth (Plate 12.5) however sightings are still too few to enable an assessment of seasonal variation.

129. Abundance estimates for white-beaked dolphin in the Moray Firth, Orkney and Shetland (Block J) during the SCANS II (2005) survey were 682 individuals, equating to a density of 0.0182 animals per km^2 (SCANS-II, 2008). This estimate is very similar to the UA density estimate for dolphins in Block B, which incorporated the Wind Farm Site, of 0.018 individuals per km^2(Thompson and Brookes, 2011).

Risso's Dolphin

130. Most Risso's dolphins in UK waters occur around the coast of western Scotland and the Outer Hebrides (Reid, 2003) but small numbers of Risso's dolphin have been sighted regularly in the Moray Firth over the last 30 years, and of those, most have been offshore (Plate 12.5). The classification tree analysis carried out for BOWL and MORL (Thompson and Brookes, 2011) indicated that this species could be seen across both coastal and offshore parts of the Moray Firth, including the Wind Farm Site. Too few sightings have been made in the Moray Firth to enable seasonal variation assessments. Similarly there have been too few sightings to estimate abundance around the Wind Farm Site, but it will be less than the estimate of 0.018 animals per km^2 in the outer Moray Firth for all dolphin species combined (Thompson and Brookes, 2011).

12.3.3 PINNIPED POPULATIONS IN THE STUDY AREA

131. Two species of seal, the harbour (or common) seal and the grey seal, are abundant and widely distributed in the study area. They are both Annex II species and the harbour seal is a primary citation feature of the Dornoch Firth and Morrich More

SAC (Figure 8.1; Section 12.3.1.4), which lies in the inner Moray Firth. There are no statutory designations within the study area for the grey seal, however, due to the large distance that this species travels there may be links between the Moray Firth study area and SAC populations in the Firth of Forth and Orkney.

12.3.3.1 Harbour Seal

132. The harbour seal is the smaller of the two species of pinniped that breed in Britain. Adults typically weigh about 80-100 kg, with males being slightly bigger than females. The UK supports a total of 28,300 individuals with Scotland accounting for approximately 83% of this number (based on 2006 data; JNCC, 2007).Harbour seals are present in the Moray Firth all year round and use intertidal haul-out sites to rest between foraging trips, to breed in June/July and to moult in August/September.

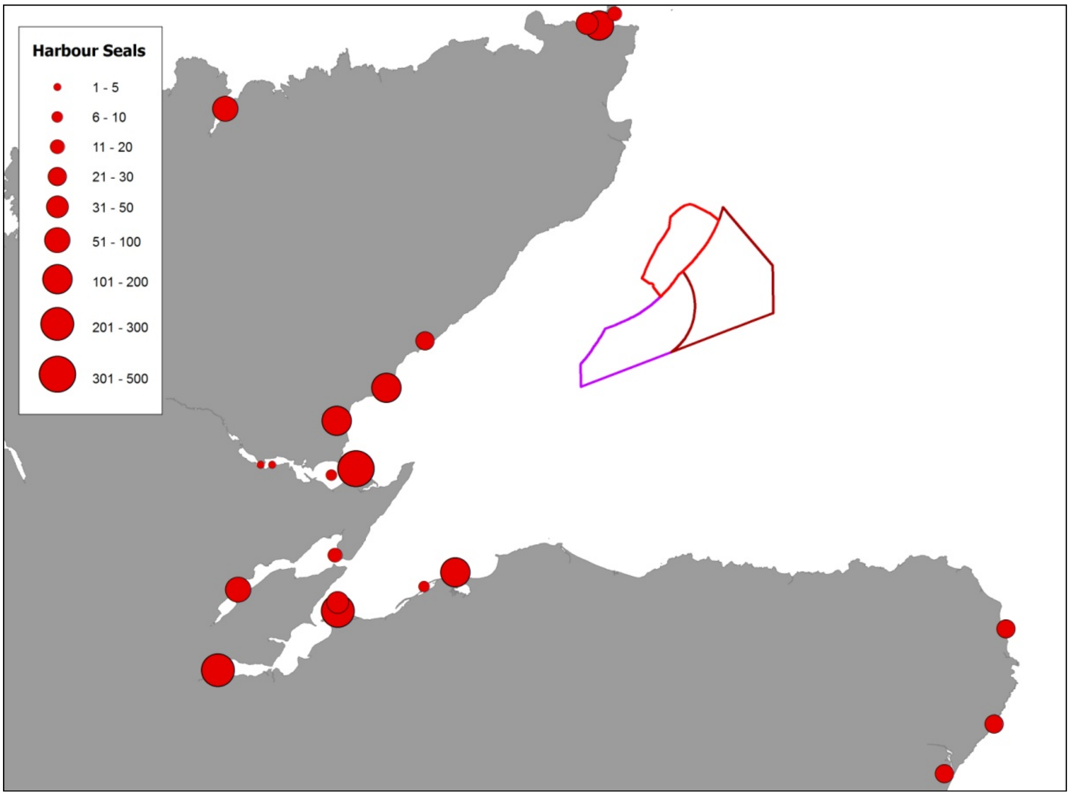
Distribution and seasonal variation on land

133. The most recent August moult surveys conducted by SMRU at haul-out sites in the Moray Firth and adjacent areas were between 2007 and 2009 (Duck, 2009). The data showed the distribution and abundance of harbour seals on land (Plate 12.9) and indicates that they haul out throughout the northern and southern shores of the inner Moray Firth. There are three haul-out sites on the northern Moray Firth coast between Helmsdale and Loch Fleet which are in the nearest proximity to the Wind Farm Site. The site near Helmsdale is approximately 37 km from the Wind Farm Site and Loch Fleet haul-out site is approximately 65 km away. The main colony in the Dornoch Firth SAC lies approximately 67 km to the west of the site and, as discussed in Section 12.3.1.4, the Wind Farm Site lies within the harbour seal foraging range from these haul-out sites.

134. Approximately 80 harbour seals use the haul-out site at Loch Fleet during the August moult and approximately 100 individuals use smaller sites between Loch Fleet and Dunbeath (shown on Plate 12.9) on the north Moray Firth coast. Over the last 15 years there has been a shift in distribution of individuals between the Dornoch Firth and Loch Fleet sites (Cordes et al., 2011).

135. Harbour seals are present at these haul-out sites in the inner Moray Firth throughout the year although seasonal peaks occur in June, July and August coinciding with the breeding and moulting seasons of this species (Thompson et al., 1996). The distribution of harbour seals throughout the haul-out sites in the Moray Firth varies both seasonally and between years and it is thought to be linked to proximity to foraging areas (outside the breeding season) and site characteristics (during the breeding season) (Sharples et al., 2008).

Plate 12.9 The Number and Distribution of Harbour Seals Counted During SMRU Thermal Imaging Surveys in the Moray Firth between August 2007 and 2009 (Duck and Thompson, 2009)



Distribution and seasonal variation at sea

136. Work carried out for BOWL and MORL integrated all available harbour seal tracking data from the Moray Firth. This includes data from Sharples (2008), Cordes et al., (2011) and earlier work by the UA (see Bailey and Thompson, 2011). This integrated analysis provided evidence that some animals form the Dornoch Firth and Morrich More SAC and Loch Fleet NNR forage in the Wind Farm Site (Bailey and Thompson, 2011).

Abundance

137. The Moray Firth supports approximately 4% of the British population of harbour seals. Breeding season counts of the inner Moray Firth population have been carried out by UA and SMRU since the late 1980s. Counts increased steadily after the phocine distemper virus outbreak in 1988 to a peak of around 1000 breeding animals in 1993. The breeding season numbers subsequently declined, but have recovered slightly since 2008 (Duck, 2010; Thompson et al., 2011). In 2010, the mean haul-out count for the inner Moray Firth was 721, which represents a total population size of 1,183 individuals.

138. Annual moult surveys provide the best estimates of population size and those carried out by UA and SMRU showed that the Dornoch Firth population has decreased since 1992 but that the Loch Fleet population has steadily increased (Cordes et al., 2011). In 1988 all mother-pup pairs counted in the two estuaries were

located at haul-out sites in the Dornoch Firth but by 2008 the recently developed site at Loch Fleet accounted for 37% of mother-pup pairs (Cordes et al., 2011).

Density

139. Habitat association modelling was used to predict the density of harbour seals in the Moray Firth and at the Wind Farm Site (Bailey and Thompson, 2011). Telemetry data from 37 tagged seals from the Dornoch Firth and Morrich More SAC showed that the seals were dispersed widely across the Moray Firth, particularly over offshore sandbanks, and that areas of the Wind Farm Site are likely to represent important foraging areas for harbour seals (Bailey, 2011). The modelling predicts that some 4 x 4 km grid squares in the Wind Farm Site and Moray Firth Round 3 Zone sites may hold up to eight harbour seals which represents a density of 0.5 individuals per km^2 (Figure 12.5).

Links between the Wind Farm Site and the SAC/NNR

140. The tracking studies described above illustrate that harbour seals from the Dornoch Firth and Morrich More SAC (and the Loch Fleet NNR) are distributed widely across the study area and that sites within the Wind Farm site are likely to constitute important foraging grounds for individuals of this species with the Moray Firth. The Loch Fleet NNR is the closest harbour seal breeding site to the Wind Farm Site, and as discussed above it has become increasingly important relative to the Dornoch Firth SAC over the last 20 years.

141. In addition to the links with the Dornoch Firth and Morrich More SAC, tagging surveys of small numbers of harbour seals in other Scottish SACs (e.g. Sanday in Orkney) have highlighted the possibility that individuals from these areas may infrequently venture down the northeast coast of Scotland, presumably to forage, and therefore may potentially use the Moray Firth (SMRU Ltd, 2011).

12.3.3.2 Grey Seal

142. Approximately 45% of the world population of grey seals is found in Britain, 90% of which breed in Scotland (SMRU, 2008). In contrast to harbour seals, grey seal pup production has increased steadily since the 1960s, and continues to increase in the North Sea, although this growth is now levelling off in Orkney and the Hebrides.

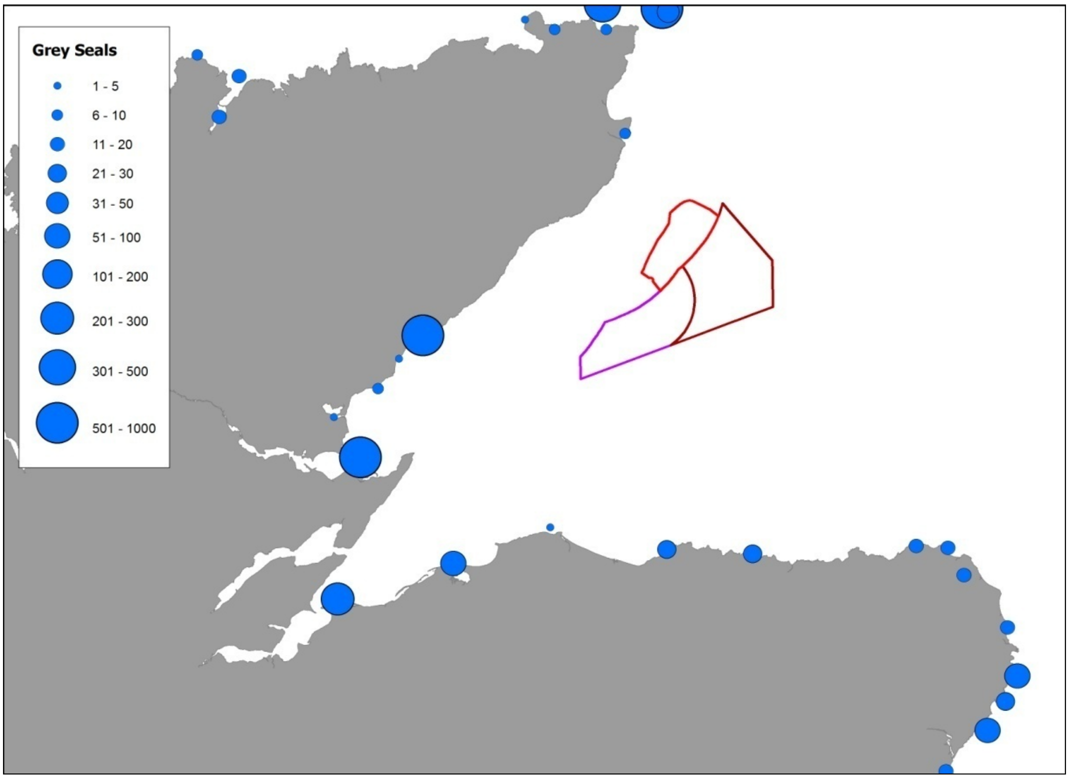
143. Like the harbour seal, the grey seal is listed as an Annex II species of the Habitats Directive and as such us protected by a network of SACs. None of these SACs fall within the study area, however, based on consultation with the statutory authorities, this assessment has considered the possibility that grey seals from SACs further afield may be using the Moray Firth during foraging trips.

Distribution and Seasonal Variation on Land

144. Grey seals haul out between foraging trips at intertidal sites distributed around the coastline of the Moray Firth, but the largest numbers occur at sites along the northern coastline particularly around Dornoch Firth, Brora and Duncansby Head (Duck and Thompson, 2009). During the summer moult numbers are greatest at haul-out sites around Dornoch Firth (501 – 1000 individuals) and at Brora, the site closest site to the Wind Farm Site (approximately 53 km away) (Plate *12.10*).

Comparatively few grey seals use these summer sites during the winter (Duck and Thompson, 2009). In winter, grey seals haul out on beaches (or in caves) above the high water mark for breeding and the majority of breeding sites in the Moray Firth are found along the Helmsdale coastline (north shore of the Moray Firth) (Duck and Thompson, 2009).

Plate 12.10 The Number and Distribution of Grey Seals Counted during SMRU Thermal Imaging Surveys of the Moray Firth in August 2007 and 2009



145. These data were further supported by the grey seal usage study conducted by SMRU on behalf of BOWL and MORL which highlighted the key haul-out sites around Dornoch Firth and Duncansby Head (Figure 12.6) (Jones and Matthiopoulos, 2011).

