ABERDEEN HARBOUR
EXPANSION PROJECT
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Statement

CHAPTER 15: MARINE MAMMALS

15. MARINE MAMMALS

15.1 Introduction

This chapter presents an assessment of the potential effects of the construction and operation of the proposed Aberdeen Harbour Expansion Project at Nigg Bay (hereafter referred to as "the Development") on marine mammals. Effects on marine mammal (principally bottlenose dolphin, harbour porpoise and grey seal) populations including those which contribute to the designation Special Areas of Conservation (SAC) within the local and regional area, are also assessed in support of the Habitats Regulations Appraisal (HRA) (please refer to ES Volume 4: Habitats Regulations Appraisal). Nature conservation designations are described addressed in Chapter 10: Nature Conservation. Impacts on likely prey, benthic ecology and fish ecology are addressed in Chapter 12: Benthic Ecology and Chapter 13: Fish and Shellfish Ecology.

The project description used within this assessment is presented in Chapter 3: Description of the Development.

This chapter is supported by, and should be read in conjunction with, the following appendices:

- ES Appendix 14-A: Marine Ornithology Vantage Point Survey Report ;
- ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay;
- ES Appendix 15-B: Seal telemetry analysis; and
- ES Appendix 13-B: Underwater noise impact study.

15.2 Policy, Legislation and Guidance

This section outlines the policy, legislation and guidance that are relevant to the assessment of potential effects on marine mammals. Policy, legislation and guidance applicable to the wider project can be found in Chapter 4: Planning and Legislation.

Further advice in relation to the project, its perceived effects and the scope of the issues to be addressed has been sought through consultation with the both statutory and non-statutory authorities (refer to Section 15.1.)

Based upon the conservation value of a wide range of species of marine mammals, these species are afforded protection under international and national legislation. An overview of the specific legislation relevant to marine mammals in Scottish waters is provided below.

15.2.1 International

- European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (commonly referred to as the Habitats Directive);
- Convention for the Protection of the Marine Environment of the Northeast Atlantic (OSPAR Convention, 1992);

- Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas, 2008 (ASCOBANS);
- Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1982);
- Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention, 1979); Aims to conserve migratory species throughout their range. Appendix 2 of the Convention lists migratory species that need or would significantly benefit from international co-operation and includes Bottlenose Dolphin; and
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1973.

15.2.2 National

- The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014;
- Conservation of Seals Act 1970.

15.2.3 UK Guidance Relevant to Project

A brief summary of the main UK guidance relevant to the project activities are provided below:

- Joint Nature Conservation Committee (JNCC) guidelines for minimising the risk of injury to marine mammals from using piling (JNCC, 2010b);
- JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC, 2010c); and
- The protection of Marine European Protected Species from injury and disturbance - Guidance for Scottish Inshore Waters (Marine Scotland, 2014).

15.3 Consultation

Table 15.1 presents the consultation that has been undertaken to date in respect of the scope of the assessment of potential effects on marine mammals.

Table 15.1: Consultations undertaken

Consultee	Date	Summary of Consultation	Where Addressed in ES
Scottish Natural Heritage (SNH)	SNH comments on Scoping Report dated 20/08/2013	As well as disturbance, consideration also needs to be given to the impacts of pollution and displacement and also the potential for injury or death. The potential causes of this are underwater noise and collision with vessels (construction and operation).	These potential impacts are all discussed and assessed in Section 15.6.
		Assessment must take into account noise impacts from drilling and blasting (including multiple charges) as well as piling.	Noise impacts for these activities are assessed in Section 15.6.3.1 and in ES Appendix 13-B: *Underwater noise impact study* presents the subsea noise modelling which informs the assessment.
		For seals the ES needs to address the risk of corkscrew injuries occurring and whether this is a relevant issue for this site. In particular, it should consider the use of vessels with ducted propellers during construction and operation of the new harbour.	Collision impacts and corkscrew injuries are considered within the impact assessment in Section 15.6.
		If multiple blasts would be used in quick succession, the interaction between the blasts and cumulative impact should be assessed. If the applicant encounters difficulties with this assessment, we ask that they contact us to discuss how to address this matter.	Addressed in Section 15.6.3.1: Effects Relating to Noise.
		Suggests wider studies to “establish possible connectivity” to SACs. For bottlenose dolphin this is not required as it has been already proven and accepted.	Bottlenose dolphin connectivity has been proven from the work undertaken by Aberdeen Lighthouse Field Station. Seal telemetry studies specific to the project have been undertaken by SMRU. This is reported in ES Appendix 15-B: Seal telemetry analysis, with the outputs summarised in Section 15.5.5.
		Analysis of seal telemetry data by the Sea Mammal Research Unit (SMRU) has shown that grey seals tagged in both the Isle of May SAC and Berwickshire and North Northumberland Coast SAC appear to routinely travel past Aberdeen (through the proposed location) on their way to the Pentland Firth. The proportion of the SAC populations that travels in this way is not known nor how long they remain in this area for.	Seal telemetry studies specific to the project have been undertaken by SMRU. This is reported in ES Appendix 15-B: Seal telemetry analysis, and the outputs are summarised in Section 15.5.5.
		Ideally there should be a baseline to run the model against. There is data from around the UK (and potentially from Aberdeen) on background noise levels that could be used to give an indication.	Discussed within ES Appendix 13-B: Underwater noise impact study.

Table 15.1: Consultations undertaken continued

Consultee	Date	Summary of Consultation	Where Addressed in ES
Scottish Natural Heritage (SNH) Continued	SNH comments on Scoping Report dated 20/08/2013		
		The telemetry study showed that harbour seals tend to be more limited in their movements (foraging distances – approximately 50k m) than grey seals and stay in the same area. The Firth of Tay and Eden Estuary SAC is approximately 80km from the development site and would normally be considered outwith 'normal' harbour seal foraging range. It would therefore be exceptional that harbour seals found in the vicinity of the proposed Development [original wording stated 'wind farm' however in the context of this project the word 'Development' has been subtituted] are from either this SAC or the Dornoch Firth SAC - the two closest harbour seal SACs. However, this subject is being reviewed as more information becomes available on the harbour seal population and the causes of its decline. The applicant will need to provide evidence as to whether or not there is a likely significant effect and we are happy to assist with this.	Seal telemetry studies specific to the project have been undertaken by SMRU. This is reported in ES Appendix 15-B: Seal telemetry analysis, and the outputs are summarised in Section 15.5.5.
		Please note that marine mammals are priority marine features.	Noted.
		All cetaceans are European Protected Species (EPS) and consideration will need to be given to how the development complies with EPS legislation and whether any licences are required.	Noted. Following the award of consent, EPS Licences will be sought where necessary, in consultation with the relevant statutory authorities.
		A detailed Construction Environmental Management Plan should be produced which should contain a marine mammal risk assessment (detailing Marine Mammal Observer (MMO) use, exclusion zones etc).	Mitigation for marine mammals is discussed in Section 15.7. A draft Outline Environmnetal Management Plan (including a Marine Mammal Protection Plan) is included within Chapter 26.
Marine Scotland	Scoping advice dated 19 September 2013	We agree with the species and potential impacts that have been scoped in at this stage. We advise that it is necessary to carry out noise propagation modelling, in particular with regard to piling noise, in order to properly assess the impacts on marine mammals. The developer should consider whether any suitable alternatives to piling exist and if not, whether there are piling methods which might create lower noise emissions and list all suitable mitigation.	Noise propagation modelling has been undertaken to support the EIA (ES Appendix 13-B: Underwater noise impact study), based upon the methods deemed to be suitable for construction.
		Any impacts on seals should be put into the context of the Potential Biological Removal (PBR) for the region. For this development, the PBR for grey seals this year is 314 and for harbour seals is 2. These values are updated annually, but it is unlikely that they will change markedly from year to year.	PBR has been considered for both seal species in section 15.8. This includes latest PBR values.

Table 15.1: Consultations undertaken continued

Consultee	Date	Summary of Consultation	Where Addressed in ES
Marine Scotland Continued	Scoping advice dated 19 September 2013	We consider that the bottlenose dolphins using the east coast of Scotland are a single population and therefore we believe that potential impacts in the area around the Aberdeen Harbour development must be assessed with respect to the Moray Firth SAC. The 'Cumulative Impacts' section (4.18) lists a number of projects for consideration and states that the list will be developed and updated throughout the Environmental Impact Assessment (EIA) process and agreed with relevant authorities prior to the submission of the application for Aberdeen Harbour Development (AHD). We agree with this approach and emphasise the requirement to take into account the whole East Coast area when considering which projects should be included.	The cumulative effects are assessed in Section 15.9, and has included projects throughout the east coast area.
Whale and Dolphin Conservation (WDC)	Comments included within Annex II of Transport Scotland's Scoping Opinion dated 10 January 2014	WDC has serious concerns about the effect of construction and operation of the proposed harbour extension on marine mammals, especially bottlenose dolphinand Connectivity of bottlenose dolphins between the Moray Firth Special Area of Conservation (SAC) and Aberdeen Harbour has been well documented e.g. Weir at al. (2006) and Cheney et al. (2013).	Noted. Potential construction and operational effects on bottlenose dolphin and the Moray Firth SAC are considered within this chapter.
		Our main concerns are that there will be a significant effect on marine mammals due to underwater noise from pile driving and dredging, and increased vessel traffic during construction and operation.	The impacts are considered within the impact assessment in Section 15.6.
		Aberdeen Harbour is an important area for bottlenose dolphins to forage. A recent study by Pirotta et al. (2013) found that bottlenose dolphins left Aberdeen harbour for five weeks whilst dredging activity occurred in the area. Although the timing of work has not been documented in the Scoping Report, construction of AHD will exceed five weeks, and is likely to cause a significant effect on animals in the area.	The findings of the study by Pirotta et al. (2013) have been acknowledged within the assessment of potential impacts in Section 15.6.
		Alternative methods to pile driving should be investigated to reduce noise impacts. If pile driving is used, a noise-reducing barrier (such as a bubble curtain) should be maintained around the source to mitigate the impacts of radiated noise levels. The barrier should remain in place until piling has been completed.	Mitigation for marine mammals is discussed in Section 15.7 .
		The Marine Mammal Protection Plan (MMPP) should be developed in consultation with scientists with expertise in the Natura species to ensure that monitoring of the bottlenose dolphin, and grey and harbour seal SAC populations contribute to existing monitoring studies, to understand how bottlenose dolphins and seals use the area and to assess any changes to site use, and are appropriate to the level of works WDC would like the opportunity to be part of the team that develops the MMPP.	Mitigation for marine mammals is discussed in Section 15.7.

Table 15.1: Consultations undertaken continued

Consultee	Date	Summary of Consultation	Where Addressed in ES
Whale and Dolphin Conservation (WDC) Continued	Comments included within Annex II of Transport Scotland's Scoping Opinion dated 10 January 2014	Due to the vast quantity of proposed and consented activity on the east coast of Scotland, we have concerns about the cumulative impacts of all the developments that may occur in the area. When assessing the cumulative impacts, AHD will need to account for all developments within the known range of each marine mammal species.	The cumulative effects are assessed in Section 15.9, which has included projects throughout the east coast area of Scotland and in the north east of England.
		Whilst we agree that surveys can be conducted in conjunction, the sea bird and marine mammal surveys should have their own dedicated observers. Marine mammal observers should be from a JNCC accredited source and there should be enough of them to work continuously without tiring.	Survey methodologies were agreed in consultation with Scottish Natural Heritage. Surveys were undertaken by a JNCC accredited European Seabirds at Sea (ESAS) observer and JNCC accredited Marine Mammal Observer (MMO).
		Passive acoustic monitoring (PAM) should be conducted in parallel to visual observations at all times. WDC welcomes the Environmental Statement and Environmental Impact Assessment including proposed mitigation methods to reduce the impact of AHD on marine mammals.	PAM and Vantage Point surveys were undertaken in conjunction with each other. The surveys undertaken are detailed within ES Appendix 14-A: Marine Ornithology Vantage Point Survey Report, and summarised in Section 15.5.3.1 of this chapter. Mitigation for marine mammals is discussed in Section 15.7.
RSPB	Comments included within Annex II of Transport Scotland's Scoping Opinion dated 10 January 2014	With regards to marine mammals and cetaceans such as harbour porpoise and bottlenose dolphin it is essential that the EIA includes adequate survey for these species to assess any potential issues.	The surveys undertaken are detailed within ES Appendix 14-A: Marine Ornithology Vantage Point Survey Report, and summarised in Section 15.5.3.1 of this chapter.
Aberdeen City Council	Comment made by Aberdeen County Council and relayed through correspondence with Barton Willmore dated 09/07/2015	Concern that the breakwater on the southern side could act as a barrier which may encourage dolphins to enter into the harbour area and into the way of boats.	This issue has been considered and scoped out of the impact assessment in section 15.6.2. However, collisions between marine mammals and vessels during operation has been assessed within section 15.6.4.3.
RSPB (Aberdeen Dolphin Watch Programme) and WDC (Shorewatch Data)	Correspondence with RSPB (dated 03 August 2015) and WDC (dated 07 August 2015)	RSPB were contacted with a request for data acquired during their Dolphin Watch recreational sightings programme. The RSPB advised that all of the data that is collected as part of the RSPB Dolphin Watch project goes to the WDC Shorewatch project. Shorewatch is a citizen science programme and the data is collected from specific locations across the Scottish coastline by trained and supported volunteers. The WDC provided Shorewatch data from 2012-2014 with some available data for 2015.	The Shorewatch data has been summarised for the respective species within the species accounts in Section 15.5.

15.4 Methodology

This section describes the methods used to define the existing marine mammal ecological conditions within and around the development as well as those used to evaluate the likely significance of effects.

15.4.1 Study Area

The study area for marine mammals includes the immediate marine development boundary and its local surroundings. This area has been demarcated in order for the study area to encompass the maximum spatial extents of potential impacts (as shown on Figure 15.1). A literature review was also conducted to collect data regarding marine mammals across a wider study area, to establish mobile receptors that may have connectivity with the study area during certain periods of the year. This wider study area broadly corresponds to the coastline running southwards from the Moray Firth in Scotland to the north Northumberland coast of England. The wider marine mammals study area is shown on Figure 15.2.

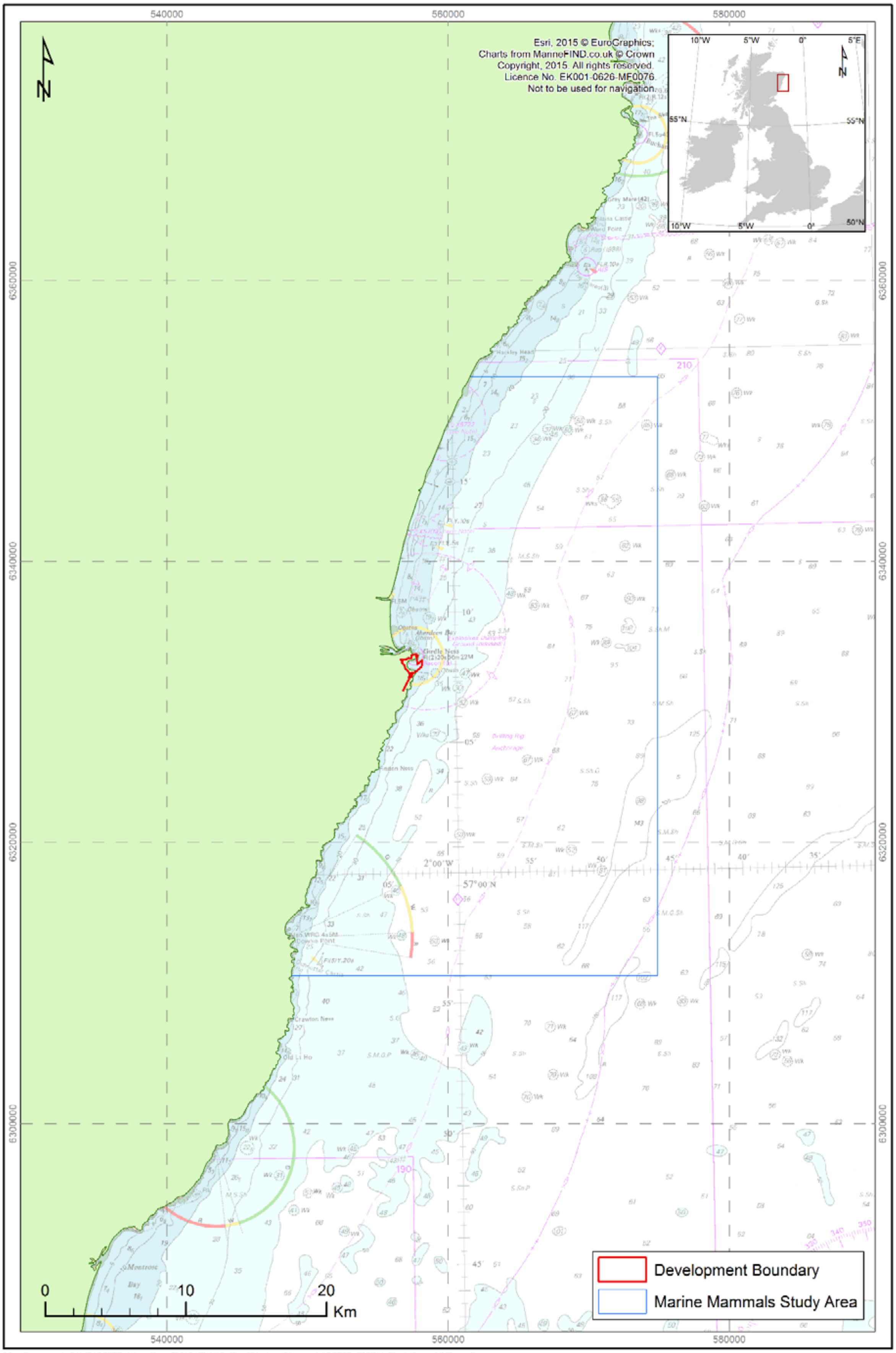

Figure 15.1: Study area encompassing development boundary and local surroundings

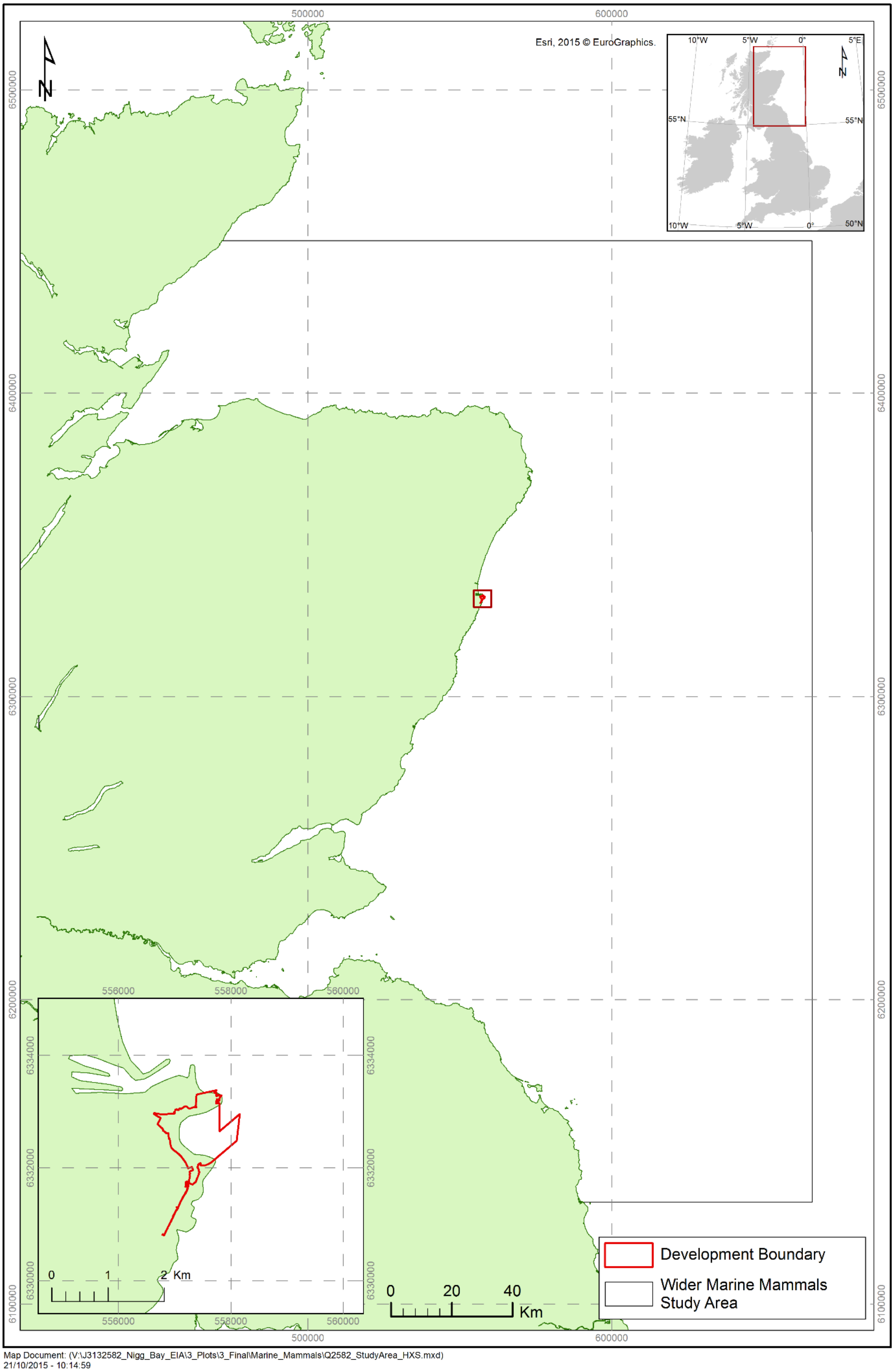

Figure 15.2: Wider marine mammals study area

15.4.2 Scope of the Assessment

The scope of this assessment has been determined through consultation with statutory and non-statutory organisations, with the results of consultation provided in Table 15.1. Figure 15.1 and Figure 15.2 show the geographical scope of the assessment.

The following marine mammal receptors were identified during the EIA scoping stage (Appendix 1-C: Scoping Report 2013 and Appendix 1-D: Scoping Report 2014) and further consultation:

- Harbour porpoise (*Phocoena phocoena*);
- Bottlenose dolphin (*Tursiops truncatus*);
- Common dolphin (*Delpinus delphis*);
- Risso's dolphin (*Grampus griseus*);
- White-beaked dolphin (*Lagenorhynchus albirostris*);
- Humpback whale (*Megaptera novaeangliae*);
- Long-finned pilot whale (*Globicephala melas*);
- Minke whale (*Balaenoptera acutorostrata*);
- Grey seal (*Halichoerus grypus*); and
- Harbour seal (*Phoca vitulina*).

Following a further review of marine mammals in the region, the following species were also identified for inclusion within a desk-based study to inform the chapter:

- Atlantic white-sided dolphin (*Lagenorhynchus acutus*);
- Killer whales (*Orcinus orca*);
- Sperm whale (*Physeter microcephalus*); and
- Fin whale (*Balaenoptera physalus*).

These species lists together account for regionally occurring species that are identified as designated features of SACs within the Study Area, species listed under Annexes II, IV and V of the EU Habitats Directive, and species identified as Priority Marine Features.

Following the desk-based study which is summarised in Section 15.5, the following species have been scoped in to the impact assessment, and are thus the focus of the scope of this chapter:

Cetaceans:
Harbour porpoise; Bottlenose dolphin; White-beaked dolphin; Risso's dolphin; and minke whale.

Pinnipeds:
Grey seal; and harbour seal.

15.4.3 Data Sources

Data used to inform this overall chapter were collated through the following studies:

- A desk-based study of existing data and literature (see Table 15.2 for list of sources);
- ES Appendix 14-A: Marine Ornithology Vantage Point Survey Report ;
- ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay;
- ES Appendix 15-B: Seal telemetry analysis;
- ES Appendix 13-B: Underwater noise impact study;
- ES Appendix 6-B: Sediment plume modelling; and
- ES Appendix 7-D: Water quality modelling.

Table 15.2: Data sources for desk-based study

Source*	Area of Research
JNCC Atlas of Cetacean distribution in northwest waters (Reid et al., 2003)	A guide to cetacean distribution, abundance and ecology throughout the waters of northwest Europe.
Marine Scotland's List of designated Scottish Haul-out areas for seals (Scottish Government, 2014a)	A list of haul-out sites designated through The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014.
Marine Scotland Designated Seal Haul-out Maps (Scottish Government, 2014b)	A series of maps showing haul-out sites designated through The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014.
Special Committee on Seals (SCOS) Annual Reports (SCOS, 2013; 2014)	On behalf of Natural Environment Research Council (NERC), SCOS are tasked with formulating scientific advice to government on the management of seal populations in UK waters. SMRU provide scientific information to SCOS on seal research, which is then disseminated in annual reports.
Small Cetaceans in the European Atlantic and North Sea (SCANS I and SCANS II) data as presented and discussed in Hammond et al. (2002; 2013)	Following support from the European Commission, boat-based survey and aerial survey data was collected in 1994 (SCANS I) in order to assess cetacean abundance and distribution in the North Sea and Celtic Sea. Further surveys were undertaken in 2005 (SCANS II), for all EU Atlantic continental shelf waters. SCANS II is recognised at the most accurate broadscale estimations of cetacean abundance in UK waters.
Seawatch Foundation Sightings Data (Anderwald and Evans, 2010)	A review of cetacean status and distribution within the east Grampian region, based upon analysis of the national sightings database from 1973 onwards.
SMRU Density Maps (Jones et al., 2013)	SMRU have produced density maps for Scottish Government which estimate both grey seal and harbour seal densities in UK waters at a 5 km by 5 km grid square resolution.
JNCC UK SAC Site List[1] and Site Summaries	The JNCC website presents a list of all SACs in the UK, with site summaries for each respective SAC.
Natura 2000 standard data forms for the respective relevant SACs in North East UK as listed by JNCC [2]	The Natura 2000 data forms submitted to the EU, detail population information on the respective site's qualifying features.

[1] http://jncc.defra.gov.uk/page-1458
[2] http://jncc.defra.gov.uk/page-1458
* Full references for all cited sources are presented in Section 15.11 of this chapter.

Table 15.2: Data sources for desk-based study continued

Source*	Area of Research
Strategic Environmental Assessment (SEA) 3, marine mammals background information (DTI, 2002)	The Background information contains collated information from a range of sources on marine mammal ecology, abundance and distribution in the SEA Blocks 2 and 3, relating to the northeast of England.
Strategic Environmental Assessment (SEA) 5, Ecology Report (DTI, 2004)	The SEA Environmental Report for Ecology contains collated information from a range of sources on marine mammal ecology, abundance and distribution in the SEA 5 area, relating to the east coast of Scotland.
Cetacean Research and Rescue Unit (CRRU) publications (Cheney et al., 2013; Culloch and Robinson, 2008; Robinson et al., 2009)	CRRU research publications on the cetaceans of the Moray Firth, northeast Scotland.
WDC publications (e.g. Robinson et al., 2010)	WDC research publications on marine mammal ecology in UK waters.
North Atlantic Marine Mammal Commission (NAMMCO) Scientific Publications for UK Seal Populations (e.g. Duck and Thompson, 2007)	A review of the status and ecology of grey seals in Britain.

15.4.4 Impact Assessment Methodology

This section explains the approach to identifying marine mammal ecological receptors, identifying impacts and impact pathways, defining effect magnitude and receptor value, and evaluating the significance of effects. The approach follows the general impact assessment methodology presented in Chapter 5: Environmental Impact Assessment Process including the magnitude and value factors, but uses tailored definitions to address relevant aspects of marine mammal ecology. The magnitude of impacts also considers the outputs of the underwater noise and sediment modelling (see ES Appendix 13-B: Underwater noise impact study and ES Appendix 6-B: Hydrodynamic Modelling and Coastal Processes Assessment) and supports quantitative assessment of the impacts of the development on marine mammals.

The impact assessment process starts with the identification of the impacts that are predicted to arise from the construction and operation of the development, based on the project description (see Chapter 3: Description of The Development) and the pathways through which those impacts are transmitted to receptors.

Table 15.3 presents the potential construction and operational impacts of the scheme together with the pathways through which effects on marine mammal may occur. In general, impacts were found to relate to the propagation of underwater noise and the suspension of sediment plumes as a product of dredging, with direct implications for marine mammal prey species.

Table 15.3: Predicted impacts and associated pathways for effects on marine mammal ecology

Activity	Impact Transmission Pathway	Receptor	Description of Effect
Construction			
Piling, drilling, blasting, dredging and rock placement	Increased levels of underwater noise	All marine mammal receptors within spatial extent of noise propagation	Mortality, permanent or temporary injury or avoidance
Capital dredging and disposal	Temporary increases in suspended sediment concentrations (SSCs) due to dredging	All marine mammal receptors within spatial extent of sediment plumes	Impairment of ability to forage and temporary displacement from habitat
	Release of sediment contaminants	All species within spatial extent of sediment plumes	Water quality changes and increase in bio-availability of sediment contaminants where marine mammals forage
	Changes to prey availability i.e. changes in fish and benthic populations from: • Seabed disturbance • Sediment plumes • Sediment deposition	All prey species of relevant marine mammal receptors	Reduction in prey species for marine mammals and lessening of foraging ability
Construction vessel activities	Increased levels of visual disturbance	All seal receptors in areas of increased vessel traffic	Disturbance visual impacts
	Collision between species and vessels	All marine mammal receptors in areas of increased vessel traffic	Mortality or physical injury due to collisions with vessel hulls or propellers
	Accidental spills of oil and fuels etc. into the marine environment during construction	Marine mammal receptors and associated habitat	Interaction of pollutants with marine mammals following accidental spills
	Increased levels of underwater noise	All marine mammal receptors within spatial extent of noise propagation	Disturbance due to vessel noise

Table 15.3: Predicted impacts and associated pathways for effects on marine mammal ecology continued

Activity	Impact Transmission Pathway	Receptor	Description of Effect
Operation			
Infrastructure foundations and scour protection	Footprint on the seabed and physical structures	Habitat of relevant marine mammal receptors	Reduction in extent of original foraging habitat
	Reduction of flushing of pollutants and increased residence times	Marine mammal receptors and associated habitat	Water quality changes and interaction of pollutants with marine mammals leading to potential displacement.
	Changes to prey availability i.e. changes in fish and benthic populations from colonisation	All prey species of relevant marine mammal receptors	Change in prey resource
Vessel movements	Collision between species and vessels	All marine mammal receptors in areas of increased vessel traffic	Mortality or physical injury due to collisions with vessel hulls or propellers
	Accidental spills of oil and fuels etc. into the marine environment during construction	Marine mammal receptors and associated habitat	Interaction of pollutants with marine mammals following accidental spills
	Increased levels of underwater noise	All marine mammal receptors within spatial extent of noise propagation	Disturbance due to vessel noise
Maintenance dredging and disposal	Increased levels of underwater noise	All marine mammal receptors within spatial extent of noise propagation	Vessel noise and disturbance from dredging noise
	Temporary increases in suspended sediment concentrations (SSCs) due to maintenance dredging	All species within spatial extent of sediment plumes	Impairment of ability to forage and displacement from habitat
	Release of sediment contaminants	All species within spatial extent of sediment plumes	Water quality changes and increase in bio-availability of sediment contaminants where marine mammals forage
	Changes to prey availability i.e. changes in fish and benthic populations from: • Seabed disturbance • Sediment deposition	All prey species of relevant marine mammal receptors	Reduction in prey species for marine mammals and weakening of foraging ability

Table 15.3: Predicted impacts and associated pathways for effects on marine mammal ecology continued

Activity	Impact Transmission Pathway	Receptor	Description of Effect
Operation			
General Operational Activities	Change in prey species due to: • Light-levels • Change in hydrodynamic regime • Colonisation of structures • Increase in vessel numbers	All prey species of relevant marine mammal receptors	Reduction or change in prey species for marine mammals

15.4.5 Impact Magnitude

Impact magnitude is categorised as severe, major, medium, low or negligible based on the definitions presented in Table 15.4, which are based on the factors identified in Chapter 5: Environmental Impact Assessment Process.

Table 15.4: Categories of magnitude of impact and definition

Impact Category	Definition
Severe	Mortality of individuals or permanent injury leading to long term reductions in breeding success with population-level consequences.
Major	Reasonable potential for mortality exists, or there is permanent possibility of injury for individuals within a localised area between hundreds of metres to kilometres (<10 km)
Moderate	Temporary possibility of injury for individuals within a localised area between hundreds of metres to kilometres (< 10 km)
Minor	Very low potential for injury or mortality to single individuals; localised (hundreds of metres)-to-wide-scale (kilometres) shifts in distribution due to localised or wider-scale avoidance or displacement, with potential to cause stress in individuals but without compromising feeding ability and detrimental energetic consequences
Negligible	No change to the baseline condition of a receptor above natural variation. No injury or detrimental energetic consequences for individuals, but might include small localised shifts in distribution due to localised avoidance or displacement with no detrimental consequence.

15.4.6 Receptor Value

In UK waters, all marine mammals receive protection at international level (for example under Annex IV and II of the EC Habitats Directive) as implemented though the Habitats Regulations 1994 (as amended in Scotland). All cetaceans are European Protected Species (EPS). Consequently, this assessment considers the value of all marine mammals to be **very high.**

The focus of the assessment analysis of this chapter is therefore on the determination of the likelihood of the impact actually occurring in the first place, and in this regard, it is necessary to establish the frequency and seasonality of occurrence of individuals of each species within the predicted sphere of construction and operational influences of the development. Section 15.5 provides the findings of a comprehensive data review of marine mammal ecology within and around Nigg Bay and Table 15.6 summarises the usage and seasonal presence of the species scoped into this assessment. The findings of site-specific vantage point surveys, which included observations of marine mammals and deployment of C-POD acoustic recording devices, are described in detail in ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay, and summarised in Section 15.5.2.1 of this chapter. Drawing upon this information review and the site specific observations, Table 15.5 has been developed to present the criteria used to determine the likelihood of species presence and are used to inform the impact statements provided in Section 15.6 of this chapter.

Table 15.5: Likelihood classification

Likelihood Classification	Criteria
Certain	Species is present or uses the study area all year round based on the available literature and has been regularly recorded (i.e. every month or nearly every month) during the site-specific surveys.
Near certain	Species is present at least seasonally based on the available literature and has been recorded occasionally or often (i.e. over one or a few months) during the site specific-surveys.
Probable	Species has not necessarily been recorded during the site-specific surveys but is known to occur in the area based on the available literature.
Unlikely	Species is not generally known in the area but can theoretically occur as it lies within its natural range.
Extremely unlikely	Species is not known in the area based on the available literature and the study area lies outside its natural range.

15.4.7 Evaluating the Significance of the Effect

The significance of an effect is assessed as ‘major’, ‘moderate’, ‘minor’ or ‘negligible’ by combining the magnitude classification with the receptor value classification, using the matrix presented in Table 5.5 of Chapter 5: Environmental Impact Assessment Process.The likelihood of the effect actually occurring (as described above) has been used to contextualise effect significance and to provide a measure of risk. In this chapter, likelihood has been applied on the basis of the expected presence of the marine mammal species in question from literature and/or empirical observation. Species that are unlikely or highly unlikely to be present are considered to be at low risk of effects and in these instances mitigation measures would generally not be warranted. Species which have a presence of probable or above are judged to be at comparatively greater risk and thus mitigation may be required.

Finally, a level of certainty based upon the availability and quality of data sources used to underpin the assessment conclusions has been assigned as defined below:

i. **High Certainty:** criteria affecting the assessment are well understood and documented. Literature and data available to quantify predictions. Information/data have very comprehensive spatial coverage/resolution; effects have been modelled;

ii. **Medium Certainty:** criteria affecting assessment reasonably well understood with some supporting evidence. The assessment may not be fully quantifiable and the information/data available might not fully incorporate the area of interest; and

iii. **Low Certainty:** criteria affecting assessment poorly understood and not documented. Predictions are made on expert interpretation using little or no quantitative data. Spatial coverage may only partly encompass area of interest.

15.4.8 Cumulative Impact Assessment Methodology

Potential cumulative impacts on marine mammal receptors have been identified and assessed following the methodologies presented in Chapter 5: Environmental Impact Assessment Process. Relevant projects and activities taken forward for cumulative impact assessment on marine mammals are identified in Section 15.9.

