Chapter 13 Marine Mammals

13.1 Introduction

1 This chapter presents the results of site-specific surveys and additional work undertaken by the developer to provide information on marine mammals to support the application. In addition, the results of the environmental impact assessment (EIA) undertaken on marine mammals based on the proposed activities, including construction, operation and decommissioning are detailed. Finally, it outlines potential mitigation and monitoring measures that may be undertaken in the event of consent being granted.

13.2 Legislation and Guidance

2 Marine mammals are protected under a range of national and international legislation, details of which are presented below (refer to Table 13.1). Chapter 11: Nature Conservation provides further details on wider legislation associated with species and habitats of nature conservation importance.

Legislation and guidance	Species/group
European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive) (as amended)	All cetaceans, grey and harbour seal.
Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) (Habitats Regulations)	All cetaceans, grey and harbour seal.
Marine (Scotland) Act 2010	All seals.
Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended) (Offshore Marine Regulations)	All cetaceans, grey and harbour seal.
Nature Conservation (Scotland) Act 2004	All cetaceans.
Wildlife and Countryside Act (WCA) 1981 (as amended)	All cetaceans.
UK Biodiversity Action Plan (UKBAP) 1994	All cetaceans.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (as amended)	All cetaceans.
Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)	All cetaceans, grey and harbour seal.
Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention)	All cetaceans.
Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) – amended in 2008 to the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas	All small cetaceans regularly occurring in the Baltic, North East Atlantic, Irish and North Seas.
Convention for the Protection of the Marine Environment of the Northeast Atlantic (OSPAR Convention)	Bowhead whale, Balaena mysticetus , Northern right whale, Eubalaena glacialis, blue whale, Balaenoptera musculus, and harbour porpoise, Phocoena phocoena.

Table 13.1: Summary of national and international legislation and guidance relevant to marine mammals

3 There are also a number of published guidance documents providing information on impact assessments that have been used to inform the marine mammal chapter including:

- European Guidance on wind energy development in accordance with European Union (EU) nature legislation (European Commission (EC), 2010);
- Oslo Paris Convention (OSPAR) Guidance on Environmental Considerations for Offshore Wind Farm Development (OSPAR, 2008);
- Natura 2000 Conservation Guidelines on Offshore Wind Farm Development (Defra, 2005);
- Scottish Natural Heritage (SNH) Guidance on Habitats Regulation Appraisal (Tyldesley and Associates, 2010);
- The protection of European protected species (EPS) from injury and disturbance. Guidance for the marine area in England Wales and UK offshore marine area (Joint Nature Conservation Committee (JNCC), 2010a);
- Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010c); and
- Institute for Ecology and Environmental Management (IEEM) Guidelines for Ecological Impact Assessment in Britain and Ireland (Marine and Coastal) (IEEM, 2010).

13.2.1 Habitats Directive

4 All species of cetacean are listed on Annex IV of the Habitats Directive. The Habitats Directive provides that those species listed in Annex IV are to be offered strict protection from all forms of deliberate capture or killing; deliberate disturbance, particularly during the period of breeding, rearing, hibernation or migration; and deterioration or destruction of breeding sites or resting places. There is also an obligation to establish a system to monitor incidental capture and killing of cetaceans.

5 The Directive also provides for the establishment of a EU wide network of nature conservation sites (the Natura 2000 network). The habitats of species listed on Annex II (which include bottlenose dolphin, harbour porpoise, grey seal and harbour seal) require the designation of Special Areas of Conservation (SAC). Both the grey seal and harbour seal are protected from wild takes due to their inclusion on the list in Annex V of the Directive. Further information on the Habitats Directive and its implementation in Scotland is presented in Chapter 11: Nature Conservation.

13.2.2 Habitats Regulations and Offshore Marine Regulations

6 The Habitats Directive has been transposed into Scottish law through the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) which implements the species protection requirements on land and inshore waters (0-12 nautical miles (NM)). Beyond 12 NM, the Offshore Marine Regulations implement the species protection requirements of the Habitats and Birds Directives.

7 The Habitats Regulations and the Offshore Marine Regulations provide protection for European protected species (EPS) which are those species listed in Schedule 2 and 4 of the Habitats Regulations and Schedule 1 of the Offshore Marine Regulations and include cetaceans (whales and dolphins).

8 Regulation 39 of the Habitats Regulations and the Offshore Marine Regulations provide protection to EPS by making it an offence to harm such species. Regulation 39(1) of the Habitats Regulations provides that "it is an offence, with certain exceptions, to:

- (a) deliberately or recklessly to capture, injure or kill a wild animal of a European protected species;
- (b) deliberately or recklessly
  - (i) to harass a wild animal or group of wild animals of a European protected species;
  - (ii) to disturb such an animal while it is occupying a structure or place which it uses for shelter or protection;
  - (iii) to disturb such an animal while it is rearing or otherwise caring for its young;
  - (iv) to obstruct access to a breeding site or resting place of such an animal, or otherwise to deny the animal use of the breeding site or resting place;
  - (v) to disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs;
  - (vi) to disturb such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young; or
  - (vii) to disturb such an animal while it is migrating or hibernating; […]
- (c) to damage or destroy a breeding site or resting place of such an animal."

9 In addition, Regulation 38(2) of the Habitats Regulations expressly states that "it is an offence to deliberately or recklessly disturb any dolphin, porpoise or whale (cetacean)".

13.2.2.1 Deliberate Injury Offence

10 The term "deliberate" has been interpreted as including indirect but foreseeable actions and the deliberate injury offence has been interpreted as occurring if a cetacean receives a sound exposure level, which may cause permanent threshold shift in hearing (JNCC, 2010a).

13.2.2.2 Disturbance Offence

11 A disturbance offence may occur if the level of disturbance is likely to:

- Impair the ability to survive, to breed or reproduce, or to rear or nurture their young;
- To impair the ability of hibernating or migratory species, to hibernate or migrate; or
- Affect significantly the local distribution or abundance.

12 In JNCC guidance a disturbance offence is more likely to occur when there is a risk of:

- Animals incurring sustained or chronic disruption of behaviour scoring 5 or more in the Southall *et al.* (2007) 'behavioural response severity scale';
- Animals being displaced from the area, with redistribution significantly different from natural variation; or
- The risk of a disturbance offence will exist if there is sustained noise in an area and/or chronic noise exposure, as a result of an activity (JNCC, 2010a).

13.2.3 European Protected Species Licence

13 EPS are animals or plants listed in Schedules 2 and 4 of the Habitats Regulations and include all species of dolphins, porpoises and whales.

14 Under Regulation 44 of the Habitats Regulations certain activities that might otherwise constitute an offence may be carried out under licence. Regulation 44(e) applies to activities relating to preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment and may apply to certain renewable projects (Marine Scotland, 2012).

15 An activity that might otherwise constitute an offence may only be granted a licence if it can be demonstrated that by granting the licence the licensing authority remains fully compliant with the requirements of the Habitats Regulations. In order to achieve this it must be demonstrated that:

- The activity is one of the licensable purposes listed in Regulation 44;
- There is no satisfactory alternative; and
- That the action authorised will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range (SNH, 2012a).

16 It is predicted that should consent be granted under Section 36 for the proposed development an application for a European protected species Licence will be required as all species of whale, porpoise and dolphin are listed under Annex IV of the Habitats Directive (SNH, 2012a).

13.2.4 Favourable Conservation Status

17 Favourable conservation status (FCS) is defined in Article 1 (i) of the Habitats Directive as follows (and FCS for marine mammals species is shown in Table 13.2 below):

- "Conservation status of a species means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the territory referred to in Article 2. The conservation status will be taken as 'favourable' when:
  - Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats;
  - The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and
  - There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis."

Species	FCS assessment	'Regional' population
Harbour porpoise ***P. phocoena***	Favourable	385,617 (confidence interval (CI) 261,266 – 569,153)
White-beaked dolphin ***Lagenorhynchus albirostris***	Favourable	22,664 (CI 10,341 – 49,670)
Bottlenose dolphin ***Tursiops truncatus***	Unfavourable[1]	195 (162 – 253)
Killer whale ***Orcinus orca***	Unknown	Unknown 1,000's
Minke whale ***Balaenoptera acutorostrata***	Favourable	18,614 (10,445 – 33,171)
Grey seal ***Halichoerus grypus***	Favourable[1]	14,047 (9330 – 19,906)
Harbour seal ***Phoca vitulina***	Unfavourable[1]	376

'Regional' population is based on Small Cetaceans Abundance in the North Sea (SCANS) II survey results presented in JNCC (2010a) and will vary between species. Bottlenose dolphin population is based on the Moray Firth to Tay east coast population from Cheney *et al.* (2012).
Grey seal population regional population from Sparling *et al.* (2011).
Harbour seal population is based Borders to Fraserburgh (Sparling *et al.*, 2011).
[1] SNH (2012b).
Note: Seals are not listed under Annex IV of the Habitats Directive but are listed in Annex II and Annex V.

Table 13.2: Favourable Conservation Status (FCS) used in this assessment

13.3 Designated Sites

18 Four SACs along the east coast of Scotland and northern England have qualifying marine mammal species whose populations may make use of the Neart na Gaoithe development site (refer to Table 13.3). These SACs are:

- Isle of May (grey seal);
- Firth of Tay and Eden Estuary (harbour seal);
- Moray Firth (bottlenose dolphin); and
- Berwickshire and North Northumberland Coast (grey seal).

19 Further information on these SACs and their quyalifying features is provided in Chapter 11: Nature Conservation.

20 Given the potential connectivity of the proposed Neart na Gaoithe project with these SACs, there is a requirement to consider the effects arising from the development of the project in terms of the potential impacts on the integrity of these SACs. This is known as a Habitats Regulation Appraisal (HRA) and is required by the Habitats Directive (and transposing regulations). Further detailed information on HRA, including the legislative background and presentation of relevant information to inform an Appropriate Assessment, is provided in Chapter 11: Nature Conservation.

Name	Annex II species that are primary reason for site selection	Other Annex II species present as a qualifying feature
Isle of May	Grey seal, *c.* 4.5% UK pup production	None
Firth of Tay and Eden Estuary	Harbour seal, *c.* 2% UK pop. Breed/moult	None
Moray Firth	Bottlenose dolphin *c.* 130 individuals	None
Berwickshire and North Northumberland Coast	None	Grey seal, *c.* 2.5% UK pup production

Table 13.3: SACs with qualifying Annex II species that could potentially be affected by the Neart na Gaoithe development (JNCC, 2010b)

13.4 Data Sources

13.4.1 Surveys

13.4.1.1 Survey Study Area

21 The survey and subsequent study area were defined as encompassing the offshore site with a surrounding buffer area, which extends out to 8 km (refer to Figure 13.1). The offshore site is shown in purple and the buffer area shown in blue. Figure 13.1 also details the boat based survey transect lines as discussed in this section.

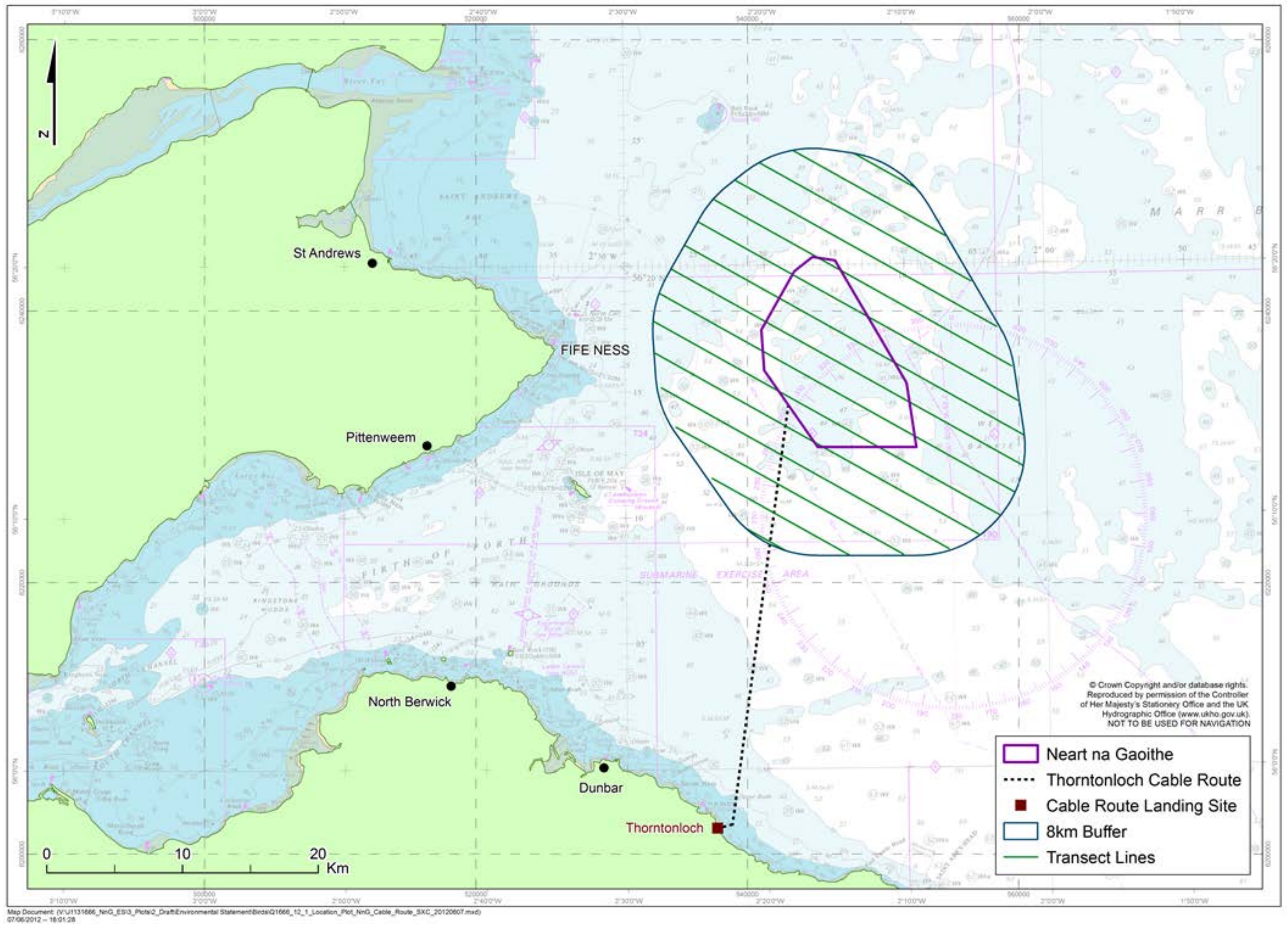


Figure 13.1: Neart na Gaoithe study area

13.4.1.2 Survey Effort

22 Marine mammal and bird surveys were conducted in parallel and from the same vessel. Table 13.4 presents the monthly boat-based survey effort in the offshore site and buffer areas in the Neart Na Gaoithe study area in Year 1 and Year 2. Survey routes for individual months are included in Appendix 12.1: Ornithology Technical Report.

23 Complete coverage of both the offshore site and buffer area was achieved in all months in Year 1.

Month	Offshore site km travelled		Buffer area km travelled		Proportion target coverage[1]	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
November	54.4	0 [2]	273.0	0	99.4 %	0 %
December	54.7	54.9	270.4	262.4	98.7 %	96.3 %
January	54.0	53.5	270.7	270.9	98.6 %	98.5 %
February	53.9	55.0	273.9	277.0	99.6 %	100.1 %
March	56.7	58.7	273.3	276.3	100 %	101.7 %
April	51.9	55.0	275.3	273.7	99.5 %	99.8 %
May	51.0	55.2	276.7	275.5	99.5 %	100.4 %
June	55.1	56.6	271.6	272.4	99.2 %	99.9 %
July	52.4	55.7	276.1	274.1	99.7 %	100.1 %
August	48.2	52.8	281.6	275.5	100.1 %	99.7 %
September	50.5	53.4	277.6	278.6	99.6 %	100.8 %
October	48.7	52.2	280.9	280.0	100.1 %	100.9 %
Total	**631.5**	**603.0**	**3,301.1**	**3,016.4**	**99.5 %**	**91.6 %**

[1]Although full coverage was achieved, there was slight variation in monthly effort, compared to the absolute length of transects, due to slight variations in the vessel trackline.
[2]No surveys were carried out in November 2011 due to poor weather during this period making it unsuitable for marine mammal surveys to be undertaken.

Table 13.4: Survey effort for the study area in Year 1 and Year 2

13.4.1.3 Boat Based Surveys

24 The methods used for the first year of baseline marine mammal surveys followed standard Collaborative Offshore Wind Research into the Environment (COWRIE) approved survey methodology (Camphuysen *et al*., 2004). Marine mammals were recorded using an adaptation of the standard JNCC Seabirds at Sea survey method, which uses line transect methodology (refer to Webb and Durinck, 1992 for further details).

25 A series of transects running in a northwest to southeasterly direction across the study area and spaced 2 km apart was surveyed each month (refer to Figure 13.1). Marine mammals were counted ahead of the ship and out to one side of the survey vessel in a 90º arc, with a 300 m transect width and using two surveyors, as per Camphuysen *et al.* (2004). Three European Seabirds At Sea (ESAS) accredited surveyors were on board for the majority of surveys. At any one time, one surveyor was acting as the primary observer, with a second acting as scribe and secondary observer, while the third surveyor was on a break.

26 Marine mammals (seals and cetaceans) were recorded concurrently with seabirds. Sightings were recorded using the same methodology as for birds on the water. Species, number of animals, direction of travel and behaviour were recorded. Binoculars were used to confirm identifications as well as to scan ahead for species. Animals were assigned to distance bands (A = <50 m, B = 51-100 m, C = 101-200 m, D = 201-300 m, E = >300 m), according to their perpendicular distance from the ship's track. The count interval for surveys was 1 minute intervals, and synchronised GPS recorders were used to record the vessel position every minute.

27 In addition, the angle of the sighting was estimated using an angle board and the radial distance was estimated either using a range finder or a visual estimate in metres, if no horizon was visible. Any marine mammals seen on the 'non-survey' side of the vessel were also recorded. Other species that were visible from the vessel, such as basking sharks, were noted regardless of the distance from the vessel.

28 Environmental conditions such as wind direction and force, sea state, swell height and visibility were recorded every 15 minutes throughout survey days. Surveys were carried out in good weather where possible, to maximise detection rates of marine mammals on the water. Surveys were halted if conditions exceeded sea state 4, as recommended in Camphuysen *et al.* (2004).

29 A full description of the boat-based survey methods is included in Appendix 12.1: Ornithological Technical Report.

13.4.1.4 Acoustic Survey

30 Acoustic surveys have been ongoing during bird and marine mammal surveys since December 2010 using a stereo towed hydrophone system capable of detecting small odontocetes (porpoises and dolphins). The addition of acoustic monitoring has two important advantages:

- It provides an additional means of collecting cetacean data, and was less affected by weather conditions and sea state. It also provides a higher detection rate under most field conditions. As acoustic data collection and analysis is semi-automated it yields a more consistent dataset than visual data; and
- Acoustic systems provide an independent method for detecting odontocete cetaceans and therefore offer the possibility of determining the proportion of available animals missed by either visual or acoustic teams, allowing g(0) (the proportion of animals detected on the trackline) to be calculated. With a reliable estimate of g(0) absolute abundance estimates can be calculated. Absolute abundance has rarely, if ever, been calculated on wind farm surveys, typically only an index of abundance is provided. However, there are several advantages to providing estimates of absolute abundance compared to relative indices. As well as being able to provide an estimate of the actual numbers of animals that may be affected by an activity or development, absolute estimates are much easier to compare between surveys and areas, and have greater potential for data validation. For example, if absolute numbers are available from more than one survey method or for subsets of the survey data, these can be directly compared in a way that relative indices cannot.

31 The passive acoustic detection system used for this work was built by EcologicUK and was a development of the systems employed successfully on the Small Cetaceans Abundance in the North Sea (SCANS) and Cetacean Offshore Distribution andAbundance (CODA) surveys (Gillespie *et al*., In press). The hydrophone was a standard high frequency stereo towed array comprising a 5 m streamlined oil filled sensor steamer towed on a 200 m Kevlar strengthened cable. A computer running a PAMGUARD configuration made continuous recordings to hard drive as well as running a click detector and collecting GPS data. Full bandwidth recordings were made continuously as .wav files using PAMGUARD software whenever the hydrophone was deployed at sea. Hard drives were backed up onboard before being posted back to EcologicUK for analysis.

13.4.1.5 Aerial Surveys

32 Aerial surveys, commissioned by The Crown Estate (TCE), were undertaken across the Firth of Forth and Firth of Tay area during 2009 and 2010. The surveys were undertaken using visual observers and using standard survey techniques along a series of fixed transects. Data were collected monthly with the exception of April, September and October.

33 The results from the aerial surveys were analysed by SMRU Ltd and the results presented within the relevant species assessments (Macleod and Sparling, 2011).

13.5 Engagement and Commitments

13.5.1 Strategic and Site Levels Commitments

34 A series of commitments has been made on behalf of the developer. These commitments are both at the strategic and site-specific levels and are outlined in Table 13.5, with details of where they are considered within this chapter.

Source	Comment	Relevance/reference
Scoping Opinion (SNH advice)	Recommend the use of sidescan sonar in conjunction with the bird surveys to aid understanding and examine indirect impacts. Methodology should be clear.	Noted but not feasible to undertake sidescan sonars at the same time as towing hydrophones and undertaking visual surveys. Refer to Section 13.4.1 Surveys.
	Clarify that the Isle of May is a SAC and grey seal are a qualifying interest.	We note that the grey seal is a qualifying interest for the Isle of May and that the Isle of May is a SAC (refer to Section 13.3 Designated Sites).
	Assessment of displacement suggested, and loss of prey assessment should cover all marine mammals (not just cetaceans as in Scoping Report).	Potential displacement due to loss of prey has been considered (refer to Section 13.10: Impact Assessment).
	Recommend the use of static PAMS (i.e., T-pods, C-pods) and seal tagging/telemetry for survey work and suggest collaborative approach.	Towed hydrophones have been used (refer to Section 13.4.1: Surveys). Desk based studies have been undertaken using existing seal tagging data (See Appendix 13.4: SMRU Ltd Report - Seal Characterisation)
	Assessment should consider activities that will lead to “deliberate or reckless disturbance”.	Noted, refer to Section 13.10: Impact Assessment.
	Assessment needed of indirect impacts of changes to other sea uses (vessel routes, changes in frequency / distribution of fishing activity) on marine mammals.	No significant impacts have been identified to shipping or fishing activity (refer to Chapters 16: Commerical Fisheries and Chapter 17: Shipping and Navigation).
	Assessment needed of impacts on SACs and their qualifying and supporting habitats and species (e.g., sandeels) and subsequent indirect impacts (e.g., marine mammals).	Assessment on potential prey species has been considered (refer to Section 13.10: Impact Assessment).
	The location of all elements of onshore infrastructure will need to be considered in respect of potential impacts to mammals.	Noted (refer to Section 13.10: Impact Assessment).
	Suggest extended otter search beyond 200 m for cable onshore. Guidance on SNH website.	Otter surveys and assessment are contained in the Onshore Environmental Statement.
	Suggest squid fishery could be in area. Assessment of this and potential interactions with marine mammals suggested.	Noted but no evidence of any impact on squid and fisheries on marine mammals in the area. Refer to Chapter 16: Commercial Fisheries for a description and assessment of the squid fishery in the area.
	Photo ID required for dolphin surveys to determine whether any bottlenose dolphins seen in the proposed site are from the Moray Firth SAC (survey licence required). Alternatively, assume all observed BNDs are from this SAC.	Commissioned reports by SMRU on bottlenose dolphins (refer to Appendix 13.3: SMRU Ltd Report – Bottlenose Dolphin Baseline).
	In assessing noise, suggest BAE systems – Environmental Risk Management Capability is a useful tool, but limited. Need to consult SNH on source data for further comment.	Noted. BAE Systems Environmental Risk Management Capability has not been used as part of the ES. Work has been undertaken by Subacoustech, SMRU Limited, and Marine Ecological Research.
Scoping Opinion (Scottish Environmental Protection Agency (SEPA))	SEPA recommends that construction methods minimise impacts on marine mammals. Suggest novel noise restriction methods such as bubble wrap, insulations, bubble curtains.	Techniques on how to reduce potential noise levels have and are being considered and is ongoing (refer to Section 13.11: Mitigation and Residual Impacts).
Advice to Forth and Tay Offshore Wind Developer Group (SNH)	A literature review is required at a regional level for standard reference to assess underwater noise impacts on marine mammals. A standard assessment methodology is also required.	The Forth and Tay Offshore Wind Developers Group (FTOWDG) has worked collaboratively on a number of projects including specific seals and bottlenose dolphin studies and noise modelling (refer to Appendix 13.1: Noise Model Technical Report, Appendix 13.2: SMRU Ltd Report – SAFESIMM Report, Appendix 13.3: SMRU Ltd Report – Bottlenose Dolphin Baseline, Appendix 13.4: SMRU Ltd Report - Seal Characterisation, Appendix 13.6 : SMRU Aerial Survey
Advice to Forth and Tay Offshore Wind Developer Group (Fife Council)	Consultation with Fife Coast and Countryside Trust (Dysart) recommended, and view of Fife Biodiversity Action Plan for information on marine mammals in the Fife area.	Noted. The Fife Biodiversity Action Plan does not mention marine mammals.

Table 13.5: Strategic and site level commitments and requirements

13.5.3 Consultation

35 Details of consultation undertaken are presented in Chapter 7: Engagement and Commitments. Illustrated in Tabl 13.6 below is a summary of the main points raised during the project specific consultation, specifically to marine mammals and in response to the interim Year 1 report. Further consultation and discussions were undertaken on a regional level via meetings with the Forth and Tay Offshore Wind Developers' Group (FTOWDG). The FTOWDG is discussed in more detail in Chapter 1: Introduction and Chapter 7: Engagement and Commitments.

Date	Consultee	Summary of Issue	Section Addressed
18 April 2011	SNH and JNCC	Presentation of 1st year survey results. Advised that distance sampling unable to be undertaken on small sample sizes, e.g.,Year 1 harbour porpoise. Advised that noise impact assessment should be based on stationary and fleeing animals. Must consider connectivity between seals in separate designated sites.	Section 13.6: Impact Assessment Methodology Section 13.8: Species Accounts Chapter 11: Nature Conservation
11 July 2011	SNH	Response to Year 1 report. Detailed general comments on the content of the Year 1 report.	All
2 November 2011	SNH and JNCC	Discussion and decisions on noise thresholds and relevant populations to be used in impact assessment.	Section 13.6: Impact Assessment Methodology Section 13.10: Impact Assessment
29 March 2012	SNH	Advice on white-beaked dolphins and minke whales.	Section 13.8.2: White-Beaked Dolphin Sections 13.8.4: Minke Whale
30 March 2012	SNH and JNCC	Response to baseline reports on seals and bottlenose dolphins. Advised on designated sites to be considered for grey seal and harbour seals. Advised of consideration of cable laying and thruster impacts.	Sections 13.8: Species Accounts Section 13.10.4: Drilling Impact Assessment Chapter 11: Nature Conservation

Table 13.6: Summary of non Forth and Tay Offshore Wind Developers Group consultation undertaken on marine mammals

13.6 Impact Assessment Methodology

36 The approach to the assessment of potential impacts on marine mammals follows that outlined in published guidance. The approach differs slightly from that outlined in Chapter 6: The Approach to Environmental Impact Assessment and is described below.

37 Effects have been defined for each receptor or receptor group, given the parameters of the proposed construction, operation and decommissioning methods as defined within the project Rochdale Envelope (see below). Impacts are assessed relative to the phase of development, i.e., those arising in the construction, operation or decommissioning phases, and are discussed individually.

13.6.1 The Rochdale Envelope

38 The overall approach to defining the Rochdale Envelope is described Chapter 6: The Approach to Environmental Impact Assessment.

39 The Rochdale Envelope parameters assessed in this chapter take account of the worst (realistic) case scenario for marine mammals. The worst (realistic) case in terms of impacts for marine mammals is generally that assessed as producing the highest level of underwater noise. Further information on the Rochdale Envelope parameters assessed is provided in Table 13.7 below and in Appendix 13.1: Noise Model Technical Report. Information on the selection justification is presented in Section 13.12.

Potential effect	Rochdale Envelope parameter	Value	Scenario/assumptions
Increased underwater noise	Wind turbine foundation piling	Details of the installation scenarios are presented in Chapter 5: Project Description. Up to 500 turbine foundation piles may be installed using 'drive-drill-drive' and 16 turbines may be installed with 'drive-only'.	Impact ranges to include zone of injury (130 dBht), zone of strong avoidance (90 dBht) and zone of significant avoidance behaviour (75 dBht) for some species. Soft start procedures are built in as an assumed control prior to drilling and driving.
	Wind turbine foundation drilling	Up to 500 foundation piles may require drilling during installation.	The levels of noise arising from drilling will be lower than those from piling activities and will be at a lower frequency.
	Presence of installation vessels	The number of vessels present during construction are provided in Chapter 5: Project Description. Likely that ducted thursters for dynamic positioning (DP) will be used during installation.	The levels of noise arising from vessels will be lower than from piling operations and at a lower frequency.
Construction, operation and decommissioning of offshore site – increased vessel presence	Presence of vessels	The number of vessels present during operations are provided in Chapter 5: Project Description.	Qualitative assessment based on the use of DP vessels.
Changes in electromagnetic fields	Inter-array and export cables	140 km of inter-array cables and two export cables of 33 km length.	Qualitative assessment based on these parameters.

Table 13.7: Rochdale Envelope used to assess the potential impacts on marine mammals

13.6.2 The Approach to Impact Assessment

40 The approach to the assessment of impact differs slightly to that described in Chapter 6: The Approach to Environmental Impact Assessment, particularly in the way ultimate significance of impact is determined. It should be noted that significance is a function of magnitude and vulnerability as per the general approach but the characteristics of magnitude and vulnerability differ.

13.6.2.1 Magnitude of Effect

41 To define potential magnitude of effect with respect to marine mammals, the assessment follows the broad approach developed by Percival *et al.* (1999), illustrated in Table 13.8 below. Magnitude of effect is considered to be a function of the severity of the effect on a particular receptor (taking into account the spatial extent of the effect) combined with the duration of the effect. Severity and duration are intrinsically linked with the specific receptor species.

Characteristic	Catagories	Definition
Severity (v)	Very high	Total loss or very major alteration to key elements/features of the baseline conditions such that post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether. Guide: >80% of population/ habitat lost.
	High	Major alteration to key elements/features of the baseline (pre-development) conditions such that post development character/ composition/ attributes will be fundamentally changed. Guide: 20-80% of population/habitat lost.
	Medium	Loss or alteration to one or more key elements/ features of the baseline conditions such that post development character/ composition/ attributes of the baseline will be partially changed. Guide: 5-20% of the population/ habitat lost.
	Low	Minor shift away from baseline conditions. Changes arising from the loss/ alteration will be discernible but underlying character/ composition/ attributes of baseline condition will be similar to pre-development circumstances/ patterns. Guide: 1-5% of population/ habitat lost
	Negligible	Very slight change from baseline condition. Change barely distinguishable approximating to the 'no change' situation. Guide: <1% of population/ habitat lost.
Duration (D)	Permanent	Impacts continuing indefinitely beyond the span of one generation (Species dependent).
	Long term	Approximately up to one generation (species dependent).
	Medium term	Approximately 1-5 years.
	Short term	Up to approximately 1 year.

Table 13.8: Definition of magnitude of effect

13.6.2.2 Vulnerability

42 Vulnerability is considered to be a capacity for reaction, either positive or negative, by a receptor to a known change in the baseline conditions. The vulnerability of marine mammals may depend on their adaptability, tolerance and recoverability from an effect, all of which affect the ability of an individual or population to accommodate the potential change. For the assessment of impacts on marine mammals, the following broad classes of vulnerability are used (refer to Table 13.9). This assessment also takes into account value as a qualifying characteristic of vulnerability, such as the conservation status of marine mammal species.

Catagories	Definition
Very high	Receptor has no capacity to accommodate the potential impact.
High	Receptor has very low capacity to accommodate the potential impact.
Medium	Receptor has low capacity to accommodate the potential impact.
Low	Receptor has some tolerance to accommodate the potential impact.
Negligible	Receptor is generally tolerant and can accommodate the potential impact.

Table 13.9: Vulnerability of receptor

13.6.2.3 Significance of Impact

43 The magnitude of the effect (including the duration), and the vulnerability of the marine mammal species combine to result in a predicted overall impact.

44 The significance of these potential impacts on marine mammals has been defined as being of major, moderate or minor significance or not significant (refer to Table 13.10).

45 However, it is recognised that this is only indicative and evidence from existing offshore wind farms and expert judgement is used to determine whether the potential impact is likely to be either significant or adverse.

Significance	Definition
Major	Potential permanent or long-term changes in regional populations. Impacts have the potential to have adverse effects on Conservation Status.
Moderate	Potential short or medium-term changes in regional populations. Impacts may have the potential to have adverse effects on Conservation Status.
Minor	Potential changes in regional populations. Impacts will not have adverse effects on Conservation Status.
Not significant	Potential changes not predicted to have an impact on regional populations. Impacts will not have adverse effects on Conservation Status.

Table 13.10: Significance of impact definitions for marine mammals

13.6.3 Cumulative and In-Combination Impact Assessment Approach

46 There may be the situation where activities arising from other plans or programmes have the potential to impact on the same populations as may be impacted by activities being undertaken by the proposed Neart na Gaoithe project. It is a requirement under both the Environmental Impact Assessment (EIA) Directive (Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment which codifies Directive 85/337/EEC and its three amendments) and the Habitats Directive as well as transposing regulations to assess these impacts as part of the EIA and HRA processes.

47 Impacts from other plans or programmes identified as being most likely to have the potential to have a cumulative effect are from other sound sources.

48 It is recognised that there may be plans, programmes or projects for which there is currently no information and yet may be undertaken at the same time as the planned construction period of Neart na Gaoithe. It is also possible that activities arising from current projects that have been identified as having the potential to cause a cumulative impact may be completed prior to works commencing at Neart na Gaoithe.

49 Cumulative and in-combination imapcts are defined in Chapter 6: The Approach to Environmental Impact Assessment but in essence are the interaction of like with like projects (offshore wind farm projects interacting with other offshore wind farm projects) and the interaction of unlike projects (an offshore wind farm project interacting with a bridge construction project) respectively. The following proposed projects, plans or programmes have been identified as having the potential to cause a cumulative impact:

- Inch Cape Offshore Wind Farm;
- Firth of Forth Round 3 Zone 2 Offshore Wind Farm development;
- Beatrice Offshore Wind Farm;
- Moray Firth Offshore Wind Farm; and
- European Offshore Wind Deployment Centre (EOWDC).

50 The following developments are considered to have the potential to cause an in-combination impact:

- European Offshore Wind Deployment Centre;
- Tay Bridge Refurbishment - ongoing works planned until at least 2016 to repaint the Tay Bridge and undertake steel works;
- Dundee Waterfront Development - the development of Dundee's waterfront for a variety of business and recreational developments. Construction started in 2009 and is planned to be completed in 2016;
- Forth Bridge Replacement Crossing - a 2.7 km road bridge with three single column towers crossing the Forth Estuary adjacent to the existing road crossing. Construction commenced in November 2011 and will be completed in 2016. Activities identified as having the potential to cause a cumulative impact include the construction of the three tower foundations:
  - The central tower will require blasting of the Beamer Rock during the preparation for the foundations, which may cause noise impacts in the marine environment.
  - The north and south towers will require the piling of four central piles between 3.3 m and 3.5 m in diameter upon which the caissons will rest;
  - Preparation of the sites for the towers will be undertaken during 2011 and 2012 and the foundations prepared in 2012 ready for installation and construction between 2012 and 2014;
  - The piling of 900 mm tubular steel piles will be required in the construction of the access trestles on the north and south of the estuary. These will provide temporary jetties for the construction vessels and consequently will be undertaken at the start of construction operations in 2011 or 2012; and
  - Construction of the bridge is planned to be completed by July 2016 (Transport Scotland, 2011).
- Montrose Tidal Project: – A proposal to install 15 tidal turbines under the South Esk bridge. The turbines will be gravity based Cygnus ISTT turbines, each of 150 MW. The location of the proposed development is such that there is the potential for an interaction between the turbines and both harbour and grey seals, which are present in Montrose Basin. There will be minimal construction noise as no piling activities are being proposed but there is the potential for a physical or displacement impact. The developer will mitigate the potential physical impacts by installing detection devices allowing the turbines to be switched off when seals are at risk. There should therefore be no physical impacts from this development; and
- Seismic surveys: There is no information available on, if, or when, seismic surveys may be undertaken. There are no oil and gas licensed blocks within the vicinity of the study area and therefore, any seismic surveys in the area are unlikely.

51 Understanding when activities, particularly construction activities, will be taking place is important in determining potential scale of cumulative and in-combination impacts. For many projects accurate schedules are not available especially for those that have yet to submit an application or are awaiting a consenting decision. However, based on the currently available likely schedules an estimated timeline of activities is presented in Figure 13.2. These are only estimates and may change depending on project specific and consenting decisions.

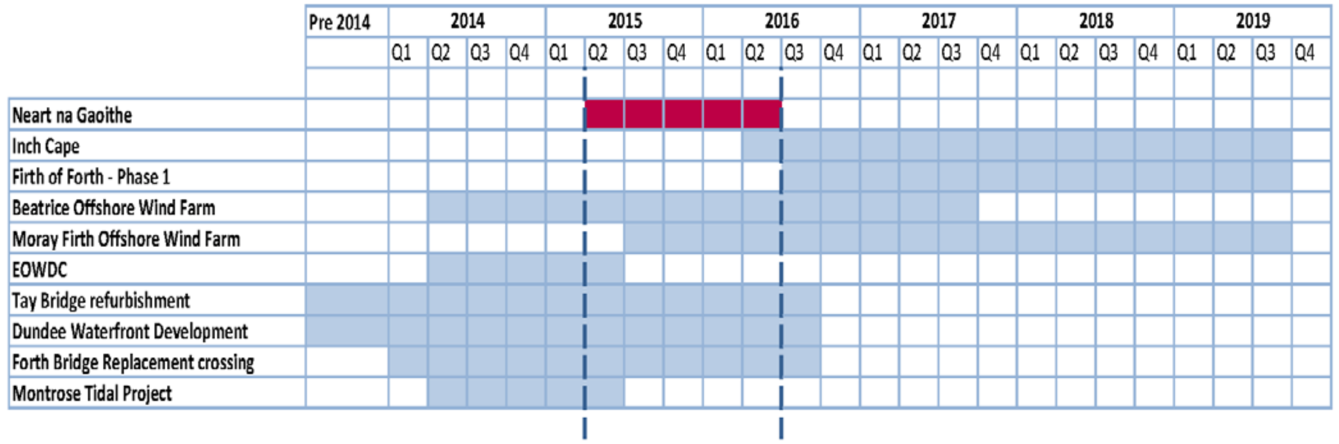


Figure 13.2: Estimated construction periods for potential cumulative and in-combination projects and proposed piling period for Neart na Gaoithe

52 Based on the available information activities relating to the Dundee Waterfront, Tay Bridge Refurbishment and Montrose Tidal project will not have an in-combination impact. Construction activities arising from the Forth Bridge Replacement Crossing project that could have an in-combination effect, in particular piling operations, will be completed prior to the commencement of activities at Neart na Gaoithe. Therefore, there will not be any cumulative or in-combination impacts arising from these projects.

53 Current timelines for other offshore wind farms are uncertain and flexible. However, based on currently known schedules, there is potential for overlapping periods of piling activity with the EOWDC and the Beatrice Offshore Wind Farm in 2015. Should piling from Neart na Gaoithe continue into 2016 there are potential cumulative piling impacts with Inch Cape, Firth of Forth and Moray Firth Offshore and Beatrice Offshore wind farms.

54 Possible cumulative and in-combination impacts arising from vessel activities and operational noise will be ongoing and overlap all developments.

13.7 Baseline Description

13.7.1 Marine Mammals in the Study Area

55 In Year 1 (November 2009 to October 2010) a total of four marine mammal species were identified from monthly boat-based surveys in the study area and six species were recorded in Year 2 (November 2010 to October 2011), (refer to Table 13.11 and Table 13.12). Across both years the harbour porpoise was the most frequently recorded marine mammal with a combined total of 50.1% of all sightings being of this species. Grey seal was the second most frequently recorded marine mammal, accounting for 29.1 % of all marine mammals. Data from the aerial surveys were more limited than that obtained from boat-based studies but the results broadly matched those obtained from using boats (Macleod and Sparling, 2011).

13.7.2 Comparison Between the Offshore Site and Buffer Areas

56 In Year 1, three species of marine mammals were recorded in the offshore site and four species in the buffer area (refer to Table 13.11). Total numbers of marine mammals in the offshore site accounted for 12.0 % of all marine mammals recorded in both the buffer area and offshore sites combined.

57 Compared to Year 1, the proportion of marine mammals recorded in the offshore site in year 2 was lower with 8.8 % of sightings within the offshore site (refer to Table 13.12).

Species	Offshore site	Buffer area	Total
Harbour porpoise	11	78	**89**
Minke whale	0	2	**2**
Unidentified dolphin	0	5	**5**
Grey seal	2	41	**43**
Harbour seal	2	4	**6**
Unidentified seal	3	3	**6**
Total numbers	**18**	**133**	**151**

Table 13.11: Comparison of marine mammal numbers in the offshore site and buffer area in Year 1 (all sea states)

Species	Offshore site	Buffer area	Total
Harbour porpoise	4	79	**83**
White-beaked dolphin	6	10	**16**
Unidentified dolphin	0	1	**1**
Orca	0	1	**1**
Minke whale	1	9	**10**
Grey seal	6	51	**57**
Harbour seal	0	17	**17**
Unidentified seal	0	7	**7**
Total numbers	**17**	**175**	**192**

Table 13.12: Comparison of marine mammal numbers in offshore site and buffer area in Year 2 (all sea states)

58 A monthly breakdown of marine mammals recorded in the offshore site and buffer areas is presented in Tables 13.13 to Table 13.16.

Species	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Harbour porpoise	0	10	0	0	0	0	0	0	0	1	0	0	**11**
Minke whale	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Unidentified dolphin	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Grey seal	0	0	0	0	1	0	0	0	0	1	0	0	**2**
Harbour seal	1	1	0	0	0	0	0	0	0	0	0	0	**2**
Unidentified seal	1	0	0	0	2	0	0	0	0	0	0	0	**3**
Total numbers	**2**	**11**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**18**

Table 13.13: Numbers of marine mammals recorded in the offshore site in Year 1

Species	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Harbour porpoise	15	27	2	1	7	7	0	0	0	7	1	11	**78**
Minke whale	0	0	0	0	0	0	0	0	0	0	0	2	**2**
Unidentified dolphin	0	5	0	0	0	0	0	0	0	0	0	0	**5**
Grey seal	3	2	0	0	13	4	1	1	0	1	0	16	**41**
Harbour seal	1	2	0	1	0	0	0	0	0	0	0	0	**4**
Unidentified seal	1	0	2	0	0	0	0	0	0	0	0	0	**3**
Total numbers	**20**	**36**	**4**	**2**	**20**	**11**	**1**	**1**	**0**	**8**	**1**	**29**	**133**

Table 13.14: Numbers of marine mammals recorded in the buffer area in Year 1

Species	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Harbour porpoise	0	0	0	0	2	0	0	0	0	2	0	0	**4**
Minke whale	0	0	0	0	0	0	0	0	0	0	1	0	**1**
White-beaked dolphin	0	0	0	0	0	0	3	3	0	0	0	0	**6**
Unidentified dolphin	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Orca	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Grey seal	0	0	0	1	0	0	0	0	3	1	0	1	**6**
Harbour seal	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Unidentified seal	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total numbers	**0**	**0**	**0**	**1**	**2**	**0**	**3**	**3**	**3**	**3**	**1**	**1**	**17**

Table 13.15: Numbers of marine mammals recorded in the offshore site in Year 2

Species	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Harbour porpoise	0	1	0	6	13	15	0	0	4	20	11	9	**79**
Minke whale	0	0	0	0	0	0	0	3	0	4	1	1	**9**
White-beaked dolphin	0	0	1	0	0	0	9	0	0	0	0	0	**10**
Unidentified dolphin	0	0	1	0	0	0	0	0	0	0	0	0	**1**
Orca	0	0	0	0	0	0	0	0	0	0	0	1	**1**
Grey seal	0	3	1	6	6	0	7	1	4	9	7	8	**52**
Harbour seal	0	0	2	1	1	3	4	2	0	2	0	2	**17**
Unidentified seal	0	0	1	3	0	0	1	0	0	0	0	1	**6**
Total numbers	**0**	**4**	**6**	**16**	**20**	**18**	**21**	**6**	**8**	**35**	**19**	**22**	**175**

Table 13.16: Numbers of marine mammals recorded in the buffer area in Year 2

13.8 Species Accounts

13.8.1 Harbour Porpoise

13.8.1.1 Status

59 Harbour porpoise is the smallest and most common cetacean species in UK waters. Although present throughout the year, there are no clear seasonal UK distribution patterns in existing North Sea datasets (Reid *et al.,* 2003).

60 Data from ESAS and other databases indicate harbour porpoise to be widespread across the North Sea and adjacent water (Reid *et al*., 2003) (refer to Figure 13.3). However, the data presented were collected over a period of 20 or more years and, as discussed below, more recent evidence indicates that there may have been a significant shift in the distribution of harbour porpoise since the publication of the report.

61 In 1994 the SCANS survey estimated a total harbour porpoise population of 345,132 individuals based on results from density surface models (Hammond *et al*., 1995). The following SCANS surveys undertaken in 2005 estimated a similar regional population of 367,260 individuals (CI 248,271 – 429,018) throughout the North Sea and adjacent waters (Hammond, 2006). SCANS II surveys were divided into alphabetically identifiable areas with Area V covering the northern Central North Sea, including the area within which Neart na Gaoithe lies. The population estimate from SCANS II of harbour porpoise in this area is 58,824 harbour porpoises with a density of 0.335 harbour porpoise/km^2 (Macleod, 2006).

62 Although the population of harbour porpoise within the North Sea remained largely unchanged between the two surveys, there was a notable change in the broadscale distribution of harbour porpoise across the North Sea. There was a clear southerly shift in distribution from northern and eastern Scotland to the central and southern North Sea off eastern England, where densities of 0.48 harbour porpoise/km^2 were recorded (Hammond, 2006).

63 Tagging studies undertaken in Denmark indicate that harbour porpoises range widely in the North Sea, with individuals tagged in the Skagerrak occurring off the east coasts of Scotland and England (Sveegaard, 2011).

64 Harbour porpoises are opportunistic feeders, preying on a wide range of fish species including, herring, cod, whiting and sandeels and their prey will vary during and between seasons. In Scotland the main prey items recorded have been sandeels and whiting, with the majority of whiting being taken during the winter period when sandeels become less available (Santos and Pierce, 2003). Studies undertaken in Denmark indicate that their local distribution may be correlated with prey availability (Sveegaard, 2011).

65 Breeding is thought to occur during the summer months, particularly in August, with calving 10 months later. Calves have been recorded between June and September with peak number of sightings in June (Weir *et al*., 2007).

66 Harbour porpoises occur widely across the North Sea. Higher densities have been recorded in areas of up-wellings and strong tidal currents and in water depths of predominantly between 20 and 40 m (Clark, 2005; Whaley, 2004). Their distribution may also be strongly correlated with seabed type, with sandy gravel areas being preferred in parts of the Moray Firth and this may be linked to prey availability (Clark, 2005). They have also been recorded as ranging widely over the course of a month with individuals covering an area of over 11,000 km^2 in the Bay of Fundy (Johnston *et al*., 2005).