Distribution and Seasonal Variation at Sea

146. As a result of modelling and interpolating satellite telemetry (from 110 tagged individuals captured at major haul-out sites during 1991-1999 and observed from May to September i.e. outside the breeding and moulting seasons) and haul-out survey data around Britain, it is clear that grey seal usage is primarily concentrated as follows:

- off the northern coasts of the British Isles;
- closer to the coast than might be expected purely on the basis of accessibility from the haul-out sites; and
- in a limited number of marine hot-spots e.g. the Pentland Firth and, to a lesser extent, the Moray Firth (Figure 55, Annex 12A).

147. The grey seal usage study conducted by SMRU also showed that grey seals forage throughout the Moray Firth with numbers greatest along the northern coastline

including the western areas of the Wind Farm Site (Figure 12.6) (Jones and Matthiopoulos, 2011).

Abundance

148. As mentioned previously, the number of grey seal pups produced every year has risen steadily in the North Sea since 1960, however, pup production at the main breeding colony Helmsdale (on the north Moray Firth coastline) has remained fairly steady in the last five years. Pup production at Helmsdale now accounts for less than 15% of the grey seal pup production in the North Sea with approximately 1000 pups in total (see Annex 12A).

Density

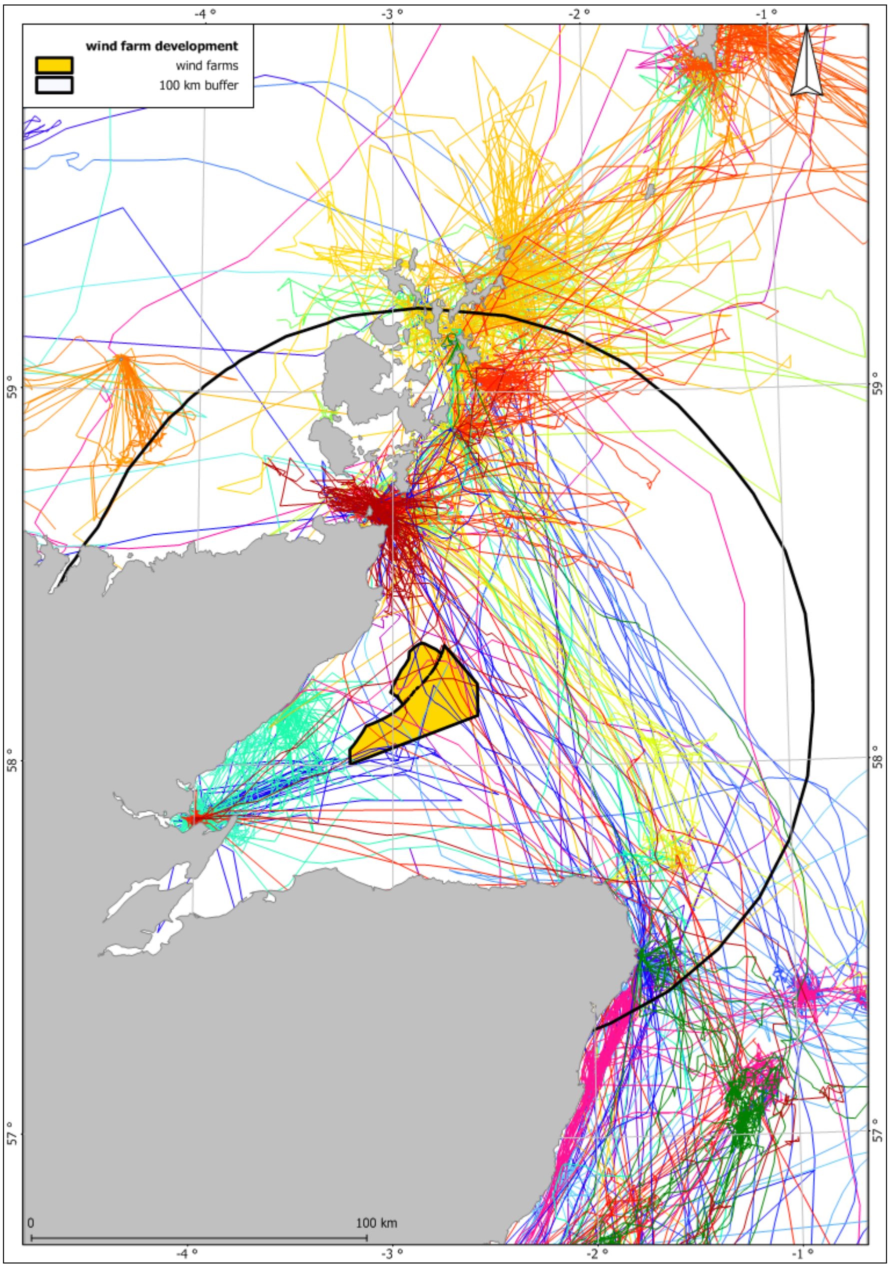
149. The density of grey seals in the Moray Firth was estimated by Jones and Matthiopoulos (2011) (see Annex 12A) using telemetry and count data. As for the other species for which density has been estimated (bottlenose dolphin, harbour porpoise and harbour seal), a 4 x 4km^2 grid was used. The maps of estimated at-sea, densities were the most appropriate when assessing the potential effect of construction.

150. Figure 12.6 shows the estimated at-sea spatial usage of grey seals around the Wind Farm Site and Moray Firth Round 3 Zone. White lines denote the standard deviation as a measure of uncertainty around the estimated usage. Densities of grey seal are greatest around the main breeding colonies at Dornoch Firth and Duncansby Head where at any point in time over 50 animals will be present in a 4 x 4 km grid cell. Densities are low within the Wind Farm Site where on average between 1 and 5 animals will be in each 4 x 4 km grid cell at any one point in time (Figure 12.6).

Movement between the Wind Farm Site and Grey Seal SACs

151. Published studies relating to grey seal movements at-sea show that, while grey seals often forage close to shore in areas local to the sites they are using to haul-out, they also make long distance movements (McConnell et al., 1999). The results of tagging studies on grey seals from different SAC locations in Scotland showed a high probability that grey seals using the Moray Firth and/or the Wind Farm Site as foraging grounds have hauled out, or will haul out, at some point at one or more of the six Scottish grey seal SACs (Plate 12.11) (Russell, 2011).

Plate 12.11 Tracks of Grey Seal Which, at Least Once While They Were Tagged, Entered a 100 km Buffer Zone Around the Wind Farm Site and Moray Firth Round 3 Zone (Russell, 2011)



Note: Seals aged one year and above, n=65. Each colour represents a different individual

12.3.4 PREY SPECIES

152. The prey items of key marine mammal species discussed in this chapter (i.e. bottlenose dolphin, harbour porpoise, minke whale and harbour and grey seals) are varied, ranging between small planktonic copepods for species classed as baleen whales, to large-bodied pelagic fish, giant squid and other marine mammals for larger species of toothed whales. Table 12.12 summarises the diet of marine mammals for the species occurring within the Moray Firth. Of those species summarised, flatfish, sandeels, herring and sprat have been found to be present in the Wind Farm Site (Section 11: Wind Farm Fish and Shellfish Ecology).

Table 12.12 Key Prey Items for the Main Species of Marine Mammals Found Within the Wind Farm Study Area (Harris and Yalden, 2008)

Marine mammal	Key prey items in the Moray Firth
Odontoceti	
Bottlenose dolphin	Preferred item in the Moray Firth is salmon *Salmo salar*, but also opportunistic exploiting a wide variety of fish and shellfish e.g. herring *Clupea harengus*, sprat *Sprattus sprattus*, sandeels *Ammodytes spp.*, cephalopod, gadoids and clupeids.
Harbour porpoise	Target pelagic shoaling fish (sandeel, whiting *Merlangius merlangus* and herring) as they aggregate along tidal channels.
Mysticeti	
Minke whale	Sandeel constitutes the largest part of the diet in the Moray Firth (Pierce et al., 2004) but this species generally targets whichever fish is most abundant in the area, primarily small fish and krill.
Pinnipeds	
Grey seal	Mainly sand eels but also other pelagic species such as cod, whiting, and squid are taken.
Harbour seal	Sandeel, cod, herring, sprat, flatfish, octopus and squid.

12.4 DEVELOPMENT DESIGN MITIGATION

153. The project has been designed to incorporate a 'soft-start' procedure for piling activities during construction (see Table 10.12 in Annex 7A for ramping up procedures). In this way pile driving does not start at full power but builds up to full power, thereby allowing opportunity for animals to flee the area and minimising the risk of lethal effects or injury. These soft-start procedures will be for a period of no less than 20 minutes, as recommended by the JNCC pile driving protocol (JNCC, 2010).

12.5 ASSESSMENT OF POTENTIAL EFFECTS

12.5.1 ASSESSMENT OF EFFECTS DURING CONSTRUCTION/ DECOMMISSIONING

12.5.1.1 Injury, Displacement and Disturbance from Noise Emissions during Pile Driving

154. Measurements from the construction of the Beatrice demonstrator project suggest that pile driving noise could be detected above background noise for a distance of up to 70 km, while consideration of the Southall et al., (2007) noise exposure criteria suggests that marine mammals may experience a levels of disturbance up to this distance, although this is dependent on a number of factors, including their hearing sensitivity (Bailey et al., 2010).

155. To provide an estimate of the potential effect range, the distance (radius from piling activity) and total area over which noise effects are predicted was calculated for each species based on the results of the INSPIRE modelling work for selected noise

thresholds (Annex 7A) (Table 12.13). As discussed above, this calculation was further refined by applying a dose response curve over 5 dB_{ht} incremental increases in received noise levels.

156. Whilst the M-weighted SELs have been modelled for both stationary and fleeing animals, and both calculations are shown in Table 12.13, the most realistic scenario is for the fleeing animal model. This approach, which has been discussed with JNCC and SNH assumes that animals are more likely to move away from high levels of noise rather than stay in the area. However, both are shown in the table below. The potential effects on each species of these noise levels are discussed in the following Sections.

Table 12.13 Results of INSPIRE Modelling Exercise for the Wind Farm

Scenario	Receptor	Thresholds	Radius of threshold around each piling operation (m)	Total affected area (km^2)
One pile driving event at Wind Farm location B	Bottlenose dolphin	Death/injury	60	0.01
		PTS	500 (7,670)	0.63 (166)
		Behaviour	43,440	3,938
	Harbour porpoise	Death/injury	60	0.01
		PTS	490 (7,920)	0.54 (175)
		Behaviour	61,250	7,380
	Harbour Seal/ Grey Seal	Death/injury	60	0.01
		PTS	2,570 (12,410)	13.1 (398)
		Behaviour	56,680	6,065
Two pile driving events at Wind Farm locations A and B	Bottlenose dolphin	Death/injury	60	0.02
		PTS	500 (7,670)	1.1 (233)
		Behaviour	43,440	4,449
	Harbour porpoise	Death/injury	60	0.02
		PTS	490 (7,920)	0.89 (242)
		Behaviour	61,250	8,053
	Harbour Seal/ Grey Seal	Death/injury	60	0.02
		PTS	2,570 (12,410)	20.8 (494)
		Behaviour	56,680	6,708

157. The thresholds used in Table 12.13 are as follows: (i) death/injury – 220 dBht; (ii) PTS fleeing and stationary (in parenthesis) – 198 dB re. 1 µPa2/s; (iii) behavioural effects – up to 75 dBht

158. The worst case scenario considered for the Wind Farm is two simultaneous piling events at locations A and B (see Figure 12.7). The piling for this scenario is assumed to occur over a 24 hour period, seven days a week for two years. For each pin pile allowance has been made for approximately five hours of piling activity, and a minimum transfer time of 0.5 hour between pin piles (i.e. 20 hours total piling per turbine), and a transfer of six hours between turbine locations and ten hours set up at the next turbine location.

159. It should be noticed that in practice pile driving will not start at full power (see Section 12.4) and full power is highly unlikely to be maintained for the duration of the installation process. Additionally, installation of piles will commence with a 'soft start'. Once up to full pile driving energy, levels of noise would be expected to decrease over time, as the pile penetrates the seabed, meaning that the noise dose would not be constant or at the highest modelled level throughout. However for the purpose of the modelling it has been assumed that once up to full power, the noise levels would stay the same for the duration of the piling activity.

Bottlenose Dolphin

160. For the Wind Farm construction scenario of two simultaneous piling events, the area calculated as giving rise to the potential for permanent physical injury or death is within the immediate vicinity of the piling activity, out to a distance of only 60 m from each pile covering an area of 0.01 km^2 (Table 12.13).

161. The distance at which PTS effects are calculated as having the potential to start is 500 m (an area of 0.63 km^2) from each pile for fleeing animals and 7.9 km (an area of 175 km^2) for stationary animals.

162. Strong behavioural reactions are calculated as likely to occur from a received noise of 90 dB_{ht}, however, in keeping with the adoption of a precautionary approach, moderate behavioural effects are also assumed to extend to the 75 dB_{ht} contour for some individuals. This contour has been calculated to a distance of 43,440 m from the piling activity, (covering an area of 3,938 km^2).

163. Figure 12.7 illustrates the extent of these noise thresholds. It additionally shows the 5 dB_{ht} contours which, as discussed above, applied to calculate the decreasing proportion of animals likely to experience disturbance effects as the distance from the pile increases through application of the dose response curve (Plate 12.3). This approach provides a more accurate assessment of potential disturbance effects than relying on single value thresholds.

164. The 5 dB_{ht} noise contours were overlaid over the distribution map in Figure 12.2 to assess the potential effects on bottlenose dolphins within the study area (Figure 12.7). This assessment applied a semi-quantitative approach to assessing potential effects by considering distribution data (Section 12.3.2.1), and expert professional

opinion on the distribution ecology and behaviour of bottlenose dolphins in the Moray Firth in the context of the geographical effects of noise depicted in the map.

165. In terms of death or injury, noise modelling suggests that there is a small area (0.01 km^2) within which lethal effects could occur. Distribution data further highlight that it is extremely unlikely that any bottlenose dolphins would be in this area at the commencement of piling. Similarly, based upon Figure 12.7, there are unlikely to be any bottlenose dolphins within the PTS threshold and it is anticipated that any individuals that were present would flee the area. Once piling had started it is assumed that avoidance of loud noise levels would result in individuals avoiding the area. Consequently any risk of death, direct injury or PTS for bottlenose dolphin is considered to be negligible.