15.5 Baseline

This section presents a summary of the marine mammal baseline which has been informed by the findings of a desk-based study and the site-specific surveys. Further details of these site-specific studies are presented in ES Appendix 14-A: Marine Ornithology Vantage Point Survey Report and ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay.

15.5.1 Regional Context

As part of the desk-top study, a review of relevant literature for cetaceans and pinnipeds was undertaken to determine the species likely to be present within the Scottish east coast region, the findings of which are summarised below and presented in Table 15.6.

A number of cetaceans are known to be present within the region, in varying levels of abundance depending on the species. The Sea Watch Grampian Group has undertaken regular shore and sea-based surveys in the region, mainly along east Grampian coastal waters including Nigg Bay. A review of sightings data acquired from these surveys between 1973 and 2009 observed a total of 14 species which included harbour porpoise, six species of dolphin and seven species of whale (Anderwald and Evans, 2010). Of these species, bottlenose dolphin, harbour porpoise, and white-beaked dolphin were by far the most frequent species recorded in the Aberdeen area during studies within the region, with peak sightings typically occurring in the summer months (Anderwald and Evans, 2010; Weir and Stockin, 2001; Reid et al., 2003). Species which can be considered occasional include Risso's dolphin, white sided dolphin and minke whale. Other species which are only rarely encountered along the Aberdeenshire coast include killer whales, long-finned pilot whales, and fin whale (Anderwald and Evans, 2010; Reid et al., 2003).

Pinnipeds are also present within the region, with both grey seal and harbour seal occurring in nationally significance numbers in certain locations. Grey seal are the most frequently sighted pinniped in Aberdeenshire waters and are known to use the full extent of the east coast, with large transits to and from the Pentland Firth to the north and the Firth of Forth and north Northumberland coasts to the south. Harbour seal are more conservative in their range of movements from their dominant colonies within the Firths of Tay and Forth, and are not commonly sighted adjacent to the Aberdeenshire coast.

Table 15.6 distinguishes the relative months of importance for each species in a regional context. A range of sources have been used to build a high-level picture of the months and seasons where the species are most likely to occur using quantitative and qualitative information from different studies. Quantitative information cannot be inferred from Table 15.6, as it merely serves to indicate which months have been identified as important for the presence of the species. As studies have been undertaken in different years, it is not necessarily appropriate to compare quantitative values between studies for individual months, as annual variation inevitably leads to some years having a higher overall level of abundance than others. Therefore, a monthly peak count in one year may be considered to be a moderate or lower monthly count in another year; so, if two studies found different months to be peak months, both of these months would be captured in Table 15.6 as months of high importance to the species. This also applies to months of moderate and low importance. Therefore, the table should be considered with caution, as the importance of certain months may be somewhat overstated.

The review of literature also highlighted qualitative information on species that are not considered to be common for the region. In some instances, reference was made to months where rare and isolated sightings had been made in previous years. These months have been indicated witin Table 15.6 as months where a species is 'likely to be absent although rare records exist'. If a month where a species is considered 'likely to be absent', this is simply because the reviewed literature did not indicate any historical records of the species in that given month.

A number of Special Areas of Conservation (SACs) exist within the region where marine mammals are listed as designated features. These sites include the Moray Firth, Firth of Tay and Eden Estuary, Isle of May, Dornoch Firth and Morrich More SACs. It is also worth noting the potential for a new designation in the form of the Outer Moray Firth draft SAC (dSAC), although consultation has not yet commenced at the time of writing so the sites do not have a legal status (see Chapter 10: Nature Conservation for further details).

Table 15.6: Species identified and monthly importance

Species	Usage	Monthly importance											
		J	F	M	A	M	J	J	A	S	O	N	D
Cetaceans													
Harbour porpoise	Resident/regular												
Bottlenose dolphin	Resident/regular												
White-beaked dolphin	Seasonal												
Risso's dolphin	Occasional/Seasonal												
White-sided dolphin	Occasional												
Minke whale	Seasonal												
Killer whale	Rare												
Long-finned pilot whale	Rare/Occasional												
Fin whale	Rare												
Humpback whale	Rare												
Sperm whale	Rare												
Pinnipeds													
Grey seal	Resident/regular												
Harbour seal	Resident/regular												

Sources: Anderwald and Evans (2010); Evans, Anderwald and Hepworth (2008); Weir and Stockin (2001); SCOS 2014; Genesis (2012)

Seasonal Presence Key:

Likely to be absent | Likely to be absent although rare records exist | Lower Importance | Moderate Importance | Moderate-High Importance (Peak Months)

Based on the review of this regional information, the species and SACs that have been considered in further detail in the baseline include the following:

- A number of resident/regularly visiting species including: harbour porpoise, bottlenose dolphin, grey seal, harbour seal, white-beaked dolphin;
- Seasonally occurring species: minke whale;
- A number of occasional visiting species including: Risso's dolphin, white sided dolphin;
- Rarely encountered species including: killer whales, long-finned pilot whales, and fin whales; and
- SACs including: Moray Firth SAC, Firth of Tay and Eden Estuary SAC, Isle of May SAC, Dornoch Firth and Morrich More SAC and the Outer Moray Firth dSAC.

The features listed above are discussed in detail in the following baseline sections:

- Cetacean species accounts: Section 15.5.4;
- Pinnipeds species accounts: Section 15.5.5; and

- Nature conservation designation site accounts: Section 15.5.6.

The baseline is underpinned by site-specific data that has been acquired from the following survey methods:

- Passive Acoustic Monitoring (PAM) C-POD deployment (see Section 15.5.2);
- Land Based Vantage Point (VP) Surveys (see Section 15.5.3).

The methodology for the CPOD and VP surveys can be found in Sections 15.5.2 and 15.5.3 respectively, and the summary of the survey results can be found in Sections 15.5.2.1 and 15.5.3.1 respectively, whilst full details are presented within ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay. Interpretation of these results and characterisation of the baseline environment in Nigg Bay and the wider region is discussed in the species-specific accounts in Section 15.5.4 (cetaceans) and Section 15.5.5 (pinnipeds).

15.5.2 Passive Acoustic Monitoring (Deployment of C-PODS)

Passive acoustic monitoring (PAM) devices known as C-PODs were deployed at two different locations directly offshore from Nigg Bay, adjacent to the location of the proposed development. Five deployments of the C-PODs took place between August 2014 and August 2015, with the specific timings of these deployments presented in Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay. The respective deployments covered the following months:

- Deployment 1: August to October 2014;
- Deployment 2: November 2014 to February 2015;
- Deployment 3: February to April 2015;
- Deployment 4: April to June 2015; and
- Deployment 5: June to August 2015.

As agreed with Marine Scotland, 12 months of C-POD data has been collected up to the end of August 2015, thus providing a seasonal representation of vocalising cetaceans in the vicinity of Nigg Bay. Full details of the methods and results of these surveys are presented in ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay, with a summary provided below.

C-PODs have been designed to detect and continuously monitor the 20 kHz to 160 kHz frequency range of odontocete (toothed whales) echolocation clicks, allowing the detection of visits by these marine mammals to the Nigg Bay area and the collection of presence-absence data over several months. The C-POD devices are able to distinguish between the high-frequency clicks from harbour porpoise and the mid frequency clicks from dolphin, but are unable to distinguish between the clicks from different dolphin species.

The effective detection radius (EDR) of the devices (a radius of having as many detections made outside it, as are missed inside it) was defined as 150 m for porpoise and 700 m for dolphin. The locations of the C-PODs and the respective spatial extents of their radii are presented within Figure 15.3.

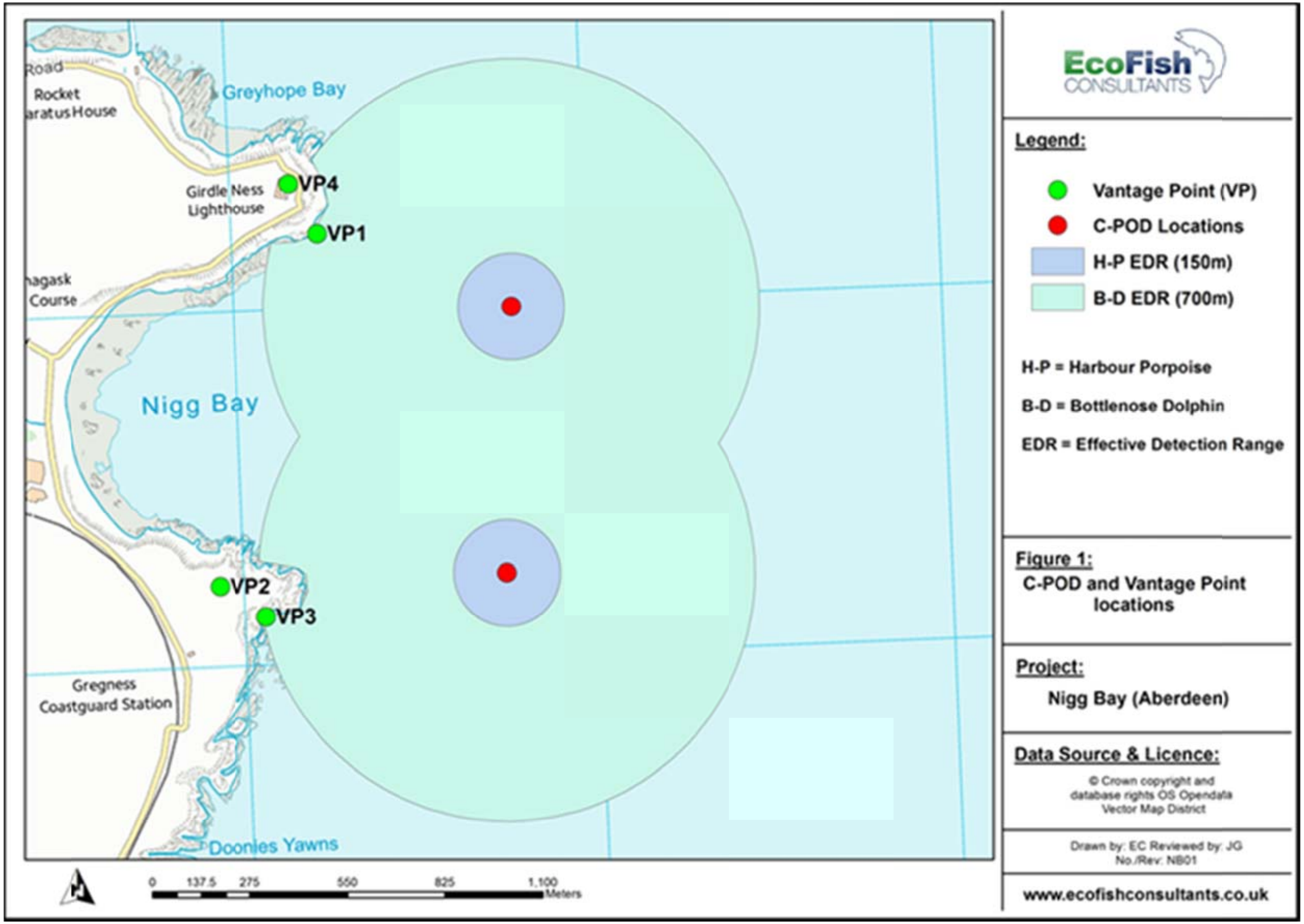

Figure 15.3: CPOD and Vantage Point locations showing effective detection range (EDR)

15.5.2.1 Summary of C-POD Survey Results

The elementary metric generated by the C-PODs is detection positive minutes (DPM), the definition of which is any given minute in which a marine mammal click train has been detected. Similarly, this principle can be applied in respect of hours in which positive detections have occurred, resulting in detection positive hours (DPH). The data for both of these metrics are presented for both porpoise detections and dolphin detections respectively in Table 15.7 and Table 15.8.

Porpoises were detected throughout the 12 month detection period by both C-PODs with some peaks in activity. Overall, porpoises were detected on 97% of all days, 53.4% of all hours and 9.5% of all minutes. Over the entire dataset of each C-POD, there is a clear activity pattern which generally shows increased activity during daylight hours and much reduced activity at night. In respect of seasonal patterns, the winter and spring months indicate higher activity towards the middle of the day and mid-morning respectively. The summer and autumn months indicate higher activity early in the morning and late afternoon with a reduction in activity mid-morning and midday respectively (ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay).

Dolphin activity was far less than porpoise activity and was detected for less days. Overall, dolphins were detected on 56.5% of all days, 5.15% of all hours and 0.4% of all minutes. It should be noted that the C-POD's Effective Detection Radius (EDR) for harbour porpoise (150 m) is significantly smaller than that for dolphins (700 m) (Figure 15.3). Therefore, higher harbour porpoise activity suggests that this species is more concentrated and/or abundant than dolphin species within the area. Also, due to the EDR for dolphins (i.e. 700 m) and the close proximity of the north and south C-PODs and subsequent EDR overlap, dolphin individuals can be detected simultaneously. Therefore, interpretation of this data should be treated with caution.

For dolphins, seasonal patterns show that while the winter months have higher activity at night, there is no clear pattern for the spring months, which may be associated with lower total activity. The summer months indicate higher activity early in the morning, afternoon and evening with a reduction in activity late morning to midday and midnight. Very little activity was recorded over the autumn months so the pattern of relatively high activity in the evening and towards the middle of the night is not highly significant as it is based on relatively few encounters (ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay).

Table 15.7: Porpoise detections across all deployments

Deployment	C-POD	Total Detection Positive Hours [DPH]	% of Hours Recorded
1	North C-POD2464	681	50
	South C-POD2460	737	62.6
2	North C-POD2459	964	59.43
	South C-POD2464	872	65.22
3	North C-POD2460	449	65
	South C-POD2459	913	63.5
4	North C-POD2460	197	12.7
	South C-POD2459	5	16.7
5	North C-POD2464	894	46.1
	South C-POD2459	1,281	66

Table 15.8: Dolphin detections across all deployments

Deployment	C-POD	Total Detection Positive Hours (DPH)	% of Hours Recorded
1	North C-POD2464	50	3.7
	South C-POD2460	28	2.38
2	North C-POD2459	58	3.58
	South C-POD2464	64	4.79
3	North C-POD2460	37	5.4
	South C-POD2459	101	7
4	North C-POD2460	154	9.9
	South C-POD2459	4	13.3
5	North C-POD2464	92	4.4
	South C-POD2459	95	4.8

15.5.3 Land Based Vantage Point Surveys

Vantage Point (VP) surveys for birds and marine mammals were conducted between June 2014 and May 2015. The survey methodology was adapted from SNH guidance (SNH, 2014) and was reviewed and agreed by SNH. A full description of the survey methods is presented in ES Appendix 14-A: Marine Ornithology Vantage Point Survey Report. In each month, surveys were conducted over a single three hour period at VP 1, two three hour periods at VP2, and a single hour period each at VPs 3 and 4. VPs 1 and 2 were the main vantage points, affording the best views into the bay. Of these, VP2 was selected to receive the greatest survey effort, as it offers the best viewing in terms of coverage of the bay, and light conditions.

A single experienced observer (a qualified JNCC Marine Mammal Observer), made observations for both birds and marine mammals, by scanning the viewshed with 10x42 binoculars and a 30 to 70 magnification telescope. Recording at VPs 1 and 2 was broken down into a series of 20 minute periods, with periods focussing on birds and marine mammals using the bay, and then birds and marine mammals passing further offshore, in turn. Recording for the one hour sessions at VPs 3 and 4 was focussed on recording marine mammals, with VP4 also focusing on vessel traffic and any interactions between boats and marine mammals.

These locations provided full coverage of the proposed development boundary as well as view shed distances of up to 2 km offshore. The vantage point surveys recorded both cetacean and seal species, and the results are summarised in Section 15.5.3.1.

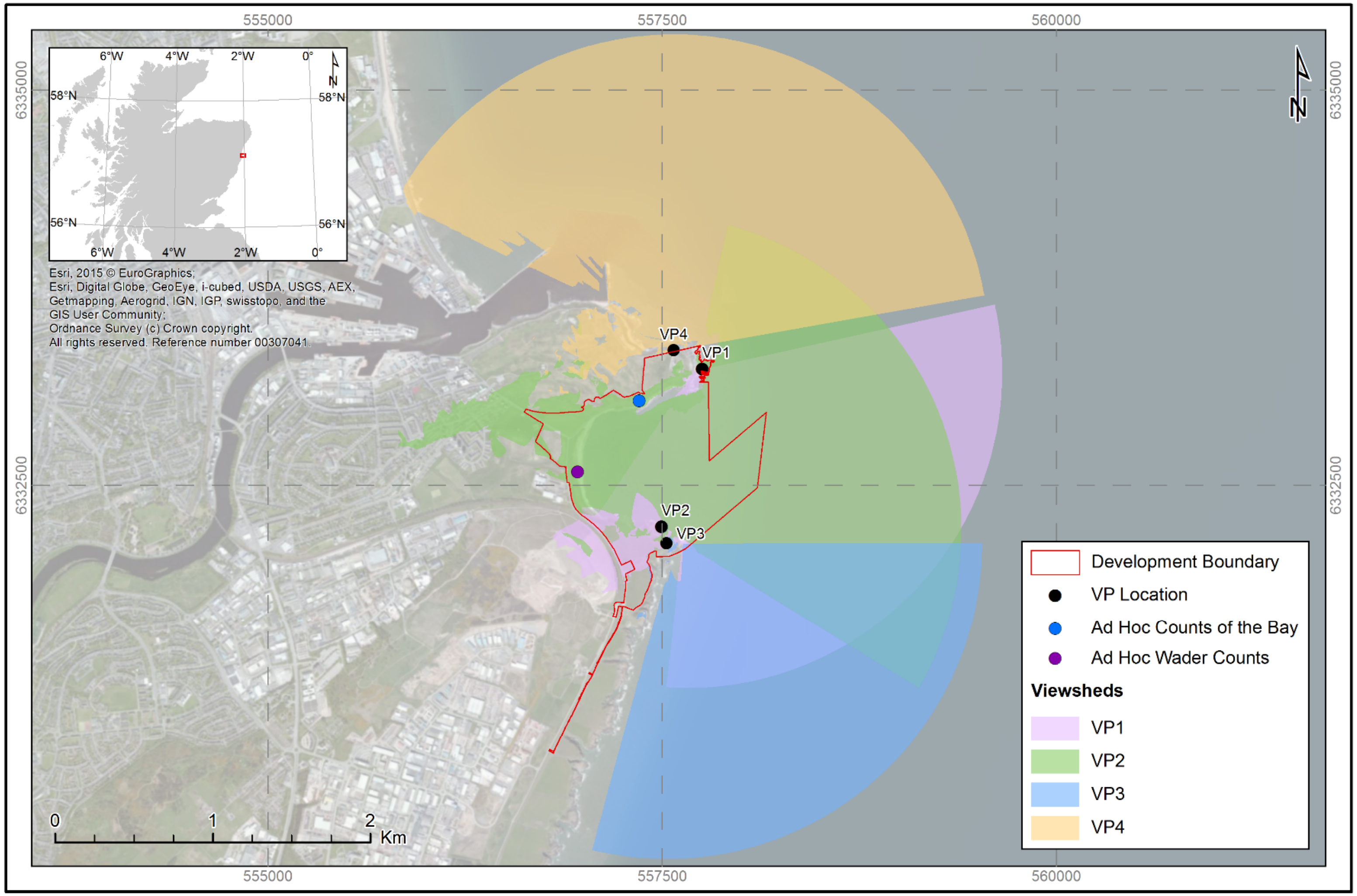

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Figure 15.4: View sheds from VPs 1 to 4 overlain, to show the total surveyed area. Note that ad hoc locations only relate to the ornithological observations, with no survey effort in relation to marine mammals at these locations

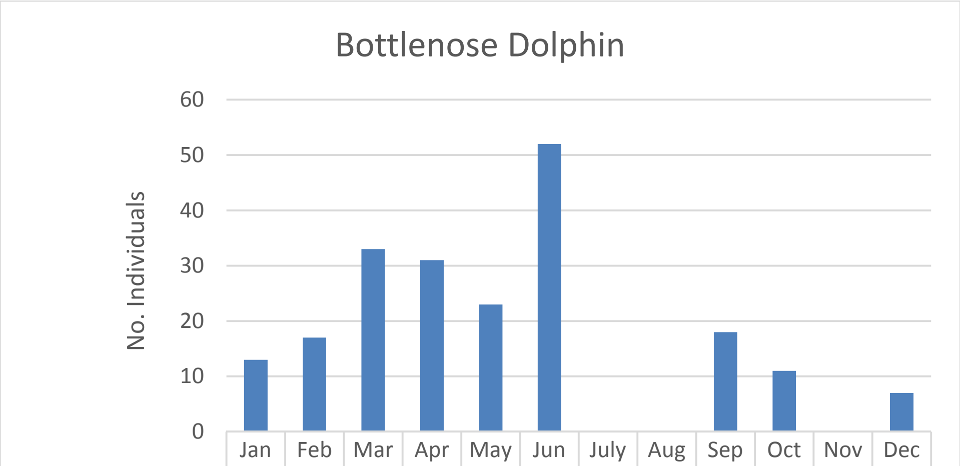
15.5.3.1 Summary of Vantage Point Survey Results

Bottlenose dolphin were recorded across all four VPs, with the distance from shore ranging between 100 m and 1 km, based upon estimated distances. They were observed from January to June and in September, October and December, with no sightings recorded in July, August or November (see Figure 15.5 for number of individuals sighted by month). Sightings took place at various times of the day and covered all tidal states.

Harbour porpoise were recorded across all four VPs, with the distance from shore ranging between 500 m and 2 km, based upon estimated distances. There were only single sightings during the months of January and February with no sightings in March; then in April and May porpoise sightings greatly increased covering all 4 VPs (see Figure 15.6 for number of individuals sighted by month). They were observed from June to October with the majority of sightings in the summer months between June and August, whilst there were no sightings in November or December. Sightings took place at various times of the day and covered all tidal states.

Grey seals were recorded across all four VPs and in all months, with the distance from shore ranging from less than 100 m to up to 1 km from the shore (see Figure 15.7 for number of individuals sighted by month). Sightings took place at various times of the day and covered all tidal states but were most commonly sighted between mid and high tides, with few sightings at low tide.

Three white-beaked dolphins were recorded for the month of July. No sightings were made of any other marine mammal species during the surveys.



	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
No. of individuals	13	17	33	31	23	52	0	0	18	11	0	7

Figure 15.5: Numbers of individuals recorded by month for bottlenose dolphin

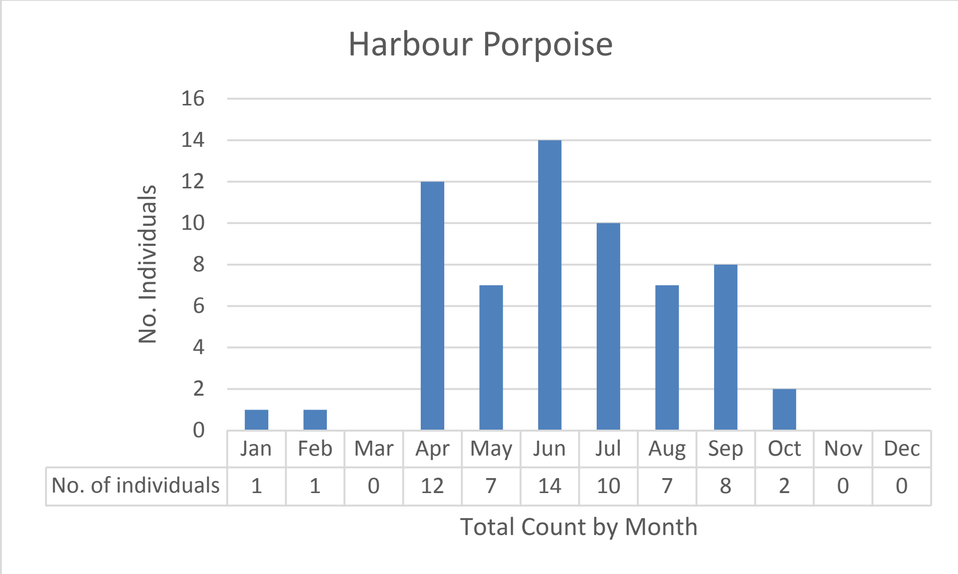


Figure 15.6: Numbers of individuals recorded by month for harbour porpoise

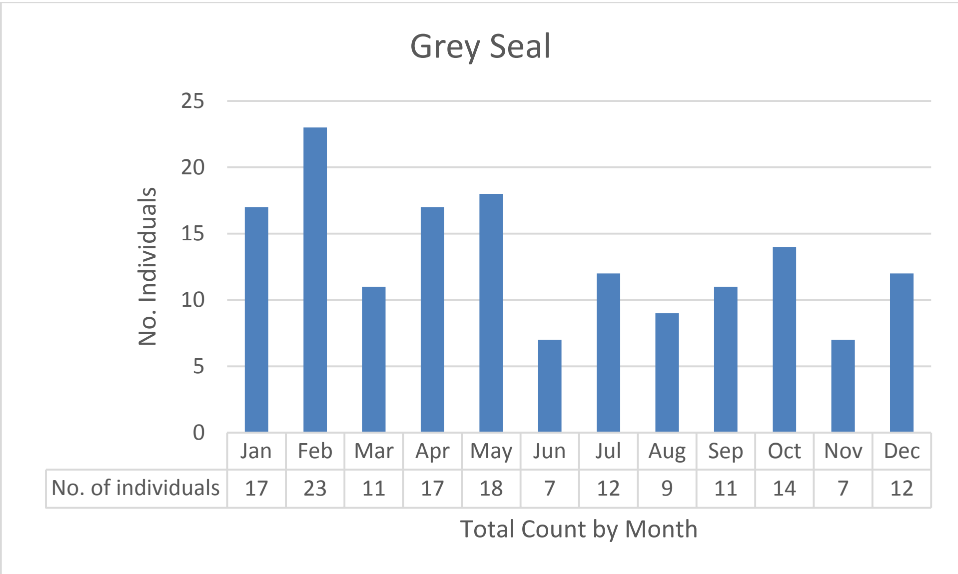


Figure 15.7: Numbers of individuals recorded by month for grey seal

15.5.4 Cetacean Species Accounts

This section presents the individual species accounts for those cetacean species identified in Section 15.5.1.

15.5.4.1 Bottlenose Dolphin (*Tursiops truncatus*)

Spatial and Temporal Distribution

Bottlenose dolphin are found in many of the UK waters, both in coastal areas and further offshore. The two significant UK populations of note that are considered to be resident are those that can be found in Cardigan Bay, Wales and the Moray Firth in northeast Scotland (Reid et al., 2003; JNCC, 2007; Culloch and Robinson, 2008). Research has also suggested that a small population may be considered resident in the Inner Hebrides (Mandleberg, 2006). Notable concentrations of the species are known to occur in St Georges Channel, the Celtic Sea, the Western Isles of Scotland, the English

Channel (in particular the western approaches of the Channel around southwest England) and the shelf waters of Scotland and Ireland.

Photo identification and numerous sightings studies have shown that there are only around 200 to 300 individual bottlenose dolphins regularly occurring in the Scottish waters (Thompson et al., 2011; Quick et al., 2014). Of these, up to approximately 80% are from the resident Moray Firth population which have been afforded protection under the Moray Firth SAC. However, there has been a decline in utilisation by bottlenose dolphin of the SAC due to an expansion of range along the Scottish east coast, which is thought to be closely linked to prey distribution, availability and abundance (JNCC, 2007; Wilson et al., 2004).

As part of the European SCANS II survey (Hammond et al., 2013) undertaken in 2005, an abundance estimate has been calculated of 157 bottlenose dolphin with a coefficient of variation (CV) of 1.14 for SCANS Block V (Central North Sea, north), the survey block in which the Aberdeen Harbour Expansion Project is located, and a density estimate of 0.0010 individuals per km^2.

Bottlenose dolphin are frequently encountered along the east coast of Scotland between Montrose and Aberdeen in waters less than 20 m depth and within 2 km of the coastline, but they have also been observed in offshore areas off northeast Scotland (Quick et al., 2014). Research has shown that there is significant movement of highly mobile individuals along the east coast of Scotland with the same identified individuals seen in the Moray Firth as well as off the Grampian/Fife coast (Cheney et al., 2013). It is thought that nearly 200 dolphins make up the east coast population between the Moray Firth and Fife, with known differences in site fidelity and ranging behaviour within this population (Thompson et al., 2011; Cheney et al,. 2013; Quick et al., 2014).

It has been estimated that greater than 60% of the total Scottish east coast bottlenose dolphin population utilise the area between Aberdeen and the Firth of Forth (Quick et al., 2014). Furthermore, approximately 25% of the total Scottish east coast population are estimated to use the area of coast between Aberdeen and Stonehaven, with an abundance estimate of 53 individuals (CV= 0.23; 95% CI 34 to 83 individuals) (Quick et al., 2014). A photo-tagging study investigated whether the individuals that use the waters between Stonehaven and Aberdeen also use other areas at the different extents of the east coast i.e. the Moray Firth and St Andrews Bay. In 2012, 17 individuals were recorded, with 10 of these using Stonehaven to Aberdeen and St Andrews Bay; 5 of the individuals using Stonehaven to Aberdeen and the Moray Firth; and 2 inviduals only using Stonehaven to Aberdeen. No individuals were found to use all three areas. In 2013, 19 individuals were recorded in total, with 11 of these using Stonehaven to Aberdeen and St Andews Bay; 4 of the individuals using Stonehaven to Aberdeen and the Moray Firth; and 3 inviduals only using Stonehaven to Aberdeen. One individual was found to use all three areas.

Various locations along the east coast of Scotland are noted as being areas of higher use. Notable ‘hotspots’ have been identified within the Moray Firth, such as Kessock Chennel, Channory narrows and the mouth of the Cromarty Firth (Genesis, 2012). Other hotspots have been identified as the waters immediately adjacent to Aberdeen, and the area between Stonehaven and Montrose (Anderwald and Evans, 2010), whilst relative encounter rates between Aberdeen and the Firth of Forth similarly show higher rates particularly around Aberdeen, Montrose, Arbroath and most notably in the outer Firth of Tay (Quick et al., 2014).

In the locality of Aberdeen, during a study of bottlenose dolphin presence it was found that one sighting was made every 529 minutes of survey effort from Girdle Ness, whilst one sighting was made for every 122 minutes of survey effort from Aberdeen Harbour (Weir and Stockin, 2001). A 2-year sightings survey undertaken between Aberdeen and Stonehaven found that the highest land-based sightings per 60 minute search effort (SPUE) was recorded from a viewpoint at Nigg Bay with an SPUE of 0.71 in comparison to 0.46 for Aberdeen Harbour (Stockin et al., 2006). This suggests that the vicinity of Nigg Bay and adjacent waters are areas of high use. All of these studies suggest that bottlenose dolphins regularly use the areas in the vicinity of the proposed development, with the existing Aberdeen Harbour consistently recognised for its high numbers of bottlenose dolphin sightings (Weir and Stockin, 2001; Anderwald, Evans and Hepworth, 2008; Anderwald and Evans, 2010; Quick et al., 2014).

It is generally accepted that bottlenose dolphin can be seen in all months of the year along the Aberdeenshire coast. However, some studies have found that peak numbers of individuals and sightings are likely to be between May and September (Anderwald and Evans, 2010), whereas others have established that the months between October and May are periods of higher bottlenose dolphin presence (Quick et al., 2014). During a study of bottlenose dolphin distribution in the Moray Firth and the east coast of Scotland using static acoustic monitoring devices, it was found that at Stonehaven during the summer months (May to September), bottlenose dolphin were present on 62% of the days monitored, dropping to just 28% during the winter months (October to April) (Thompson et al., 2007). Conversely, the majority of the sightings within a 2 year study along the Aberdeenshire coast undertaken by Stockin et al. (2006) were observed during February to May, with very young calves recorded regularly, particularly during March to May. Bottlenose dolphins were observed within the harbour at all states of the tide with numbers peaking 2 hours to 3 hours after high tide.

There are numerous rivers within Aberdeenshire that are recognised as salmon runs and it is therefore likely that the availability of salmon is a key driver for bottlenose dolphin presence within these areas (Weir and Stockin, 2001). The seasonal occurrence of bottlenose dolphins in the Dee Estuary is a prime example of this, and the dolphins have been regularly observed throwing large fish within the mouth of the harbour. The high presence of bottlenose dolphin in the spring months has been attributed to the return to spawn of multisea – winter salmon i.e. fish that enter rivers before the beginning of May (Weir and Stockin, 2001). The dolphins are known to occur between the two outer breakwaters of the existing Aberdeen Harbour, feeding close to the surface, which is related to the tidal front as a result of the River Dee's freshwater flow. It has been suggested that dolphins may use the tidal front in order to assist in the capture of prey (Pirotta et al., 2013).

Trained and supported volunteers have undertaken marine mammal observations from Torry Battery, Aberdeen as part of the RSPB's Dolphin Watch programme, with the data being included within the WDC's Shorewatch citizen science programme. Over the course of the programme between 2012 and 2015, over 400 adult bottlenose dolphin sightings have been made, approximately 100 of these involving the presence of calves, however effort-corrected sightings are not available and this merely serves to further highlight the presence of the species in the Aberdeen Harbour area.

The data indicates that for the majority of bottlenose dolphin sightings between 2012 and 2015, 68% of dolphins were typically staying in the area during the time of the sightings, whilst 28% were travelling and 4% were of unknown activity. Qualitative observation notes highlight how the bottlenose dolphins using the waters around the entrance to the existing Aberdeen Harbour are often seen feeding, playing and breaching, whilst other behaviours such as bow riding have also been observed. These observations also comment on how some dolphins have appeared to be uninterested in vessel movements through the harbour, whilst one observation suggested that the dolphins moved away on one occasion as a tanker passed through.

Site-specific Surveys

Visual observation data from the VP surveys (Figure 15.4) shows a clear period of higher bottlenose dolphin presence between the months of March and June, with a marked peak of 52 bottlenose dolphin in June. Numbers sharply dropped with no sightings in July and August before low numbers occurred in the autumn and winter months. This data is supported by the findings of the C-POD data. The percentage of days where dolphins were detected (average between north and south C-PODs) between the end of August and October 2014 was 46%; between November and February this was 53%; between February and April detections increased to 67%; between April and June dolphins were detected on 89% (north C-POD only) of the days monitored; and between June and August 2015 dolphins were detected on 40% of the days monitored.. These results clearly show an increase in dolphin activity into the summer months also, but then dropping off after June. The DPM and DPH reflect this in Table 15.8.

When comparing C-POD data alongside the visual survey data it is clear that on the majority of survey days, dolphin were detected and therefore present in the vicinity of Nigg Bay. Dolphins were detected in the Nigg Bay area on 18 out of the 30 visual survey days, whilst in total over the course of the five C-POD deployments the north C-POD detected dolphin on 56.5% of all days, 5.15% of all hours and 0.4% of all minutes. From the survey data it is clear that dolphins, (likely to be bottlenose dolphins according to VP observations) are therefore using the waters adjacent to the Nigg Bay area (i.e. the areas within the EDRs of the C-PODs) regularly throughout much of the year.

In respect of seasonal daily activity patterns, where the winter months have higher activity at night, there is no clear pattern for the spring months which may be associated with lower total activity. The summer months indicate higher activity early in the morning, afternoon and evening with a reduction in activity late morning to midday and midnight. Very little activity has been recorded for the autumn months so the pattern of relatively high activity in the evening and towards the middle of the night is not highly significant as is due to relatively few encounters.

Conservation

The bottlenose dolphin is a priority marine feature (PMF) in Scotland's seas, it is listed as a species of "Least Concern" on the IUCN Red List (Hammond et al., 2012), and it is also afforded protection under European law and is listed as an Annex II and Annex IV species under the Habitats Directive. The species is a European Protected Species under the Habitats Regulations. The species is a designated feature of the Moray Firth SAC (see Section 15.5.6.1 for further details of the site), which is located approximately 155 km from the development. This population have recently been shown to have expanded their range southward from Fraserburgh down as far as the Firth of Forth, likely due to changes in prey resource (Wilson et al., 2004; Stockin et al., 2006; Anderwald and Evans, 2010).

This is particularly pertinent given that a number of data sources suggest that the coastal areas in the vicinity of the development support, at times, a considerable proportion of the Scottish east-coast bottlenose dolphin population. The east coast population also includes individuals from the Moray Firth SAC population. The presence of the species in the vicinity of the development is thus of potential significance with regards to the conservation of the species.