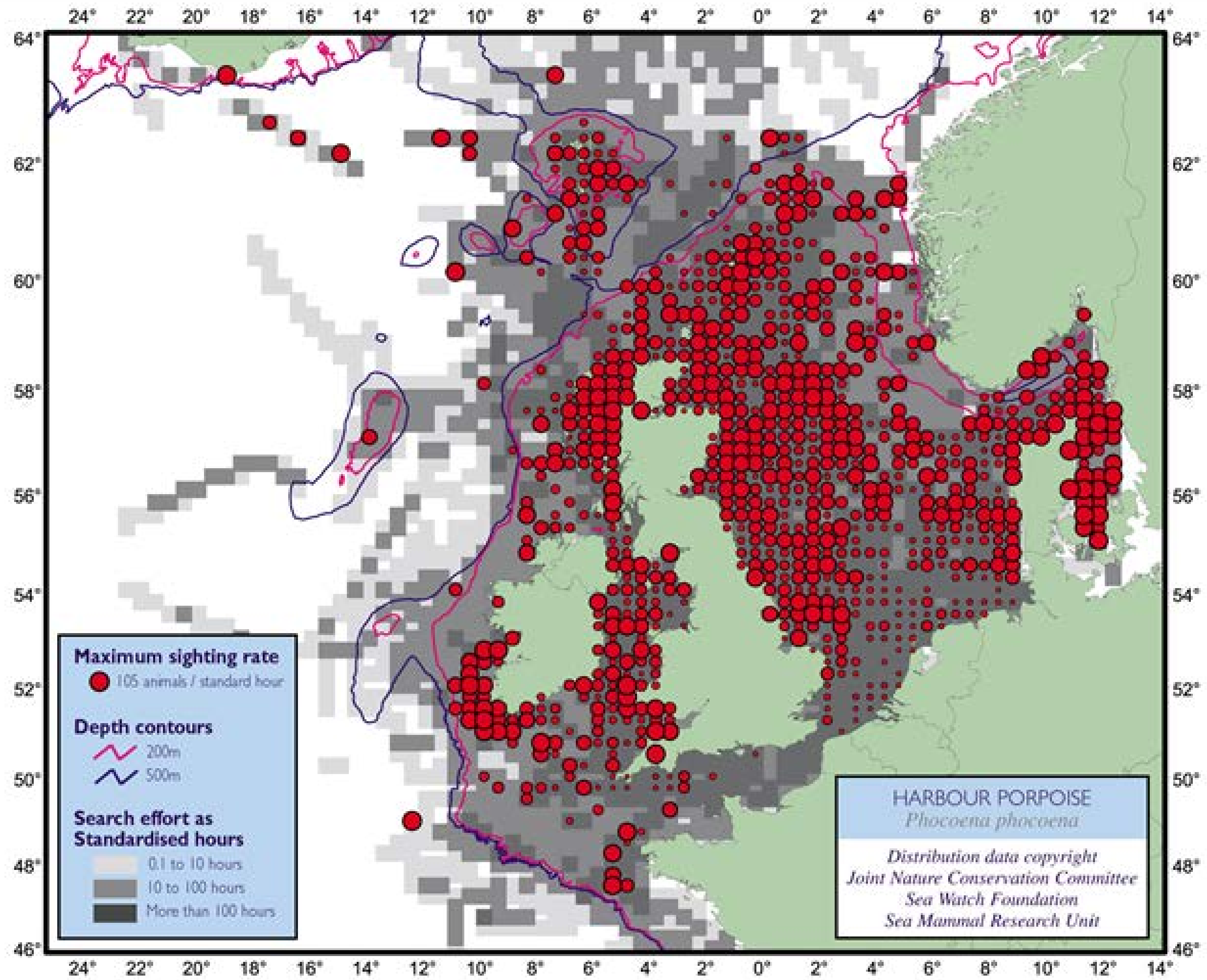


Figure 13.3: Harbour porpoise distribution in North Sea and adjacent waters (Source Reid *et al.,* 2003)

13.8.1.2 Neart na Gaoithe Study Area

Year 1 Harbour Porpoise Results

67 Harbour porpoise was the commonest marine mammal in the study area in Year 1, with 89 individuals observed, accounting for 58.9% of all marine mammals recorded. The majority of animals (87.6%) were recorded in the buffer area (refer to Table 13.11 and Table 13.12).

68 There was an increase in the number of sightings during November and December with a peak of 37 individuals. No harbour porpoise were recorded between May and July in Year 1 (refer to Figure 13.4).

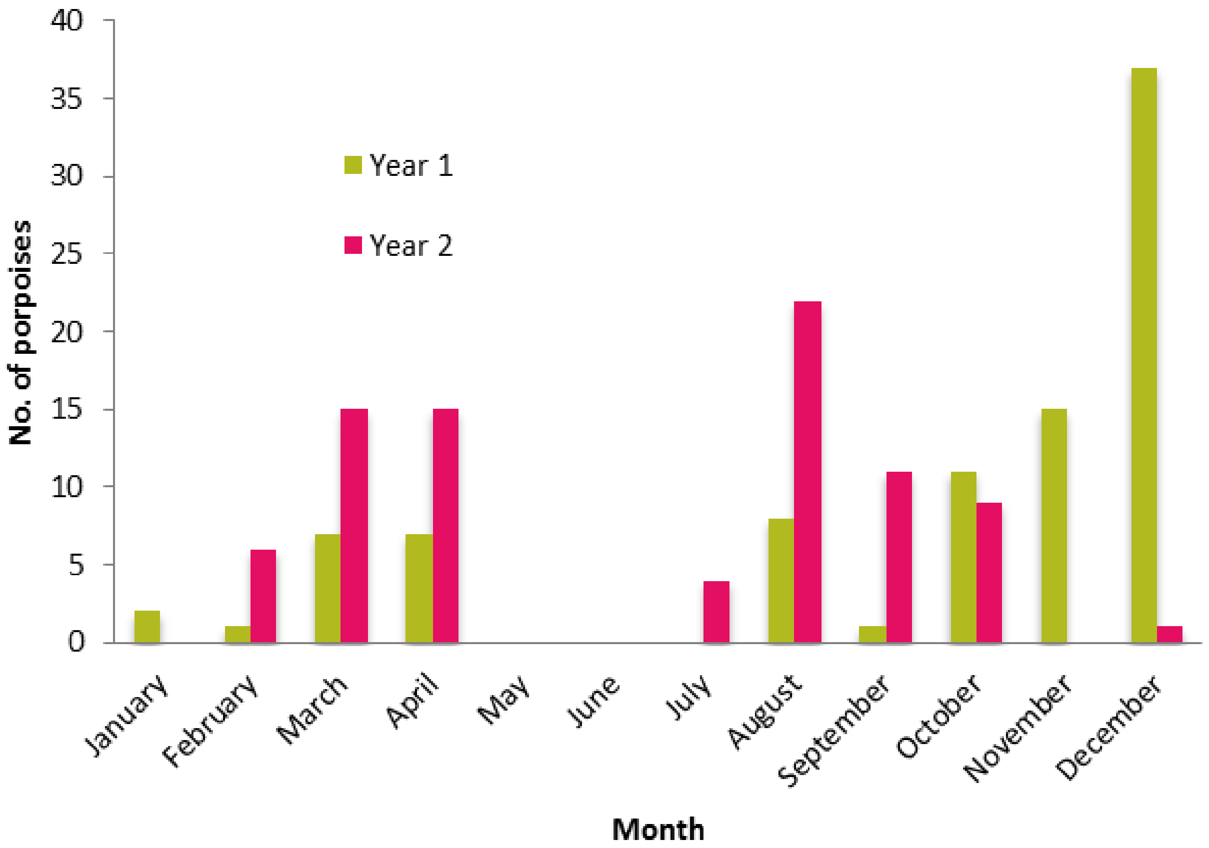


Figure 13.4: Monthly number of harbour porpoises observed from boat-based surveys in year 1 and year 2

69 There were not enough data to undertake monthly distance analysis on Year 1 data with any reasonable degree of confidence.

Year 2 Harbour Porpoise Results

70 A total of 83 harbour porpoises were recorded during Year 2, which is similar to the total recorded in Year 1. Of the 83 recorded individuals, four were within the proposed offshore site and the rest within the buffer area (refer to Table 13.11 and Table 13.12).

71 There were some differences in the seasonal distribution across the two years; with few records in November and December compared to Year 1 but relatively more in August when a peak of 22 harbour porpoise were recorded (refer to Figure 13.4).

72 The distribution of harbour porpoise across the surveyed area was uneven with few sightings within the offshore site but widely scattered sightings across the buffer area (refer to Figure 13.5).

Harbour Porpoise Density Estimates

73 By undertaking both visual and acoustic surveys a g(0) estimate can be calculated thus allowing density estimates from both acoustic data and visual data to be used to calculate density estimates (refer to Appendix 13.4: SMRU Ltd Report – Seal Characterisation).

74 Using acoustic data from 8,272 minutes of survey effort and covering an area of 2,140 km^2 during which 184 harbour porpoise were detected, a density of 0.27 porpoises per km^2 is estimated to occur across the whole surveyed area.

75 Using visual data collected over the same period an estimated density of 0.28 harbour porpoises occur across the study area. However, based on all visual data covering a period of 22,754 minutes a density of 0.38 porpoises per km^2 has been calculated (refer to Table 13.17).

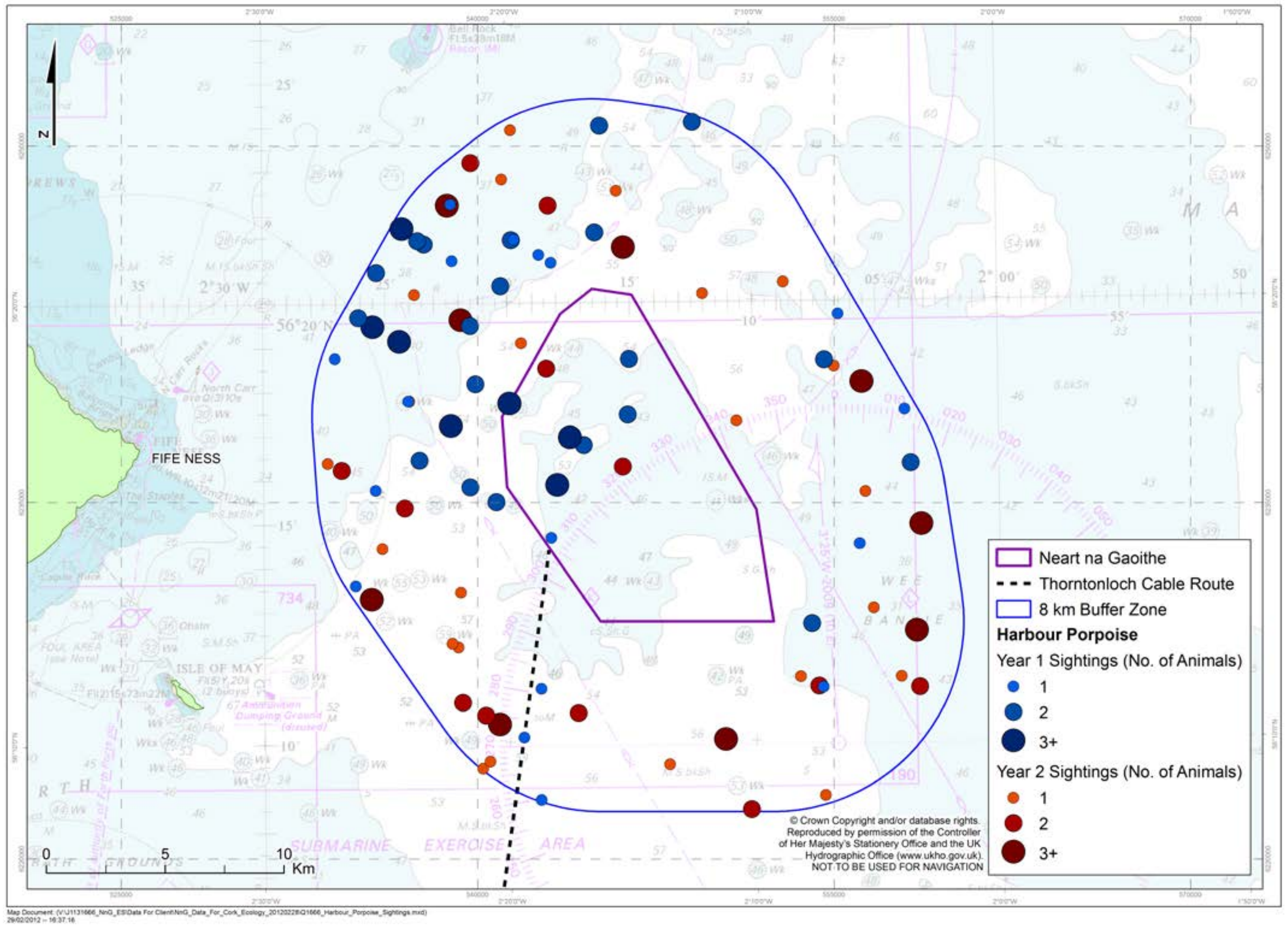


Figure 13.5: Distribution of harbour porpoise observed from boat-based surveys in Year 1 and Year 2

	Harbour porpoise acoustic (all detections)	Harbour porpoise visual (same effort as acoustics)	Harbour porpoise visual (all data)
Effort in minutes	8,272	8,272	22,754
Mean speed	10.1	10.1	10.1
Estimated strip half width (m)	416	180	180
Total strip width	832	180	180
Track surveyed (km)	2,579	2,579	7,094
Area surveyed (km^2)	2,140	464	1,277
Group size (average total for all surveys)	1.43	1.43	1.43
Groups detected	184	30	113
Individuals detected	263	43	161
g(0)	0.45	0.33	0.33
Density (individuals km^{-2})	0.27	0.28	0.38

Table 13.17: Visual sightings, acoustic detections and density estimates for harbour porpoise (Source: Gordon, 2012)

13.8.1.3 Summary

76 Harbour porpoises were recorded in relatively low numbers across the survey area throughout both years of surveys with few records within the proposed offshore site. Across both years there was some seasonal variation with no sightings during June and July but no other significant seasonal patterns recorded. Estimated densities of between 0.27 and 0.39 porpoises per km^2 are similar to those reported from the SCANS II surveys. Therefore, the area of the proposed development is not thought to be of significant importance for harbour porpoise.

13.8.2 White-Beaked Dolphin

13.8.2.1 Status

77 White-beaked dolphin is the most widely occurring and abundant dolphin in the North Sea. The species occurs throughout the year with no known seasonal migrations but with some evidence of localised movements, e.g., in northeast Scotland there is an increase in sightings of white-beaked dolphins in nearshore waters between June and August but they are largely absent at other times. The reason for the seasonal pattern may be due to changes in the distribution of prey species (Weir *et al.*, 2002). The main prey for white-beaked dolphin off eastern Scotland is haddock, whiting and cod (Canning *et al*., 2008).

78 White-beaked dolphins occur widely across the North Sea and adjacent waters but remain in areas with water depths of <200 metres (Reid *et al.,* 2003) (refer to Figure 13.6) and their range may be influenced by sea temperatures or inter-specific competition with common dolphin (Macleod *et al.,* 2008; Weir *et al.,* 2009).

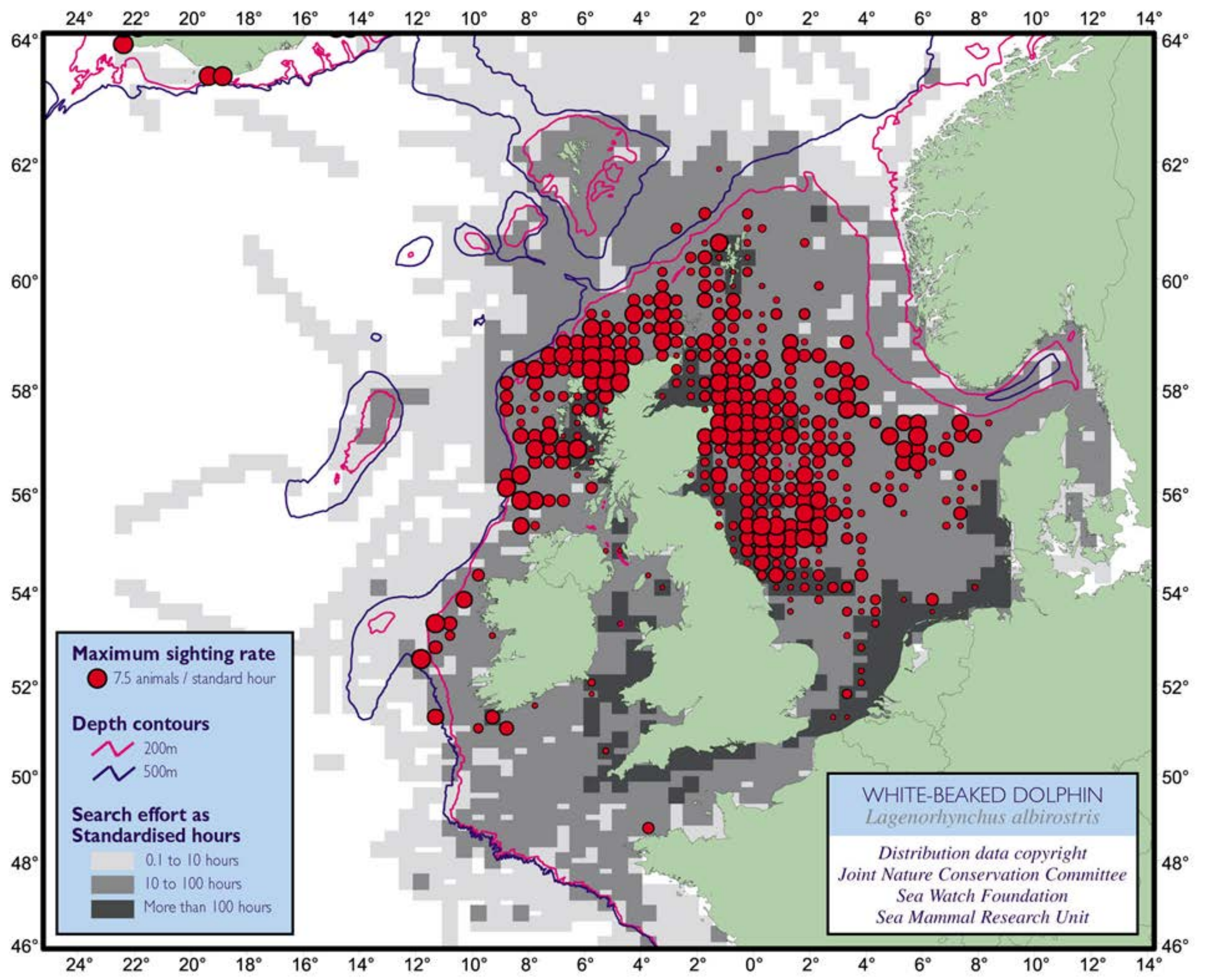


Figure 13.6: White-beaked dolphin distribution in North Sea and adjacent waters (Source: Reid *et al.,* 2003)

13.8.2.2 Neart na Gaoithe Study Area

79 In 1994 the SCANS survey estimated a total white-beaked dolphin population of 7,856 individuals in the North Sea compared to 10,562 in 2005 (Hammond, 2006). The population estimate from SCANS II surveys of white-beaked dolphin in this area is 7,900 individuals.

80 No white-beaked dolphins were recorded in Year 1 but a total of 16 were recorded in Year 2. The majority of sightings were in May when there were 12 individuals recorded and a further three in June (refer to Figure 13.7). The only other sighting was in January. Due to there being so few sightings from surveys, no clear pattern in the distribution of white-beaked dolphins has been identified with recorded sightings scattered across the surveyed area (refer to Figure 13.8).

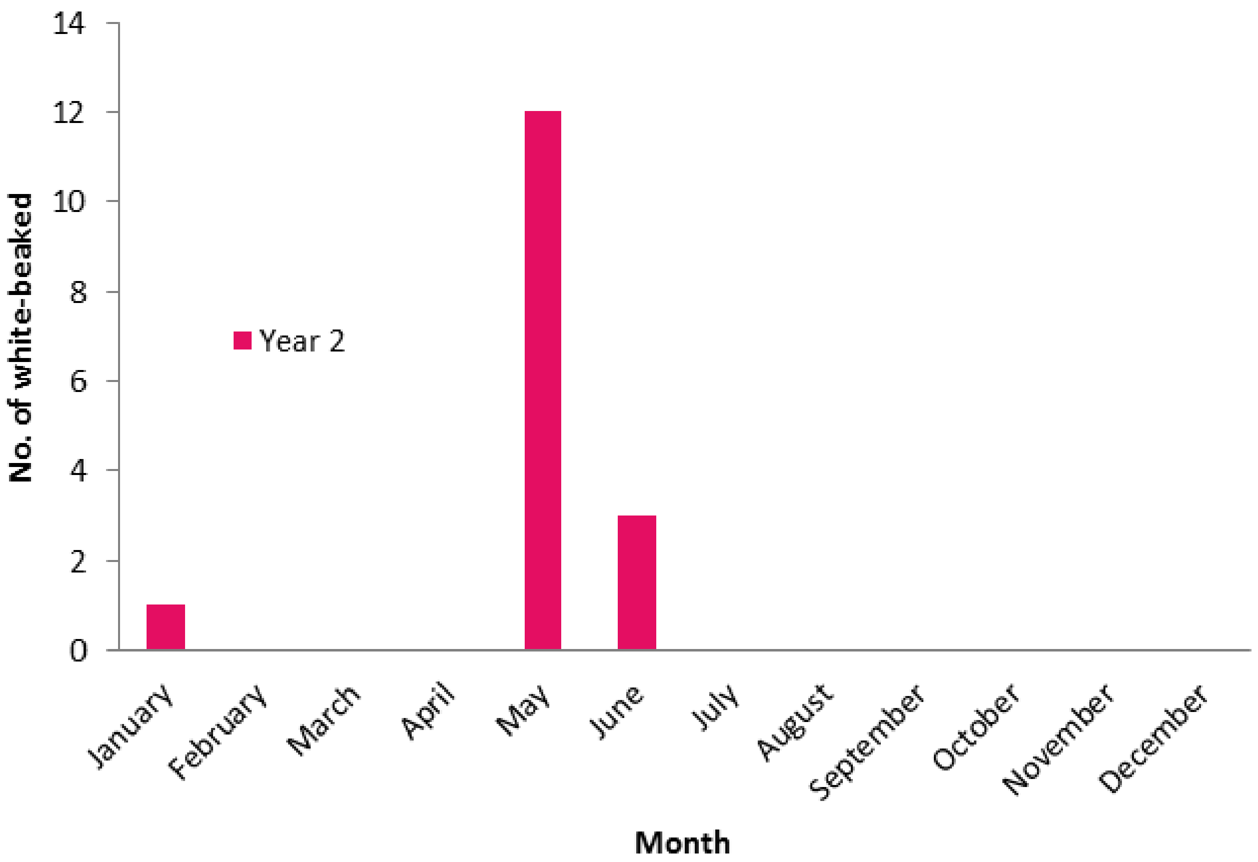


Figure 13.7: Total number of white-beaked dolphins observed from boat-based surveys

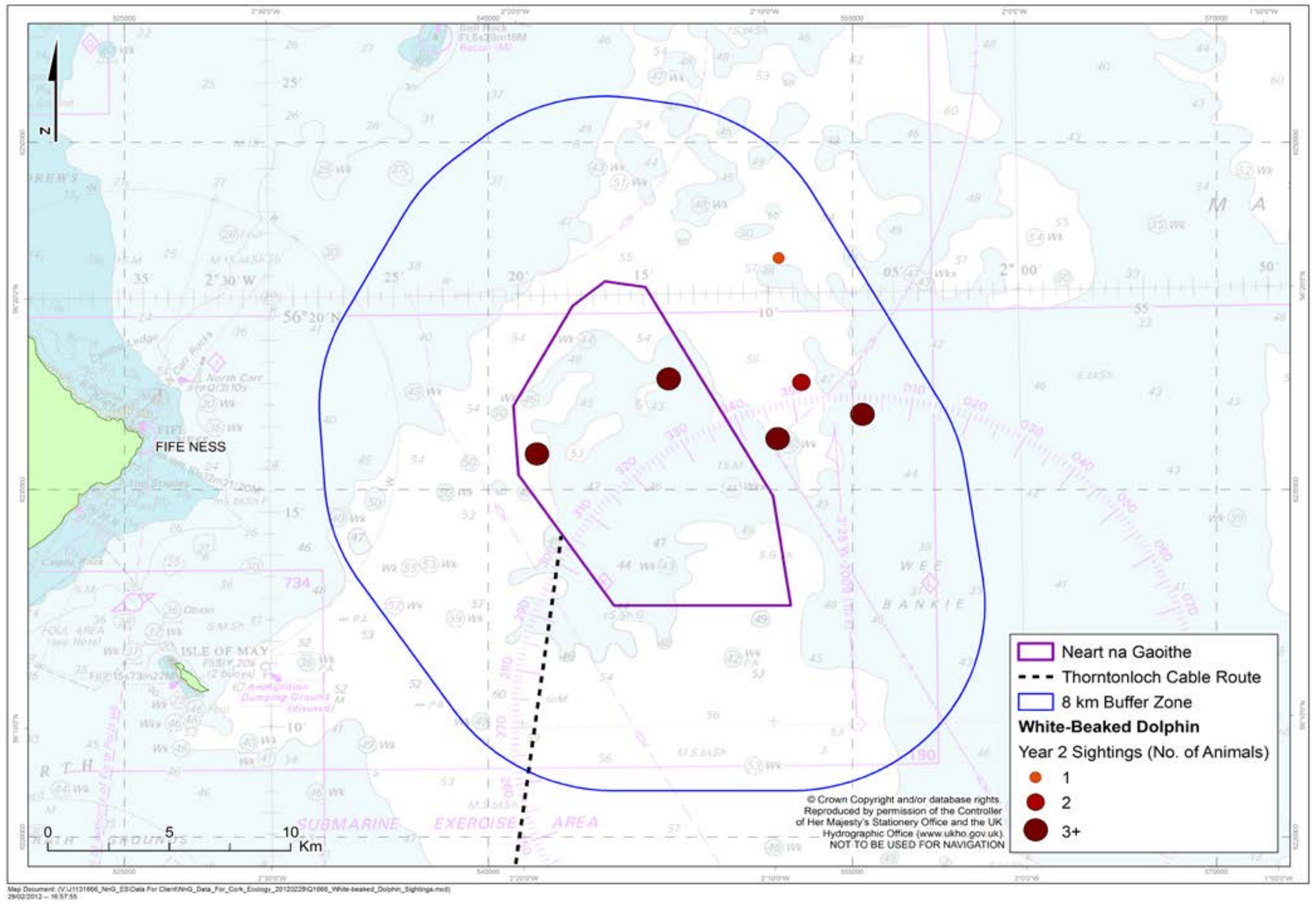


Figure 13.8: Distribution of white-beaked dolphin from boat-based surveys at Neart Na Gaoithe

13.8.2.3 Summary

81 White-beaked dolphins were recorded in low numbers across the survey area and only during the second year of surveys. The area of the proposed development is not thought to be of significant importance for white-beaked dolphin.

13.8.3 Bottlenose Dolphin

13.8.3.1 Status

82 Bottlenose dolphin has a localised distribution in the UK with two recognised areas of particular concentrations: in Cardigan Bay off west Wales and the Moray Firth in northeast Scotland. There are scattered sightings elsewhere in the North Sea (refer to Figure 13.9). Populations are thought to be largely resident with some localised movements between populations, particularly along the east coast of Scotland (Reid *et al.,* 2003).

83 In Scotland, bottlenose dolphins occur widely along the east coast between the Moray Firth and the Firth of Forth and to a lesser extent along the west coast (refer to Figure 13.10). The main area for bottlenose dolphins in Scotland is the Moray Firth where there is a designated SAC (the Moray Firth SAC), for which bottlenose dolphin is a qualifying species.

84 Bottlenose dolphins are known to occur within the Firth of Tay area. Using photo identification techniques it is recognised that many, if not all, the bottlenose dolphins occurring in the Firth of Tay area are associated with those that occur to the north, along the east coast of Scotland and the Moray Firth including within the SAC (Quick and Cheney, 2011). They are also known to occur, at least occasionally, in the Firth of Forth, but due to the lack of studies carried out in the area, their distribution and abundance in the Firth of Forth are unclear.

85 The main prey items for bottlenose dolphins in the Moray Firth have been reported to be cod, saithe and whiting with some salmon, haddock and cephalopods (Santos *et al*., 2001).

86 The estimated population of bottlenose dolphins in the Moray Firth and the east coast of Scotland is 195 individuals (range 16-253) of which, based on surveys undertaken in 2003, between 81 and 142 bottlenose dolphins might occur in the Tay area (Cheney *et al*., 2012; Quick and Cheney, 2011; Thompson *et al.,* 2011a).

87 Surveys undertaken between 2003 and 2004 and again in 2009 and 2010 indicate that the bottlenose dolphins occurring in the Tay area do so largely within coastal waters and rarely occur far offshore (Quick and Cheney, 2011) (Appendix 13.3: SMRU Ltd – Bottlenose Dolphin Baseline).

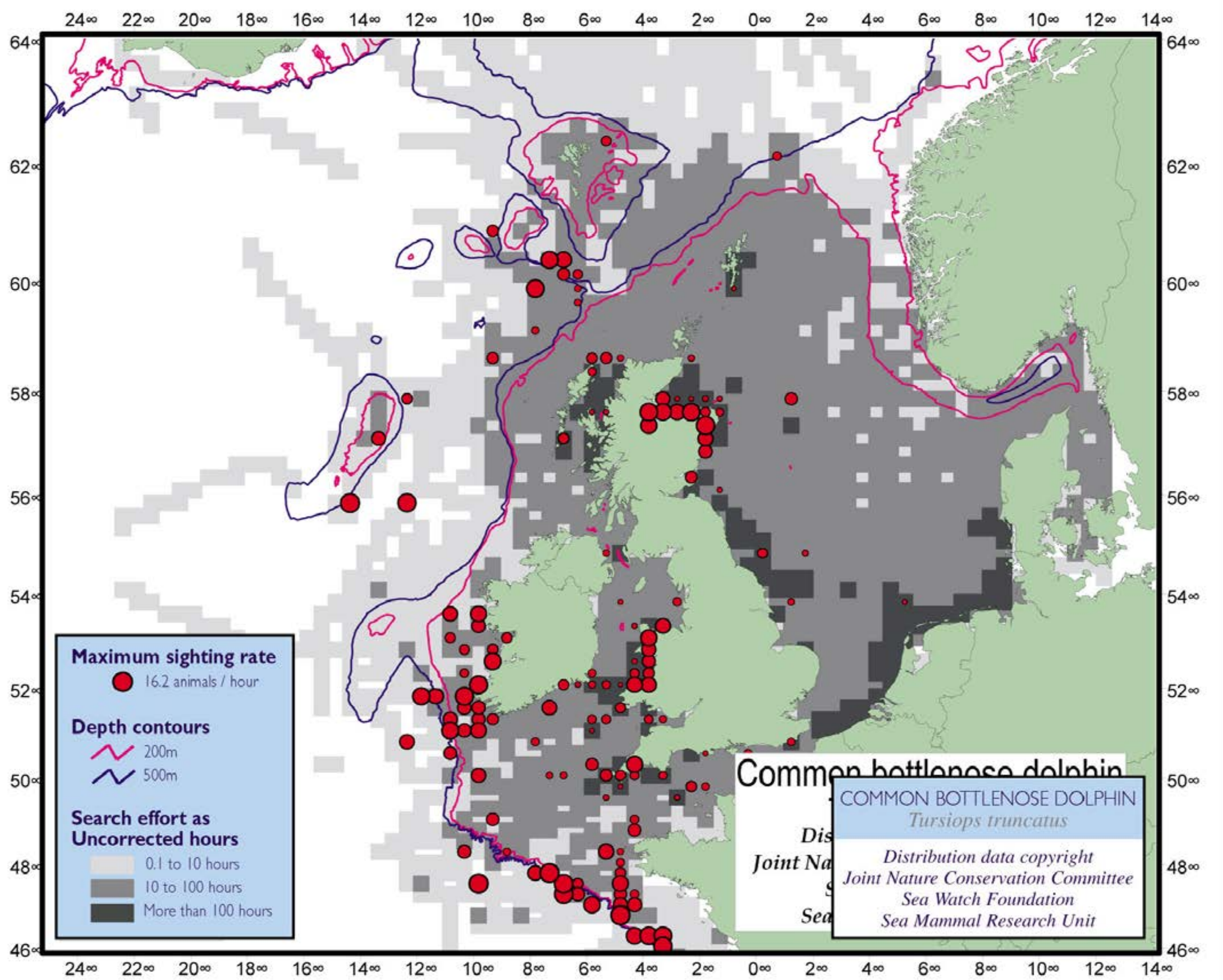


Figure 13.9: Bottlenose dolphin distribution in North Sea and adjacent waters (Source: Reid *et al.,* 2003)

88 Based on data obtained from T-pods (devices which can record dolphin vocalisations) placed at two locations near Arbroath and Fife Ness, dolphins occur in the region throughout the year. With the exception of a slight peak in detections of bottlenose dolphins during the autumn period, there appear to be relatively even numbers in the region across the year (refer to Figure 13.11 and Figure 13.12).

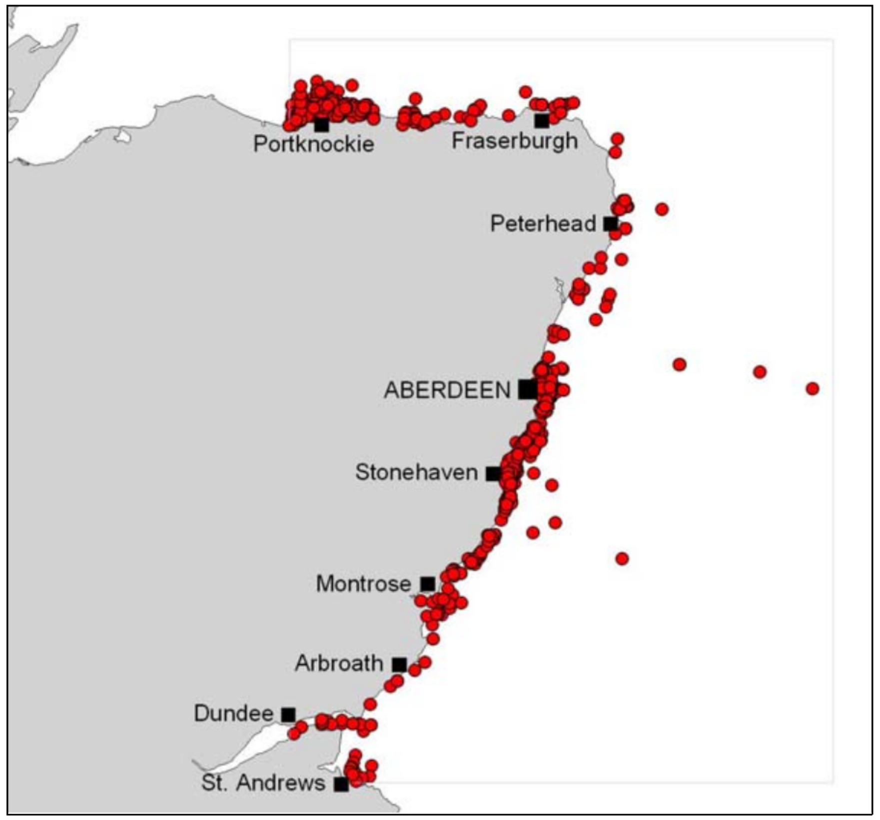


Figure 13.10: Distribution of bottlenose dolphin in East Grampian (Source: Anderwald and Evans, 2010)

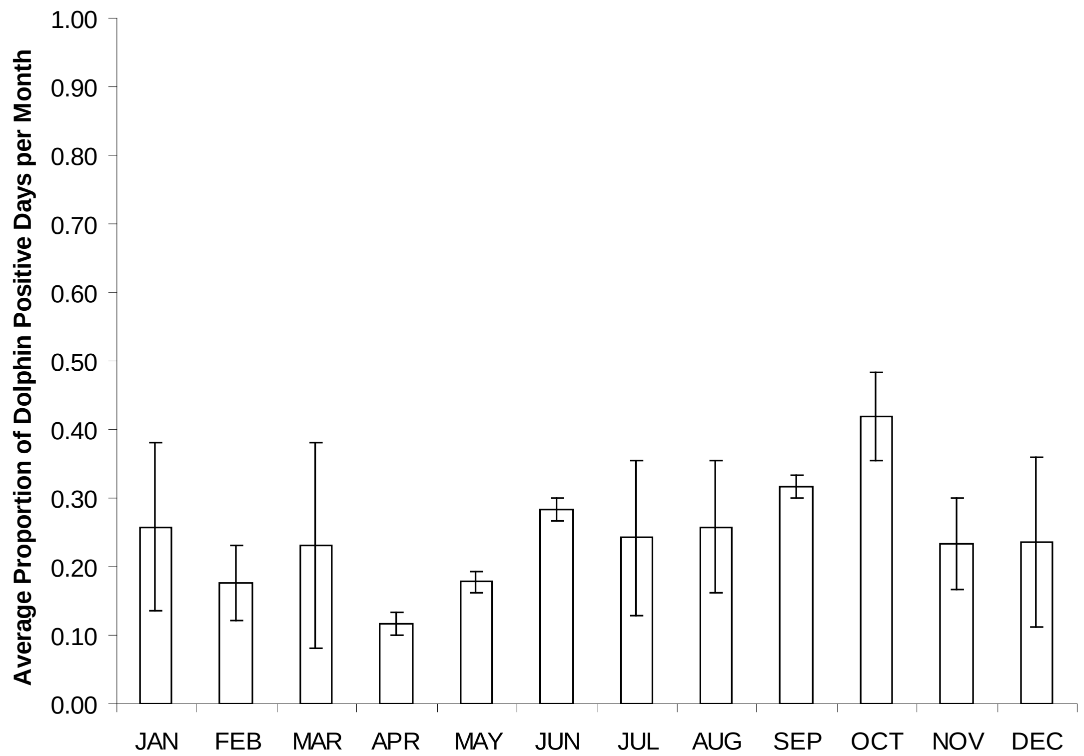


Figure 13.11: The average proportion of dolphin positive days in each month (+/- SE) for T-pod sites at Arbroath for the entire T-pod deployment period (Source: Quick and Cheney, 2011)

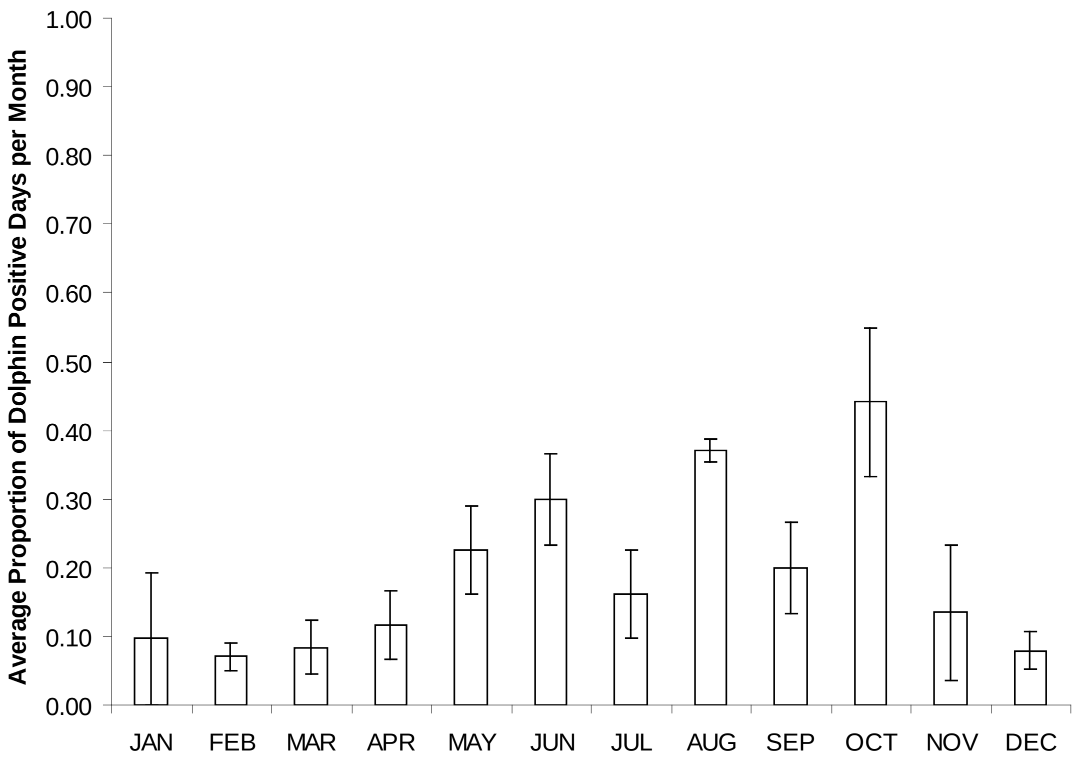


Figure 13.12: The average proportion of dolphin positive days in each month (+/- SE) for T-pod sites at Fife Ness for the entire T-pod deployment period (Source: Quick and Cheney, 2011).

13.8.3.2 Neart na Gaoithe Study Area

89 There were no sightings of bottlenose dolphin during the two years of boat-based surveys undertaken at Neart na Gaoithe.

13.8.4 Minke Whale

13.8.4.1 Status

90 Minke whales are predominantly a summer visitor to the waters off the east coast of Scotland, with animals distributed in both coastal waters and offshore throughout the central and northern North Sea during the summer months, particularly during July and August. There are few sightings of minke whale in the region between October and April (Anderwald and Evans, 2010; Reid *et al.,* 2003). Minke whales appear to be more frequent to the north of the Firth of Forth and Firth of Tay area, with highest numbers occurring off the coasts of Aberdeenshire (Anderwald and Evans, 2010).

91 Minke whales feed on both invertebrates and a variety of fish species, particularly herring, sandeels, cod, haddock and saithe (Anderwald and Evans, 2010).

92 Studies undertaken in the Moray Firth have identified strong correlations in the distribution of minke whales and water depth and sediment type, with minke whales occurring most frequently in water depths of between 20 m and 50 m and over areas with sandy gravel sediments. These habitats are known to be areas used by sandeels and it is thought that the distribution of minke whales during the summer months is associated with the distribution and availability of sandeels that make up between 62% and 87% of their diet by weight. Another strong influencing factor in their distribution is the seabed bathymetry with more frequent occurrence in areas of relatively steep slopes and, in the Moray Firth, north facing slopes were preferred (Robinson *et al*., 2009). The presence of relatively steep seabed is thought to provide up-wellings where increased concentrations of prey may occur.

93 Numbers of minke whales may vary across years and this may be due to the presence of seasonal or inter-annual variations in water temperature with higher numbers being recorded in areas of warm water where there is increased productivity (Tetley *et al*., 2008).

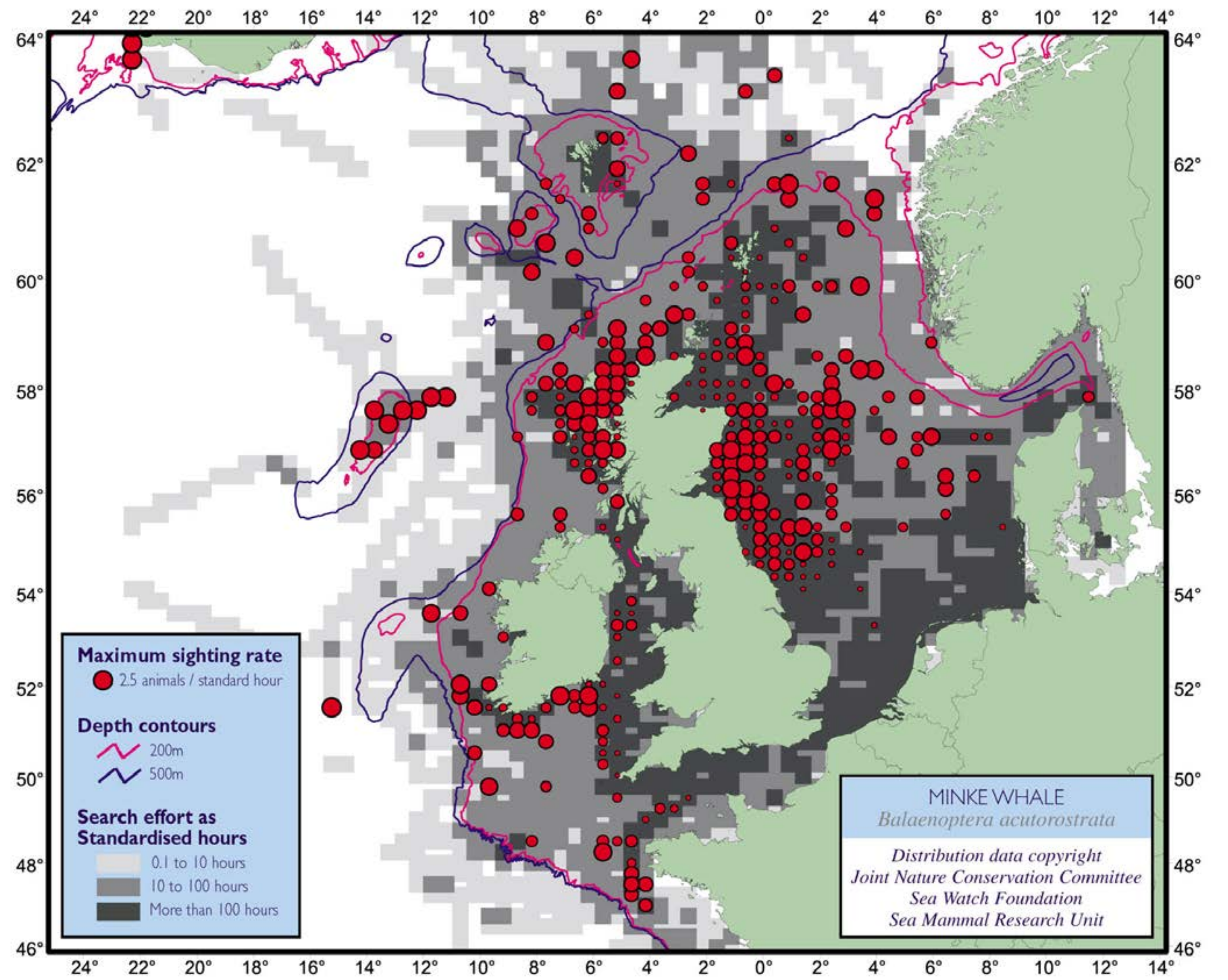


Figure 13.13: Minke whale distribution in North Sea and adjacent waters (Source: Reid *et al.,* 2003)

94 SCANS survey data from the 1994 surveys estimated a regional population of minke whales of 7,785 individuals and in 2005, over the same area, an apparent increase to 15,614 individuals. The North Sea population alone was 10,541 individuals. The increase in the number of minke whales recorded was not statistically significant. However, density modelling indicated higher densities in the offshore waters in the central northern North Sea than previously recorded (Hammond, 2006).

95 Population estimates from SCANS II of minke whale in this area from boat-based surveys is 3,704 minke whales with a density of 0.023 minke whale/km^2.

13.8.4.2 Study Area

96 Minke whale was the only baleen whale recorded during surveys, with all sightings between June and October (refer to Figure 13.14). Two minke whales were recorded in October 2010 of Year 1 and ten in Year 2 with most records in June and August. Sightings were widely scattered across the whole surveyed area (refer to Figure 13.15).