166. Consideration of the thresholds in Figure 12.7 therefore suggests that the only potentially significant effects on bottlenose dolphins will be behavioural.

167. Assessment of behavioural effects is subject to a number of uncertainties discussed above. In particular there are limitations in the underlying data (Section 12.2.9.1) and in current scientific understanding of these effects on individuals and populations (Section 12.2.9.3). Therefore, whilst this assessment uses the best available scientific data, the robustness of the following conclusions is subject to those limitations.

168. Generally the risk in respect of behavioural effects arising from noise is considered to be relatively low, as the 90 dB_{ht} threshold for significant behavioural disturbance is well outside the main areas frequented by dolphins. There is, however, more likelihood of lower level behavioural effects resulting from disturbance within the 75 dB_{ht} threshold (Figure 12.7). Based on the dose response curve from harbour porpoise data (Plate 12.3) one might expect a graded response with a smaller proportion of animals showing some degree of behavioural response at 75 dB_{ht} than at 90 dB_{ht}.

169. This 75 dB_{ht} noise band extends to the north coast of the Moray Firth but does not extend as far as the south coast or inner reaches of the Moray Firth. Thus, there is not expected to be significant displacement from this population's known core-feeding areas, although there may be some effect on the level of use of some affected areas, most notably those utilised for movement between feeding areas. Whether this effect will amount to biologically insignificant changes in behaviour or displacement (as the precautionary approach adopted in this assessment assumes) cannot be easily assessed given the current relatively low level of scientific understanding of noise effects on individuals.

170. There is good evidence in the distributional data that the majority of the area subject to levels of noise with the potential to cause behavioural effects is not important to bottlenose dolphin.

171. Additionally it is important to note that short term effects from noise are not anticipated to result in long-term population level effects. Bottlenose dolphins are known to range widely from the Moray Firth to Fife and whilst 50% of the estimated Moray Firth SAC population are estimated to use the SAC each year

(Cheney et al., in press a) they are clearly not restricted to the Moray Firth and surrounding waters (Thompson, 2012). This availability of suitable alternative habitat further suggests that any displacement which may occur may not give rise to significant population level effects.

172. In summary, while the possibility of some negative behavioural effects on some of the bottlenose dolphins using the southern Moray Firth coast may exist, the levels of received noise in this area are unlikely to result in displacement of all individuals. Furthermore, any effects are predicted to be temporary in nature, occurring during just part of the construction period, which is itself short in relation to both the reproductive cycle and life-time of individual females.

173. Subject to the uncertainties described above noise disturbance is predicted to have a short-term effect of small to medium magnitude which is probable, and due to the sensitivity and conservation status of bottlenose dolphins, is considered to be of minor to moderate significance and significant in terms of the EIA Regulations. Any long-term effects are unlikely, but those that do occur are predicted to be of small to medium magnitude. Consequently, the potential long-term effect on bottlenose dolphin is of moderate significance and significant in terms of the EIA Regulations.

Moray Firth SAC

174. The most recent estimate of the Moray Firth SAC bottlenose dolphin population is 195 individuals and the current condition status of the population is 'unfavourable recovering' (Thompson et al., 2006; Thompson et al., 2009). Figure 12.7 shows that the noise contours abuts the boundary of the SAC protected area but does not extend inside, and therefore effects are predicted only on individuals ranging outside the SAC. As discussed above, the population data for bottlenose dolphins is most accurately presented as distributional information, it is not appropriate to predict numbers of individuals (and therefore the proportion of the SAC population) potentially affected by noise disturbance.

175. The potential effects on bottlenose dolphins and the challenges associated with making these predictions are discussed above, particularly in respect to the longer-term population-level effects. Subject to those uncertainties, the effects on the SAC population out with the SAC boundary, can similarly be predicted as being of short-term duration, small to medium magnitude and probable. The effects are therefore of minor to moderate significance, and significant in terms of the EIA Regulations. Any long-term effects are unlikely to occur, but those that do, are predicted to be of small to medium magnitude. Consequently, the potential long-term effect on the population of the Moray Firth SAC is of moderate significance and significant in terms of the EIA Regulations.

Harbour Porpoise

176. As part of the ongoing monitoring of operational offshore wind farm projects, data on marine mammal numbers and distribution are becoming increasingly available. Early studies into construction effects were carried out by Tougaard et al., (2003) in relation to harbour porpoise at the Horns Rev Offshore Wind Farm. This study found that harbour porpoise left the construction area during pile driving,

returning again within a few hours of the installation being completed. Fewer animals were observed engaging in foraging behaviour during pile driving but, again, this activity increased once pile driving was finished.

177. Noise modelling indicates that harbour porpoises could be at risk of injury or death within the immediate vicinity of the piling activity (up to 60 m), PTS may occur up to 490 m (applying a model which assumes a fleeing response) or up to 7,920 m (for a modelled stationary response) and behavioural effects may occur up to 61.3 km from the piling activity (Table 12.13; Figure 12.8). The density estimates for harbour porpoise were incorporated into an assessment framework similar to that developed for harbour seals to give an estimate of the population potentially affected during the piling works. The model predicted that no individuals would suffer injury/mortality, approximately eight individuals would suffer PTS (fleeing), up to 43 individuals would suffer PTS (stationary) and up to 4350 individuals have the potential to suffer behavioural effects (including displacement) to varying degrees.

178. Harbour porpoise are abundant throughout the British Isles with the North Sea population recorded as 280,000 individuals (JNCC, 2003) and Regional SEA 1 area population recorded as 169,294 in 2005 (DECC, 2011). Harbour porpoise are most frequently recorded offshore (thus the distribution throughout the Wind Farm Site), and occur widely throughout the North Sea from the north Norwegian coast down to the Dutch coast. Therefore, whilst there is likely to be displacement during the piling activity, the extent of suitable habitat available to this species is considerable and therefore temporary displacement is unlikely to have any biological significance on the population.

179. In summary, there may be a negative effect on harbour porpoise (a high level receptor) through temporary displacement over the two year piling period, and will be of negligible to small magnitude compared to the size of the North Sea population and their extent of available habitat and probable. Due to the sensitivity and conservation status of harbour porpoise, this will result in an effect of minor significance. There are no long-term effects predicted and this assessed as being probable. No significant effects in the short- or long-term, in terms of the EIA Regulations, are predicted on harbour porpoise.

Minke Whale

180. Minke whales are within the order *Mysticetes* (baleen whales), a low-frequency cetacean, which often show regular avoidance behaviour to noise effects. Construction noise from the Wind Farm has the potential to affect minke whale since this species was recorded both in offshore areas (around the Wind Farm Site) and in the southern Moray Firth along the coast to the east of Spey Bay.

181. Minke whale are one of the most commonly occurring baleen whales along the north east coast of minke whale in northeast Scotland with a population of 835 individuals estimated for SCANS II Block J (Moray Firth, Orkney and Shetland) and 10,541 in the Regional SEA area 1 (DECC, 2011). However, the Moray Firth is thought to represent a transitory feeding area for this species in the summer months

only. Minke whales are often observed along the southern Moray coastline in particular where they feed on sandeels as their main prey item.

182. Density and noise impact maps were unavailable for the minke whale and in the absence of a species-specific noise assessment they were considered to be potentially affected at least to the same geographical extent as seals. The site-specific surveys showed that this species are distributed throughout the Moray Firth and therefore fall within the potential area of noise effect (based on the seal noise maps) although the southern coastal distribution is unlikely to be affected.

183. In summary, it is predicted that that during construction in the summer months there will be a short-term effect of displacement on minke whale from parts of the offshore areas of the Moray Firth, but since this represents only a small proportion of their range (and there are other feeding areas available), the effect will be of small to negligible magnitude and probable. Based on the sensitivity and conservation status of minke whale, this will result in an effect of minor to negligible significance. There are no long term effects predicted for minke whale and this is probable. No significant effects, in terms of the EIA Regulations, are predicted on minke whale either in the short-term or in the long-term.

Harbour Seal

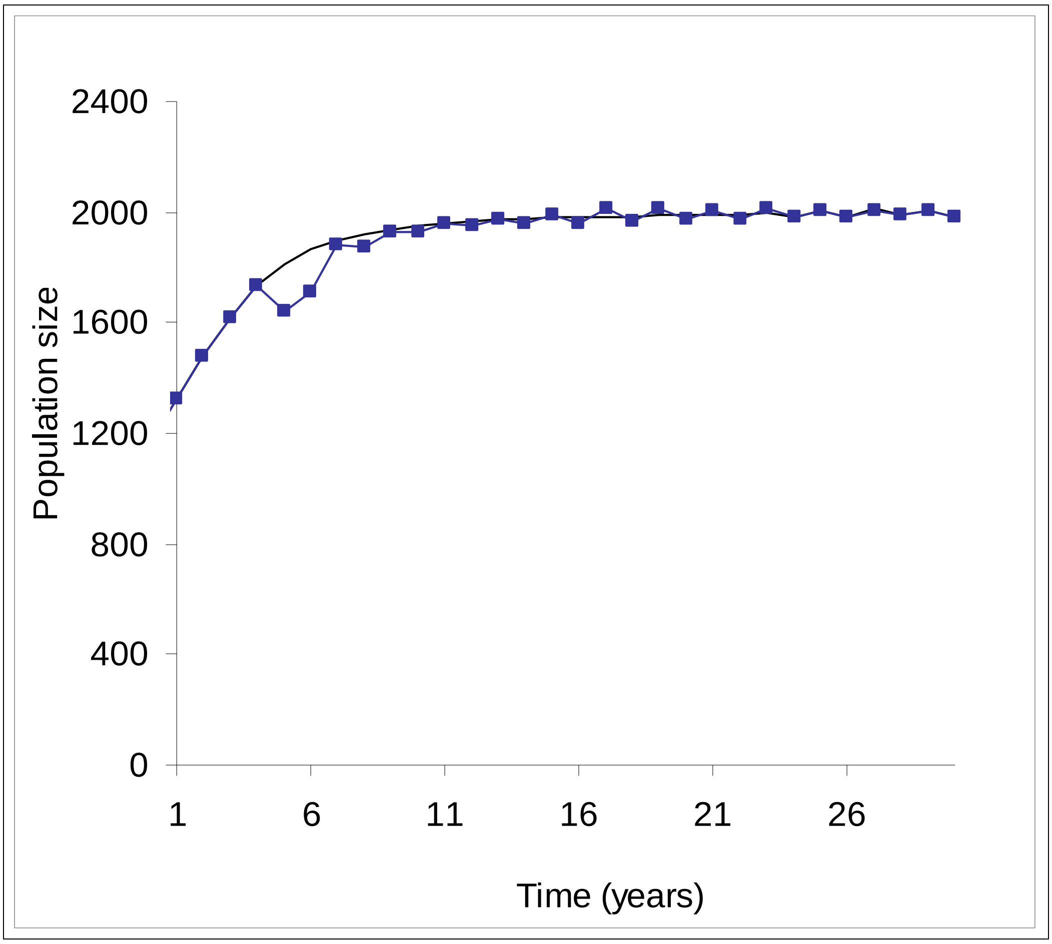
184. Harbour seal are present throughout the Moray Firth including the proposed Wind Farm area. At sea, individuals are likely to be affected by noise disturbance from the piling operations but their year-round haul-out locations in the inner Moray Firth are unlikely to be affected as they fall out-with the ensonified area (Figure 12.9). The density figures were incorporated into the harbour seal framework to determine the number of individuals affected within each impact zone, the proportion of the regional population that this relates to, and finally the long term (25 years) effect on the viability of the population (Thompson et al., 2011).

185. The noise model predicted that there would be no potential injury or death to individuals arising from the direct effects of piling noise, that up to four individuals could be affected by PTS (based on the fleeing model) and that up to 18 individuals could be affected by PTS if assumptions based on the stationery model were applied. Potential behavioural effects were modelled as extending over a substantial area of the Moray Firth (6,708 km^2; Table 12.13) and were predicted to affect up to 1126 individuals.

186. A population model was used to assess the risk of a population level effect arising from the displacement of harbour seals. This was based on the conservative assumption that the displacement would result in breeding failure for a large proportion (up to 65%) of the population during this time. This breeding failure was compared with a baseline scenario with no piling. It should be noted that the numbers of individuals considered in this way gives rise to a precautionary estimate of the magnitude of effect, although the limitations and assumptions of the population model as discussed in Section 12.2.9.4 are acknowledged.

187. The harbour seal population model showed that, whilst population size was temporarily reduced during the construction period, there was no long-term effect on population viability (Plate 12.12).

Plate 12.12 Population Model Predicting the Normal Increase in Harbour Seals within the Moray Firth (black line) Compared with the Population Increase After the Two Simultaneous Piling Scenario at the Wind Farm Site



188. In summary, there is predicted to be a large magnitude, short-term effect of displacement of harbour seals over the two year piling period which is reversible and probable. Due to the sensitivity and conservation status of harbour seal this would result in a short-term effect of major significance and significant in terms of the EIA Regulations. Based on the evidence from the harbour seal population model it can be shown that, subject to the limitations of the population model, there is likely to be no long-term effect of piling on population of harbour seals in the Moray Firth, and therefore effects on the viability of this population are assessed as being probable and of minor-negligible significance, which is not significant in terms of the EIA Regulations.

Dornoch Firth and Morrich More SAC

189. The most recent estimate for SAC population size is 1,183 individuals and the current condition status of the population is 'unfavourable recovering' (SNH, 2005). Figure 12.9 shows that the noise contours do not overlap with the SAC protected

area and therefore effects are predicted only on individuals ranging outside the SAC. As described above the harbour seal framework was used to assess both short-term and long-term effects on the population in the Moray Firth. Conservatively it is assumed that the majority of individuals affected by noise will be from the Dornoch Firth and Morrich More SAC population.

190. As assessed above there is predicted to be a large magnitude, short-term effect of displacement of harbour seals in the Moray Firth over the two year piling period which is reversible and probable. Based on the high conservation status of the Dornoch Firth and Morrich More SAC this would result in a short-term effect of major significance, which is significant in terms of the EIA Regulations. However, based on the evidence from the harbour seal population model it can be seen that there is likely to be no long-term effect of piling on the Dornoch Firth and Morrich More SAC population, and therefore effects on the viability of this SAC are assessed as being probable and of minor-negligible significance, which is not significant in terms of the EIA Regulations.