These areas include those between Aberdeen and Stonehaven, with an abundance estimate of 53 individuals (CV= 0.23; 95% CI 34 to 83 individuals) that use this stretch of coast on occasions (Quick et al., 2014). Activity around Aberdeen Harbour has largely been linked to the salmon resource in the mouth of the River Dee, where bottlenose dolphin spend a lot of time foraging. It should be noted that the east coast population is highly mobile, and therefore individuals will use these areas on occasions, and will forage elsewhere during other periods. They are not limited in range to the aforementioned areas and as previous discussed, photo-tagging has shown the majority of individuals between Aberdeen and Stonehaven to also associate with St Andrews Bay, and to a lesser extent the Moray Firth.

Prey

The Moray Firth bottlenose dolphin population are recorded to have a great variety in their diet including bottom dwelling and shoaling fish and invertebrates, especially preying on saithe (*Pollachius virens)*, whiting (*Merlangius merlangus*) and cod (*Gadus morhua*), as well as, occasionally, on salmon (*Salmo salar*), haddock (*Melanogrammus aeglefinus*) and cephalopods. Aberdeen and Nigg Bay are known to be areas used for foraging (Stockin et al. 2006). Bottlenose dolphin behaviour analysis showed that foraging accounted for 17% of the activity in Nigg Bay, which was only recorded when prey was also present (Stockin et al., 2006). The higher numbers of bottlenose dolphin at Aberdeen Harbour has been attributed to the salmon presence in the area with the salmon migrating up the River Dee. The deep waters of the harbour channel which runs between the harbour walls is recognised as being a potential “bottleneck” for the migrating fish (Genesis, 2012).

Summary

Based on the information presented above, bottlenose dolphin are undoubtedly using the waters adjacent to Nigg Bay throughout the year. An increase in numbers has been identified in spring, followed by a clear peak in summer, before a marked decline as autumn approaches. These results are comparable to the SNH Commissioned Report No. 354 (2011), where dolphin positive days in the area of Stonehaven decreased markedly at the end of the summer months (i.e. in August) and peak dolphin positive days in this region were between April and July (see ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay).

Based on this Stonehaven data it was expected that the percentage of dolphin positive days for bottlenose dolphin would remain low until April 2015 in the Aberdeen area. This study contradicts other observations, which found an increase in bottlenose dolphin activity in the Aberdeen Bay area between the months of November and May (Genesis 2012), but local factors such as food availability, e.g. seasonal salmon migrations up the rivers Dee and Don, are no doubt important when interpreting this bottlenose dolphin activity. The results of the Nigg Bay site-specific survey show that between February and April 2015, dolphin detections started to increase from winter detection rates, and it found that dolphins were detected nearly every day between April and June 2015 as the summer months progressed (see ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay).

Marine Scotland provided C-POD data from various locations along the Scottish east coast during the summer months in 2013/14. This indicated that dolphin were detected between 6% and 17% of the days monitored in Fraserburgh, Stonehaven, Cruden Bay and Arbroath between May and August 2014, which are comparatively low with the detection rates found at Nigg Bay. A summary of the MS C-POD data is provided in ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay. In the vicinity of Nigg Bay, dolphin detection rates ranged from a peak of 89% of all days monitored between April and June 2015, to a low of 40% of all days monitored between June and August 2015 and similarly from August to October 2014. These results indicate that Nigg Bay and its local vicinity may be an important area or hotspot for dolphin activity along the Scottish east coast.

Based on comparisons with other areas along the east coast of Scotland, it was concluded that the vicinity of Nigg Bay is of Regional importance for bottlenose dolphin due to their high presence in this area when compared to other areas (see ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay).

Due to the abundance and year-round presence of bottlenose dolphins in the local area, the species has been **scoped in** for further assessment within this ES.

15.5.4.2 Harbour Porpoise (*Phocoena phocoena*)

Spatial and Temporal Distribution

The harbour porpoise is the most abundant cetacean in the North Sea and is common in continental shelf waters of the northern and central North Sea, with a general preference for waters less than 200 m in depth. However, the species is known to use deep offshore waters also, and can be distributed long distances from shore (220 km) in deep waters (Northridge et al., 1995; Genesis, 2012). Whilst widely distributed throughout the UK's waters and the North Sea, notable concentrations occur off the west coast of Scotland, in the southern Irish Sea and to the southwest of Ireland (Northridge et al., 1995). The species is known to frequent shallow bays and estuaries, whilst aggregations occur in areas with dominant tidal features (Genesis, 2012). Despite a wide distribution in UK waters, some shifts in abundance have been observed in previous years. The SCANS II aerial and shipboard survey data showed a marked change in the species distribution between 1994 (SCANS I) and 2005 (SCANS II). In 1994 high densities of harbour porpoise were observed in the north-western waters of the North Sea, with high concentrations around Scotland and also northern Denmark; whereas in 2005 the densities in these areas were unremarkable whilst the highest concentrations had shifted to the south western areas of the North Sea and off eastern England (Hammond et al., 2013). The total abundance of the species between years was not considered to have changed; however this shift in distribution was clear suggesting that the Aberdeenshire coastal waters are becoming less important for harbour porpoise.

Despite the shift in distribution, harbour porpoise continue to be present and widely distributed throughout the east Grampian coastal waters with no particular area of significant concentration within this (Andervald and Evans, 2010), although the area east of Aberdeen Harbour is known to be used often by harbour porpoise. This species occurs in very small groups of up to three individuals. There is some evidence to suggest that harbour porpoise will seek out areas that are not being used by bottlenose dolphin, which are known to exhibit aggressive behaviour towards harbour porpoise (Andervald and Evans, 2010), and may explain why the species is observed further offshore adjacent to the existing Aberdeen Harbour, with frequent usage of the inshore waters by bottlenose dolphin. On one occasion, a porpoise was observed to rapidly leave the harbour area, as a group of three adult bottlenose dolphins arrived (Weir and Stockin, 2001).

Harbour porpoise are known to be present year round in UK waters, and along the Grampian coast. Summer surface density estimates produced for Aberdeen Offshore Wind Farm predicted a density of 0.052907 to 0.069695 harbour porpoise per km^2 for the waters off Nigg Bay (Genesis, 2012). The months of August to September are considered to be the peak months for sightings and for numbers of individuals and groups (Andervald and Evans, 2010; Genesis, 2012), potentially with an additional peak in Spring, between March and May (Evans, Anderwald and Hepworth, 2008). Immature porpoises were recorded principally over the summer months between May and September (Weir et al., 2007). A similar seasonal pattern of increased observations were made in surveys along the southern coast of the Moray Firth, and Aberdeenshire coast, thought to be associated with the nearshore movements of lactating females (Genesis, 2012). Breeding occurs predominantly during the months between May and August, with a peak in June, although this can occur as early as March.

Site-Specific Surveys

During the VP surveys, harbour porpoise were recorded across all four VPs, with the distance from shore ranging between 500 m and 2 km. They were observed from June to October 2014 with the majority of sightings in the summer months between June and August 2014; there were no sightings in November or December (Figure 15.4). In 2015 there were only single sightings during the months of January and February with no sightings in March, but then in April and May porpoise sightings greatly increased covering all four VPs.

This data contrasts with the C-POD data, which indicates porpoise presence in the Nigg Bay area on every day that was monitored between August 2014 and April 2015, with DPH ranging between 50% and 65%. Importantly, also between April and June there was a large decrease in porpoise activity, whilst VP sightings show an increase in porpoise activity during these months. It is likely that this species is under reported in respect of VP data, especially outwith the summer months as harbour porpoise are less conspicuous than dolphins and whales due to their small size and prominence in the water. This decrease in porpoise activity coincides with a large increase in dolphin activity shown by the C-PODs between April and June 2015, which corresponds strongly with the visual survey showing the highest level of dolphin activity between the months of March and June. Porpoise activity then continued to increase from June to August 2015.

Porpoises were detected throughout the full five deployment periods on both C-PODs with some peaks in activity. Overall, porpoises were detected on 97% of all days, 53.4% of all hours and 9.5% of all minutes.

Based upon the combined VP and C-POD data, it is apparent that harbour porpoise are using the Nigg Bay area year-round, with some peaks within the respective seasons. In respect of seasonal daily activity patterns, the winter and spring months indicate higher activity towards the middle of the day and mid-morning respectively. The summer and autumn months indicate higher activity early in the morning and late afternoon with a reduction in activity mid-morning and midday respectively (ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay).

Conservation

The harbour porpoise has been identified as a PMF in Scottish waters, it is listed as a species of "Least Concern" on the IUCN Red List (Hammond et al., 2008), and is also afforded protection under European law as it is listed as an Annex II and Annex IV species under the Habitats Directive. The species is therefore a European Protected Species under the Habitats Regulations. Currently there are no SACs designated for the species in UK waters (although it is a Grade C qualifying feature of the Skerries and Causeway Site of Community Importance in Northern Ireland); however, at the time of writing JNCC are evaluating potential suitable sites for designation[3]. As such, a draft SAC is understood to have been discussed (the outer Moray Firth dSAC) to afford protection to harbour porpoise in the north east waters of Scotland, although consultation has not yet commenced at the time of writing so the sites do not have a legal status (see Section 15.5.6 and Chapter 10: Nature Conservation for further details).

Prey

The diet of harbour porpoise is known to comprise typically of small fish (less than 40 cm in length). This may encompass species such as juvenile herring (*Clupea harengu*), sprat (*Sprattus sprattus*), sandeel (*Ammodytidae spp*), whiting (*Merlangius merlangus*), saithe (*Pollachius virens*), and pollock (*Pollachius pollachius*), although particularly in winter months, prey such as dab (*Limanda limanda*), flounder, sole, and cod (*Gadus morhua*) are more typical (Evans, Anderwald and Hepworth, 2008).

Summary

Marine Scotland provided C-POD data from various locations along the Scottish east coast in 2013/14. Results from this monitoring data that include locations in Fraserburgh, Stonehaven, Cruden Bay and Arbroath along the Scottish east coast, indicate that during the summer months (approximately May to August) porpoise were detected between 98% and 100% of the days monitored (see Marine Scotland 2013-14 C-POD summary data). At the C-PODs adjacent to Nigg Bay during the site-specific surveys, porpoises were detected on 100% of the days monitored between August 2014 and April 2015, although it was shown that porpoise detection days decreased to 68% (north C-POD only) between April and June, coinciding with a large increase in dolphin activity. Porpoise activity then increased to 100% of the days monitored between the months of June and August 2015. Between these datasets, it can be inferred that the species is commonly occurring through much of the year in the east coast region.

It is also clear that the vicinity of Nigg Bay is an important area for harbour porpoise that are present daily throughout much of the year, with the exception of April to June where they seemingly spend

[3] http://jncc.defra.gov.uk/ProtectedSites/SACselection/species.asp?FeatureIntCode=S1351

less time in the area as bottlenose dolphin numbers increase, according to the C-POD data. A similar decrease in usage was observed in a towed passive acoustic monitoring study of harbour porpoise for Aberdeen Offshore Wind Farm, with lower numbers of porpoise detections between March and August (Genesis, 2012).

The site-specific data may indicate a localised avoidance of the area by harbour porpoise due to the aggression and fatal attacks on the species by bottlenose dolphin that have been observed (Andervald and Evans, 2010; Genesis, 2012; Ross and Wilson, 1996). These interactions have been noted as being of a highly violent nature and non-consumptive, with the harbour porpoise as the victim between the two species (Ross and Wilson, 1996). Observations have shown harassment by bottlenose dolphins to harbour porpoises, where a number of dolphins have chased individual harbour porpoises before butting them from the water, potentially leading to blunt impact traumas. It is not clear why this behaviour is exhibited, however competition for the same prey resource has been attributed as a potential cause (Ross and Wilson, 1996).

The vicinity of Nigg Bay has been concluded to be of Local importance (see ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay). Even though the species was recorded nearly every day in the vicinity of Nigg Bay, at other comparative sites along the east coast of Scotland the same presence patterns can be found.

Due to the abundance and year-round presence of harbour porpoise within the local area, the species has been **scoped in** for further assessment within this ES.

15.5.4.3 White-Beaked Dolphin *(Lagenorhynchus albirostris)*

Spatial and Temporal Distribution

White-beaked dolphins occur only in the North Atlantic, and are widely distributed year round on the UK continental shelf. The species is recognised as the second most common cetacean in UK waters, with a stronghold in Scottish shelf waters (Lancaster et al., 2014). White-beaked dolphin are concentrated highest in offshore waters, although show preference for water depths of less than 200 m (EMU, 2012; Lancaster et al., 2014). Their distribution is believed to be restricted by water temperature, with a preference for waters below 13°C, and they are seen particularly in the cooler waters of the western central and northern North Sea (Macleod et al., 2008). The species also occurs occasionally around southern England, southern Ireland and in the Irish Sea.

Inter-species competition with common dolphin has also been attributed as a contributing factor to changes in distribution (Weir et al., 2009). Due to the warming of waters with climate change, there is evidence that the range of the species in Scottish waters is contracting northwards (Lancaster et al., 2014). The SCANS II survey calculated an abundance estimate of 7557 (CV = 0.47) white-beaked dolphin individuals for survey block V (the survey block in which the Aberdeen Harbour Expansion Project is located) with a density estimate of 0.047 individuals per km^2 (Hammond et al., 2013).

Land-based and boat-based sightings surveys undertaken between Collieston and St Cyrus showed that the area between Cove and Girdle Ness (encompassing Nigg Bay) had the highest total sightings of white-beaked dolphins (Weir et al., 2007). Of the sightings recorded throughout all surveys, 32% were pods containing calves and 48% of all sightings containing pods and juveniles, whilst the mean group size was calculated to be 5.7 individuals. There were significantly higher sightings from the land-based surveys at Girdle Ness in comparison to the areas to the north, however boat-based survey results showed that the areas to the north had a similar sightings incidence with no significant differences to that at Girdle Ness. The area of highest relative abundance of the species was noted to be the area of Stonehaven to St Cyrus, although this was solely covered by boat-based survey (Weir et al., 2007).

This is consistent with results from land and vessel based surveys between 1999 and 2001 along Aberdeenshire coastline which found that white-beaked dolphins are generally found in groups of less than 10 individuals with the most frequent sightings recorded to the south of Aberdeen between Girdle Ness and Fowlsheugh, therefore encompassing the area of Nigg Bay (Weir and Stockin, 2001). The majority of white-beaked dolphin schools contained 20 or fewer individuals with an estimated 60% of groups containing juveniles. In addition, white-beaked dolphins were generally sighted further from shore than other species.

The higher frequency of white-beaked dolphins sighted along this part of coastline may in part be attributed to the relatively close proximity of deeper water. Along most of the Aberdeenshire coastline, the 30 m isobath is around 3 km offshore, with depths 20 m or less within 1 km of land extending to greater distances offshore between the areas of Kinnaird Head to Peterhead, Buchan Ness to Aberdeen and St Cyrus to Montrose. However, between Girdle Ness and Portlethen and in the waters off Peterhead, the 50 m isobath is only 3.5 km from the shore along these short stretch of coast (Andervald and Evans, 2010).

The presence of white-beaked dolphins is highly seasonal and they are most frequently observed along the Aberdeenshire coast between June and September with a peak in occurrence during August (Weir et al., 2007; Canning et al., 2008).

The only record of white-beaked dolphins in the WDC's Shorewatch data for Torry Battery was of eight individuals on the 31st July 2014. Although this was only given a sighting confidence of 60%, the date of the sighting would be in keeping with the reported seasonality of the species in the Aberdeen area.

Site-Specific Surveys

Three white-beaked dolphins observed during the VP surveys, with all three occurring in July. This is consistent with the reported periods of peak abundance between June and September and the species preference for waters further offshore with a distance of between 500 m and 1,000 m recorded for the sightings. These records were observed from the south site (VP2). No other sightings of this species were made during the Nigg Bay VP survey. Due the dominance of bottlenose dolphin in the VP dataset, the majority of C-POD detections are considered highly likely to be bottlenose dolphin detections, with white-beaked dolphin evidently not a common user of the Nigg Bay area, and a seasonal visitor.

Conservation

This species is listed as a PMF in Scotland, it is also listed as a species of "Least Concern" on the IUCN Red List (Hammond et al., 2012b) and is also afforded protection under European law as it is listed as an Annex IV species under the Habitats Directive. The species is therefore a European Protected Species under the Habitats Regulations.

Prey

White-beaked dolphin are known to forage for a range of prey species, with the predominant prey consisting of clupeids such as herring, Atlantic cod (*Gadus morhua*), hake (*Merluccius merluccius*), haddock (*Melanogrammus aeglefinus*), poor-cod (*Trisopterus minutus, T. luscus*), whiting (*Merlangius merlangus*) and capelin (*Mallotus villosus*) (Lancaster et al., 2014). White-beaked dolphin have been observed foraging in mixed-herds with other dolphin species such as white-sided, bottlenose, common and Risso's dolphins (JNCC, 2007). The movement of the species into coastal waters in the summer months has been linked to the movement of their prey species during this period as a potential cause (Weir and Stockin, 2001).

Summary

Despite the infrequent sightings of white-beaked dolphin in the Nigg Bay area during the site-specific surveys, the sighting of the species in July is in keeping with reports for the wider region that cite the summer months as a peak period of abundance for the species in the region (Weir et al., 2007; Canning et al., 2008). This is when the species tends to move inshore from its usually preferred deeper waters (EMU, 2012; Lancaster et al., 2014). It should be noted that the species has been reported to occur more frequently in these months in proximity to Nigg Bay and in other years numbers may be higher.

Based upon the observed presence of the species within the local area and the reported seasonality and abundance of white-beaked dolphin in the wider study area, the species has been **scoped in** for further assessment within this ES.

15.5.4.4 White-sided Dolphin (*Lagenorhynchus acutus*)

Spatial and Temporal Distribution

Atlantic white-sided dolphins are found only in the North Atlantic, sharing most of their range with the white-beaked dolphin, but with a greater deep-water distribution (Reid et al., 2003). They tend to occur more frequently in waters to the northwest of the UK and Ireland, whilst they have also been sighted in the northwest sector of the North Sea which they are known to enter in the summer months, likely following prey species (Reid et al., 2003; JNCC 2007. White-sided dolphins tend to form large groups of tens to hundreds of individuals and there are no known local populations of the species in the UK (JNCC, 2007).

White-sided dolphin mostly occur in offshore areas in the east Grampian, which is typical for the species based which has a preference for deep-water. The majority of sightings occur in July and August, although white-sided dolphins have been known to be present during winter and spring months also (Andervald and Evans, 2010). Few records exist in recent years and therefore the species is only an occasional visitor to the Aberdeen and Nigg Bay area.

Site Specific Surveys

No white-sided dolphins were observed during the site-specific surveys, whilst the majority of dolphin C-POD detections are considered highly likely to be bottlenose dolphin based on the dominance of this species during the VP visual observations.

Conservation

This species is listed as a PMF in Scotland, it is also listed as a species of "Least Concern" on the IUCN Red List (Hammond et al., 2008b) and is also afforded protection under European law as it is listed as an Annex IV species under the Habitats Directive. The species is therefore a European Protected Species under the Habitats Regulations.

Prey

The diet of the species includes varyious fish species including whiting, cod, hake, cluepeids, in particular herring, silvery pout, lantern fishes, mackerel and salmonids (Reid et al., 2003).

Summary

White-sided dolphin are reported to be an occasional or rare visitor to the waters around the Aberdeen and Nigg Bay areas and records in recent years are few. This information in conjunction with the absence of the species during the site-specific surveys suggests that the Nigg Bay area is not important for the species, which would be expected given the typical deep-water distribution of the species.

Based upon the absence of the species within the Nigg Bay area, and the rarity of reports within the coastal waters of the Grampian region, white-sided dolphin has therefore been **scoped out** of further assessment within this ES.

15.5.4.5 <u>Risso's Dolphin (*Grampus griseus*)</u>

Spatial and Temporal Distribution

The highest concentrations of Risso's dolphin in UK waters are found in the Hebrides, the Northern Isles and the Irish Sea (Evans et al., 2011), the species being one that resides within areas of the continental shelf. Risso's dolphin are also known to also use the northern and central North Sea, including Shetland, Orkney, Aberdeen and Berwick (Genesis, 2012). Risso's dolphin have been reported to use the waters of northeast Scotland in the winter, however the species has been found to occur in the southern outer Moray Firth in September, with sightings occurring exclusively in this month during a study between 2001 and 2005 (Robinson et al., 2008).

Whilst sightings are infrequent and low numbers of Risso's dolphin have been observed, the species does appear to use the northeast Scottish waters on occasions. The species has been observed in Aberdeenshire waters, with records off Girdle Ness in 2005, Cruden Bay also in 2005, several reported sightings in Aberdeen during July 2006, August 2006, February 2007 and April 2007, and also Longhaven Cliffs in 2010 (Genesis, 2012). Therefore, whilst numbers of Risso's dolphin are low in the region, there have been increases in the number of sightings.

Site Specific Surveys

No Risso's dolphins were observed during the site specific surveys, whilst the majority of dolphin C-POD detections are considered highly likely to be bottlenose dolphin based on the dominance of this species during the VP visual observations.

Conservation

This species is listed as a PMF, it is also listed as a species of "Least Concern" on the IUCN Red List (Taylor et al., 2012) and is also afforded protection under European law as it is listed as an Annex IV species under the Habitats Directive. The species is therefore a European Protected Species under the Habitats Regulations.

Prey

Risso's dolphin mostly feed on cephalopods and also small fish. Octopus, cuttlefish, sepiolids and small bottom-dwelling squid have been found in analyses of Risso's dolphin stomach content (Reid et al., 2003).

Summary

Risso's dolphin are evidently not a frequent user of the Aberdeen and Nigg Bay areas, with limited numbers of sightings over the years, consisting of few numbers of individuals, whilst the species is mostly concentrated in the northern and north western waters of Scotland (Reid et al., 2003). Sightings have occurred in close proximity to Aberdeen in coastal waters (Genesis, 2012), whilst records also exist in the waters off the Stonehaven area (Andervald and Evans, 2010).

Despite Risso's dolphin occurring within the region infrequently in low numbers, numbers of sightings have increased in recent years and the species has therefore been **scoped in** for further assessment within this ES.

15.5.4.6 Minke Whale (*Balaenoptera acutorostrata*)

Spatial and Temporal Distribution

Minke whales are known to occur in a number of locations around the British Isles, with a wide distribution across the central and northern North Sea and the Atlantic waters off the west coast of Britain and to the south of Ireland. Within survey block V of the SCANS II surveys, an abundance estimate of 4,515 (CV = 0.51) minke whales was calculated, with an estimated density of 0.028 minke whales per km^2 (Hammond et al., 2013). The North Sea population estimates have shown a number of variations over years, which may or may not reflect changes in prey availability.

The species is widely distributed along the east coast of Scotland, with sightings of minke whales close to the coast, especially between Aberdeen and Stonehaven (Andervald and Evans, 2010). Minke whales appear to move into the North Sea from the north, as they are not known to frequent the waters of the southern North Sea and eastern English Channel. Minke whales have been identified as preferring water depths between 20 m and 50 m, with 70% of sightings occurring in such waters during a study of the species' habitat preferences (Robinson et al., 2009).

They move into the North Sea waters at the beginning of May, and are present until October, with sightings most likely to occur in July to August (Anderwald and Evans, 2010). In the autumn, a general offshore movement of the species has been reported and has been linked to breeding which is known to occur during periods between autumn and spring (Evans et al., 2011). Peak sightings along the Aberdeenshire coast typically occur in July and August (Weir et al, 2007), consistent with the general populations of the species elsewhere in the UK. These whales are generally seen singly or in pairs, but can form aggregations of up to fifteen individuals when feeding (Reid et al. 2003). Minke whales were reported mostly during July and August suggesting a limited seasonal occurrence within Aberdeenshire waters, with very few sightings occurring outside of May to September which are the months where they may also be present on occasions.

Site-Specific Surveys

No minke whales or any other species of whale were observed during the site-specific surveys.

Conservation

This species is listed as a PMF, it is also listed as a species of "Least Concern" on the IUCN Red List (Reilly et al., 2008), and is also afforded protection under European law and are listed as an Annex IV species under the Habitats Directive. The species is therefore a European Protected Species under the Habitats Regulations. Minke whale are also an interest feature of the Southern Trench proposed Nature Conservation Marine Protected Area (NCMPA), which is currently progressing through the MPA selection process and is located 45 km to the north of the development. The demarcation of the site encompasses the Southern Trench, which is a large undersea valley that consists of an area of deep water. The area extends along the south of the outer Moray Firth, approximately 10 km from the coast between Banff and Fraserburgh. The proposed NCMPA represents one of two areas that have been identified as essential areas for the species in Scottish waters (Cunningham et al., 2015), the other being located where the Sea of the Hebrides MPA is being proposed off the west coast of Scotland.

Prey

Minke whale prey upon a variety of invertebrates and fish species, in particular sandeels (Anderwald and Evans, 2010) which are reported to make up to 85% of their diet by weight. The localised distribution of minke whales tends to be associated with the sandeel's preferred habitat in the summer months, i.e., sandy gravels in around 20 m to 50 m water depths (Robinson et al., 2009; Anderwald and Evans, 2010; EMU, 2012).

Summary

Whilst no sightings of minke whale occurred during the site-specific surveys, the species is known to be a very seasonal but regular visitor to the waters around Aberdeen, with other locations along the Scottish east coast also exhibiting seasonal occurrences of the species such as Stonehaven and to a lesser extent Montrose (Anderwald and Evans, 2010). It is therefore expected that during these seasonal periods, minke whales will be present in the Aberdeenshire waters in relatively close proximity to Nigg Bay.

Due to the seasonal occurrence and abundance of minke whales in the region, the species has therefore been **scoped in** for further assessment within this ES.

15.5.4.7 Other Species

A number of cetacean species are either distributed in concentrations elsewhere in the UK, with minimal or rare usage of the northern North Sea, or are found mainly in deeper waters such as the Faroe-Shetland channel and are only rarely observed close to shore. These species include common dolphin, killer whale, sperm whale, long finned pilot whale, fin whale and humpback whale.

- **Common dolphin (*Delphinus delphis*)**: Sightings of common dolphin within the Aberdeen area are considered to be infrequent or rare and seasonal, with the UK distribution of the species mostly in relation to western and southern UK waters (Weir and Stockin, 2001; Reid et al., 2003; Anderwald and Evans, 2010; Genesis, 2012 . The majority of sightings in the East Grampian region have been in summer months, although some records also exist in autumn and winter months with groups typically less than 20 individuals (Anderwald and Evans, 2010). The species appears to have increased its presence in the North Sea during the 2000's, whilst it was previously noted as scarce. One notable sightings event took place in July 2007, where over 300 common dolphins were recorded in the outer southern Moray Firth (Anderwald and Evans, 2010; Genesis, 2012), although this has been a one-off event, with far smaller groups associated with sightings historically.
- **Killer whales (*Orcinus orca*):** are distributed in oceans worldwide and in UK waters they are most commonly found to the north and west of Scotland, but occasional sightings are made also in the North Sea. The species can usually be found within 800 km of coastlines and prefers deep water; however, killer whales also occur in shallow bays and estuaries (Reid et al., 2003). They live in stable family groups (pods), although most sightings in the UK are of single individuals or small groups of less than 8 whales. Sightings of killer whales along the Aberdeenshire coast generally peak between June and August with intermittent sightings. Killer whales are renowned for an extremely diverse diet and consume a wide range of prey. This includes fish (e.g. herring, mackerel, cod and halibut), squid, birds, turtles and other cetaceans and pinnipeds, including seals at their haul-outs as well as the possibility of individuals offshore (Reid et al., 2003; Genesis, 2012).
- **Sperm whale (*Physeter microcephalus*):** previous sightings of the species in UK have mostly been around the deep waters outside of the continental shelf and nearby areas. In the UK and Irish waters, Rockall, the Outer Hebrides, the Faroe-Shetland Channel and the west of Ireland are considered to be the locations where sperm whales are most likely to be sighted (Evans et al., 2011). When sperm whales have ventured into the North Sea waters, strandings are often observed indicating their presence (Evans et al., 2011). All of these standings have been reported to relate to the males who migrate to high latitudes to feed (Genesis, 2012). Sperm whales typically will be present within the UK waters between July and December (Reid et al., 2003), although stranding records suggest that low numbers may occur occasionally between January and May on the Scottish East Coast (Genesis, 2012).
- **Long-finned pilot whale (*Globicephala melas*):** pilot whales are found mainly in deep waters over 200 m, preferably to the north of Scotland and southeast of the Faroes. However, occasional sightings have been made in the northern North Sea. They occur in large pods around 20 individuals, frequently associated with other cetaceans such as dolphins. Due to their preference for deeper waters, they are only rarely sighted close to the coast.

- **Fin whale (*Balaenoptera physalus*):** around the UK, fin whales are most commonly occurring beyond or around the extent of the continental shelf along the western seaboard, with most sightings occurring off southwest Ireland, the Celtic sea and the Outer Hebrides and Shetland islands (Anderwald and Evans, 2010). Sightings of fin whale in the east Scotland Grampian region have been rare, with only 8 sightings of the species recorded since the 1970s within the sightings database of the Sea Watch Foundation (Anderwald and Evans, 2010). Only one sighting of two individual fin whales were recorded during the boat-based surveys on the Dogger Bank between 2010 and 2012, again highlighting the scarcity of the species in the North Sea (Forewind, 2013).
- **Humpback whale (*Megaptera novaeangliae*):** Humpback whales occur in UK shelf waters in very low numbers, with this largely relating to the waters of the Northern Isles and along the western waters between the Hebrides and the English Channel. As a highly migratory species, the humpback whales are present in the high latitudes whilst feeding during summer months, and have a strong reliance on these feeding areas. The species does occur on rare occasions in the waters between the Northern Isles and Eastern Scotland, with Anderwald and Evans (2010) noting 8 records in the East Grampian region, with all but one of the records relating to a single individual. The majority of these records were between June and August, whilst one was in November and one in February. Occasional records exist at locations such as the southern Moray Firth, Girdle Ness and Cove, Aberdeen and Porthlethen. Although almost absent from the North Sea in the past due to whaling operations, the increase in small numbers of the species may show some recovery of the North Atlantic population.

Due to the rarity of sightings of common dolphin, killer whale, sperm whale, long finned pilot whale, fin whale and humpback whale in nearshore waters in proximity to the Aberdeen and Nigg Bay area, these species have therefore been **scoped out** of further assessment within this ES.

15.5.5 Pinniped Species Accounts

This section presents the individual species accounts for those pinniped species identified in Section 15.5.1.

15.5.5.1 Grey Seal (*Halichoerus grypus*)

Spatial and Temporal Distribution

Individuals belonging to the north east Atlantic grey seal population commonly frequent the waters of the UK and many supratidal and intertidal areas at the shore, where they use outlying islands and remote coastlines as moulting, pupping and general haul-out sites.

Approximately 38% of the global grey seal population breed in the UK. Of these, 88% breed in Scotland (SCOS, 2014).The main breeding areas are located in the Outer Hebrides and Orkney, whilst Shetland and the northern and eastern UK coasts and the south west of England and Wales also hold breeding colonies. Increasing use of the northern and east coasts of Scotland has been recognised (Duck and Thompson, 2007). Pup production has increased in the UK since the 1960's, however evidence has indicated that this growth is levelling off in the majority of areas, with the exception of the southern and central North Sea areas (SCOS, 2013). In relation to the development, large grey seal breeding colonies are located on the Isle of May, approximately 109 km south-southwest of the Aberdeen Harbour Expansion Project area (Marine Scotland, 2015). Pup production in the Firth of Forth has continued to rise annually, with an average annual increase of 11.6% between 2006 and 2012 (SCOS, 2014).

Grey seals spend a high proportion of their time ashore during their pupping and moulting seasons (Hammond et al., 2001). Grey seals in Scotland pup from September to late November (SCOS, 2013) and then moult from December to April (SCOS, 2013). At sea, densities are therefore likely to be lower during these periods (DTI, 2009).

Several important grey seal haul-out sites are located along the east coast of Aberdeenshire at the mouths of the river Don and Ythan, Peterhead harbour, Catterline, Boddam and in Cruden Bay (ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay). Grey seals are often observed throughout the year in Aberdeen Bay with known aggregations at the mouth of the rivers Don and Dee. The areas between Aberdeen and Stonehaven are recognised as feeding areas for grey seal and seals have been observed foraging and eating fish at the sea surface in these areas (Genesis, 2012).

Telemetry tracking data has shown that grey seal foraging trips can extend several hundred kilometres offshore; however, most foraging tends to occur within 100 km of a haul-out site (SCOS, 2013). Telemetry data sourced from SCOS (2013) is presented in Figure 15.8, and clearly demonstrates how grey seals use the full length of the Scottish east coast, with potential connectivity between the Aberdeen area and the Orkney, Pentland Firth and Moray Firth areas to the north and the Firths of Tay and Forth and north Northumberland coast to the south. Figure 15.9 presents telemetry data of the movement of grey seal pups within the various regions. Telemetry data has also shown movement of an adult grey seal between the Isle of May SAC and the Outer Hebrides, as well as grey seal movement between other SACs (SCOS, 2014), however routine movements have been difficult to identify. This wide ranging movement is also demonstrated by the offshore distribution data presented by the Sea Mammal Research Unit (SMRU) density maps (Jones et al., 2013) for grey seal Figure 15.10.

The same data has been used to present the density estimates for grey seals at sea in the study area, and the same with density estimates using the 95% upper confidence interval (CI). These are presented in Figure 15.11. The figures show that the grey seal density estimate for the 5 km^2 block in which the Aberdeen Harbour Expansion Project is located is 10.1 to 50.0 grey seals at any one time, which is also the same estimate using the 95% upper CI.