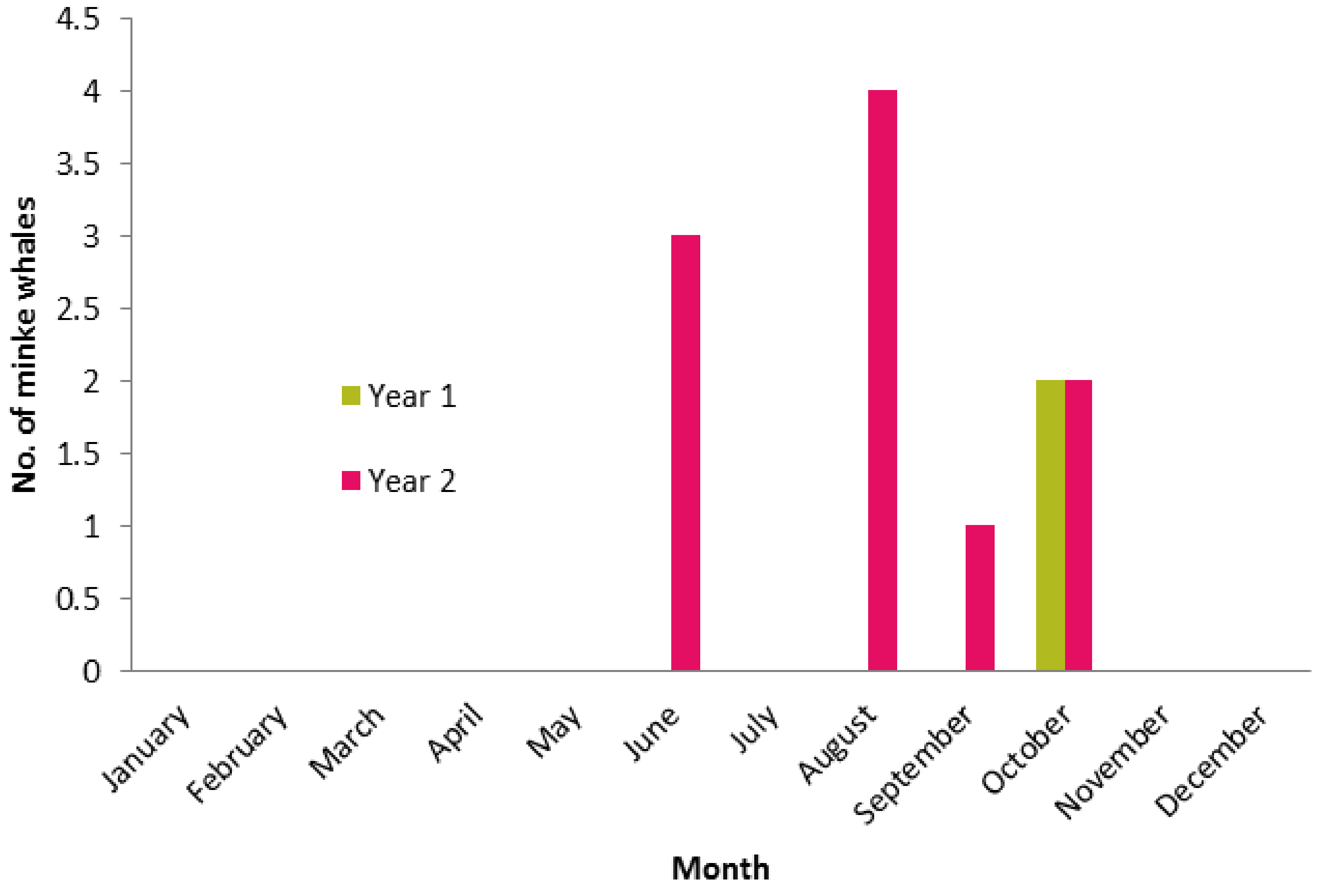


Figure 13.14: Total number of minke whales recorded in study area each month in Year 1 and Year 2

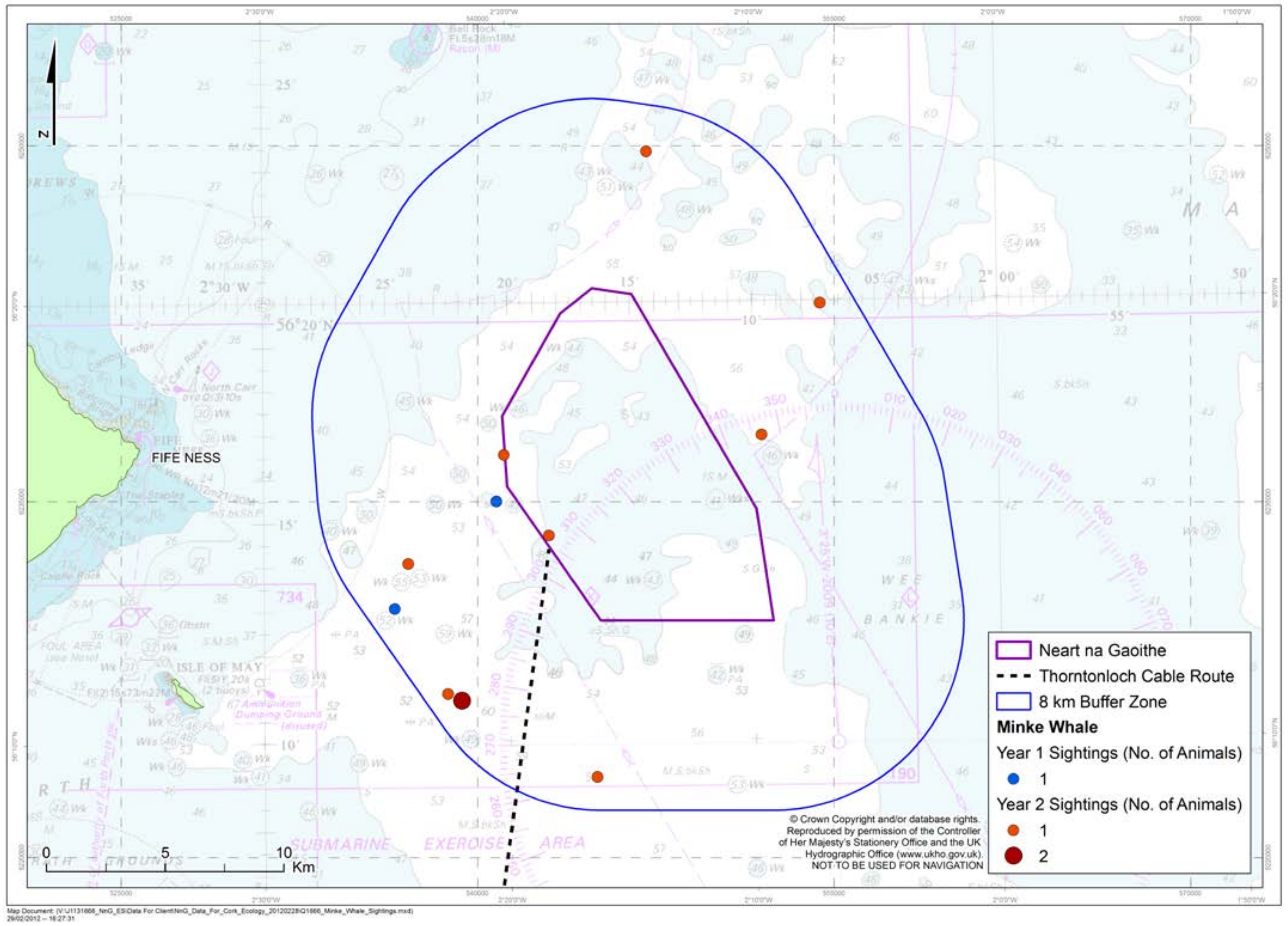


Figure 13.15: Distribution of minke whales from boat-based surveys in Year 1 and Year 2

13.8.5 Unidentified Dolphin Species

97 Five unidentified dolphins were recorded in December 2009 in the northwest of the buffer area and one in the northern area of surveys was recorded in Year 2 (refer to Figure 13.15 and Figure 13.16).

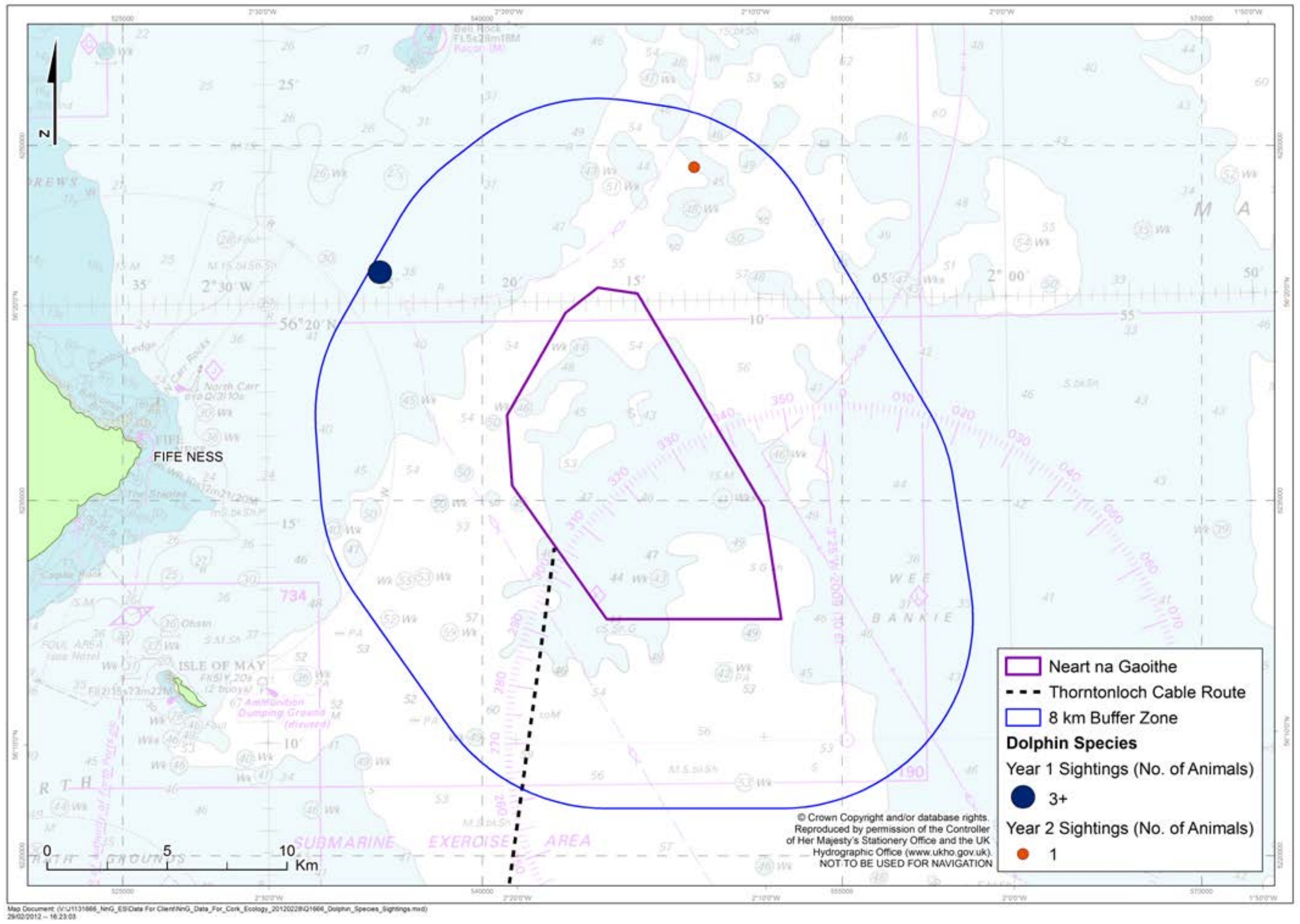


Figure 13.16: Distribution of unidentified dolphin species from boat-based surveys in Year 1

13.8.6 Orca

13.8.6.1 Status

98 Orcas occur predominantly in waters to the north and west of the UK and are very scarce in the North Sea with few records south of the Moray Firth (Reid *et al*., 2003).

13.8.6.2 Study Area

99 A single orca was recorded in October 2011 within the buffer area. Due to the scarcity of this species in the area no further assessment has been made.

13.8.7 Grey Seal

13.8.7.1 Status

100 The grey seal is the larger of the two species of seal that breed around the coast of the British Isles. About 39% of the world population of grey seals is found in Britain, with over 90% of British grey seals breeding in Scotland, mostly in the Hebrides and Orkney (Special Committee on Seals (SCOS), 2005). Elsewhere, they occur in Shetland and along the north and east coasts of the UK and in the southwest. Major grey seal colonies on the east coast of Scotland and England include the Isle of May, Fast Castle and the Farne Islands, which between them hold 12% of the UK grey seal population. The population of grey seals (based on the number of pups produced) is increasing at all three sites (refer to Table 13.18) (Sparling *et al.,* 2011).

Colony	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Isle of May	1766	2133	1932	1977	1882	1953	1954	1827	1751	1875	2065
Fast Castle	268	381	321	532	717	659	764	804	1005	1265	1715
Firth of Forth islands					86	72	110	171	206	247	267
Farne Islands	843	1171	1247	1200	1266	1133	1138	1254	1164	1318	1346
Total	2877	3685	3500	3709	3951	3817	3966	4056	4126	4705	5393

Table 13.18: Grey seal pup production estimates for breeding colonies on the northeast coast of England and southeast coast of Scotland for the last decade (Source: Sparling *et al*., 2011)

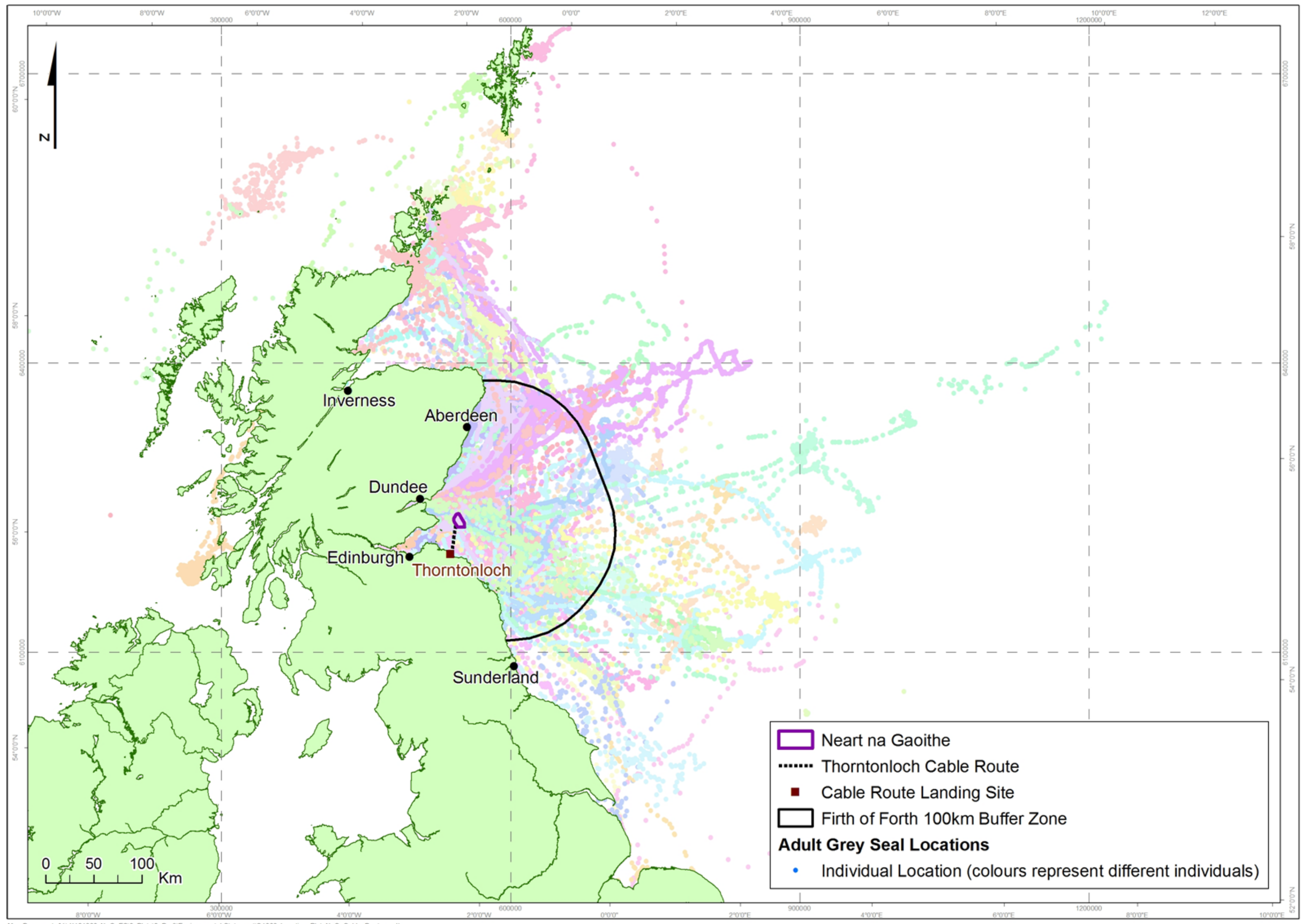
101 Total counts of grey seals hauled-out along the east coast of Scotland and northeast England are presented in Table 13.19 and indicate a peak population during July of 6,498 grey seals at haul-out sites. However, as not all grey seals are at haul-out sites at the same time the actual population will be greater than this. Based on the numbers hauled-out and the number of pups, the grey seal population in the region is between 9,000 and 20,000 grey seals depending on time of year (Sparling *et al.,* 2011).

Haulout Region	April	May	June	July	August	September	Mean
Northeast Scotland	278	346	163	698	95	305	315
Abertay	980	1,001	2,037	1,609	866	1,663	1,359
Farnes	2,415	2,358	3,443	4,191	2,370	2,079	2,809
Total	**3,673**	**3,705**	**5,643**	**6,498**	**3,331**	**4,047**	**4,483**

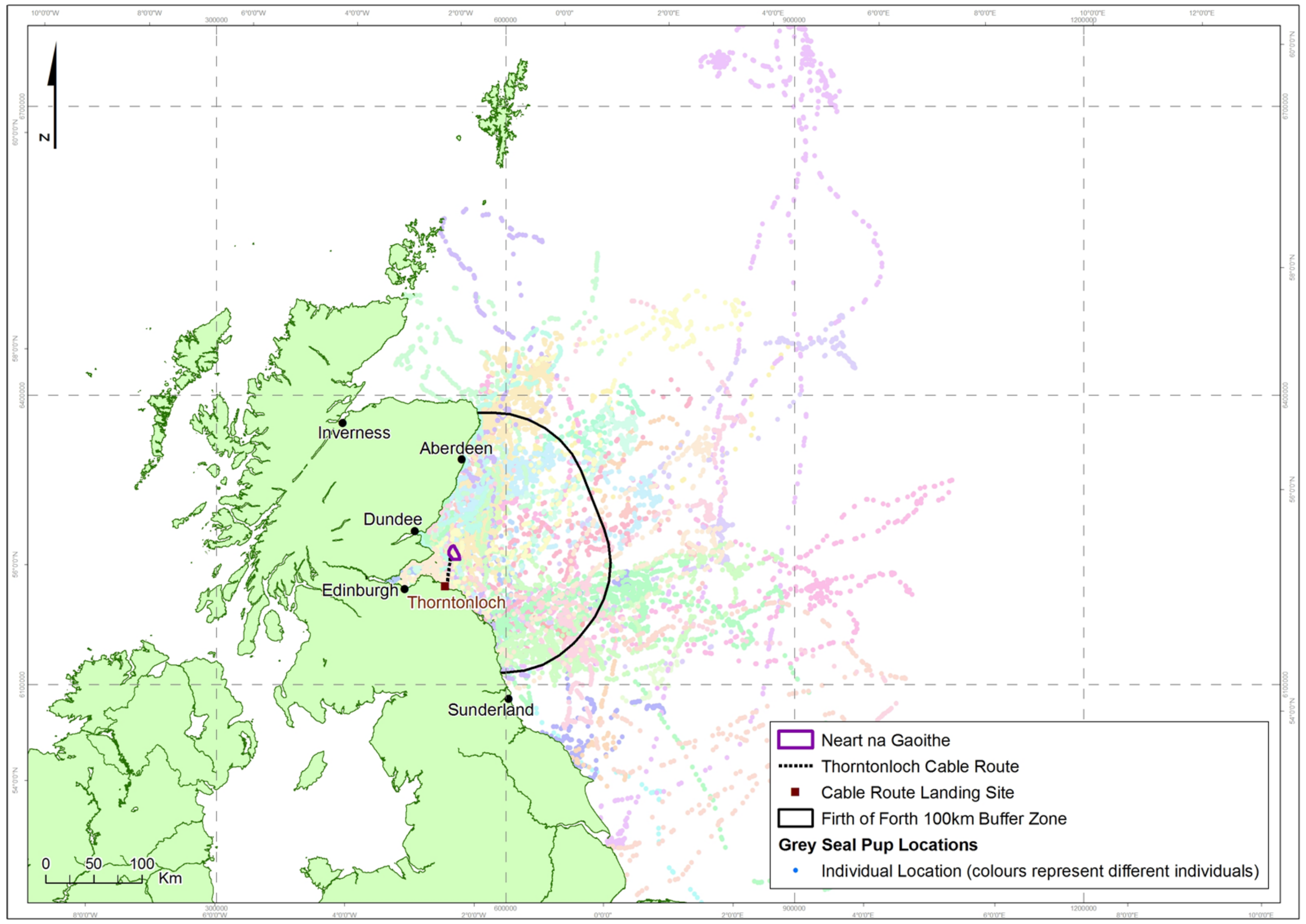
Table 13.19: Total counts of grey seals hauled-out during monthly aerial surveys in April-September 2008 (Source: Sparling *et al.,* 2011)

102 Pupping occurs during November and December and during this period grey seals remain largely onshore or in nearshore waters. Outside this period, grey seals are more widespread, occurring more frequently in offshore foraging areas (JNCC, 2007). Grey seals forage in areas that are up to at least 100 m deep and that tend to have gravel/sand seabed sediments, which are the preferred burrowing habitat of their primary prey, sandeels. Grey seal foraging movements are on two geographical scales; long and distant trips from one haul-out site to another; and local repeated trips to specific offshore areas. Long-term telemetry studies show that grey seals occur regularly in the waters around the Neart na Gaoithe site (Hammond *et al.,* 2004).

103 A total of 92 adult and 30 grey seal pups have been tagged at the Isle of May and the Farnes with some adults from Orkney. The results from the tagging studies indicate that grey seals occur widely between haul-out sites (refer to Figure 13.17)



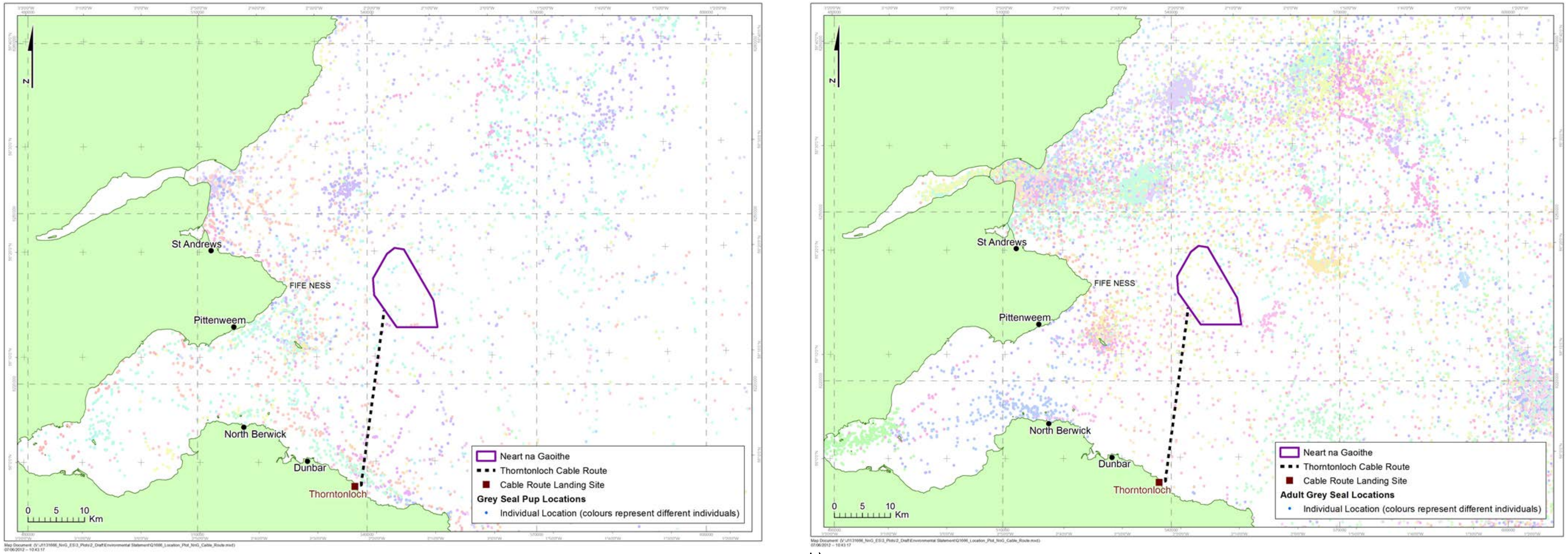
a)



b)

Figure 13.17: Distribution of grey seals (a – adults, b – pups) from colonies in northern and eastern Scotland and northeast England (Source Sparling *et al*., 2011)

104 Within the Firth of Forth and Firth of Tay area results from tagging studies indicate that both adult grey seals and pups occur widely with relatively high occurrence in the nearshore area and further offshore in areas to the north of Neart na Gaoithe (refer to Figure 13.18).



a) b)

Figure 13.18: The locations of grey seal adults (a) and pups (b) in theFirth of Forth and Firth of Tay area in 2011 (Source Sparling *et al*., 2011)

105 Density surface modelling using data obtained from Neart Na Gaoithe and the wider Firth of Forth and Firth of Tay area indicates that highest densities of grey seal occur near to the haul-out sites in the Firth of Tay area and off northeast England (refer to Figure 13.19 and Figure 13.20). Further offshore highest densities occur to the north and east of Neart na Gaoithe with relatively low densities in the proposed offshore site (Sparling *et al*., 2012).

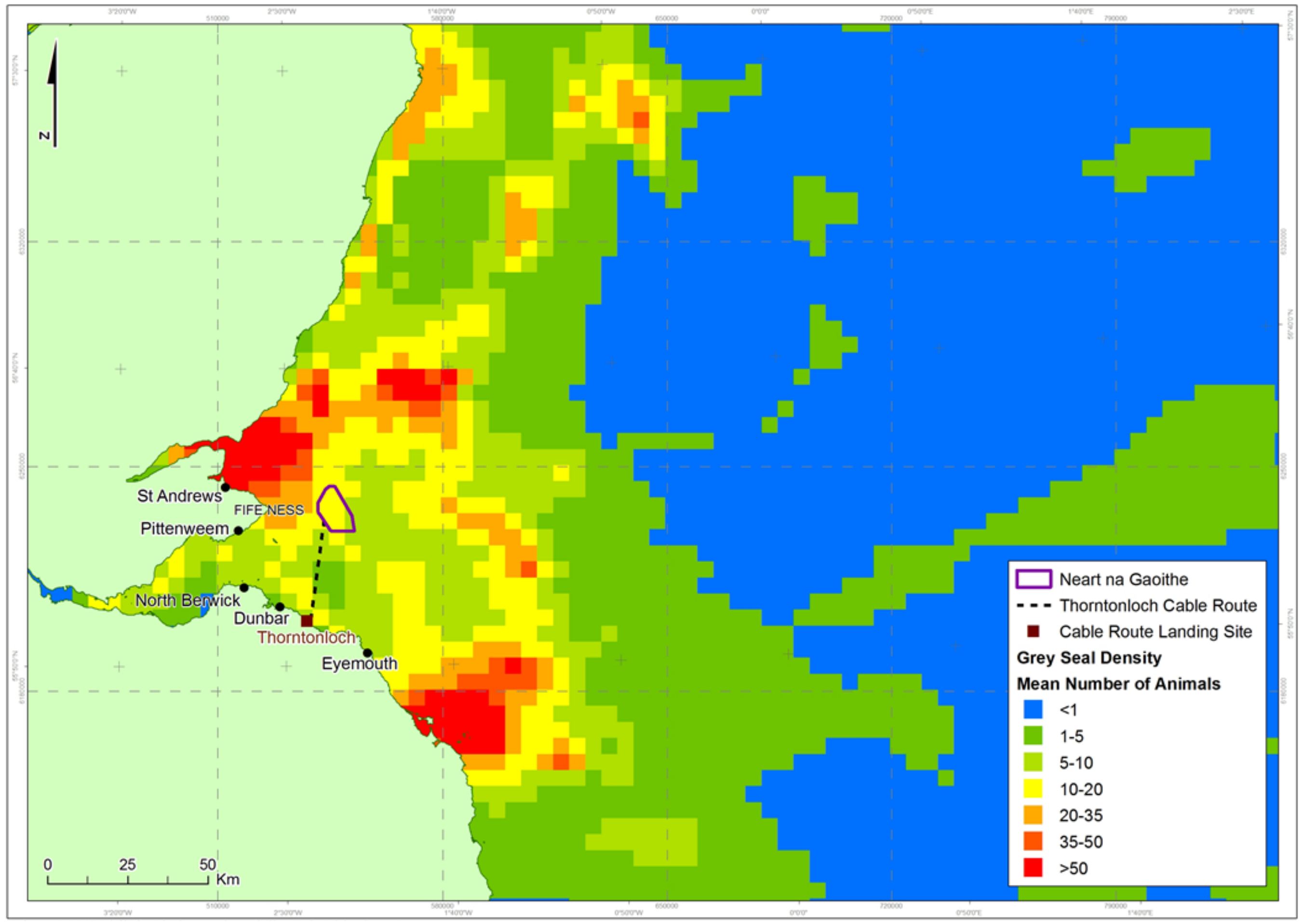


Figure 13.19: Grey seal density in the Firth of Forth and Firth of Tay area (Source Sparling *et al*., 2012)

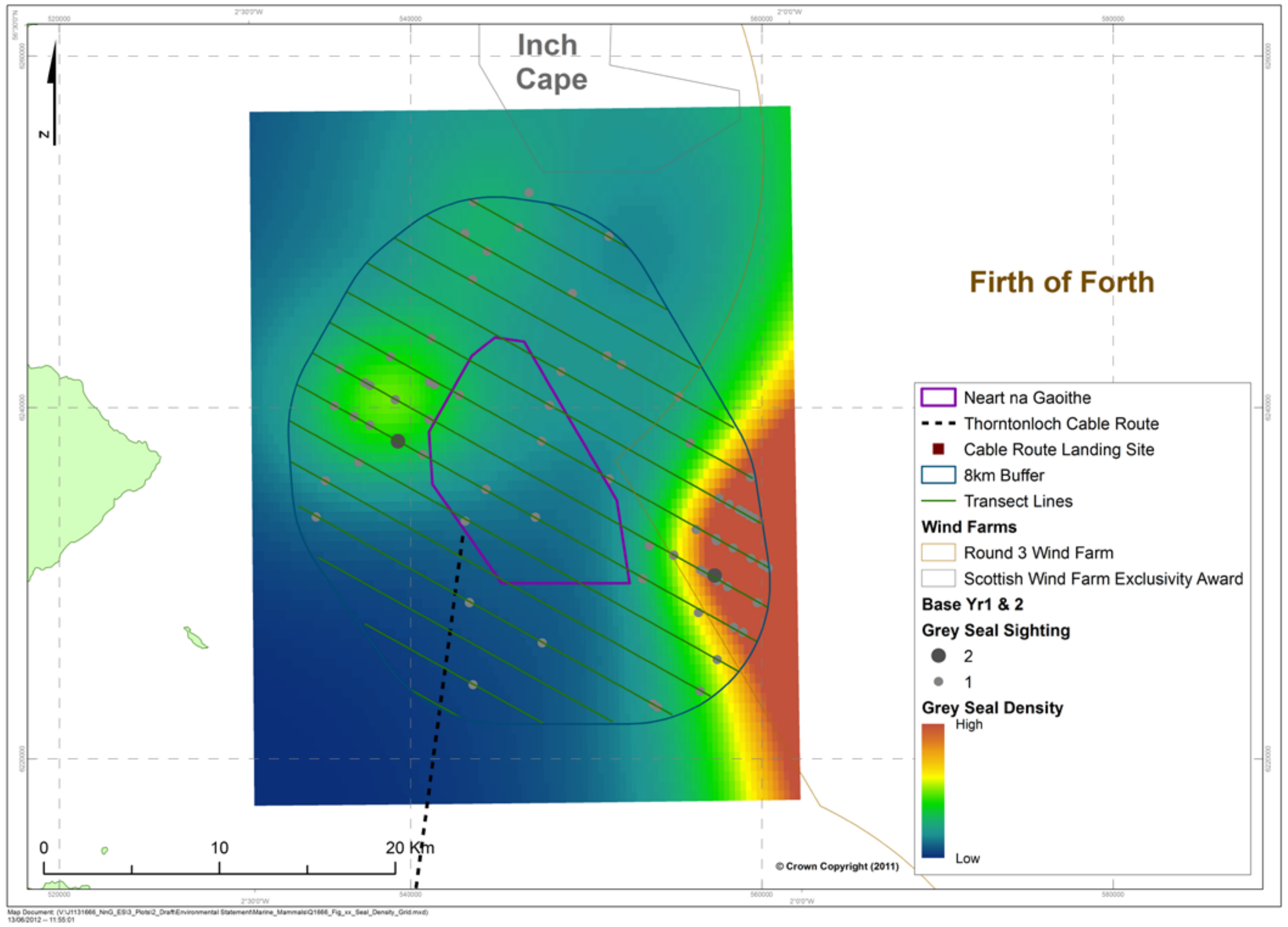


Figure 13.20: Grey seal density in the Neart na Gaoithe offshore site (Source Gordon, 2012)

106 Grey seals feed mostly on fish that live on or close to the seabed. Diet varies seasonally and from region to region, but includes sandeels, cod, haddock, whiting, ling, plaice, sole, flounder and dab In the northern North Sea, grey seal diet comprises primarily sandeel and gadoids, particularly cod and haddock and also benthic species (Sparling *et al*., 2011; Hammond and Grellier, 2006; SCOS, 2005).

13.8.7.2 Study Area

Year 1 Grey Seal Results

107 Grey seal was the second commonest marine mammal in the study area in Year 1, with 43 animals recorded. The majority of animals (95.3%) were recorded in the buffer area (refer to Table 13.11 and Table 13.12).

108 In Year 1 peak numbers occurred in October and March with few sightings at other times of year, especially during the pupping and moulting periods of winter and early spring (refer to Figure 13.21).

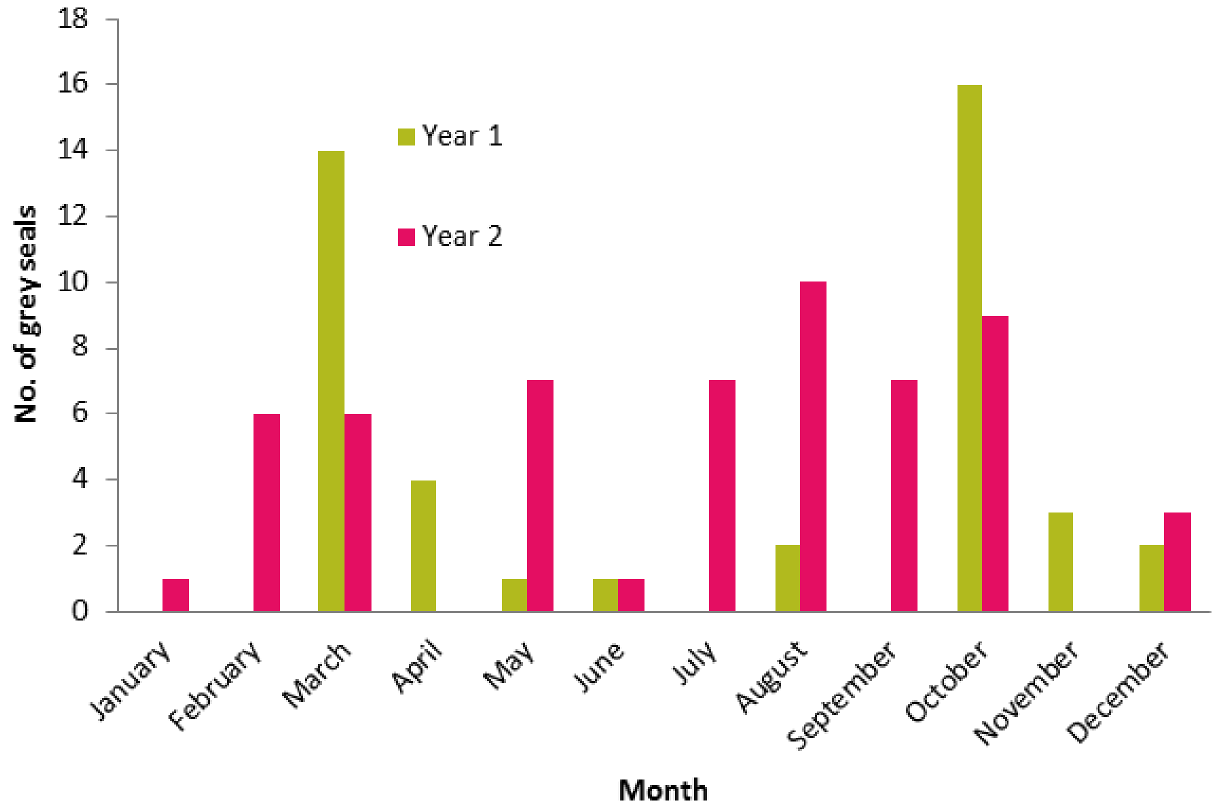


Figure 13.21: Total number of grey seals recorded from boat-based surveys across two years

109 Sightings of grey seals were most regular to the northwest and southeast of the offshore site, with only two sightings of grey seals within the offshore site in Year 1 (refer to Figure 13.22).

Year 2 Grey Seal Results

110 In Year 2 the grey seal was the second most frequently recorded marine mammal in the study area, with a total of 57 individuals recorded. The majority of animals (89.4%) were recorded in the buffer area (refer to Table 13.12) with most sightings to the east and southeast of the proposed offshore site (refer to Figure 13.22).

111 In Year 2 peak numbers occurred in the late summer and autumn. However, sightings occurred in most months (refer to Figure 13.21).

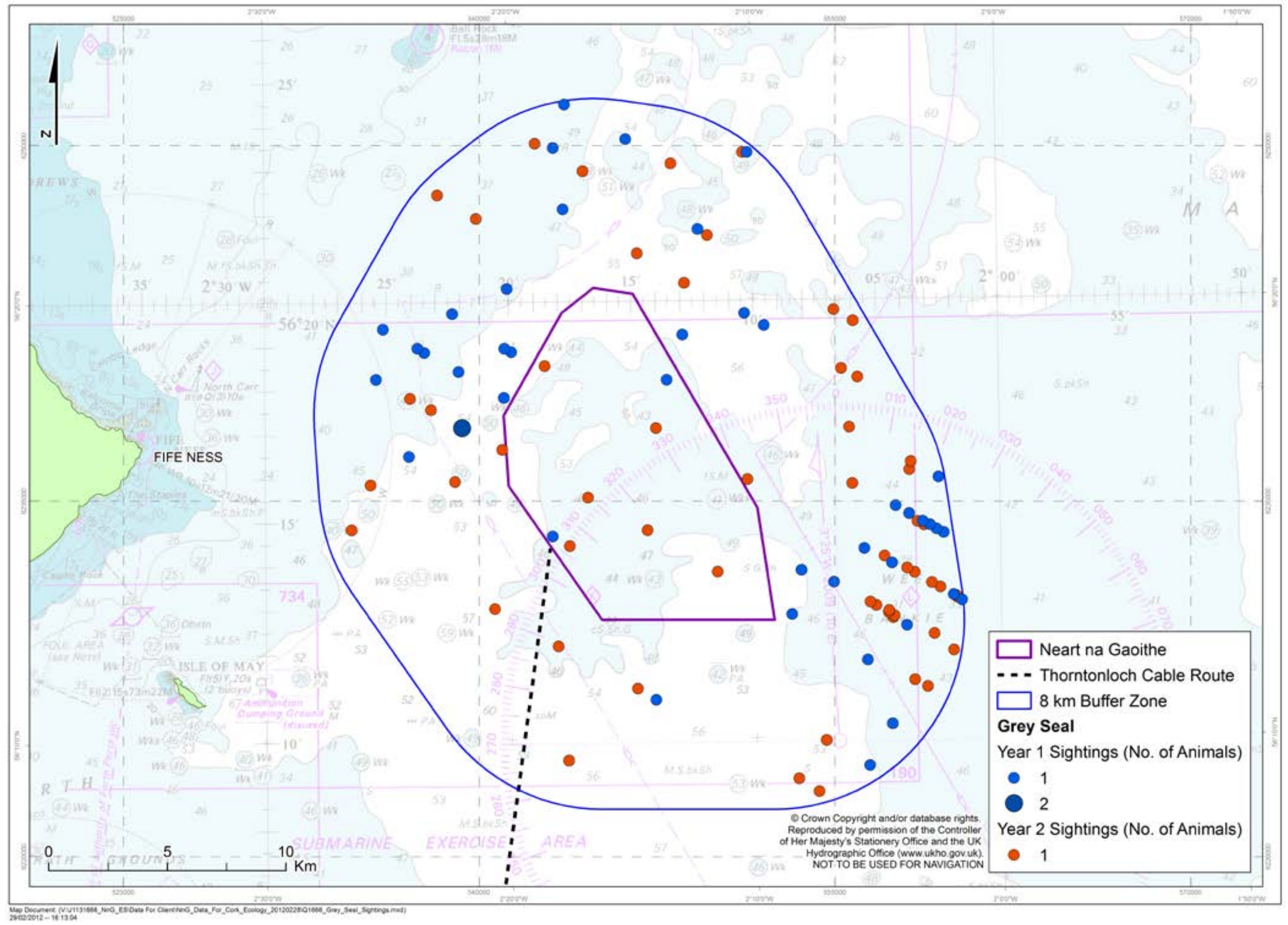


Figure 13.22: Grey seal sightings at Neart Na Gaoithe from boat-based surveys

13.8.8 Harbour (Common) Seal

13.8.8.1 Status

112 In Scotland harbour seals are widespread around the west coast, the Hebrides and Northern Isles (refer to Table 13.21). On the east coast they are present in the Firth of Tay and Moray Firth area and further south to The Wash. Most harbour seals in southeast Scotland haul-out along the Angus, Fife and Lothian coasts, which hold approximately 2% of the UK population (Sparling *et al.*, 2011). Since 1997 there has been a wide spread decline in the number of harbour seals in the UK with significant reductions at most haul-out sites. In the region overall numbers recorded have decreased by 42% between 1997 and 2007 (refer to Table 13.20).

Region	1997	2005	2007
Tayside (Montrose to Newburgh)	92	101	166
Fife (Newburgh to Kincardine Bridge)	617	445	215
Central (Upper Forth)	0	0	1
Lothian (Kincardine Bridge to Torness Power Station)	40	104	55
Borders (Torness Power Station to Berwick upon Tweed)	0	0	0
Total	**749**	**650**	**437**

Table 13.20: The number of harbour seals counted on the southeast coast of Scotland (Sparling *et al.*, 2011)

Seal management area	Current estimate (2007-2009)	% of total for Scotland
Shetland	3003	15%
Orkney	2874	14%
Highland North Coast	112	1%
Outer Hebrides	1804	9%
West Scotland, Highland (Cape Wrath to Ardnamurchan)	4969	24%
West Scotland, Strathclyde (Ardnamurchan to Mull of Kintyre)	5834	28%
South West Scotland, Firth of Clyde (Mull of Kintyre to Loch Ryan)	811	4%
South West Scotland, Dumfries and Galloway (Loch Ryan to the English Border)	23	0%
East Scotland, Firth of Forth (Border to Fife Ness)	**148**	**1%**
East Scotland, Firth of Forth (Fife Ness to Fraserburgh)	**228**	**1%**
East Scotland, Moray Firth (Fraserburgh to Duncansby Head)	871	4%
TOTAL SCOTLAND	**20,677**	
TOTAL UK	**24,404**	

Highlighted area is the regional population for harbour seal totalling 376 individuals

Table 13.21: Minimum estimates of the UK harbour seal population from most recent surveys in each seal management area (Sparling *et al*., 2011)

113 The Firth of Tay and Eden Estuary SAC lies approximately 30 km from the proposed development. As with most harbour seal sites, it has recorded a decrease in the number of harbour seals present (refer to Table 13.22).

Site	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010
Eden Estuary	267	341	93	78	88	90	99	83	22	36
Abertay and Tentsmuir point	153	167	53	126	53	34	32	50	8	9
Upper Tay	115	51	83	134	85	91	62	49	45	41
Broughty Ferry and Buddon Ness	165	109	232	121	97	127	68	40	36	38
Firth of Tay and Eden Estuary SAC total	**700**	**668**	**461**	**459**	**323**	**342**	**261**	**222**	**111**	**124**

Table 13.22: The number of harbour seals in the Firth of Forth and Eden Estuary SAC since 2000 (Source: Sparling *et al*., 2011)

114 Based on the current population decline, and assuming a future exponential decline in the Firth of Tay and Eden Estuary population, the harbour seal population has the potential to be close to extinction in the next ten years. If the decline is linear then the population will decrease at a significantly greater rate (refer to Figure 13.23). The cause of the decline in the harbour seal population is unknown.

115 Harbour seals normally feed within 40-50 km around their haul-out sites, and take a wide variety of prey including sandeels, cod, haddock, whiting, ling, herring and sprat, flatfish, octopus and squid. There are some seasonal and regional variations to this, with sandeels, octopus, whiting, flounder and cod being prey items for harbour seals in northeast Scotland and sandeels and salmonids being prey items for harbour seals in the Tay Estuary (Sparling *et al.,* 2011; SCOS, 2005; Tollit and Thompson, 1996).

116 Tagging studies of harbour seals indicate that they remain largely in nearshore waters with relatively infrequent occurrences in the Neart na Gaoithe offshore site (Sparling *et al*., 2011; Figure 13.24 and Figure 13.25). The tagging results identify key offshore foraging areas, which occur in the nearshore waters of the Firth of Forth and Firth of Tay area and further offshore to the northeast of the offshore site. Pupping occurs during June and July followed by moulting during August. During this period harbour seals remain closer to their haul-out sites.