Grey Seal

191. In the absence of species specific audiograms the noise model adopts same noise thresholds for grey seals as for harbour seals with injury/death occurring in the immediate vicinity of the piling activity (up to 60 m), PTS occurring up to 2,570 m, and behavioural effects out to 56.6 km from the piling activity (Table 12.13; Figure 12.10).

192. Piling activity at the Wind Farm would result in an area of ensonification of up to 75 dB_{ht} in the sea around the closest haul-out site at Brora (53 km from the Wind Farm Site) where between 300 to 500 individuals may haul-out during the breeding season (Figure 12.10). However, grey seals tagging studies show that individuals regularly move between other haul-out locations in the North Sea and therefore the population is unlikely to be dependent on any single haul-out site.

193. At-sea densities around the Wind Farm Site and wider area of ensonification are mostly low. Noise modelling indicates that no individuals are likely to suffer death/injury, up to three individuals are affected by PTS based on the fleeing model, 14 individuals are affected by PTS based on the stationary model and 1,593 individuals will suffer behavioural effects.

194. The latest estimates for grey seal population size in Scotland from the Special Committee on Seals (SCOS) is 119,400 (95% CI 92,550 – 156,200) individuals (SCOS, 2010). Thus, PTS would affect a negligible proportion of the population (~0.01% for the stationary model) and limited behavioural effects would be felt by 1.3% of the population.

195. Potential effects during construction include displacement of grey seals at sea and therefore loss of foraging area and possibly displacement from one of the haul-out sites along the north coast of the Moray Firth (Brora). It is also possible that individuals from distant grey seal SACs may also be displaced during this time. However, given the wide-ranging nature of this species, individuals are likely to move to other unaffected areas during the period of disturbance, and return

following cessation of the piling activity. In addition, given that the 'closed' population of harbour seals show a successful recovery following a greater potential effect on their population (Plate 12.12), it can be confidently assumed that grey seals (a much larger 'open' population which is increasing in size), will similarly recover from any temporary, short-term decrease in population.

196. In summary, there is predicted to be a small magnitude, short-term negative effect on grey seals of displacement of 1.3% of the Scottish population over the two year construction phase, which is considered to be probable and of minor significance based on the sensitivity and conservation status of grey seals. There are no long-term effects predicted and this assessed as being probable. In terms of the EIA Regulations, there are no short- or long-term significant effects predicted on grey seals

12.5.1.2 Ship strike and potential injury from ducted propellers

197. Collision risk from vessel strikes in general during the construction period is considered to be low for all marine mammal species. This is considered in the context of the existing level of vessel activity in the Moray Firth from oil industry support, shipping, fisheries and recreation, where there are in excess of 4,000 shipping movements per year, (see Section 18: Wind Farm Shipping and Navigation). As such marine mammals are likely to have habituated to the current levels of activity such that the additional 26 construction vessels per year (plus 20 crew transfer vessels) represents a negligible increase compared to the already high level of vessel activity in the area. In addition, it is likely that the noise generated by the construction vessels will deter marine mammals from the immediate vicinity (see noise impact assessment) and therefore collision with construction vessels in the proximity of turbine locations is unlikely.

198. A recent review has highlighted concerns that harbour and grey seals may be vulnerable to "corkscrew" injuries from ducted propellers, such as a Kort nozzle or some types of Azimuth thruster (Thompsen et al., 2010). These propellers are used on a wide range of vessels used in offshore industries including tugs, self-propelled barges, rigs, offshore support vessels and research boats. Currently the links between the use of such vessels and corkscrew mortalities remains unproven. Furthermore the circumstances in which such injuries might occur remain speculative and subject to further research. It is not, therefore, possible to assess at this stage what the potential effect of the use of ducted propellers on project vessels might be although it should be noted that no confirmed cases of seals with corkscrew injuries were located in the Moray Firth despite the extensive use of ducted propellers in this area (Thompsen et al., 2010).

199. The issue of vessel strike and potential injury from ducted propellers has been discussed during the EIA process with statutory consultee in light of outcomes of meetings and advice notes, specifically: the stakeholder meeting on corkscrew injuries (5th July 2011); the letter on seal mortalities in UK waters from JNCC (9th May 2011); and more recently a meeting between BOWL and MS (1st April 2012).

200. BOWL will continue to monitor research being carried out in respect of corkscrew injuries and, in discussion with MS, SNH and JNCC.

201. In summary, there is predicted to be a small-negligible magnitude negative effect of short-term duration due to the risk of collision with vessels, which has the potential to affect a small number of individuals although it is considered that any effect on the grey and harbour seal populations in the area will be unlikely. The significance of the effect is considered to be minor, and is not significant in terms of the EIA Regulations.

12.5.1.3 Suspended Solids Impairing Foraging Efficiency

202. Section 9: Wind Farm Physical Processes and Geomorphology predicts an elevation in suspended solids of a maximum of 21 mg/l during dredging operations (seabed preparation for gravity bases) over a very localised area (50 to 100 m) and of short term (up to one hour) duration. After one hour the SSC would be reduced to <4 mg/l due to dispersion and deposition of sediments. Material deposited on the seabed would be re-suspended and typically lead to elevations of <1 mg/l. During the drilling works to facilitate piling the maximum increase in SSC was predicted to be 25 mg/l within 50-100 m of the drilling vessel (Section 9: Wind Farm Physical Processes and Geomorphology). As with the gravity base scenario preparation sediments are predicted to disperse after one hour and SSC is reduced to <4 mg/l. Sediments deposited from the drilling operations will be re-suspended by tidal currents but lead to just a small increase in SSC of 1-2 mg/l. Any re-deposition will also be of small magnitude (<1 mg/l).

203. Given their highly mobile nature, marine mammals would easily be able to avoid these areas of turbidity. Also, the effect are likely to occur over a very small proportion of the range of marine mammals in the Moray Firth as in the worst case scenario there would only be two small areas (representing the two simultaneous turbine installations) that animals are likely to avoid. In addition, the effects are temporary in nature and reversible.

204. In summary, there is predicted to be a negligible magnitude effect of very short-term duration on marine mammals (high level receptor) which is probable and of negligible significance. This is not significant in terms of the EIA Regulations.

12.5.1.4 Indirect Effects Due to Loss of Foraging Area / Reduction of Prey Species

205. The construction of the Wind Farm may result in indirect effects on marine mammals. The key prey species for marine mammals include a number of clupeids (e.g. herring), gadoids (e.g. cod, whiting), flatfish and *Ammodytes* (sandeel). Fish may be vulnerable to injury or displacement resulting from construction noise (piling) or temporary habitat loss due to seabed preparation in the event that gravity base foundations were used, which may result in reduced prey availability for marine mammals. However, predicted levels of avoidance by marine mammals suggest that any reduction in prey availability may be offset through a reduction in predation in these areas. For most of the prey species found within the study area the effect was assessed as being of small magnitude, and of negligible to minor significance (Section 11: Wind Farm Fish and Shellfish Ecology). The effects are

considered to be of slightly higher significance (minor to moderate) for hearing-sensitive species that spawn and have nursery habitat within the area (including herring and sprat), although the spawning/nursery areas for these species within the Moray Firth only represent a very small proportion of the wider North Sea spawning/nursery area and therefore it was considered unlikely that that there are any long term implications for the populations of these species within the Moray Firth. In addition, since marine mammals exploit a suite of different species as a food resource they are unlikely to experience reduced prey availability through declines in just one or two of their potential prey item.

206. In summary there is predicted to be a small to negligible magnitude, indirect negative effect of very short-term duration on prey species which will result in a negligible effect on marine mammals (high value receptor), which is probable and is not significant in terms of the EIA Regulations.

12.5.2 ASSESSMENT OF EFFECTS DURING OPERATION

12.5.2.1 Operational Noise

207. During operation marine mammals may potentially be disturbed by operational noise and vibration associated with the turbine rotation. The potential effects were assessed in relation to noise exposure criteria using a SPEAR model based on an extensive database of noise estimates from other wind farm. These data indicated that marine mammals would be excluded from a negligible area of sea (0 km^2-hr) due to operational noise (Annex 7A Figure 10.12). Therefore, this assessment concludes that is it certain/near certain that no effects are predicted on marine mammals as a result of operational noise.

12.5.2.2 Noise disturbance from maintenance vessels

208. The current level of vessel activity passing within 10 nm of the Wind Farm Site is nine to 12 vessels per day equating to up to 4,380 vessels per year (Annex 18A). There is high variability in vessel activity in the Moray Firth, both daily and seasonally, and a wide range of different vessel types operate throughout the area (Richard Robinson Consulting, 2011). The main source of noise from vessels comes from propeller cavitation and for any ship, noise increases with speed and loading (Senior et al., 2008). In addition, noise may also increase if boats with smaller engines (particularly for older vessels) are working harder to attain cruising speed.

209. Vessel noise can affect marine mammals through ‘masking’, whereby vocal communication either between individuals of the same species or during hunting for prey may become ineffective. In addition, at closer range, vessel noise may also affect individuals through auditory damage, such as TTS, or even PTS for prolonged periods of exposure (Erbe, 2002). As described previously in this Section, different species will react differently based on their hearing ability. Harbour porpoise, as one of the most hearing sensitive species, generally avoids vessels, whilst other species, including bottlenose dolphin, are regularly sighted near vessels and may also approach vessels (e.g. bow-riding). However, dolphins may also show avoidance behaviours such as increased swimming speed, spatial avoidance and longer breath intervals and sensitivity to vessel noise is most likely

related to the dolphin activity at the time (Senior et al., 2008). As with the effects of piling noise there are uncertainties in predicting the potential effects of vessel noise on marine mammals, as the science is still poorly understood. Based on the precautionary approach it is therefore assumed that marine mammals will respond to disturbance from vessel noise through avoidance behaviour.

210. During operation and maintenance there are estimated to be up to a maximum of 8 vessels per day on site but vessels will not operate daily through the year (Section 7: Project Description). The maintenance vessels will be similar to those used during construction e.g. jack-up vessels, and will therefore be operating at a slow speed between maintenance operations around the wind farm site. The greater potential for disturbance is likely to arise from crew transport vessels to and from the Wind Farm Site. These will be smaller vessels of between 18-20 m in length.

211. Disturbance from vessel noise is predicted to be of short-term duration i.e. during the crew transfer times and most likely to result in avoidance behaviour and auditory masking during that time for individuals that are sensitive. The distance over which effects will occur will vary according to the species but masking may occur several kilometres from the noise source. Against a background of high vessel activity, including many smaller vessels operating at fast speeds, it is considered unlikely that this increase in vessel activity will affect marine mammals in the Moray Firth due to their apparent habituation to vessel noise. This is may be due to the ability of marine mammals to compensate to some extent for masking by, for example, increasing their whistle rate to maintain communication, as was seen with bottlenose dolphins in Florida (Buckstaff, 2004).

212. In summary, there is predicted to be a small magnitude effect of disturbance from vessel noise on marine mammals, which would be intermittent over the period of operation and subject to uncertainties described above, it its considered to be unlikely. Due to the high sensitivity and conservation status of marine mammals, the effect is assessed as being of minor significance and not significant in terms of the EIA Regulations.

12.5.2.3 Ship Strike and Potential Injury from Ducted Propellers

213. Collision risk from vessel strikes in general during the operation period is considered to be low for all marine mammal species. A summary of the potential effects is given in Section 12.5.1.2 above which describes that there is a very small risk of injury to seals and that the evidence for seal injury from vessel strike remains inconclusive.

214. In summary, there is predicted to be a small-negligible magnitude negative effect of intermittent frequency over the operation phase, which has the potential to affect a small proportion of the grey and harbour seal populations in the area due to collision risk, although this is considered to be unlikely. In acknowledgement of the levels of uncertainty discussed in (Section 12.5.1.2) the effect is considered to be minor although not significant in terms of the EIA Regulations.

12.5.2.4 Behavioural Effects Arising from Electromagnetic Fields (EMF)

215. The effects of EMF on marine mammals are poorly understood. The more common concerns are that species that rely on EMF for finding food, such as elasmobranchs, may become confused and hence reduce food intake, or that EMF may cause migratory species to deviate from their migration. It is not thought that marine mammals are electro-sensitive, however, they may be sensitive to magnetic fields, produced by the current flow on the cable. Theoretical evidence suggests that some species of cetacean may use the Earth's magnetic field to aid with long distance migration (Kirshvinck et al., 1986). These include bottlenose dolphin and harbour porpoise both of which have a predicted sensory range of 0.05 µT (Kirshvinck et al., 1986). In addition, cetaceans may use ambient magnetic stimuli for several life-history dependant functions including determination of feeding locations, reproduction, and refugia (Normandeau et al., 2011). The study by Normandeau et al., (2011) provided estimates of magnetic fields for a typical 33 kV inter-array cable based on measurements from other offshore wind farms (Table 12.14).

Table 12.14 Magnetic Fields Arising from Typical Inter-array Cables (Normandeau et al., 2011)

Cable Specification	MF at source (µT)	MF horizontally (µT)
33 kV @ 641 Amp	1.7	0.61 @ 2.5m
33 kV @ 359 Amp	1.45	0.24 @ 2.5m

216. CMACS suggests that the magnetic effect of subsea cables is unlikely to affect magnetically sensitive species to any great extent and would most likely be perceived as a variation to the Earth's natural field (Normandeau et al., 2011). In addition, magneto-sensitive species are unlikely to respond to a magnetic fields from AC cables because the rate of change of the field (polarity reversal) would be too rapid for a behavioural response to occur (Normandeau et al., 2011).

217. Based on the values presented in this study and the sensitivity of the marine mammals receptors in the study area, there is likely to be very localised effects for animals within the vicinity of the inter-array cables, with potential responses such as temporary changes in swimming direction or slight deviation from a transit route, however, these are unlikely to cause a negative effect on marine mammals or populations.

218. In summary, subject to the uncertainties discussed above, there is predicted to be a small magnitude, localised, and reversible negative effect arising from EMF over the duration of the operation phase, which is probable, and will result in an effect of minor significance on marine mammals (high value receptor). This effect is not significant in terms of the EIA Regulations.