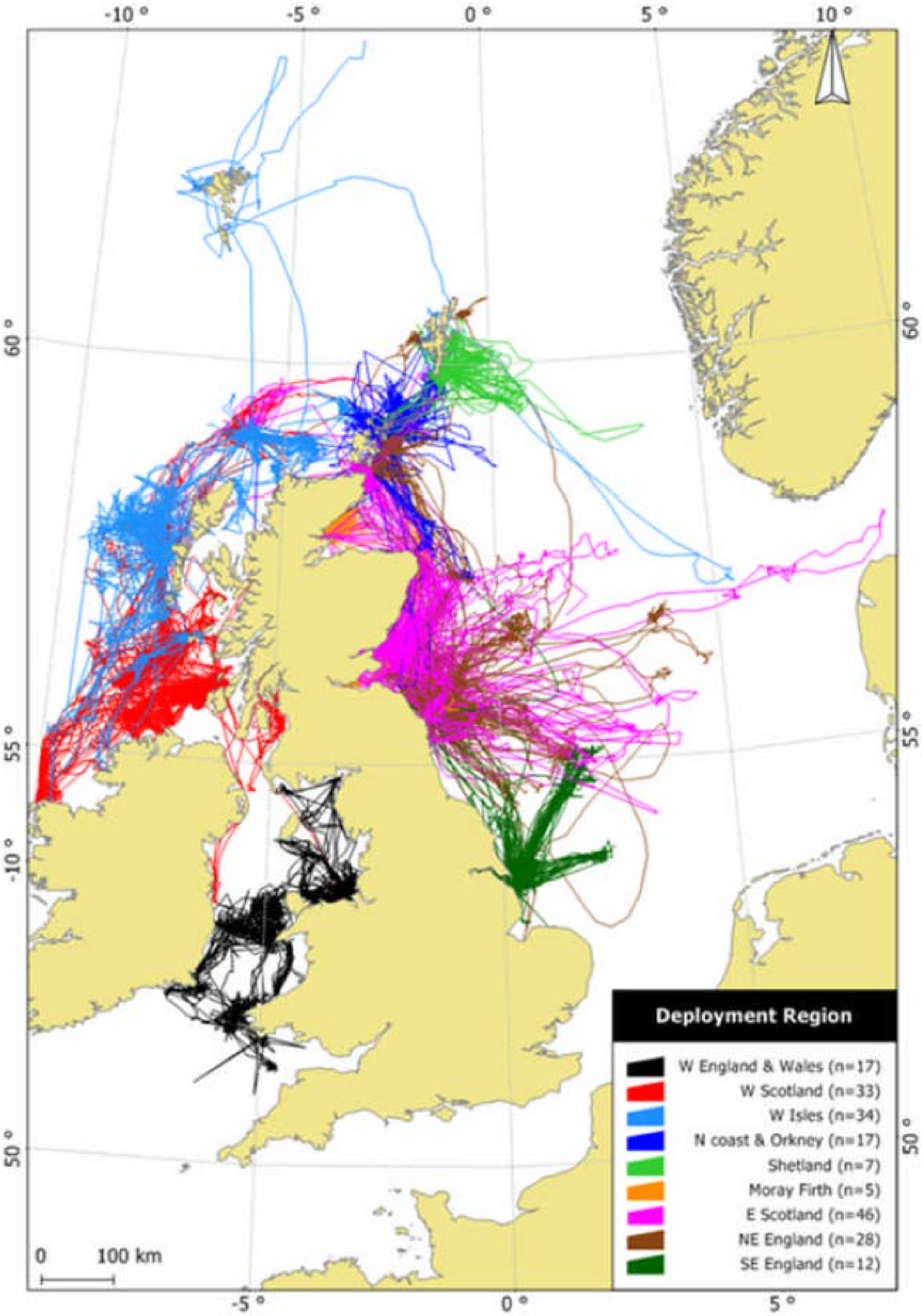


Figure 15.8: Telemetry tracks of grey seal adults by region of deployment for data collected between 1988 and 2012

Sourced: SCOS (2013)

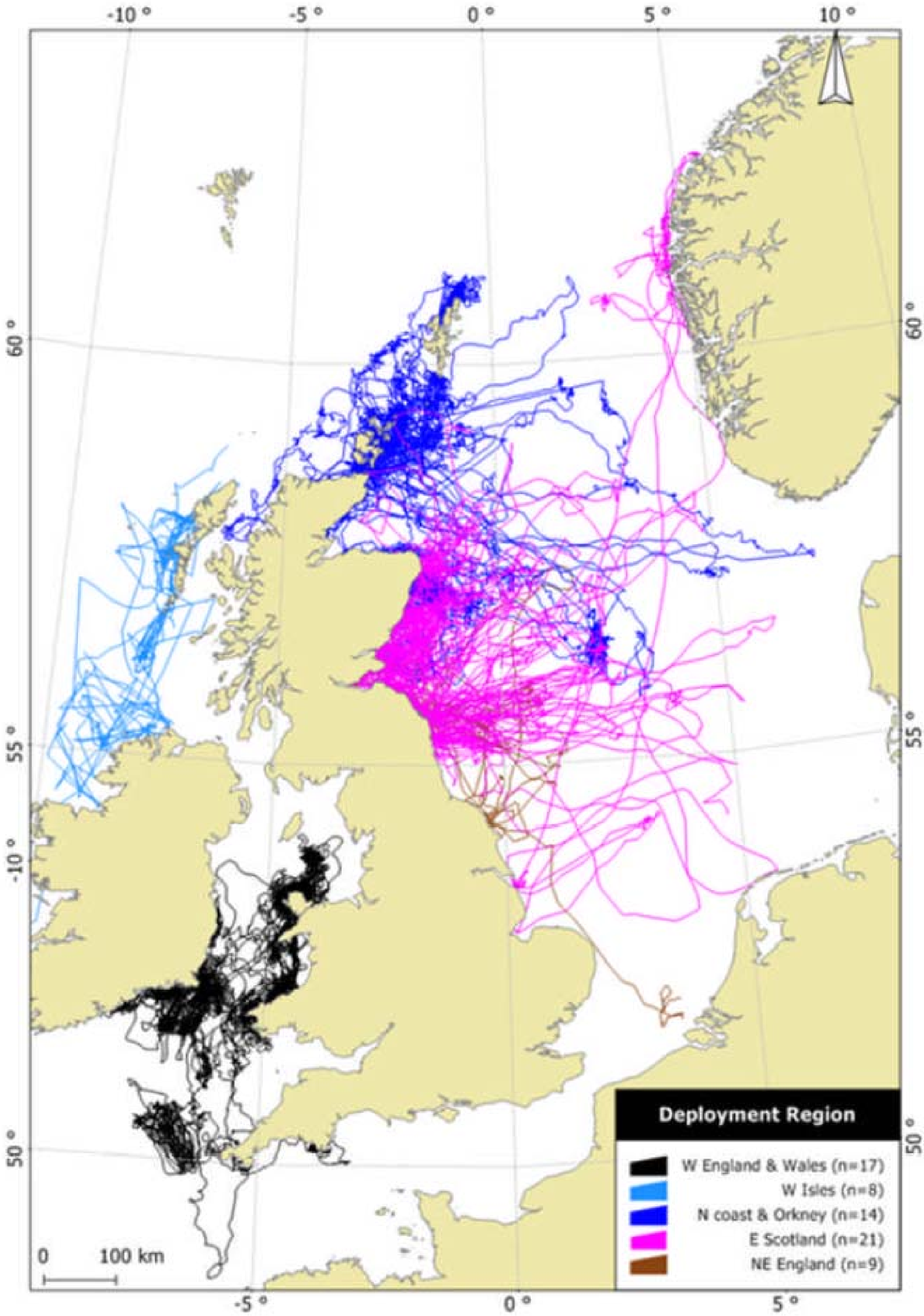


Figure 15.9: Telemetry tracks of grey seal pups by region of deployment for data collected between 1988 and 2012

Sourced: SCOS (2013)

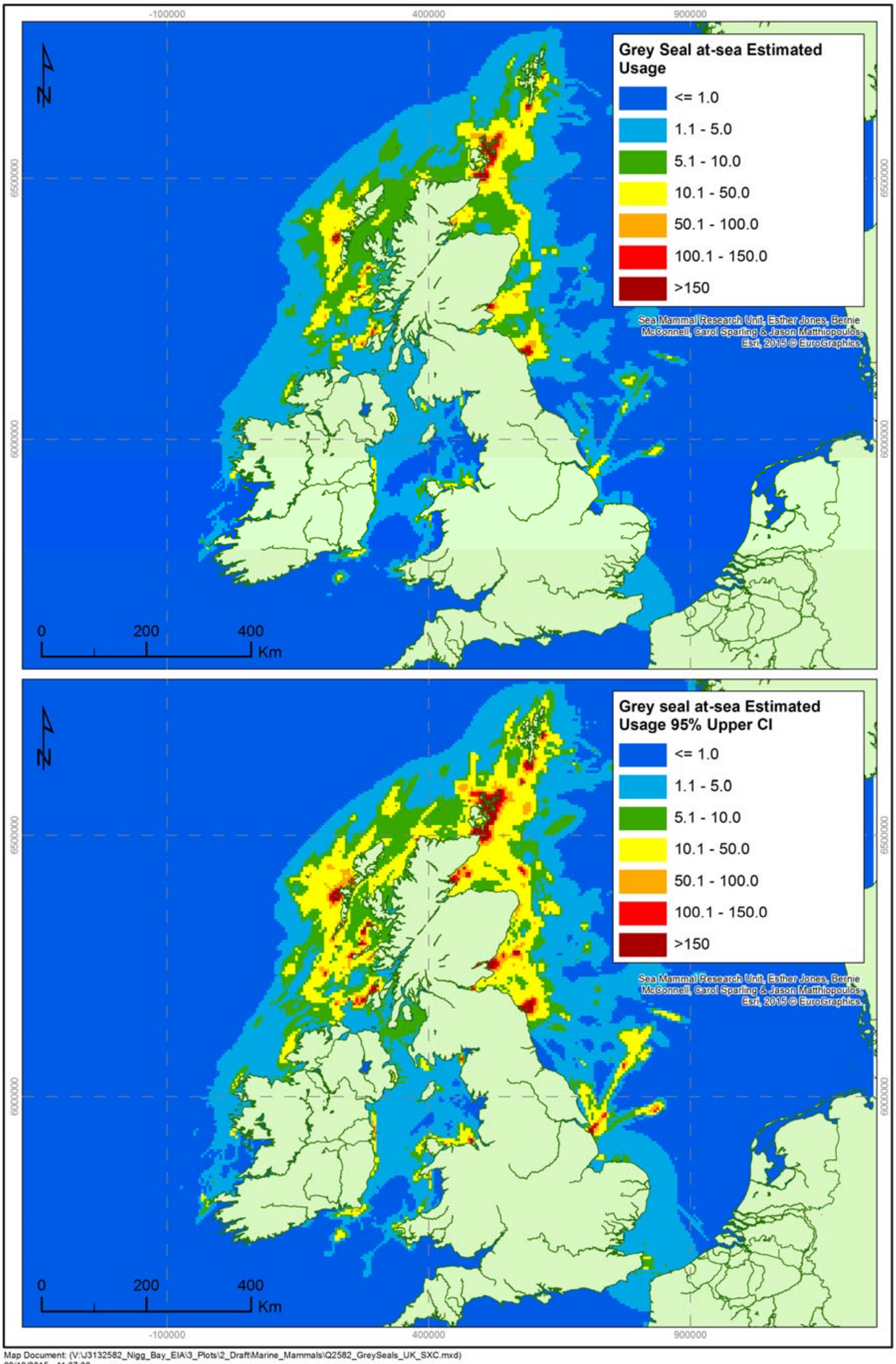


Figure 15.10: Density estimate of at sea grey seals in UK and Irish waters (top) with density estimate using 95% confidence interval (CI) (below). Figure produced using data sourced from Jones et al. (2013)

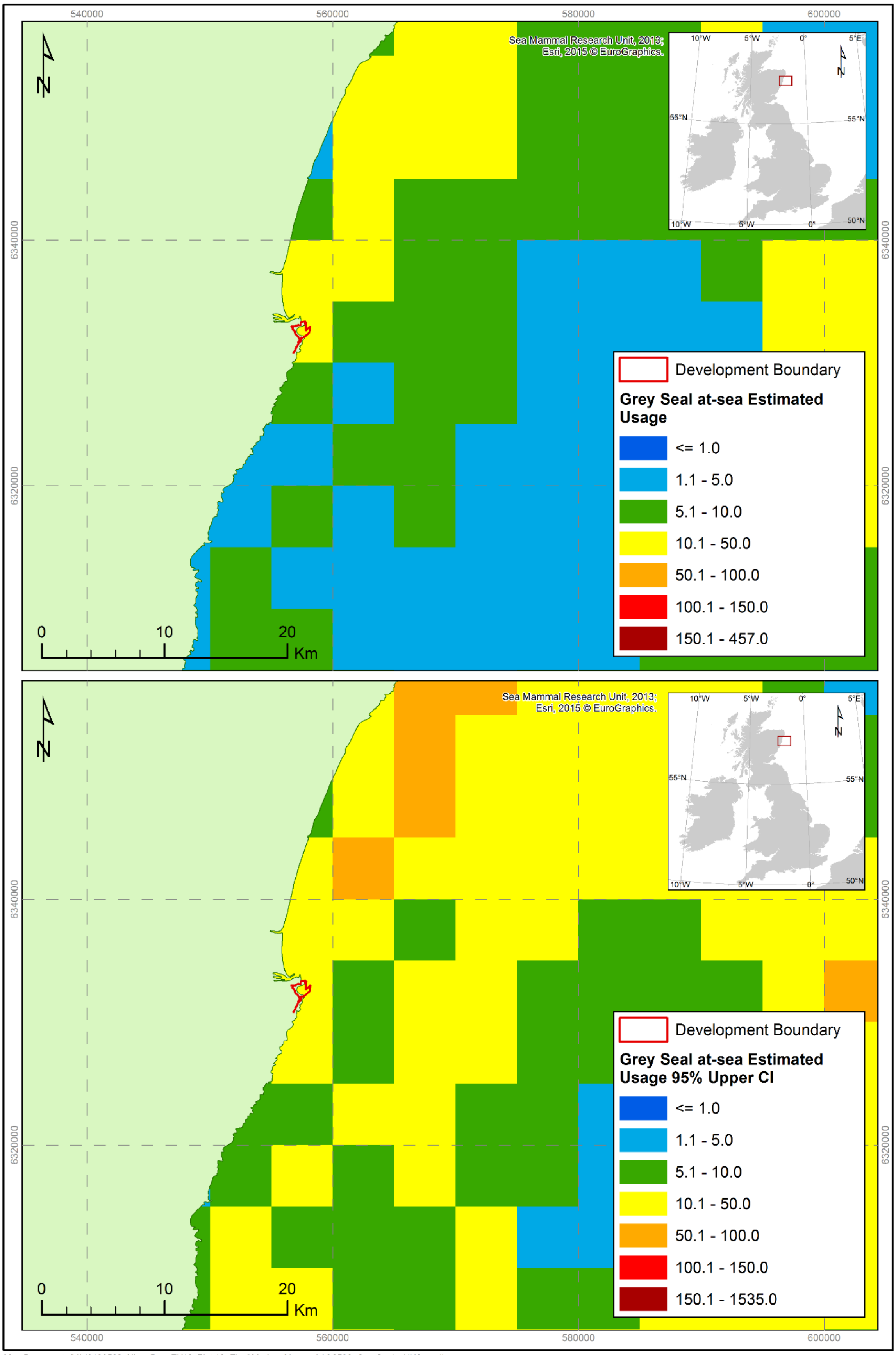


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Figure 15.11: Grey seal at-sea density estimates within the study area. Figure produced using data sourced from Jones et al. (2013)

In order to investigate the potential connectivity of important seal populations and the area surrounding the Aberdeen Harbour Expansion Project, a technical study was carried out by SMRU in support of the development (ES Appendix 15-B: Seal telemetry analysis). This provided a focussed analysis of SMRU's historic telemetry data in respect of the areas surrounding the development. This analysis aimed to establish the potential connectivity between grey seal SACs and the Nigg Bay area, and also the nature of use of the area by seals not associated with SACs. Of the 265 grey seals tagged by SMRU between 1988 and 2012, a total of 35 entered the Nigg Bay study area between 1997 and 2010. Figure 15.12 shows the telemetry tracks of the 35 grey seals that used the study area at some point in time between 1997 and 2010. Of these, 13 were tagged at SACs with grey seal as a feature (see Table 15.9 for a list of the SAC locations and the number of individuals that used the study area from these SACs and Figure 15.13 and Figure 15.14 for the telemetry tracks of these individuals).

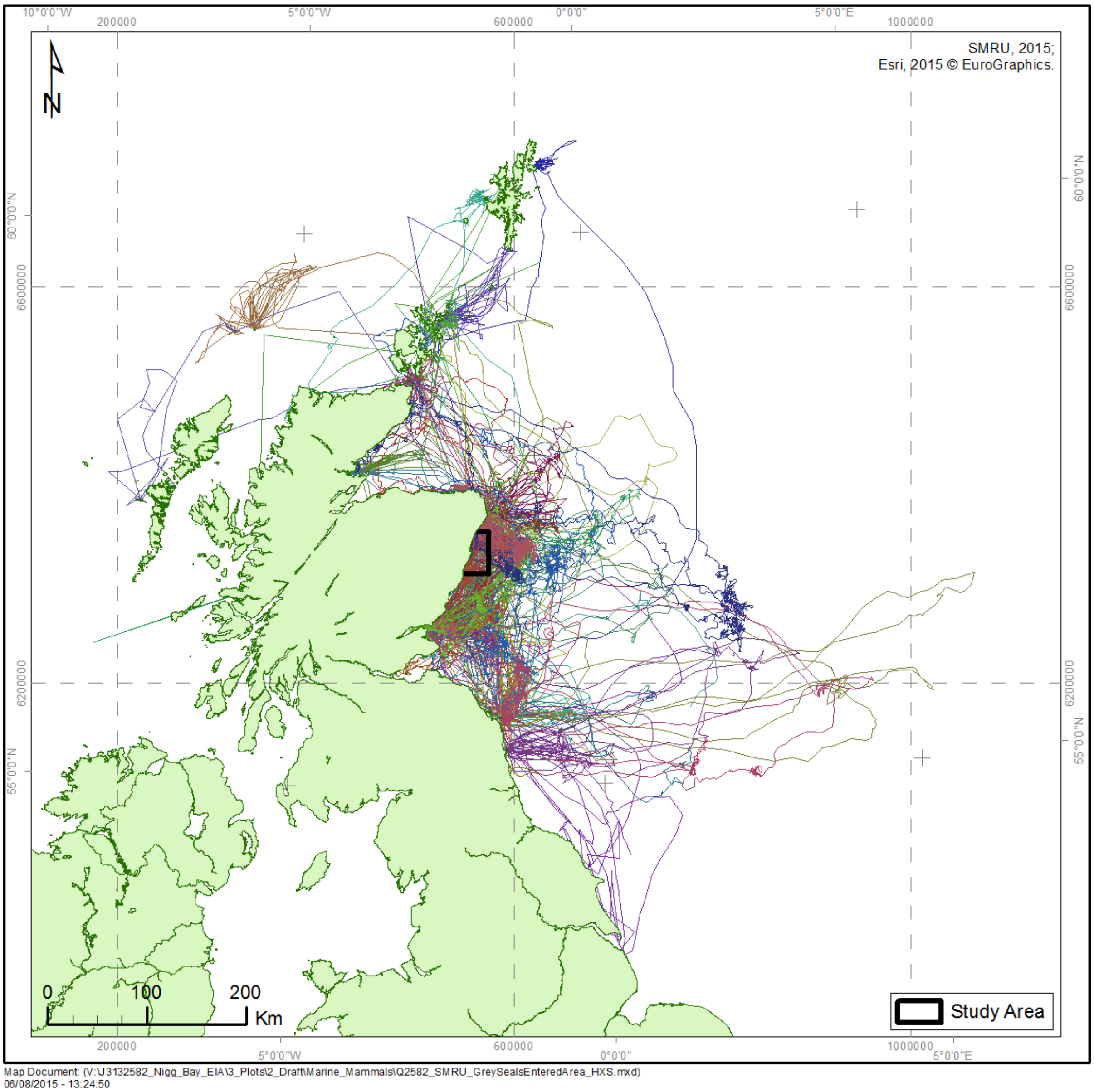
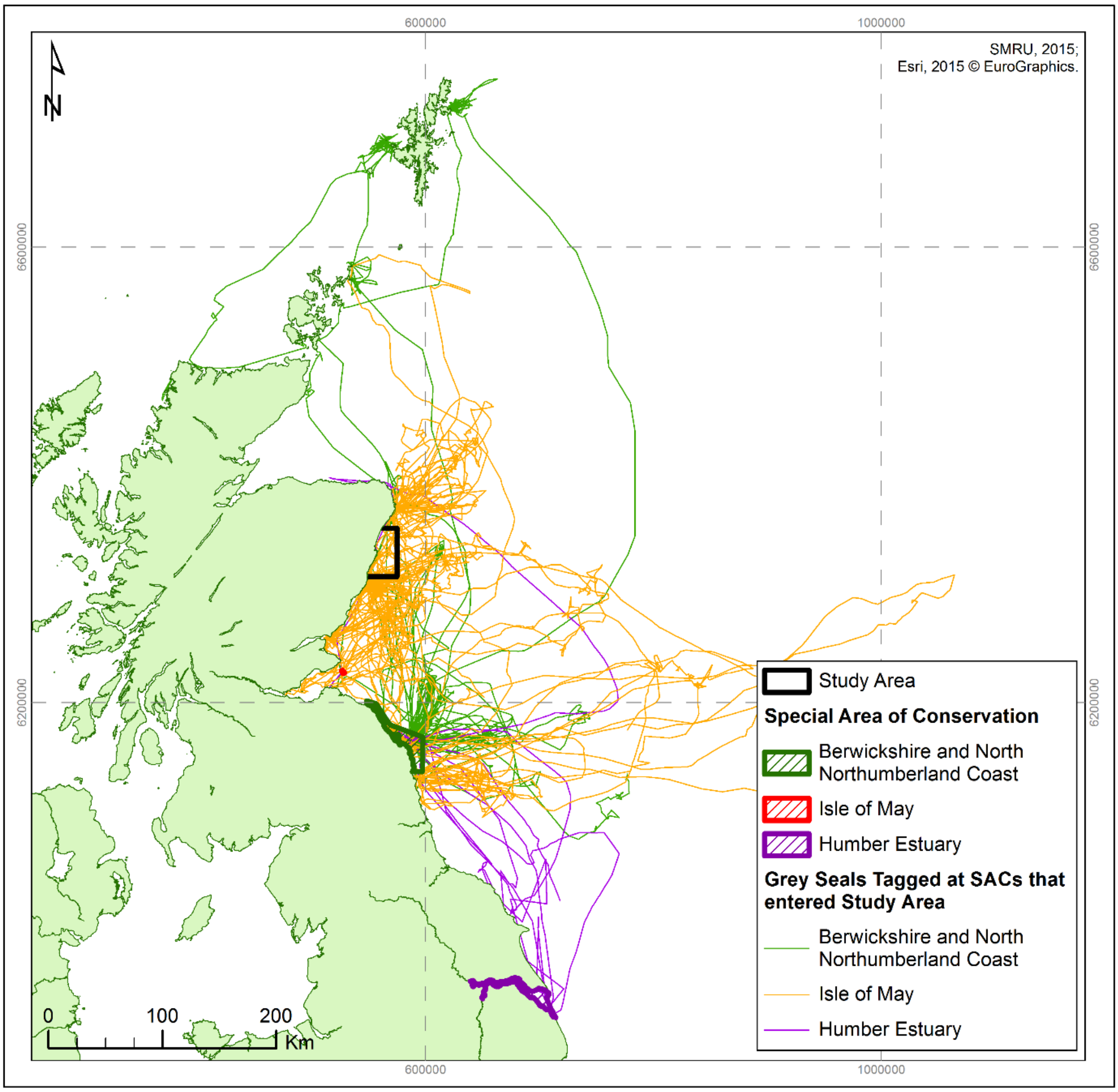


Figure 15.12: Historic telemetry data showing tagged grey seals that have used the study area and between 1997 and 2010

(Figure reproduced from Plunkett and Sparling, 2015)

Table 15.9: Numbers of grey seals that used the study area that were tagged at SACs

Grey Seal SACs	Number of Individuals Tagged at Grey Seal SACs that used Nigg Bay
Isle of May SAC	8
Berwickshire and north Northumberland Coast SAC	4
Humber Estuary SAC	1



Map Document: (V:\J3132582_Nigg_Bay_EIA\3_Plots\2_Draft\Marine_Mammals\Q2582_SMRU_GreySealsTaggedSACs_HXS.mxd)
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Figure 15.13: Telemetry tracks of grey seals that were tagged at SACs designated for grey seal with subsequent use of the study area (Figure reproduced from Plunkett and Sparling, 2015)

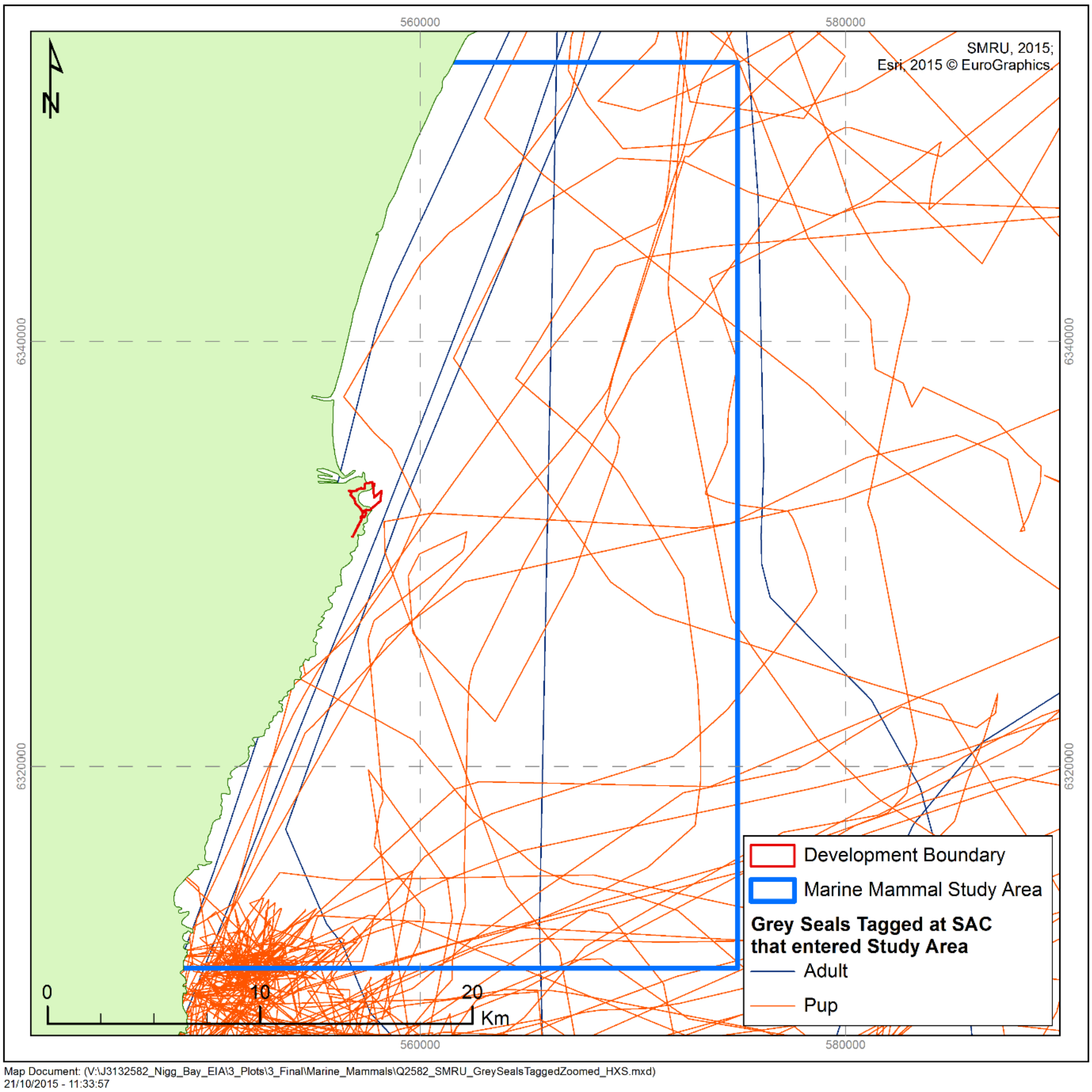


Figure 15.14: Telemetry tracks of the grey seal adults and pups that were tagged at SACs designated for grey seal and subsequently entered the study area (Figure reproduced from Plunkett and Sparling, 2015)

There were also nine grey seals which entered the Nigg Bay study area, that were not tagged at a grey seal SAC, but visited grey seal SACs. These included seals that were tagged at Abertay and also visited grey seal SACs including Berwickshire and north Northumberland Coast SAC, the Isle of May SAC, the Monach Islands SAC and the Faray and Holm of Faray SAC and 1 seal that was tagged at Sanday which visited the Faray and Holm of Faray SAC (see ES Appendix 15-B: Seal telemetry analysis). This shows that there is some potential for connectivity between seals that enter the Nigg Bay study area and grey seal SACs that are much further away from the development such as the Monach Island SAC (Western Isles) and the Faray and Holm of Faray SAC (Orkney Islands).

Figure 15.15 shows that the tracks of both adult and pup grey seals cross the Nigg Bay development boundary, however, it appears that that many adult grey seals transit along the coast, passing just offshore of the proposed development, while grey seal pups tend to spend most of their time off

Newburgh to the north of the development at the top of the Nigg Bay study area (see green circle in Figure 15.15) or just south of Stonehaven at the south of the Nigg Bay study area (see green square in Figure 15.15).

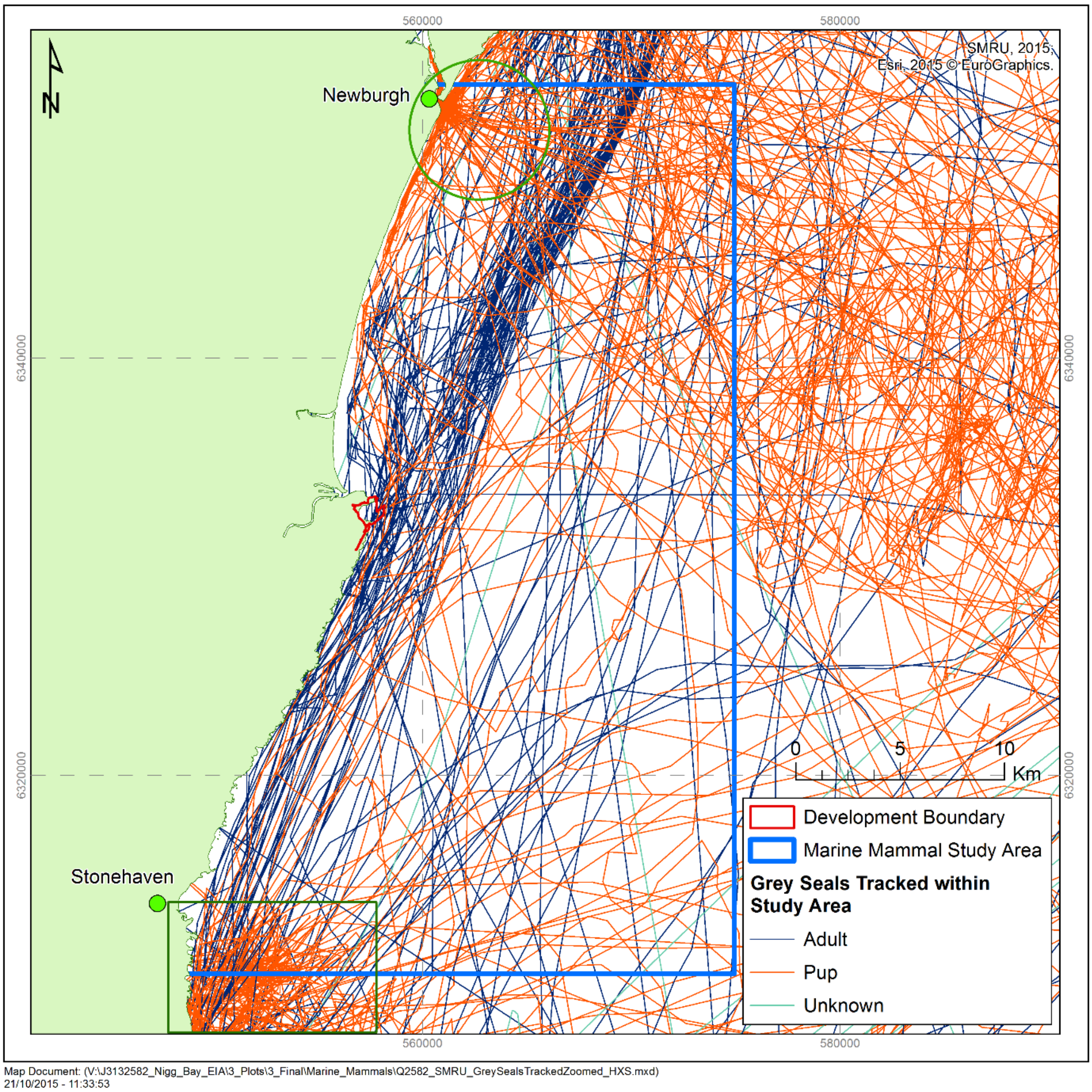


Figure 15.15: All grey seal tracks within the study area (Figure reproduced from Plunkett and Sparling, 2015)

A further 13 tagged grey seals never recorded any tracks or locations in a grey seal SAC throughout the tag duration, however, this does not mean they never visit grey seal SACs, only that they didn't during the tagging duration. Tags are expected to fall off during a moulting period, whilst battery life is also a potentially limiting factor during telemetry tagging studies (SCOS, 2012).

In respect of the seals that used the study area that were tagged at SACs (listed in Table 15.9), the seal from the Humber Estuary SAC only recorded 1.2% of its telemetry-derived locations within the study area, whilst the maximum percentage of locations within the study area for any of the four seals associated with the Berwickshire and North Northumberland Coast SAC was 1%. Seals from the Isle of May SAC had significantly more interaction with the study area, with three of the eight individuals recording 17.2%, 10.2% and 7.2% of their telemetry-derived locations within the study area respectively, whilst the remaining five individuals recorded values between 0.5% and 4.8%.

With regard to all seals tagged and used within the telemetry analysis (including both those seals tagged at SACs and the seals tagged at non-SAC locations), the number of grey seal telemetry-derived locations within the study area was generally low in comparison to the locations recorded outside of the study area during the duration of the tracking. This was with the exception of 5 individual grey seals that recorded greater than 10% of their locations in the study area, two of these being seals tagged at an SAC (Isle of May SAC). One seal recorded 31% of its telemetry-derived locations in the study area (tagged at Abertay and did not visit any SACs), however, most tagged grey seals (77%) recorded less than 5% of their locations in the study area, with 40% only recording up to 0.5% of their locations in the area. The average percentage of locations recorded within the Nigg Bay area was highest for those seals tagged at Stroma (Pentland Firth, n=3) with an average of 11.3% of recorded locations being in the study area. This was followed by the one seal tagged at Green Holm (Orkney) with 8.9% of its recorded locations being in the study area and the eight grey seal pups tagged at the Isle of May with an average of 2.8% of their recorded locations being in the study area.

Seawatch data held by WDC and collected at Torry Battery Aberdeen, notes incidental pinniped sightings alongside those of cetaceans. During 2012-2014, a total of around 100 unidentified seals (with two seals positively identified as grey seals) were observed and recorded. This included an aggregation of approximately 75 individuals on the rocks as Aberdeen Harbour mouth in a single sighting, whereas the other sightings consisted or one or two individuals.

Site-Specific Surveys

During VP surveys, grey seals were recorded across all four vantage points and in all months(Figure 15.4) with the distance from shore ranging from less than 100 m to up to 1 km. Intra-annual variation was small in the numbers observed, with numbers of individuals ranging between 7 and 23 across months, with the highest numbers recorded between January and May. Sightings took place at various times of the day and covered all tidal states but were most commonly sighted between mid and high tides, with few sightings at low tide.

Conservation

Grey seals are a priority marine features (PMF) and are therefore considered to be of particular importance to Scotland's seas, it is also listed as a species of "Least Concern" on the IUCN Red List (Thompson and Härkönen, 2008) and is also afforded protection under European law as they are listed as an Annex II and Annex V species under the Habitats Directive. Due to the importance of the Isle of May for breeding grey seals, it has been designated as an SAC accordingly (see Section 15.5.6 for further details on this site). Whilst no other SACs exist for grey seal within the Scottish east coast region, grey seal are a designated feature of the Berwickshire and North Northumberland SAC[4] to the south in northeast England, whilst the Faray and Holm of Faray SAC[5] to the north at Orkney is also

4 http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUcode=UK0017072
5 http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUcode=UK0017096

designated for grey seal, due to the second largest breeding colony in the UK occurring there with approximately 9% of annual UK pup production.

There are no designated seal haul-out sites, under the Marine Scotland (2010) Act, in Aberdeenshire (Marine Scotland, 2014). However, 3 breeding colonies are designated haul-outs within the Firth of Forth at Fast Castle, Inchkeith and Craigleith respectively.

Prey

Grey seal are known for being an opportunistic predator, capable of consuming a wide variety of prey. In close proximity to the development, grey seal are known to feed primarily on sandeels and gadoid fish species, feeding on salmon and marine fish in the Don and Dee estuaries (Carter 2001, Genesis 2012). Sandeel habitat includes gravel and sandy areas, where grey seal will often forage.

Summary

Grey seals are known to be present throughout the year along the east coast of Scotland and in Aberdeen Bay with known aggregations at the mouth of the rivers Don and Dee. The site-specific VP surveys have demonstrated that grey seal are using the Nigg Bay area throughout the year. The SMRU telemetry study (ES Appendix 15-B: Seal telemetry analysis) has indicated that this usage predominantly comprises of adult grey seals that transit directly past the Nigg Bay harbour mouth, whilst some pups might also pass through this area. However, pups appear to spend most of their time at Newburgh to the north of the development and Stonehaven to the south which could potentially indicate foraging areas.

The telemetry data show a lot of overlap between grey seal movements and Nigg Bay and surrounding areas, however, the degree of connectivity with grey seal SACs is low. A large proportion (69%) of the grey seals tagged at SACs that entered the Nigg Bay study area were pups (n=9 pups), mostly from the Isle of May SAC. Pups tend to disperse more after leaving the breeding site and have less ‘settled’ movement patterns than adult seals (ES Appendix 15-B: Seal telemetry analysis). It is not certain that those pups tagged at the Isle of May SAC would return there to form part of the breeding population for which the SAC is designated.