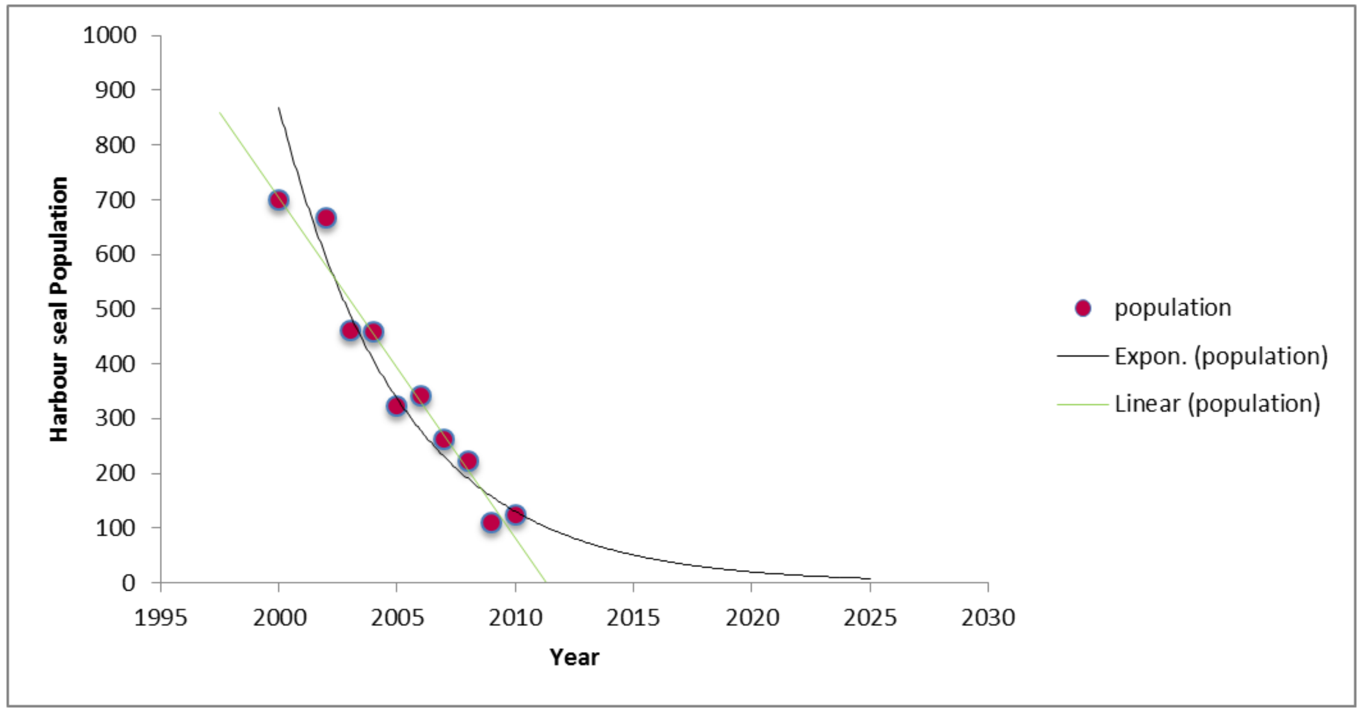


Figure 13.23: Firth of Tay and Eden Estuary harbour seal population Source: Sparling *et al*., 2011)

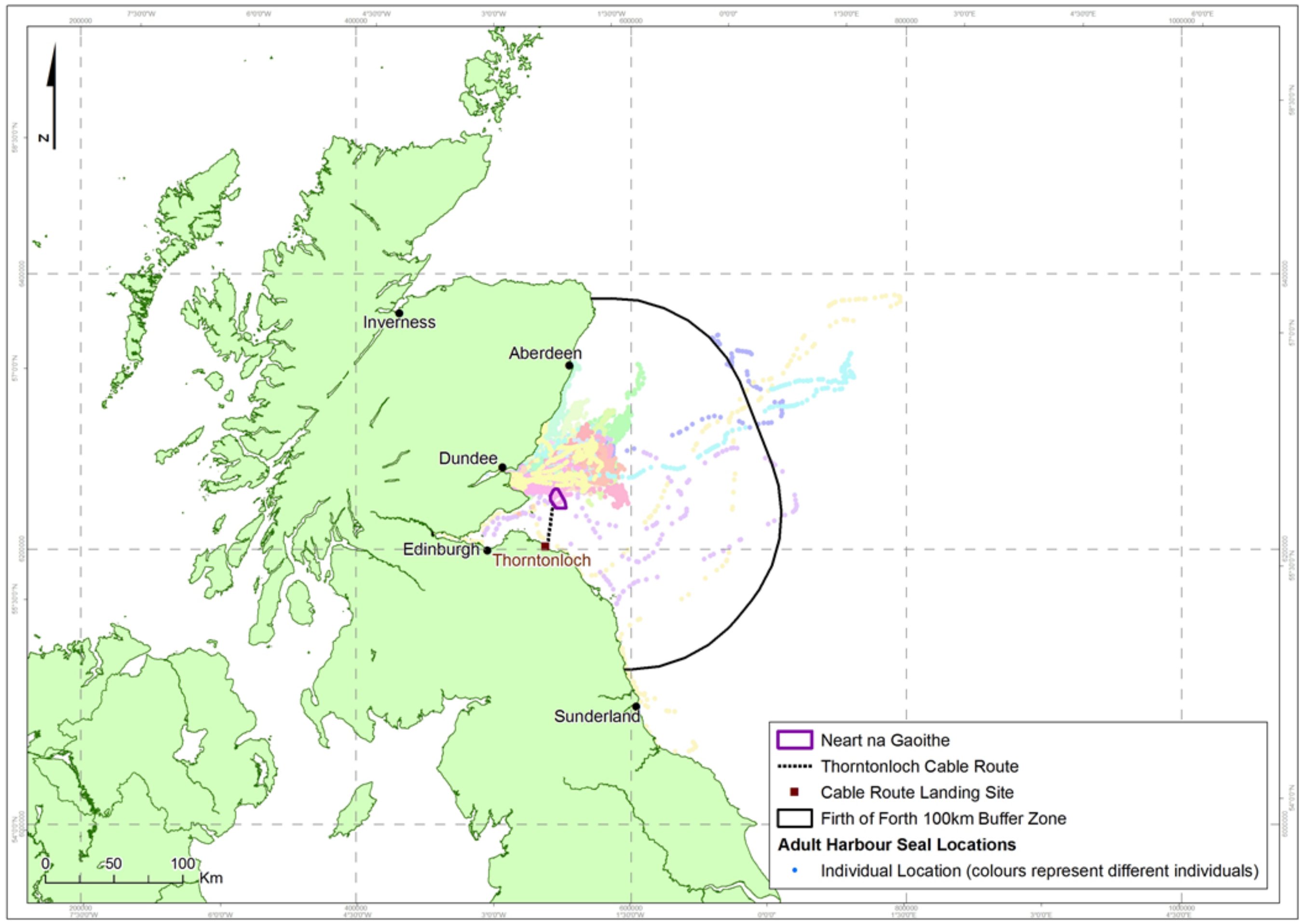
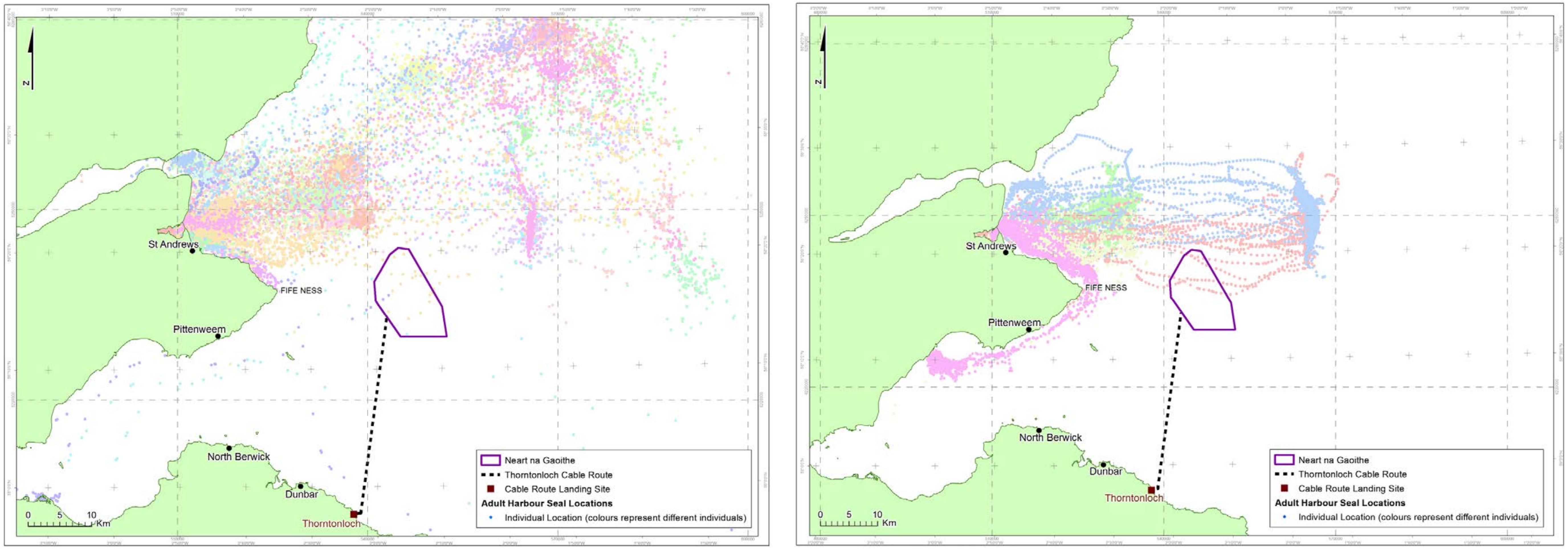


Figure 13.24: The locations of tagged adult harbour seals (2001 – 2008) that have occurred within 100 km of the Firth of Forth and Firth of Tay area (different colours are presented for each individual) (Source: Sparling *et al*., 2011)



a) b)

Figure 13.25: The locations of adult harbour seals in 2001 – 2008 (a) and in 2011 (b) in the Firth of Forth and Firth of Tay area (Source: Sparling *et al*., 2011)

117 Density surface modelling undertaken using Firth of Forth and Firth of Tay wide data indicates that harbour seals occur predominantly to the north and northeast of the Neart na Gaoithe offshore site (refer to Figure 13.26).

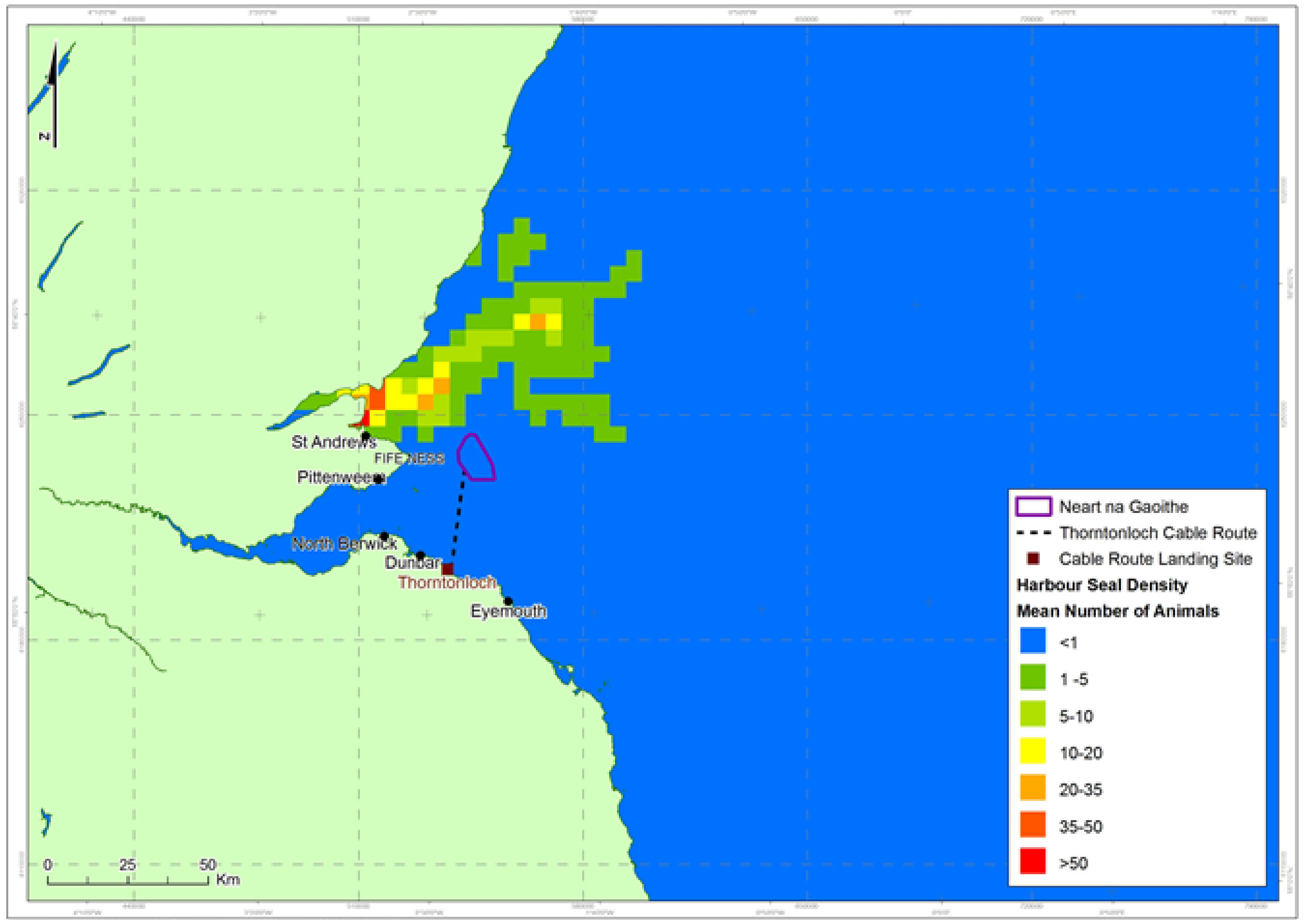


Figure 13.26: Harbour seal density surface in the Firth of Forth and Firth of Tay area (Source: Sparling *et al*., 2012)

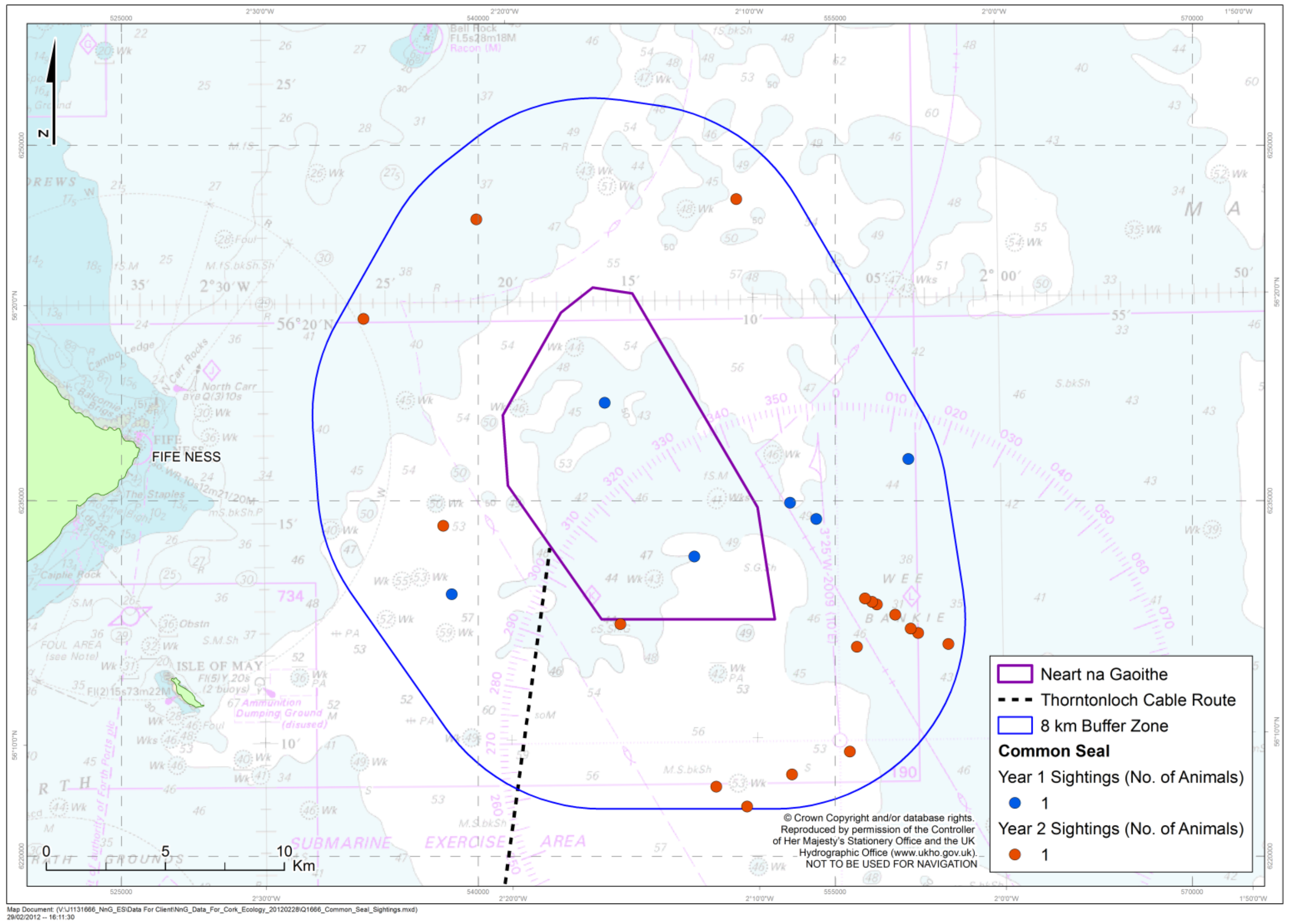


Figure 13.27: Harbour (common) seals observed at Neart na Gaoithe from boat-based surveys

13.8.8.2 Study Area

118 A total of six harbour seals were recorded in the study area in Year 1. There were two harbour seals recorded in the offshore site and four recorded in the buffer area. In Year 2, 17 harbour seals were recorded in most months in the buffer area (refer to Table 13.12 and Figure 13.27 and Figure 13.28).

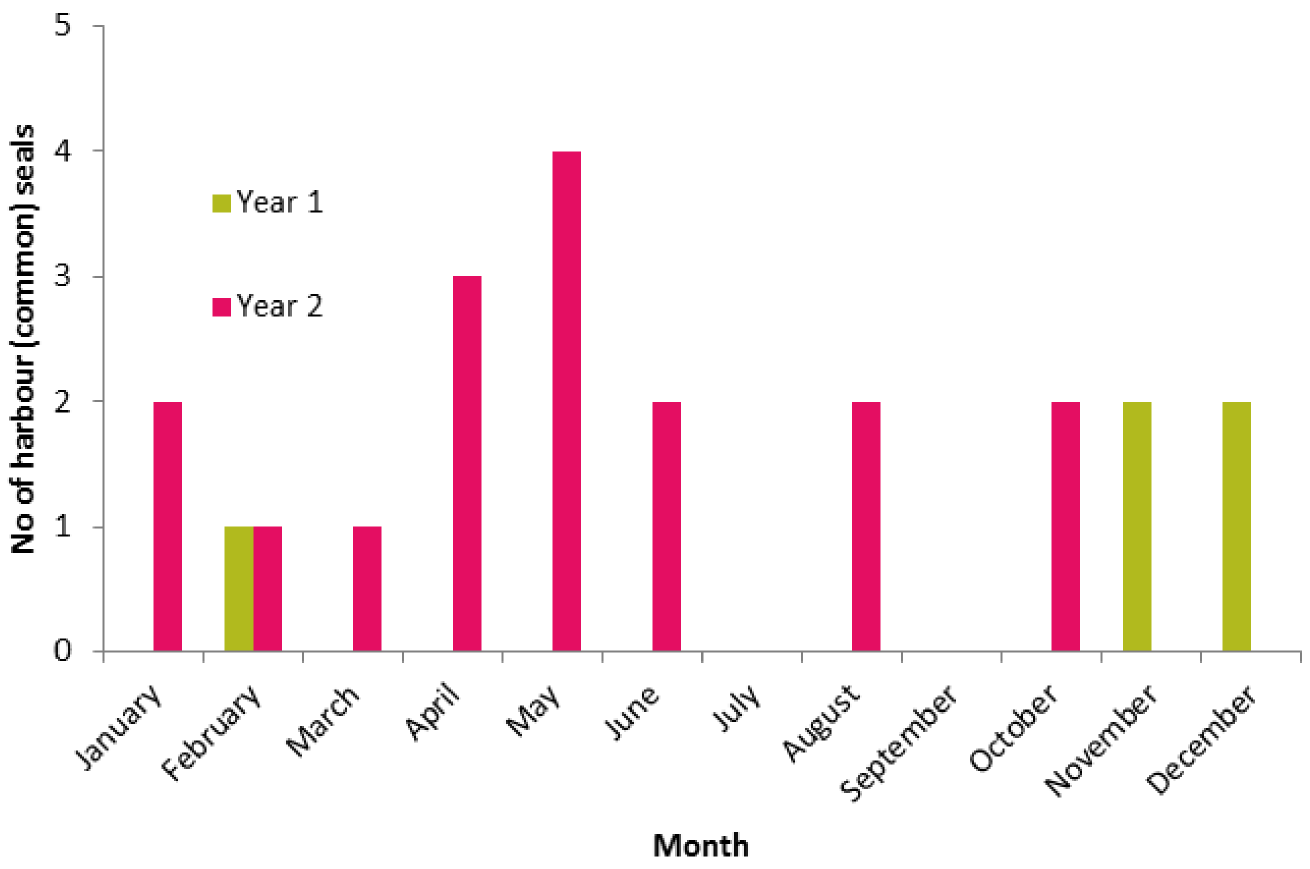


Figure 13.28: Total number of harbour seals recorded from boat-based surveys across two years

13.8.9 Unidentified Seal Species

119 A further six unidentified seals were recorded in the study area in Year 1 and one in Year 2. Four animals were recorded in the buffer area and three in the offshore site.

13.8.10 Summary of Main Seasonal Sensitivities

120 The main seasonal sensitivities in terms of breeding, pupping and moulting are presented in Figure 13.29. The figure indicates that there are sensitivities throughout the year but potentially lower periods of sensitivity during March, April and May. It is noted that the period of breeding and mating for minke whale is not when they are found in the Firth of Forth and Firth of Tay area.

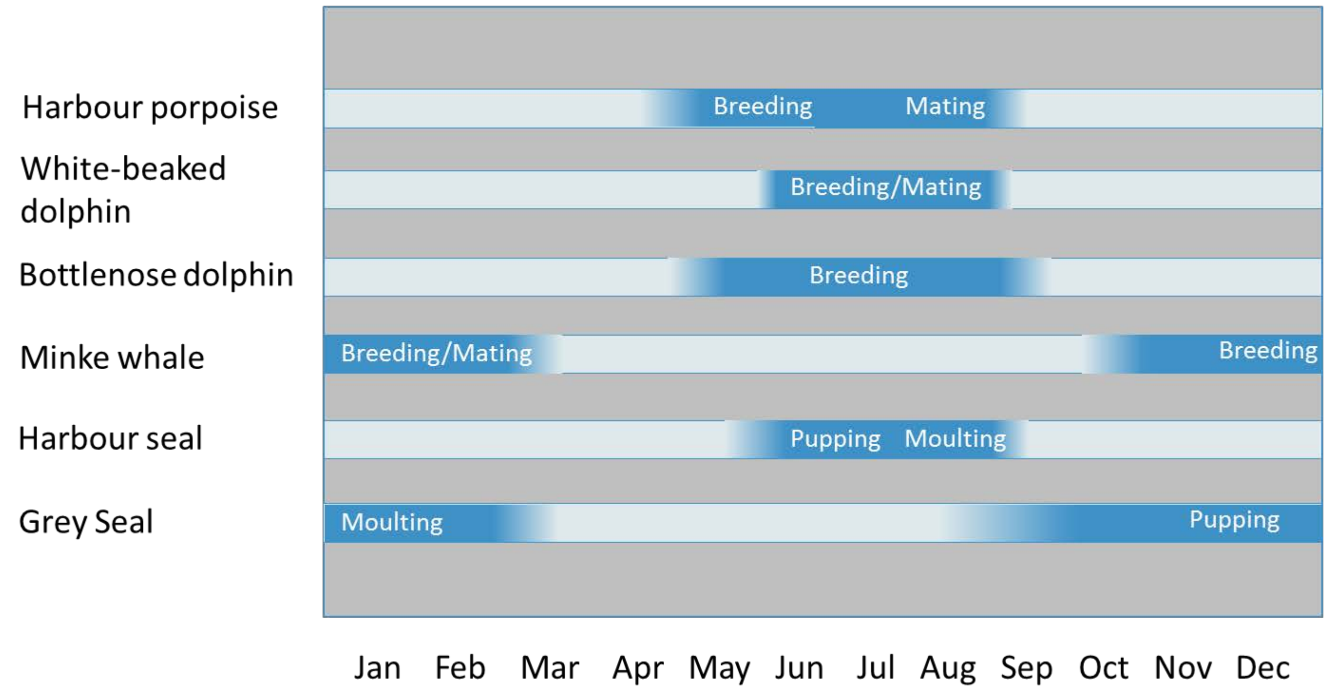


Figure 13.29: Summary of the main seasonal sensitivities of the regularly occurring marine mammals in the Firth of Forth and Firth of Tay area

13.9 Underwater Noise

13.9.1 Sound Sources

121 Sound generated during the construction and operational phases of the proposed project has the potential to interact with, and impact on, marine mammals. Such impacts can arise from a number of sources:

- Pile driving during construction;
- Noise generated by operating wind turbines; and
- Vessel noise, both during construction and in the operational phase.

122 For the purposes of this assessment, consideration of the potential scale of impacts is focused on those arising from pile driving. If that process takes place, it is likely to be the loudest source of sound and therefore has the potential to have the most significant effect. However, it is recognised that sound may also arise from other sources and these are also discussed.

13.9.1.1 Pile Driving

123 The noise levels arising from pile driving varies depending on the type and diameter of the pile, the ground conditions and the method of pile driving, which may be ‘impact’ or ‘vibro’ (vibration). Studies undertaken during the construction of existing wind farms have recorded noise source levels of between 243 dB re 1 Pa@1 m and 257 dB re 1 Pa@1 m depending on the pile diameter (refer to Table 13.23) (Nedwell *et al.,* 2007a) and cover a bandwidth from 20 Hz to 20 kHz with a major amplitude of 100 – 500 Hz (OSPAR, 2009).

Wind farm	Pile diameter (m)	Source level (dB re 1 µPa@1 m)	N	dB/m	Approximate depth at wind farm
North Hoyle	4.0	249	17	0.0011	10 – 15
Scroby Sands	4.2	257	20	0.0030	3 – 30
Kentish Flats	4.3	243	20	0.0020	5 – 8
Barrow	4.7	252	18	0.0003	10 – 20
Burbo Bank	4.7	249	21	0.0047	15
Source: Nedwell *et al.* (2007a)					

Table 13.23: Source level noises from pile driving activities at offshore wind farms

124 Noise from piling can be detected above ambient noise levels up to 25 km from source and for larger diameter turbines up to 100 km from source (Nedwell *et al*., 2007a).

13.9.1.2 Operational Noise

125 Sound arising from operating wind farms is relatively low in both frequency and level. Studies undertaken at four operating offshore wind farms recorded sound levels of between 114 and 130 dB re 1 µPa inside the wind farms with occasionally higher figures recorded outside the wind farm areas (e.g., 132 dB re 1 µPa at Scroby Sands) (Nedwell *et al*., 2007a). Measurements undertaken at a number of operating wind farms in the UK are presented in Table 13.24. Sound levels range from between 113 and 132 dB re 1µPa (Nedwell *et al*., 2007a). Elsewhere, measurements undertaken in Sweden reported 1/3 octave sound pressure levels of between < 90 and 115 dB $_{LEQ}$ re 1 µPa @ 1 m from operating offshore turbines with most energy at 50, 160 and 200 Hz (Thomsen *et al*., 2006). Sound levels from operating wind farms do not always correlate with the size of the turbines but the levels may increase with the number of operating turbines (SMRU, 2012).

Wind farm	Noise level (unweighted dB re 1µPa)	
	Inside wind farm	Outside wind farm
Scroby Sands	130	132
Kentish Flats	114	113
Barrow	120	122
North Hoyle	128	120

Table 13.24: Operating noise recorded at offshore wind farms (Source: Nedwell *et al*., 2007a)

126 Measurements from operating wind farms have reported levels of sound of 125 dB re 1µPa at around 180 Hz and between 100 and 110 dB at frequencies up to 1 kHz for mid to high frequency pinnipeds at a range of 83 m. Temporary Threshold Shift (TTS) may potentially occur within about 5 m of the turbine (SMRU, 2012). Predicted zones of audibility for odontocetes are predicted to be very localised and less than 1 km or even less than 100 m due to low source levels and restricted range of frequencies (Thomsen *et al.,* 2006; SMRU, 2012). For species with better low frequency hearing, i.e., seals and baleen whales then they may be able to detect operating wind turbines between 60 m and 6.4 km (SMRU, 2012).

13.9.1.3 Decommissioning Noise

127 Details on how the proposed development will be decommissioned are not currently known but will be set out in detail in the project Decommissioning Plan which will be prepared prior to the commencement of construction (see Chapter 25: Summary of Mitigation). There will be noise arising from cutting activities and removal of structures but the noise levels from these sources are likely to be less than those arising from activities during construction.

13.9.1.4 Drilling Noise

128 Drilling may be required if the turbines are installed under the 'drive-drill' scenario (refer to Chapter 5: Project Description for additional information on the construction strategy and options). The drill vessel used to undertake the drilling will be either a jack-up drilling rig or a drill vessel using dynamic positioning thrusters.

129 Noise from drilling operations will result from machinery noise and the vibration of the drilling bit against the seabed. There may also be noise arising from the use of thrusters (refer to Section 13.9.1.5: Shipping Noise – below). Turbines installed using the drive-drill-drive option will initially be piled into the seabed, followed by a period of drilling which is estimated to last for approximately 26.5 hrs, including preparation time, and then completion with a second period of piling (refer to Chapter 5: Project Description for additional information).

130 Noise source levels from drilling have been reported as being below 145 dB re 1µ @ 1m with the majority of sound levels recorded as being between 119-127 dB re 1 µPa @ 1m. Main frequencies arising from drilling activities are generally low at below 100 Hz and with strongest signals at around 2 to 5 Hz (Nedwell and Howell, 2004; Senior *et al*., 2008; OSPAR, 2009; Genesis, 2011). Recorded received levels of noise arising from jack-up drilling rigs operating in the North Sea have been reported as dominant between 2 Hz and 1.4 kHz with rapid decrease at higher frequencies. Noise levels vary but are predominantly at around 120 dB re 1µ ±1 dB (Todd *et al*., 2007). Drilling operations during the installation of turbines at North Hoyle reported significant tonal components up to 375 Hz. There were sound levels of 5 to 15 dB above background levels at 160 m from the drilling activities which were predicted to remain above background levels out to 7 km from the drilling (Lucke *et al*., 2007).

131 The strongest signals from drill ships occur at higher frequencies than those from jack-up ships, at around 600 Hz (Genesis, 2011; Nedwell and Edwards, 2004). Levels of noise are reported as being higher, 190 dB re 1 µPa rms @ 1 m, due to the use of thrusters to maintain position (OSPAR, 2009).

132 All levels of noise arising from any drilling activities will be substantially lower than those arising from pile driving operations.

13.9.1.5 Shipping Noise

133 Shipping noise is continuous and varies depending on the type of vessel being used. Larger vessels tend to produce lower frequency noise compared to smaller vessels (OSPAR, 2009). However, the level of noise will vary depending on the vessel's activity, with vessels equipped with dynamic positioning systems producing the greatest sound levels (OSPAR, 2009).

134 Supply and maintenance vessels produce sound source levels of between 130 and 160 dB re 1 µPa, with frequencies of between 20 Hz and 10 kHz. Most of the acoustic energy from vessels is below 1 kHz, typically within the 50-300 Hz (Genesis, 2011). Consequently, vessels have greater potential to impact seals and baleen whales that are more sensitive to low frequency sounds (Okeanos, 2008). Thruster noise from DP vessels has been recorded to increase sound levels in the spectrum from 3 Hz to 30 Hz (Nedwell and Edwards, 2004).

13.9.2 Potential Effects of Sound on Marine Mammals

135 There is a substantial volume of literature describing the potential effects of sound on marine mammals and this is summarised in e.g., Thomsen *et al.* (2006), Southall *et al.* (2007), OSPAR (2009).

136 It is recognised that there are four main types of potential effect:

- Fatal effects caused by significant levels of noise in close proximity to the receptor;
- Hearing impairment, which might either be permanent, (and referred to as a Permanent Threshold Shift (PTS)) or temporary, (Temporary Threshold Shift (TTS)). These can impact on the ability of the marine mammal to communicate, forage or avoid predators;
- Behavioural effects such as avoidance, displacement from suitable feeding or breeding areas, changes in travelling routes; and
- Secondary impacts caused by the direct effects of noise on potential prey causing an overall loss of available prey.

137 The principal sources of sound which are of potential concern will arise during the construction phase of the proposed development. These sources will occur particularly during piling operations, where noise levels in excess of 200 dB re 1 μPa@1 m may be generated with frequencies below 1 kHz (Nedwell *et al.,* 2007a).

138 The range at which marine mammals may be able to detect sound arising from offshore activities depends on the hearing ability of the species and the frequency of the sound. Pinnipeds (seals) are likely to be more sensitive to sounds below 1 kHz than harbour porpoises, which are in turn, more sensitive than bottlenose dolphin or baleen whales to low frequency sound. Other factors which may affect the potential impact sound may have on marine mammals includes ambient background noise, the effect of which can vary depending on water depth, seabed topography and sediment type. Natural conditions such as weather and sea state and other existing sources of human produced sound, such as shipping, can reduce the auditory range.

13.9.2.1 Fatal Effects

139 If source peak pressure levels from the piling operations are high enough, there is the potential to cause a lethal effect on marine mammals. Studies suggest that potentially lethal effects can occur to marine mammals (seals and otters) when the peak pressure level is greater than 246 or 252 dB re. 1 μPa (Parvin *et al.*, 2007).

140 Damage to soft organs and tissues can occur when the peak pressure level is greater than 220 dB re. 1 μPa (Parvin *et al*., 2007).

13.9.2.2 Hearing Damage

141 Underwater sound has the potential to cause hearing damage in marine mammals. This can be either be a PTS, in which case there is no recovery in hearing over time or TTS, when the hearing will return to its former capability often within hours or a few days (Southall *et al.,* 2007). The potential for either of these conditions to occur is dependent on the hearing bandwidth of the animal, duty cycle and duration of the exposure (Southall *et al*., 2007, OSPAR, 2009).

142 Sound exposure levels (SEL) is a measure of the energy of sound that can be useful when assessing potential physiological impacts, in particular from activities that may cause a period of prolonged noise exposure and cumulatively with other sound sources, e.g., ongoing piling activities. Sound exposure levels (SEL) with the potential to cause PTS or TTS for cetaceans and pinnipeds based on the Southall *et al.* (2007) criteria are presented in Table 13.25.

143 A recent review of the potential SEL for pinnipeds has suggested that the use of 186 dB re 1 μPa^{2}s SEL M-weighted limit is not supported by the available data and that the use of a 198 dB re 1 μPa^{2}s SEL M-weighted limit may be more appropriate (Thompson and Hastie, 2011). This SEL has been reportedly ageed with Statutory Authorities (Beatrice Offshore Wind Farm Limited (BOWL), 2012).

144 Studies undertaken on bottlenose dolphins suggest that TTS can occur from mid-frequency sounds of 224 dB re. 1 μPa and last for up to 40 minutes (Finneran *et al*., 2002) and between 193 to 201 dB re. 1 μPa (Parvin *et al*., 2007). For harbour porpoise, TTS has been reported to occur at received sound levels of 199.7 dB re. 1 μPa (Lucke *et al.,* 2009).

Exposure levels	Cetaceans and pinnipeds
230 dB re 1 μPa (peak)	PTS Auditory injury onset (cetaceans)
224 dB re 1 μPa (Peak)	TTS onset (cetaceans)
218 dB re 1 μPa (Peak)	PTS Auditory injury onset (pinnipeds)
212 dB re 1 μPa (Peak)	TTS onset (pinnipeds)
198 dB re 1 μPa^{2}s SEL M-weighted	PTS Auditory injury onset (cetaceans)
186 dB re 1 μPa^{2}s SEL M-weighted	PTS Auditory injury onset (pinnipeds)
183 dB re 1 μPa^{2}s SEL M-weighted	TTS onset (cetaceans)
171 dB re 1 μPa^{2}s SEL M-weighted	TTS onset (pinnipeds)

Table 13.25: Sound exposure levels for cetaceans and pinnipeds (Source: Southall *et al*., 2007)

145 The potential TTS is predicted to occur for a relatively short duration, presuming the sound levels causing the hearing damage remain the same. However, prolonged levels of sound that cause TTS may, over time, cause PTS. It is predicted that the marine mammals will move away due to hearing discomfort or an inability to communicate or feed effectively. Should this occur, the sound levels received are reduced, but there is a displacement effect which may be high and may be total, resulting in no mammals in the area in a worst case scenario.

13.9.2.3 Behavioural Change

146 Potential changes in behaviour may occur depending on the sound source levels and the species' and individuals' sensitivities. Behavioural changes can vary and, for example, be changes in swimming direction, diving duration, avoidance of an area and reduced communication.

147 Masking effects may also cause changes in behaviour as the level of sound may impair the detection of echolocation clicks and other sounds that species use to communicate or detect prey which may cause them to alter their behaviour.

148 Changes in behaviour arising from noise impacts may be easily detectable, such as a significant displacement from an area. Studies undertaken in Denmark during piling operations indicated that harbour porpoise might be displaced at distances of 20 km or further during piling operations involving monopiles (Tougaard *et al*., 2003). Other studies undertaken in the Moray Firth during the construction of the Beatrice demonstrator project wind turbines also recorded a decrease in porpoise activity during the piling activities but not at sites 40 km away. However, the Beatrice demonstrator project wind turbines were jacket type turbines and consequently the diameter of the piles, at 1.8m, was smaller than a single monopile (ICES, 2010). Other changes in behaviour, e.g. stress, may be more difficult to detect and go unnoticed (OSPAR, 2009). Behavioural effects have been observed using play-back experiments based on sound arising from operating wind farms on harbour porpoise and harbour seals. The results from these experiments indicated that there may be some avoidance behaviour due to operating wind turbines (Koschinski *et al.,* 2003).

13.9.2.4 Secondary Effects

149 There is the potential for impacts on prey species to affect marine mammals, in particular possible impacts from noise on fish species.

150 The main prey items for the majority of the marine mammals recorded within the study area are fish, although some non-fish prey items such as cephalopods will also be taken by the marine mammals. The main prey items recorded for marine mammals in the region are presented in Table 13.26.

Species	Main prey
Harbour porpoise	Sandeel, whiting
White-beaked dolphin	Haddock, whiting, cod
Bottlenose dolphin	Cod, saithe, whiting and also salmon and haddock
Minke whale	Herring, sandeel, cod, haddock and saithe
Grey seal	Sandeel, cod and haddock
Harbour seal	Sandeel, whiting, flounder and cod

Table 13.26: Main prey items for marine mammals recorded within the study area

151 Sandeels are one of the main prey items for many of the marine mammals recorded in the area. They are also an important prey species for predatory fish such as whiting, cod and haddock, all of which are also prey to marine mammals (Greenstreet *et al*., 2006).

152 Sandeels are not considered to be hearing specialists and there are no data on the impacts piling activity may have on sandeels during the construction phase. Studies undertaken using airguns indicate that sandeels have shown distinct but weak reactions to seismic airguns with initial startle responses reducing in frequency with ongoing noise, and no increase in mortality (Hassel *et al.,* 2004). Noise modelling undertaken using the similar sandlance species indicates that at 90 dBht (species-specific hearing) thresholds, there is a potential effect extending 147 m from the sound source and at 75 dBht the effect extends to 1.3 km from the piling activities. Although the impacts on sandeels are unknown, it is predicted that there is likely to be either an avoidance effect

within these areas or behavioural impacts, such as sandeels remaining in sediments. However, the seabed sediments within the proposed offshore site are not suitable for sandeels and therefore it is predicted that sandeels will not be present in the area during construction activities.

153 Fish belonging to the family Gadidae, e.g., whiting, saithe, cod and haddock are thought to be moderately sensitive to noise (Nedwell *et al.,* 2007. There have been no studies during piling activities on the impact construction noise may have on these species. Studies undertaken during seismic surveys indicate that saithe may leave the area but may return shortly afterwards (Løkkeborg *et al.,* 2010). Predicted levels of behavioural impact from existing offshore wind farms for cod have ranged from 1.6 km and 20 km (Nedwell *et al*., 2007a).

154 Construction surveys from existing wind farms have indicated that fish numbers present within operating wind farms are at least similar to those prior to construction and may be higher (e.g. Jensen *et al.,* 2006; Leonhard and Pederson, 2006; Lindeboom *et al.,* 2011, Leonhard *et al*., 2011). Consequently no long-term impacts on fish on which marine mammals prey are predicted following cessation of construction activities.

13.9.3 Duration of Potential Impacts

13.9.3.1 Construction

155 Studies undertaken using T-pods to detect harbour porpoises during the construction of Horns Rev I and Horns Rev II offshore wind farms reported significant decreases in the number of acoustic detections recorded during pile driving activities. The decrease in the number of detections lasted for up to six hours at Horns Reef I and 48 hrs at Horns Reef II (Brandt *et al*., 2009, Tougaard *et al.,* 2006). Further studies undertaken at the Alpha Ventus test station indicated that there was a decrease of harbour porpoise up to 20 km from the wind farm for up to one to two days (Lucke, 2010).

156 There is limited information on the impacts from pile driving on seals. Studies undertaken during vibro-piling at Nysted in Denmark recorded a decrease of between 20% and 60% in the number of seals at haul-out sites during days when construction activities were undertaken (Carstensen *et al*., 2006). Elsewhere, studies undertaken at the Dutch Egmond aan Zee offshore wind farm used data loggers to track the location of seals during pile driving construction activities and found that seals were not present within 40 km of the wind farm location during the construction period (ICES, 2010).

13.9.3.2 Operation

157 During the lifetime of the project, which is expected to be 25 years, there will be some noise arising from the turbines. Any impacts are likely to last for the duration of the project unless there is a degree of acclimatisation and therefore any initial impacts are likely to decline over time.

13.9.3.3 Decommissioning

158 There are no details as to the method of removal of the turbines at the time of decommissioning. Removal techniques are likely to include the use of cutting tools and heavy lift vessels. The duration of potential impacts are likely to be for the duration of the decommissioning programme. The nature and magnitude of impacts will be similar to vessel impacts arising during construction.

13.9.4 EMF Impact Assessment

159 There is circumstantial evidence to suggest that marine mammals may be able to detect electromagnetic fields from subsea cables. There are two elements of an electromagnetic field: the E 'electric' field which remains within the cable and B 'magnetic' field which can be detected beyond the cable (Gill *et al.,* 2009).

160 Eight regularly occurring marine mammals in the UK have been reported as being able to detect B 'magnetic' field emissions including harbour porpoise and bottlenose dolphin (Scottish Executive, 2007). However, no studies have detected any impact on marine mammals (Scottish Executive, 2007).

161 The strength of the magnetic field varies but is generally very localised in nature and returns to below background levels within 20 m of the cable if the cable is buried to 1 m, which removes much of the stronger magnetic fields (Gill *et al.,* 2009; Scottish Executive, 2007). Further, the rate of change in polarity of the electromagnetic field emitted by a cable is reported to be too rapid to be detected by a marine mammal (Normandeau *et al.,* 2011).

162 Studies undertaken on bottlenose dolphin predict that they are unlikely to be able to detect the electromagnetic fields emitted from a buried AC cable greater than 2 m away. Any effect will therefore be localised (Normandeau *et al.,* 2011). The localised effect of magnetic fields means that in order for a marine mammal to detect it, if at all, it will need to be within very close proximity to the cable. The impact, if any, will be negligible as the marine mammal may swim away from the cable without any effects.

163 Overall the potential impacts on marine mammals from EMF are predicted to be ***not significant*** (refer to Table 13.27).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Inter-array and export cables	Electromagnetic fields	All marine mammal species	Negligible	Negligible	Not significant	The predicted range of detectable magnetic fields will be very localised and cetaceans, if they can detect them, will be able to swim away without any effects.

Table 13.27: Significance of potential impacts on cetaceans from electromagnetic fields

13.9.5 Noise Modelling

164 Noise modelling has been undertaken to assist in the assessment of potential impacts piling operations at three proposed offshore wind farms (Neart Na Gaoithe, Inch Cape and Firth of Forth Round 3 Zone 2) in the Firth of Forth and Firth of Tay area.

165 The Impulse Noise Sound Propagation and Impact Range Estimator (INSPIRE) model has been used to calculate both species-specific hearing thresholds, dBht and SEL. INSPIRE has been developed specifically to model the propagation of impulsive broadband underwater noise in shallow waters. It uses a combined geometric and energy flow/hysteresis loss model to conservatively predict propagation in relatively shallow coastal water environments, and has been tested against measurements from a large number of other offshore wind farm piling operations. The model imports electronic bathymetry data as a primary input to allow it to calculate the transmission losses along transects extending from the pile location. Other physical data are also supplied as input to the model and outputs include the peak pressure, impulse, dBht and SEL (see Appendix 13.1: Noise Model Technical Report).

166 As well as calculating the SEL variation with range, the model incorporates a "fleeing animal receptor" extension, which enables the amount of noise an animal receives as it is moves away from a piling operation to be calculated. This feature enables the calculation of the nearest distance from a pile from which an animal must start fleeing.

13.9.5.1 Noise Modelling – Species Selection

167 The selection of species for which noise modelling has been undertaken is based on their known abundance in the Firth of Forth and Firth of Tay area and the predicted sensitivity of each species to noise based on current literature.

168 Noise modelling has been undertaken for the following marine mammals:

- Harbour porpoise;
- Bottlenose dolphin;
- Minke whale; and
- Harbour seal and grey seal).

169 Noise modelling was also undertaken for sandeel (or sand lance), which is the main marine mammal prey species.

170 The noise modelling uses species-specific hearing thresholds (dBht), which take into account sound being perceived differently by different species. As sound sources may contain frequencies that are beyond the hearing range of individual species, the perceived noise levels are often lower than unweighted levels.

171 In order to undertake noise modelling based on the hearing threshold of the selected species, an understanding of hearing capabilities of the selected species is required. This is obtained from audiograms, for which there are some for harbour porpoise, bottlenose dolphin and seals. However, there are no audiograms available for minke whale and so humpback whale audiograms have been used as they are similar low-frequency specialists.

13.9.5.2 Noise Modelling – Installation Scenarios

172 Methods used to install offshore turbines are, in part, dependent on the physical environment such as water depth and the type of seabed at the location the turbines are to be installed. The choice of method can only be made with detailed site-specific knowledge of the seabed conditions present.

173 Based on detailed engineering studies undertaken at Neart na Gaoithe two possible installation scenarios are considered as possible:

a. **'Drive-drill-drive':** This scenario will occur in areas at Neart na Gaoithe where there is an underlying layer of bedrock, which covers the majority of the proposed offshore site. Following the initial piling into the seabed for a period of up to 120 minutes, drilling will take place for up to 12.5 hrs, followed by a final 90 minute period of piling. Three or four piles might be required for each turbine with each pile being 2.5 m in diameter, with maximum hammer energy of 1,200 kj. All turbines could potentially be installed based on the 'drive-drill-drive' scenario (refer to Table 13.28 to Table 13.32) and it is the most likely installation scenario for the majority of turbines.

b. **'Drive only':** This scenario may occur in areas of the Neart na Gaoithe offshore site where there is no bedrock and therefore no drilling is required. Drilling into areas without bedrock may cause liquefaction of the seabed and cause the underlying seabed to become unstable and unsuitable for the installation of turbines. Piling turbines into areas without bedrock is considered to be the only practical option. In the event of turbines being installed under the 'drive only' scenario the piles will be 3.5 m in diameter with maximum hammer energy of 1,635 kj. A period of soft start up to 114 minutes may be undertaken (refer to Table 13.27). The 'drive only' scenario is the least likely option with a predicted 16 piles installed using piling only.

Profile	Drive-drill-drive	Drive only
Soil conditions	Bedrock	Channel (no bedrock)
Hammer	IHC 1200	IHC 1800
Pile diameter (mm)	2,500	3,500
Maximum number of piles	500 (125 x 3.6 MW x 4 piles)	16 (4 x 3.6 MW x 4 piles)
Wall thickness (mm)	100	100
Target penetration (m)	27.5	38.5
Maximum hammer energy (kj)	1,200	1,635
Soft start duration (mins)	20	114
Energy (kj)	240	318
Pile drive duration (mins)	180	85
Energy (kj)	995	925
Pile drive duration (mins)	-	17
Energy (kj)	-	1,383
Total drive duration (mins)	200	216
Drilling time (mins)	19.5 (hrs)	no drilling
Strike rate – soft start (bc/s)	0.5	0.5
Strike rate (bc/s)	0.5	0.5

Table 13.28: 'Drive-drill-drive' and 'drive only' jacket foundation installation scenarios at Neart na Gaoithe

13.9.5.3 Noise Modelling – Hearing Thresholds (dBht)

174 In order to assess potential behavioural responses to sound, the assessment uses species-specific hearing thresholds (dBht) as to indicate possible behavioural responses.

175 For each of the two installation scenarios, three hearing thresholds have been modelled: 75 dBht and 90 dBht and 130 dBht. It is recognised that predicting how individuals respond to sound is problematic and behaviour is highly variable and dependent on various factors, including the sensitivity of each individual affected or the attractiveness of the area to an individual. A good foraging area may cause the animal to be more tolerant of the noise and enter or remain in the area, compared to a site with relatively poor foraging potential when the animal may be more likely to avoid the area.

176 The following responses are predicted from the thresholds modelled based on published literature (e.g. Nedwell *et al.,* 2005; Nedwell *et al.,* 2007b):

- At 75 dBht sound may be heard by the marine mammal and might cause some behavioural responses such as some avoidance behaviour;
- At 90 dBht significant avoidance behaviour is predicted; and
- At 130 dBht there is the potential for TTS and the onset of traumatic hearing damage (PTS) to occur.