12.5.2.5 Indirect Effects Resulting from Changes in Prey Resources and Tidal Regimes due to Presence of Turbine Structures

219. Presence of turbine structures on the seabed has the potential to alter the seabed topography and change the tidal regime within the wind farm area. The Smith

Bank to the east of the Wind Farm Site is thought to be a key area for foraging harbour porpoises and seals and therefore the effects on this area, in particular, were explored. A second indirect effect of turbine structures is the long-term loss of seabed habitat and the creation of new habitat. Effects are assessed in terms of loss of key prey items due to habitat loss and the potential for attracting prey items to the turbine structures as they become colonised by invertebrate communities and subsequently attract fish populations.

220. Marine mammals commonly exploit high energy environments during foraging activity, using tidal races, upwellings and overfalls during the tidal ebb to herd prey (Pierpoint, 2008). A combination of seabed topography, in the form of trenches, and fast tidal currents are thought to concentrate prey species which are funnelled towards the foraging harbour porpoises. Prey items exploited in this way include shoaling fish species, such as herring and sprat (Clupeidae), sandeel (Ammodytidae) and members of the cod family (Gadidae).

221. Section 9: Wind Farm Physical Processes and Geomorphology assesses there to be no significant changes in current speed, water levels or current direction of the tidal regime. Therefore, the indirect effect on marine mammals is assessed as being not significant.

222. Section 11: Wind Farm Fish and Shellfish Ecology concludes that loss of habitat and changes in the tidal regime would have a negative effect of negligible significance on fish and shellfish populations. The effect of the introduction of new habitat on fish and shellfish was based on studies of other wind farms (see Section 11: Wind Farm Fish and Shellfish Ecology for further details). These suggested that whilst there may be some increases in abundance and aggregation around turbine structures at offshore wind farms this is not always the case and in some instances the species composition and relative abundance of communities remains the same. The most apparent benefits of the creation of new habitats was through colonisation by shellfish, many of which are of commercial importance (e.g. edible crab, lobster, and whelk). Based on this evidence the fish and shellfish report assessed this as being a positive effect of minor significance and probable.

223. Since shellfish are not key prey items of the marine mammals in the study area it is considered that whilst there may be some benefits of turbine structures as fish aggregating devices (FADs) these are likely to be of small to negligible magnitude in terms of providing an additional food resource. Species likely to experience some benefits include harbour porpoise, grey seal and harbour seal as these may forage in offshore areas. Bottlenose dolphin, which tend to forage along the coast are unlikely to experience positive effects from FADs unless the abundance of fish populations in the Moray Firth as a whole increase as a result, and this is unknown.

224. In summary, there will be a negligible effect on marine mammals due to changes in tidal regimes and a small-negligible magnitude positive effect on marine mammals due to a potential increase in abundance of prey species in the Wind Farm area and this will be probable. This will result in an effect of negligible significance on marine mammals (a high level receptor) which is not significant in terms of the EIA Regulations.

12.6 MITIGATION AND MONITORING

225. Mitigation will be required to reduce the effects of construction noise on marine mammals.

226. In first instance, BOWL will adopt piling protocol according to the JNCC guidelines (JNCC, 2010). This involves employment of dedicated MMOs and Passive Acoustic Monitoring (PAM) operatives with the aim of detecting marine mammals within an agreed 'mitigation zone' (no less than 500 m measured from the pile location) and potentially recommending a delay in the commencement of piling activity if any marine mammals are detected. The pre-piling search will be carried out for a minimum of 30 minutes prior to the commencement of piling. Reports detailing the piling activity and marine mammal mitigation will subsequently be sent to JNCC/SNH after the end of all the piling activity.

227. At present BOWL and the wider offshore wind industry are investigating a number of mitigation measures to reduce the effects of construction noise on marine mammals. There are techniques under development that may help to reduce construction noise levels at source (Nehls et al., 2007). In summer 2011 a study was undertaken by ESRa (a consortium of offshore wind developers and the German Environment Ministry) to trial a number of different mitigation tools to reduce underwater noise. The results of this project are not yet available to the wider industry and the technology is not yet proven for wide scale commercial use. As such it is not possible to commit to applying any of these mitigation tools to the Wind Farm. However, if these tools prove to be viable commercially and achieve sufficient sound reduction such that effects on marine mammals would be significantly reduced BOWL will look to investigate further their application to the Wind Farm. Other solutions to reducing noise could include alternative piling installation designs such as drilling, vibro-piling, jackets and drive–drilling (some of which were suggested by SNH in Table 12.2). However, as with other foundation types i.e. gravity bases and suction piles these techniques are not proven technologies and may not be feasible for the site technically or economically and as such cannot be guaranteed at this stage to offer a suitable mitigation for underwater noise from pile driving.

228. Gordon et al., (2007) considers the use of acoustic deterrents as a means of mitigating potential effects on marine mammals from piling noise. The report concludes that although deployment of such devices may have the potential to minimize risk of injury or death, there are a number of uncertainties and legal barriers to using acoustic deterrents, and further research in this area is required (Gordon et al., 2007).

229. In order to further understand the effects of underwater noise on marine mammals behaviourally and at a population level BOWL will continue to work with MS and key stakeholders to fill gaps in the understanding of these two key impact areas. The aim of this work is to further the knowledge base on marine mammals' responses to underwater noise. The schedule of works has not yet been defined for inclusion but could include a study to look at behavioural effect of installation of a meteorological mast installation on harbour seals and harbour porpoises (not

suitable for bottlenose dolphin); a study to monitor how bottlenose dolphin respond to other loud noise sources (to be used as a surrogate for low lever piling noise); and inclusion of the outputs of a DECC study into the effects of seismic surveys in the Moray Firth on marine mammals.

230. BOWL will work collaboratively with the wider Offshore Wind Industry in Scotland and the UK as well as with key experts in the field of underwater noise and marine mammals to undertake this work. As part of BOWL's involvement in the Offshore Wind Underwater Noise Working Group developments in this area will be fed into the detailed design phases of the project if they are deemed useful and feasible.

231. The development and implementation of a comprehensive marine mammal monitoring programme will provide an opportunity to undertake monitoring on key marine mammal populations. BOWL will work with MS, SNH/JNCC and other key stakeholders to develop the specification for an appropriate monitoring programme.

232. BOWL will work closely with the statutory authorities to further the understanding of the potential risk to grey seals from DP vessels using ducted propellers. This is an issue that has been discussed throughout the EIA process and it is BOWL's understanding that a number of research initiatives have been proposed including a MS funded programme by SMRU and an MMO funded programme. The results of such programmes will be useful in determining mitigation measures should these vessels be found to be responsible for seal deaths.

233. In order to minimise the potential risk of mortality (given the uncertainty of effects), in the first instance operators of all vessels involved in construction of the OfTW will be made aware of the risks. BOWL will continue to monitor research being carried out in respect of corkscrew injuries and, in discussion with MS, SNH and JNCC.

12.7 RESIDUAL EFFECTS

234. The assessment has found that the effect of disturbance arising from piling noise has the potential to cause both and short-term and long-term effect of moderate significance on bottlenose dolphin and the Moray Firth SAC. In addition, there is predicted to be a short-term effect of disturbance on harbour seals and the Dornoch Firth and Morrich More SAC which would result in an effect of major significance.

235. Mitigation measures adopted from the JNCC piling protocol (e.g. the use of MMOs and PAM operatives etc) will reduce the risk of injury and death (from already low levels). At this stage there are no proven engineering design mitigation measures available to reduce noise effects and therefore the residual effects are predicted to be the same.

236. None of the remaining effects arising from construction, operation and decommissioning activities were significant in terms of the EIA Regulations and therefore since no mitigation is required the residual effects remain the same.

12.8 SUMMARY OF EFFECTS

237. The effects on marine mammals, expected as a result of the construction/decommissioning and operational phases of the Wind Farm are summarised in Table 12.15.

Table 12.15 Summary of Effects on Marine Mammals

Residual Effect	Receptor	Magnitude of effect	Nature	Significance of effect	Probability of Effects Occurring as Predicted
Construction/Decommissioning					
Short-term injury/displacement from noise emissions during pile driving with potential for longer term effects on the population	Bottlenose dolphin	Small to medium	Negative	Minor to moderate	Probable for short-term; and Unlikely for long-term
	Moray Firth SAC	Small to medium	Negative	Minor to moderate	Probable for short-term; and Unlikely for long-term
	Harbour Porpoise	Small to negligible	Negative	Minor	Probable
	Minke whale	Small to negligible	Negative	Minor to negligible	Probable
	Harbour seal	Large short-term effect Negligible long-term effect	Negative Negative	Major Minor to negligible	Probable Probable
	Dornoch Firth and Morrich More SAC	Large short-term effect Negligible long-term effect	Negative Negative	Major Minor to negligible	Probable Probable
	Grey seal	Small	Negative	Minor	Probable
Short term physical injury/ mortality from vessels with ducted propellers and ship strike	Seals	Small-negligible	Negative	Minor	Unlikely
Short term suspended solids impairing foraging efficiency	All marine mammals	Negligible	Negative	Negligible	Probable
Short term indirect effects due to temporary loss of foraging area/reduction in prey species	All marine mammals	Small to negligible	Negative	Negligible	Probable

Residual Effect	Receptor	Magnitude of effect	Nature	Significance of effect	Probability of Effects Occurring as Predicted
Operation					
Long-term disturbance due to operational noise	All marine mammals	Negligible	Negative	Not significant	Certain
Long-term but intermittent noise disturbance from maintenance vessels	All marine mammals	Small	Negative	Minor	Unlikely
Long-term but intermittent physical injury/ mortality from vessels with ducted propellers and ship strike	All marine mammals	Small-negligible	Negative	Minor	Unlikely
Long term behavioural effects arising from EMFs	All marine mammals	Small	Negative	Minor	Probable
Long-term indirect effects arising from changes in prey resources and tidal regimes due to presence of turbine structures	All marine mammals	Small to negligible	Negative/positive	Negligible	Probable

12.9 CUMULATIVE ASSESSMENT

12.9.1 INTRODUCTION

238. This Section provides an assessment of the potential cumulative effects upon marine mammals arising from the Wind Farm in conjunction with other existing or foreseeable planned project/development activities.

239. A Scoping Report for the Wind Farm was issued to MS in March 2010. With respect to cumulative and in-combination effects, the Scoping Report identified a number of Round 3 offshore wind farm and Scottish territorial waters developments that were to be included within this cumulative effect assessment. In order to address data sharing and development of methodology, the MFOWDG was formed by BOWL and MORL in partnership with The Crown Estate to agree an approach to the cumulative and in-combination assessment.

240. A CIADD was prepared by MFOWDG and submitted to stakeholders in April 2011 which identified the potential cumulative effects on the physical, biological and human environment (Annex 5B).

12.9.2 SCOPE OF ASSESSMENT

241. The scope and method of this assessment was previously described in the CIADD (MFOWDG, 2011). The assessment of significance of cumulative effects has used the same criteria to determine significance based on the sensitivity of the receptor and the magnitude of the potential change as presented in Section 4: Environmental Impact Assessment Process and Methodology.

242. The cumulative assessment has been made against the existing baseline conditions as presented in this Section and in Section 24: OfTW Marine Mammals.

12.9.2.1 Consultation

243. The CIADD (MFOWDG, 2011) was presented to MS for review in April 2011 for comment. Responses from the statutory consultees are summarised in Table 12.16 and have been considered during the assessment of cumulative and in-combination effects for marine mammals.

Table 12.16 Summary of Responses to the CIADD

Consultee	Summary of Consultation Response	Project Response
Marine Scotland (MS)	Cumulative and in-combination effects should consider SACs and SPAs that may be affected, taking into account other Offshore Wind Farms other developments (e.g. oil and gas operations) and activities (e.g. shipping and fishing industries).	The cumulative assessment presented in this Section has considered the development of Moray Firth Round 3 Zone alongside other relevant developments in the context of relevant protected areas, including SACs.

Consultee	Summary of Consultation Response	Project Response
	Cumulative assessment will need to consider the possibility of all piling being undertaken concurrently for Beatrice and Moray Firth Round 3 Zone.	The underwater noise assessment has considered concurrent piling operations at both sites (Annex 7A).
JNCC/SNH	Structure of ES (including Cumulative Assessment) to address the requirements of HRA as well as EIA.	This assessment has considered effects on species associated with relevant SACs (i.e. bottlenose dolphins and harbour seals) Information to inform an appropriate assessment is provided in a separate document.
	We advise that it will be important to estimate the density of key marine mammal species across the entire area of predicted effect from each wind farm individually and cumulatively (to be determined on a species by species basis).	Density and abundance estimates have been made for marine mammal species for the entire Moray Firth region which incorporates other projects/proposals that are being considered as part of the CIA.
	We recommend that underwater noise generated from dredging activities / sea disposal is considered. Also, this table should include the seismic survey work associated with the oil and gas licensing blocks in the Moray Firth (and not just the placement of any new infrastructure). Under military activities we would specifically highlight the MOD Joint Warrior exercises for consideration	The CIA considers dredging, oil and gas licensing activities and military activities as potential cumulative noise effects.
	MFOWDG suggest that 'long term avoidance' of the windfarm sites by marine mammals is scoped out as a potential effect (Section 4.5.6, page 48). We think it is too early to do so and that this issue should be considered in CIA.	The assessment deals with the issue of cumulative avoidance including the likely duration of avoidance with reference to observations at other operational offshore wind farms
RSPB	The CIA should take into account any potential marine SPAs or offshore SACs and any future Marine Protected Areas.	Future protected areas are described for the Moray Firth region in the Section 12.3.1.
WDCS	Military aviation should be included as an activity that could affect marine mammals.	Military aviation has been considered but there was limited information on noise affects available (see Section 12.9.2.3)

Consultee	Summary of Consultation Response	Project Response
	Long term avoidance should be included as a potential cumulative effect.	The assessment deals with the issue of cumulative avoidance including the likely duration of avoidance with reference to observations at other operational offshore wind farms.
	All modelling works should be ground-truthed with in-field data verification.	The INSPIRE noise model has been validated using actual measured data taken during the installation of a 1.8 m diameter pile at the Beatrice demonstrator project in the Moray Firth and other offshore wind farm projects.

12.9.2.2 Geographical Scope

244. As presented in the CIADD the geographical extent of the study area for the cumulative assessment focuses on the Moray Firth. However, due to the highly mobile nature of marine mammals, it is recognised that animals may be affected by developments further afield.