The telemetry data serves to demonstrate how grey seal foraging trips can extend long distances offshore and coastally. The potential connectivity that is apparent along the Scottish east coast between the development and the Orkney, Pentland Firth and Moray Firth areas to the north and the Firths of Tay and Forth and north Northumberland coast to the south is particularly pertinent considering the designated populations at the Isle of May and Berwickshire and north Northumberland SACs. Whilst a single individual from the Humber Estuary SAC passed through the Nigg Bay area, it would only be expected that this would occur in extremely rare circumstances given the long distance between these locations.

Due to the year-round presence of grey seals in the local area, the species has been **scoped in** for further assessment within this ES.

15.5.5.2 Harbour Seal (*Phoca vitulina*)

Spatial and Temporal Distribution

Harbour seals are distributed globally, with concentrations around the coastal areas of the North Atlantic, North Pacific, the subtropics and the Arctic (SCOS, 2014). The subspecies discussed here is *Phoca vitulina vitulina*, the European subspecies. The harbour seals are distributed widely, ranging from southern areas of the waters of France, to Iceland in the west, Svalbard to the north and the Baltic region to the east, whilst the Wadden Sea holds the largest population of harbour seals in Europe. The UK is home to approximately 30% of the European population of harbour seals (SCOS, 2013; 2014), a figure which previously stood at 40% in 2002 before this declined.

Haul-out, breeding and moulting sites are typically situated in sheltered estuaries and on sandbanks but they also use rocky areas. Harbour seals are present along the coast of Aberdeenshire although the area is not particularly important for this species, with seals widespread around the Scottish west coast, the Hebrides and Northern Isles (SCOS, 2014). On the eastern Scottish coast, the species is distributed in slightly less ranging concentrations, with the Firth of Tay and Moray Firth considered to be the important locations for harbour seals. Harbour seals spend a high proportion of time ashore during the pupping and moulting seasons from June to September (SCOS, 2013). The harbour seal annual moult takes place between June and September, and the pupping season takes place from June to July. It is during these important seasons that harbour seals will spend more time in coastal waters and ashore in local haul-out sites (Genesis 2012).

Major declines occurred in multiple harbour seal populations around Scotland in the recent past and have been documented (SCOS, 2014). The Firth of Tay population decreased by 92% between 2002 and 2013, whilst the Moray Firth population declined by 50% before 2005 and then showed a 40% increase by 2010 with a fluctuating population ever since. These declines have not been attributed to the phocine distemper virus (PDV) epidemic which did not affect Scottish seal populations notably, but did detrimentally affect English east coast populations in 1988 and 2002 significantly (SCOS, 2014). The cause of the decline of the Scottish populations is not clear.

Telemetry studies have observed that foraging trips are generally within 40 km to 50 km of haul-out sites. Although longer trips of over 200 km were observed, these were between haul-out sites on Orkney and Shetland, rather than to offshore foraging areas (SCOS, 2013). Figure 15-16 shows telemetry data which illustrates how large stretches of the east coast of Scotland is used by seals, with a concentration of usage apparent in the areas adjacent to the Firth of Tay. The distribution of harbour seals is also demonstrated by the offshore distribution data presented by the density maps for harbour seal movements in Figure 15.17 (Jones et al., 2013) with the populations from the Moray Firth, and the Firths of Tay and Forth highly prominent.

The same density data has been used to present the density estimates for harbour seals at sea in the study area and the same with density estimates using the 95% upper confidence interval (CI). These are presented in Figure 15.18. The figure shows that the harbour seal density estimate for the 5 km^2 block in which the development is located is 1.1 to 5.0 harbour seals at any one time, which is also the same estimate using the 95% upper CI.

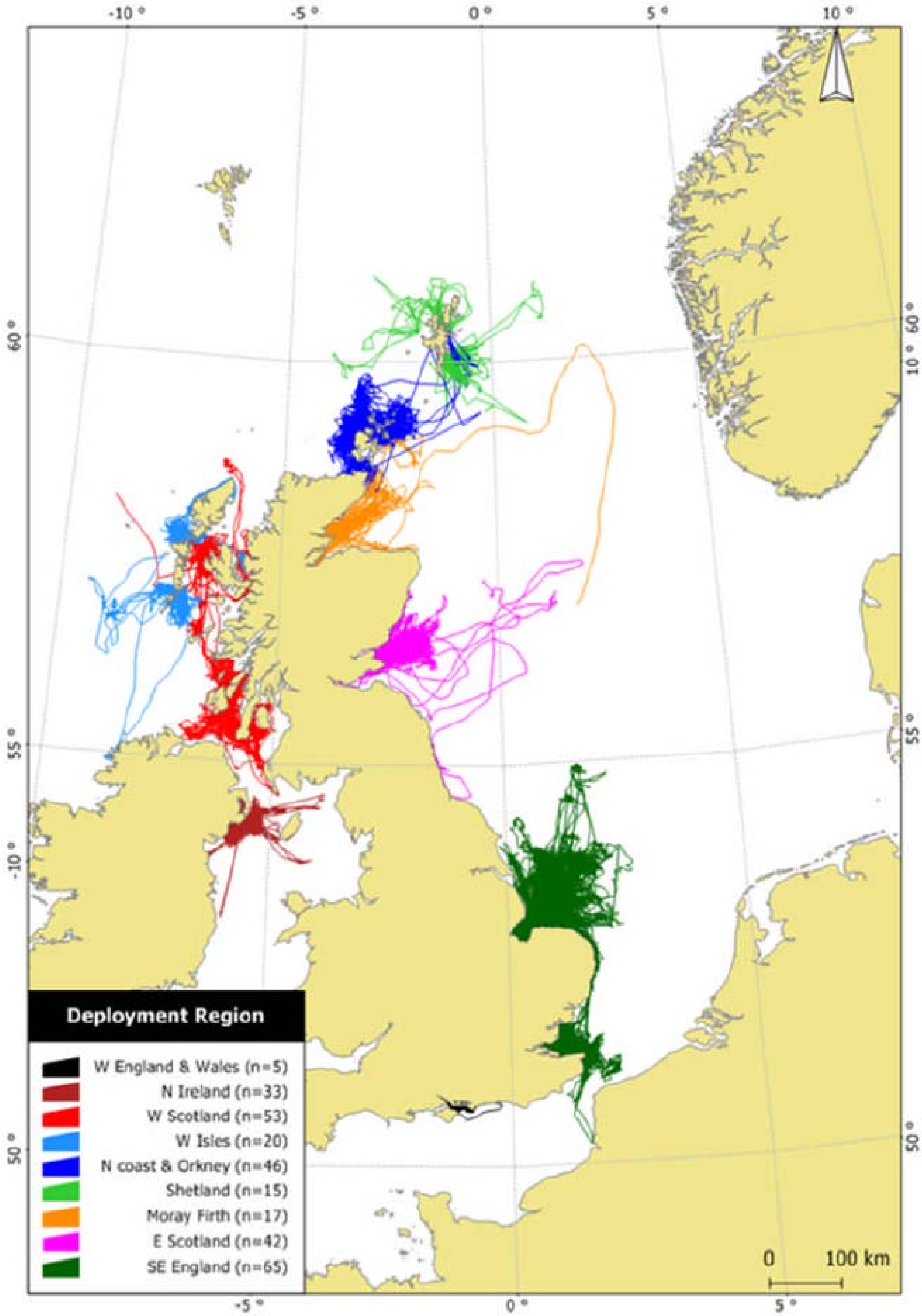
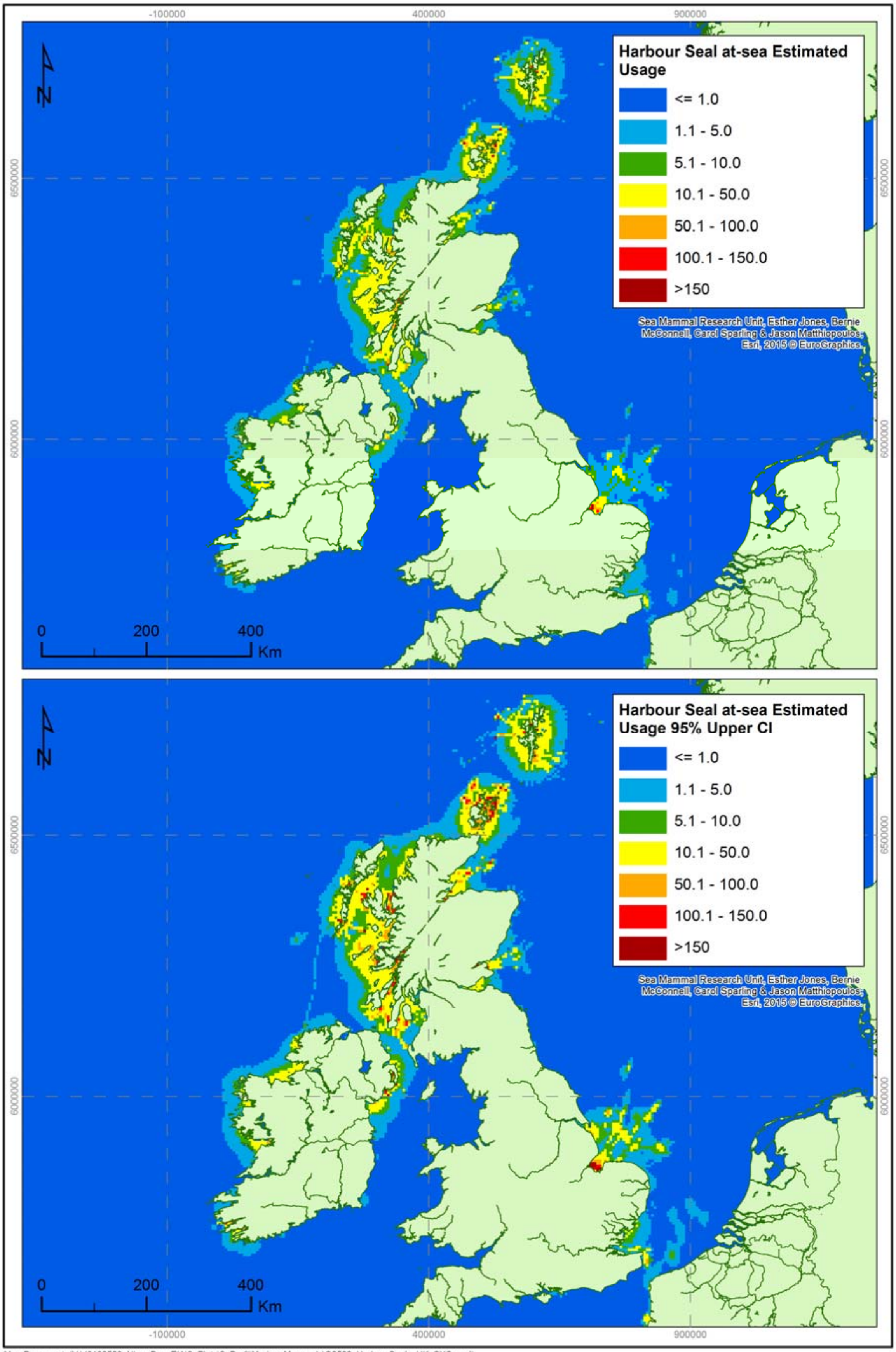


Figure 15-16: Telemetry tracks showing overall range of harbour seal by deployment region, using data up to 2012

Sourced: SCOS, 2013



Map Document: (V:\J3132582_Nigg_Bay_EIA\3_Plots\2_Draft\Marine_Mammals\Q2582_HarbourSeals_UK_SXC.mxd)
09/10/2015 - 11:37:32

Figure 15.17: Density estimate of at sea harbour seals in UK and Irish waters (top) with density estimate using 95% confidence interval (CI) (below). Figure produced using data sourced from Jones et al. (2013).

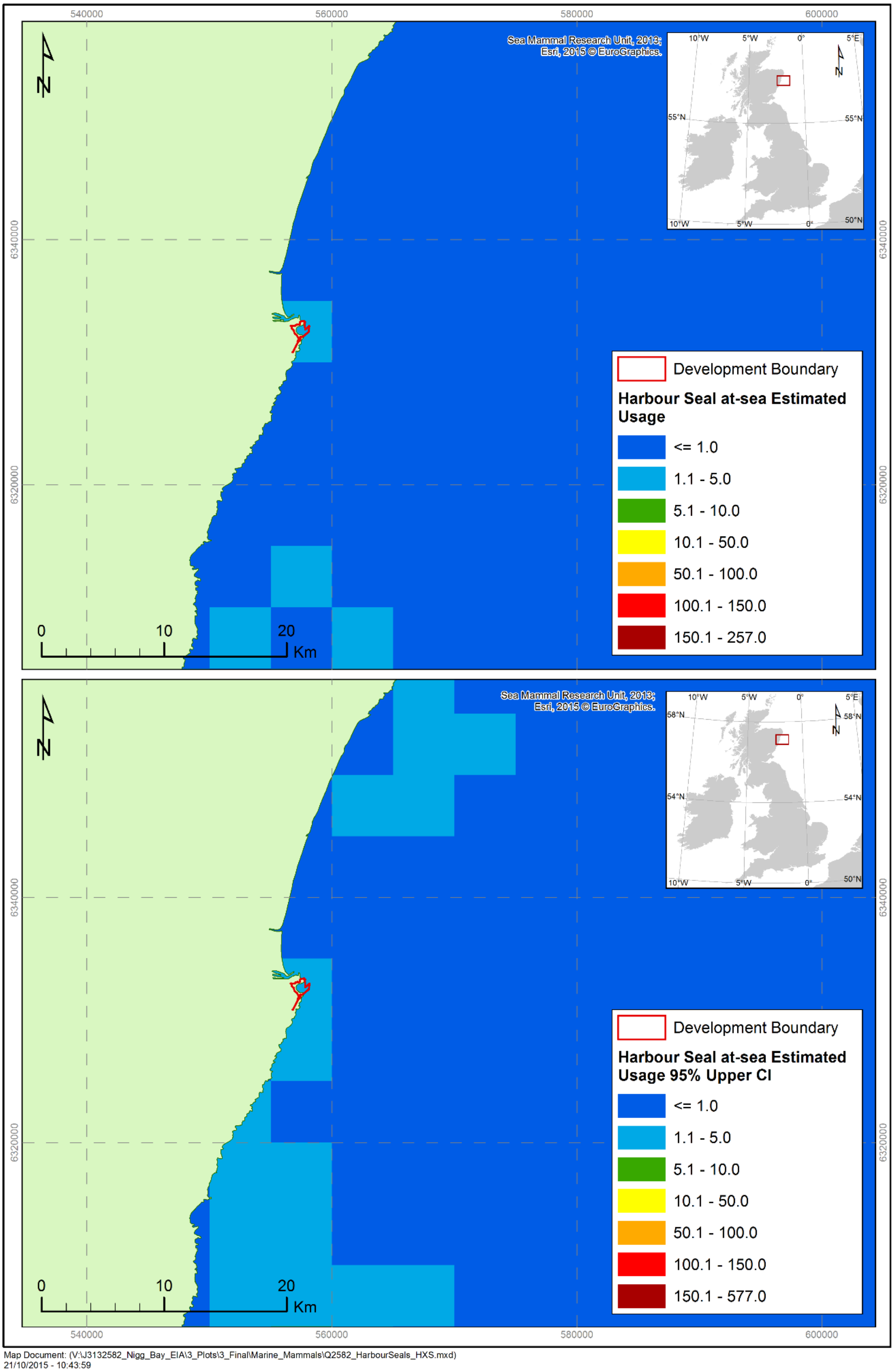


Figure 15.18: Harbour seal at sea density estimates within the study area. Figure produced using data sourced from Jones et al. (2013)

In the Aberdeen area, seasonal aggregations of harbour seal are known to occur within the estuaries of the rivers Dee and Don, with maximum numbers observed in the winter and early spring months and absent from these areas in the summer months of June and July. The River Don is known to be used as a haul-out site, whilst the River Dee is used as a foraging location, where the seals feed on mostly salmonids, flounder and other marine fish species (Carter, 2001, Genesis, 2012). Other haul-out sites used by harbour seals along the Aberdeenshire east coast include the mouth of the River Ythan and at Catterline (Genesis 2012).

The technical study carried out by SMRU in support of the development (ES Appendix 15-B: Seal telemetry analysis) focussed the analysis of SMRU telemetry data on the areas around the Aberdeen Harbour Expansion Project. This aimed to establish connectivity between harbour seal SACs and the study area, and also the nature of use of the area by seals not associated with SACs.

Of the 121 harbour seals tagged by SMRU between 1988 and 2012 in Scottish waters, the only tagged harbour seal to enter the study area was a single adult female harbour seal in 2002, which was tagged at the Firth of Tay and Eden Estuary SAC. The telemetry track of this individual showing connectivity with the study area is presented in Figure 15.19.

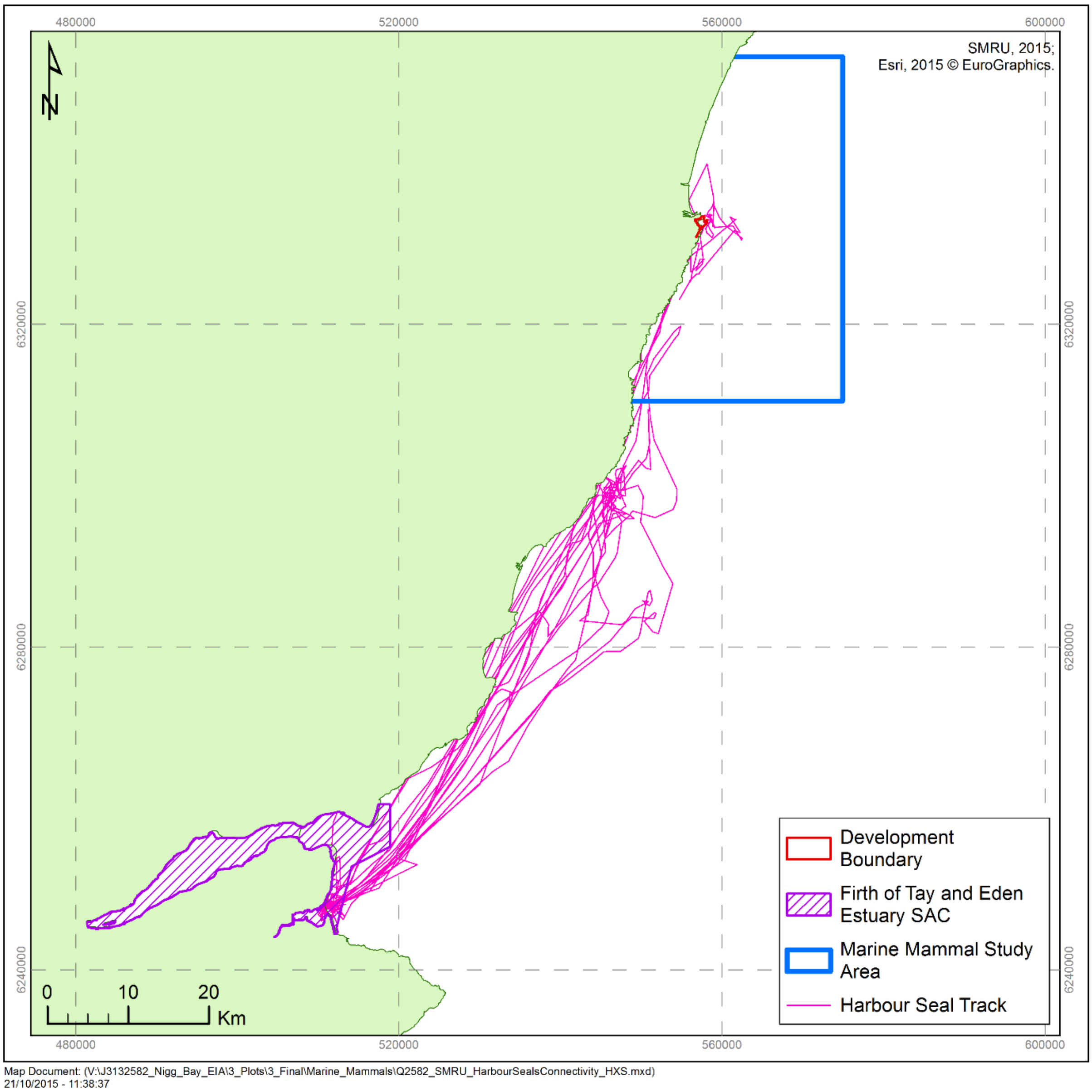


Figure 15.19: A single seal's telemetry track showing connectivity between the study area and the Firth of Tay and Eden Estuary SAC

Of the 714 telemetry-derived locations associated with this tagged individual, 107 were within the Nigg Bay study area which equates to 15% of its recorded locations. As can be seen in Figure 15.20, the Nigg Bay study area represents the northern most locations at which this tagged seal was recorded. This individual appeared to concentrate some activity during the trip around the mouth of the Nigg Bay area.

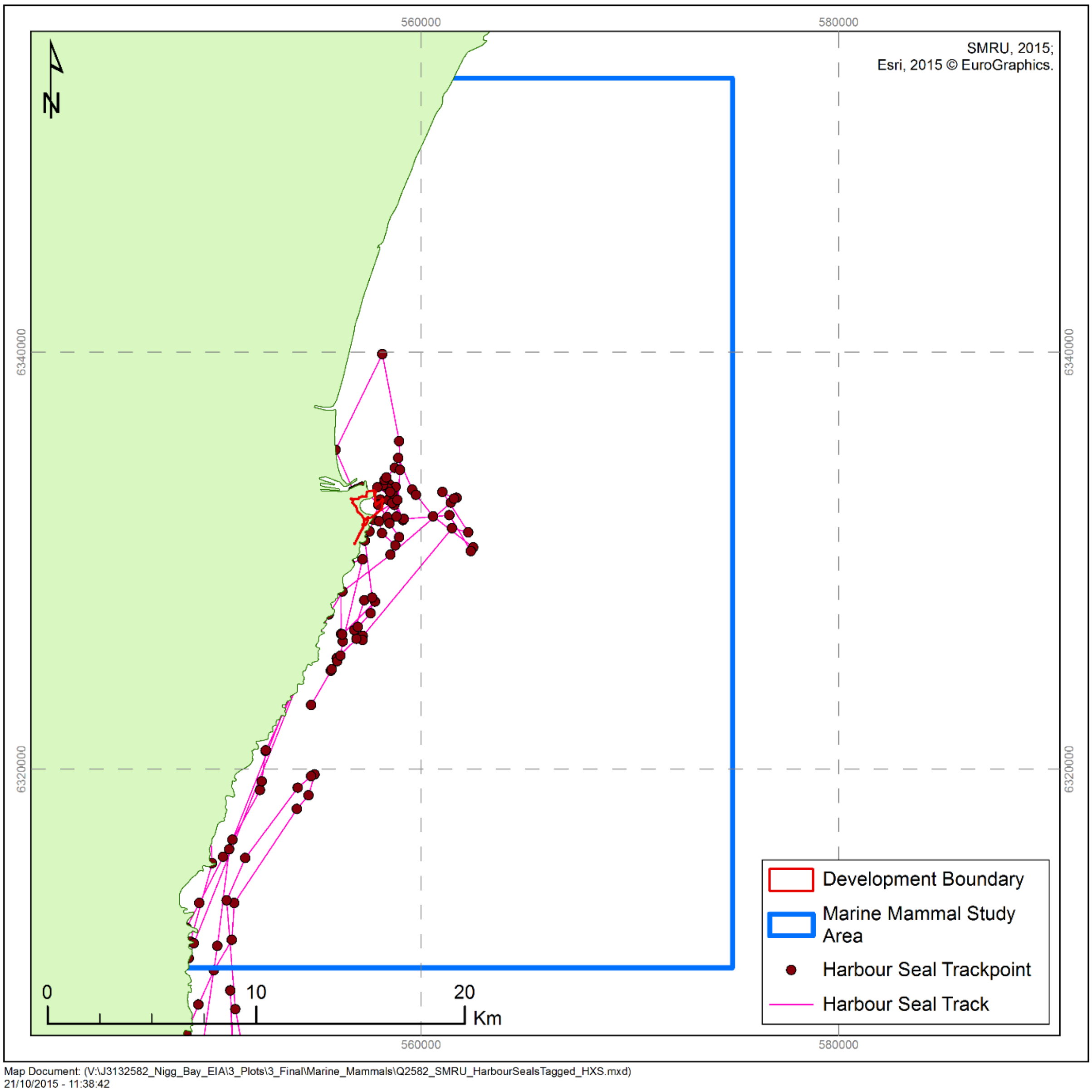


Figure 15.20: Track and locations of the single tagged harbour seal that entered the study area

Seawatch data held by WDC and collected at Torry Battery Aberdeen, notes incidental pinniped sightings alongside those of cetaceans. During 2012 to 2014, a total of around 100 unidentified seals were observed and recorded. This included an aggregation of approximately 75 individuals on the rocks at the mouth of the existing Aberdeen Harbour in a single sighting, whereas the other sightings consisted or one or two individuals.

Site-specific Surveys

No harbour seals were identified during the site-specific surveys. The trained observer was precautionary when identifying to species level, and was confident that no harbour seals were present during surveys. Harbour seals are known to be uncommon in the area and the absence of sightings supports this.

Conservation

Harbour seals are listed as a PMF in Scotland, they are also listed as a species of “Least Concern” on the IUCN Red List (Thompson and Härkönen, 2008b) and are also afforded protection under European law as they are listed as an Annex II and Annex V species under the Habitats Directive. The Firth of Tay and Eden Estuary and Dornoch Firth and Morrich More SACs are designated due to the importance of the breeding colonies at these sites which support nationally significant populations of harbour seals (see Section 15.5.6).

Prey

Research as to why harbour seal populations have been in decline have tentatively hypothesised that competition for prey with grey seals could be a driving mechanism behind this, with some locations showing increasing numbers of grey seals and decreasing numbers of harbour seals (SCOS, 2014). Prey typically comprises sandeels, gadoids, flatfish, scorpion fish, sandy benthic fish, pelagic fish and cephalopods, although regional differences are thought to occur. Central North Sea populations have shown an increase in sandeels in their diet in recent years (SCOS, 2014).

Summary

Harbour seals are known to be present within the Aberdeen area, based upon observations of seasonal aggregations of harbour seal within the estuaries of the rivers Dee (foraging location) and Don (haul-out location), with maximum numbers observed in the winter and early spring months and absent from these areas in the summer months of June and July. Other haul-out sites include the mouth of the River Ythan and at Catterline (Genesis 2012), whilst they use the waters around Newburgh.

Despite this, Nigg Bay itself is not an important area for harbour seals, as demonstrated by the absence of sightings during the site-specific VP surveys. Similarly, only one harbour seal telemetry track entered the surrounding area to Nigg Bay in the SMRU harbour seal analysis. Whilst the potential for connectivity between the Firth of Tay and Eden Estuary SAC harbour seal population and the Nigg Bay area has been established from the movements of this individual, the movements of a single individual are not likely to be representative of the SAC population, and it is clear that any connectivity between the two sites is extremely limited.

Due to the reported presence of harbour seals in the local area at the River Dee, and the connectivity (albeit highly limited) of harbour seal as demonstrated by telemetry analysis, the species has been **scoped in** for further assessment within this ES.

15.5.6 Nature Conservation Designations

There are numerous conservation areas designated for the protection of marine mammals along the eastern Scottish coastline. These are presented in Figure 15.21 and include the Moray Firth SAC, the Firth of Tay and Eden Estuary SAC, the Dornoch Firth and Morrich More SAC, the Isle of May SAC. The wider study area also includes the Berwickshire and North Northumberland SAC, which is located in northeast England. Draft SACs for harbour porpoise have also been discussed as potential future designations. An overview of all designations is provided below, with further details on these sites and other protected areas discussed in detail in Chapter 10: Nature Conservation.

15.5.6.1 Moray Firth SAC

The Moray Firth SAC[6] has been designated for bottlenose dolphin as a primary qualifying feature, due to the site supporting the only known resident population of the species in the North Sea (Culloch and Robinson, 2008). The designation's data form lists a resident population estimate of 101 to 250 individuals, with the SAC situated 155 km from the proposed development (Figure 15.21). As discussed in Section 15.5.4.1, the bottlenose population for which this site is designated have been found to utilise the coastal waters of eastern Scotland as far as the Firth of Forth. Any negative impact to bottlenose dolphins in the development boundary will therefore also have the potential for implications on the Moray Firth bottlenose dolphin population.

15.5.6.2 Firth of Tay and Eden Estuary SAC

The Firth of Tay and Eden Estuary SAC[7] is the closest designation to the proposed development (for marine mammals) and is situated approximately 86 km south-south-west of Nigg Bay (Figure 15.21). The site supports a nationally important breeding colony of harbour seal. Around 600 adults haul-out at the site to rest, pup and moult, representing around 2% of the UK population of this species. Given the relatively short distances travelled by harbour seal for foraging (typically 50 km), it is considered unlikely that harbour seals from the Firth of Tay and Eden Estuary colony will be present at Nigg Bay.

15.5.6.3 Isle of May SAC

The Isle of May SAC[8] situated approximately 109 km south-southeast of Nigg Bay (Figure 15.21) and supports the largest east coast breeding colony of grey seals in Scotland and the fourth-largest breeding colony in the UK, contributing approximately 4.5% of annual UK pup production. As discussed in Section 15.5.5.1, grey seals tend forage within 100 km of a haul-out site (SCOS, 2013). However the telemetry data (SCOS, 2013) also presented in Section 15.5.5.1 clearly shows grey seal transits along the east coast of Scotland do occur and this may include individuals from the Isle of May colony.

15.5.6.4 Dornoch Firth and Morrich More SAC

The Dornoch Firth and Morrich More SAC[9] is situated approximately 195 km from the proposed development (Figure 15.21), with the site located within the Moray Firth at the Dornoch Firth estuary. The harbour seal population which is present there represents almost 2% of the national population, with the harbour seals using the sandbanks at the mouth of the estuary for hauling out and breeding.

15.5.6.5 Berwickshire and North Northumberland SAC

The Berwickshire and North Northumberland SAC[10] is located in northeast England close to the Scottish border. The site is located approximately 132 km from the proposed development (Figure 15.21). Grey seal are a primary reason for the site designation, with the breeding colony at the site supporting 2.5% of annual UK pup production. It is the most south easterly site within the breeding range of the species within the UK.

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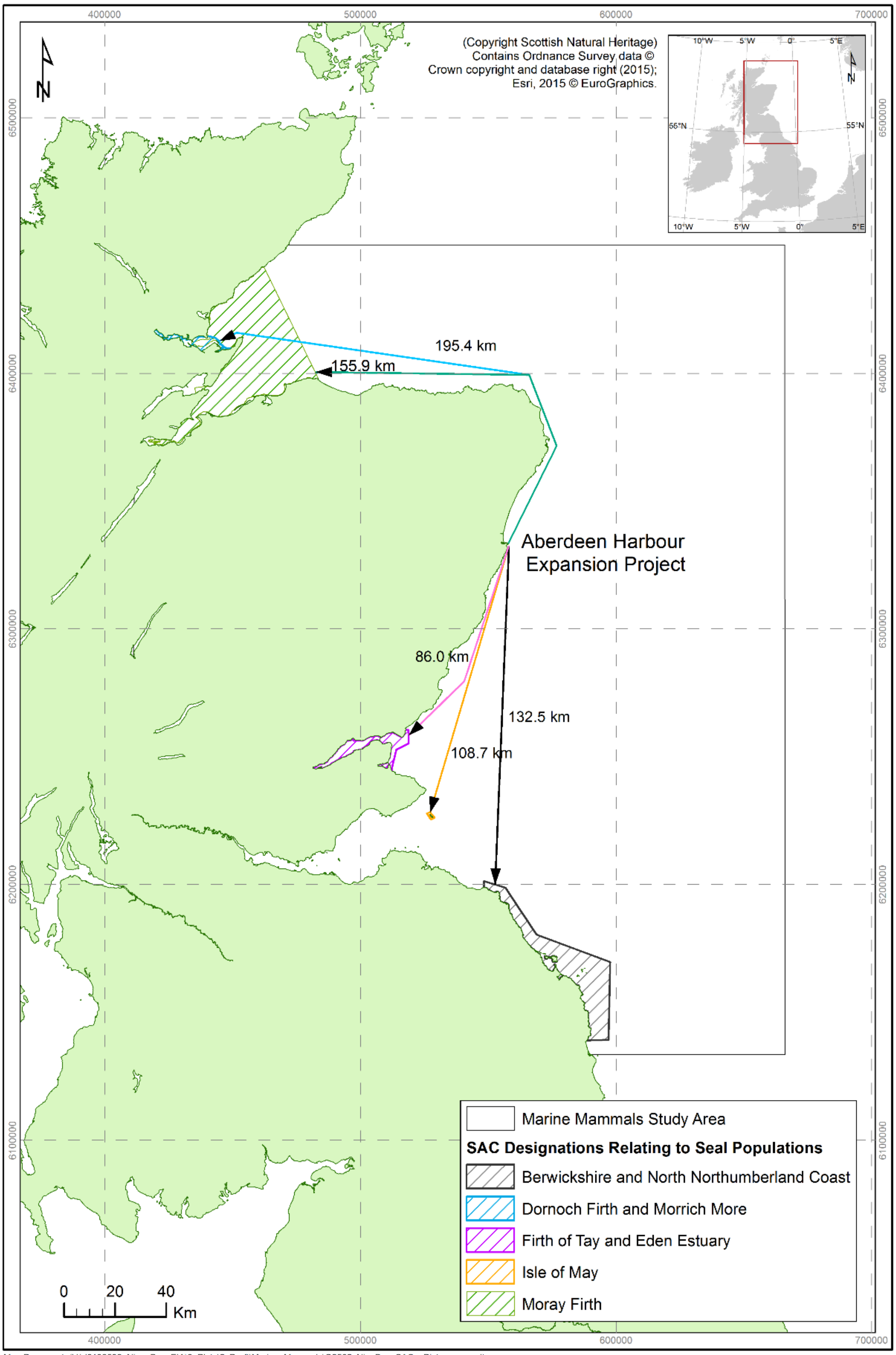
6 http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0019808
7 http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUcode=UK0030311
8 http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUcode=UK0030172
9 http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUcode=UK0019806
10 http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0017072

15.5.6.6 Draft SACs (dSACs)

It is understood that a future round of marine designations may take place in coming years. Two of the potential designations may include designations for harbour porpoise in the outer Moray Firth area and the central North Sea; however, consultation has not yet commenced at the time of writing so the sites do not have a legal status (see Chapter 10: Nature Conservation for further details).



Map Document: (V:\J3132582_Nigg_Bay_EIA\3_Plots\2_Draft\Marine_Mammals\Q2582_NiggBay_SACs_Distances.mxd)
20/08/2015 - 10:16:07

Figure 15.21: Marine mammal SACs

15.6 Assessment of Effects

15.6.1 Project Description

Table 15.10 presents the project metrics used to assess each of the predicted impacts of the construction and operation of the development, which are taken from the full project description provided in Chapter 3: Description of the Development.

Table 15.10: Project metrics used in the assessment of impacts on marine mammals

Description of Impacts and Effects	Project Metrics Considered in the Assessment of the Impact
Construction	
Impacts Relating to Noise	
Mortality, startle reaction and avoidance due to piling, drilling and blasting	Blasting of the seabed will be undertaken using explosive in areas or rock to facilitate the dredging process. Drilling will be used to place the explosives within the rock. Piling will be undertaken to install piled walls as part of the construction of the quays.
Startle reaction and avoidance due to rock placement	A dredger with a split hopper will transit to the designated offshore disposal area, then open up and allow the material to fall to the seabed.
Disturbance and avoidance due to dredging noise	The seabed will be deepened within the proposed basin areas using a trailer suction hopper and/or backhoe dredging method. The dredging is likely to be undertaken continuously over 19 months. Dredging will create underwater noise due to the vessel operation and the physical activity of the dredging process at the seabed.
Disturbance due vessel noise	Construction vessels will produce underwater noise as a result of their engine operation.
Impacts Relating to Increased SSCs	
Temporary increases in suspended sediment concentrations (SSCs) due to dredging	The seabed will be deepened within the proposed basin areas using a trailer suction hopper and/or backhoe dredging method. The dredging is likely to be undertaken continuously over 19 months. A portion of the material generated from the dredging and blasting operations is likely to be beneficially used within the construction, where possible, with the remainder transported away from site and disposed at an existing licenced marine disposal site. This will be by a dredger with a split hopper, which will transit to the designated area, then open up and allow the material to fall to the seabed.
Temporary increases in suspended sediment concentrations (SSCs) due to disposal of sediments at a licensed site	
Impacts Relating to Construction Vessel Activity	
Mortality or physical injury due to collisions with vessels	The construction window is up to 3 years, in which time vessel presence and traffic will increase due to the presence of construction vessels.
Disturbance due to vessel movements	
Impacts Relating to Accidental Release of Pollutants	
Interaction of pollutants with marine mammals due to accidental spills	The construction window is up to 3 years, in which time vessel presence and traffic will increase due to the presence of construction vessels.
Interaction of pollutants with marine mammals due to release of sediment contaminants	Dredging has the potential to release contaminants that are stored within the seabed sediments. Site-specific studies have shown the area to be characterised by sediments below Marine Scotland's Action Level One for contaminants.