177 The results from the behavioural modelling are presented in the species impact assessment Section 13.10.

13.9.5.4 Noise Modelling – Sound Exposure Levels

178 By applying a M-weighting filter a weighting can be applied specific to differing marine mammal hearing sensitivities based on 'low', 'medium' or 'high' categories and 'pinnipeds' (refer to Table 13.29) (Southall *et al*., 2007). The SEL modelling also considers potential avoidance reaction of the receptor and assumes that the marine mammal will move away from the sound.

Hearing type	Single pulse	Multiple pulse	Species
Mlf – Low frequency cetaceans			
Sound Pressure Level	230 dB re 1 µPa (peak)	230 dB re 1 µPa (peak)	Minke whale
Sound Exposure Level	198 dB re 1 $\mu Pa^2/s$ (M_{lf})	198 dB re 1 $\mu Pa^2/s$ (M_{lf})	
Mmf – Mid frequency cetaceans			
Sound Pressure Level	230 dB re 1 µPa (peak)	230 dB re 1 µPa (peak)	Dolphins
Sound Exposure Level	198 dB re 1 $\mu Pa^2/s$ (M_{hf})	198 dB re 1 $\mu Pa^2/s$ (M_{hf})	
Mhf – High frequency cetaceans			
Sound Pressure Level	230 dB re 1 µPa (peak)	230 dB re 1 µPa (peak)	Harbour porpoise
Sound Exposure Level	198 dB re 1 $\mu Pa^2/s$ (M_{hf})	198 dB re 1 $\mu Pa^2/s$ (M_{hf})	
Mpf – Pinnipeds			
Sound Pressure Level	218 dB re 1 µPa (peak)	218 dB re 1 µPa (peak)	Seals
Sound Exposure Level	186 dB re 1 $\mu Pa^2/s$ (M_{pw}) 198 dB re 1 $\mu Pa^2/s$ (M_{hf})	186 dB re 1 $\mu Pa^2/s$ (M_{pw}) 198 dB re 1 $\mu Pa^2/s$ (M_{hf})	
Sound pressure level is the logarithmic expression of the sound pressure (sound level) in decibels			

Table 13.29: Auditory exposure criteria for marine mammals (Source: Southall *et al*., 2007)

179 In order to determine potential effects on marine mammals over time, SEL modelling has been undertaken for the Neart na Gaoithe project, both on its own and cumulatively with Inch Cape and Firth of Forth Round 3, Zone 2 offshore wind farms.

180 The results from the SEL modelling indicate that the distance that PTS may occur for all cetaceans was very localised and in all cases within 100 m of the sound source For pinnipeds, based on weighted exposure levels of 186 dB re 1 $\mu Pa^2/s$ (M_{pw}) a potential impact up to 8.2 km away may occur from the pile driving activities. At 198 dB re 1 $\mu Pa^2/s$ (M_{pw}) the potential distance an impact capable of causing PTS was reduced to 100 m (Figure 13.30).

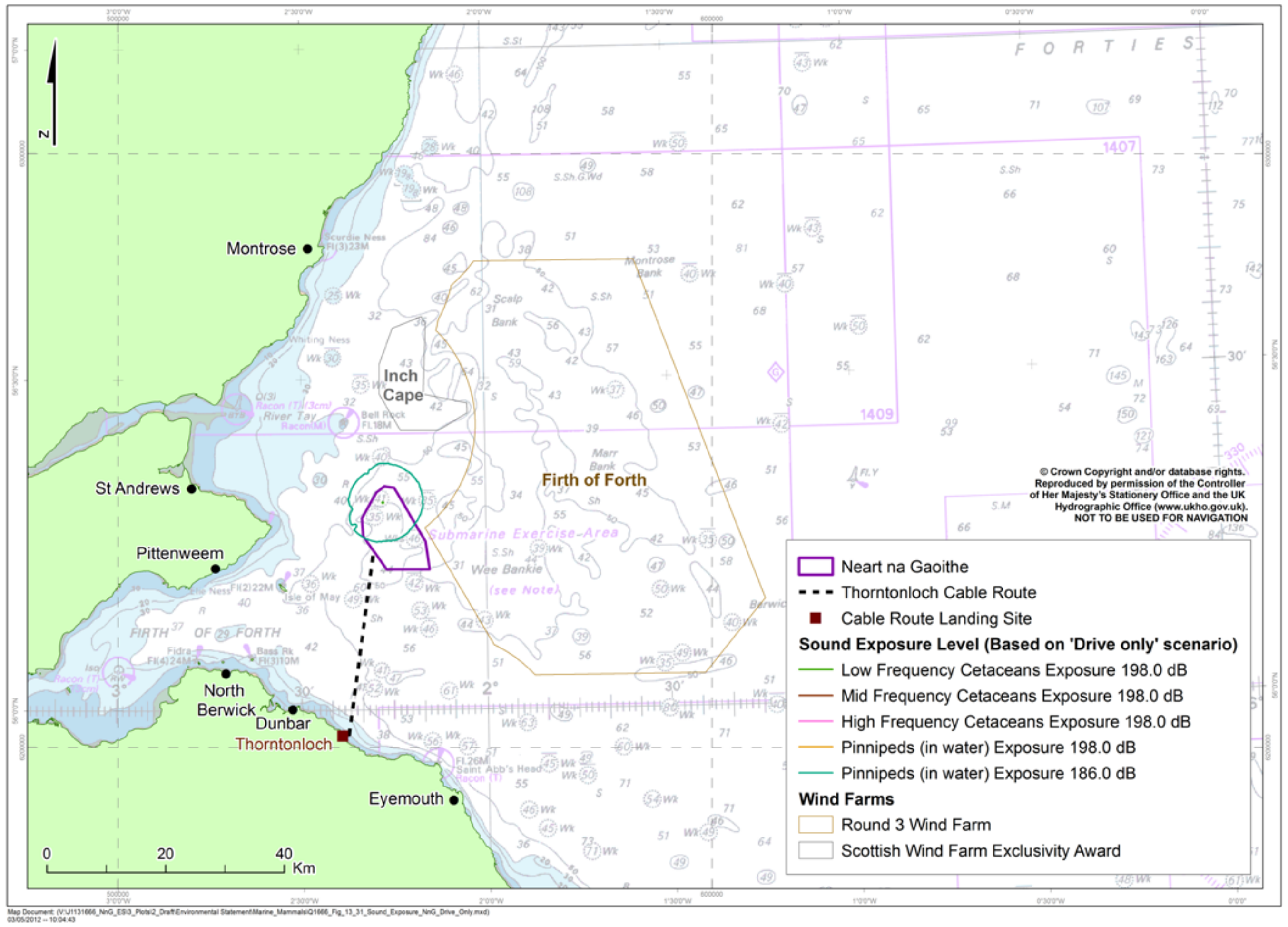


Figure 13.30: SEL contours based on 'drive only' scenario

13.9.5.5 SAFESIMM Modelling

181 The third modelling approach undertaken to determine PTS, TTS and behavioural responses uses SAFESIMM (Statistical Algorithms For Estimating the Sonar Influence on Marine Megafauna) algorithm developed by SMRU Ltd (Sparling *et al*., 2012). SAFESIMM provides estimates of the number of animals of each species of marine mammal that may experience PTS and TTS from a particular sound field using species-specific response curves and estimates of the expected densities of marine mammal species at each location. The model does not presume that all individuals within a certain area of potential impact will be affected to the same extent. SAFESIMM modelling has been undertaken for Neart na Gaoithe both alone and in-combination with Inch Cape and Firth of Forth offshore wind farms for harbour porpoise, bottlenose dolphin, grey seal and harbour seal (Appendix 13.2: SMRU Ltd Report –SAFESIMM Report).

13.9.5.6 Cumulative Noise Modelling

182 Outputs from dBht modelling are not suitable for assessing cumulative impacts as dBht is based on an instantaneous impact and cannot be used for assessing impacts from multiple locations. The use of M-weighted SEL is suitable for multiple sound sources and consequently this approach to cumulative noise modelling has been followed to assess the potential cumulative impacts (refer to Figure 13.31 and Table 13.30).

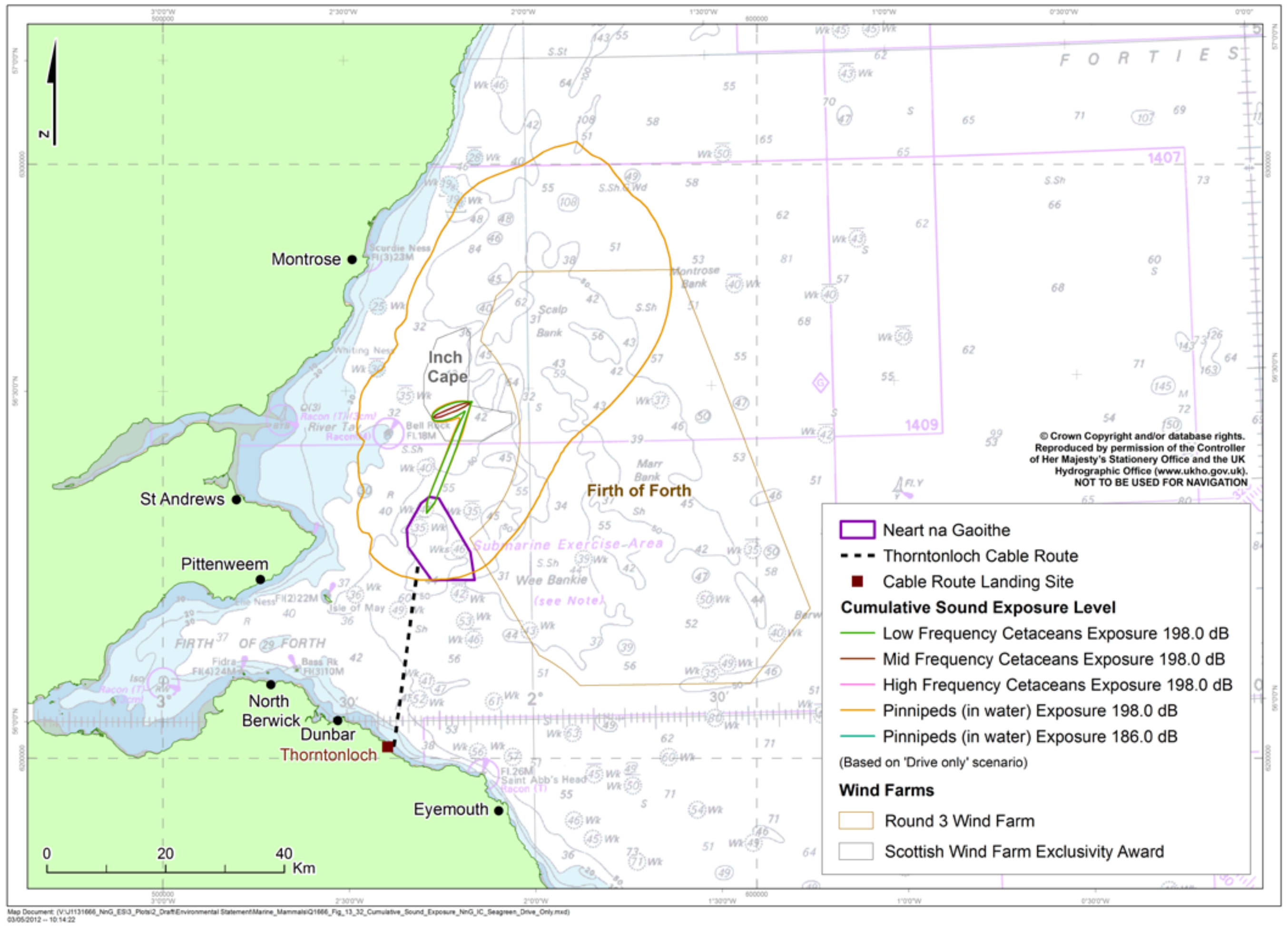


Figure 13.31: Cumulative SEL contours based on 'drive only' scenario

Hearing Type	re 1 µPa^2/s	Area of Impact (km^2)	Maximum Radius (km)
High frequency cetaceans	198.0	3.4	2.2
Low frequency cetaceans	198.0	32.2	8.4
Mid frequency cetaceans	198.0	3.9	2.2
Pinnipeds (in water)	186.0	2,462.5	31.6
	198.0	37.9	8.0

Table 13.30: Potential area of cumulative impact at which PTS may occur basedon M-weighted SEL modelling

Species	Construction Option	Impact	Dbht		SEL		SAFESIMM
			Area (km^2)	No. Impacted	Area (km^2)	No. Impacted	No. Impacted
Harbour porpoise High-frequency	'Drive-drill-drive'	PTS	1.0	<1	<0.1	<1	6
		Total displacement/TTS	1,013.8	385	-	-	53
		50% Partial displacement/Behaviour	4,329.2	822	-	-	1,309
	'Drive only'	PTS	1.2	<1	-	<1	5
		Total displacement/TTS	1,212.2	460	-	-	47
		50% Partial displacement/Behaviour	4,668.6	887	<0.1	-	923
White-beaked dolphin Mid-frequency	'Drive-drill-drive'	PTS	0.3	<1	<0.1	<1	-
		Total displacement/TTS	451.9	22	<0.1	-	-
		50% Partial displacement/Behaviour	2,567.8	64	<0.1	-	-
	'Drive only'	PTS	0.4	<1	<0.1	<1	-
		Total displacement/TTS	555.5	28	-	-	-
		50% Partial displacement/Behaviour	2,898.5	72	-	-	-
Bottlenose dolphin Mid-frequency	'Drive-drill-drive'	PTS	0.3	-	<0.1	<1	0
		Total displacement/TTS	451.9	-	-	-	6
		50% Partial displacement/Behaviour	2,567.8	-	-	-	124
	'Drive only'	PTS	0.4	-	<0.1	<1	0
		Total displacement/TTS	555.5	-	-	-	1
		50% Partial displacement/Behaviour	2,898.5	-	-	-	116
Minke whale Low-frequency	'Drive-drill-drive'	PTS	1.4	<1	<0.1	<1	-
		Total displacement/TTS	3,346	77	-	-	-
		50% Partial displacement/Behaviour	6,645	76	-	-	-
	'Drive only'	PTS	1.6	<1	<0.1	<1	-
		Total displacement/TTS	3,852	88	-	<1	-
		50% Partial displacement/Behaviour	7,400	85	-	<1	-
Grey seal Pinniped-frequency	'Drive-drill-drive'	PTS	0.1	<1	196.8	27	453
		Total displacement/TTS	689.6	96	-	-	1,833
		50% Partial displacement/Behaviour	3,550	248	-	-	5,483
	'Drive only'	PTS	0.1	<1	128.1	18	235
		Total displacement/TTS	813.8	113	-	-	1,263
		50% Partial displacement/Behaviour	4,133	289	-	-	4,404
Harbour seal Pinniped-frequency	'Drive-drill-drive'	PTS	0.1	-	196.8	-	41
		Total displacement/TTS	689.6	-	-	-	152
		50% Partial displacement/Behaviour	3,550	-	-	-	314
	'Drive only'	PTS	0.1	-	128.1	-	18
		Total displacement/TTS	813.8	-	-	-	95
		50% Partial displacement/Behaviour	4,133	-	-	-	283

Table 13.31: Outputs from noise modelling undertaken for Neart na Gaoithe

Species	SEL		SAFESIMM		
	Auditory injury		PTS	TTS	Partial displacement/ behaviour
	Area (km^2)	No. Impacted	No. Impacted	No. Impacted	No. Impacted
Harbour porpoise	3.5	1	21	157	1,745
White-beaked dolphin	3.9	<1	-	-	-
Bottlenose dolphin	3.9	<1	0	6	124
Minke whale	32.2	<1	-	-	-
Grey seal	2,462.6	344	722	2,579	6,163
Harbour seal	-	-	72	206	305

Table 13.32: Cumulative impact outputs from noise modelling undertaken for Neart na Gaoithe based on 'drill-drive-drill' scenario

13.10 Impact Assessment

183 This section is structured on an activity based approach and where appropriate, species based. It assesses the potential impacts from sound on marine mammals from construction, operation and decommissioning phases of the proposed project. The impacts are addressed individually and on a species by species basis, and cumulative and in-combination impacts are also described.

13.10.1 Introduction

184 The impact assessment has been undertaken using site-specific survey data collected over a period of two years, relevant reports commissioned specifically to inform the impact assessment, published literature and the project's 'drive-drill-drive' and 'drive only' scenarios (refer to Table 13.33 and Table 13.34) which are within the project's Rochdale envelope (as described in Chapter 5: Project Description).

185 Based on the findings from dedicated project specific boat-based surveys and existing data, a total of seven species of marine mammal are predicted to be at potential risk of impact from sound originating from the construction, operation and eventually the decommissioning of the proposed offshore wind farm.

- Harbour porpoise *P. phocoena*;
- White-beaked dolphin *Lagenhorynchus albirostris*;
- Bottlenose dolphin *Tursiops truncates*;
- Orca *O. orca*;
- Minke whale *B. acutorostrata*;
- Grey seal *H. grypus*; and
- Harbour seal *P. vitulina*.

186 The data from the site-specific surveys undertaken at Neart na Gaoithe identified harbour porpoise, minke whale, grey seal and harbour seal as being the most regularly occurring marine mammals in the area, albeit in relatively low numbers (refer to Table 13.11 and Table 13.12). However, it is recognised that there is potential for sound, particularly from pile driving, to propagate relatively large distances in the marine environment compared to other noise sources. Consequently, there is the potential for sound to travel across a wider area than that surveyed, impacting marine mammals that were only infrequently or not recorded during the surveys. In particular, this may include bottlenose dolphins, which are regularly observed in the coastal waters of the Firth of Tay and Firth of Forth but have not been recorded in the study area during the boat-based surveys or aerial surveys.

187 Potential impacts have been assessed for all species of marine mammal that have been recorded during site-specific surveys and bottlenose dolphin.

188 For the purposes of this assessment, the following potential impacts are predicted from the thresholds modelled based on published literature (e.g. Nedwell *et al.,* 2005; Nedwell *et al.,* 2007a, Thompson *et al.,* 2011b):

- Levels greater than 130 dBht are considered to cause a PTS;
- Levels at 90 dBht are considered to cause 100% displacement, meaning all individuals will remain outwith the 90 dBht zone of impact for the duration of the activities. There is potential for some TTS to occur within this area; and
- Levels at 75 dBht may cause some behavioural changes including up to an 50% displacement of all individuals within the zone of impact.

Activity	Action	Hours	Hours	Action
Preparation	Move jack-up on position	8	20	Pre-piling
	Lowering and levelling template on position	6		
Pile 1	Position first pile and install hammer	6		
	Hammer 1 pile 1	2	2	Virgin pile drive
	Remove hammer and install drill	4	26.5	Preparation and drilling
	Perform drilling operations	19.5		
	Trip out drill string	3		
	Hammer 2 pile 1	1.3	1.3	Drive after drill
	Remove hammer	3	9	Preparation
Pile 2	Position second pile and install hammer	6		
	Hammer 1 pile 2	2	2	Virgin pile drive
	Remove hammer and install drill	4	26.5	Preparation and drilling
	Perform drilling operations	19.5		
	Trip out drill string	3		
	Hammer 2 pile 2	1.3	1.3	Drive after drill
	Remove hammer	3	9	Preparation
Pile 3	Position third pile and install hammer	6		
	Hammer 1 pile 3	2	2	Virgin pile drive
	Remove hammer and install drill	4	26.5	Preparation and drilling
	Perform drilling operations	19.5		
	Trip out drill string	3		
	Hammer 2 pile 3	1.3	1.3	Drive after drill
	Remove hammer	3	9	Preparation
Pile 4	Position fourth pile and install hammer	6		
	Hammer 1 pile 4	2	2	Virgin pile drive
	Remove hammer and install drill	4	26.5	Preparation and drilling
	Perform drilling operations	19.5		
	Trip out drill string	3		
	Hammer 2 pile 4	1.3	1.3	Drive after drill
	Remove hammer	3	3	Preparation
Potential delay	Estimated weather delay	20	20	-
Total duration – 189.33 hrs **Total duration piling – 13.3 hrs** **Total duration preparation – 156 hrs**				

Table 13.33: 'Drive-drill-drive' scenario predicted piling duration for each jacket foundation with drilling requirements

	Action	Hours	Hours	Action
Preparation	Move jack-up on position	8	20	Preparation
	lowering and levelling template on position	6		
Pile 1	Position first pile and install hammer	6		
	Hammer 1 Pile 1	3.6	3.6	Virgin pile drive
	Remove hammer	3	9	Preparation
Pile 2	Position second pile and install hammer	6		
	Hammer 1 Pile 2	3.6	3.6	Virgin pile drive
	Remove hammer	3	9	Preparation
Pile 3	Position third pile and install hammer	6		
	Hammer 1 Pile 3	3.6	3.6	Virgin pile drive
	Remove hammer	3	9	Preparation
Pile 4	Position fourth pile and install hammer	6		
	Hammer 1 Pile 4	3.6	3.6	Virgin pile drive
	Remove hammer	3	3	Preparation
Total duration – 64.4 hrs **Total duration piling – 14.4 hrs** **Total duration preparation – 50 hrs**				

Table 13.34: 'Drive only' scenario predicted piling duration without drilling requirements

13.10.1.1 Selection Justification

189 There have been a number of different data sources, project specific studies and modelling exercises used in the assessment which have occasionally produced differing results. Where this has occurred, both sets of data have been presented. Below provides a brief justification on the relevant data used for each species.

Site Specific Data

190 Data on marine mammals present within the offshore site and wider area have been obtained from project specific boat-based surveys collected on a monthly basis over a period of 2 years, aerial survey data collected by The Crown Estate for 9 months and wider ESAS data collected over a period of at least 20 years. For all species, the boat-based survey data collected specifically to obtain marine mammal and bird observations have been used in preference to other sources of data. Project specific data obtained from boats are the most comprehensive set of data on marine mammals in the area and therefore the most appropriate set of data to use in the impact assessment.

Marine Mammal Densities

191 In order to obtain marine mammal densities a number of different sources of data have been used. Where sufficient observations have been obtained from boat-based survey data to calculate site-specific densities these have been used. For harbour porpoise and grey seal, densities have been calculated using g(0), allowing absolute densities to be calculated. The harbour porpoise densities have been supported through the use of acoustic detection equipment deployed during the second years of boat-based surveys.

192 For species for which there were not enough visual sightings, densities from SCANS II surveys from region 'V' have been used. This area is significantly larger than the offshore site and covers the waters from Eastern Scotland across to Norway. The densities are not therefore site-specific but are currently the best available. SCANS II densities have been used for white-beaked dolphin and minke whale.

193 Densities used for modelling using SAFESIMM have been obtained from SMRU and cover a wider area than those obtained within the study area. For bottlenose dolphin the densities calculated are 0.35 dolphins/km^2, which is higher than the zero density recorded within the study area.

Populations

194 In order to determine the potential significance of any impacts the size of the receptor, the population needs to be established. For the majority of species, the population against which the scale of any impact is assessed is the regional population obtained from SCANS II survey results and presented in the European protected species Guidance (JNCC, 2010a). The exception to this is bottlenose dolphin where there is recognised to be a largely isolated regional population with published papers providing the latest population estimates (Quick and Cheney, 2011; Thompson *et al.,* 2011a). Population levels for both common and grey seals are based on the regional populations calculated from the latest monitoring data and presented in an industry funded study undertaken by SMRU Ltd (Sparling *et al*., 2011).

Installation Scenarios

195 There are currently two installation scenarios proposed for Neart na Gaoithe ('drive-drill-drive' and 'drive only'), both of which provide differing impacts with respect to sound levels and differing levels of potential impact. The two installation techniques are required to account for the differing seabed conditions found across the offshore site. The majority of piles will be installed using the 'drive-drill-drive' option where there will be two periods of piling at the beginning and end of each installation with drilling undertaken for the majority of the installation time (refer to Table 13.33). The 'drive only' option has only a single piling activity with an overall longer duration than the 'drive-drill-drive' option but no gap between piling (refer to Table 13.34). Outputs from noise modelling undertaken for both scenarios are presented within the impact assessment and the worst (realistic) case and the most precautionary figures have been used in the assessment.

Noise Modelling Outputs

196 Three different noise modelling outputs have been calculated for Neart na Gaoithe. Using the INSPIRE software, noise outputs using the dBht approach have been provided for all species for which appropriate hearing audiograms are available. For minke whale, for which there is no audiogram, humpback whale has been used as a substitute and for white-beaked dolphin it has been assumed that its hearing capabilities are similar to those of bottlenose dolphin. Outputs from the dBht modelling have been used to assess potential behavioural impacts for Neart na Gaoithe on its own. It is not a suitable approach for undertaking cumulative assessments.

197 M-weighted SEL has been calculated using the INSPIRE model, the outputs from which have been used to determine potential auditory injury impacts for both Neart na Gaoithe alone and in-combination with other proposed offshore wind farm developments in the Firth of Forth and Firth of Tay area.

198 SAFESIMM modelling using site-specific data has been undertaken to determine potential auditory and behavioural impacts for harbour porpoise, bottlenose dolphin, grey and harbour seals. Results from both the INSPIRE and SAFESIMM modelling are presented. The results from the SAFESIMM modelling are thought to be more precautionary than those from the INSPIRE model. The SAFESIMM results do not assume the individual flees the sound source in the most direct route and allows for the individual not fleeing at all if the levels of sound are below the threshold at which flight may occur. Individuals may therefore be exposed to noise levels for a longer duration than would be the case if the individual takes the most direct route away from the sound source and consequently be at greater risk of PTS. For the purposes of this assessment the more precautionary results from SAFESIMM are used in the first instance to determine potential level of effect.

Thresholds

199 The outputs from the modelling are presented at a variety of sound levels, each of which are predicted to have a particular level of effect on the marine mammal.

200 Outputs from the INSPIRE dBht modelling are presented as contours at 130 dBht, 90 dBht and 75 dBht thresholds. For the purposes of this assessment it is predicted that individuals within the 130 dBht contour at the commencement of piling will suffer PTS, all those within the 90 dBht contour will show a strong avoidance response and be displaced for at least the duration of the piling activity and 50% of those within 75 dBht contour will either be displaced or have some negative behavioural response to the noise level. These figures are based on those presented in Thompson *et al.* (2011b) but it is also recognised that there is uncertainty about the responses predicted by the use of the figures which are considered to be precautionary (Thomsen *et al.,* 2006).

201 Predicted impacts from the M-weighted SEL modelling undertaken using the INSPIRE model are based on those presented in Southall *et al.* (2007) with a potential auditory injury occurring at 198 dB re 1µPa²s for cetaceans and 186 dB re 1µPa²s for pinnipeds. However, it is recognised that the use of 186 dB re 1µPa²s for pinnipeds is highly precautionary. It is probable the real sound level at which auditory injury may occur is higher than this and that 198 dB re 1µPa² is likely (Thompson and Hastie, 2011).

202 Results from the SAFESIMM modelling are based on M-weighted SEL outputs and the impacts for auditory injury or behavioural responses from Southall *et al*. (2007). Dose response curves that take into account the increase in the risk of an impact with increasing duration are also included in the modelling. The results from SAFESIMM modelling provide estimates of the number of individuals that may receive levels of noise that could cause PTS, TTS or behavioural responses.

13.10.2 Piling Noise Impact Assessment

203 Piling will occur during the construction phase. It will take place either as a single operation in the 'drive only' scenario during which piling will last for approximately 3.6 hrs or in two stages in the 'drive-drill-drive' scenario during which piling will last approximately 2.0 hrs and 1.3 hrs. The duration of the piling may vary depending on the duration of any soft start and the energy force used. The seabed conditions may also either lengthen or shorten the duration of any piling activity.

13.10.2.1 Harbour Porpoise

204 Harbour porpoise was the most frequently encountered marine mammal in the study area (the offshore site plus buffer area), with a total of 89 individuals recorded in Year 1 and 83 in Year 2. Peak numbers occurred in the early winter and spring periods, although there were some variations between the years. (refer to Figure 13.4).

205 Harbour porpoise has high frequency and broad bandwidth hearing capability, with its best hearing frequencies at 100 kHz or above and hearing ability between 16-140 kHz (refer to Table 13.35) (Thomsen *et al*., 2006). Hearing thresholds for harbour porpoise are presented in Figure 13.32.

Hearing threshold	Frequency
92 – 115 dB$_{rms}$ re 1 µPa	< 1 kHz
60 – 80 dB$_{rms}$ re 1 µPa	1 – 8 kHz
32 – 46 dB$_{rms}$ re 1 µPa	16 – 140 kHz

Table 13.35: Hearing ability of harbour porpoise (Source: Thomsen *et al*., 2006)

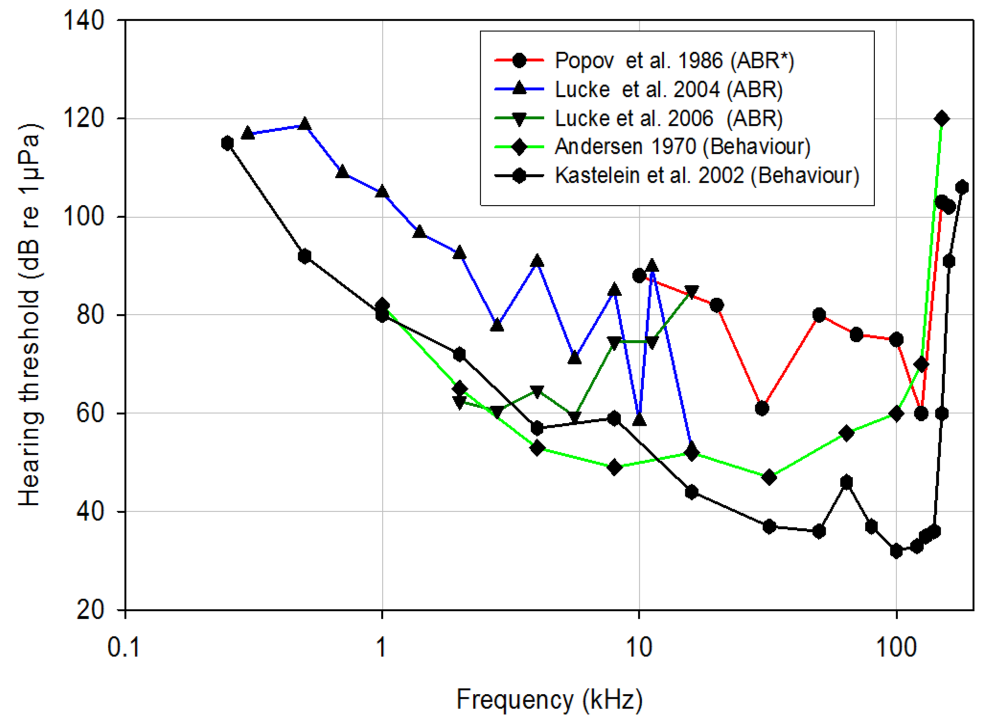


Figure 13.32: Hearing thresholds of harbour porpoise (Source: Thomsen *et al.*, 2006)

13.10.2.2 Harbour Porpoise – Pile Driving Impacts

206 For harbour porpoise the zone of audibility from pile driving activity has been calculated to be up to 80 km and temporary hearing loss may occur at 1.8 km (Thomsen *et al.,* 2006). Evidence of behavioural responses has been reported to occur between 7 km and 20 km from the piling activities (Thomsen *et al.,* 2006), with reduced vocalisation and lower densities occurring out to at least 15 km (Tougaard *et al*., 2006).

207 Results from the noise modelling are presented in Figure 13.33, Figure 13.34 and Table 13.37.

Permanent Threshold Shift

208 The results from the SEL noise modelling indicate that for PTS to occur the harbour porpoise will have to be within 100 m of the piling activities when operations start and that less than one harbour porpoise is at risk of a PTS from pile driving.

209 Results from SAFESIMM modelling indicate that up to six harbour porpoise may receive sound levels that could potentially cause PTS.

210 The relatively small area of potential impact within which a harbour porpoise may receive noise at levels that could cause a PTS indicates that it is unlikely that any will be present within this zone at the start of operations. To reduce the risk of a potential impact, industry best practice mitigation measures, agreed with and set out in detail in the Environmental Management Plan, will be in place prior to, and during, any piling activities. Mitigation measures may include the use of marine mammal observers or acoustic monitoring devices to detect marine mammals prior to the commencement of any piling activities or acoustic deterrent devices to deliberately disturb animals away from construction activities (refer to Section 13.11: Mitigation and Residual Impacts). Consequently, although the vulnerability of the receptor is potentially very high, the magnitude of effect is negligible and as a result, the overall significance level is assessed to be ***not significant*** (refer to Table 13.36).

13.10.3 Behavioural Impacts – 'Drive-Drill-Drive' Scenario

211 Results from noise modelling based on the 'drive-drill-drive' scenario indicate that there is the potential for sound arising from pile driving to remain above the 90 dBht threshold up to 18 km from the sound source and cover an area of approximately 1,013 km^2.

212 Noise modelling predicts that sound may remain above the 75 dBht threshold out to approximately 53 km in nearshore waters. The total area where the potential for sound levels to be below 90 dBht but above 75 dBht is 4,329 km^2.

Behavioural Impacts – 'Drive only' Scenario

213 Modelling undertaken based on the 'drive only' scenario indicates that there is the potential for sound arising from pile driving to remain above 90 dBht threshold up to 20 km and 57 km at 75 dBht. The total area impacted is between 1,212 km^2 and 4,668 km^2, respectively.

Total Displacement and Temporary Threshold Shift

214 Total displacement of harbour porpoises may occur out to 18 km from the piling operations and cover an area of 1,013 km^2. Based on site-specific density of harbour porpoise of 0.38/km^{-2} across the area of potential impact, it is estimated that up to 385 harbour porpoise may be displaced during potential pile driving operations under the 'drive-drill-drive' scenario. Under the 'drive only' scenario it is predicted that that up to 460 harbour porpoise may be displaced (refer to Table 13.37). However, it is expected that should it occur, no more than four jackets with up to 16 piles will be installed under the 'drive only' scenario and therefore the duration of potential impacts from 'drive only' installation will be limited.

215 Results using SAFESIMM predict that up to 53 harbour porpoise may receive levels of noise that could cause TTS.

216 Harbour porpoise use acoustic senses to detect prey, communicate and avoid predators. Therefore, the potential impacts from a TTS could be the reduction in an individual's ability to feed or communicate. The duration of the TTS on harbour porpoise is predicted to be of short duration and has been reported to be less than two hours for harbour porpoise, although this may increase if the level of noise received remains high (Kastelein *et al*., 2010). However, it is predicted that harbour porpoise will swim away from sound sources that could cause TTS and they are unlikely to remain in the area of potential impact that could cause prolonged periods of TTS.

217 Based on SCANS II results, the regional population of harbour porpoise is estimated to be 367,260 individuals (CI 248,271-429,018). The displacement of up to 460 harbour porpoise is approximately 0.1% of the regional harbour porpoise population.

218 The vulnerability of the harbour porpoise is potentially negligible and the magnitude of effect is low and as a result, the overall significance of harbour porpoise to displacement and TTS has been assessed as ***minor significance*** (refer to Table 13.36).

Behavioural Change and Partial Displacement

219 Behavioural changes will vary between individuals but may include masking effects, reduced vocalisation or reduced foraging behaviour. The predicted effects caused by changes in behaviour are that individuals may move away from the area until piling activities cease. There is the potential for some habituation and not all individuals may leave the area. However, significant displacement, with up to 50% of the animals leaving the area, may occur.

220 Behavioural change or partial displacement may occur out to 53 km from the piling operations and cover an area of 4,329 km^2 beyond that where total displacement is predicted to occur. This is considerably greater than that predicted from other studies where mild behavioural responses have been predicted to occur between 7 km and 20 km from piling activity (Thomsen *et al.,* 2007). Based on a peak density of harbour porpoise of 0.38 animals/km^2 across the area of potential impact and 50% avoidance, it is estimated that up to 822 harbour porpoise could be displaced during potential pile driving operations under the 'drive-drill-drive' scenario. Under the 'drive only' scenario it is predicted that up to 887 harbour porpoises could be displaced (refer to Table 13.37). However, it is expected that, should it occur, no more than four jackets with up to 16 piles will be installed under the 'drive only' scenario and therefore the duration of potential impact will be limited.

221 Based on SCANS II results, the regional population of harbour porpoise is estimated to be 367,260 individuals (CI 248,271-429,018). The partial displacement or a behavioural change of up to 887 harbour porpoises is predicted to impact upon approximately 0.2 % of the regional harbour porpoise population.

222 The total number of harbour porpoises predicted to be displaced combining 90 dBht figures and 75 dBht figures is 1,347 individuals which is 0.4% of the regional population.

223 Results from the SAFESIMM modelling indicate that up to 1,309 harbour porpoise may receive sound levels that could cause a behavioural effect; 0.4% of the regional population.

224 Monitoring undertaken at existing offshore wind farms indicates that harbour porpoise will not return to the area whilst activities are ongoing but may do so once piling has ceased.

225 Noise arising from piling is largely below 1 KHz and therefore below best hearing for harbour porpoise (Thomsen *et al.,* 2006). Results from Horns Rev offshore wind farm indicated that harbour porpoises either left the area or reduced vocalisation to at least 11 km from the construction activities but were present in the area within 48 hrs of piling operations having stopped (Tougaard *et al.,* 2006). Although similar results were not recorded immediately after construction of the Nysted Offshore Wind Farm, numbers of harbour porpoise did return to the original baseline within 2 years (Diederichs *et al.*, 2008). Results from constructed offshore wind farms in the UK indicate similar results to those from Denmark, with harbour porpoises returning to the pre-construction population levels at Greater Gabbard Offshore Wind Fafm within 4 weeks of cessation of piling (Galloper Wind Farm Limited (GWFL), 2011) and within 2 to 3 days in the Moray Firth during the installation of two jacket based wind turbines (Thompson *et al*., 2010a).

226 Although, the impacts on harbour porpoises from displacement are unknown, displaced harbour porpoise will relocate elsewhere. The species occurs widely across the North Sea and is therefore not restrained by specific habitat preferences. Harbour porpoise are known to forage widely and prey on a wide selection of fish species (Sveegaard, 2011); they are therefore adaptable and capable of relocating to new areas. Results from existing studies suggest that they may return relatively soon following cessation of operations.

227 Harbour porpoise echolocate at between 120 KHz and 150 KHz, which are frequencies at which piling has little or no energy (Thomsen *et al*., 2006). Although there is some degree of uncertainty in this, it is predicted that masking effects are unlikely to occur at distances beyond which other auditory impacts are predicted to occur.

228 Based on the above modelling and published literature it is predicted that the magnitude of any displacement or behavioural effects could be negligible and the vulnerability of the receptor is considered to be low. The overall significance of behavioural change and partial displacement of harbour porpoise have been assessed to be of ***minor significance*** (refer to Table 13.36).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Piling during installation of jacket foundations	Noise lethal effect/PTS	Harbour Porpoise	Negligible	Very high	Not significant	Area of potential impact very localised and numbers at risk very low from PTS. Harbour porpoise may relocate and return following cessation of piling.
	Noise displacement/TTS		Negligible	Low	Minor significance	
	Noise partial displacement/behaviour		Negligible	Low	Minor significance	

Table 13.36: Significance of potential impacts on harbour porpoise from pile driving

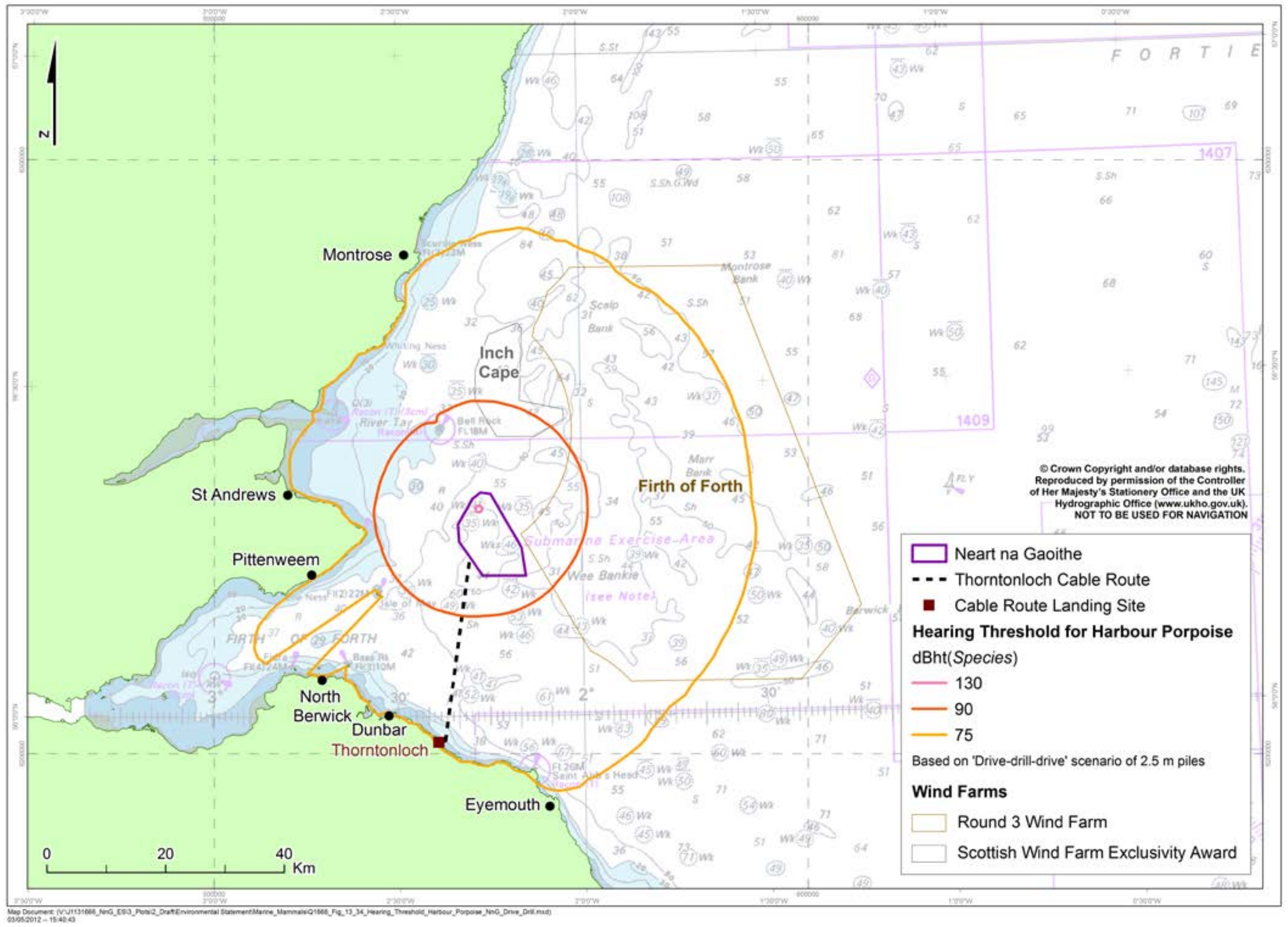


Figure 13.33: Hearing threshold results for harbour porpoise based on 'drive-drill-drive' scenario of 2.5 m piles

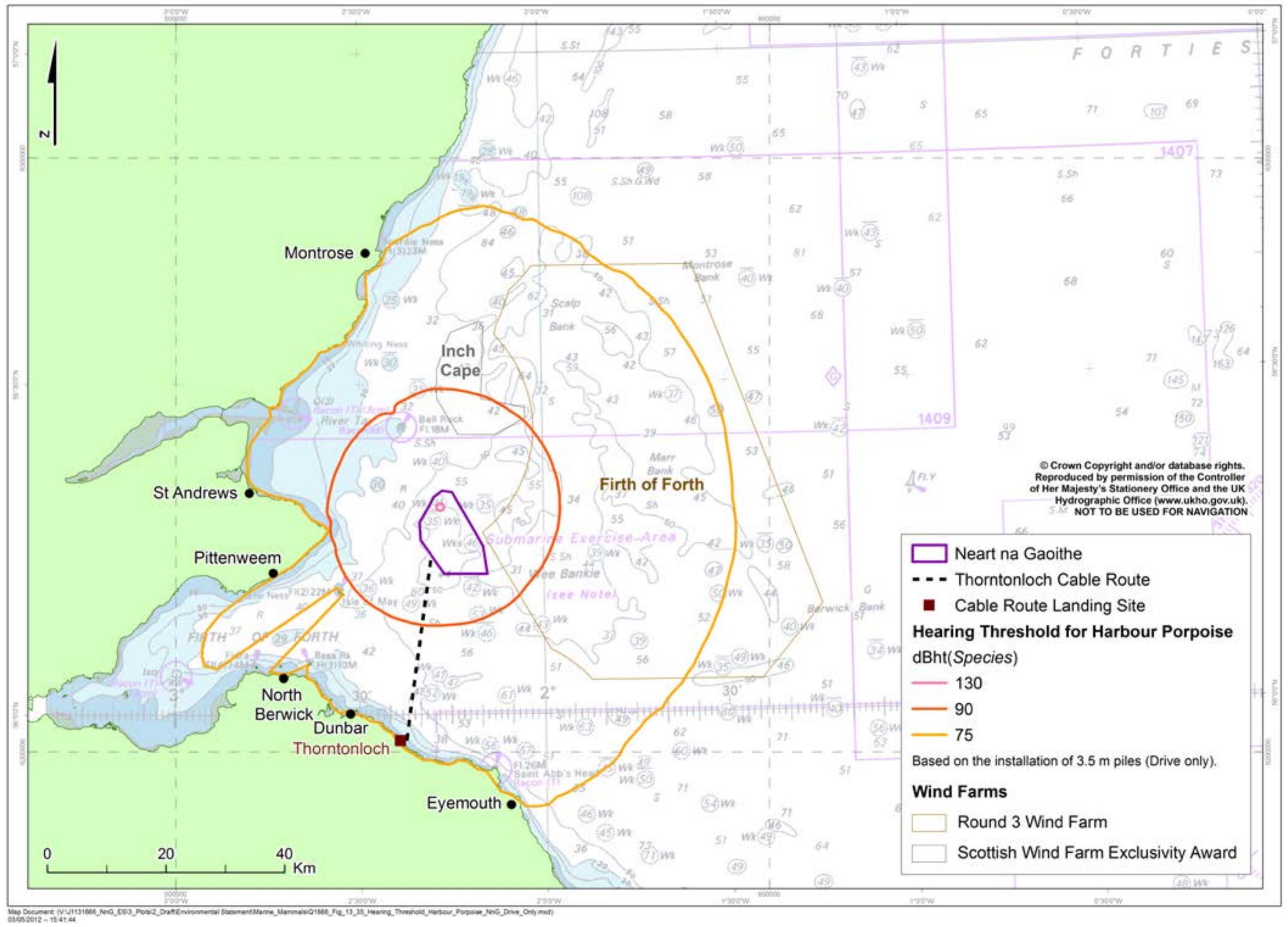


Figure 13.34: Hearing threshold results for harbour porpoise based on the installation of 3.5 m piles (drive only)

Harbour porpoise	Sound Level			
	90 dBht		75 dBht	
	Area (km2)	No. impacted	Area (km2)	No. impacted
'Drive-drill-drive'	1,013	385	4,329	822
'Drive only'	1,212	460	4,668	887
Note: the number impacted is based on the highest predicted density of 0.38 porpoise/km^2 and 50% displacement occurring within the area of audibility of between 75 dBht and 90 dBht**.**				

Table 13.37: Predicted number of harbour porpoises displaced from pile driving operations

13.10.3.1 Harbour Porpoise – Operating Noise

229 Operating noise from offshore wind turbines occurs at relatively low frequencies (Section 13.9.1.2). Studies undertaken for offshore wind farms indicate that turbine noise may be audible to harbour porpoises out to 100 m but no further than 1 km (Degraer *et al.,* 2011; Thomsen *et al*., 2006; SMRU, 2012). Although the range of audibility may vary depending on the size of the turbines and their structure (Degraer *et al.,* 2011). Masking effects have been predicted to occur within several 'tens of metres' (Lucke *et al*., 2007).