12.9.2.3 Developments Considered in Assessment

245. The CIADD (MFOWDG, 2011) presented the developments for which it was considered an assessment of cumulative effects with the Project should be undertaken for marine mammals. These were:

- Beatrice Offshore Wind Farm (the Wind Farm) including the meteorological mast, substations and inter-array cables;
- Beatrice Offshore Transmission Works (OfTW)
- Moray Firth Round 3 Zone Eastern Development area;
- Moray Firth Round 3 Zone Western Development area;
- Moray Firth Round 3 Zone OFTO cable;
- Relevant oil and gas activities;
- Proposed SHETL cable and offshore hub;
- Relevant port and harbour developments in the Moray Firth;
- Relevant military and aviation activity;
- Other relevant offshore renewable development outside the Moray Firth;
- Dredging and sea disposal in the Moray Firth; and
- Marine energy developments in the Pentland Firth and Orkney waters.

246. There are not currently any aggregate dredging areas in the Moray Firth. Similarly, there are no port and harbour developments planned to be undertaken in coastal areas in the vicinity of the Wind Farm. Cumulative effects in relation to dredging and disposal and port and harbour development in the Moray Firth are not considered further in the cumulative assessment.

247. As part of the cumulative assessment, military exercises, specifically Exercise Joint Warrior (JW) by the Ministry of Defence (MOD) were considered as activities that have the potential to cause cumulative noise effects in the marine environment. Based on summary information received with respect to JW, information regarding

specific underwater activity and locations is very limited. It is known that the Wind Farm Site lies within the range typically used by JW and as such maritime and air activities could potentially coincide with wind farm operations. However, with little knowledge of noise levels associated with the potential activities for JW or the likelihood of them coinciding temporally or spatially with activities relating to wind farm construction, a reasonable assessment of cumulative effects is not possible. Consequently military activities have not been considered further.

248. With the exception of these scoped out developments, those listed above have been considered for cumulative effects on marine mammals within the following Section. The developments considered varies as applicable between each type of effect assessed, the applicable developments are noted within the assessments below.

249. No cumulative assessment of the onshore transmission works (OnTW) has been undertaken as there will be no interactions that affect marine mammals.

12.9.3 ASSESSMENT OF EFFECTS

250. The methodology used to assess potential cumulative effects on marine mammals from the construction, operation and decommissioning of the Wind Farm in conjunction with other existing or foreseeable planned project/development activities are as described for the Wind Farm alone.

12.9.3.1 Noise modelling and assessment

251. The INSPIRE model was used to model a number of scenarios for cumulative effects between the Project and other planned or existing developments within the Moray Firth. No seismic surveys are planned as part of the oil and gas developments within the Moray Firth and the only other noise generating works are for development of the Moray Firth Round 3 Zone Eastern Development Area. Therefore the worst case scenario was for two simultaneous pile driving events at the Wind Farm Site (2.4 m pin piles) and six simultaneous pile driving events at the Moray Firth Round 3 Zone Eastern Development Area (3 m pin piles) (Table 12.17). References to piling at the Moray Firth Round 3 Zone refer specifically to the Eastern Development Area; the Western Development Area is not given further consideration as this area will not be piled within the same timeframe as for the Wind Farm construction programme. Therefore, the Moray Firth Round 3 Zone Western Development Area has been scoped out. There is also the potential for cumulative effects from piling during the installation of the SHETL hub. However, in the absence of any detailed information on construction methods, it was assumed that this was unlikely to be greater than the cumulative piling noise for the worst case scenario considered here, as was the case for installation of the OSPs and meteorological mast for the Wind Farm alone (see Section 12.2.7.9).

Table 12.17 Summary of Cumulative Scenario Modelled for the Wind Farm (WF) and Moray Firth Round 3 Zone (MFR3Z)

Pile Location	Pile Diameter	Blow Force	Species	Potential Effect
WF A+B MFR3 M1 to M6	2.4 m 3 m	2300 kJ 1800 kJ	Bottlenose dolphin, harbour porpoise, harbour seal, grey seal, minke whale*	As above

*Note: there were no data available to model noise thresholds for minke whale.

12.9.4 ASSESSMENT OF EFFECTS DURING CONSTRUCTION/DECOMMISSIONING

12.9.4.1 Cumulative Noise Effects associated with Simultaneous Piling

252. Assessment of the cumulative effects from piling considers the two simultaneous piling events at the Wind Farm Site together with six simultaneous piling events at the Moray Firth Round 3 Zone, Eastern Development Area as the worst case scenario. There is also potential for noise disturbance from offshore wind farms further afield to affect marine mammals due to their wide ranging nature. The construction programme for the Firth of Forth offshore wind farms coincides with the Wind Farm construction programme and therefore marine mammals may be temporarily excluded from a large proportion of their range (see Table 12.18). Similarly, there may be potential cumulative effects from construction of the offshore renewable energy developments in the Pentland Firth and Orkney waters, however, no details on the construction (or operation) phases of these developments were available at the time of this assessment.

Table 12.18 Construction Phasing of Firth of Forth Offshore Wind Farms

	2014	2015	2016	2017	2018	2019
Seagreen Round 3 Phase 1	x	✓	✓	x	x	x
Seagreen Round 3 Phase2/3	x	x	x	✓	✓	✓
Inchcape	x	x	✓	✓	✓	x
Neartna Gaoithe	x	✓	✓	x	x	x

253. There are two worst case scenarios to consider for the cumulative assessment. The first is the worst case scenario in terms of the magnitude of effect. In this case, the noise modelling undertaken showed that the two simultaneous piling events at the Wind Farm site combined with the six simultaneous piling events at the Moray Firth Round 3 Zone led to the greatest area of ensonification. The second worst case scenario considered is the temporal effect. Based on the construction schedules for the Wind Farm and the Moray Firth Round 3 Zone, the piling within the Moray Firth would at best be two years and at worst be six years. The SeaRoc modelling looked at the different cumulative scenarios (i.e. short term intense piling versus

longer term and fewer simultaneous piling events) in terms of the potential numbers of animals affected. Due to the limitations of the model in its ability to estimate numbers of individuals affected, for all species, the numbers estimated were similar for the two scenarios. Intuitively it is more likely that the magnitude of effects for the longer term scenario will be less than that for the short term scenario. However, the similarities in the estimates do suggest that potentially the effects may not be as different as might be expected, and consequently only the results of eight simultaneous piling events scenario (as the worst case) are presented below.

254. The noise modelling that was undertaken for the eight simultaneous piling events within the Moray Firth was used to calculate the effect thresholds for each species (Table 12.19). As with the Wind Farm assessment above the noise modelling incorporates a soft-start scenario (see Section 12.4) and which assumes that animals will flee the area before piling at full power commences.

Table 12.19 Results of the INSPIRE Model for the Cumulative Wind Farm and Moray Firth Round 3 Zone Scenario.

Scenario	Receptor	Thresholds	Total radius of threshold around each piling operation (m)	Total affected area (km^2)
Two pile driving events at the Wind Farm locations A and B, concurrently with six pile driving events at Moray Firth Round 3 Zone locations M1 to M6	Bottlenose dolphin	Death/injury	Wind Farm – 60 Moray Firth R3 Zone – 80	0.14
		PTS	2,250 (13,000)	510 (1,769)
		Behaviour	43,150	7,793
	Harbour porpoise	Death/injury	Wind Farm – 60 Moray Firth R3 Zone – 80	0.14
		PTS	2,400 (14,000)	499 (1,760)
		Behaviour	61,550	12,041
	Harbour seal /Grey seal	Death/injury	Wind Farm – 60 Moray Firth R3 Zone – 80	0.14
		PTS	9,000 (20,750)	1,191 (3,094)
		Behaviour	59,050	10,881
		Behaviour	59,050	10,881

The thresholds used in Table 12.19 are as follows: (i) death/injury – 220 dBht; (ii) PTS fleeing and stationary (in parenthesis) – 198 dB re. 1 µPa2/s; (iii) behavioural effects – up to 75 dBht

Bottlenose dolphin

255. As with the Wind Farm scenario alone, it is considered unlikely that bottlenose dolphins within the study area will suffer injury/death since the areas within which the thresholds for these effects occur are small and therefore do not overlap areas within which bottlenose dolphins are predicted to be present (Figure 12.11). However, the area over which PTS is predicted to occur for bottlenose dolphin is

considerable greater for the Wind Farm and the Moray Firth Round 3 Zone in combination, and therefore, whilst these still do not overlap with areas in which bottlenose dolphin are likely to present, the risks are nonetheless higher for individuals in the Moray Firth, simply because the extent of effect area is larger.

256. Although the noise contours for the Wind Farm and the Moray Firth Round 3 Zone overlap to a very large extent, the cumulative behavioural effect threshold (75 dB_{ht}) in this instance extends slightly further towards the south coast, which density data suggests is an important area for this species. In the worst case, some individuals that suffer behavioural effects may be excluded from the key foraging areas along the south coast (e.g. Spey Bay) during the period of cumulative piling (two years). Noise levels such as this are not predicted to form a barrier to movement (P. Thompson pers. comm), although they may influence movement rates between difference parts of the population's range. However, the 75 dB_{ht} threshold represents a precautionary estimate of the outer limit of the likely noise disturbance threshold and therefore not all individuals are expected to be affected. In addition, Spey Bay is only one of a number of key foraging areas regularly used by animals in the Moray Firth, and whilst there may be noise disturbance in this area the quality of the foraging habitat will not itself be affected. Given the current levels and range of background noise in the Moray Firth at different sea states to which marine mammals have habituated together with the precautionary nature of the 75 dB_{ht} threshold, it is considered probable that a significant proportion of individuals will continue foraging in these areas of lower disturbance. Bottlenose dolphin commonly experience background levels of up to 66 dB_{ht} in sea state 1 (Annex 7A). Quantitative measurements area lacking, but Subacoustech's SPEAR model also highlights that higher levels of noise may occur close to large ships and recreational vessels as they transit the Moray Firth.

257. There is also potential for cumulative noise effects with the proposed Firth of Forth offshore wind farms and the magnitude and significance depends on the importance of the Firth of Forth to the Moray Firth bottlenose population and the degree of overlaps between piling activities. It is likely that bottlenose dolphins from the Moray Firth range down as far as the Firth of Forth (Thompson et al., 2004), but this represents just a small proportion of their potential range along the east coast. However, the construction period for the Firth of Forth offshore wind farms may overlap with that of the Wind Farm and the Moray Firth Round 3 Zone and therefore there is still potential for some small magnitude cumulative effects on bottlenose dolphin as they would be excluded from a larger proportion of their range during the simultaneous construction activities. In summary, there is likely to be the potential for a negative effect on bottlenose dolphin through displacement in some areas during piling activity for between two to six years (depending on the piling scenario). If displacement occurs, and if alternative foraging areas are unavailable, then this may result in an effect on animals by affecting their reproductive fitness (for example by extending their inter-calf intervals or reducing growth rates).

258. Subject to the uncertainties described in Sections 12.2.9.1, 12.2.9.2 and 12.2.9.3 noise disturbance is predicted to have a medium to short-term effect of medium magnitude which is probable, and due to the sensitivity and conservation status of bottlenose dolphins, is considered to be of moderate significance. Following cessation of piling, any longer-term effects that may occur are predicted to be of small to medium magnitude but unlikely. Consequently, the potential long-term effect on bottlenose dolphin is of moderate significance. The short and long-term effects are both significant in terms of the EIA Regulations.

Moray Firth SAC

259. Figure 12.11 shows that the 75 dB_{ht} cumulative noise contour abuts the boundary of the Moray Firth SAC protected area but does not extend inside the SAC and therefore effects are predicted only on individuals ranging outside the SAC. However, as discussed above there is potential for bottlenose dolphins from the SAC to be affected in areas out with the SAC boundary, including as far south as the Firth of Forth, and in particular they may be displaced from one of their key feeding areas (Spey Bay) in the short term. As discussed above, since the population data for bottlenose dolphins is most accurately presented as distributional information, it is not appropriate to predict numbers of individuals (and therefore the proportion of the SAC population) potentially affected by noise disturbance within the Moray Firth.

260. The potential effects from the Wind Farm alone on bottlenose dolphins and the challenges associated with making these predictions were discussed in Section 12.5.1.1, particularly in respect to the longer-term population-level effects. Subject to those same uncertainties, the cumulative effects on the SAC population out with the SAC boundary, can be predicted as being of short- to medium-term duration, medium magnitude and probable. The significance of this effect on the SAC is moderate. Following cessation of piling activity, any longer-term effects that may occur are predicted to be of small to medium magnitude but unlikely. Consequently, the potential effect on the Moray Firth SAC is of moderate significance. The short and long-term effects are both significant in terms of the EIA Regulations.

Harbour porpoise

261. The noise-density map (Figure 12.12) and noise threshold calculations (Table 12.19) show that since the noise contours for the Wind Farm and the Moray Firth Round 3 Zone overlap to such a great extent, the cumulative area of the Moray Firth affected is only marginally greater than for the Wind Farm alone. For example, the maximum radius of behavioural disturbance for the Wind Farm alone is 61,250 m from the piling activity yet for the Wind Farm and the Moray Firth Round 3 Zone cumulatively is 61,550 m. Consequently there is little change in the numbers affected cumulatively compared with the Wind Farm alone.

262. The model predicted that no individuals would suffer injury/mortality, however, there is greater risk of animals suffering PTS from the cumulative noise effect since the area of sea affected is larger (Figure 12.12). In terms of the behavioural noise

threshold, the model predicted that a similar number of individuals (4337) have the potential to suffer behavioural effects to varying degrees compared with the Wind Farm alone. However, as discussed above the SeaRoc model only provides an approximation of the numbers potentially affected, and in some cases the prediction is counterintuitive, predicting potentially less than for the Wind Farm alone. Therefore, it is important not to place too much emphasis on relatively small differences in potential numbers of animals affected as predicted by the model. However, in this case the behavioural noise contours for cumulative piling are similar to those for the Wind Farm alone and as a result the effects are considered to be the same (see Para 176).

263. Harbour porpoise range widely and therefore there is potential for the population to be affected by the construction of the Firth of Forth offshore wind farms. However, as the 4,337 individuals represents a small proportion of their natural range and large population size (1.5% based on the 280,000 individuals in the North Sea population). Therefore, the magnitude of potential cumulative noise effects from the Firth of Forth offshore wind farms is likely to be negligible.