Table 15.10: Project metrics used in the assessment of impacts on marine mammals continued

Description of Impacts and Effects	Project Metrics Considered in the Assessment of the Impact
Construction	
Impacts Relating to Changes in Prey Resource	
Changes to prey availability	Project metrics which may affect marine mammal prey availability are detailed within Chapter 13: Fish and Shellfish Ecology.
Operation and Maintenance	
Impacts Relating to Underwater Noise	
Disturbance and avoidance due to vessel noise	550 commercial vessels; 1,700 platform supply vessel (PSV)/offshore vessels; 40 diving support vessel (DSV) and 33 cruise ships are predicted to use the harbour per annum.
Impacts Relating to Changes in Habitat as a Result of Physical Structure	
Reduction in extent of foraging habitat	There will be a loss of subtidal habitat of 140,984.76 m^2 inside the marine development boundary. The existing area of subtidal habitat within the development boundary is 563,869.34 m^2, therefore there will be an approximate 25% reduction in subtidal habitat. Seabed depths within the site will be increased to 9.0 m and 10.5 m below CD.
Impacts Relating to Increased SSCs	
Temporary increases in suspended sediment concentrations (SSCs) due to maintenance dredging	The harbour and entrance channel will have an ongoing maintenance dredging requirement. Dredged material from maintenance dredging will be transported away from site and disposed at an existing licensed marine disposal site.
Temporary increases in suspended sediment concentrations (SSCs) due to disposal of sediments at an offshore licensed site	
Impacts Relating to Increased Vessel Activity	
Mortality or physical injury due to collisions with vessels	550 commercial vessels; 1,700 platform supply vessel (PSV)/offshore vessels; 40 diving support vessel (DSV) and 33 cruise ships are predicted to use the harbour per annum. This is in addition to those that already usethe existing Aberdeen Harbour.
Disturbance due to vessel movements	
Impacts Relating to Changes in Water Quality as a Result of Pollutants	
Interaction of Marine Mammals with Pollutants and Displacement	The presence of the breakwaters will increase retention of water within the harbour with reduced flushing, leading to an increase in contaminants and a reduction in dissolved oxygen (DO), within the harbour.
Impacts Relating to Changes in Prey Resource	
Changes to prey availability	Project metrics which may affect marine mammal prey availability are detailed within Chapter 13: Fish and Shellfish Ecology.

15.6.2 Impacts Scoped Out

15.6.2.1 Barrier effects caused by physical presence of breakwater structures

A comment was raised in consultation expressing concern that the breakwater on the southern side of the development could act as a barrier which may encourage dolphins to enter into the harbour area and into the path of vessels. However, no evidence of previous examples of this type of impact occurring could be sourced. Marine mammals are intelligent and typically base their distribution on the presence of prey; they are highly mobile and able to adapt to new habitats. Professional ecological judgement has been used to determine that the issue of interception by a barrier-type structure should be scoped out of the impact assessment, whilst vessel collisions with marine mammals have, however, been considered within Section 15.6.4.3.

15.6.3 Construction Phase

The following sections present the respective assessments of potential effects that have been identified for the construction phase of the development, as outlined in Table 15.10.

15.6.3.1 Effects Relating to Noise

The movement of construction vessels, pile driving, drilling, blasting, dredging and rock disposal (for reuse within the development boundary) will increase the level of underwater noise and vibration above natural background conditions and will have the potential to impact upon marine mammal populations causing startle reactions, avoidance and mortality. ES Appendix 13-B: Underwater noise impact study presents the results of detailed underwater noise modelling and shows the predicted propagation of significant noise levels from these sources.

Underwater noise modelling was undertaken for a variety of construction scenarios within the development footprint in Nigg Bay. The underwater noise model assumes straight line sound propagation, casting acoustic shadow zones behind topographic barriers, including Girdle Ness and Greg Ness, therefore SPL or SEL values are not modelled in these regions for activities undertaken within Nigg Bay. There are very few models that that can cope with horizontal spreading due to refraction, diffraction or reflection, and therefore it is assumed that modelled sound cannot penetrate behind such obstacles (National Measurement Office et al., 2014).

The Scenarios Considered

Sound is the periodic disturbance in pressure from some equilibrium value. The unit of pressure is given in Pascals (Pa) or Newton per square metre (N/m2). The measurements however cover a very wide range of pressure values, typically from 1 × 10-3 Pa for the hearing threshold value of a human diver at 1 kHz to 1 x 107 Pa, to the sound of a lightning strike on the sea surface. Sound levels are expressed in decibels (dB) relative to a fixed reference pressure, commonly 1 μPa for measurements made underwater this is described in more detail in ES Appendix 13-B: Underwater noise impact study.

Piling noise is generated through the percussion of a hydraulically powered hammer onto the end surface of a foundation pile. The noise is dependent on the force applied and the dimensions of the percussive hammer, which for the harbour development will likely be 90 to 200 kJ force. For the purposes of this assessment underwater sound modelling was undertaken based on a pile diameter of 1.5 m with generating levels of 209.3 dBpeak re 1 μPa at 1 m (Appendix 13-B: Underwater noise impact study).

For the removal of rock, holes of 0.125 m diameter will be drilled for the subsequent deployment of explosives. Noise is generated through the action of the drill bit on surrounding rocks. Noise levels created are dependent not only on the size of the drill but also on the consolidation of the surrounding seabed rock. Seabed substrates within the development site consist of sandy gravel overlying glacial till with a granitic schist type of basement rock and so considerable variation in the levels of noise arising the during the drilling task are expected. Blast noise will propagate from approximately 20 kg explosives contained the pre-drilled holes. For a 20 kg charge, the peak pressure in open water is 259 dB re 1 μPa; however, the peak pressure within pre-drilled holes is expected to be significantly less, as reflected in ES Appendix 13-B: Underwater noise impact study.

Two forms of dredging will be undertaken to remove naturally laid seabed material and material resulting from blasting. A backhoe dredger consists of a barge fitted with a mechanically powered excavator, which is lowered over the side of the barge and scoops up the seabed sediment prior to depositing it into a hopper barge nearby. The sound arising from a dredging vessel consists of a number of discrete sources: the digging or scraping sound of the excavator on the seabed; the engine noise driving the excavator; and the noise of the barge engine or the engines of the tug boat that has moved the barge into position. A trailer suction hopper dredger is a fully powered sea-going vessel fitted with one or more large diameter suction pipes which descend to the seabed. A trailing draghead is connected to the end of the suction pipe. The seabed material is sucked up into the pipe then into a hopper installed on the vessel. The sources of noise include the draghead being trailed across the seabed; the suction pump; the seabed material being drawn up the suction tube; the ship's engine; propeller and the dynamic positioning systems fitted to the hull.

Material dredged from the seabed will be dispoesed using a dredge split hopper, with the exception of rock material which will be reused in the construction of the harbour. A review of the literature for the underwater oise modelling study found only one set of acoustic data relating to rock placement operations (Appendix 13-B: Underwater noise impact study). The reviewed literature indicated no evidence that rock placement contributed to the noise level to the extent of causing lethality, injury or temporary hearing impairment, though behavioural and cumulative noise effects may be evident.

<u>Species Sensitivity</u>

A number of marine mammal species are regularly found within the proposed Aberdeen Harbour Expansion Project area, and the surrounding areas are therefore susceptible to construction noise propagation effects. Table 15.11 notes species of concern and the reason(s) for inclusion within the current assessment.

Cetaceans make extensive use of underwater sound and have hearing that is highly tuned for the undersea environment (Richardson et al., 1995). Their susceptibility to impacts from anthropogenic noise in the marine environment is well-documented. Species of most concern within the proposed development boundary and its surroundings are bottlenose dolphin and harbour porpoise, though white-beaked dolphin, Risso's dolphin and minke whale are also seen periodically in and around Aberdeen Bay.

The two pinniped species present in the development boundary are harbour seals and grey seals. Although seals are classed as marine mammals, they spend considerable periods of time on land. As a consequence, seals are known to hear very well in-air as well as underwater (ES Appendix 13-B: Underwater noise impact study). In the water, they may be susceptible to impacts arising from high levels of underwater sound and, when on land, they may be liable to impacts arising through the emission of sound in-air such as construction noise.

Table 15.11: Species considered within this assessment and rationale

Scientific Name	Common Name	Receptor/Inclusion Rationale	Ecological Presence
Cetaceans			
Tursiops truncatus	Bottlenose dolphin	PMF in Scotland Annex II and Annex IV species under the Habitats Directive SAC primary qualifying feature species (Moray Firth SAC) *"Least Concern*" on IUCN Red List Identified within consultation Year-round resident	Foraging/food availability
Phocoena phocoena	Harbour porpoise	PMF in Scotland Annex II and Annex IV species under the Habitats Directive "*Least Concern*" on IUCN Red List Identified within consultation Year-round resident	Foraging/food availability. Common in continental shelf waters of the northern and central North Sea.
Lagenorhynchus albirostris	White-beaked dolphin	PMF in Scotland Annex IV species under the Habitats Directive "*Least Concern*" on IUCN Red List Seasonal resident	Relatively close proximity of deeper water
Grampus griseus	Risso's dolphin	PMF in Scotland Annex IV species under the Habitats Directive "*Least Concern*" on IUCN Red List Occasional resident	
Balaenoptera acutorostrata	Minke whale	PMF in Scotland Annex IV species under the Habitats Directive "*Least Concern*" on IUCN Red List Seasonal resident	Associated with the sandeel's preferred habitat in the summer months (Anderwald and Evans, 2010).
Pinnipeds			
Halichoerus grypus	Grey seal	PMF in Scotland Annex II and Annex V species under the Habitats Directive SAC qualifying designation species (Isle of May SAC) and feature species (Berwickshire and North Northumberland SAC and Faray and Hold of Faray SAC) No designated seal haul-out sites, under the Marine Scotland (2010) Act, in Aberdeenshire (Marine Scotland, 2015) "*Least Concern*" on IUCN Red List Identified within consultation Year-round resident	Feeding areas for grey seal between Aberdeen and Stonehaven (Genesis, 2012) Haul-out sites; mouths of the River Don and Ythan, Peterhead harbour, Catterline, Boddam and Cruden Bay (ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay)
Phoca vitulina	Harbour seal	PMF in Scotland Least Concern" on IUCN Red List Annex II and Annex V species under the Habitats Directive SAC qualifying designation species (Firth of Tay and Eden Estuary SAC and Dornoch Firth and Morrich More SAC) Identified within consultation Year-round resident	Foraging area in the River Dee (Carter, 2001, Genesis, 2012) Haul-out sites; River Don and Ythan and Catterline (Genesis, 2012)

Underwater Noise Modelling Approach

The degree to which a given species might be affected by underwater sound emissions depends on a number of factors: the sensitivity of the species or individual to the sound; the level of sound on the receptor; its frequency content; and the duration of the sound. The criteria upon which the modelling for noise assessment was undertaken to estimate impact zones around noise sources within the proposed development were based on best scientific practice, discussed extensively in the international peer-reviewed literature.

Effects on receptors were classified into three main criteria:

- Lethality and physical injury;
- Auditory damage; and
- Behavioural reactions.

Lethality and Physical Injury

Mortality or direct physical injury from noise and vibration propagated from a sound source is associated with very high peak pressure or impulse levels. Typically, these effects can be associated with blasting in open water or in the immediate vicinity of an impact piling operation. Yelverton et al. (1975) concluded that mortality is related to body mass of the receptor and the magnitude of the impulsive wave. Studies of blasting in open water showed mortality in marine mammals when peak to peak sound levels exceeded 240 dB re. 1 μPa (Yelverton et al., 1975). It should be noted that blasting for the proposed development will be confined within rock and the noise modelling used for this assessment reflects that scenario.

A limiting threshold for physical injury of 100 kPa (corresponding to a peak to peak level of 220 dB re 1 μPa) was adopted for use during blasting work in Canadian waters.

Auditory Damage

Permanent and temporary hearing loss may occur when marine animals are exposed to sound pressure levels lower than those which give rise to lethality and physical injury. Permanent hearing loss in mammals results from the death of the sensory hair cells of the inner ear. This gives rise to a permanent increase in threshold sensitivity over the affected frequencies and is known as Permanent Threshold Shift (PTS). Temporary Threshold Shift (TTS), on the other hand, is a temporary hearing impairment and is not considered an injury (Southall et al., 2007). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. At least in terrestrial mammals, TTS can last from minutes or hours to (in cases of strong TTS) days. For sound exposures at or somewhat above the TTS threshold, hearing sensitivity of both terrestrial and marine mammals recovers rapidly after exposure to the sound ends. Limited data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals. Available data on TTS in marine mammals are reviewed in some detail by Southall et al., (2007).

The Southall et al. (2007) group classifications, based on the frequency response of marine mammal hearing, have been used in the modelling of the noise effects of the proposed development activities. Southall et al. (2007) suggested that thresholds for injury (and behavioural responses) should be examined separately for five functional marine mammal hearing groups:

- Mlf: low-frequency cetaceans (mysticetes, for which the functional hearing range is concluded to be 7 Hz to 22 kHz);
- Mmf: mid-frequency cetaceans (the majority of odontocetes, 150 Hz to 160 kHz);
- Mhf: high-frequency cetaceans (remaining odontocetes, 200 Hz to 180 kHz);
- Mpw: pinnipeds in water (75 Hz to 75 kHz); and
- Mpa: pinnipeds in air (75 Hz to 30 kHz).

Hence, minke whale are classified as a low-frequency cetacean, bottlenose dolphin, white-beaked dolphin and Risso's dolphin amongst others are classified as a mid-frequency cetacean, and harbour porpoise are classified as a high frequency cetacean. Grey seals and harbour seals listening in water or air are thus classified as pinnipeds in water or air (ES Appendix 13-B: Underwater noise impact study).

Studies reviewed in Southall et al. (2007) indicated that hearing damage can occur following a single exposure to a loud sound or to multiple exposures to lower level sound. Therefore, when a marine mammal is exposed to a sound which, in itself, may not be sufficiently loud to produce the onset of injury or to induce a behavioural reaction, when the sound exposure is allowed to build up over a period of time, physical damage or a behavioural response may occur. For single exposure to a loud sound, the threshold is given by the peak sound pressure level; whilst for multiple exposures to lower level sound, the threshold is given by the sound exposure level (SEL) indicating a build-up of energy over a period of time, providing guidance on the cumulative exposure of a receptor to propagation of noise (ES Appendix 13-B: Underwater noise impact study). The cumulative build-up of noise is explored using a fleeing–animal model where the animal moves around through the noise field at various distances from the noise source and over a period of time. For each noise source/animal separation, the corresponding sound pressure level is computed.

Assessment criteria were also based on the type of noise e.g. multiple pulses such as those arising from percussive piling; and non-pulse or continuous noise such as that from shipping, dredging or underwater drilling. Specific thresholds using peak-level metrics indicate that, based on current evidence, the onset of PTS and TTS are not dependent on the animal species, while thresholds using energy-level metrics are dependent (ES Appendix 13-B: Underwater noise impact study). Summaries of thresholds for PTS and TTS as a function of noise type and animal species are given in Table 15.12 and Table 15.13 respectively.

Work carried out by Lucke et al (2009) determined that harbour porpoise appeared to be more sensitive to underwater sound than indicated by Southall et al. (2007). Accordingly, the TTS limit used for noise modelling was set at 199.7 dB re 1 μPa and 164.3 dB re 1 μPa^2 s in both cases using un-weighted Sound Pressure Level (SPL) (ES Appendix 13-B: Underwater noise impact study).

The route mean square (RMS) SPL is used to quantify noise of a continuous nature. It is the mean square pressure level measured over a given time interval, measuring the average sound pressure level over that time. The US National Marine Fisheries Services (NMFS) propose non-injury limits of 190 dB re 1 μPa (RMS) and 180 dB re 1μPa (RMS) for pinnipeds and cetaceans respectively (ES Appendix 13-B: Underwater noise impact study).

Table 15.12: Summary of PTS levels for noise types and marine mammal groups used in the modelling of noise effects

Marine Mammal Group	Weighting	Multiple Pulses	Nonpulses
Cetaceans – low frequency	Unweighted	230 dB re 1 uPa	230 dB re 1 µPa
	SEL M-Weighted	198 dB re 1 µPa^2-s	215 dB re 1 µPa^2-s
Cetaceans – medium frequency	Unweighted	230 dB re 1 uPa	230 dB re 1 uPa
	SEL M-Weighted	198 dB re 1 µPa^2-s	215 dB re 1 µPa^2-s
Cetaceans – high frequency	Unweighted	230 dB re 1 µPa	230 dB re 1 uPa
	SEL M-Weighted	198 dB re 1 µPa^2-s	215 dB re 1 µPa^2-s
Pinnipeds	Unweighted	218 dB re 1 uPa	218 dB re 1 uPa
	SEL M-Weighted	186 dB re 1 µPa^2-s	203 dB re 1 µPa^2-s

Table 15.13: Summary of TTS levels for noise types and marine mammal groups used in the modelling of noise effects

Marine Mammal Group	Weighting	Multiple Pulses	Nonpulses
Cetaceans – low frequency	Unweighted	224 dB re 1 uPa	224 dB re 1 uPa
	SEL M-Weighted	183 dB re 1 µ83^2-s	195 dB re 1 µ95^2-s
Cetaceans – medium frequency	Unweighted	224 dB re 1 uPa	224 dB re 1 uPa
	SEL M-Weighted	183 dB re 1 □83^2-s	195 dB re 1 µ95^2-s
Cetaceans – high frequency	Unweighted	224 dB re 1 uPa	224 dB re 1 uPa
	SEL M-Weighted	183 dB re 1 □83^2-s	195 dB re 1 µ95^2-s
Pinnipeds	Unweighted	212 dB re 1 uPa	212 dB re 1 uPa
	SEL M-Weighted	171 dB re 1 □71^2-s	183 dB re 1 µ83^2-s

Behavioural Reactions

At lower sound pressure levels, marine mammals may exhibit changes in their normal behaviour. These changes range from a startle reaction to the sound, a cessation of their current activities (e.g. feeding, nursing, breeding) or the animals may leave the area for a period of time.

Koschinski et al. (2003) found that porpoise's closest point of approach to a wind turbine increased from 120 m when no noise was present to 182 m when noise was present. The sound pressure levels at 182 m was estimated at 125-130 dB re 1 µPa.

Porpoises exposed to seal scarers were found to turn around and swim directly away at distances between 1.6 km and 2.4 km from the noise source. At these ranges, sound pressure levels were recorded around 119 dB re 1 µPa (ES Appendix 13-B: Underwater noise impact study).

Before, during and after a seismic survey in the Irish Sea, Goold (1996) observed an avoidance reaction in the common dolphin (*Delphinus delphis*) at distances of 1 km to 2 km from the survey vessel. Sound pressure levels that gave rise to the observed reactions were not provided but it may be estimated that sound pressure levels were 60 dB to 80 dB down on source levels – estimated around 120 to 130 dB re 1 µPa (ES Appendix 13-B: Underwater noise impact study).

The existing Aberdeen Harbour currently receives heavy marine traffic and the existence marine mammals species in this environment should be placed in context.

Behavioural thresholds using un-weighted metrics used in noise modelling for the proposed development consist of:

- Level B Harassment (defined by the 1994 amendment to the US Federal law Marine Mammal Protection Act of 1972) states that sound has "*the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild*". For impulsive sounds, the threshold has been set at 160 dB re 1 µPa (RMS) while for continuous sounds the threshold is 120 dB re 1 µPa (RMS) (ES Appendix 13-B: Underwater noise impact study);
- Low Level Disturbance to impulsive sounds where the threshold has been set at 140 dB re 1 µPa (RMS, 1995).

Weighted metrics such as the dB_{ht} effect criterion have been used in modelling areas of likely effect on the behaviour of species, but the dB_{ht} metric has not been validated by either rigorous peer-review or extensive experimental study, and therefore has not been used for this assessment.

Assessment of Underwater Noise from Impact Piling

The results of modelling are summarised below and species-specific assessment sections discuss the results and effect significance by species. A summary of effect significance for all species is presented in Table 15.23. Proposed mitigation is also discussed with a summary of the assessment of underwater noise from piling.

Table 15.14 presents the results of the noise modelling of peak pressure associated with impact piling activity and shows the spatial extents over which physiological and behavioural effects on marine mammals are predicted to occur. Results of the cumulative noise assessment for piling undertaken at representative locations on the south and north breakwaters are shown in Table 15.15. In both instances, both winter and summer values are shown, as noise propagation varies with the seasonal variation in seawater densities.

Table 15.14: Summary of acoustic effects for piling vessel spread

Exposure Limit	Effect	Southern Breakwater		Northern Breakwater	
		Winter	Summer	Winter	Summer
240 dB re 1 μPa pk	Lethality	<1 m	<1 m	<1 m	<1 m
224 dB re 1 μPa pk	Auditory injury (PTS) onset in cetaceans	<1 m	<1 m	<1 m	<1 m
218 dB re 1 μPa pk	Auditory injury (PTS) onset in pinnipeds	<1 m	<1 m	<1 m	<1 m
218 dB re 1 μPa pk	Temporary deafness (TTS) onset in cetaceans	<1 m	<1 m	<1 m	<1 m
212 dB re 1 μPa pk	Temporary deafness (TTS) onset in pinnipeds	<1 m	<1 m	<1 m	<1 m
199.7 dB re 1 μPa pk	Temporary deafness (TTS) onset in harbour porpoise	3.2 m	3.2 m	3.2 m	3.2 m
190 dB re 1 μPa (RMS)	Level A-Auditory injury in pinnipeds	246 m	242 m	244 m	236 m
180 dB re 1 μPa (RMS)	Level A-Auditory injury in cetaceans	651 m	609 m	600 m	560 m
174 dB re 1 μPa pk-pk	Aversive behavioural reaction in harbour porpoise	1344 m	1239 m	1220 m	1060 m
160 dB re 1 μPa (RMS)	Level B-Harassment in cetaceans exposed to impulsive noise	10.5 km	7.3 km	8.2 km	6.0 km
140 dB re 1 μPa (RMS)	Low level disturbance in cetaceans exposed to impulsive noise	49.2 km	30.7 km	40 km	27 km

Table 15.15: Summary of cumulative acoustic effects for piling vessel spread

Species	Effect	Threshold dB re 1 μ Pa^2 s	South breakwater		North breakwater	
			Feb	Aug	Feb	Aug
Hf cetaceans	PTS	198	210 m	210 m	200 m	200 m
	TTS	183	2500 m	2360 m	2030 m	1880 m
Mf cetaceans	PTS	198	210 m	210 m	200 m	200 m
	TTS	183	3150 m	2810 m	2590 m	2260 m
Lf cetaceans	PTS	198	280 m	250 m	250 m	230 m
	TTS	183	5610 m	4080 m	4650 m	3510 m
Pn pinniped	PTS	186	2490 m	2180 m	2080 m	1800 m
	TTS	171	>10 km	>10 km	>10 km	9870 m
Harbour porpoise	TTS	164.3	>10 km	>10 km	>10 km	>10 km
	Aversive	145	>10 km	>10 km	>10 km	>10 km

For impact piling, worst case acoustic effects with the potential for permanent auditory injury are presented in Figure 15.22 for cetaceans and pinnipeds. Effects have been presented in respect of Level A-Auditory Injury for cetaceans, whilst effects associated with PTS (cumulative) have been presented for pinnipeds. This is due to these two criteria resulting in the largest ranges of effect (associated with permanent auditory injury) for the two respective species groups. The location 'top of Nigg Bay' has been presented as this is considered to be the most representative location for impact piling. This is because the quaysides where impact piling may take place in the mouth of the bay will be behind breakwaters.

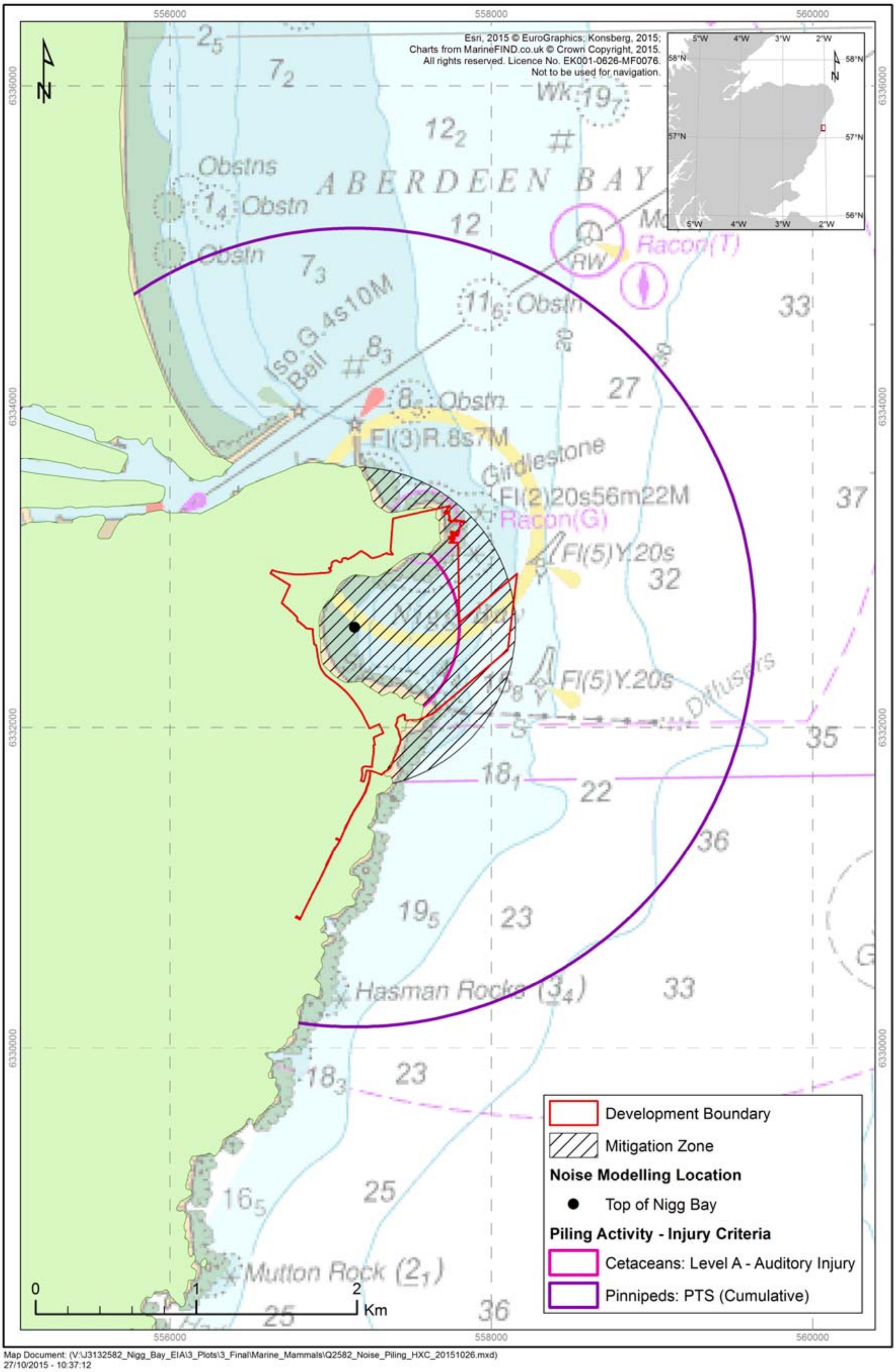


Figure 15.22: Impact piling noise effects with potential to cause permanent auditory injury for marine mammals. Based on worst case scenario distances associated with impact piling at the top of Nigg Bay

Although the timing, frequency, duration and nature of impact piling operations cannot be determined at this time, certain considerations must be made:

- Piling will not be continuous throughout the 3 years of construction. Quay piling operations are anticipated to occur within a 23 month window. Piling activities will be temporary and limited to certain periods within the window;
- Individual piling operations will likely be limited in duration, with breaks in between operations; and
- A proportion of piling activity, may take place following the construction of the harbour breakwaters. If the breakwaters were constructed earlier in the construction phase, the breakwater walls will tend to reflect construction noise back into the bay. The result of this is that the region of the North Sea beyond Nigg Bay will not be subsequently impacted by man-made noise and the Level B-Harassment criterion in this region will no longer apply (Appendix 13-B: Underwater noise impact study.

Bottlenose dolphin

Potential effects of impact piling and the ranges of effects are presented for bottlenose dolphin in Table 15.16. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study).

Table 15.16: Worst case scenario impact piling effects and ranges of effects for bottlenose dolphin

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 μPa pk
PTS	< 1	224 dB re 1 μPa pk
Level A-Injury	651	180 dB re 1 μPa (RMS)
Cumulative PTS	210	198 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	218 dB re 1 μPa pk
Cumulative TTS	3150	183 dB re 1 μPa^2 s
Level B-Harassment	10500	160 dB re 1 μPa (RMS)
Low-level disturbance	49200	140 dB re 1 μPa (RMS)

The potential for noise levels to cause permanent injury to bottlenose dolphin are predicted to remain within 651 m of the piling source (based upon the Level A-Injury criterion). This is considered to be highly unlikely to occur, given that a soft start procedure (see Section 15.7 for mitigation measures) will be employed prior to full impact piling and will give individuals the opportunity to move away before the onset of injury.

Temporary auditory damage (TTS) is predicted to occur up to 3,150 m, and this would be likely result in avoidance and temporary displacement of bottlenose dolphin from these areas for the duration of piling activities. These effects are temporary and not a permanent loss of hearing. This represents a relatively localised area and individuals would be expected to forage in adjacent waters for these periods. The presence of Girdle Ness will cast an acoustic shadow zone. Instantaneous and cumulative acoustic effects within modelled acoustic shadow zones are assumed to be negligible, and within background noise levels of the existing operational harbour. Therefore, TTS would not be expected to occur on individuals using the existing Aberdeen Harbour entrance for foraging.

Behavioural effects are also predicted to occur on bottlenose dolphin within 49.2 km (low-level disturbance), although the disturbance levels of most concern (associated with the Level B-Harassment) are predicted to occur up to 10.5 km. Therefore, bottlenose dolphins may experience some interruption to their migration, breathing, nursing, breeding, feeding, or sheltering within these distances. However, the NMFS low-level disturbance criterion is set at 140 dB re 1 µPa, whilst the NMFS Level B-Harassment criterion is set at 160 dB re 1 µPa. Background noise levels in Aberdeen (and within the river Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1µPa mms over a frequency bandwidth of 10 Hz – 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, baseline conditions exceed the threshold level for the Low-level Disturbance criterion and are within 11 dB re 1µPa of the Level B-Harassment criterion. For individuals that use Aberdeen Harbour regularly, the potential exists for these individuals to have become habituated to prevailing high noise levels and this is considered likely. The individuals present in the vicinity of Nigg Bay are likely to be the same individuals that will use Aberdeen Harbour. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal. The use of such a criterion in an impact assessment can therefore be deemed precautionary given the high background noise from nearby vessel activity in Aberdeen harbour (Appendix 13-B: Underwater noise impact study).

The potential effects relating to lethality, injury and behavioural changes are a result of impacts that will be intermittent and temporary on bottlenose dolphin individuals. There will be very low potential for injury or mortality to single individuals due to soft-start piling procedures. Due to disturbance effects, wider-scale shifts in distribution due to avoidance may occur (should the breakwaters not be constructed prior to piling activities). This has the potential to cause stress in individuals. However, this is unlikely to compromise feeding ability or cause detrimental energetic consequences, as individuals will be able to move out of the adversely affected areas into adjacent coastal habitat to the north and south. The Scottish East Coast bottlenose dolphin population is recognised as being comprised of individuals that are highly mobile, and commonly use the full length of the east coast when foraging. Observations of species close to the existing Aberdeen Harbour suggest considerable tolerance and habituation to noise disturbances, although this is operational noise and not construction-related noise. However, vessel noise does represent a component of the modelled piling noise propagation, and harassment effects may be lesser if there is a level of existing habituation to vessel noise. Baseline noise levels in Aberdeen Harbour have been shown to be high, and therefore disturbance effects may not be experienced.

Due to the very low potential for permanent injury, the effect magnitude is considered to be **minor** on **very high** value bottlenose dolphin receptors (i.e. EPS individuals and SAC individuals) and effect significance without mitigation is considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered **certain** for bottlenose dolphin. The species was recorded during the site-specific surveys and is present in the area in abundance throughout the year.

Harbour porpoise

Potential impact piling effects and the ranges of effects are presented for harbour porpoise in Table 15.7. These represent the worst case scenario based on the underwater noise modelling (ES Appendix 13-B: Underwater noise impact study).

Table 15.17: Worst case scenario piling effects and ranges of effects for harbour porpoise

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	224 dB re 1 µPa pk
Level A-Injury	651	180 dB re 1 µPa (RMS)
Cumulative PTS	210	198 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
Temporary deafness (TTS) onset in harbour porpoise	< 3.2	199.7 dB re 1 µPa pk
Cumulative TTS	> 10,000	164.3 dB re 1 μPa^2 s
Aversive behavioural reaction in harbour porpoise	1344	174 dB re 1 µPa pk-pk
Cumulative aversive behavioural reaction in harbour porpoise	> 10,000	
Level B-Harassment	10,500	160 dB re 1 µPa (RMS)
Low-level disturbance	49,200	140 dB re 1 µPa (RMS)

The potential for noise levels from impact piling to cause permanent damage to harbour porpoise are predicted to remain within 651 m. This is considered to be highly unlikely, given that a soft start procedure (see Section 15.7 for mitigation measures) will be employed prior to full piling and will give individuals the opportunity to move away before the onset of injury.

Temporary auditory damage (TTS) is predicted to occur up to 10,000 m, and this would be likely result in avoidance and temporary displacement of harbour porpoise from these areas for the duration of temporary and intermittent impact piling activities. The vicinity of Nigg Bay is considered only to be of local importance, following comparisons of harbour porpoise usage between the areas around Nigg Bay and that of other locations along the Scottish east coast, where similar levels of presence have been identified (ES Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay). The harbour porpoise is the most abundant cetacean in the North Sea and is common in shelf waters of the northern and central North Sea and around the UK coast, with a general preference for waters less than 200 m in depth. However, the species is known to use deep offshore waters also, and can be distributed long distances from shore (220 km) in deep waters (Northridge et al., 1995). Therefore, temporary displacement is highly unlikely to have the potential to result in significant effects on individuals, as alternative habitat is likely to be available.

Behavioural effects during impact piling are predicted to occur on harbour porpoise within 1,344 m for aversive behavioural reactions, 10.5 km for Level B-Harassment and 49.2 km for low-level disturbance. Therefore, harbour porpoise may experience some interruption to their migration, breathing, nursing, breeding, feeding, or sheltering within the areas of higher noise within 10.5 km, whilst low-level disturbance may occur over a wider area. However, the NMFS low-level disturbance criterion is set at 140 dB re 1 μPa, whilst the NMFS Level B-Harassment criterion is set at 160 dB re 1 μPa. Background noise levels in Aberdeen (and within the River Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1μPa mms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, baseline conditions exceed the threshold level for the Low-level Disturbance criterion and are within 11 dB re 1μPa of the Level B-Harassment criterion. For individuals that use Aberdeen Harbour regularly, the potential exists for these individuals to have become habituated to prevailing high noise levels and this is considered likely. The individuals present in the vicinity of Nigg Bay are likely to be the same individuals that will use Aberdeen Harbour. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal. The use of such a criterion in an impact assessment can therefore be deemed precautionary given the high background noise from nearby vessel activity in Aberdeen harbour (Appendix 13-B: Underwater noise impact study).