230 Results from operating wind farms indicate that harbour porpoises occur within them at population levels similar to, or greater than, those that occurred prior to construction. Harbour porpoises occurred in similar numbers following construction at both Horns Rev and Nysted offshore wind farms (Tougaard, 2006) and an increase in numbers have been reported at the operating Egmond aan Zee offshore wind farm in the Netherlands (Lindeboom *et al.,* 2011).

231 Based on the reported monitoring results from existing offshore wind farms it is predicted that the magnitude of any displacement effects may be negligible and the vulnerability of harbour porpoises to operating noise is also negligible. Based on this, the significance of operating noise on harbour porpoises is considered to be ***not significant*** (refer to Table 13.38).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Turbine noise during operational phase	Noise generated by turbine rotation	Harbour Porpoise	Negligible	Negligible	Not significant	Harbour porpoise are known to enter operating wind farms in similar or greater numbers than prior to construction.

Table 13.38: Significance of potential impacts on harbour porpoise from operating noise

13.10.3.2 Harbour Porpoise – Vessel Noise

232 The vessels likely to be used during construction and operation are described in Chapter 5: Project Description. Due to the wide range of activities being undertaken, a variety of vessels producing different operational noise will be used.

233 Thomsen *et al*. (2006) calculated that harbour porpoise may be able to detect vessel noise out to 20 km, although behavioural responses to vessels are predicted to be seen considerably closer than this, with studies estimating behavioural responses to occur less than 1 km from the vessel (Thomsen *et al*., 2006).

234 There is the potential for localised avoidance of vessels by harbour porpoise. Vessel noise is transitory and impact can be considered to be relatively localised and temporary. The magnitude of the impact will be negligible and the vulnerability of harbour porpoise is low. The overall significance of the impact from vessel noise has been assessed as ***not significant*** (refer to Table 13.39).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Vessel noise during construction or operation and maintenance	Noise generated by construction or maintenance vessels	Harbour Porpoise	Negligible	Low	Not significant	Harbour porpoise may move away from operating vessels but return to the area once vessels leave the area.

Table 13.39: Significance of potential impacts on harbour porpoise from vessel noise

13.10.3.3 Cumulative Impacts – Harbour Porpoise

235 Potential cumulative impacts on harbour porpoises may arise from the proposed development of offshore wind farms at Inch Cape, Firth of Forth Round 3 Zone 2 and Neart na Gaoithe. The precise periods of construction for the projects are not currently known, however there is the potential for periods of overlapping piling activities to be undertaken in the region.

Cumulative Permanent Threshold Shift

236 M-weighted SEL modelling has been undertaken across all three offshore sites and assumes that piling will occur simultaneously at all three sites. The results of the cumulative noise modelling for high frequency specialists, such as harbour porpoise, are presented in Figure 13.31.

237 Densities of harbour porpoise recorded at Inch Cape or Firth of Forth are not currently available and therefore harbour porpoise densities obtained from Neart na Gaoithe have been used to extrapolate a potential total displacement. Based on the results from the aerial surveys, (Macleod and Sparling, 2011) the general wide ranging occurrence of the species in UK waters (Reid *et al.,* 2003) and no known areas of significant concentrations of harbour porpoise in the North Sea (Hammond, 2006; Reid *et al.,* 2003), it is predicted that densities of harbour porpoises across the whole area of potential impact will remain constant.

238 The cumulative area across the three discrete areas of potential impact within which there is the potential for PTS to occur is 3.5 km^2. It is predicted that one harbour porpoise is at risk of a PTS from piling operations across all three locations.

239 The results from SAFESIMM modelling undertaken using the SEL outputs from the INSPIRE modelling and a wider area harbour porpoise density indicate that up to 21 harbour porpoise may receive sound levels that could cause PTS.

240 The relatively small area of potential impact within which a harbour porpoise may receive noise at levels that could cause a PTS indicates that it is unlikely that any harbour porpoise will be present within this zone at the start of operations. Harbour porpoise may also avoid the area due to vessel noise, which is predicted to cause avoidance behaviour out to 1 km from a vessel (Thomsen *et al*., 2006). Industry best practice mitigation measures, agreed through the Environmental Management Plan, will be in place prior to, and during, any piling activities (See Section 13.11: Mitigation and Residual Impacts). Consequently, the risk of an impact that might cause a PTS is low, although should it occur the impact on the individual would be high.

241 The overall impact from cumulative PTS has been assessed to be ***not significant***.

Cumulative Temporary Threshold Shift

242 The total number of harbour porpoises predicted to receive SEL that could cause TTS, should all three developments undertake piling operations simultaneously, is 157 individuals (refer to Table 13.32).

243 The duration of the TTS on harbour porpoise is predicted to be of short duration and has been reported to be less than 2 hours, although this may increase if the level of noise received remains high (Kastelein *et al*., 2010). However, it is predicted that harbour porpoise will avoid sound sources that could cause TTS and therefore are unlikely to remain in the area of potential impact that could cause prolonged periods of TTS.

244 The total number of harbour porpoises potentially at risk of TTS is relatively small compared to the regional or national populations. It is predicted that harbour porpoises will move away from the sound source and hearing recovery will occur within hours of the harbour porpoises moving into areas with lower levels of noise. The magnitude of effect is predicted to be low and the vulnerability low. Consequently, the significance of a cumulative impact has been assessed to be ***not significant***.

Cumulative Behavioural Change and Displacement

245 The cumulative total number of harbour porpoises predicted to receive SELs that could cause behavioural change or displacement is predicted to be 1,745 individuals.

246 The regional population of harbour porpoise is estimated to be 367,260 individuals (CI 248,271-429,018). The partial displacement or impacts on behaviour of up to 1,745 harbour porpoise is approximately 0.4% of the regional population.

247 The number of harbour porpoises for which there is the potential for some behavioural impact or displacement is relatively small compared to the regional population and harbour porpoises may return to the area following cessation of piling operations. The exact duration of the overlapping piling activities may take place is unknown. However, the duration of construction activities from all three sites being undertaken at the same time is likely to be relatively short as Neart Na Gaoithe will be undertaking piling over a period of between 12 and 18 months. Assuming no delays, it is likely that piling activities will be near completion prior to commencement of construction periods for other developments in the Firth of Forth and Firth of Tay area (refer to Table 13.40).

248 The effect of displacement of harbour porpoise is that individuals will relocate to areas, which could in theory, be less optimal habitat. Harbour porpoise occur widely across the North Sea (refer to Figure 13.3) and there have been no areas identified as being of particular importance to them. They feed on widely occurring species of fish and so any displacement effects are unlikely to have any adverse impact on the individuals displaced. There may be increased intra-specific competition with increased competition between individuals, but the wide area across which harbour porpoise may disperse and the low proportion of the regional population potentially impacted indicates that intra-specific competition will be slight.

249 The potential magnitude of effect from displacement is predicted to be low to medium, and of medium term, the vulnerability Low. Consequently, the significance of a cumulative impact has been assessed to be of ***minor significance*** with potential changes in local populations during construction, but with a predicted full recovery once construction has ceased.

Source	Pathway	Magnitude of effect	Vulnerability of receptor	Significance of impact
Piling	Noise lethal effect/PTS	Negligible	Very high	Not significant
	TTS	Low	Low	Not significant
	Noise partial displacement/behaviour	Low to Medium	Low	Minor significance
Qualification of significance Area of potential impact very localised and numbers at risk very low from PTS. Low proportion of regional population may relocate and return following cessation of piling.				
Mitigation Mitigation measures will reduce the risk of PTS and may reduce some TTS.				

Table 13.40: Significance of potential cumulative impacts on harbour porpoise from operating noise

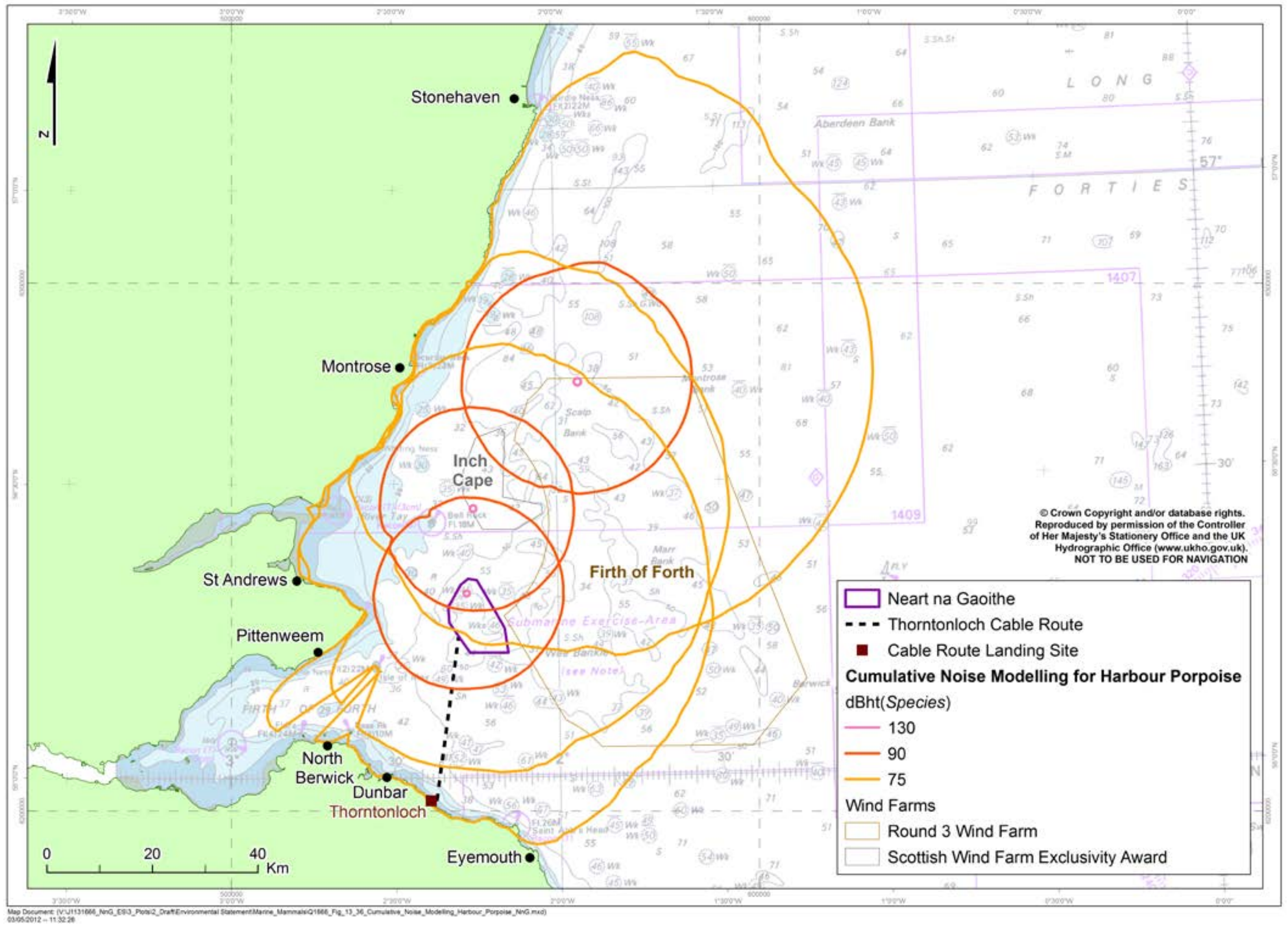


Figure 13.35: Cumulative noise modelling results for harbour porpoise

Species	SEL		SAFESIMM		
	PTS		PTS	TTS	Behaviour
	Area (km^2)	No. impacted	No. impacted	No. impacted	No. impacted
Harbour porpoise	3.5	1	1	32	1,745

Table 13.41: Predicted number of harbour porpoises cumulatively impacted from pile driving operations

250 Potential cumulative impacts arising from potential developments in the Moray Firth include the Moray Firth Offshore Wind Farm and the Beatrice Offshore Wind Farm. Results from the Beatrice Offshore Wind Farm impact assessment are available (BOWL, 2012). Additional potential cumulative impacts are from the EOWDC (AOWFL, 2011).

251 Results from cumulative noise modelling for Beatrice Offshore Wind Farm and Moray Firth Offshore Wind Farm indicate that the total radius for PTS to occur on harbour porpoise is 2.4 km and 61.5 km for potential behavioural effects (BOWL, 2012). The modelling undertaken indicates that cumulatively up to eight harbour porpoise may be impacted by PTS and 4,337 may demonstrate behavioural or avoidance responses.

252 The area of potential effect does not overlap with the potential zone of effect from the Firth of Tay developers (refer to Figure 13.35) and therefore no direct cumulative impacts are predicted to occur. However, an additional impact could occur with an increasing proportion of the regional population being displaced. It should be noted that the cumulative numbers are not directly comparable due to differing assessment techniques, but based on the two results, up to nine harbour porpoise may be at risk of PTS and 6,082 harbour porpoise may be at risk of a behavioural impact should all five wind farms be piling simultaneously (refer to Table 13.41). Based on current schedules this is not predicted to occur.

13.10.3.4 White-Beaked Dolphin

253 No white-beaked dolphins were recorded in Year 1 of the boat-based surveys and only 16 were recorded in Year 2. Consequently, white-beaked dolphins are scarce in the Neart na Gaoithe area. Data from aerial surveys across the whole of the Firth of Forth and Firth of Tay area recorded a total of 64 white-beaked dolphins (Macleod and Sparling, 2011).

254 Noise modelling has not been undertaken specifically for white-beaked dolphin but it is thought to have similar hearing capabilities as bottlenose dolphin and therefore similar areas of potential effect (refer to Table 13.42). Data from SCANS II surveys indicate that the density of white-beaked dolphins in the region is 0.05 per km^2. The total population in the region is 22,400 individuals.

White-Beaked Dolphin	Sound Level			
	90 dBht		75 dBht	
	Area (km^2)	No. impacted	Area (km^2)	No. impacted
'Drive-drill-drive'	451.9	22	2,567.8	64
'Drive only'	555.5	28	2,898.5	72
Note: the number impacted is based on the highest predicted density of 0.05/km^2 and 50% displacement occurring within the area of audibility of between 75 dBht and 90 dBht.				

Table 13.42: Predicted number of white-beaked dolphin impacted from pile driving operations

13.10.3.5 White-Beaked Dolphin – Pile Driving Impacts

Permanent Threshold Shift

255 The results from the SEL noise modelling indicate that for PTS to occur the white-beaked dolphins will have to be within 100 m of the piling activities when operations start. The relatively small area of potential impact within which a white-beaked dolphin may receive noise at levels that could cause a PTS indicates that it is unlikely that any will be present within this zone at the start of operations. The magnitude of effect is predicted to be negligible and the vulnerability very high. However, due to the very low risk of a white-beaked dolphin being present, the impact has been assessed to be ***not significant***. Mitigation measures in place, such as soft-starts, will reduce the risk still further.

Total Displacement and Temporay Threshold Shift

256 Modelling predicts that total displacement may occur out to 13.3 km from the piling operations based on a 'drive only' scenario and cover an area of 551 km^2. It is predicted that up to 28 white-beaked dolphins may be displaced during pile driving operations. The magnitude of effect is predicted to be negligible and the vulnerability low. The potential impacts have been assessed to be ***not significant*** (refer to Table 13.43).

Behavioural Change and Partial Displacement

257 Based on the modelling undertaken, it is predicted that between 64 and 72 white-beaked dolphins may be displaced or change their behaviour due to the pile driving activity (refer to Table 13.31).

258 The results of the modelling indicate that up to 0.3% of the regional white-beaked dolphin population may be impacted either by displacement or behavioural impacts. No studies on impacts arising from the construction of offshore wind farms on white-beaked dolphins have been published (e.g. Thomsen *et al*., 2006; Lucke *et al*., 2006; Michel *et al*., 2007) but based on the relatively low numbers predicted to be impacted, the significance of any impacts have been assessed to be ***not significant*** (refer to Table 13.43).

259 The total number of white-beaked dolphins predicted to be displaced combining 90 dBht figures and 75 dBht figures is 100 individuals.

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Piling during installation of jacket foundations	Noise lethal effect/PTS	White-beaked dolphin	Negligible	Very high	Not significant	Area of potential impact very localised and numbers at risk very low from PTS. White-beaked dolphin may relocate and return following cessation of piling.
	Noise displacement/TTS		Negligible	Low	Not significant	
	Noise partial displacement/behaviour		Negligible	Low	Not significant	

Table 13.43: Significance of potential impacts on white-beaked dolphin from pile driving

13.10.3.6 White-Beaked Dolphin – Operating Noise

260 The low numbers of white-beaked dolphin recorded in the proposed offshore site indicate that Neart na Gaoithe is not an important location for white-beaked dolphin. The level of noise arising from operating wind turbines may be audible, but unlikely to be audible at any significant distance, which is predicted to be no greater than approximately 1 km (Thomsen *et al*., 2006). Although there are no studies indicating whether or not white-beaked dolphins will enter operating wind farms, other species of cetacean have done so and it is predicted that white-beaked dolphins will behave similarly. The impact is therefore prdicted to be ***not significant*** (refer to Table 13.44)

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Turbine noise during operational phase	Noise generated by turbine rotation	White-beaked dolphin	Negligible	Low	Not significant	White-beaked dolphin will probably enter the wind farm area.

Table 13.44: Significance of potential impacts on white-beaked dolphin from operating noise

13.10.3.7 White-beaked dolphin – Vessel Noise

261 The vessels likely to be used during construction and operation are described in Chapter 5. Due to the wide range of activities being undertaken, a variety of vessels will be used and each will produce different operational noise.

262 Noise arising from vessel activities may cause masking effects, behavioural changes or displacement.

263 Impacts from sounds arising from vessel activity may be impact on white-beaked dolphins present in the area. The zone within which a potential behavioural response may occur is predicted to be relatively localised and any white-beaked dolphins may move away from the area. However, white-beaked dolphins are known to bow ride vessels and therefore the level of sound from vessels in transit is not predicted to have a significant displacement effect (ASCOBANS, 2012).

264 The magnitude of the impact will be negligible and the vulnerability of white-beaked dolphin also negligible. The overall significance of the impact from vessel noise is ***not significant***.

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Vessel noise during construction or operation and maintenance	Noise generated by construction or maintenance vessels	Bottlenose dolphin	Negligible	Negligible	Not significant	White-beaked dolphins are known to tolerate vessel noise.

Table 13.45: Significance of potential impacts on white-beaked dolphin dolphin from vessel noise

13.10.3.8 Cumulative Impacts – White-Beaked dolphin

Cumulative Permanent Threshold Shift

265 M-weighted SEL modelling has been undertaken across all three offshore sites and assumes that piling will occur simultaneously. The results of the cumulative noise modelling for mid frequency specialists, e.g. dolphins are presented in Figure 13.31.

266 The cumulative area across the three discrete areas of potential impact within which there is the potential for PTS to occur is 3.3 km^2. Based on the SCANS II density of 0.05 white-beaked dolphin/km^2 it is predicted that less than one white-beaked dolphin may be impacted.

Cumulative Temporary Threshold Shift

267 No white-beaked dolphins were recorded in year 1 surveys at Neart na Gaoithe and 16 in year 2. Due to the infrequency of sightings, it has not been possible to undertake SAFESIMM modelling to assess potential cumulative TTS. However, based on the potential range of impact and low densities of white-beaked dolphin recorded, it is predicted that low numbers of white-beaked dolphin may receive levels of sound that could cause TTS. Should it occur it is predicted that TTS will last for a short period of time.Based on results from studies undertaken on bottlenose dolphins this is likely to be for no longer than a few hours (Finneran *et al;* 2002; Parvin *et al.*, 2007). During this period of TTS, individuals will likely have reduced foraging ability and communication. The predicted duration of the potential impact is such that the impact has been assessed as not significant.

Cumulative Behavioural Change and Displacement

268 Potential cumulative impacts that could cause changes in behaviour and or displacement have not been modelled using SAFESIMM due to the low numbers recorded at Neart na Gaoithe. However, the area of effect is predicted to be similar to that for bottlenose dolphin, as both species are similar mid-frequency specialists.

269 White-beaked dolphins are primarily a summer visitor to the area and numbers vary across years, the reason for which is unknown (Weir *et al.*, 2007). The species occurs widely across the central and northern North Sea and, aside from having preferences for deeper water of greater than 20 m, have no known habitat preferences and can forage on a wide range of fish species (Weir *et al.*, 2007). Therefore, it is predicted that any displacement effects will occur primarily during the summer months and white-beaked dolphins avoiding the area will relocate elsewhere during the construction period. The wide range of white-beaked dolphin and its broad range of prey species indicate that the impact of displacement on displaced individuals will ***not significant*** (refer to Table 13.46).

Source	Pathway	Magnitude of effect	Vulnerability of receptor	Significance of impact
Piling	Noise lethal effect/PTS	Negligible	Very high	Not Significant
	Noise TTS	Negligible	Low	Not significant
	Noise displacement/behaviour	Low	Low	Not Significant
Qualification of significance Area of potential impact very localised and numbers at risk very low from PTS. White-beaked dolphin may relocate and return following cessation of piling.				
Mitigation Mitigation measures will reduce the risk of PTS and may reduce some TTS.				

Table 13.46: Significance of potential cumulative impacts on white-beaked dolphin from construction

13.10.3.9 Bottlenose Dolphin

270 Bottlenose dolphins were not recorded from any of the boat-based surveys undertaken at Neart na Gaoithe. However, they do occur in the Firth of Tay area and are within the range of potential impact from noise arising from piling activities.

271 The hearing thresholds for bottlenose dolphin have been one of the best studied for any cetacean, the results from which are presented in Figure 13.36. Bottlenose dolphins are mid-frequency hearing specialists particularly between 15 to 130 kHz (Southall *et al.,* 2007; David, 2006).

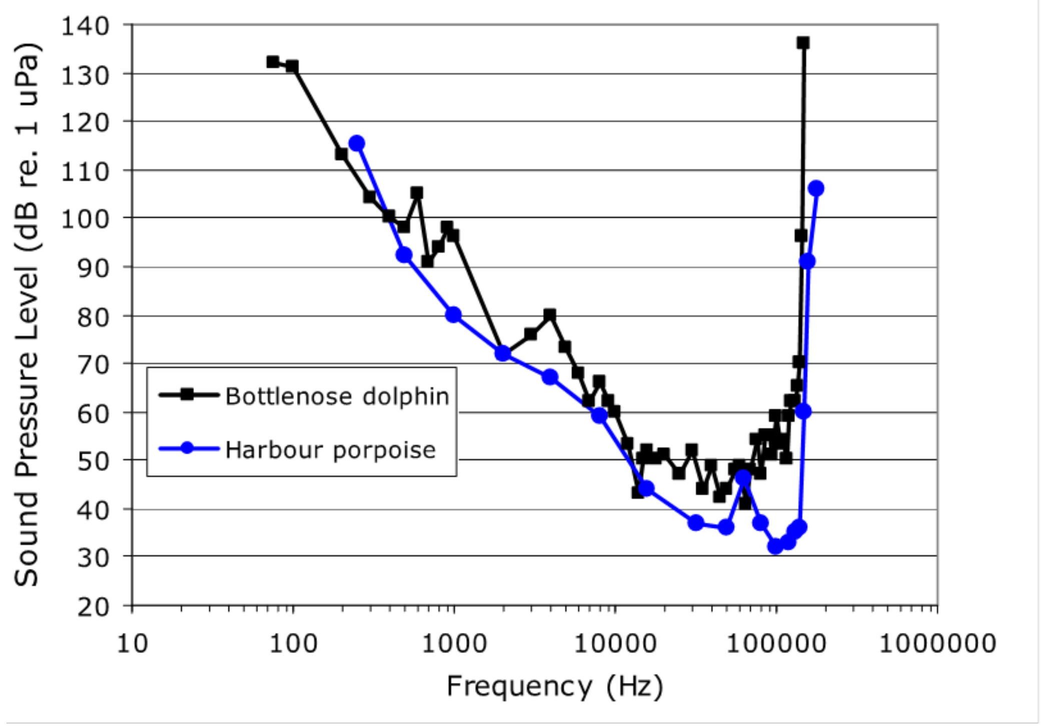


Figure 13.36: Bottlenose dolphin and harbour porpoise hearing thresholds (Source: Kongsberg, 2010)

13.10.3.10 Bottlenose Dolphin – Pile Driving Impacts

272 Noise modelling has been undertaken for Neart na Gaoithe based on two scenarios 'drive-drill-drive' scenario and 'drive only' the results from which are presented in Table 13.30.

'Drive-drill-drive' Scenario

273 Results from noise modelling based on the 'drive-drill-drive' scenario indicate that there is the potential for sound arising from pile driving to remain above the 90 dBht threshold up to 12 km from the sound source and cover an area of approximately 451 km^2.

274 Noise modelling predicts that sound may remain above the 75 dBht threshold out to approximately 35.5 km in nearshore waters. The total area where there is potential for sound levels to be above 75 dBht but below 90 dBht is 2,568 km^2.

'Drive-only' Scenario

275 Modelling undertaken based on the 'drive only' scenario indicates that there is the potential for sound arising from pile driving to remain above 90 dBht threshold up to 13.3 km and 38.9 km at 75 dBht. The total area of potential impact is between 555.5 km^2 and 2,898 km^2.

Permanent Threshold Shift

276 The results from the SEL noise modelling indicate that for PTS to occur the bottlenose dolphins will have to be within 100 m of the piling activities when operations start. Bottlenose dolphins have not been recorded in the area and along with the relatively small area of potential impact it is unlikely that any will be present within this zone at the start of operations. Industry best practice mitigation measures, agreed through the Environmental Management Plan (See Section 13.11: Mitigation and Residual Impacts) will reduce the risk still further (Senior *et al*. 2008). The level of impact has been assessed to be ***not significant***.

Total Displacement and Temporary Threshold Shift

277 Modelling predicts that total displacement may occur out to 13.3 km from the piling operations based on a 'drive-only' scenario (refer to Table 13.31). Results using SAFESIMM predict that a total of six bottlenose dolphins may receive levels of noise that could cause TTS.

278 No bottlenose dolphins were recorded within 8 km of the proposed offshore site and aerial surveys undertaken by The Crown Estate recorded only one bottlenose dolphin outwith 12 nm from the coast and two within 12 nm (Macleod and Sparling, 2011). Therefore, site specific data indicate that the risk of any bottlenose dolphin being within range of activities that could cause TTS is remote.

279 Bottlenose dolphins in Firth of Forth and Firth of Tay area rarely occur further than 12 km from the coast with most records within a few kilometres from the coast (Quick and Cheney, 2011). The noise modelling undertaken indicates that the potential area within which total avoidance may occur is no closer than 6 km from the coast at Fife Ness and more than 20 km from the Tay Estuary. Therefore, the majority of the area of usage in the Tay area by bottlenose dolphins is outside the zone of effect where total displacement is predicted to occur (refer to Figure 13.37 and Figure 13.38).

280 The magnitude and vulnerability of any displacement effects are predicted to be low. The overall impact has been assessed to have ***minor significance*** (refer to Table 13.47).

Behavioural Change and Partial Displacement

281 Modelling predicts that there is potential for some behavioural effect or partial displacement to occur out to between 35 km and 39 km from the piling operations and cover an area of up to 2,898.5 km^2.

282 Results from the SAFESIMM modelling indicate that up to 124 bottlenose dolphins may exhibit some avoidance behaviour (Sparling *et al.,* 2012).

283 The area of potential behavioural change and partial displacement extends closer to shore than the area of total displacement and there is a potential for some bottlenose dolphins to be affected, particularly those occurring near Fife Ness. Should this occur, bottlenose dolphins may avoid swimming through the area or alter their behaviour, e.g. by reducing vocalisation or by changing feeding patterns. The consequences of this are difficult to predict as no studies identifying impacts from the construction of offshore wind farms on bottlenose dolphin have been published (e.g. Michel *et al*., 2007; Thomsen *et al*., 2006; Lucke *et al*., 2006;).

284 The results from both the 'drive-drill-drive' and 'drive-only' scenarios indicate that the levels of sound at which up to 50% of bottlenose dolphins may be displaced do not reach the coast except for Fife Ness (refer to Figure 13.37 and Figure 13.38). Consequently, for bottlenose dolphins travelling between the Tay and the Moray Firth there is a coastal corridor where sound levels are below the level that will cause significant displacement or behavioural changes. However, some effects may still occur in this area with a predicted sound level of 70 dBht occurring along the coastline (refer to Figure 13.39).

285 The levels of sound in the area where the majority of bottlenose dolphins occur are at levels that are unlikely to cause total displacement and bottlenose dolphins can move through or into the area. Masking of whistles and clicks could occur within the area of potential behavioural change. There is potential for masking effects to occur between 10 km and 15 km for sounds at 9 KHz, but closer for sounds at higher frequencies (David, 2006). Results from studies undertaken during the construction of the Beatrice demonstrator project in the Moray Firth were inconclusive, although they did indicate that dolphins remained in the wider area. There was insufficient data to assess whether there were any near-field effects (Thompson *et al*., 2010a).

286 Should displacement occur, it is predicted to only occur during the installation of the turbine foundations when piling occurs. This activity will have a duration of between 12 and 18 months, during which times bottlenose dolphin may avoid the area.

287 The distribution of bottlenose dolphin along the east coast of Scotland is near to the coast, with few sightings of bottlenose dolphins reported far from shore. The aerial surveys undertaken by The Crown Estate reported only one dolphin beyond 12 NM from the coast and there have been no sightings in the study area from 2 years of surveys (Macleod and Sparling, 2011). Studies in the Moray Firth and in the seas close to northeast Scotland have rarely recorded bottlenose dolphin more than a few kilometres from the coast and although this may, in part, be a reflection of survey coverage, it indicates that bottlenose dolphins remain largely inshore along the east coast of Scotland (Thompson *et al.,* 2010c; Anderwald and Evans, 2010; Reid *et al.,* 2003).

288 Any displacement will cause the bottlenose dolphins to move either to the north or south, although they are predicted to remain coastal. Displaced bottlenose dolphins will be able to forage and communicate when outside the zone of effect. There is potential for increased intra-specific competition during the construction period, but as bottlenose dolphins occur widely along the coast (as shown in Figure 13.10) any that are displaced will be able to move elsewhere.

289 Based on the above modelling and published literature it is predicted that the magnitude of any displacement effects may be high and the vulnerability of bottlenose dolphins to piling noise is medium. The overall impact has been assessed to have ***minor significance*** but of minor duration only during the installation of the turbine foundations (refer to Table 13.45).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Piling during installation of jacket foundations	Noise lethal effect/PTS	Bottlenose Dolphin	Negligible	Very high	Not significant	Area of potential impact very localised and numbers at risk very low from PTS. Bottlenose dolphins may relocate but potential for a high proportion to receive SELs that may cause some behavioural changes.
	Noise displacement/TTS		Low	Low	Minor significance	
	Noise partial displacement/behaviour		Medium	Low	Minor significance	

Table 13.47: Significance of potential impacts on bottlenose dolphin from pile driving

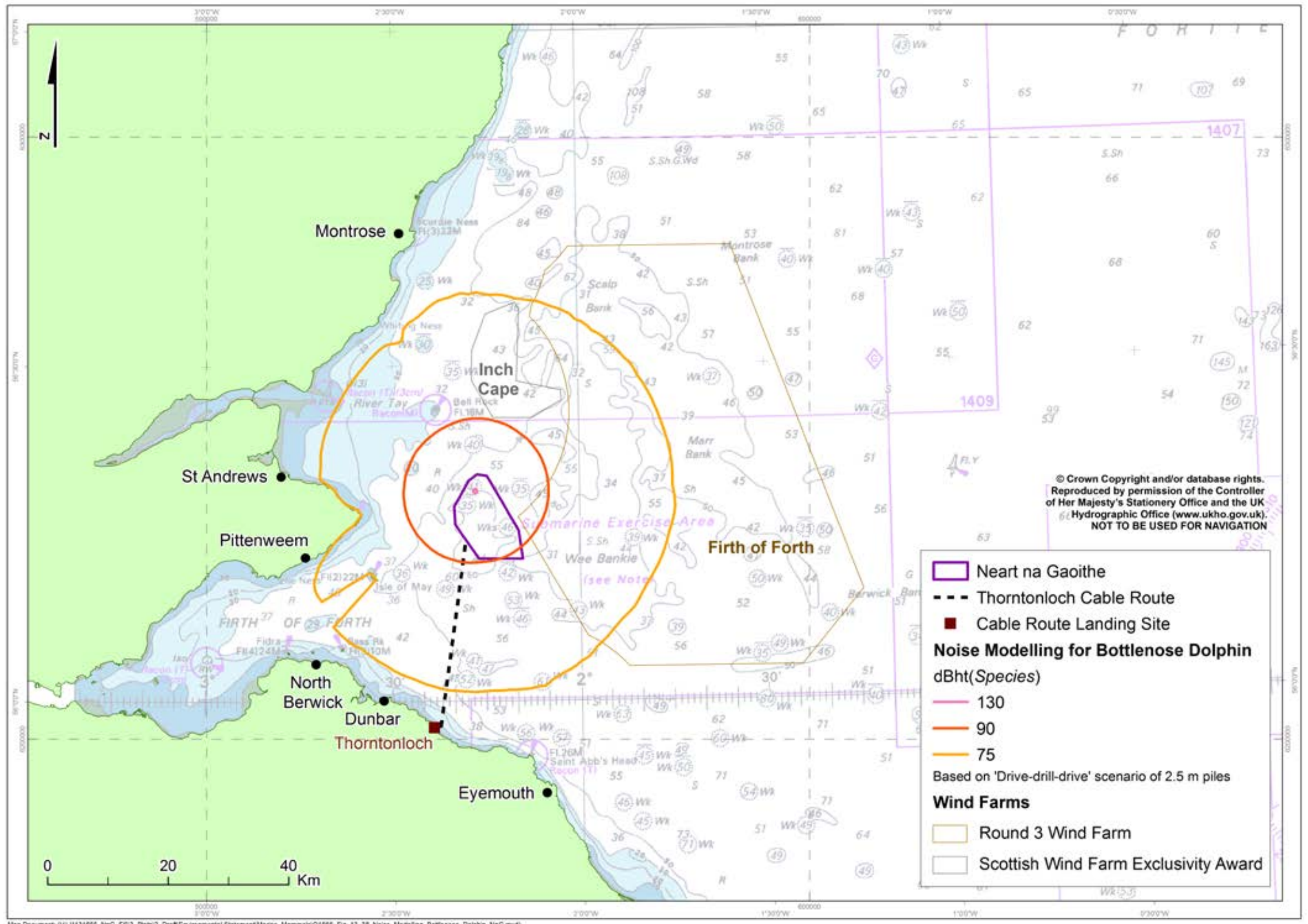


Figure 13.37: Noise modelling results for bottlenose dolphin based on 'drive-drill-drive' scenario of 2.5 m piles

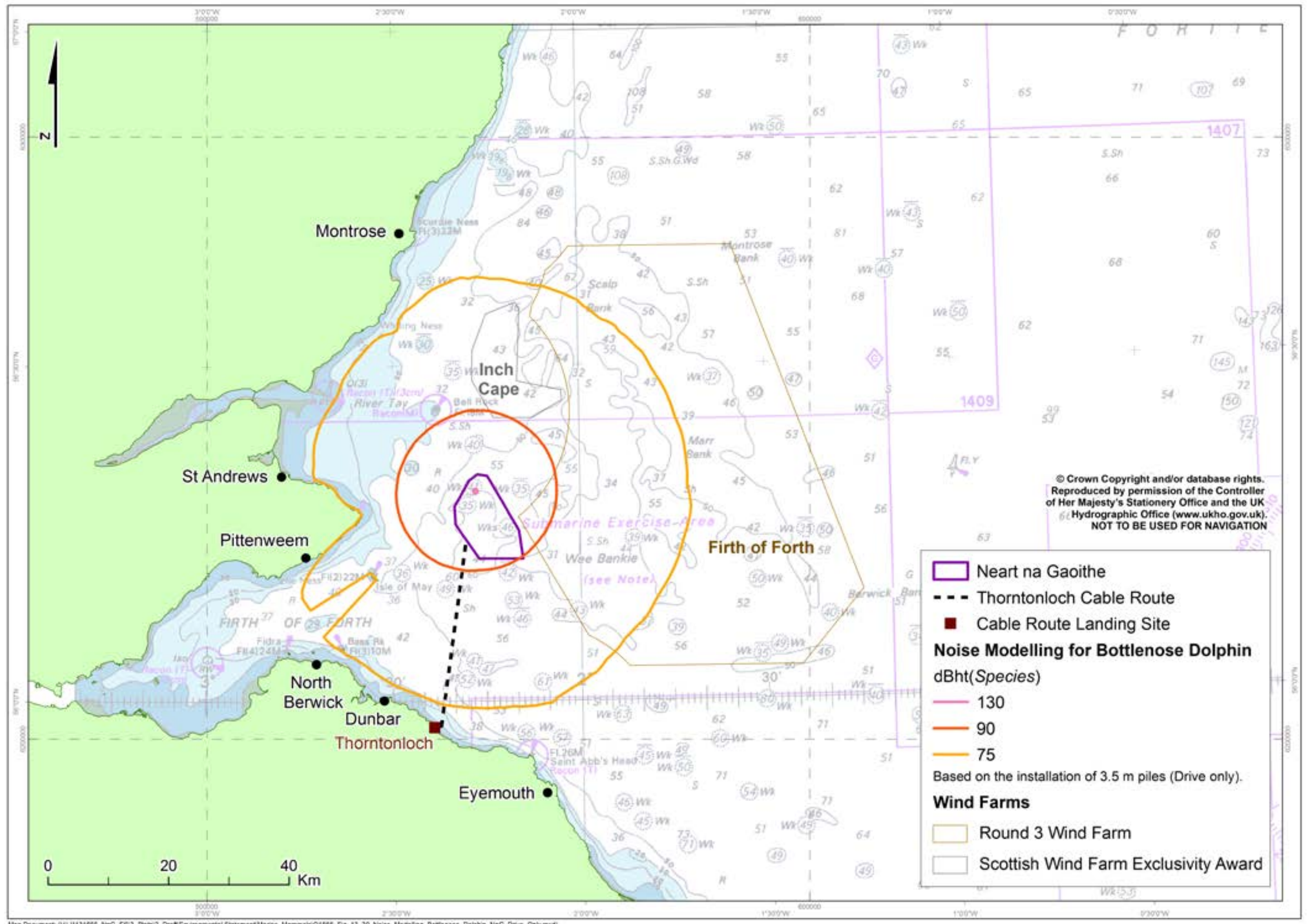


Figure 13.38: Noise modelling results for bottlenose dolphin based on the installation of 3.5 m piles (drive only)

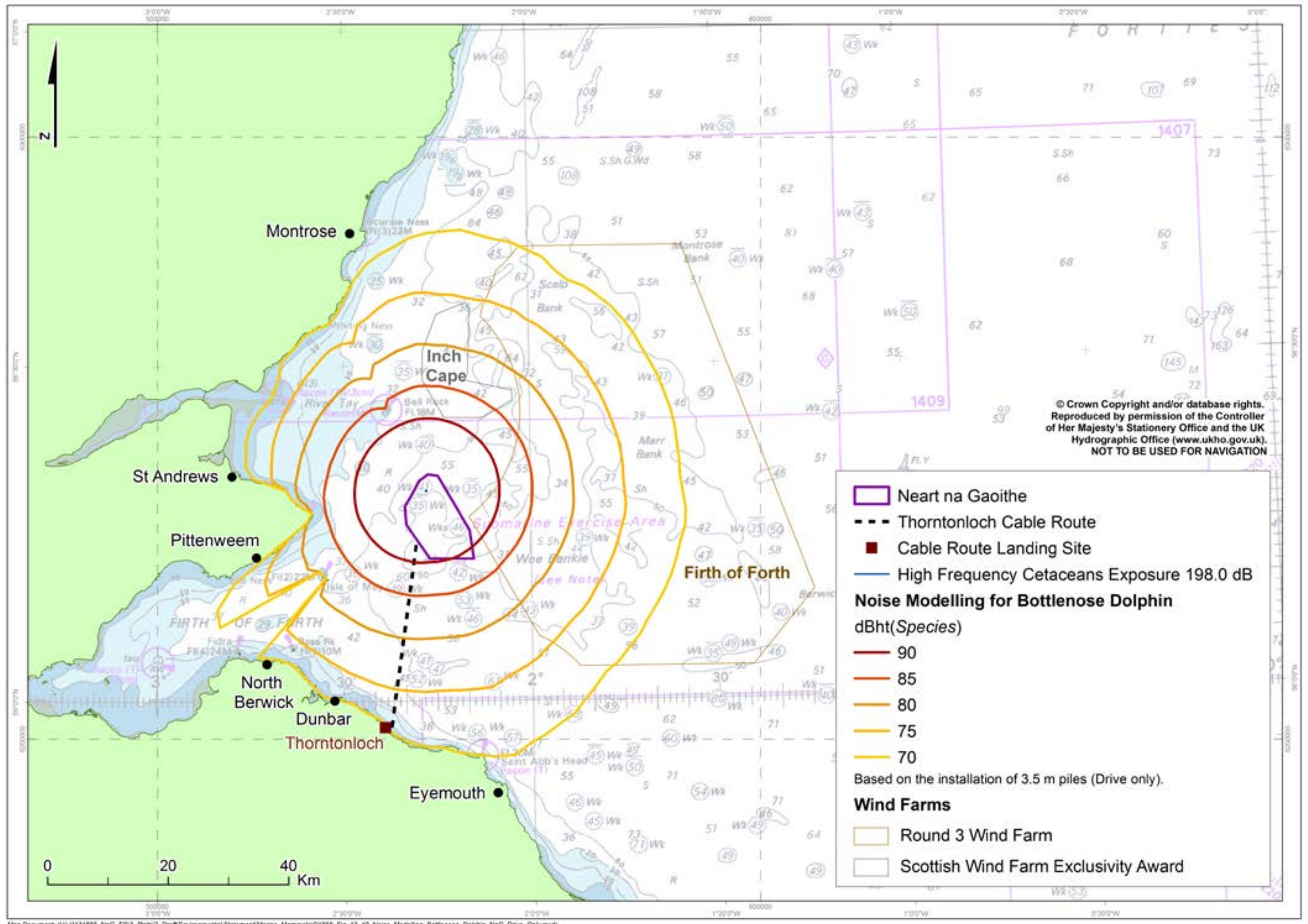


Figure 13.39: Noise modelling contours from 90 dBht to 70 dBht for bottlenose dolphin based on the installation of 3.5 m piles (drive only)

13.10.3.11 Bottlenose Dolphin – Operating Noise

290 The range at which operating noise is reported to be audible to cetaceans is relatively low (Thomsen *et al.,* 2006) and therefore no bottlenose dolphins are predicted to be affected by operating noise arising from the proposed development and impacts have been assessed as ***not significant*** (refer to Table 13.48).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Turbine noise during operational phase	Noise generated by turbine rotation	Bottlenose dolphin	Negligible	Negligible	Not significant	No bottlenose dolphins are predicted to occur in the area.

Table 13.48: Significance of potential impacts on bottlenose dolphin from operating noise

13.10.3.12 Bottlenose Dolphin – Vessel Noise

291 The vessels likely to be used during construction and operation are described in Chapter 5: Project Description. Due to the wide range of activities being undertaken a variety of vessels will be used, each producing different operational noise.

292 Noise arising from vessel activities may cause masking effects, displacement or behavioural changes such as increased vocalisation related to vessel activity (Lucke *et al*., 2006).

293 Impacts from sounds arising from vessel activity may be audible to coastal populations of bottlenose dolphin (Thomsen *et al*., 2006). The zone within which a potential behavioural response may occur is predicted to be outside any area where bottlenose dolphins are known to occur.

294 The magnitude of the impact will be negligible and the vulnerability of bottlenose dolphin negligible. The overall significance of the impact from vessel noise has been assessed as ***not significant*** (refer to Table 13.45).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Vessel noise during construction or operation and maintenance	Noise generated by construction or maintenance vessels	Bottlenose dolphin	Negligible	Negligible	Not significant	Bottlenose dolphins are known to tolerate vessel noise.

Table 13.49: Significance of potential impacts on bottlenose dolphin from vessel noise

13.10.3.13 Bottlenose Dolphin – Cumulative Impacts

295 Potential cumulative impacts on bottlenose dolphin may arise from the proposed development of offshore wind farms at Inch Cape, Firth of Forth and Neart na Gaoithe. The precise periods of construction for the projects are not currently known, although there is the potential for periods of overlapping piling activities to be undertaken in the region.

296 Noise modelling has been undertaken across all three offshore sites and assumes that piling will occur simultaneously at all three sites.

Cumulative Permanent Threshold Shift

297 The results of the cumulative noise modelling for mid frequency specialists, such as dolphins, are presented in Figure 13.31 (also refer to Figure 13.40 and Table 13.51).

298 The cumulative area across the three discrete areas of potential impact within which there is the potential for PTS to occur is 3.3 km^2. No bottlenose dolphins were recorded in the area of proposed development by the aerial surveys and none were recorded from boat-based surveys at Neart na Gaoithe. Industry best practice mitigation measures, agreed through the Environmental Management Plan, will be in place prior to and during any piling activities (See Section 13.11: Mitigation and Residual Impacts). Consequently, the risk of an impact that might cause a permanent threshold shift is low, although should it occur the impact on the individual would be high. The potential impact has been assessed to be ***not significant.***

Cumulative Temporay Threshold Shift

299 Results from SAFESIMM modelling indicate that up to six bottlenose dolphins may receive levels of sound that could cause TTS. Should that occur, it is predicted that TTS will last for a short period of time until the individual moves to areas with reduced sound levels.Studies show that this is not likely to be longer than a few hours (Parvin *et al.,* 2007; Finneran *et al.,* 2002). During this period of TTS, individuals are likely to have reduced foraging and communication capability but the predicted duration of the potential impact is short and will not have any significant effect on the individual impacted nor on the population as a whole. The potential impact has been assessed to be of ***minor*** significance.

Cumulative Behavioural Change and Partial Displacement

300 It is not possible to predict with certainty the changes in behaviour that may occur, but these may include reduced foraging, increased vocalisation and increased avoidance of the area.

301 Results from the SAFESIMM modelling indicate that up to 124 bottlenose dolphins may exhibit some avoidance behaviour from the cumulative impacts of piling (Sparling *et al.,* 2012).

302 Bottlenose dolphins in the Tay are known to be from the same population as those that occur in the Moray Firth and there is a regular passage of individuals along the east coast of Scotland between the two sites (Quick and Cheney, 2011). In areas where the levels of sound are such that there is predicted to be avoidance then there is the potential for the cumulative sound levels to reduce the level of interaction of bottlenose dolphins between the Moray Firth and the Tay Estuary.

303 Bottlenose dolphins occur in the Firth of Forth and Firth of Tay area throughout the year. Numbers present appear to increase during the summer and peak during the autumn, then reduce during the late winter and spring periods (refer to Figure 13.11 and Figure 13.12).

304 The level of sound occurring along the coast between Arbroath and Fife Ness is predicted to be at levels below which total displacement effects will occur. Some bottlenose dolphins may therefore remain within the Tay area and there may be some passage of individuals between the Forth and Tay and the Moray Firth. The level of activity is likely to be reduced during periods of piling.

305 Bottlenose dolphins that are displaced may relocate to other areas, in particular the Moray Firth or Aberdeen Bay. There are currently two proposed offshore wind farm developments in the Moray Firth (Beatrice Offshore Wind Farm and Moray Firth Offshore Wind Farm) and one test centre in Aberdeen Bay. These may also be carrying out installation activities during the period when Neart Na Gaoithe, Inch Cape and Firth of Forth Round 3 Zone 2 are also undergoing construction. Should this occur then it is predicted that there is the potential for a cumulative impact on bottlenose dolphins in both the Moray Firth and Tay areas.

306 The timing of the construction activities may be such that the period of cumulative piling will be significantly lower than predicted by SAFESIMM modelling and therefore the potential cumulative impacts also lower. Currently the timing of the scheduled construction periods are uncertain but based on current predicted schedules, this may mean that there is a period of less than 12 months during which one or more of the Firth of Forth and Firth of Tay developments may be being constructed at the time of Neart na Gaoithe (refer to Figure 13.2).