264. Due to the wide distribution, large population size and transitory nature of harbour porpoise (i.e. not site faithful) within the Moray Firth it is considered that there will be a negative effect on harbour porpoise (a high level receptor) through displacement over the two to six year piling period (including displacement from the Firth of Forth), and will be of negligible to small magnitude compared to the size of the North Sea population and their extent of available habitat and probable. Due to the sensitivity and conservation status of harbour porpoise, this will result in a probable effect of minor significance. Following cessation of piling activity, there are no long-term effects predicted and this assessed as being probable and not significant. Both the short and long-term effects are not significant in terms of the EIA Regulations.

Minke whale

265. The cumulative noise impact assessment for seals (as a proxy species) showed that the noise contours for the Wind Farm and the Moray Firth Round 3 Zone overlap considerably and therefore the extent of area affected is only marginally greater for cumulative effects compared to the Wind Farm alone. The site-specific surveys showed that minke whale are distributed throughout the Moray Firth during the summer months and therefore individuals occur within the potential area of noise impact, although the southern coastal distribution is unlikely to be affected.

266. Minke whale commonly occurs along the northeast coast of the British Isles, including the Firth of Forth. Therefore, the construction phase of the proposed Firth of Forth offshore wind farms may cumulatively affect minke whale within this region. However, the Moray Firth and Firth of Forth represent just a small proportion of their natural range and are only likely to be affected in the summer months when minke whales occur closer to shore.

267. In summary, it is predicted that that during construction in the summer months there will be a short-term effect of displacement on minke whale from the offshore

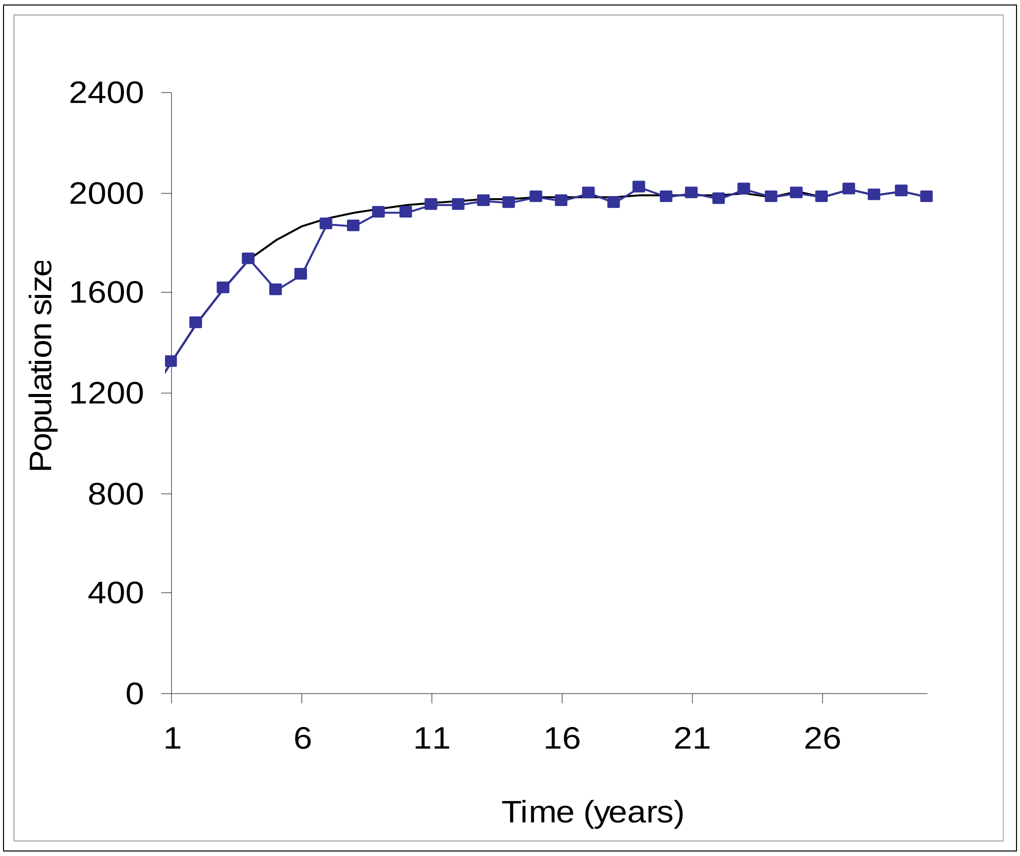
areas of the Moray Firth and from the area of effect of the Firth of Forth, but since these represents only a small proportion of their range, the effect will be of small magnitude. Based on the sensitivity and conservation status of minke whale, this will result in a probable effect of minor significance, which is not significant in terms of the EIA Regulations. There are no long term effects predicted for minke whale and both the short and long-term effects are not significant in terms of the EIA Regulations.

Harbour seal

268. The cumulative assessment showed that the noise contours for the Wind Farm and the Moray Firth Round 3 Zone overlap considerably and therefore the extent of area affected is marginally greater for cumulative effects compared to the Wind Farm alone. The noise contours extend over a similar area for behavioural displacement (56 km radius for the Wind Farm compared to 59km for the Wind Farm and the Moray Firth Round 3 Zone) (Table 12.19) and the majority of haul-outs are away from ensonified areas (Figure 12.13).

269. Population modelling (see Section 12.2.7.12) was carried out for the worst case scenario of eight simultaneous piling events and showed that as with the Wind Farm alone the population recovered after an initial slight decrease in the population growth trend (Plate 12.13). The limitations and assumptions of the model are described in Section 12.2.9.3. The population model predicted that during the noise disturbance from piling loss of individuals due to injury/death was unlikely, and very few individuals (<10) would be likely to be affected by PTS based on both the fleeing model and the stationery model(Thompson et al., 2012 (Annex 12B)). Behavioural effects may extend over a substantial area of the Moray Firth (10,881 km^2; Table 12.19) and would be likely to affect over 1000 individuals. As described above for harbour porpoise, it is important not to place too much weight on these numbers as the SeaRoc model only gives an approximation of the number of individuals potentially affected.

Plate 12.13 Population Model Predicting the Normal Increase in Harbour Seals within the Moray Firth (black line) Compared with the Population Increase (blue squares) After the Eight Simultaneous Piling Scenario at the Wind Farm Site and the Moray Firth Round 3 Zone



270. Further cumulative effects have also been considered in relation to potential noise disturbance from construction of the Firth of Forth offshore wind farm. However, the Moray Firth population is both site-faithful (i.e. less likely to haul-out at other locations) and not wide-ranging (i.e. compared to grey seals). Therefore, the cumulative effects on harbour seals from the Moray Firth are considered to be negligible with respect to developments at this distance from their preferred haul-out locations.

271. Based on the conservative assumptions of the modelling work, there is predicted to be a short to medium term (two to six years), large magnitude effect during the cumulative piling works on a high level receptor. The precautionary model has assumed that such an effect could potentially result in breeding failure for a large proportion of the population and therefore gives rise to an assessment of an effect of major significance and probable, and is significant in terms of the EIA Regulations. However, according to the population model, after an initial decrease, the population would continue to increase rapidly reaching the baseline population levels after just two years. Therefore, the long-term effects of piling on the harbour seal population following cessation of piling, are considered to be of negligible magnitude and probable, and are of minor-negligible significance. Long-term effects are not significant in terms of the EIA Regulations.

12.9.4.2 Dornoch Firth and Morrich More SAC

272. Figure 12.13 shows that the contour maps for cumulative piling noise do not overlap the Dornoch Firth and Morrich More SAC and therefore effects are predicted only on individuals ranging outside the SAC. As described above the harbour seal framework was used to assess both short-term and long-term cumulative effects on the population in the Moray Firth. Conservatively it is assumed that the majority of individuals affected by noise impacts will be from the Dornoch Firth and Morrich More SAC population.

273. Therefore, there is predicted to be a large magnitude, short-medium term effect of displacement of harbour seals (two to six years) which is reversible and probable. Based on the high conservation status of the Dornoch Firth and Morrich More SAC this would result in a short-term effect of major significance, which is significant in terms of the EIA Regulations. Based on the evidence from the harbour seal population model it can be seen that there is a negligible long-term effect of piling on the Dornoch Firth and Morrich More SAC population, and therefore effects on the viability of this SAC are assessed as being probable and of minor-negligible significance. Long-term effects are therefore not significant in terms of the EIA Regulations.

Grey seal

274. As with the harbour seal the cumulative assessment showed that the noise contours for the Wind Farm and the Moray Firth Round 3 Zone overlap substantially such that there is negligible difference between the cumulative impact area and the impact area from the Wind Farm alone. The noise contours extend over a similar area for behavioural displacement (56 km radius for the Wind Farm compared to 59km for the Wind Farm and the Moray Firth Round 3 Zone) (Table 12.19) and only the Brora haul-out is likely to experience ensonification in the surrounding waters (Figure 12.14).

275. The numbers of seals affected in each noise threshold were compared with the most recent estimates for the Scottish population of 119,400 individuals. The results suggested that it was unlikely that any individuals would suffer death/injury, very few (<10) were likely to be affected by PTS based on both the fleeing model and stationary model, and 1,334 individuals were likely to suffer behavioural effects.

276. Although there is an initial potential loss of foraging habitat within the disturbed area over the construction phase, for reasons described above (Para 194) grey seals are less likely to be significantly affected than harbour seals due to their lack of site fidelity and larger potential foraging area, such that any displaced individuals may not necessary suffer fitness consequences (such as reduced breeding success).

277. In summary, there will be a small magnitude negative effect on grey seals (a high level receptor) of displacement of 1.1% of the Scottish population over the two to six year construction phase, which is considered to be of minor significance and probable and no longer term effects are predicted following cessation of the piling activity. The short and long-term effects are not significant in terms of the EIA Regulations.

12.9.4.3 Ship Strike and Potential Injury from Ducted Propellers

278. Potential cumulative impacts of collision risk on marine mammals, particularly seals, may arise from simultaneous construction at the Wind Farm and the Moray Firth Round 3 Zone. It assumed that the number of vessels during construction of the Moray Firth Round 3 Zone will be three times that of the Wind Farm alone and therefore there could be a maximum of 104 construction vessels within the Wind Farm and the Moray Firth Round 3 Zone at any one time. As discussed previously (Section 12.5.1.2) it is considered unlikely that this will lead to increased collision risk as the noise generated by construction activities would most likely displace seals from the area and the types of vessels involved in construction activities present a low risk of collision. Animals are thought to be vulnerable to this impact due to the potential for injury or mortality associated with vessels using ducted propellers. However, as discussed previously, at present there is little scientific evidence to suggest that injury from ducted propellers is likely to present a risk in the Moray Firth (see Section 12.5.1.2),

279. In summary, there is predicted to be a small-negligible magnitude negative effect of short to medium-term duration over the construction phase due to collision risk, which has the potential to affect a small proportion of the grey and harbour seal populations in the area, although this is considered to be unlikely. Due to the levels of uncertainty the effect is considered to be of minor significance and not significant in terms of the EIA Regulations.

12.9.4.4 Suspended Solids Impairing Foraging Efficiency

280. Changes to the SSC were considered in relation to: the Wind Farm and the Moray Firth Round 3 Zone foundation installation, inter-array cable burial, and export cable burial; the oil and gas foundation installation; and the SHETL cable burial. The assessment for these is summarised in Section 9: Wind Farm Physical Processes and Geomorphology. The assessment concluded that due to the localised nature of the sediment plumes there is unlikely to be interaction such that SSC will rise above the level predicted by the Wind Farm alone (i.e. <30 mg/l). The ranges of SSC due to cumulative interactions are consistent with the natural range of variability and would be of short-term duration and very localised. The cumulative effect in relation to physical processes has been assessed to be of minor significance and consequently it is considered that the effect of increased SSC and subsequent sediment re-deposition have little potential to result in a cumulative effect on marine mammals.

281. Therefore, there will be a negligible magnitude effect of short-term duration on marine mammals (high level receptor) which is probable and of negligible significance. The effect is not significant in terms of the EIA Regulations.

12.9.4.5 Indirect Effects Due to Loss of Foraging Area / Reduction of Prey Species

282. The assessment of cumulative construction noise on fish and shellfish species concluded that there is the potential for significant effects to occur, particularly in relation to salmon and sea trout. Salmon and sea trout are migratory species and there is potential for them to be affected by other offshore wind farm developments

in Aberdeen Bay or the Firth of Forth, subject to construction schedules. However, the migration routes of these species are unknown and therefore the magnitude of effects remain un-quantified.

283. Since marine mammals exploit a suite of different species as a food resource they are unlikely to experience reduced prey availability through declines in just one or two of their potential prey item. However, bottlenose dolphin may exploit the Atlantic salmon on migration through Spey Bay and up into the Spey River, therefore there is the potential for some minor effects on bottlenose dolphin, although there are other key foraging areas for bottlenose dolphin within the Moray Firth.

284. In summary there is predicted to be a small magnitude, indirect negative effect of short to medium-term duration on marine mammals (high value receptor) due to a temporary displacement in some of their prey species and is therefore considered to be of minor significance and probable. The effect is not significant in terms of the EIA Regulations.

12.9.5 ASSESSMENT OF EFFECTS DURING OPERATION

12.9.5.1 Operational Noise from Turbines

285. Operational noise in relation to the turbines installed at the Wind Farm alone was assessed as being negligible and not significant and therefore there is no potential for cumulative effects with other developments, such as the Moray Firth Round 3 Zone site or oil and gas operations, within the Moray Firth or wider area.

12.9.5.2 Cumulative Noise and Disturbance associated with Other Activities in the Moray Firth

286. During operation, there may be an additional two to seven maintenance vessels on site as a minimum or ten to 45 as a maximum (based on information provided by MORL) but vessels will not operate daily through the year. The maintenance vessels will be similar to those used during construction e.g. jack-up barges, and will therefore be operating at a slow speed between maintenance operations around the wind farm site. The greater potential for disturbance is likely to arise from crew transport vessels to and from the Wind Farm and the Moray Firth Round 3 Zone. These will be smaller vessels of between 18-20 m in length.