The potential effects relating to lethality, injury and behavioural changes are a result of impacts that will be intermittent and temporary on harbour porpoise individuals. There will be very low potential for injury or mortality to single individuals due to soft-start piling procedures, although wide-scale shifts in distribution due to avoidance may occur (should the breakwaters not be constructed prior to piling activities). This has the potential to cause stress in individuals, however this is unlikely to compromise feeding ability or result in detrimental energetic consequences, as individuals will be able to move out of the adversely affected areas into adjacent areas. Harbour porpoise are not limited to coastal waters, and are also known to use deep offshore waters, and can be distributed long distances from shore (up to 220 km) (Northridge et al., 1995). Observations of species close to the existing Aberdeen Harbour suggest considerable tolerance and habituation to noise disturbances, although this is operational noise and not construction-related noise. However, vessel noise does represent a component of the modelled piling noise propagation, and effects may be lesser if there is a level of exisiting habituation to vessel noise.

Due to the very low potential permanent for injury, the effect magnitude is considered to be **minor** on **very high** value receptors and effect significance without mitigation is considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered **certain** for harbour porpoise. The species was recorded during the site-specific surveys and is present in the area in abundance throughout the year.

White-beaked Dolphin

Potential impact piling effects and the ranges of effects are presented for white-beaked dolphin in Table 15.18 below. These represent the worst case scenario based on the underwater noise modelling (ES Appendix 13-B: Underwater noise impact study).

Table 15.18: Worst case scenario piling effects and ranges of effects for white-beaked dolphin

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 μPa pk
PTS	< 1	224 dB re 1 μPa pk
Level A-Injury	651	180 dB re 1 μPa (RMS)
Cumulative PTS	210	198 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	218 dB re 1 μPa pk
Cumulative TTS	3,150	183 dB re 1 μPa^2 s
Level B-Harassment	10,500	160 dB re 1 μPa (RMS)
Low-level disturbance	49,200	140 dB re 1 μPa (RMS)

The potential for noise levels during impact piling to cause permanent damage to white-beaked dolphin are predicted to remain within 651 m. This is considered to be highly unlikely, given that a soft-start procedure (see Section 15.7 for mitigation measures) will be employed prior to full impact piling and will give individuals the opportunity to move away before the onset of injury.

Temporary auditory damage (TTS) is predicted to occur within 3,150 m. This would be likely result in avoidance and temporary displacement of white-beaked dolphins from these areas for the duration of piling activities. These effects are temporary and do not represent a permanent loss of hearing. This area of potential effect is relatively localised and individuals would be expected to forage in adjacent waters for these periods. White-beaked dolphin are not known to the use the vicinity of Nigg Bay for foraging and therefore displacement is highly unlikely to have significant consequences for individuals. The presence of Girdle Ness will cast an acoustic shadow zone. Instantaneous and cumulative acoustic effects within modelled acoustic shadow zones are assumed to be negligible, and within background noise levels of the existing operational harbour. Therefore, TTS would not be expected to occur on individuals using waters to the north for foraging.

Behavioural effects are predicted to occur on white-beaked dolphin within 10.5 km for Level B-Harassment and 49.2 km for low-level disturbance. Therefore, white-beaked dolphins may experience some interruption to their migration, breathing, nursing, breeding, feeding, or sheltering within these distances. However, the NMFS low-level disturbance criterion is set at 140 dB re 1 μPa, whilst the NMFS Level B-Harassment criterion is set at 160 dB re 1 μPa.

Background noise levels in Aberdeen (and within the River Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1μPa rnms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, baseline conditions exceed the threshold level for the Low-level Disturbance criterion and are within 11 dB re 1μPa of the Level B-Harassment criterion. For individuals that use Aberdeen Harbour regularly, the potential exists for these individuals to have become habituated to prevailing high noise levels and this is considered likely. The individuals present in the vicinity of Nigg Bay are likely to be the same individuals that will use Aberdeen Harbour. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal. The use of such a criterion in an impact assessment can therefore be deemed precautionary given the high background noise from nearby vessel activity in Aberdeen harbour (ES Appendix 13-B: Underwater noise impact study).

The potential effects relating to lethality, injury and behavioural changes are a result of impacts that will be intermittent and temporary on white-beaked dolphin individuals. There will be very low potential for injury or mortality to single individuals due to soft-start piling procedures, although wider-scale shifts in distribution due to avoidance may occur (should the breakwaters not be constructed prior to piling activities). This has the potential to cause stress in individuals, however this is unlikely to compromise feeding ability or cause detrimental energetic consequences as individuals will be able to move out of the adversely affected areas into adjacent offshore and coastal waters. The species is known to prefer waters of higher water depths (generally < 200 m), and has a predominantly offshore concentration (EMU, 2012; Lancaster et al., 2014), with a tendency to use coastal waters in a highly seasonal manner.

Due to the very low potential for permanent injury, the effect magnitude is considered to be **minor** on **very high** value receptors and effect significance without mitigation is considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered **near certain** for white-beaked dolphin. The species was sighted during the site-specific surveys, but only on a single occasion with three individuals. The species is highly seasonal, with higher abundance in the summer months, and is known to occur within the region and local area based on relevant literature.

Risso's Dolphin

Potential impact piling effects and the ranges of effects are presented for Risso's dolphin in Table 15.19. These represent the worst case scenario based on the underwater noise modelling (ES Appendix 13-B: Underwater noise impact study).

Table 15.19: Worst case scenario impact piling effects and ranges of effects for Risso's dolphin

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 μPa pk
PTS	< 1	224 dB re 1 μPa pk
Level A-Injury	651	180 dB re 1 μPa (RMS)
Cumulative PTS	210	198 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	218 dB re 1 μPa pk
Cumulative TTS	3,150	183 dB re 1 μPa^2 s
Level B-Harassment	10,500	160 dB re 1 μPa (RMS)
Low-level disturbance	49,200	140 dB re 1 μPa (RMS)

The potential for noise levels during impact piling to cause permanent damage to Risso's dolphin are predicted to remain within 651 m. This is considered to be highly unlikely, given that a soft start procedure see Section 15.7 for mitigation measures) will be employed prior to full piling and will give individuals the opportunity to move away before the onset of injury.

Temporary auditory damage (TTS) is predicted to occur within 3150 m. This would be likely result in avoidance and temporary displacement of Risso's dolphin from these areas for the duration of piling activities. These effects are temporary and do not represent a permanent loss of hearing. This area of potential effect is relatively localised and individuals would be expected to forage in adjacent waters for these periods. Risso's dolphin are not known to the use the vicinity of Nigg Bay for foraging and therefore displacement is highly unlikely to have significant consequences for individuals. The presence of Girdle Ness will cast an acoustic shadow zone. Instantaneous and cumulative acoustic effects within modelled acoustic shadow zones are assumed to be negligible, and within background noise levels of the existing operational harbour. Therefore, TTS would not be expected to occur on individuals using waters to the north for foraging.

Behavioural effects are predicted to occur on Risso's dolphin within 10.5 km for Level B-Harassment and 49.2 km for low-level disturbance. Therefore, Risso's dolphins may experience some interruption to their migration, breathing, nursing, breeding, feeding, or sheltering within these distances. However, the NMFS low-level disturbance criterion is set at 140 dB re 1 μPa, whilst the NMFS Level B-Harassment criterion is set at 160 dB re 1 μPa. Background noise levels in Aberdeen (and within the River Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1μPa mms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, baseline conditions exceed the threshold level for the Low-level Disturbance criterion and are within 11 dB re 1μPa of the Level B-Harassment criterion. For individuals that use Aberdeen Harbour regularly, the potential exists for these individuals to have become habituated to prevailing high noise levels and this is considered likely. The individuals present in the vicinity of Nigg Bay are likely to be the same individuals that will use Aberdeen Harbour. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal. The use of such a criterion in an impact assessment can therefore be deemed precautionary given the high background noise from nearby vessel activity in Aberdeen Harbour (ES Appendix 13-B: Underwater noise impact study).

The potential effects relating to lethality, injury and behavioural changes are a result of impacts that will be intermittent and temporary on Risso's dolphin individuals. There will be very low potential for injury or mortality to single individuals due to soft-start piling procedures, although wider-scale shifts in distribution due to avoidance may occur (should the breakwaters not be constructed prior to piling activities). This has the potential to cause stress in individuals, however this is unlikely to compromise feeding ability or result in detrimental energetic consequences as individuals will be able to move out of the adversely affected areas into adjacent offshore and coastal waters. The species exhibits a wide-ranging and dispersed distribution, and alternative habitat will therefore be available.

Due to the very low potential for permanent injury, the effect magnitude is considered to be **minor** on **very high** value receptors and effect significance without mitigation is considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered **unlikely** for Risso's dolphin, which has the potential to occur in the local area based upon their ranges as recognised within the literature, although were not sighted in the site-specific surveys.

Minke Whale

Potential impact piling effects and the ranges of effects are presented for minke whale in Table 15.20. These represent the worst case scenario based on the underwater noise modelling (ES Appendix 13-B: Underwater noise impact study).

Table 15.20: Worst case scenario piling effects and ranges of effects for minke whale

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	224 dB re 1 µPa pk
Level A-Injury	651	180 dB re 1 µPa (RMS)
Cumulative PTS	280	198 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	218 dB re 1 µPa pk
Cumulative TTS	5,610	183 dB re 1 μPa^2 s
Level B-Harassment	10,500	160 dB re 1 µPa (RMS)
Low-level disturbance	49,200	140 dB re 1 µPa (RMS)

The potential for noise levels during impact piling to cause permanent damage to minke whale are predicted to remain within 651 m. This is considered to be highly unlikely, given that a soft start procedure (see Section 15.7 for mitigation measures) will be employed prior to full piling and will give individuals the opportunity to move away before the onset of injury.

Temporary auditory damage (TTS) is predicted to occur within 5,610 m. This would be likely result in avoidance and temporary displacement of minke whales from these areas for the duration of piling activities. These effects are temporary and do not represent a permanent loss of hearing. This area of potential effect is relatively localised and individuals would be expected to forage in adjacent waters for these periods. Minke whales are not known to the use the vicinity of Nigg Bay for foraging and therefore displacement is highly unlikely to have significant consequences for individuals.

Behavioural effects are predicted to occur on minke whale within 10.5 km for Level B-Harassment and 49.2 km for low-level disturbance. Therefore, minke whale may experience some interruption to their migration, breathing, nursing, breeding, feeding, or sheltering within these distances. However, the NMFS low-level disturbance criterion is set at 140 dB re 1 µPa, whilst the NMFS Level B-Harassment criterion is set at 160 dB re 1 µPa. Background noise levels in Aberdeen (and within the River Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1µPa mms over a frequency bandwidth of 10 Hz – 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, baseline conditions exceed the threshold level for the Low-level Disturbance criterion and are within 11 dB re 1µPa of the Level B-Harassment criterion. For individuals that use Aberdeen Harbour regularly, the potential exists for these individuals to have become habituated to prevailing high noise levels and this is considered likely. The individuals present in the vicinity of Nigg Bay are likely to be the same individuals that will use Aberdeen Harbour. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal. The use of such a criterion in an impact assessment can therefore be deemed precautionary given the high background noise from nearby vessel activity in Aberdeen harbour (Appendix 13-B: Underwater noise impact study).

The potential effects relating to lethality, injury and behavioural changes are a result of impacts that will be intermittent and temporary on minke whale individuals. There will be very low potential for injury or mortality to single individuals due to soft-start piling procedures, although wider-scale shifts in distribution due to avoidance may occur (should the breakwaters not be constructed prior to piling activities). This has the potential to cause stress in individuals, however this is unlikely to compromise feeding ability or cause detrimental energetic consequences as individuals will be able to move out of the adversely affected areas into adjacent offshore and coastal waters. The species exhibits a wide-ranging and dispersed distribution, and alternative habitat will therefore be available. The proposed Southern Trench NCMPA in the southern Outer Moray Firth and north of Aberdeenshire, lists minke whale as an interest feature, and reflects that the species distribution and highest concentrations are focussed in areas that are located in areas far outside of the range of effects from the Development.

Due to the very low potential for permanent injury, the effect magnitude is considered to be **minor** on **very high** value receptors and effect significance without mitigation is considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered to be **near certain** for minke whale, which although not sighted during the site-specific surveys, are known to be present seasonally and are relatively abundant in the areas adjacent to Aberdeen.

<u>Grey Seal</u>

Potential impact piling effects and the ranges of effects are presented for grey seal in Table 15.21. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study).

Table 15.21: Worst case scenario piling effects and ranges of effects for grey seal

Effect	**Range of Effect (m) (Worst Case Scenario)**	**Criterion**
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	218 dB re 1 µPa pk
Level A-Injury	246	190 dB re 1 µPa (RMS)
Cumulative PTS	2490	186 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	212 dB re 1 µPa pk
Cumulative TTS	> 10,000	171 dB re 1 μPa^2 s

The potential for noise levels during impact piling to cause permanent damage to grey seal are predicted to remain within 246 m in respect of RMS levels, although injury may occur up to 2,490 m with cumulative noise exposure. Soft-start procedures (see Section 15.7 for mitigation measures) will be employed prior to full piling, and will give individuals the opportunity to move away from the area, before the onset of injury.

Temporary auditory damage (TTS) is predicted to occur within distances of > 10 km, and may interrupt activities such as foraging, feeding and migration amongst others. This would likely result in avoidance and temporary displacement of grey seals from these areas for the duration of piling activities. These effects are temporary and do not represent a permanent loss of hearing. Individuals would be expected to forage in adjacent waters for these periods. Should the construction of the harbour breakwaters occur before piling operations commence, noise propagation would likely be significantly reduced and the spatial extent of effects would be less.

To the south, the areas between Aberdeen and Stonehaven are recognised as feeding areas for grey seal and seals have been observed foraging and eating fish at the sea surface in these areas (Genesis, 2012). Pups show significant concentrated activity around Newburgh and Stonehaven, which has been suggested as a result of the foraging opportunities available to grey seals (ES Appendix 15-B: Seal telemetry analysis). To the north, the important haul-out for grey seal at the mouth of the River Don is unlikely to be affected due to the attenuation of noise by Girdle Ness, whilst the haul-outs at the Ythan estuary and those further to the north are not predicted to be affected. From telemetry data analysis, adult grey seals have been shown to pass the vicinity of Nigg Bay and Aberdeen, within relatively close proximity to the coast. This transit activity is therefore likely to be intercepted by the spatial extents of the propagating noise. However, the telemetry analysis has also shown adults to use areas further offshore and areas which are significantly offshore when transiting along the east coast. Therefore, it is considered that individuals will have the ability to transit north and south, by moving further offshore to avoid higher noise levels, or to make these movements during periods when piling is not taking place in between operations.

The potential effects relating to lethality, injury and behavioural changes are a result of impacts that will be intermittent and temporary on grey seal individuals. There will be very low potential for mortality and low potential for injury to single individuals due to soft-start piling procedures, although wide-scale shifts in distribution due to avoidance may occur (should the breakwaters not be constructed prior to piling activities). This has the potential to cause stress in individuals, however it is unlikely to compromise feeding ability or cause detrimental energetic consequences as individuals will be able to move out of the adversely affected areas into adjacent offshore and coastal waters. Grey seals are extremely mobile and adept at foraging over significant distances, with a reported foraging range of 145 km (Thompson et al., 1996). Grey seals are likely to be in transit past the entrance to Nigg Bay, and this migration may be interrupted during piling operations.

Due to the very low potential for permanent injury, effect magnitude is considered to be **minor** on **very high** value receptors. effect significance without mitigation is considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered to be **certain** for grey seal as the area of potential effect lies within an area where the species is known to occur throughout the year, and sightings were made during site-specific surveys.

Harbour Seal

Potential impact piling effects and the ranges of effects are presented for harbour seal in Table 15.22. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study).

Table 15.22: Worst case scenario impact piling effects and ranges of effects for harbour seal

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 μPa pk
PTS	< 1	218 dB re 1 μPa pk
Level A-Injury	246	190 dB re 1 μPa (RMS)
Cumulative PTS	2,490	186 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	212 dB re 1 μPa pk
Cumulative TTS	> 10,000	171 dB re 1 μPa^2 s

The potential for noise levels during impact piling to cause permanent damage to harbour seals are predicted to remain within 246 m in respect of RMS levels, although injury may occur up to 2,490 m with cumulative noise exposure. Soft-start procedure (see Section 15.7 for mitigation measures) will be employed prior to full piling, and will give individuals the opportunity to move away from the area, before the onset of injury.

Temporary auditory damage (TTS) is predicted to occur within distances of > 10 km, and may interrupt activities such as foraging, feeding and migration amongst others. This would likely result in avoidance and temporary displacement of harbour seals from these areas for the duration of piling activities. These effects are temporary and do not represent a permanent loss of hearing. Individuals would be expected to forage in adjacent waters for these periods. Should the construction of the harbour breakwaters occur before piling operations commence, noise propagation would likely be significantly reduced and the spatial extent of effects would be less.

The River Don is known to be used mostly as a haul-out site, whilst the River Dee is used as a foraging location, where the seals feed on mostly salmonids, flounder and other marine fish species (Carter et al., 2001; Genesis, 2012). The areas around the mouth of the River Don where they haul-out (particularly in winter and spring) are unlikely to be affected as the presence of Girdle Ness will cast an acoustic shadow zone. Instantaneous and cumulative acoustic effects within modelled acoustic shadow zones are assumed to be negligible. The haul-outs at the Ythan estuary and those further to the north are not predicted to be affected. The River Dee may be affected, however as stated above, the presence of Girdle Ness will cast an acoustic shadow zone. Instantaneous and cumulative acoustic effects within modelled acoustic shadow zones are assumed to be negligible, and within background noise levels of the existing operational harbour. If seals were to be prevented from foraging at the mouth of the Dee, they have alternative foraging areas in adjacent waters. This will likely be in proximity to the waters around haul-out sites at the mouth of the River Don where some feeding is known to occur (Carter et al, 2001), the Ythan estuary (where salmon is predated upon) and at Catterline (Genesis 2012). Individuals will be able to forage at the Dee in between piling operations which will be intermittent and temporary.

The potential effects relating to lethality, injury and behavioural changes are a result of impacts that will be intermittent and temporary on harbour seal individuals. There will be very low potential for mortality and low potential for injury to single individuals due to soft-start piling procedures, although wide-scale shifts in distribution due to avoidance may occur (should the breakwaters not be constructed prior to piling activities). This has the potential to cause stress in individuals, however this is unlikely to compromise feeding ability or result in detrimental energetic consequences as individuals will be able to move out of the adversely affected areas into adjacent offshore and coastal waters. Harbour seals are extremely mobile and adept at foraging over significant distances, with reported foraging ranges of approximately 40 km to 50 km.

Due to the very low potential for permanent injury, effect magnitude is considered to be **minor** on **very high** value receptors. effect significance without mitigation is considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered to be **unlikely** for harbour seal as the area of potential effect for permanent injury lies within the theoretical range of the species, however harbour seals are not known to use the area and were not sighted within the site-specific surveys.

Underwater Noise Summary and Mitigation Proposals

A summary of the significance of effects from underwater noise associated with impact piling is provided in Table 15.23. Certainty associated with the assessment is **high** as modelling has informed the assessment and is considered precautionary.

Table 15.23: Predicted significance of effects from underwater noise from piling

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Harbour porpoise	Minor	Very High	Moderate adverse	Certain	High
Bottlenose dolphin	Minor		Moderate adverse	Certain	High
White-beaked dolphin	Minor		Moderate adverse	Near Certain	Med-High
Risso's dolphin	Minor		Moderate adverse	Unlikely	Low-Med
Minke whale	Minor		Moderate adverse	Near Certain	Med-High
Grey seal	Minor		Moderate adverse	Certain	High
Harbour seal	Minor		Moderate adverse	Unlikely	Medium

In light of this assessment, significant effects have been identified and mitigation measures are proposed for underwater noise in relation to impact piling. As disturbance effects have the potential to occur on EPS species, an EPS licence is likely to be required. This will be discussed with the relevant statutory authorities and will be the subject of a subsequent application. The mitigation measures for impact piling are discussed in Section 15.7.

Assessment of Underwater Noise from Drilling

Although the timing, frequiency, duration and nature of drilling operations cannot be determined at the time of consent application, certain considerations must be made:

- Drilling will not be continuous throughout the 3 years of construction. Drilling operations are anticipated to occur within a 19 month window. Drilling activities will be temporary and limited to certain periods within the window; and
- Individual drilling operations will likely be limited in duration, with breaks in between operations.

Table 15.24 and Table 15.25 present the spatial extents over which noise peak pressures are predicted to elicit physiological and behavioural effects on marine mammals as a result of underwater noise from drilling activities.

Table 15.24: Summary of acoustic effects for drilling vessel spread

Exposure Limit	Effect	Southern Breakwater		Northern Breakwater	
		Winter	Summer	Winter	Summer
240 dB re 1 μPa pk	Lethality	<1 m	<1 m	<1 m	<1 m
224 dB re 1 μPa pk	Auditory injury (PTS) onset in cetaceans	<1 m	<1 m	<1 m	<1 m
218 dB re 1 μPa pk	Auditory injury (PTS) onset in pinnipeds	<1 m	<1 m	<1 m	<1 m
218 dB re 1 μPa pk	Temporary deafness (TTS) onset in cetaceans	<1 m	<1 m	<1 m	<1 m
212 dB re 1 μPa pk	Temporary deafness (TTS) onset in pinnipeds	<1 m	<1 m	<1 m	<1 m
199.7 dB re 1 μPa pk	Temporary deafness (TTS) onset in harbour porpoise	<1 m	<1 m	<1 m	<1 m
190 dB re 1 μPa (RMS)	Level A-Auditory injury in pinnipeds	10 m	10 m	3.6 m	3.6 m
180 dB re 1 μPa (RMS)	Level A-Auditory injury in cetaceans	21 m	21 m	25 m	25 m
174 dB re 1 μPa pk-pk	Aversive behavioural reaction in harbour porpoise	52 m	52 m	50 m	50 m
120 dB re 1 μPa (RMS)	Level B-Harassment in cetaceans exposed to continuous noise	46 km	30 km	37 km	26 km

Table 15.25: Summary of cumulative acoustic effects for drilling vessel spread

Species	Effect	Threshold dB re 1 Pa^2 s	South breakwater		North breakwater	
			Feb	Aug	Feb	Aug
Hf cetaceans	PTS	215	20 m	20 m	20 m	20 m
	TTS	195	210 m	210 m	200 m	200 m
Mf cetaceans	PTS	215	20 m	20 m	20 m	20 m
	TTS	195	210 m	210 m	200 m	200 m
Lf cetaceans	PTS	215	20 m	20 m	20 m	20 m
	TTS	195	210 m	210 m	200 m	200 m
Pn pinniped	PTS	203	210 m	210 m	200 m	200 m
	TTS	183	580 m	560 m	450 m	430 m
Harbour porpoise	TTS	164.3	>10 km	>10 km	>10 km	8670m
	Aversive	145	>10 km	>10 km	>10 km	>10 km

For drilling, the worst case acoustic effects with the potential for permanent auditory injury are presented in Table 15.23 for cetaceans and pinnipeds. The figure presents drilling at the southern breakwater as this is considered to be the worst case location based upon modelling results. Effects have been presented in respect of the PTS (cumulative) criterion for both cetaceans and pinnipeds. This is due to this criterion resulting in the largest ranges of effect (associated with permanent auditory injury) for the two respective species groups.

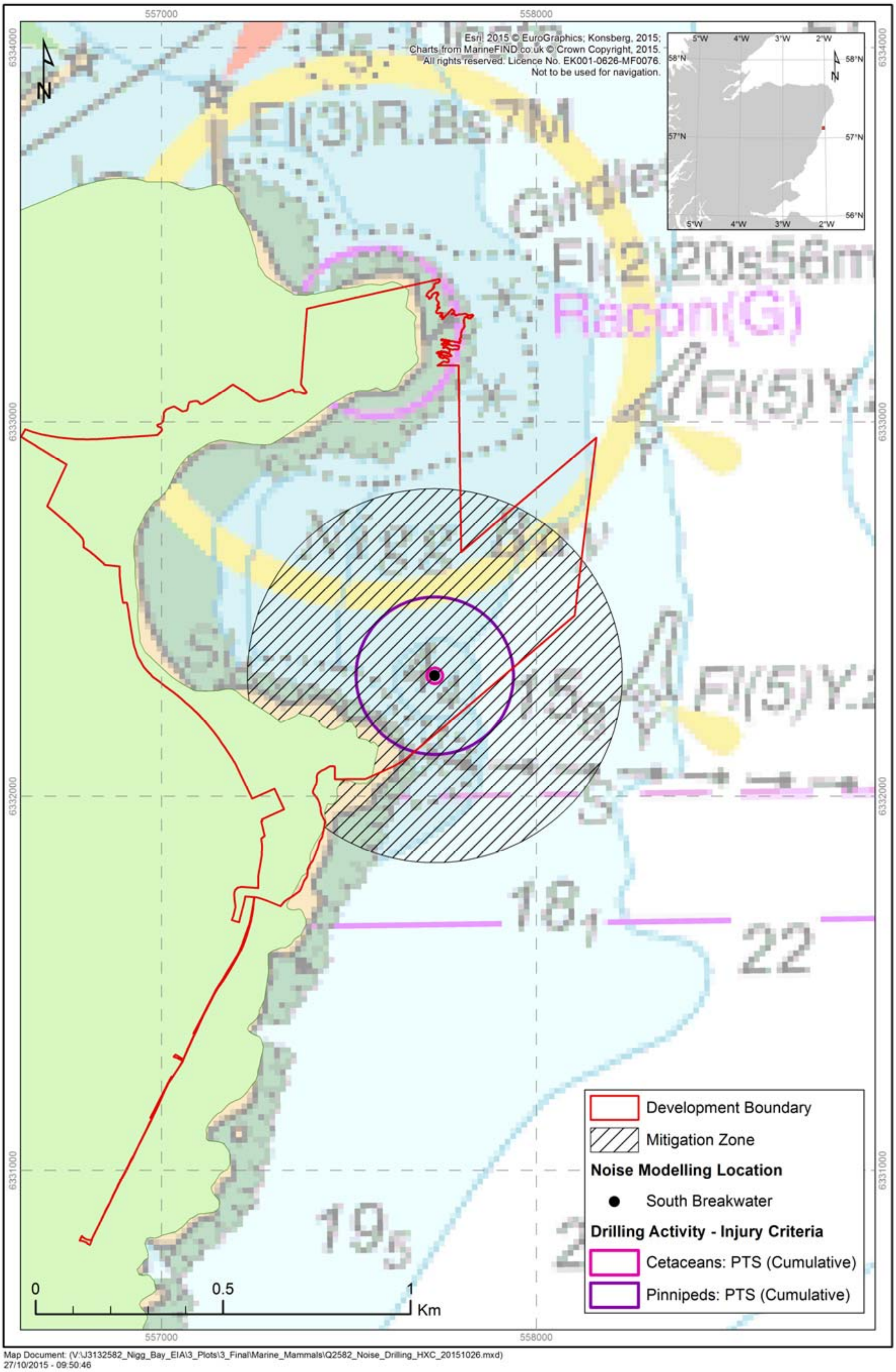


Figure 15.23: Drilling noise effects with potential to cause permanent auditory injury for marine mammals. Based on worst case scenario distances associated with drilling at the southern breakwater

Bottlenose Dolphin

Potential drilling effects and the ranges of effects are presented for bottlenose dolphin in Table 15.26. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study).

Table 15.26: Worst case scenario drilling effects and ranges of effects for bottlenose dolphin

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	224 dB re 1 µPa pk
Level A-Injury	25	180 dB re 1 µPa (RMS)
Cumulative PTS	20	215 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	218 dB re 1 µPa pk
Cumulative TTS	< 210	195 dB re 1 μPa^2 s
Level B-Harassment (Continuous)	46,000	120 dB re 1 µPa (RMS))

For bottlenose dolphin, the total area of effect for permanent damage is predicted to be within 25 m. Receptors are expected to be able to avoid adverse noise arising from the drilling by simply moving away from these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur up to 210 m, and this would be likely result in avoidance and temporary displacement of bottlenose dolphin from these areas for the duration of drilling activities. These effects are temporary and not a permanent loss of hearing. Inviduals would be expected to forage in adjacent waters for these periods.

The behavioural effects (associated with the Level B-Harassment) and resultant avoidance of affected areas may cause reduced feeding for the duration of the drilling. This has the potential to occur within 46 km. Individuals may be displaced from local foraging areas. However, drilling activities will be temporary and intermittent, and therefore foraging within the local area will be possible between drilling activities. Therefore, bottlenose dolphins may experience some interruption to their migration, breathing, nursing, breeding, feeding, or sheltering within these distances. However, the low NMFS Level B-Harassment criterion is set at 120 dB re 1 µPa. Background noise levels in Aberdeen (and within the river Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1µPa mms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, baseline conditions exceed the threshold level for the Level B-Harassment criterion. For individuals that use Aberdeen Harbour regularly, the potential exists for these individuals to have become habituated to prevailing high noise levels and this is considered likely. The individuals present in the vicinity of Nigg Bay are likely to be the same individuals that will use Aberdeen Harbour. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal. The use of such a criterion in an impact assessment can therefore be deemed precautionary given the high background noise from nearby vessel activity in Aberdeen harbour (ES Appendix 13-B: Underwater noise impact study).

The spatial extents over which behavioural effects are predicted can be placed into context with maintenance dredging and bed levelling occurring regularly within Aberdeen harbour. These activities create an existing level of underwater noise disturbance along with the vessel traffic at the mouth of the harbour, where the highest intensity of foraging by bottlenose dolphins currently occurs. Bottlenose dolphin have been shown to avoid the area during periods of highest dredging intensity, but return following a decrease in the intensity of the operations and the cessation of the operations. Drilling may similarly lead to bottlenose dolphins foraging elsewhere during the operations for temporary periods. The presence of Girdle Ness also has the potential to attenuate the sound associated with the Level B-Harassment criterion, which would mean effects would be unlikely to occur at the key foraging patch at the mouth of the River Dee at Aberdeen Harbour.

The potential effects relating to lethality, injury and behavioural changes are a result of an impact that will be intermittent and temporary on bottlenose dolphin individuals, and will cease on completion of the drilling activity. Given the wide ranging and highly mobile nature of the species, other adjacent areas can be used for foraging and significant effects on feeding are not forecast. Although considered extremely unlikely, permanent injury may occur within 25 m and therefore effect magnitude is thus judged to be **minor** on **very high** receptors. The effect significance without mitigation is therefore considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered to be **certain** due to bottlenose dolphin presence in the area.

<u>Harbour Porpoise</u>

Potential drilling effects and the ranges of effects are presented for harbour porpoise in Table 15.27. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study).

Table 15.27: Worst case scenario drilling effects and ranges of effects for harbour porpoise

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	224 dB re 1 µPa pk
Level A-Injury	25	180 dB re 1 µPa (RMS)
Cumulative PTS	20	215 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	199.7 dB re 1 µPa pk
Cumulative TTS	> 10,000	164.3 dB re 1 μPa^2 s
Aversive behavioural reaction	52	174 dB re 1 µPa pk-pk
Aversive behavioural reaction (Cumulative)	> 10,000	145 dB re 1 μPa^2 s
Level B-Harassment (Continuous)	46,000	120 dB re 1 µPa (RMS)

For harbour porpoise the total area of effect for permanent damage is therefore predicted to be within 25 m and receptors are expected to be able to avoid adverse noise arising from the drilling by simply moving away from these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur up to distances of > 10,000 m, and this would be likely result in avoidance and temporary displacement of harbour porpoise from these areas for the duration of drilling activities. These effects are temporary and not a permanent loss of hearing. Individuals would be expected to forage in adjacent waters for these periods.

The behavioural effects (associated with the Level B-Harassment) and resultant avoidance of affected areas may cause reduced feeding for the duration of the drilling. This has the potential to occur within 46 km. Individuals may be displaced from local foraging areas. However, drilling activities will be temporary and intermittent, and therefore foraging within the local area will be possible between drilling activities. Therefore, harbour porpoise may experience some interruption to their migration, breathing, nursing, breeding, feeding, or sheltering within these distances. However, the low NMFS Level B-Harassment criterion is set at 120 dB re 1 μPa. Background noise levels in Aberdeen (and within the River Dee itself) have been reported to be high, mainly from shipping, in the region of 118 to 149 dB re 1μPa mms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, baseline conditions exceed the threshold level for the Level B-Harassment criterion. For individuals that use Aberdeen Harbour regularly, the potential exists for these individuals to have become habituated to prevailing high noise levels and this is considered likely. The individuals present in the vicinity of Nigg Bay are likely to be the same individuals that will use the areas around Aberdeen Harbour. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal. The use of such a criterion in an impact assessment can therefore be deemed precautionary given the high background noise from nearby vessel activity in Aberdeen harbour (ES Appendix 13-B: Underwater noise impact study).

The vicinity of Nigg Bay is considered only to be of local importance for harbour porpoise. This follows comparisons of harbour porpoise usage between the areas around Nigg Bay and that of other locations along the Scottish east coast, where similar levels of presence have been identified (Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay). The harbour porpoise is the most abundant cetacean in the North Sea and is common in shelf waters of the northern and central North Sea and around the UK coast, with a general preference for waters less than 200 m in depth. However, the species is known to use deep offshore waters also, and can be distributed long distances from shore (220 km) in deep waters (Northridge et al., 1995). Therefore, temporary displacement is highly unlikely to have the potential to result in significant effects on individuals, as alternative habitat is likely to be available.

The potential effects relating to lethality, injury and behavioural changes are a result of an impact that will be intermittent and temporary on harbour porpoise individuals, and will cease on completion of the drilling activity. Given the wide ranging and highly mobile nature of the species, other adjacent areas can be used for foraging and significant effects on feeding are not forecast. Although considered extremely unlikely, permanent injury may occur within 25 m and therefore effect magnitude is thus judged to be **minor** on **very high** receptors. The effect significance without mitigation is therefore considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered to be **certain** due to harbour porpoise presence in the area.

White-beaked Dolphin

Potential drilling effects and the ranges of effects are presented for white-beaked dolphin in Table 15.28. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study).

Table 15.28: Worst case scenario drilling effects and ranges of effects for white-beaked dolphin

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 μPa pk
PTS	< 1	224 dB re 1 μPa pk
Level A-Injury	25	180 dB re 1 μPa (RMS)
Cumulative PTS	20	215 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	218 dB re 1 μPa pk
Cumulative TTS	< 210	195 dB re 1 μPa^2 s
Level B-Harassment (Continuous)	46000	120 dB re 1 μPa (RMS))

For white-beaked dolphin the total area of effect for permanent damage is therefore predicted to be within 25 m, and receptors are expected to be able to avoid adverse noise arising from the drilling by simply moving away from these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur up to 210 m, and this would be likely result in avoidance and temporary displacement of white-beaked dolphin from these areas for the duration of drilling activities. These effects are temporary and not a permanent loss of hearing. This represents an area where white-beaked dolphin are not known to commonly forage and individuals would be expected to forage in adjacent waters for these periods.

The behavioural effects (associated with the Level B-Harassment) and resultant avoidance of affected areas may cause reduced feeding for the duration of the drilling. This has the potential to occur within 46 km. Individuals may be displaced from local areas where they may forage seasonally. However, drilling activities will be temporary and intermittent, and therefore foraging within the local area will be possible between drilling activities. However, the low NMFS Level B-Harassment criterion is set at 120 dB re 1 μPa. Background noise levels in Aberdeen (and within the river Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1μPa mms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, in Aberdeen Harbour, baseline conditions exceed the threshold level for the Level B-Harassment criterion. The spatial extent of these existing high noise levels is not known, however high noise levels may extend outside of the harbour to areas where white-beaked dolphin may be present. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to white-beaked dolphins.

This has the potential to cause stress in individuals, however this is unlikely to compromise feeding ability or cause detrimental energetic consequences as individuals will be able to move out of the adversely affected areas into adjacent offshore and coastal waters. White-beaked dolphin are known to prefer waters of greater water depths (generally < 200 m), and have a predominantly offshore concentration (EMU, 2012; Lancaster et al., 2014), with a tendency to use coastal waters in a highly seasonal manner.