307 The SAFESIMM modelling predicts little or no additional cumulative impact arising from construction activities if one or more Firth of Forth and Firth of Tay developments occur simultaneously. However, this may in part be due to the spatial range that the model predicted potential impacts, particularly to the north of the Neart na Gaoithe offshore site, which was limited by a lack of available data to provide density estimates (Sparling *et al.,* 2012). It is thought that areas to the north that could have a cumulative impact also have bottlenose dolphins present. The proportion of east coast of Scotland bottlenose dolphin population that could be impacted may therefore be higher than the 124 predicted using SAFESIMM.

308 Bottlenose dolphins that may be displaced will, based on their wide ranging coastal distribution (refer to Figure 13.10), be able to relocate elsewhere for the duration of the construction activity. However, it is not known whether the Firth of Tay area is of significant importance to bottlenose dolphins. Photo identification studies have shown strong links between the Moray Firth and the Firth of Tay area. Substantial numbers of sightings between both locations in any single year indicate that there is potential for displaced dolphins to relocate northwards.

EOWDC

309 The proposed EOWDC in Aberdeen Bay is composed of eleven turbines, some of which will be installed by pile driving. Results from noise modelling indicate that behavioural impacts may arise up to 16 km from the piling activities (AOWFL, 2011) and therefore there will not be any overlap in significant noise thresholds with Neart na Gaoithe. However, it is predicted that all bottlenose dolphins from within that range during construction will be displaced and locate to sites elsewhere to the north or south. The bottlenose dolphins may move into the area of potential effect with Neart na Gaoithe.

310 The duration of piling activity during EOWDC is predicted to last no longer than 24 hours for each turbine and four or less turbines may be installed using piling and so the duration of impacts is likely to be less than four days. The current schedule is for construction activity to commence in 2014 and therefore there is a risk of a period of overlapping construction activity. However, the duration of this potential cumulative impact is low and the distance between the Neart Na Gaoithe and the proposed EOWDC is in excess of 100 km. The risk of a cumulative impact arising between the two projects is therefore considered low.

311 There are currently two proposed offshore wind farms in the Moray Firth: the Beatrice Offshore Wind Farm and the Moray Firth Offshore Wind Farm. The cumulative impacts arising from the construction of Beatrice and Moray Firth offshore wind farms are unknown. However, presuming that the area of effect from piling activities is of a similar magnitude as those modelled for the Firth of Forth and Firth of Tay developers, then the impact on the same population of bottlenose dolphins will be proportionally larger and potentially adverse, as the area affected will be greater and suitable areas within their current range will reduce.

312 Behavioural effects and level of displacement will vary with individuals and there is potential for some habituation to occur (Thomsen *et al*., 2006). However, the scale and duration of potential displacement is such that the magnitude of any displacement effects may be high as the bottlenose dolphin is highly vulnerable to piling noise. The cumulative impact has been assessed as being of ***moderate*** to ***major significance***.

Source	Pathway	Magnitude of effect	Vulnerability of receptor	Significance of impact
Piling	Noise lethal effect/PTS	Negligible	Very high	Not significant
	Noise displacement/TTS	Low	Low	Minor significance
	Noise partial displacement/behaviour	High	Medium	Moderate/major significance
Qualification of significance Area of potential impact very localised and numbers at risk very low from PTS. Bottlenose dolphins may relocate but potential for a high proportion to receive SELs that may cause some behavioural changes.				
Mitigation Mitigation measures will reduce the risk of PTS and may reduce some TTS. Possible mitigation may include the use of Marine Mammal Observers, acoustic monitoring and deterrent devices.				

Table 13.50: Significance of potential cumulative impacts on bottlenose dolphin from pile driving

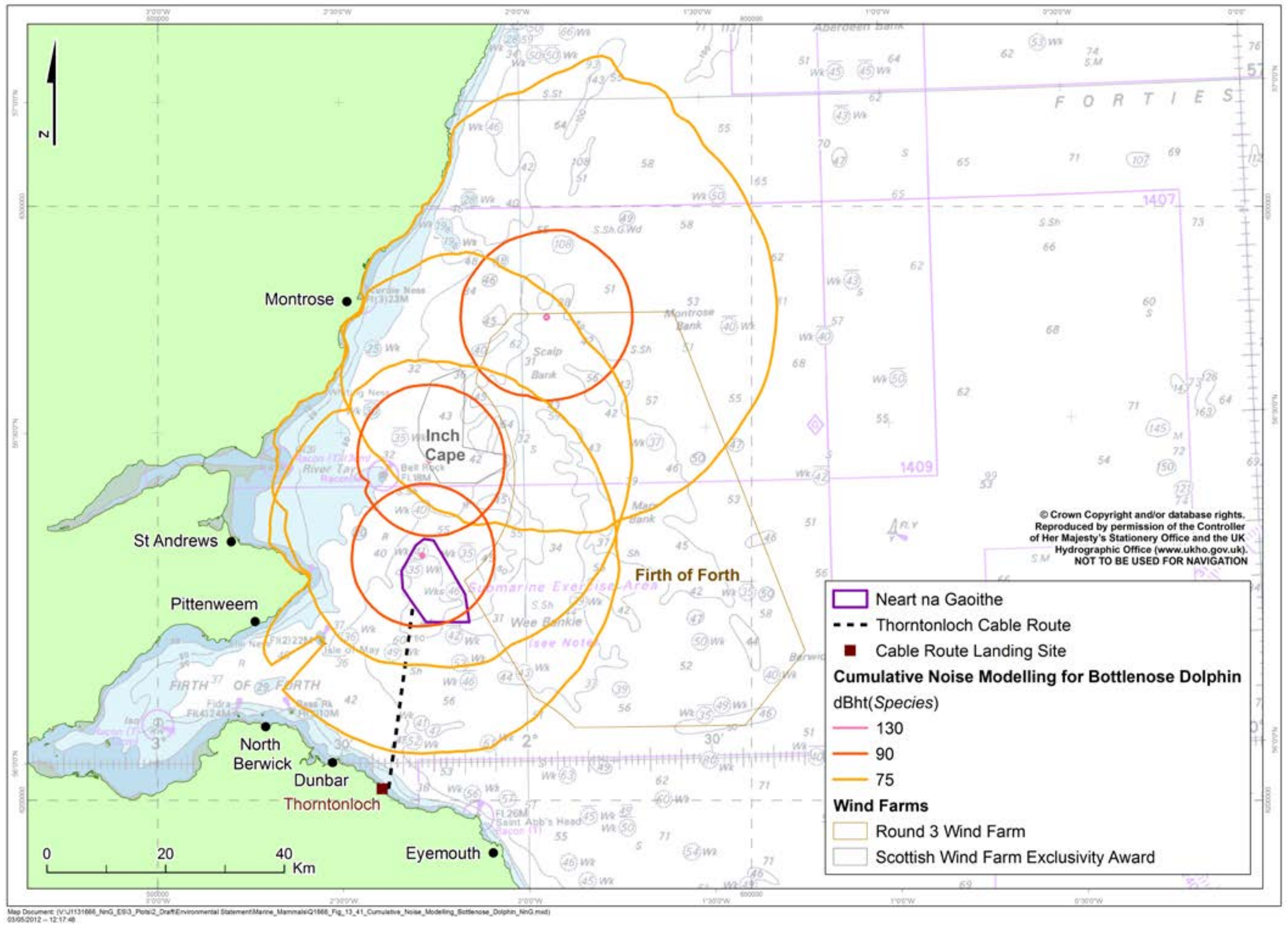


Figure 13.40: Firth of Tay developments cumulative noise modelling results for bottlenose dolphin

Species	SEL		SAFESIMM		
	PTS		PTS	TTS	Behaviour
	Area (km^2)	No. impacted	No. impacted	No. impacted	No. impacted
Bottlenose dolphin	3.93	0	0	6	124

Table 13.51: Predicted number of bottlenose dolphin cumulatively impacted by Forth of Tay developments from pile driving operations

313 Potential cumulative impacts arising from potential developments in the Moray Firth include the Moray Firth Offshore Wind Farm and the Beatrice Offshore Wind Farm. Results from the Beatrice Offshore Wind Farm impact assessment are available (BOWL, 2012). Additional potential cumulative impacts are from the EOWDC (AOWFL, 2011).

314 Results from cumulative noise modelling for Beatrice Offshore Wind Farm and Moray Firth Offshore Wind Farm indicate that the total radius for PTS to occur on bottlenose dolphin is 0.5 km and 43.4 km for potential behavioural effects (BOWL, 2012). The modelling undertaken indicates that there is potential for displacement of bottlenose dolphins within the Moray Firth and that individuals displaced may relocate elsewhere (BOWL, 2012).

315 The area of potential effect does not overlap with the potential zone of effect from the Firth of Tay developers and therefore no direct cumulative impacts are predicted to occur. However, it is recognised that bottlenose dolphins in the Moray Firth and those in the Firth of Tay area are largely one population and that should bottlenose dolphins be simultaneously displaced from both areas as predicted by the noise models then there is potential for a cumulative behavioural impact.

316 However, current project schedules indicate that not all developers will be undertaking construction activities at the same time and the potential zone of cumulative effect will be lower than predicted.

13.10.3.14 Minke Whale

317 The hearing frequencies and abilities for minke whale are unknown and there are no audiograms available for this species. Minke whales produce sound at a range from between 100 Hz and 20 kHz, with much vocalisation between 0.5 and 1 kHz but clicks upwards to 20 kHz (Anderwald and Evans 2010; Vella *et al.*, 2001) and it is predicted that they have good hearing range at low frequencies (Thomsen *et al*., 2006). The distances at which behavioural responses by minke whale from pile driving may occur are unknown but may be 'many tens of kilometres', while the potential for TTS shift may be out to 1.8 km (Thomsen *et al*., 2006).

318 Only two minke whales were recorded Year 1 and ten in Year 2. SCANS II survey data indicate densities of 0.023/km^{-2} in the area (JNCC, 2012a; Hammond, 2006)

319 With no audiograms available for minke whale the audiogram for humpback whale has been used as a substitute for noise modelling. Although it cannot be certain that the hearing capabilities of both species are the same, they are both baleen whales and are low frequency specialists and therefore are likely to have similar levels of sensitivity towards noise (see Appendix 13.1: Noise Model Technical Report).

320 Noise modelling has been undertaken for Neart na Gaoithe based on two scenarios 'drive-drill-drive scenario' and 'drive only' the results from which are presented in Figure 13.41, Figure 13.42 and Table 13.53.

'Drive-drill-drive' Scenario

321 Results from noise modelling based on the 'drive-drill-drive' scenario indicate that there is the potential for sound arising from pile driving to remain above the 90 dBht threshold up to 39 km from the sound source and cover an area of approximately 3,470 km^2.

322 Noise modelling predicts that sound may remain above the 75 dBht threshold out to approximately 79 km in nearshore waters. The total area where the potential for sound levels to be below 90 dBht but above 75 dBht is 6,645 km^2.

'Drive only' Scenario

323 Modelling undertaken based on the 'drive only' scenario indicates that there is the potential for sound arising from pile driving to remain above 90 dBht threshold up to 42.1 km and 82.7 km at 75 dBht. The total areas of potential displacement effects are between 3,852 km^2 and 7,400 km^2, respectively.

Permanent Threshold Shift

324 The results from the SEL noise modelling indicate that for PTS to occur, minke whale will have to be within 100 m of the piling activities when operations start. The relatively small area of potential impact within which a minke whale may receive noise at levels that could cause a PTS indicates that it is unlikely that any will be present within this zone at the start of operations. The potential impacts are considered to be ***not significant***. Industry best practice mitigation measures, agreed through the Environmental Management Plan, (See Section 13.11: Mitigation and Residual Impacts) will reduce the risk still further.

Total Displacement and Temporary Threshold Shift

325 Total displacement of minke whales may occur out to 42 km from the piling operations and affect an area of between 3,346 and 3,852 km^2 depending on installation methods Based on a density of minke whale of 0.023 per/km^{-2} across the area of potential impact, it is estimated that up to 77 minke whales may be displaced during pile driving operations under the 'drive-drill-drive' scenario. Under the 'drive only' scenario it is predicted that that up to 88 minke whales may be displaced (refer to Table 13.53).

326 The regional population of minke whale is estimated to be 18,614 individuals (JNCC, 2010a). The displacement of up to 88 minke whales is approximately 0.5% of the regional minke whale population.

327 It is predicted that the magnitude of any displacement effects may be negligible and the vulnerability of minke whales to piling noise is low. The overall impact has been assessed to be ***not significant*** (refer to Table 13.52).

Behavioural Change and Partial Displacement

328 There is potential for some changes in behaviour such as reduced or increased vocalisation or reduced feeding, or partial displacement out to 84.3 km from the piling operations. This covers an area of 7,400 km^2 beyond that where total displacement is predicted to occur. Based on a density of minke whale of 0.023 animals/km^{-2} across the area of potential impact and 50% avoidance, it is estimated that up to 76 minke whale may be displaced during potential pile driving operations under the 'drive-drill-drive' scenario. Under the 'drive only' scenario it is predicted that that up to 85 minke whales may be displaced (refer to Table 13.53).

329 Based on a regional population of minke whale 18,614 individuals the partial displacement or a behavioural change are predicted to impact on approximately 0.4% of the regional minke whale population.

330 The total number of minke whale predicted to be displaced combining 90 dbht figures and 75 dbht figures is 173 individuals; 0.9% of the regional population.

331 There are no data available on the potential impacts pile driving may have on minke whale or other baleen whales. Minke whales and other baleen whales have been reported to show avoidance behaviour to seismic surveys and therefore will potentially show similar patterns of behaviour towards pile driving noise (OSPAR, 2009). Should they be displaced, it is not known if or when minke whales would return to the area following cessation of piling.

332 Although, the impacts on minke whale from displacement are unknown, displaced minke whales are able to relocate elsewhere. Little is known about movements of minke whale but there are significant inter-annual variations in areas of northeast Scotland with numbers present dependent on the availability of suitable prey (Baumgartner, 2008; Robinson *et al.*, 2009). Minke whale distribution has been shown to overlap suitable habitats for sandeels, herring and sprats (Macleod *et al.,* 2004; Robinson *et al.*, 2009), which are their main prey items in Scottish waters (Pierce *et al*., 2004). The area is not of significant importance for these species of fish and therefore not an area likely to be of significant importance for minke whale (refer to Chapter 15: Fish and Shellfish Ecology**]**. Only ten minke whales were recorded during the 2 years of boat-based surveys and eight were seen from aerial surveys (Macleod and Sparling, 2011). This indicates that the number of minke whale present and the densities may be lower than elsewhere in the North Sea from which the densities used in the assessment have been obtained. Therefore, the number of minke whales potentially displaced may be lower than predicted by the modelling results. Minke whales are opportunistic feeders (Baumgartner, 2008) and should they be displaced they can relocate to other suitable foraging areas.

333 It is predicted that the magnitude of any displacement effects would be negligible and the vulnerability of minke whales to piling noise is low. The overall impact has been assessed to be ***not significant*** (refer to Table 13.52).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Piling during installation of jacket foundations	Noise lethal effect/PTS	Minke whale	Negligible	Very high	Not significant	Area of potential impact very localised and numbers at risk very low from PTS. Level of sound impact is large but minke whale may relocate.
	Noise displacement/TTS		Negligible	Low	Not significant	
	Noise partial displacement/behaviour		Negligible	Low	Not significant	

Table 13.52: Significance of potential impacts minke whale from pile driving

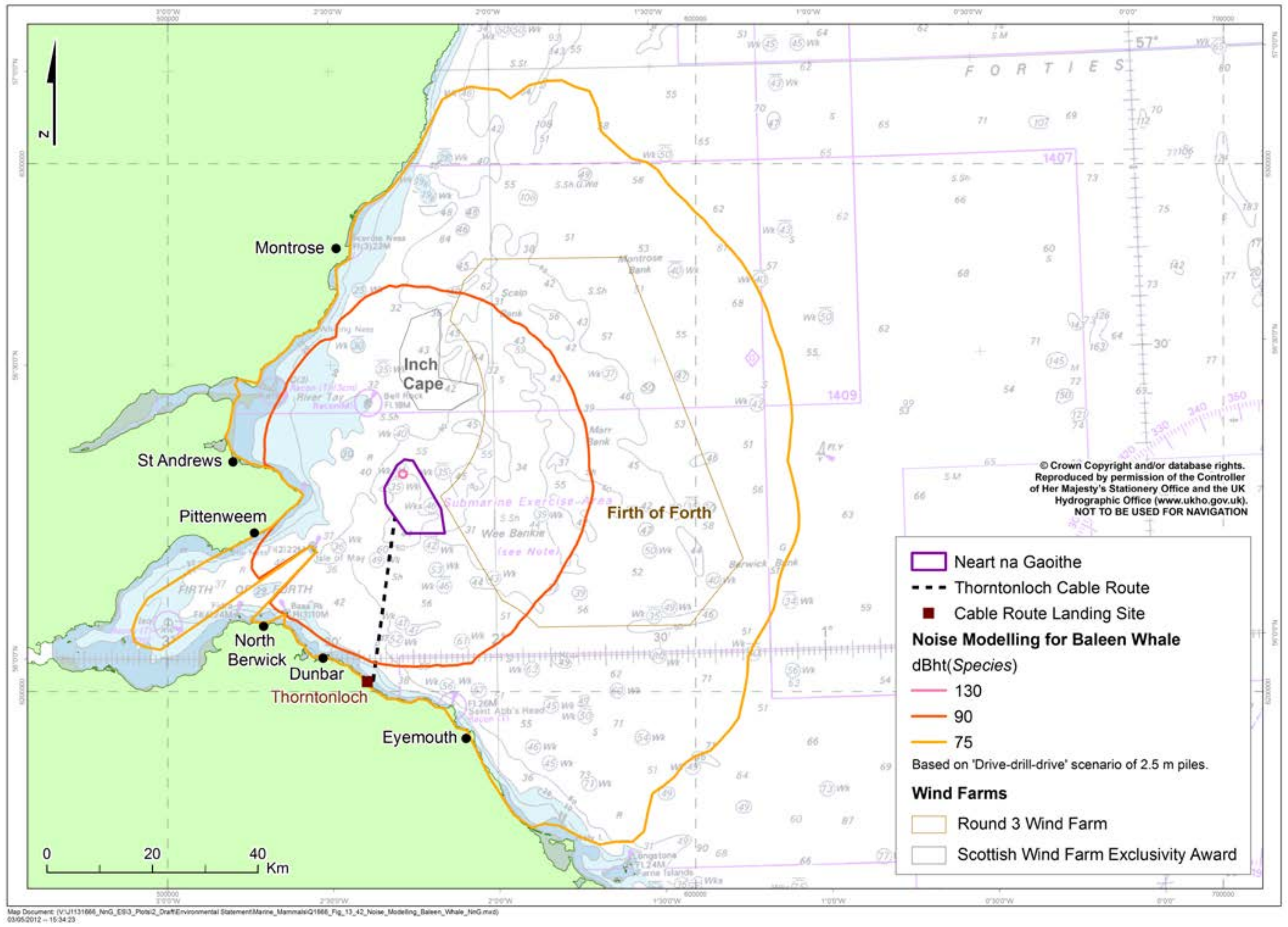


Figure 13.41: Noise modelling results for baleen whale based on 'drive-drill-drive' scenario of 2.5 m piles

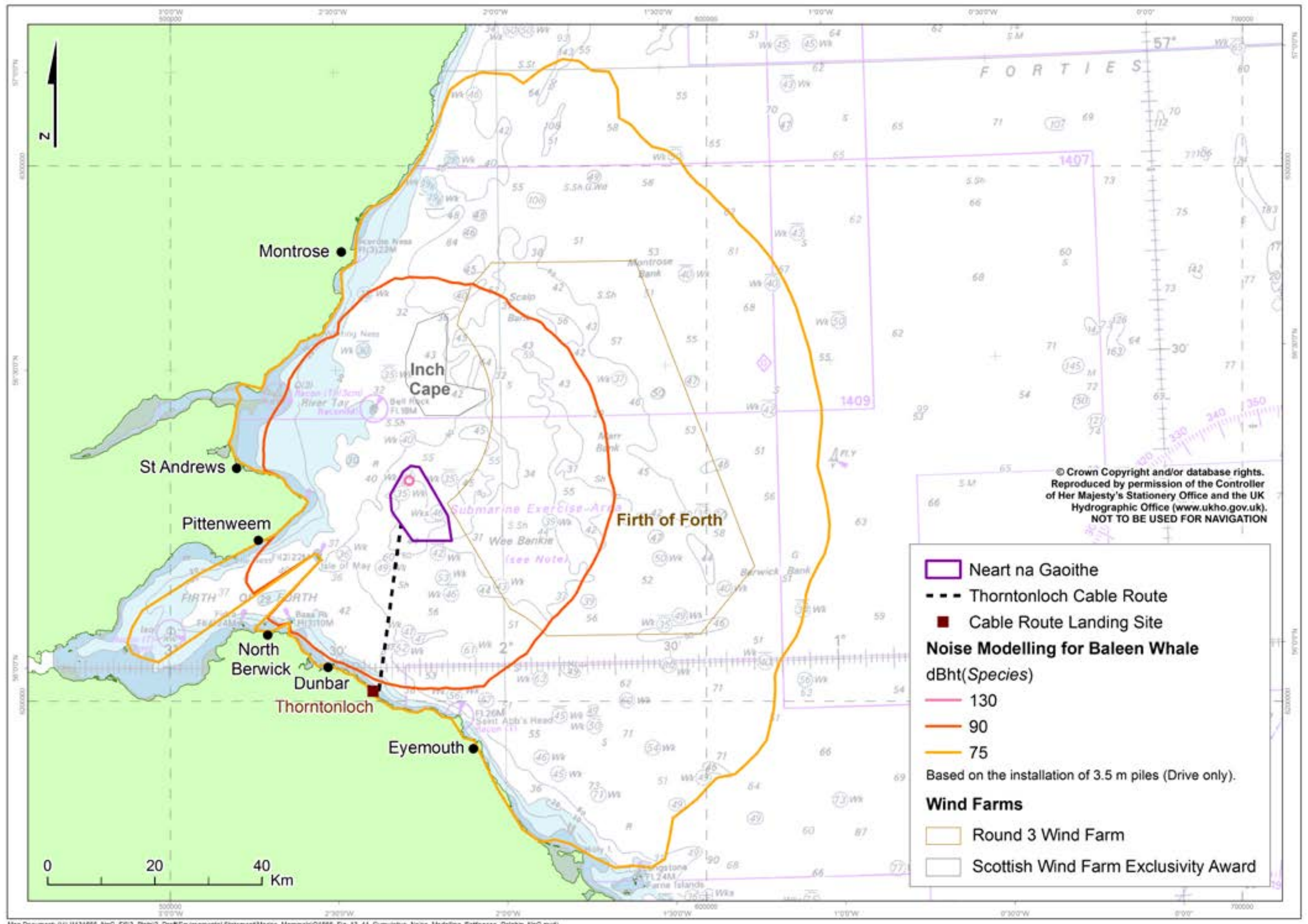


Figure 13.42: Noise modelling results for baleen whale based on the installation of 3.5 m piles (drive only)

Minke whale	Sound Level			
	90 dBht		75 dBht	
	Area (km^2)	No. impacted	Area (km^2)	No. impacted
'Drive-drill-drive'	3,346	77	7,063	76
'Drive only'	3,852	88	7,403	85
Note: the number impacted is based on the SCANS II density of 0.023/km^2 and 50% displacement occurring within the area of audibility of between 75 dBht and 90 dBht.				

Table 13.53: Predicted number of minke whale impacted from pile driving operations

13.10.3.15 Minke Whale – Operating Noise

334 Operating noise from offshore wind turbines occurs at relatively low frequencies (Section 13.9.1) and therefore may be audible to low frequency specialists such as baleen whales. However, studies undertaken across a number of offshore wind farms indicate that the level of noise is very low and although sound arising from operating wind turbines may be audible it is not any greater than natural variations in background noise levels and remains below levels that are likely to cause any behavioural or displacement impacts (Nedwell *et al*., 2007a) (refer to Table 13.54).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Turbine noise during operational phase	Noise generated by turbine rotation	Minke whale	Negligible	Negligible	Not significant	The low numbers of minke whale recorded and the predicted small area of impact.

Table 13.54: Significance of potential impacts on minke whale from operating noise

13.10.3.16 Minke Whale – Vessel Noise

335 The vessels likely to be used during construction and operation are described in Chapter 5: Project Description. Due to the wide range of activities being undertaken a variety of vessels will be used, each producing different operational noise.

336 A range of potential impacts may arise from vessel noise, in particular masking effects, reduced vocalisation or avoidance behaviour (OSPAR, 2009; Michel *et al*., 2007

337). Studies of minke whales in the Pacific Ocean have indicated potential avoidance behaviour and/or reduced vocalisation in response to vessels (Noris, 2010).

338 There is the potential for localised avoidance of vessels by minke whales. Vessel noise is transitory and impact both relatively localised and temporary and the overall significance of the impact from vessel noise is predicted to be ***not significant*** (refer to Table 13.55).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Vessel noise during construction or operation and maintenance	Noise generated by construction or maintenance vessels	Minke whale	Negligible	Negligible	Not significant	The low numbers of minke whale recorded and the predicted small area of impact.

Table 13.55: Significance of potential impacts on minke whale from vessel noise

13.10.3.17 Cumulative Impacts – Minke Whale

339 Potential cumulative impacts on minke whales may arise from the proposed development of offshore wind farms at Inch Cape, Firth of Forth and Neart na Gaoithe. The precise periods of construction for the projects are not currently known, although there is the potential for some periods of overlapping piling activities to be undertaken in the region.

340 Noise modelling has been undertaken across all three Firth of Forth and Firth of Tay development sites and assumes that piling will occur simultaneously at all three sites.

341 Densities for minke whale 0.023 per/km^2 are based on those published from the SCANS II surveys.

Cumulative Permanent Threshold Shift

342 Results from M-weighted SEL modelling based on low frequency, e.g., minke whale are presented in Figure 13.31.

343 The cumulative area across the three discrete areas of potential impact within which there is the potential for PTS to occur is 32.2 km^2 and radiates out to a maximum of 8.4 km. Based on the SCANS II density for minke whale it is predicted that less than one minke whale will be impacted. Industry best practice mitigation measures, agreed through the Environmental Management Plan, (See Section 13.11: Mitigation and Residual Impacts) will reduce the risk still further of an individual minke whale occurring in the area at sound levels that could cause PTS.

Cumulative Temporary Threshold Shift

344 The cumulative total displacement arising from all three developments has not been modelled due to the low numbers recorded at Neart na Gaoithe. However, based on the results from the INSPIRE modelling it is predicted that the total numbers at risk of TTS is between 50 and 100 individuals. This is approximately 0.5% of the regional population. The duration and effects of TTS on minke whales are unknown but based on results for other marine mammals are predicted to last for a relatively short duration. During the period of TTS, minke whales may reduce vocalisation and reduce feeding effort. They are predicted to respond by leaving the area as has been found for other baleen whales (e.g., Southall *et al.,* 2007; Richardson *et al., 1995*).

Cumulative Behavioural Change and Displacement

345 Displaced minke whale will relocate to areas elsewhere in the region. Minke whales occur widely but do have preferred foraging areas over sandy gravel sediments and areas with seabed slopes. The predicted zone of displacement effect is likely to be similar to that predicted by Neart na Gaoithe on its own but also extending northward in relation to the other proposed Firth of Forth and Firth of Tay developments. It is estimated that approximately 300 minke whales may be displaced. This is an estimate based on there being a relative increase in area of potential impact in proportion to the distance between the proposed offshore sites and a uniform density of minke whales across the wider area. As discussed above, displaced minke whale may be able to locate to other foraging areas, in particular areas to the north and south that are known to be herring spawning locations or to the east or southeast where sandeels may occur more frequently.

Source	Pathway	Magnitude of effect	Vulnerability of receptor	Significance of impact
Piling	Noise lethal effect/PTS	Negligible	Very high	Not significant
	Noise TTS	Negligible	Very high	Not significant
	Noise displacement/behaviour	Negligible	Very high	Not significant
Qualification of significance Area of potential impact very localised and numbers at risk very low from PTS. Level of sound impact is large but minke whale may relocate.				
Mitigation Mitigation measures may reduce the risk of PTS. Possible mitigation may include the use of Marine Mammal Observers, acoustic monitoring and deterrent devices				

Table 13.56: Significance of potential cumulative impacts minke whale from pile driving

13.10.3.18 Harbour Seal

346 The noise modelling undertaken for common and grey seal is the same as both have similar physiological characteristics. However, differing behaviours may make them more or less sensitive to sound at differing times of year.

347 Hearing thresholds for harbour seals are presented in Figure 13.43 and indicate that they have a hearing range from between 100 Hz to 100 kHz with a peak hearing sensitivity between 1 kHz and 40 kHz.

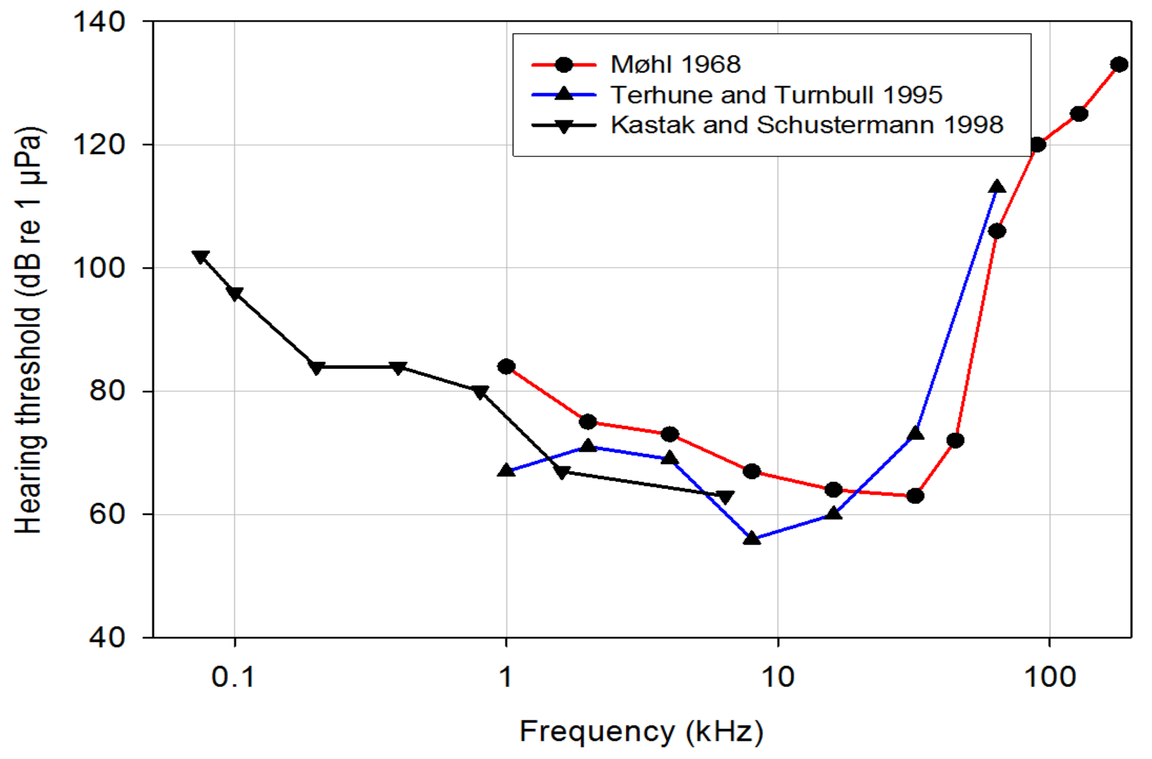


Figure 13.43: Hearing thresholds for harbour seals (Source Thomsen *et al.*, 2006)

348 Within the study area a total of six harbour seals were recorded in year 1 and 17 in Year 2, with most sightings in the buffer area and occurring during most of the year but no sightings during July, which coincides with their pupping period. Due to the low numbers recorded it has not been possible to calculate densities for harbour seal within Neart na Gaoithe. Consequently, it is not possible to predict the potential number of harbour seals that may be impacted from densities obtained from site-specific surveys. However, densities of harbour seal obtained from wider Firth of Forth and Firth of Tay area have been used in the SAFESIMM modelling.

13.10.3.19 Harbour Seal – Pile Driving Impacts

349 Noise modelling has been undertaken for Neart na Gaoithe based on two scenarios 'drive-drill-drive' scenario and 'drive only', the results from which are presented in Figure 13.44 and Figure 13.45.

'Drive-drill-drive' Scenario

350 Results from noise modelling indicate that there is the potential for sound arising from pile driving to remain above the 90 dBht threshold up to 15 km from the sound source and cover an area of approximately 682 km^2. Sound may remain above the 75 dBht threshold out to approximately 47.1 km. The total area where the potential for sound levels to be above 75 dBht but below 90 dBht is 3,581 km^2.

'Drive only' Scenario

351 Modelling results indicate that there is the potential for sound arising from pile driving to remain above 90 dBht threshold up to 16.1 km and remain above 75 dBht out to 50.3 km. The total area of potential impact is between 813.8 km^2 and 4,133 km^2.

Permanent Threshold Shift

352 The results from the SEL noise modelling indicate that the risk of PTS varies considerably depending on the exposure level selected. For seals Southall *et al.* (2007) recommend the use of 186 dB dB re 1 $\mu Pa^2/s$ (M_{pw}) although this is considered precautionary and the use of 198 dB dB re 1 $\mu Pa^2/s$ (M_{pw}) may be more appropriate.

353 Based on the use of SEL of 186 dB re 1 $\mu Pa^2/s$ (M_{pw}) for PTS to occur, harbour seals will have to be within 8.2 km of the piling activities when operations start.

354 Based on the use of SELs of 198 dB re 1 µPa^2/s (M_{pw}) for PTS to occur, harbour seals will have to be within 100 m of the piling activities when operations start.

355 Outputs from SAFESIMM modelling indicate that between 18 and 41 harbour seals may receive levels of sound capable of causing PTS. This is based on a precautionary dose response curve and therefore is predicted to be a worse case scenario.

356 The regional population of harbour seal is 376 individuals (Sparling *et al*., 2011) (refer to Table 13.21). Therefore, between 4.7% and 10.9% of the regional harbour seal population is at risk of receiving SELs that may cause PTS.

357 The number of harbour seals recorded from boat-based surveys within the study area and 8 km buffer area was very low with a total of 23 individuals over 2 years of surveys. The low number of sightings indicates that harbour seals are scarce in the study area. This is further supported by results from tagging studies that show the majority of harbour seals occur in the coastal waters to the west or in near-shore waters to the north (refer to Figure 13.25). Depending on the SEL threshold selected, the zone of potential PTS impact is within the area surveyed at between 100 m and 8.2 km. Based on the low number of sightings and the results from the tracking data it is not thought that between 4.7% and 10% of the regional harbour seal population will be within the area at the commencement of piling as indicated by the results from SAFESIMM.

358 It is recognised that there is potential for PTS to occur on some harbour seals within the vicinity of the construction activities. Mitigation measures in place include the possible use of acoustic mitigation devices designed to deter seals from the area of potential impact and will reduce the risk of any harbour seals receiving sound levels that could cause PTS.

359 Overall it is predicted that the potential impact has been assessed to be of ***moderate significance.***

Total Displacement and Temporary Threshold Shift

360 Total displacement of seals may occur out to 15 km from the piling operations and cover an area of 682 km^2.

361 Outputs from SAFESIMM modelling indicate that between 95 and 152 harbour seals may receive levels of sound capable of causing TTS. Based on the regional population of 376 harbour seals, between 25% and 40% of the regional harbour seal population may receive sound levels that could cause TTS and/or displacement.

362 The duration of TTS on harbour seals is predicted to be for less than 24 hours (Kastak *et al.,* 2005) but will depend on the duration that the harbour seal experiences sound at levels that can cause TTS.

363 Harbour seals are not hearing specialists and do not use sound to detect prey. They have good vision in clear waters and sensitive mystacilia vibrissae to locate prey in waters with poor visibility and therefore the temporary loss of hearing would not affect the ability of harbour seals to forage effectively (Dehnhardt and Kaminski, 1995).

364 It is predicted that the temporary hearing loss or displacement has been assessed to be of ***moderate significance***.

Behavioural Change and Partial Displacement

365 The 'drive-drill-drive' scenario modelled, predicts a potential for some behavioural effect or partial displacement to occur out to 47 km from the piling operations and cover an area of 3,585 km^2. Under the 'drive only' scenario for 16 piles, some displacement may occur out to 50.3 km and cover an area of 4,133 km^2.

366 Outputs from SAFESIMM modelling indicate that between 283 and 314 harbour seals may receive levels of sound capable of causing behavioural change. Based on the regional populations between 75% and 83% of harbour seals may receive sound levels that could cause behavioural effects.

367 Results from site tagging studies, (refer to Figure 13.24 and Figure 13.25) density surface modelling (refer to Figure 13.26) and site-specific surveys (refer to Figure 13.27) all indicate that harbour seals are scarce within the proposed Neart na Gaoithe offshore site. They also indicate that harbour seals forage mainly within the nearshore coastal waters of the Firth of Forth and Firth of Tay area or to the north and east and in particular over shallower sandbanks.

368 Within the Tay and Eden estuaries, harbour seals breed and are a qualifying species of the Firth of Forth and Tay and Eden Estuary SAC. Harbour seals pup during June and July and the pups enter the sea very shortly after birth; following pupping the adults moult during August. Harbour seals tend to forage in relatively inshore waters but can make regular foraging trips further offshore to suitable feeding areas. One such area is clearly identifiable to the north of Neart na Gaoithe based on the 2011 tagging data but, although still present, is less obvious in the years between 2001 and 2008 when harbour seal distribution occurred more frequently further north (refer to Figure 13.25). This suggests that although harbour seals may use regular feeding areas there is, across years, variation in the level and extent of usage as, presumably, harbour seals forage at other suitable feeding locations. Similar foraging behaviour patterns have been identified at other UK harbour seal populations (Sharples *et al.,* 2008). This pattern of behaviour indicates that harbour seals are opportunistic feeders relocating to areas with high prey availability.

369 The effect of causing displacement may vary depending on season. The period of main sensitivity is predicted to be during the pupping season of June and July when females give birth at regular haul-out sites. Pups enter the water very shortly after birth, often within a tidal cycle and may spend up to 40% of their time in the water (Bekkby and Bjorge, 2000; Bowen *et al*., 1999). Pups remain with their mothers until weaning approximately 25 days after birth. During this period pups and adults remain largely within a few kilometres of the haul-out sites, as the pups need to rest more frequently than adults (Bekkby and Bjorge, 2000, Thompson *et al.,* 1994). Following weaning, pups and adults become less reliant on the breeding area and increase their foraging range further offshore shore.

370 During the pupping season, harbour seals may avoid the haul-out sites due to displacement effects. If so, pregnant females will have to relocate to other alternative, potentially less suitable, pupping locations. Should this occur then there might be an increase in juvenile mortality.

371 The construction period during which turbine foundations will be installed is predicted to last between 12 and 18 months, therefore the risk of displacement effects moving harbour seals away from Firth of Tay pupping areas will potentially occur over one or two seasons. Should this occur, then there will potentially be a temporary adverse effect on Firth of Tay and Eden Estuary SAC pupping areas during which time harbour seals will relocate to alternative pupping grounds.

372 Outside the breeding season, harbour seal distribution offshore is predicted to be closely associated with optimal foraging areas. Harbour seals prey on a wide variety of species including sandeels, whiting, flounder, cod and other fish species (SCOS, 2005; Tollit and Thompson, 1996). They are opportunistic feeders and can adapt to foraging on alternative prey if their prey availability changes. The main prey species for harbour seals in the Tay Estuary area are sandeels and salmonids (Sparling *et al*., 2011) neither of which are hearing specialists and both have a relatively localised potential displacement area. The impacts of piling on other prey may mean that fin fish species, particularly those with swim bladders, such as herring, may avoid the area. However, noise modelling indicates only localised effects on species such as sandeels. Consequently, it is predicted that there will be potential prey available in the area during the period of construction and displaced harbour seals will be able to forage during construction activities.

373 Data from existing offshore wind farms indicate that harbour seals may avoid the offshore site during construction. Studies undertaken in Denmark at Nysted Offshore Wind Farm identified a reduction in the use of haul-out sites of between 20 and 60% during the installation of a turbine 10 km away (Teilmann *et al*., 2006) and that they may avoid the area out to 40 km (ICES, 2010). No effects on the harbour seal populations were found following completion of the construction activities. At Scroby Sands offshore wind farm there was a decrease in the number of harbour seals for a period of 2 years at haul-out sites within 2 km of the piling operations. Since the commencement of the operation of the wind farm, the number of harbour seals has increased but remains below the pre-construction population levels. The reason may be due to the construction piling activities, increased vessel traffic or inter-specific competition with grey seals; populations of which have increased in numbers since the time of construction (Skeate *et al.,* 2012).

374 Data from existing offshore wind farms and the potential for harbour seals to forage opportunistically elsewhere together indicate that the impacts from displacement and changes in behaviour will last for the duration of the foundation construction period but populations are predicted to return to natural levels following cessation of piling operations. It is predicted that the potential impacts have been assessed to be of ***moderate significance*** (refer to Table 13.57)**.**

Source	Pathway	Receptor	Magnitude of Effect	Vulnerability of Receptor	Significance of Impact	Qualification of Significance
Piling during installation of jacket foundations	Noise lethal effect/PTS	Harbour seal	Low	High	Moderate significance	Area of potential impacts relatively wide and numbers potentially high. Population of harbour seal is unfavourable.
	Noise displacement/TTS		High	Low	Moderate significance	
	Noise partial displacement/behaviour		High	Low	Moderate significance	

Table 13.57: Significance of potential impacts on harbour seals from pile driving

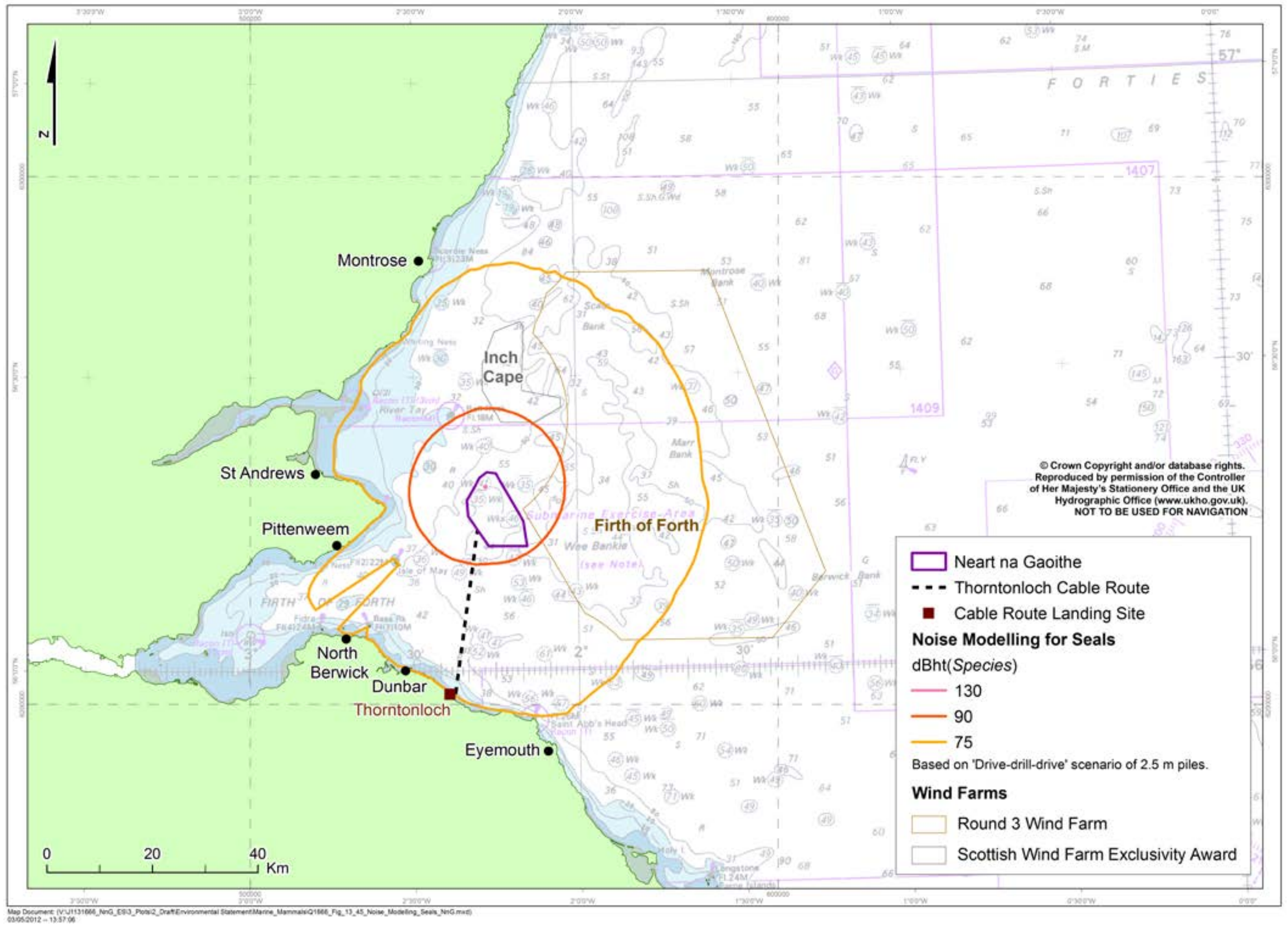


Figure 13.44: Noise modelling results for Seals based on 'drive-drill-drive' scenario of 2.5 m piles

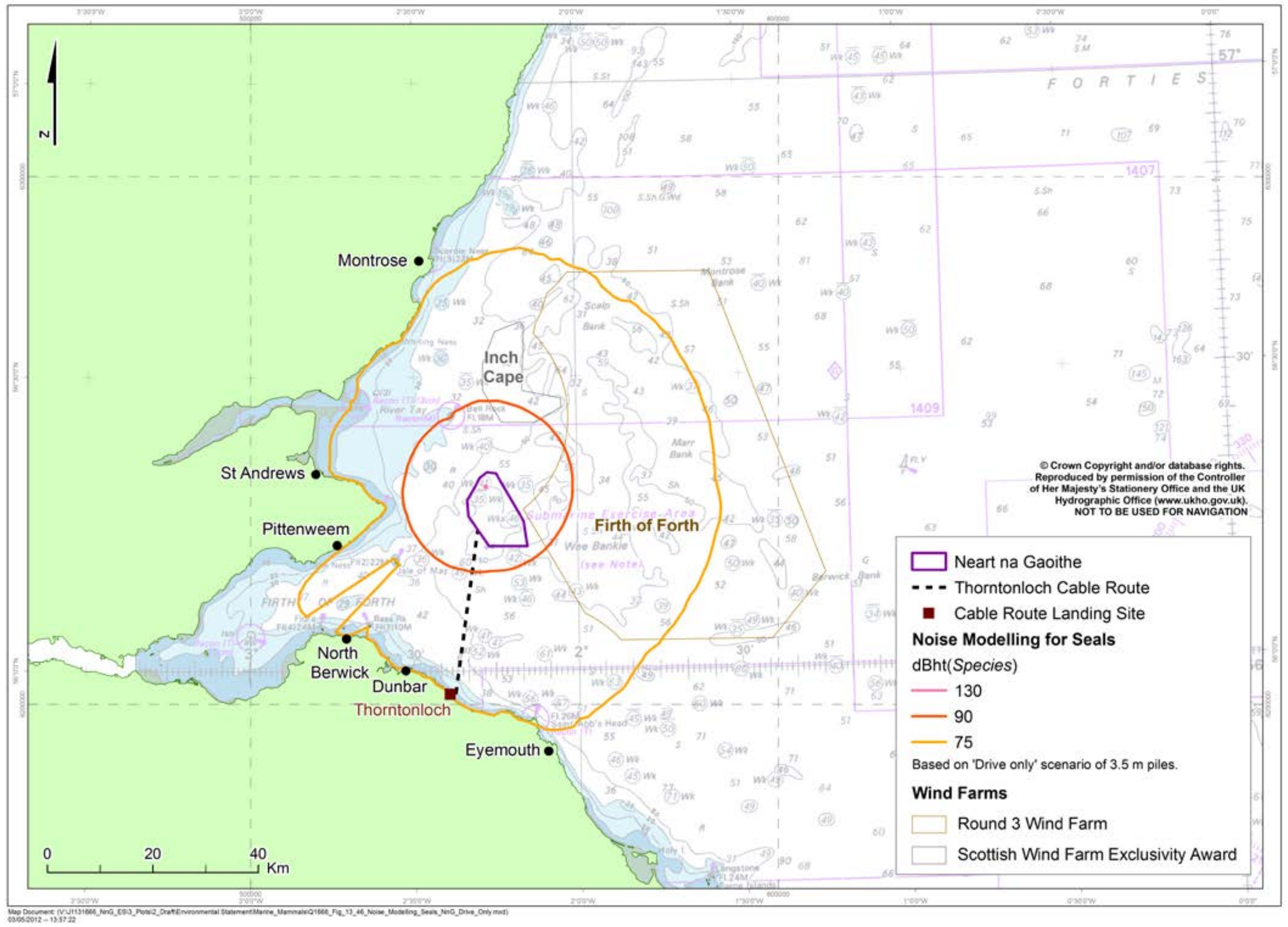


Figure 13.45: Noise modelling results for grey seals based on 'drive only' scenario of 3.5 m piles

13.10.3.20 Cumulative Impacts – Harbour Seal

375 Potential cumulative impacts on harbour seals may arise from the proposed development of offshore wind farms at Inch Cape, Firth of Forth and Neart na Gaoithe. The precise periods of construction for the projects are not currently known, although there is the potential for some periods of overlapping piling activities to be undertaken in the region.