287. Disturbance from vessel noise is predicted to be of short-term duration i.e. during the crew transfer times and most likely to result in avoidance behaviour and auditory masking during that time for individuals that are sensitive (see Section 12.5.2.2 for description of potential effects). Although the uplift in vessel numbers will be greater for the Wind Farm and the Moray Firth Round 3 Zone together, against the background of high vessel activity, to which marine mammals appear to have habituated, it is considered unlikely that this increase in vessel activity will have a significant effect.

288. In summary, there is predicted to be a small magnitude effect of disturbance from vessel noise on marine mammals, which would be intermittent over the period of operation and subject to uncertainties described above, it its considered to be unlikely. Due to the high sensitivity and conservation status of marine mammals,

the effect is assessed as being of minor significance and not significant in terms of the EIA Regulations.

12.9.5.3 Ship Strike and Potential Injury from Ducted Propellers

289. During operation, there may be an additional two to seven vessels on site as a minimum or ten to 45 as a maximum (based on information provided by MORL). As described previously (Section 12.5.2.3) this must be considered in the context of considerable daily and seasonal variation and as such the minimum figures represent a negligible increase in vessel movements. At the maximum levels, the vessel movements may represent a slight increase in the risk of collision. Maintenance work is likely be carried out via a floating HLV jack-up barge, similar to that used in construction, and crew transfer vessels will be typically 20 m in length. Although there are likely to be a greater number of vessels during maintenance operations, these will be concentrated in just a small area of the Moray Firth and therefore any effects will be localised and temporary in nature.

290. Animals are thought to be vulnerable to this type of effect due to the potential for injury or mortality associated with vessels using ducted propellers. However, as discussed previously, at present there is little scientific evidence to suggest that injury from ducted propellers is likely to present a risk in the Moray Firth (see Section 12.5.1.2),

291. In summary, there is predicted to be a small-negligible magnitude cumulative effect of intermittent frequency over the operation phase, which has the potential to negatively affect a small proportion of the grey and harbour seal populations in the area due to collision risk, although this is considered to be unlikely. Due to the levels of uncertainty discussed in (Section 12.5.1.2) the effect is considered to be of minor significance and not significant in terms of the EIA Regulations.

12.9.5.4 Behavioural Effects Arising from EMF

292. There is potential for cumulative effects from EMF to arise as a result of the OfTW and Moray Firth Round 3 Zone export cables and the SHETL cable. The Wind Farm and the Moray Firth Round 3 Zone inter-array cables are not considered likely to result in a cumulative effect as these are both AC, which due to the rapid reversal in polarity, are not predicted to cause a negative effect (see Section 12.5.2.4). In contrast, currents arising from DC cables may result in very small alterations in swimming direction and foraging behaviour (Normandeau et al., 2011). The SHETL cable has been specified as DC and the Wind Farm and the Moray Firth Round 3 Zone export cables may be AC or DC. The assessment of effects on marine mammals from EMF associated with the Wind Farm OfTW cables (see Section 24: OfTW Marine Mammals and 12.5.2.4) demonstrates that effects of EMF are very localised and unlikely to result in a significant effect. Cumulatively, the effects will occur over a greater area than that assessed in the stand alone assessment as a result of the longer length of cable within the Moray Firth.

293. As described in the assessment for the Wind Farm alone, the effects of EMF on marine mammals are localised to a small distance from the cable with potential responses such as temporary changes in swimming direction or slight deviation

from a transit route, however, these are unlikely to cause a negative effect on marine mammals or populations.

294. The in-combination effects will not be additive in terms of increasing the magnitude of the magnetic field itself, but will occur over a larger area of seabed within the Moray Firth. However, the extent to which effects occur also depend on other factors including burial depth, proximity to other cables and alignment with the earth's geomagnetic field. The effects have greater potential to occur closer to the shore where shallower water depths mean that animals may move closer to the cables. The locations at which the cable enters shallower water (i.e. near the landfall points) are at Fraserburgh or Rattray Head for the Moray Firth Round 3 Zone, at Portgordon in Spey Bay for SHETL and the OfTW.

295. Due to the uncertainty of this effect, there is predicted to be a small magnitude, localised, and reversible cumulative effect over the duration of the operation phase, which will result in a probable negative effect of minor significance on marine mammals (high level receptor), subject to the uncertainties relating to a lack of scientific understanding of the effects of EMF on marine mammals. The effect is not significant in terms of the EIA Regulations.

12.9.5.5 Indirect Effects Due to Changes in Prey Species/Tidal Regimes

296. Section 9: Wind Farm Physical Processes and Geomorphology scoped out cumulative effects of all other projects/developments in the study area with the exception of the development of the Moray Firth Round 3 Zone. Changes to the tidal regime as a result of the Wind Farm and the Moray Firth Round 3 Zone together were subsequently assessed as being negligible and not significant (see Section 9: Wind Farm Physical Processes and Geomorphology).

297. Similarly the introduction of new habitat was not considered to be significant in terms of cumulative effects on fish and shellfish populations in the study area.

298. The potential effects on marine mammals from changes in tidal regime and creation of new habitat are described in Section 12.5.2.5 above. Based on the assessment provided by the coastal processes and fish and shellfish Sections, any cumulative effects on marine mammals in the study area are predicted to be small to negligible magnitude and probable. Therefore the effects are considered to be of negligible significance and not significant in terms of the EIA Regulations.

12.9.6 MITIGATION AND MONITORING

299. Mitigation for the Wind Farm alone (see Section 12.6) can similarly be applied here.

12.9.7 RESIDUAL CUMULATIVE EFFECTS

300. The assessment has found that the effect of disturbance arising from cumulative piling noise has the potential to cause both and short-term and long-term effect of moderate significance on bottlenose dolphin and the Moray Firth SAC. In addition, there is predicted to be a short-term effect of disturbance on harbour seals and the Dornoch Firth and Morrich More SAC which would result in an effect of major significance. At this stage there are no proven mitigation measures available to reduce noise effects and therefore the residual effects are predicted to be the same.

301. None of the remaining effects arising from cumulative activities during construction, operation and decommissioning were significant in terms of the EIA Regulations and therefore since no mitigation is required the residual effects remain the same.

12.10 SUMMARY

302. The effects on marine mammals, expected as a result of the cumulative construction/decommissioning and operational phases of the Wind Farm are summarised in Table 12.20.

303. The effects have also been summarised in terms of their Likely Significant Effect (LSE) on features of the European designated sites (Table 12.21) in order to highlight those effects that will be carried forward for further assessment under the Habitats Regulations (to be presented in a Report to Inform an Appropriate Assessment).

Table 12.20 Summary of Cumulative Effects on Marine Mammals

Residual Effect	Receptor	Magnitude of effect	Nature	Significance of Effect	Probability of Effects Occurring as Predicted
Construction/Decommissioning					
Short-to medium term injury/displacement from noise emissions during pile driving with potential for longer term effects on the population	Bottlenose dolphin	Small to Medium	Negative	Moderate, Significant	Probable for short-term; and Unlikely for long-term
	Moray Firth SAC	Small to Medium	Negative	Moderate, Significant	Probable for short-term; and Unlikely for long-term
	Harbour Porpoise	Small to negligible	Negative	Minor, Not Significant	Probable
	Minke whale	Small	Negative	Minor, Not Significant	Probable
	Harbour seal	Large short-term effect Negligible long-term effect	Negative Negative	Major, Significant Minor to negligible, Not Significant	Probable Probable
	Dornoch Firth and Morrich More SAC	Large short-term effect Negligible long-term effect	Negative Negative	Major, Significant Minor to negligible, Not Significant	Probable Probable
	Grey seal	Small	Negative	Minor, Not Significant	Probable
Short to medium term physical injury/ mortality from vessels with ducted propellers and ship strike	Seals	Small-negligible	Negative	Minor, Not Significant	Unlikely
Short term suspended solids impairing foraging efficiency	All marine mammals	Negligible	Negative	Negligible, Not Significant	Probable
Short to medium term indirect effects due to temporary loss of foraging area/reduction in prey species	All marine mammals	Small	Negative	Minor, Not Significant	Probable

Residual Effect	**Receptor**	**Magnitude of effect**	**Nature**	**Significance of Effect**	**Probability of Effects Occurring as Predicted**
Operation					
Long-term disturbance due to operational noise	All marine mammals	Negligible	Negative	Negligible, Not Significant	Certain/near-probable
Long-term but intermittent noise disturbance from maintenance vessels	All marine mammals	Small	Negative	Minor, Not Significant	Unlikely
Long-term but intermittent physical injury/ mortality from vessels with ducted propellers and ship strike	All marine mammals	Small-negligible	Negative	Minor, Not Significant	Unlikely
Long term behavioural effects arising from EMFs	All marine mammals	Small	Negative	Minor, Not Significant	Probable
Long-term indirect effects arising from changes in prey resources and tidal regimes due to presence of turbine structures	All marine mammals	Small to negligible	Negative/positive	Negligible, Not Significant	Probable

Table 12.21 Habitats Regulations Screening Matrix for the Moray Firth SAC and Dornoch Firth and Morrich More SAC

Designated Site and Qualifying Feature	Conservation Objectives	Potential Impacts and Effects	Proposed Generic Mitigation Measures	Likely Significant Effects Alone	Likely Significant Effects in Combination
Moray Firth SAC Bottlenose Dolphin *Tursiops truncatus*	To avoid deterioration of the habitats of the qualifying species (Bottlenose dolphin *Tursiops truncatus*) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest.	Noise generated during pile driving has potential to cause injury and displacement.	Use of soft-start and monitored zone	Likely significant effect	Likely significant effect
		Behavioural effects arising from EMF Increase in suspended solids impairing foraging efficiency; Indirect effects due to loss of foraging area as well as a change or reduction of prey species; and, Noise disturbance from turbine operations and maintenance vessels. Change in tidal regime/prey species	No mitigation required	No likely significant effect	No likely significant effect
	To ensure for the qualifying species that the following are established then maintained in the long term: o Population of the species as a viable component of the site; o Distribution of the species within the site; o Distribution and extent of habitats supporting the species; o Structure, function and supporting processes of habitats supporting the	Noise generated during pile driving has potential to cause injury and displacement.	Use of soft-start and monitored zone	Likely significant effect	Likely significant effect
		Behavioural effects arising from EMF Increase in suspended solids impairing foraging efficiency; Indirect effects due to loss of foraging area as well as a change or reduction of prey species; and, Noise disturbance from turbine operations and	No mitigation required	No likely significant effect	No likely significant effect

Designated Site and Qualifying Feature	**Conservation Objectives**	**Potential Impacts and Effects**	**Proposed Generic Mitigation Measures**	**Likely Significant Effects Alone**	**Likely Significant Effects in Combination**
	species; o No significant disturbance.	maintenance vessels. Change in tidal regime/prey species.			
Dornoch Firth and Morrich More SAC Harbour Seal *Phoca vitulina*	To avoid deterioration of the habitats of the qualifying species (common seal *Phoca vitulina*) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interests	Noise generated during pile driving has potential to cause injury and displacement.	Use of soft-start and monitored zone	Likely significant effect	Likely significant effect
		Collision risk which has the potential to cause injury/mortality from increased vessel activity during construction and operation Behavioural effects arising from EMF Increase in suspended solids impairing foraging efficiency; Indirect effects due to loss of foraging area as well as a change or reduction of prey species; and, Noise disturbance from turbine operations and maintenance vessels. Change in tidal regime/prey species	No mitigation required	No likely significant effect	No likely significant effect
	To ensure for the qualifying species that the following are established then maintained in the long term: o Population of the species as a viable component of the site;	Noise generated during pile driving has potential to cause injury and displacement.	Use of soft-start and monitored zone	Likely significant effect	Likely significant effect

Designated Site and Qualifying Feature	Conservation Objectives	Potential Impacts and Effects	Proposed Generic Mitigation Measures	Likely Significant Effects Alone	Likely Significant Effects in Combination
	o Distribution of the species within the site; o Distribution and extent of habitats supporting the species; o Structure, function and supporting processes of habitats supporting the species; o No significant disturbance of the species.'	Behavioural effects arising from EMF Increase in suspended solids impairing foraging efficiency; Indirect effects due to loss of foraging area as well as a change or reduction of prey species; and, Noise disturbance from turbine operations and maintenance vessels. Change in tidal regime/prey species.	No mitigation required	No likely significant effect	No likely significant effect

12.11 STATEMENT OF SIGNIFICANCE

304. The effects of activities during the construction, operation and decommissioning phases of the Project, both alone and in combination with other plans and projects, were assessed with respect to key marine mammal species within the study area. The majority of effects were assessed as being of negligible to minor significance and therefore not significant in terms of the EIA Regulations. The exception to this was the impact from piling noise which for the Wind Farm alone, in the short-term (two years), could result in moderately significant effects for bottlenose dolphin and major significant effects for harbour seal. These are therefore significant in terms of the EIA Regulations. In the long-term, the effects from the Wind Farm alone were considered unlikely to occur, and based on population modelling it was shown that harbour seal are likely to recover within two years following cessation of the piling activity. Due to a number of uncertainties, it was not possible to accurately predict long-term effects on bottlenose dolphin, although these were considered to be unlikely. However, if long-term effects did occur these would be of moderate significance and therefore significant in terms of the EIA Regulations.

305. These results were also important in the context of SACs within the Moray Firth. The Moray Firth SAC is designated for bottlenose dolphin and harbour seals are on the citation list for the Dornoch Firth and Morrich More SAC. The assessment concluded that the short- and long-term effects on these SACs were the same as the short- and long-term effects on the species for which they were designated. Therefore, there is a LSE predicted from construction noise on both SACs and this will require further assessment under the Habitats Regulations.

306. The cumulative assessment showed similar results in that the majority of effects would be of negligible to minor significance. As before, cumulative piling works from the Wind Farm, the Moray Firth Round 3 Zone and other offshore renewable developments, have the potential to negatively affect both bottlenose dolphin (and the Moray Firth SAC) and harbour seal (and the Dornoch Firth and Morrich More SAC). In this case, the magnitude of effects would occur over a much larger area and could be of long-term duration (i.e. six years). Medium-term effects on bottlenose dolphin and harbour porpoise are considered to be significant in terms of the EIA Regulations, as are long-term effects on bottlenose dolphin. As before, there is a LSE predicted from cumulative construction noise on both SACs and this will require further assessment under the Habitats Regulations.

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