376 Noise modelling has been undertaken across all three development sites and assumes that piling will occur simultaneously at all three sites.

Cumulative Permanent Threshold Shift

377 Results from M-weighted SEL modelling based on pinniped frequency are presented in Figure 13.31.

378 The cumulative area across the three discrete areas of potential impact within which there is the potential for PTS to occur is 2,462.6 km^2 and radiates out to a maximum of 31.6 km.

379 Outputs from SAFESIMM modelling indicate that up to 72 harbour seals may receive levels of sound capable of causing PTS.

380 The regional population of harbour seal is 376 individuals from the Scottish Borders to Fraserburgh (Sparling *et al.*, 2011) (refer to Table 13.2) andtherefore up to 19% of the regional harbour seal population is at risk of receiving SELs that may cause PTS.

381 For reasons described previously it is predicted that the impacts have been assessed to be of ***moderate significance.***

Cumulative Temporary Threshold Shift

382 Outputs from SAFESIMM modelling indicate that up to 206 harbour seals may receive levels of sound capable of causing TTS (refer to Table 13.31).

383 Based on the regional populations, up to 54.5% of harbour seals may receive sound levels that could cause TTS.

384 For reasons described previously the potential impacts has been assessed to be of ***moderate significance*** (refer to Table 13.58)**.**

Cumulative Behavioural Change/Displacement

385 Outputs from SAFESIMM modelling indicate that up to 305 harbour seals may receive levels of sound capable of causing some behavioural change (refer to Table 13.33).

386 Based on the regional populations, up to 81% of harbour seals may receive sound levels that could cause behavioural change and/or displacement.

387 The potential effects from the cumulative impacts arising on harbour seal from the three proposed offshore developments are similar to those described under Neart na Gaoithe on its own. The scale of the impacts, particularly those for potential PTS, are greater however.

388 Seals that may suffer from PTS will permanently lose their ability to hear. Although hearing may not be important for foraging it is likely to have significance in communication and predator avoidance and therefore individuals that suffer PTS may either fail to breed or have significantly greater mortality rates. Consequently, the significance of the impact has been assessed to be of ***moderate significance***.

389 There is predicted to be a higher number of harbour seals at risk of TTS cumulatively than from Neart na Gaoithe on its own. Should all three developments be undertaking piling simultaneously then up to 25% of the regional population of harbour seals could suffer TTS. The impacts from TTS on each individual harbour seal are similar to those arising from Neart na Gaoithe on its own, but the scale of impact on the population is greater.

390 SAFESIMM modelling predicts a similar level of cumulative impact from all three developments as that from Neart na Gaoithe on its own as although the potential area of effect across all three developments is greater, the number of individuals affected remains similar. Therefore, the cumulative impact across all three developments is similar in effect to any one single development on its own, although the duration of the impact will be longer.

391 The potential impacts have been assessed to be of ***moderate significance.***

Source	Pathway	Magnitude of effect	Vulnerability of receptor	Significance of impact
Piling	Noise lethal effect/PTS	Medium	High	Moderate significance
	Noise displacement/TTS	High	Low	Moderate significance
	Noise partial displacement/behaviour	High	Low	Moderate significance
Qualification of significance Area of potential impacts relatively wide and numbers high. Population of harbour seals is unfavourable**.**				
Mitigation Mitigation measures may reduce the risk of PTS. Possible mitigation may include the use of Marine Mammal Observers, acoustic monitoring and deterrent devices.				

Table 13.58: Significance of potential cumulative impacts on harbour seals from pile driving

392 Cumulative impacts arising from potential developments in the Moray Firth include the Moray Firth Offshore Wind Farm and the Beatrice Offshore Wind Farm. Results from the Beatrice Offshore Wind Farm impact assessment are available (BOWL, 2012). Additional potential cumulative impacts are from the EOWDC (AOWFL, 2011).

393 Results from cumulative noise modelling for Beatrice Offshore Wind Farm and Moray Firth Offshore Wind Farm indicate that the total radius for PTS to occur on harbour seal is 2.5 km and for potential behavioural effects it is 59 km (BOWL, 2012). The modelling undertaken indicates that cumulatively less than ten harbour seals may be impacted by PTS and 1,126 may demonstrate some behavioural or avoidance responses (BOWL, 2012).

394 The area of potential effect does not overlap with potential zone of effect from the Firth of Tay developments and therefore no direct cumulative impacts are predicted to occur. However, an additive impact could occur with seals being displaced from two separate areas, resulting in an increased proportion of the regional population being displaced. The cumulative numbers are not directly comparable due to differing assessment techniques, but based on the two results, up to 82 harbour seals may be at risk of PTS and 1,431 harbour seals may be at risk of a behavioural impact should all five wind farms be piling simultaneously. Based on current schedules, this level of impact is not predicted to occur.

395 The regional population of harbour seals, including the Moray Firth, is approximately 1,569 individuals and therefore should cumulative impacts occur from all five developments then up to 5% of the population may suffer PTS and 91% may suffer behavioural or avoidance effects. If this were to occur the significance of the impact has been assessed to be of ***major significance.***

13.10.3.21 Grey Seal

396 Within the study area a total of 43 grey seals were recorded in Year 1 and 57 in Year 2, with all but two sightings in the buffer area. The estimated maximum number of grey seals in the whole surveyed area was 84 in March and 70 in October. Densities of 0.14 grey seal/km^{-2} have been calculated for the whole of the study area (Gordon, 2012).

13.10.3.22 Grey Seals – Pile Driving Impacts

397 Noise modelling has been undertaken for Neart na Gaoithe based on two scenarios 'drive-drill-drive' scenario and 'drive only' the results from which are presented in Figure 13.44 and Figure 13.45.

'Drive-drill-drive' Scenario

398 Results from noise modelling indicate that there is the potential for sound arising from pile driving to remain above the 90 dBht threshold up to 15 km from the sound source and cover an area of approximately 682 km^2. Sound may remain above the 75 dBht threshold out to approximately 47.1 km. The total area where the potential for sound levels to be above 75 dBht but below 90 dBht is 3,581 km^2.

'Drive only' Scenario

399 Modelling results indicate that there is the potential for sound arising from pile driving to remain above 90 dBht threshold up to 16.1 km and remain above 75 dBht out to 50.3 km. The total area of potential impact is between 813.8 km^2 and 4,133 km^2.

Permanent Threshold Shift

400 The results from the INSPIRE dBht thresholds indicate that the potential area within which a seal may be impacted that could cause PTS is 0.096 km^2.

401 SEL noise modelling based on a sound exposure level of 186 dB re 1 $\mu Pa^2 s$ SEL M-weighted, indicates that for PTS to occur, grey seals will have to be within 6.7 km of the piling activities when operations start for PTS to occur. Based on densities obtained from site-specific surveys it is estimated that between 18 and 27 grey seals may be impacted.

402 Based on a SEL of 198 dB re 1 $\mu Pa^2 s$ SEL M-weighted then it is predicted PTS will only impact grey seals within 100 m of the piling activities and therefore no, or very few, grey seals are at risk of PTS.

403 Outputs from SAFESIMM modelling indicate that between 235 and 453 grey seals may receive levels of sound capable of causing PTS.

404 There is a significant difference in the results from the two modelling exercises undertaken. The SAFESIMM modelling is very precautionary and is based on densities higher than those recorded within the offshore site and buffer areas. It does not assume that all individuals flee and that they remain in the zone of effect that can cause PTS. The dose response curve also assumes a higher sensitivity to SELs than may be experienced in reality.

Consequently, the numbers predicted to be impacted by SAFESIMM are greater than those which presume that all individuals avoid the area of potential effect.

405 The regional population of grey seals is 14,047 (9,330-19,906) (Sparling *et al*., 2011) (refer to Table 13.19). Therefore, up to 3.2% of the regional grey seal population is at risk of receiving SELs that may cause PTS. The number of grey seals predicted by SAFESIMM modelling to receive levels of sound capable of causing PTS is relatively high. The predicted area of impact is likely to be localised and the numbers at risk lower than predicted by SAFESIMM.

406 The use of suitable mitigation measures will reduce the risk of any seals within the area of risk of PTS. Potential mitigation measures include the use of acoustic mitigation devices (AMD) designed such that marine mammals will avoid the area of potential risk without causing physical damage. Overall the level of impacts has been assessed to be of ***minor significance***.

Total Displacement and Temporary Threshold Shift

407 Total displacement of grey seals may occur out to 15 km from the piling operations and cover an area of 682 km^2. Based on a density of grey seals of 0.14 per/km^{-2} across the area of potential impact, it is estimated that up to 95 grey seals may be displaced during potential pile driving operations under the 'drive-drill-drive' scenario. Under the 'drive only' scenario it is predicted that that up to 113 grey seals may be displaced (refer to Table 13.59).

408 Outputs from SAFESIMM modelling indicate that between 1,263 and 1,833 grey seals may receive levels of sound capable of causing TTS. Based on the regional populations, up to 13% of grey seals may suffer TTS and/or displacement.

409 It is predicted that grey seals which receive levels of sound capable of causing TTS will avoid the area. Consequently, the duration at which individual seals are at risk will be short as they avoid the area and become displaced.

410 Grey seals are not hearing specialists and do not use sound to detect prey. They have good vision in clear waters and sensitive mystacilia vibrissae to locate prey in waters with poor visibility and therefore the temporary loss of hearing may not affect the ability of grey seals to forage effectively (Miersch *et al*., 2011). The predicted duration of any TTS is less than 24 hours (Kastak *et al.,* 2005) and therefore the temporary hearing loss on grey seals has been assessed to be of ***minor significance***.

Behavioural Change and Partial Displacement

411 The 'drive-drill-drive' scenario modelled predicts a potential for some behavioural effect or partial displacement to occur out to 47 km from the piling operations and cover an area of 3,585 km^2. Under the 'drive only' scenario for four jackets and up to 16 piles, some displacement may occur out to 50.3 km and cover an area of 4,133 km^2.

412 Based on a peak density of grey seals of 0.14 per/km^{-2} across the area of potential impact, it is estimated that up to 498 grey seals may show some behavioural change and or displacement under the 'drive-drill-drive' scenario. Under the 'drive only' scenario it is predicted that up to 289 grey seals may be displaced. Up to 2% of the regional grey seal population may be impacted (refer to Table 13.58).

413 Combining 90 dBht figures and 75 dBht figures, the total number of grey seal predicted to be displaced is 384 individuals or 2.7% of the regional population

414 Outputs from SAFESIMM modelling indicate that between 4,403 and 5,483 grey seals may receive levels of sound capable of causing behavioural change. Based on the regional populations, up to 39% of grey seals may receive sound levels that could cause behavioural effects.

Grey Seal	Sound level			
	90 dBht		75 dBht	
	Area (km^2)	No. impacted	Area (km^2)	No. impacted
'Drive-drill-drive'	689.6	96	3,550	248
'Drive only'	813.8	113	4,133	289
Note: the number impacted is based on the highest predicted density of 0.14/km^2 and 50% displacement occurring within the area of audibility of between 75 dBht and 90 dBht.				

Table 13.59: Predicted number of grey seals displaced from pile driving operations

416 Results from site tagging studies (refer to Figure 13.17 and Figure 13.18), density surface modelling (refer to Figure 13.19 and Figure 13.20) and site-specific surveys (refer to Figure 13.27) indicate that grey seals are scarce within the proposed Neart na Gaoithe offshore site. They also indicate that grey seals forage widely between Shetland and northeast England. In the Firth of Forth and Firth of Tay area grey seals are widely dispersed with pups occurring in more inshore waters compared to adults. Concentrations of grey seals occur in patches to the north, northeast and southeast of Neart na Gaoithe.

417 Within the region the main grey seal haul-outs are on the Isle of May, Fast Castle (Berwickshire) and the Farne Islands off Northumberland. The population in the region has increased significantly in recent years and is currently estimated to be between 9,000 and 19,900 grey seals depending on time of year and survey methods (Sparling *et al*., 2011).

418 Grey seals pup from August to the end of December with those on the Isle May being predominantly from October onwards. Pups and females remain on the haul-out beaches until the pups have weaned up to 23 days after birth. After weaning the pups may remain in the colony for a further two weeks (Thompson and Duck, 2010). Prior to pupping there is a gradual increase in the numbers occurring in nearshore waters adjacent to the haul-out beaches (SNH, 2006a). Following breeding, grey seals undergo a moult in January and February (SNH, 2006a).

419 Grey seals forage widely, feeding on variety of benthic and fish prey species. Within the Firth of Forth and Firth of Tay area, concentrations occur near to the Tay Estuary and to the north and northeast of Neart na Gaoithe (refer to Figure 13.17). There is a small localised patch of higher concentrations near to the south east of the Neart na Gaoithe offshore site (refer to Figure 13.17 and Figure 13.20).

420 The potential effect of causing a displacement may vary depending on the season. The period of main sensitivity is predicted to be during the pupping season from October to December when the majority of grey seals are near to the coastal haul-out sites. The lowest numbers were recorded within the study area during this period (refer to Figure 13.21). Unlike harbour seals, during the breeding season grey seals remain largely ashore.

421 Displacement effects may mean that during the pupping season grey seals may avoid the haul-out sites. If so, pregnant females will have to relocate to other alternative, potentially less suitable, pupping locations. Should this occur then there might be an increase in juvenile mortality. During the 1970s and 1980s, disturbance from culling of grey seals on the Farnes Islands caused extensive relocation of pregnant seals to other areas with significant increases in grey seal populations on the Isle of May and this is likely to have caused the initial start of the colony at Donna Nook in Lincolnshire. Since the cessation of culling and disturbance activities on the Farne Islands the population of grey seals has rapidly increased (Thompson and Duck, 2010). Consequently, it is predicted that any displacement effects will cause temporary relocation of grey seals to other haul-out sites but will return to existing natural levels following the completion of foundation installation.

422 The construction period during which turbine foundations will be installed is predicted to last between 12 and 18 months, therefore the displacement effects away from pupping areas are likely only to occur over one season or possibly two. Should this occur then there will be a temporary adverse effect at the pupping areas during which time grey seals will relocate to alternative pupping grounds.

423 Outside the breeding season, grey seal distribution offshore is predicted to be associated with optimal foraging areas. However, grey seals are opportunistic feeders and can adapt to foraging on alternative prey if their prey

availability changes. The impacts of piling on their prey may mean that fin fish species, particularly those considered to be hearing specialists such as herring, may avoid the area. However, noise modelling indicates only localised effects on species such as sandeels (See Chapter 15: Fish and Shellfish Ecology) and so it is predicted that there will be potential prey available in the area during the period of construction. Grey seals should therefore be able to find food during construction activities.

424 Data from existing offshore wind farms indicate that grey seals may avoid the offshore site during construction but may return following cessation of construction activities. At North Hoyle, grey seals were counted at non-breeding haul-out sites 10 km away before during and after construction and changes in the number of seals were reported. The study concluded that there appeared to be no direct effect on the grey seals from construction activity (SMRU, 2009).

425 At Scroby Sands offshore wind farm there was an increase in the number of grey seals at haul-out sites within 2 km of the piling operations during the construction period (although no direct observations were made during piling operations) and post-construction period (SMRU, 2009).

426 The potential for grey seals to forage opportunistically elsewhere and data from existing wind farms indicate that the impacts from displacement and changes in behaviour will last for the duration of the foundation construction period but populations are predicted to return to natural levels following cessation of piling operations. Overall, the potential impact has been assessed to be of ***minor significance*** (refer to Table 13.60).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Piling during installation of jacket foundations	Noise lethal effect/PTS	Grey seal	Negligible	Very high	Minor significance	Area of potential impacts relatively wide and numbers high. Population of grey seals is favourable. High likelihood of individuals returning post construction.
	Noise displacement/TTS		Low	Low	Minor significance	
	Noise partial displacement/behaviour		High	Low	Minor significance	

Table 13.60: Significance of potential impacts on grey seals from pile driving

13.10.3.23 Cumulative Impacts – Grey Seal

427 Potential cumulative impacts on grey seals may arise from the proposed development of offshore wind farms at Inch Cape, Firth of Forth and Neart na Gaoithe. The precise periods of construction for the projects are not currently known, although there is the potential for some periods of overlapping piling activities to be undertaken in the region.

428 Noise modelling has been undertaken across all three development sites and assumes that piling will occur simultaneously at all three sites.

429 Densities for grey seals of 0.14/km^2 are based on site-specific surveys (Gordon, 2012).

Cumulative Permanent Threshold Shift

430 Results from M-weighted SEL modelling based on pinniped frequency are presented in Figure 13.31.

431 The cumulative area across the three discrete areas of potential impact within which there is the potential for PTS to occur is 2,462.6 km^2 and radiates out to a maximum of 31.6 km. Based on the site-specific density for grey seal it is predicted that up to 344 grey seals may be affected.

432 Outputs from SAFESIMM modelling indicate that up to 733 grey seals may receive levels of sound capable of causing PTS.

433 The regional population of grey seal is 14,047 (9,330-19,906) (Sparling *et al*., 2011) (refer to Table 13.2). Therefore, 5% of the regional grey seal population is at risk of receiving sound exposure at levels that may cause PTS. Overall the potential impacts have been assessed to be of ***moderate significance***.

Cumulative Temporary Threshold Shift

434 Outputs from SAFESIMM modelling indicate that up to 2,579 grey seals may receive levels of sound capable of causing TTS (refer to Table 13.31). Based on the regional populations, up to 18.3% of grey seals may receive sound levels that could cause TTS. Overall the potential impacts have been assessed to be of ***minor significance.***

Cumulative Behavioural Change and Partial Displacement

435 Outputs from SAFESIMM modelling indicate that up to 6,163 grey seals may receive levels of sound capable of causing some behavioural change (refer to Table 13.31). Based on the regional populations, up to 43% of the grey seal population may be displaced during construction activities.

436 The potential effects from the cumulative impacts on grey seal from the three proposed offshore developments are similar to those described under Neart na Gaoithe on its own. The scale of the cumulative impact, particularly for PTS is greater.

437 Grey seals that suffer from PTS will permanently lose their ability to hear and although hearing may not be important for foraging it is likely to have significance in communication and predator avoidance. Individuals that suffer PTS may either fail to breed or have significantly greater mortality rates. Consequently, the significance of the impact may be moderate.

438 There is predicted to be a higher number of grey seals at risk of TTS cumulatively than from Neart na Gaoithe on its own. Should all three developments be undertaking piling simultaneously then up to 18.3% of the regional population of grey seals could suffer TTS. The impacts from TTS on each individual grey seal are similar to those arising from Neart na Gaoithe on its own and likely to last no longer than 24 hrs (Kastak *et al.*, 2005) but the scale of impact on the population is greater.

439 SAFESIMM modelling predicts a similar level of cumulative impact from all three developments as that from Neart na Gaoithe on its own. Although the potential area of effect across all three developments is greater, the number of individuals affected remains similar. The cumulative impact across all three developments is therefore similar in effect to any one single development on its own. However, the duration of the effect will last longer as all three potential developments progress and there are periods of overlapping activity. Overall the potential impacts have been assessed to be of ***minor significance*** (refer to Table 13.61)**.**

Source	Pathway	Magnitude of effect	Vulnerability of receptor	Significance of impact
Piling	Noise lethal effect/PTS	Low	Very high	Moderate significance
	Noise displacement/TTS	Medium	Low	Minor significance
	Noise partial displacement/behaviour	High	Low	Minor significance
Qualification of significance Area of potential impacts relatively wide but grey seals predicted to relocate and return following cessation of construction and population is in favourable conservation status.				
Mitigation Mitigation measures may reduce the risk of PTS. Possible mitigation may include the use of Marine Mammal Observers, acoustic monitoring and deterrent devices.				

Table 13.61: Significance of potential cumulative impacts on grey seals from pile driving

440 Potential cumulative impacts arising from potential developments in the Moray Firth include the Moray Firth Offshore Wind Farm and the Beatrice Offshore Wind Farm. Results from the Beatrice Offshore Wind Farm impact assessment are available (BOWL, 2012). Additional potential cumulative impacts are from the EOWDC (AOWFL, 2011).

441 Results from cumulative noise modelling for Beatrice Offshore Wind Farm and Moray Firth Offshore Wind Farm indicate that the total radius for PTS to occur on grey seal is 2.5 km and for potential behavioural effects is 59 km (BOWL, 2012). The modelling undertaken indicates that cumulatively less than ten grey seals may be impacted by PTS and 1,334 demonstrate some behavioural or avoidance responses (BOWL, 2012).

442 The area of potential effect does not overlap with the potential zone of effect from the Firth of Tay developers and therefore no direct cumulative impacts are predicted to occur. However, an additional impact could occur with an increasing proportion of the regional population being displaced. The cumulative numbers are not directly comparable due to differing assessment techniques but based on the two results, up to 743 grey seals may be at risk of PTS and 7,497 grey seals may be at risk of a behavioural impact should all five wind farms be piling simultaneously. Based on current schedules this level of impact is not predicted to occur but if this were to occur the impact has been assessed to be of ***major significance.***

13.10.3.24 Grey Seal and Harbour Seal – Operating Noise

443 Operating noise from offshore wind turbines occurs at relatively low frequencies and therefore may be audible to grey seals. However, studies undertaken across a number of offshore wind farms indicate that the level of noise is very low. Although sound arising from operating wind turbines may be audible, it is no greater than natural variations in background noise levels and remains below levels that are likely to cause any behavioural or displacement impacts (Nedwell *et al*., 2007a).

444 Studies undertaken in Denmark at two offshore wind farms indicate that there was no negative effect on either harbour or grey seals from operating wind turbines with seals occuring in the areas of the wind farms. No significant effects on seals behaviour were observed (McConnell *et al.,* 2012).

445 Overall the potential impacts have been assessed to be ***not significant***.

13.10.3.25 Grey Seal and Harbour Seal – Vessel Noise

446 The vessels likely to be used during construction and operation are described in Chapter 5: Project Description. Due to the wide range of activities being undertaken, a variety of vessels will be used and different operational noise will be produced.

447 A range of potential impacts may arise from vessel noise, in particular masking effects or avoidance behaviour (OSPAR, 2009; Michel *et al*., 2007).

448 There is the potential for localised avoidance of vessels by seals. Vessel noise is transitory and the impact is both relatively localised and temporary. The overall significance of the impact from vessel noise has been assessed to be ***not significant*** (refer to Table 13.62).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Vessel noise during construction or operation and maintenance	Noise generated by construction or maintenance vessels	Grey and harbour seals	Negligible	Negligible	Not significant	The predicted small area of impact and predicted localise response of temporary duration.

Table 13.62: Significance of potential impacts on seals from vessel noise

13.10.4 Drilling Impact Assessment

449 There are limited studies on the potential impacts drilling noise may have on marine mammals. The levels of noise recorded and the low frequencies indicate that there will not be any potential for PTS. For there to be a risk of TTS, the marine mammal will need to be very close to the drilling activity.

450 Studies undertaken on the Dogger Bank have reported no changes in the activity of porpoises during drilling activities but some reduction during manoeuvring of drill platforms due to vessel activity (Todd *et al.,* 2007). Elsewhere, studies have shown various behavioural changes caused by drilling activities. Grey whales have been reported as showing avoidance behaviour, compared with some species of seal, small odontocetes and baleen whales which may not (OSPAR, 2009; SMRU, 2007).

451 There are no published reports indicating that there is an impact on dolphins from drilling noise. It is further reported that the predominantly low frequency sound sources arising from drilling suggests that bottlenose dolphins may not be able to hear drilling noise until in close proximity to the drilling when there is potential for habituation and tolerance to occur as a result of this (Senior *et al.*, 2008).

452 The low levels of noise arising from drilling and results from studies indicate that potential injuries to marine mammals will not occur, although there is potential for some very localised behavioural responses.

453 Overall the potential impacts from drilling noise on marine mammals has been assessed to be ***not significant*** (refer to Table 13.63).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Drilling during installation of jacket foundations	Noise lethal effect/PTS	All marine mammal species in area	Negligible	Low	Not significant	Area of potential impacts very localised and impacts unlikely to occur.
	Noise displacement/TTS		Negligible	Low	Not significant	
	Noise partial displacement/behaviour		Negligible	Low	Not significant	

Table 13.63: Significance of potential impacts on marine mammals from drilling noise

13.10.5 Physical Impact Assessment

13.10.5.1 Collision with Vessels

455 There is potential for collisions between marine mammals in the area and vessels associated with the construction, operation or decommissioning of the proposed wind farm.

456 Vessel collisions with marine mammals are known to occur and may account for a large proportion of deaths. The majority of recorded mortalities are of large baleen whales, particularly fin and northern right whales although injuries to smaller marine mammals may go unnoticed (Wilson *et al*., 2007). Collisions with seals have been reported but pinnipeds are recognised as being agile swimmers and predicted to be able to avoid the relatively slow moving vessels used during the construction and operational phases of the project.

457 Larger vessels of at least 80 m or longer are thought to cause most injuries and deaths, particularly those travelling at 14 knots or faster. Slower moving or smaller vessels are not thought to have such a significant effect (Laist *et al*., 2001). There is also an increased risk of a collision should masking effects caused during construction operations reduce the ability of the marine mammal to detect oncoming vessels.

458 Vessel surveys indicate that currently there are on average 16 to 17 vessels per day passing within 10 NM of the proposed development. The majority of vessels are associated with the ports in the Firth of Forth and Firth of Tay area and there are clear shipping routes to and from the ports (See Chapter 17: Shipping and Navigation).

459 The number of additional vessels predicted to be using the area associated with the proposed development is described in Chapter 5: Project Description. There will be an increase in vessel movements, particularly during the construction period. However, vessels already use the area extensively and the increase in the number of vessels is predicted to cause only a small increase in collision risk with marine mammals. Overall, it is predicted that there will not be a significant, if any, increase in collisions to marine mammals from the proposed development (refer to Table 13.64).

460 Overall the potential impacts on marine mammals from vessel collisions has been assessed to be ***not significant***.

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Vessel presence during construction or operation and maintenance	Presence of vessel leading to potential physical impact	All marine mammal species	Negligible	Negligible	Not significant	The relatively small incremental increase in the number of vessel movements and the predicted low number of collisions.

Table 13.64: Significance of potential impacts on marine mammals from vessel collisions

13.10.5.2 Collision with Ducted Propellers

461 A relatively recently identified impact from vessels, and a topic subject to ongoing-research, is the apparent increase in impacts between seals and certain types of ships using ducted propellers. Since 2008 a total of 15 seals have been found ashore along Eastern Scotland with skin lacerations caused by what is thought to be the use of ducted propellers on vessels. A further 42 have been found along North Norfolk and some in Northern Ireland (JNCC, 2011). This is likely to be a significant under-estimate on the real number of mortalities (JNCC 2011). The cause of the impact is unknown but it is linked to certain types of azimuth thruster or ducted propeller, which are commonly used offshore (JNCC, 2011).

462 During the construction, operation and decommissioning of the proposed development a wide range of vessels will be used, many of which use ducted propellers order to undertake safe and effective operations. The number and type of ducted propellers used vary across vessels. A construction support vessel will have between four and five thrusters split between bow and stern that may be ducted or azimuth types (Fugro, 2012). Some vessels have gratings over the ducted propellers that may help reduce the risk of seal injury.

463 Based on the current information the risk of an impact in the Firth of Forth and Firth of Tay area is primarily with harbour seals, in particular during the summer months. There have been a number of recorded deaths of harbour seals in the Tay and Eden area (Thompson *et al*., 2010b). The number of harbour seals occurring in the Neart na Gaoithe offshore site is relatively low with the majority of movements occurring to the north (refer to Figure 13.25 and Figure 13.26). Only two harbour seals were recorded within the offshore site and none during the breeding and pupping season (refer to Table 13.13 and Table 13.15). Therefore, the risk of an interaction with a vessel operating within the Neart na Gaoithe offshore site is low. However, if female harbour seals are attracted to the sound from ducted propellers then there is an increased risk of harbour seals being attracted into the area, although over what distance this attraction effect would be seen is not known.

464 Low numbers of grey seals were recorded in the study area, with eight being recorded over the course of 2 years of surveys (refer to Table 13.13 and Table 13.15). Tagging studies indicate that the Neart na Gaoithe offshore site has a relatively low level of usage compared to elsewhere in the Firth of Forth and Firth of Tay area (refer to Figure 13.18 and Figure 13.19) and therefore the risk of an interaction is relatively low.

465 The frequency of interactions between seals and ducted propellers is unknown and is subject to ongoing research. However, the low numbers of seals recorded in the Neart na Gaoithe offshore site, in particular the absence of any harbour seals during the breeding and pupping period, indicates that the risk of an interaction is low and the magnitude of any effect is predicted to be negligible. The overall impact on harbour or grey seals from interactions with ducted propellers is considered to be not significant.

466 Potential mitigation measures will be developed at the time and included within the Environmental Management Plan and will be in line with industry best practice.

467 A monitoring programme will be developed and may potentially use marine mammal observers and or cameras to observe operations immediately prior to and during activities that are using thrusters considered to be of risk. The use of acoustic deterrents may also be considered (refer to Section 13.11: Mitigation and Residual Impacts).

468 Overall the potential impacts on marine mammals from impacts by ducted propellers has been assessed to be ***not significant*** (refer to Table 13.65).

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Vessel presence during construction or operation and maintenance	Vessel ducted propellers leading to physical impacts	Grey and harbour seals	Negligible	Negligible	Not significant	The predicted low number of seals present in the area, particularly during periods of greatest sensitivity.

Table 13.65: Significance of potential impacts on seals from impacts with ducted propellers

13.10.6 Installation of Cables

469 The construction of the proposed wind farm will involve the laying of 140 km of inter-array cables and two 33 km export cables to shore near to Thorntonloch, south of Dunbar.

470 The cables will be trenched and buried using a trenching plough (see Chapter 5:Project Description for detailed description). The trenching and burying of the lines will cause some seabed disturbance which may cause reduced visibility in the water column and potentially affect marine mammals in the surrounding area. In addition to that a cable laying vessel and cable separator vessel will be used to install the cable.

471 The potential impacts from vessels are addressed in Section 13.10.4. Cable laying vessels will be travelling at about 3 km per day and therefore the risk of a marine mammal colliding with a cable vessel is remote.

472 Noise from cable vessels recorded during the construction of North Hoyle offshore wind farm and undertaken during cabling operations reported sound pressure level of 123 dB re 1 µPa at 160 m and an estimated source level of 178 dB re 1 µPa @ 1 m. This was assessed using species-specific hearing thresholds (dBht) and showed that all levels of noise arising from cable laying were below 75 dBht (Nedwell *et al.,* 2003).

473 The scale of redeposition of sediments depends on the type of sediment and the cable installation techniques employed. Studies undertaken at exisiting offshore wind farms indicate that up to 90% of sediments are redeposited on the seabed within 200 m of the activities and therefore the effects are localised along the cable route corridor (BERR, 2008).

474 Marine mammals in the area may avoid foraging in an area of high sediment loads or poor visibility. However, marine mammals are adapted to conditions with high sediment loads and therefore are unlikely to be affected by a localised and temporary area impacted during cable laying. Should it occur then marine mammals may forage elsewhere away from the zone impacted predicted to be within 200 m. The potential impacts from cable laying have been assessed to be ***not significant***.

Source	Pathway	Receptor	Magnitude of effect	Vulnerability of receptor	Significance of impact	Qualification of significance
Inter-array and export cables	Increase sediment load in water colum	All marine mammal species	Negligible	Negligible	Not significant	The impact will be localised and temporary and marine mammals can forage in water with high sediment loads.
Inter-array and export cables	Increased noise	All marine mammal species	Negligible	Negligible	Not significant	The predicted level of noise will be below levels likely to cause displacement.

Table 13.66: Significance of potential impacts on cetaceans from cable laying

13.11 Mitigation and Residual Impacts

475 Identifying potential measures that can mitigate impacts, particularly those that are identified as being potentially significant is an important part of the assessment process.

476 The following section identifies potential mitigation measures, their potential effectiveness and consequent reduction of an impact and their practicality.

13.11.1 Foundation Options

477 There are three basic types of foundation that have been used for offshore turbines: monopiles, tripod/jackets and gravity based. The use of each depends on various physical site-specific factors including water depth and sediment type. The use of monopiles at Neart na Gaoithe is not an option due to water depth. The alternative foundation types of tripods and gravity based can both, in theory, be used at Neart na Gaoithe. Tripods and jackets are installed using three or four, 2.0 to 3.0 m piles. Gravity based structures are considered the 'quietest' structures to install as they do not require piling.

478 Floating turbines are available, however their use requires significant anchoring and they are only at the first stages of testing.

479 Consideration has been given to all the potential foundation types that could be used at Neart na Gaoithe and the options available are the use of a jacket or gravity based foundation (refer to Chapter 4: Site Selection, Project Alternatives and Design Evolution).

13.11.1.1 Drilled Piles

480 The drilling of piles minimises noise from impact piling. The construction options for the site presumes that the majority of the piles to be drilled, however, during detailed design minimising piling further will be explored.

13.11.1.2 Reduced Energy Input

481 The methods for installing piles into the seabed using a hammer are similar. However, there is a linear relationship between the acoustic output and hammer energy and therefore the level of noise emitted can be reduced by minimising the energy used to install the pile. There are technical considerations that affect the minimum level of energy that is required in order to successfully install a pile, in particular the seabed type and pile diameter. By reducing the level of energy required, the level of noise into the marine environment is also reduced.

482 Ongoing studies being undertaken by the developer will ensure that the installation of piles will be carried out using the lowest amount of energy as practically possible.

13.11.1.3 Soft Start

483 Gradually increasing hammer energy level over time is known as a soft start and allows animals in the vicinity to leave the area of potential impact before the before maximum levels are achieved. The length of time taken in increasing the hammer energy can affect the level of impact as the animal has more time to leave the area the longer the soft start is. There are technical issues to consider when considering the duration of the soft start, as it is necessary to install the pile using steady and frequent strikes to ensure the pile continuously enters the seabed.

484 The use of soft starts is industry best practice and the developer will continue to explore the optimal installation technique combining reduced energy and soft start scenarios. This will be detailed in the Environmental Management Plan.

13.11.1.4 Barriers

485 By providing a barrier between the pile and the environment there is the potential for reducing the level of noise entering the marine environment. There are a number of differing types of barrier currently being considered including:

- Large Bubble Curtain – Creating a bubble curtain around specific construction works such as a pile driving activity. Previously used during the installation of FINO3 platform and elsewhere (e.g., Lucke *et al*., 2011). Unproven at site water depths and requires significant compressors to create a big enough bubble curtain;
- Small Bubble Curtain – Create a barrier to sound by encasing the pile in air bubbles which can be free flowing through a stacked system, contained in a sleeve or through some other means. A number of small bubble curtain systems have been in development over the last few years and testing in shallower water depths has proved successful however, there are limitation when transferring this technology to deeper water and larger operations;
- Piling Sleeve – Sound absorbing material in the form of a sleeve which fits around the pile. These systems have been in development over the last couple of years and have been tested with some success in water depth shallower than the site. Limitation will include water depth and incorporating a sleeve into piling design; and
- Operators of piling equipment have recognised the need to minimise noise from piling activities and are considering ways to incorporate noise reduction technology into equipment rather than use a barrier.

As part of the Environmental Management Plan for piling operations, the developer will complete an assessment of all available mitigation measures for piling noise. The assessment will be based on technical feasibility, Health and Safety requirements, environmental benefit and cost.

13.11.1.5 Marine Mammal Observers

486 Using Marine Mammal Observers (MMO) to minimise the risk of a marine mammal being present in the vicinity of pile driving operations may mitigate against direct injury and PTS for marine mammals. There is a protocol in place providing guidance on the use of MMOs as a form of mitigation (JNCC, 2010c).

487 The developer will ensure that all MMOs used are trained, experienced and fully understand the MMO guidance.The use of MMOs during construction will be assessed as part of the Site Environmental Management Plan.

13.11.1.6 Passive Acoustic Monitoring

488 The use of Passive Acoustic Monitoring (PAM) can be a useful tool in reducing the risk of a marine mammal being present but not visually detected prior to starting pile driving activities (JNCC, 2010c). However, PAM is limited in its effective range, the species it may detect, cannot detect species that are not vocalising and cannot be used to detect seals. However, PAM may be useful in areas where highly vocal but difficult to see species such as porpoises, may occur.

489 The use of PAM during construction will be assessed as part of the Site Environmental Management Plan.

13.11.2 Acoustic Deterrents

490 Acoustic Deterrent Devices (ADD) are widely used by other industries as a means to displace marine mammals from a particular area. They are used most widely around fish farms where they aim to deter seals from entering the sites. However, their effectiveness can diminish overtime as individuals become habituated to the sound levels and may (in the case of fish farms) become attracted to the sound as they associate it with profitable feeding areas. ADDs have been used by the offshore wind farm industry during installation and there is potential for them to be effective means of minimising the risk to marine mammals (Gordon *et al*., 2007).

491 The use of ADDs, particularly for seals during construction, will be assessed as part of the Environmental Management Plan.

13.11.3 Timing

492 By managing the timing of certain activities there is the potential for reducing the impact of noise on marine mammals by avoiding undertaking activities at particularly sensitive times of year.

493 The results of the impact assessment have identified particular periods when sensitivities for individual species may be greater. However, across all species there is no one period of greater or lesser sensitivity and therefore the potential to reduce significantly the impacts by avoiding certain periods is limited.

494 The developer is exploring, with other developers, potential ways to reduce the impacts by managing the timing of construction activities.

13.12 Summary

495 Table 13.67 below provides a summary of the impact assessment for marine mammals.

Source	Pathway	Receptor	Impact significance ore-mitigation	Mitigation	Residual impact post-mitigation	Cumulative and in-combination impact	Qualification of significance
Construction							
Piling noise during installation of jacket foundations	Noise lethal effect/PTS	Harbour porpoise	Not significant	Minimise the duration of piling activities. Where practicable, preferentially selecting installation techniques that emit least amount of sound. Optimising soft start procedures and minimising hammer energy. Use of Acoustic Deterrent Devices and/or visual and acoustic detection devices.	Reduced risk of auditory injury	Not significant	Area of potential impact very localised and numbers at risk very low from PTS. Harbour porpoise may relocate and return following cessation of piling. At a cumulative level area of potential impact very localised and numbers at risk very low from PTS. Low proportion of regional population may relocate and return following cessation of piling.
	Noise displacement/TTS		Minor significance		Reduced risk of temporary auditory injury	Not significant	
	Noise partial displacement/behaviour		Minor significance		Reduced area of potential displacement	Minor significance	
	Noise lethal effect/PTS	White-beaked dolphin	Not significant	Minimise the duration of piling activities. Where practicable, preferentially selecting installation techniques that emit least amount of sound. Optimising soft start procedures and minimising hammer energy. Use of Acoustic Deterrent Devices and/or visual and acoustic detection devices.	Reduced risk of auditory injury.	Not significant	Area of potential impact very localised and numbers at risk very low from PTS. White-beaked dolphin may relocate and return following cessation of piling. At a cumulative level area of potential impact very localised and numbers at risk very low from PTS. White-beaked dolphin may relocate and return following cessation of piling.
	Noise displacement/TTS		Not significant		Reduced risk of temporary auditory injury	Not significant	
	Noise partial displacement/behaviour		Not significant		Reduced area of potential displacement	Not significant	
	Noise lethal effect/PTS	Bottlenose dolphin	Not significant	Minimise the duration of piling activities. Where practicable, preferentially selecting installation techniques that emit least amount of sound. Optimising soft start procedures and minimising hammer energy. Use of Acoustic Deterrent Devices and/or visual and acoustic detection devices.	Reduced risk of auditory injury	Not Significant	Area of potential impact very localised and numbers at risk very low from PTS. Bottlenose dolphins may relocate but potential for a high proportion to receive sound exposure levels that may cause some behavioural changes. At a cumulative level area of potential impact very localised and numbers at risk very low from PTS. Bottlenose dolphins may relocate but potential for a high proportion to receive sound exposure levels that may cause some behavioural changes.
	Noise displacement/TTS		Minor significance		Reduced risk of temporary auditory injury	Minor significance	
	Noise partial displacement/behaviour		Minor significance		Reduced area of potential displacement	Moderate/major significance	
	Noise lethal effect/PTS	Minke whale	Not significant	Minimise the duration of piling activities. Where practicable, preferentially selecting installation techniques that emit least amount of sound. Optimising soft start procedures and minimising hammer energy. Use of Acoustic Deterrent Devices and/or visual and acoustic detection devices.	Reduced risk of auditory injury	Not significant	Area of potential impact very localised and numbers at risk very low from PTS. Level of sound impact is large but Minke whale may relocate. At a cumulative level Area of potential impact very localised and numbers at risk very low from PTS. Level of sound impact is large but minke whale may relocate.
	Noise displacement/TTS		Not significant		Reduced risk of temporary auditory injury	Not assessed	
	Noise partial displacement/behaviour		Not significant		Reduced area of potential displacement	Not assessed-	

Source	Pathway	Receptor	Impact significance ore-mitigation	Mitigation	Residual impact post-mitigation	Cumulative and in-combination impact	Qualification of significance
	Noise lethal effect/PTS	Harbour seal	Moderate significance	Minimise the duration of piling activities. Where practicable, preferentially selecting installation techniques that emit least amount of sound. Optimising soft start procedures and minimising hammer energy. Use of Acoustic Deterrent Devices and/or visual and acoustic detection devices. Consider avoiding the starting of the installation of turbine foundations immediately prior to or during pupping period.	Reduced risk of auditory injury	Moderate significance	Area of potential impacts relatively wide and numbers high. Population of harbour seal is unfavourable.
	Noise displacement/TTS		Moderate significance		Reduced risk of temporary auditory injury	Moderate significance	
	Noise partial displacement/behaviour		Moderate significance		Reduced area of potential displacement	Moderate significance	
	Noise lethal effect/PTS	Grey seal	Minor significance	Minimise the duration of piling activities. Where practicable, preferentially selecting installation techniques that emit least amount of sound. Optimising soft start procedures and minimising hammer energy. Use of Acoustic Deterrent Devices and/or visual and acoustic detection devices. Consider avoiding the starting of the installation of turbine foundations immediately prior to or during pupping period.	Reduced risk of auditory injury	Moderate significance	Area of potential impacts relatively wide and numbers high. Population of grey seals is favourable. High likelihood of individuals returning post construction. At a cumulative level area of potential impacts relatively wide but grey seals predicted to relocate and return following cessation of construction and population is in favourable conservation status.
	Noise displacement/TTS		Minor significance		Reduced risk of temporary auditory injury	Minor significance	
	Noise partial displacement/behaviour		Minor significance		Reduced area of potential displacement	Minor significance	
Drilling during installation of jacket foundations	Noise lethal effect/PTS	All marine mammal species in area	Not significant	Minimise the duration of drilling activities.	Reduced duration of disturbance	Not significant	Area of potential impacts very localised and impacts unlikely to occur. Levels of noise will be considerably lower than that from piling operations and no cumulative effects predicted.
	Noise displacement/TTS		Not significant		Reduced duration of disturbance		
	Noise partial displacement/behaviour		Not significant		Reduced duration of disturbance		
Vessel noise during construction	Noise generated by construction vessels	Harbour porpoise	Not significant	Minimise as far as practicable the number of vessels used during the construction periods.	Reduced level of disturbance	Not significant	Harbour porpoise may move away from operating vessels but return to the area once vessels leave the area.
		Minke whale	Not significant		Reduced level of disturbance		The low numbers of minke whale recorded and the predicted small area of impact.
		Bottlenose dolphin	Not significant		Reduced level of disturbance		Bottlenose dolphins are known to tolerate vessel.
		Grey and harbour seals	Not significant		Reduced level of disturbance		Low numbers of seals recorded and localised effects from vessel noise.
Vessel presence during	Presence of vessel	All marine mammal species	Not significant	Minimise as far as	Reduced risk of seal	Not significant	The relatively small incremental increase in the number of vessel

Source	Pathway	Receptor	Impact significance ore-mitigation	Mitigation	Residual impact post-mitigation	Cumulative and in-combination impact	Qualification of significance
construction	leading to potential physical impact			practicable the number of vessels used during the construction periods. Ensure vessels using thrusters follow the latest best practices at the time concerning injuries to seals.	injuries		movements and the predicted low number of collisions.
Operation and Maintenance							
Turbine noise during operational phase	Noise generated by turbine rotation	Harbour porpoise	Not significant	None envisaged	Not significant	Not significant	Harbour porpoise are known to enter operating wind farms in similar or greater numbers than prior to construction.
	Noise generated by turbine rotation	White-beaked dolphin	Not significant		Not significant	Not significant	White-beaked dolphin will probably enter the wind farm area.
	Noise generated by turbine rotation	Bottlenose dolphin	Not significant		Not significant	Not significant	No bottlenose dolphins are predicted to occur in the area.
	Noise generated by turbine rotation	Minke whale	Not significant		Not significant	Not significant	The low numbers of minke whale recorded and the predicted small area of impact.
Vessel noise during operation and maintenance	Noise generated by maintenance vessels	All marine mammal species	Considered analogous to that assessed during construction period	Minimise as far as practicable the number of vessels used during the operational period.	Reduced level of disturbance	Not significant	The noise generated by vessels during operation will be relatively low level, localised and transient in its nature.
Vessel presence during operation and maintenance	Presence of vessel leading to potential physical impact			Minimise as far as practicable the number of vessels used during the operational period. Ensure vessels using thrusters follow the latest best practices at the time concerning injuries to seals.	Reduced level of disturbance. Reduced risk of seal injuries	Not significant	Very low numbers of seals recorded indicate low risk of an impact. The use of appropriate best practice will further reduce the risk.
Inter-array and export cables	Electromagnetic fields	All marine mammal species	Not significant	None envisaged	Not significant	Not significant	The predicted range of detectable magnetic fields will be very localised and cetaceans, if they can detect them will be able to swim away without any effects.
Inter-array and export cables	Sediment disturbance	All marine mammal species	Not significant	None envisaged	Not significant	Not significant	The impact will be localised and temporary and marine mammals can forage in water with high sediment loads.
Inter-array and export cables	Vessel noise	All marine mammal species	Not significant	None envisaged	Not significant	Not significant	The predicted level of noise will be below levels likely to cause displacement.

Table 13.67: Summary of potential marine mammal impacts and mitigation

13.13 References

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Appendices

Appendix 13.1: Noise Model Technical Report

Appendix 13.2: SMRU Ltd Report – SAFESIMM Report

Appendix 13.3: SMRU Ltd Report – Bottlenose dolphins baseline

Appendix 13.4: SMRU Ltd Report – Seal Characterisation

Appendix 13.5: Acoustic and visual surveys

Appendix 13.6: SMRU Aerial Survey