The potential effects relating to lethality, injury and behavioural changes are a result of an impact that will be intermittent and temporary on white-beaked dolphin individuals, and will cease on completion of the drilling activity. Given the wide ranging and highly mobile nature of the species, other adjacent areas can be used for foraging and significant effects on feeding are not forecast. Although considered extremely unlikely, permanent injury may occur within 25 m and therefore effect magnitude is thus judged to be **minor** on **very high** receptors. The effect significance without mitigation is therefore considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered to be **near certain** due to the highly seasonal nature of white-beaked dolphin. The site-specific surveys only noted three individuals during the 12 months of survey, consistent with the reported seasonality of the species in the literature.

<u>Risso's Dolphin</u>

Potential drilling effects and the ranges of effects are presented for Risso's dolphin in Table 15.29. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study).

Table 15.29: Worst case scenario drilling effects and ranges of effects for Risso's dolphin

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 μPa pk
PTS	< 1	224 dB re 1 μPa pk
Level A-Injury	25	180 dB re 1 μPa (RMS)
Cumulative PTS	20	215 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	218 dB re 1 μPa pk
Cumulative TTS	< 210	195 dB re 1 μPa^2 s
Level B-Harassment (Continuous)	46,000	120 dB re 1 μPa (RMS))

For Risso's dolphin the total area of effect for permanent damage is predicted to be within 25 m. Receptors are expected to be able to avoid adverse noise arising from the drilling by simply moving away from these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur up to 210 m. This would be likely result in avoidance and temporary displacement of Risso's dolphin from these areas for the duration of drilling activities. These effects are temporary and not a permanent loss of hearing. This represents a localised area and individuals would be expected to forage in adjacent waters for these periods.

The behavioural effects (associated with the Level B-Harassment) and resultant avoidance of affected areas may cause reduced feeding for the duration of the drilling. This has the potential to occur within 46 km. Individuals may be displaced from local areas where they may forage seasonally. However, drilling activities will be temporary and intermittent, and therefore foraging within the local area will be possible between drilling activities. However, the low NMFS Level B-Harassment criterion is set at 120 dB re 1 μPa. Background noise levels in Aberdeen (and within the river Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1μPa mms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, in Aberdeen Harbour, baseline conditions exceed the threshold level for the Level B-Harassment criterion. The spatial extent of these existing high noise levels is not known, however high noise levels may extend outside of the harbour to areas where Risso's dolphins may be present. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal.

The potential effects relating to lethality, injury and behavioural changes are a result of an impact that will be intermittent and temporary on Risso's dolphin individuals, and will cease on completion of the drilling activity.Given the wide ranging and highly mobile nature of the species, other adjacent areas can be used for foraging and significant effects on feeding are not forecast. Although considered extremely unlikely, permanent injury may occur within 25 m and therefore effect magnitude is thus judged to be **minor** on **very high** receptors. The effect significance without mitigation is therefore considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered **unlikely** for Risso's dolphin, which has the potential to occur in the local area based upon their ranges as recognised within the literature, although were not sighted in the site-specific surveys.

<u>Minke Whale</u>

Potential drilling effects and the ranges of effects are presented for minke whale in Table 15.30. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study).

Table 15.30: Worst case scenario drilling effects and ranges of effects for minke whale

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	224 dB re 1 µPa pk
Level A-Injury	25	180 dB re 1 µPa (RMS)
Cumulative PTS	20	215 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	218 dB re 1 µPa pk
Cumulative TTS	< 210	195 dB re 1 μPa^2 s
Level B-Harassment (Continuous)	46,000	120 dB re 1 µPa (RMS))

For minke whale, the total area of effect for permanent damage is predicted to be within 25 m, and receptors are expected to be able to avoid adverse noise arising from the drilling by simply moving out of these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur up to 210 m. This would likely result in avoidance and temporary displacement of minke whales from these areas for the duration of drilling activities. These effects are temporary and not a permanent loss of hearing. This represents a localised area and individuals would be expected to forage in adjacent waters for these periods.

The behavioural effects (associated with the Level B-Harassment) and resultant avoidance of affected areas may cause reduced feeding for the duration of the drilling. This has the potential to occur within 46 km. Individuals may be displaced from local areas where they may forage seasonally. However, drilling activities will be temporary and intermittent, and therefore foraging within the local area will be possible between drilling activities. However, the low NMFS Level B-Harassment criterion is set at 120 dB re 1 µPa. Background noise levels in Aberdeen (and within the river Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1µPa mms over a frequency bandwidth of 10 Hz – 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, in Aberdeen Harbour, baseline conditions exceed the threshold level for the Level B-Harassment criterion. The spatial extent of these existing high noise levels is not known, however high noise levels may extend outside of the harbour to areas where minke whales may be present. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to minke whale.

The potential effects relating to lethality, injury and behavioural changes are a result of an impact that will be intermittent and temporary on minke whale individuals, and will cease on completion of the drilling activity. Given the wide ranging and highly mobile nature of the species, other adjacent areas can be used for foraging and significant effects on feeding are not forecast. Although considered extremely unlikely, permanent injury may occur within 25 m and therefore effect magnitude is thus judged to be **minor** on **very high** receptors. The effect significance without mitigation is therefore considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered to be **near certain** for minke whale, which although not sighted during the site-specific surveys, are known to be present seasonally and are relatively abundant in the areas adjacent to Aberdeen.

Grey Seal

Potential drilling effects and the ranges of effects are presented for grey seal in Table 15.31. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study).

Table 15.31: Worst case scenario drilling effects and ranges of effects for grey seal

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	218 dB re 1 µPa pk
Level A-Injury	10	190 dB re 1 µPa (RMS)
Cumulative PTS	210	203 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	212 dB re 1 µPa pk
Cumulative TTS	580	183 dB re 1 μPa^2 s

For grey seal, the total area of effect for permanent damage is therefore predicted to be within 210 m, and receptors are expected to be able to avoid adverse noise arising from the drilling by simply moving away from these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur up to 580 m, and this would be likely result in avoidance and temporary displacement of grey seals from these areas for the duration of drilling activities. TTS effects are considered temporary. Drilling activities will also be temporary and intermittent, and therefore foraging within the local area will be possible between drilling activities.

The potential effects relating to lethality, injury and behavioural changes are a result of an impact that will be intermittent and temporary on grey seal individuals, and will cease on completion of the drilling activity. Grey seals are extremely mobile and adept at foraging over significant distances, with a reported foraging range of 145 km (Thompson et al., 1996). Given the wide ranging and highly mobile nature of the species, other adjacent areas can be used for foraging and significant effects on feeding are therefore not forecast. Although considered extremely unlikely, permanent injury may occur within 210 m and therefore effect magnitude is thus judged to be **minor** on **very high** receptors. The effect significance without mitigation is therefore considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered to be **certain** for grey seal as the species is known to occur throughout the year in close proximity to the areas of potential effect, and sightings were made during site-specific surveys.

Harbour Seal

Potential drilling effects and the ranges of effects are presented for harbour seal in Table 15.32. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study).

Table 15.32: Worst case scenario drilling effects and ranges of effects for harbour seal

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 μPa pk
PTS	< 1	218 dB re 1 μPa pk
Level A-Injury	10	190 dB re 1 μPa (RMS)
Cumulative PTS	210	203 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	212 dB re 1 μPa pk
Cumulative TTS	580	183 dB re 1 μPa^2 s

For harbour seal, the total area of effect for permanent damage is therefore predicted to be relatively small i.e. 210 m and receptors are expected to be able to avoid adverse noise arising from the drilling by simply moving out of these (relatively confined) affected areas before onset of significant injury or mortality.

The resultant behavioural effects and avoidance of affected areas may however, cause reduced feeding for the duration of the drilling. TTS is predicted to occur due to cumulative noise up to 580 m. Individuals may be displaced from this small localised area to avoid the adverse noise, and any TTS effects are considered temporary. Drilling activities will be temporary and intermittent, and therefore foraging within the local area will be possible between drilling activities.

The potential effects relating to lethality, injury and behavioural changes are a result of an impact that will be intermittent and temporary on harbour seal individuals, and will cease on completion of the drilling activity. Given the wide ranging and highly mobile nature of the species, other adjacent areas can be used for foraging and significant effects on feeding are not forecast. Although considered extremely unlikely, permanent injury may occur within 210 m and therefore effect magnitude is thus judged to be **minor** on **very high** receptors. The effect significance without mitigation is therefore considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered to be **unlikely** for harbour seal as the area of potential effect lies within the theoretical range of the species, however harbour seals are not known to use the area and were not sighted within the site-specific surveys.

Underwater Noise Summary and Mitigation Proposals

A summary of the significance of effects from underwater noise associated with drilling is provided in Table 15.33. Certainty associated with the assessment is **high** as modelling has informed the assessment and is considered precautionary.

Table 15.33: Predicted significance of effects from underwater noise from drilling

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Harbour porpoise	Minor	Very High	Moderate adverse	Certain	High
Bottlenose dolphin	Minor		Moderate adverse	Certain	High
White-beaked dolphin	Minor		Moderate adverse	Near Certain	Med-High
Risso's dolphin	Minor		Moderate adverse	Unlikely	Low-Med
Minke whale	Minor		Moderate adverse	Near Certain	Med-High
Grey seal	Minor		Moderate adverse	Certain	High
Harbour seal	Minor		Moderate adverse	Unlikely	Medium

In light of this assessment, significant effects have been identified and mitigation measures are proposed for underwater noise in relation to drilling. As disturbance effects have the potential to occur on EPS species, an EPS licence is likely to be required. This will be discussed with the relevant statutory authorities and will be the subject of a subsequent application. The mitigation measures for drilling are discussed in Section 15.7.

Assessment of Underwater Noise from Blasting

Contained blasting is to be undertaken on occasions during the construction phase of the development. This method of blasting involves charges being inserted into pre-drilled chambers within the rock before the blasting takes place. This significantly reduces the propogration of underwater noise in comparison to open-water blasting, as a large proportion of the noise is contained rather than being propagated fully through the water body.

Blasting is an infrequent, near-instantaneous event, punctuated by intervals between blasting events. Charge hole drilling will take place between blasting operations, before further blasting. No other activities capable of producing adverse noise levels will occur during periods where blasting is taking place.

Table 15.34 presents the spatial extents over which noise peak pressures are predicted to elicit physiological and behavioural effects on marine mammals as a result of underwater noise from blasting activities.

Table 15.34: Summary of acoustic effects for blasting

Exposure Limit	Effect	Range [m]
224 dB re 1 µPa pk	Auditory injury (PTS) onset in cetaceans	16
218 dB re 1 µPa pk	Auditory injury (PTS) onset in pinnipeds	26
218 dB re 1 µPa pk	Temporary deafness (TTS) onset in cetaceans	26
212 dB re 1 µPa pk	Temporary deafness (TTS) onset in pinnipeds	40
199.7 dB re 1 µPa pk	Temporary deafness (TTS) onset in harbour porpoise	95
190 dB re 1 µPa (RMS)	Level A-Auditory injury in pinnipeds	200
180 dB re 1 µPa (RMS)	Level A-Auditory injury in cetaceans	410
174 dB re 1 µPa pk-pk	Aversive behavioural reaction in harbour porpoise	630
160 dB re 1 µPa (RMS)	Level B-Harassment in cetaceans exposed to impulsive noise	1700
140 dB re 1 µPa (RMS)	Low level disturbance in cetaceans exposed to impulsive noise	7180

For blasting, the worst case acoustic effects with the potential for permanent auditory injury are presented in Table 15.26 for cetaceans and pinnipeds. Effects have been presented in respect of the Level A-Auditory criterion for both cetaceans and pinnipeds. This is due to this criterion resulting in the largest ranges of effect (associated with permanent auditory injury) for the two respective species groups.

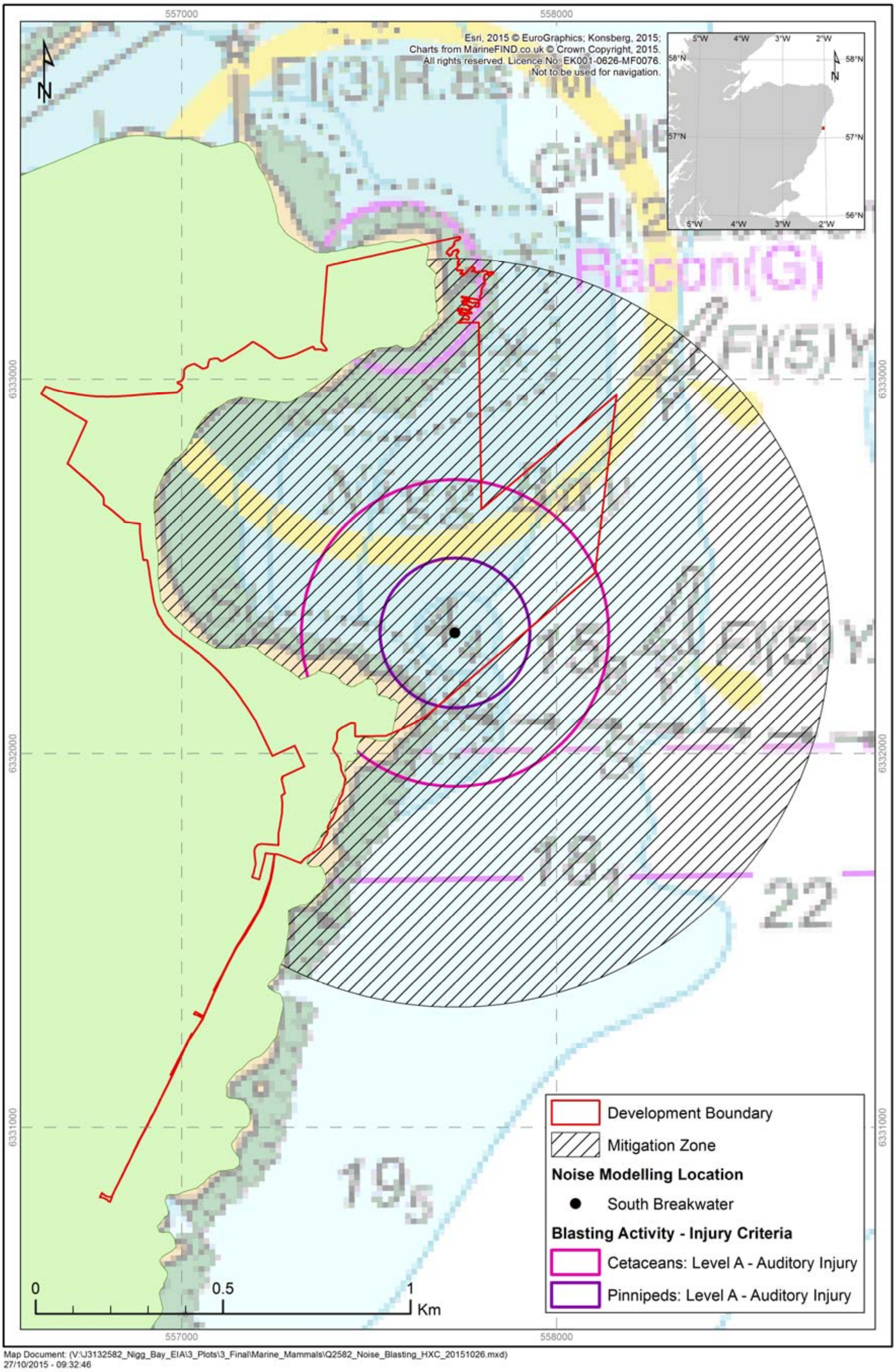


Figure 15.24: Blasting noise effects with potential to cause permanent auditory injury for marine mammals. Based on worst case scenario distances associated with blasting at the southern breakwater.

From the ranges presented in Table 15.34, it is evident that PTS may occur within 16 m for cetaceans and within 25 m for pinnipeds, based on peak pressure levels. Level A-Auditory Injury may occur within 400 m for cetaceans and within 200 m for pinnipeds when RMS levels are considered.

TTS is predicted to occur within 26 m for cetaceans, 95 m for harbour porpoise and 40 m for pinnipeds, based on peak pressure levels.

An aversive behavioural reaction is predicted to occur within 630 m for harbour porpoise, whilst Level B-Harassment is predicted to occur for cetaceans within 1,700 m based on RMS levels. Low-level disturbance is predicted for cetaceans up to 7,180 m based on RMS levels.

Body weight of an individual also affects the range at which certain effects will be received by a receptor. This is regardless of species, and is based on body weight of any marine mammal (see ES Appendix 13-B: Underwater noise impact study). Table 15.35 presents the limiting ranges at which marine mammals, based on body weight, may survive the maximum contained explosive blast predicted to be used. The table presents the effect ranges in metres for '50% lethality' (i.e. 50% of individuals within the specific ranges would experience mortality), '1% lethality' (i.e. 1% of individuals within the specific ranges would experience mortality) and 'onset of injury' (i.e. individuals within these ranges would experience physical injury). Note that the 'onset of injury' values are based on a different criterion to criteria such as Level A-Injury (see ES Appendix 13-B: Underwater noise impact study).

From Table 15.35, it is clear that all effect ranges for all size classes are forecast to be very small. The maximum range for potential lethality is 9 m (based on the 1% lethality criterion for an individual that weights 5 kg). The maximum range for potential onset of injury is only predicted to occur within 16 m (based on an individual marine mammal weighing 5 kg). Most marine mammals will evidently be heavier than 5 kg, and effect ranges decrease as body weight increases (as shown by Table 15.35). For example, at a body weight of 100 kg, the 50% mortality criterion lies at a range of 2 m while the 'onset of injury' effect range is 7 m. For a heavier body weight of 200 kg, the 50% mortality criterion lies at a range of 2 m, whilst the no-injury effect range is 6 m.

Table 15.35: Effect ranges for lethality and injury criteria for mammals from contained blasting

	50% Lethality			1% Lethality			Onset of Injury		
Body weight kg	Impulse [Pa s]	Range [m]	Peak pressure [dB]	Impulse [Pa s]	Range [m]	Peak pressure [dB]	Impulse [Pa s]	Range [m]	Peak pressure [dB]
5	278.9	6	238.4	176.0	9	232.8	73.8	16	224.8
10	364.3	5	241.0	230.0	7	236.3	96.4	14	226.6
20	476.0	4	244.1	300.5	6	238.4	125.9	11	230.0
50	677.8	3	248.1	427.9	4	244.1	179.3	9	232.8
80	812.5	3	248.1	512.9	4	244.1	214.9	8	234.4
100	885.6	2	253.7	559.0	4	244.1	234.2	7	236.3
150	1035.5	2	253.7	653.7	3	248.1	273.9	6	238.4
200	1157.0	2	253.7	730.4	3	248.1	306.0	6	238.4

In respect of the potential for lethality, effects are confined to within 9 m and this is considered highly unlikely to occur. However, permanent auditory injury does have the potential to occur over a wider area, with an area of effect of 200 m for pinnipeds and 410 m for cetaceans.

Behavioural effects are also presented. Effect ranges show that harbour porpoise may exhibit an aversive reaction within 600 m, whilst cetaceans will experience harassment within 1700 m. Low-level disturbance effects are predicted to be within 7180 m. However, as blasting will only take place on a maximum of two occasions on any given day where blasting is to take place, significant behavioural effects are not anticipated. An instantaneous blast is not considered to cause harassment in the manner which a repetitive impulsive noise may cause.

The effect of underwater noise from rock blasting will be intermittent and of short duration. Whilst lethality is considered to be highly unlikely based on effect ranges, there is however a temporary possibility of injury from instaneous blasts. Before mitigation is added, magnitude is considered to be **moderate** on **very high** value receptors, and thus the effect significance will be **major adverse**.

Likelihood is considered to be **certain** for bottlenose dolphin, harbour porpoise, white-beaked dolphin and grey seal due to the confirmed presence of these species within Nigg Bay. Likelihood is considered to be **probable** for minke whale. Likelihood is considered **unlikely** for Risso's dolphin and harbour seal, which have the potential to occur in the area of effect based on their range, although were not sighted in the site-specific surveys.

Certainty associated with this assessment is **high** as the results have been predicted with numerical modelling.

Underwater Noise Summary and Mitigation Proposals

A summary of the significance of effects from underwater noise associated with drilling is provided in Table 15.36 below. Certainty associated with the assessment is **high** as modelling has informed the assessment and is considered precautionary.

Table 15.36: Predicted significance of effects from underwater noise from blasting

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Harbour porpoise	Moderate	Very High	Major	Certain	High
Bottlenose dolphin	Moderate		Major	Certain	High
White-beaked dolphin	Moderate		Major	Near Certain	High
Risso's dolphin	Moderate		Major	Unlikely	Medium
Minke whale	Moderate		Major	Probable	Medium - High
Grey seal	Moderate		Major	Certain	High
Harbour seal	Moderate		Major	Unlikely	Medium

In light of this assessment, significant effects have been identified and mitigation measures are proposed for underwater noise in relation to blasting. As disturbance effects have the potential to occur on EPS species, an EPS licence is likely to be required. This will be discussed with the relevant statutory authorities and will be the subject of a subsequent application. The mitigation measures for blasting are discussed in section 15.7.

Assessment of Underwater Noise from Dredging

Table 15.37 presents the spatial extents over which noise peak pressures are predicted to elicit physiological and behavioural effects on marine mammals as a result of underwater noise from Trailer Suction Hopper Dredging (TSHD) and Backhoe (BH) dredging activities.

Table 15.37: Summary of acoustic effects for TSH and BH dredging vessel spread

Exposure Limit	Effect	Nigg Head		Southern Breakwater		Northern breakwater	
		Winter	Summer	Winter	Summer	Winter	Summer
Trailing Suction Hopper Dredging							
240 dB re 1 µPa pk	Lethality	<1 m	<1 m	<1 m	<1 m	<1 m	<1 m
224 dB re 1 µPa pk	Auditory injury (PTS) onset in cetaceans	<1 m	<1 m	<1 m	<1 m	<1 m	<1 m
218 dB re 1 µPa pk	Auditory injury (PTS) onset in pinnipeds	<1 m	<1 m	<1 m	<1 m	<1 m	<1 m
218 dB re 1 µPa pk	Temporary deafness (TTS) onset in cetaceans	<1 m	<1 m	<1 m	<1 m	<1 m	<1 m
212 dB re 1 µPa pk	Temporary deafness (TTS) onset in pinnipeds	<1 m	<1 m	<1 m	<1 m	<1 m	<1 m
199.7 dB re 1 µPa pk	Temporary deafness (TTS) onset in harbour porpoise	<1 m	<1 m	<1 m	<1 m	<1 m	<1 m
190 dB re 1 µPa (RMS)	Level A-Auditory injury in pinnipeds	1.5 m	1.5 m	5.3 m	1.6 m	1.3 m	1.2 m
180 dB re 1 µPa (RMS)	Level A-Auditory injury in cetaceans	4.5 m	4.5 m	18 m	17 m	8 m	4 m
174 dB re 1 µPa pk-pk	Aversive behavioural reaction in harbour porpoise	23 m	23 m	38 m	33 m	100 m	100 m
120 dB re 1 µPa (RMS)	Level B-Harassment in cetaceans exposed to continuous noise	44.4 km	26.4 km	59 km	28 km	39 km	27.2 km
Backhoe Dredging							
240 dB re 1 µPa pk	Lethality	<1 m	<1 m	<1 m	<1 m	<1 m	<1 m
224 dB re 1 µPa pk	Auditory injury (PTS) onset in cetaceans	<1 m	<1 m	<1 m	<1 m	<1 m	<1 m
218 dB re 1 µPa pk	Auditory injury (PTS) onset in pinnipeds	<1 m	<1 m	<1 m	<1 m	<1 m	<1 m
218 dB re 1 µPa pk	Temporary deafness (TTS) onset in cetaceans	<1 m	<1 m	<1 m	<1 m	<1 m	<1 m
212 dB re 1 µPa pk	Temporary deafness (TTS) onset in pinnipeds	<1 m	<1 m	<1 m	<1 m	<1 m	<1 m
199.7 dB re 1 µPa pk	Temporary deafness (TTS) onset in harbour porpoise	<1 m	<1 m	<1 m	<1 m	<1 m	<1 m
190 dB re 1 µPa (RMS)	Level A-Auditory injury in pinnipeds	2.2 m	2.2 m	2.9 m	2.8 m	3.3 m	3.3 m
180 dB re 1 µPa (RMS)	Level A-Auditory injury in cetaceans	24 m	24 m	82 m	82 m	80 m	80 m
174 dB re 1 µPa pk-pk	Aversive behavioural reaction in harbour porpoise	390 m	390 m	357 m	357 m	340 m	340 m
120 dB re 1 µPa (RMS)	Level B-Harassment in cetaceans exposed to continuous noise	56 km	34 km	59 km	37 km	47 km	33 km

Cumulative exposure to noise (SELs) from dredging, however, increase the potential for adverse effects on marine mammals over greater distances, as presented in Table 15.38 and Table 15.39.

Table 15.38: Summary of cumulative acoustic effects for TSH dredging vessel spread

Species	Effect	Threshold dB re 1 μPa^2 s	Head of Nigg Bay		South Breakwater		North Breakwater	
			Feb	Aug	Feb	Aug	Feb	Aug
Hf cetaceans	PTS	215	20 m	20 m	20 m	20 m	20 m	20 m
	TTS	195	230 m	230 m	230 m	230 m	220 m	220 m
Mf cetaceans	PTS	215	20 m	20 m	20 m	20 m	20 m	20 m
	TTS	195	230 m	230 m	230 m	230 m	220 m	220 m
Lf cetaceans	PTS	215	20 m	20 m	20 m	20 m	20 m	20 m
	TTS	195	230 m	230 m	230 m	230 m	220 m	220 m
Pn pinniped	PTS	203	150 m	150 m	150 m	150 m	140 m	140 m
	TTS	183	480 m	410 m	730 m	670 m	540 m	500 m
Harbour porpoise	TTS	164.3	8730 m	6500 m	>10 km	>10 km	>10 km	8760m
	Aversive	145	> 10 km	> 10 km	>10 km	>10 km	>10 km	>10 km

Table 15.39: Summary of cumulative acoustic effects BH dredging vessel spread

Species	Effect	Threshold dB re 1 μPa^2 s	Head of Nigg Bay		South Breakwater		North Breakwater	
			Feb	Aug	Feb	Aug	Feb	Aug
Hf cetaceans	PTS	215	20 m	20 m	20 m	20 m	20 m	20 m
	TTS	195	350 m	350 m	320 m	320 m	300 m	300 m
Mf cetaceans	PTS	215	20 m	20 m	20 m	20 m	20 m	20 m
	TTS	195	350 m	350 m	320 m	320 m	300 m	300 m
Lf cetaceans	PTS	215	20 m	20 m	20 m	20 m	20 m	20 m
	TTS	195	350 m	350 m	340 m	330 m	310 m	300 m
Pn pinniped	PTS	203	270 m	260 m	240 m	240 m	220 m	220 m
	TTS	183	1040 m	950 m	1840 m	1820 m	1400 m	1370 m
Harbour porpoise	TTS	164.3	> 10 km	> 10 km	>10 km	>10 km	>10 km	>10 km
	Aversive	145	> 10 km	> 10 km	>10 km	>10 km	>10 km	>10 km

For Backhoe Dredging (considered to be a worst case in comparison to TSHD), the worst case acoustic effects with the potential for permanent auditory injury are presented in Figure 15.25 for cetaceans and pinnipeds. Effects have been presented in respect of Level A-Auditory Injury for cetaceans, whilst effects associated with PTS (cumulative) have been presented for pinnipeds. This is due to these two criteria resulting in the largest ranges of effect (associated with permanent auditory injury) for the two respective species groups.

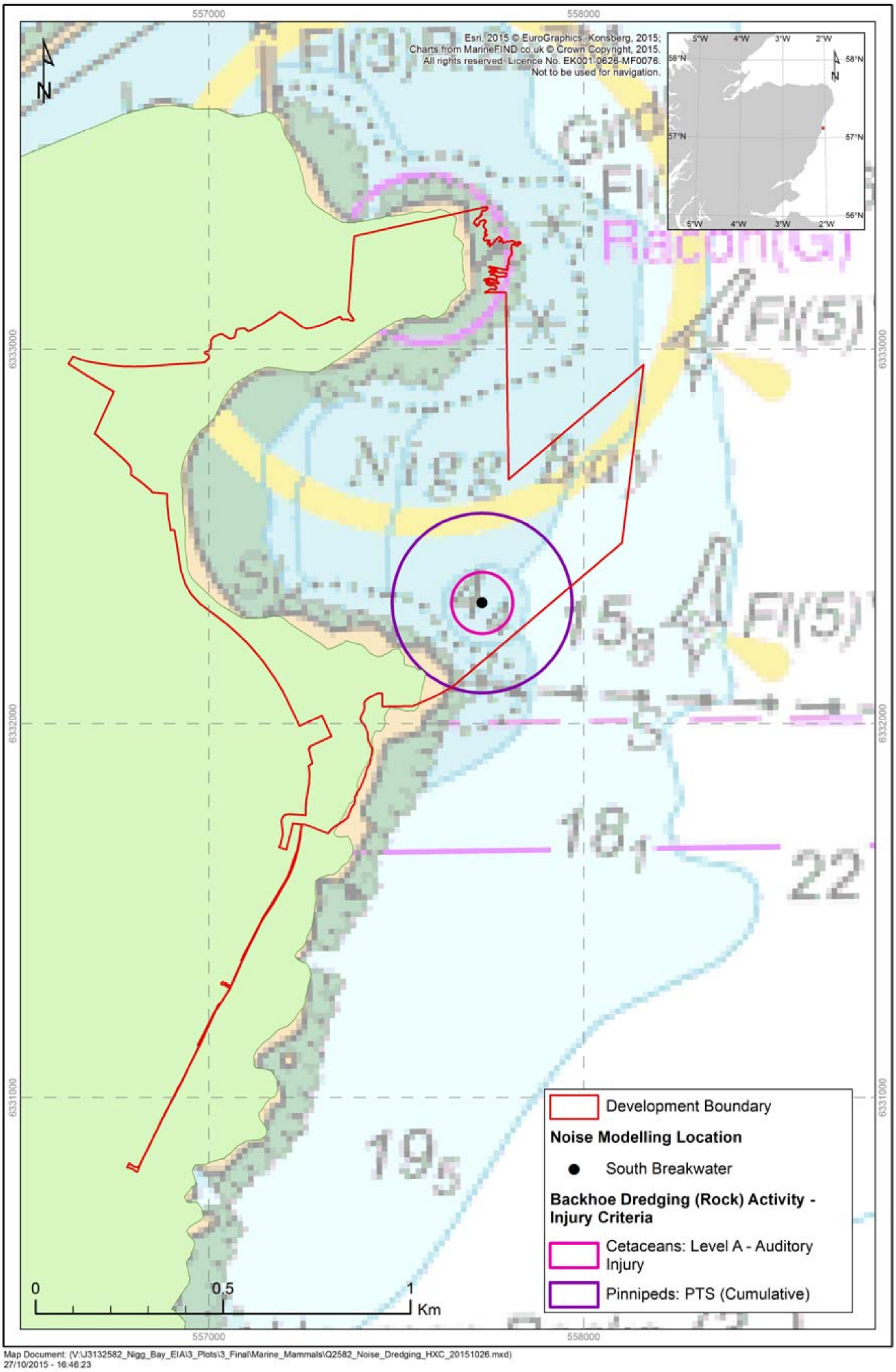


Figure 15.25: Backhoe Dredging noise effects with potential to cause permanent auditory injury for marine mammals. Based on worst case scenario distances associated with dredging rock at the southern breakwater

Bottlenose dolphin

Potential dredging effects and the ranges of effects are presented for bottlenose dolphin in Table 15.40 below. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study (Kongsberg, 2015)).

Table 15.40: Predicted Significance of effects from underwater noise from dredging for Bottlenose dolphin

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	224 dB re 1 µPa pk
Level A-Injury	82	180 dB re 1 µPa (RMS)
Cumulative PTS	20	215 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	218 dB re 1 µPa pk
Cumulative TTS	350	195 dB re 1 μPa^2 s
Level B-Harassment (continuous)	59000	120 dB re 1 µPa (RMS)

For bottlenose dolphin the total area of effect for permanent damage is therefore predicted to be within 82 m, and receptors are expected to be able to avoid adverse noise arising from the dredging by simply moving out of these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur up to 350 m, and this would be likely result in avoidance and temporary displacement of bottlenose dolphin from these areas for the duration of dredging activities. These effects are temporary and not a permanent loss of hearing. Individuals would be expected to forage in adjacent waters for these periods.

Behavioural disturbance (Level B-Harassment) is predicted to occur over a wide area up to 59 km. Therefore, bottlenose dolphins may experience some interruption to their migration, breathing, nursing, breeding, feeding, or sheltering within these distances. However, the low NMFS Level B-Harassment criterion is set at 120 dB re 1 µPa. Background noise levels in Aberdeen (and within the river Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1µPa rms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, baseline conditions exceed the threshold level for the Level B-Harassment criterion. For individuals that use Aberdeen Harbour regularly, the potential exists for these individuals to have become habituated to prevailing high noise levels and this is considered likely. The individuals present in the vicinity of Nigg Bay are likely to be the same individuals that will use Aberdeen Harbour. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal. The use of such a criterion in an impact assessment can therefore be deemed precautionary given the high background noise from nearby vessel activity in Aberdeen harbour (Appendix 13-B: Underwater noise impact study (Kongsberg, 2015)).

Disturbance effects associated with the Level B-Harassment criterion are forecast to occur over wide areas. A level of disturbance is there anticipated to occur. Bottlenose dolphin individuals may leave the area during the periods of very highest dredging activity in a similar manner to that observed by Pirotta et al. (2013) at Aberdeen Harbour. Pirotta et al. found that as the proportion of dredging time increased, the proportion of dolphin presence time decreased. The study found that during the observation period, there was a 5 week period where dredging intensity was very high, with an absence of bottlenose dolphins during this period. However, dolphin presence rapidly returned to high levels following a significant reduction in dredging intensity, whilst dolphins were shown to use the area during periods of lesser dredging intensity across all three years of the study. Whilst the perceived threat of the dredging operations may be the cause of bottlenose dolphins avoiding the area, it may also be that the dredging causes changes to the behaviour of the dolphin's prey, thus compromising the foraging habitat temporarily. Whatever the cause for the avoidance of the area by bottlnose dolphin, it is probable that the dolphins move to foraging patches elsewhere where they can forage more efficiently. This is likely to follow a trade-off between a reduction in foraging habitat quality in combination with increased energy levels (to forage efficiently), and the benefits of the alternative habitat.

Dredging will occur within a 19 month window during construction. However, as details on the duration of dredging operation are not known, the dredging intensity cannot be accurately determined at present. What can be determined, is that during periods of high dredging intensity bottlenose dolphins are likely to leave the vicinity of Nigg Bay until dredging insensity reduces. Whilst the Level-B harassment criterion implies potential disruption to certain life-cycle activities of bottlenose dolphin within a 59 km area, the study of dredging effects at Aberdeen Harbour by Pirotta et al. (2013) can be used as a strong proxy for effects at the nearby vicinity of Nigg Bay. Evidently, bottlenose dolphins are able to forage when dredging intensity is lower, and are not completely prevented from foraging or using the area. These observations, in combination with the high reported background noise levels in Aberdeen Harbour, suggest that the 59 km of Level B-Harassment should be treated with caution, as indviduals are voluntarily using the waters during lower-intensity operations and likely foraging. However, it is highly likely that bottlenose dolphin will be temporarily displaced for varying periods of time during the 19 month dredging window.

If bottlenose dolphins are to use other areas during dredging operations, it is possible that Girdleness will attenuate harassment noise from Aberdeen Harbour where bottlenose dolphin are known to forage at one of their key feeding grounds. Although, due to high baseline noise levels in Aberdeen Harbour, disturbance effects are unlikely regardless of the consideration of Girdleness.

There is a very low potential for lethality or injury, which will be highly localised. Displacement has the potential to cause stress in individuals, however this is unlikely to compromise feeding ability or cause significant detrimental energetic consequences, as individuals will likely be able to move out of the adversely affected areas into adjacent coastal habitat to the north and south. Based on the background noise levels reported for Aberdeen Harbour, individuals will be able to continue using the waters in and around Aberdeen Harbour. The Scottish East Coast bottlenose dolphin population is recognised as being comprised of individuals that are highly mobile, and commonly use the full length of the east coast when foraging. However, it is considered that dredging is likely to result in behavioural effects that are more continuous in nature than for other noise-producing activities e.g.

piling, drilling and blasting. Whilst it should be recognised that dredging may be an intermittent activity, and therefore effects will be reduced during periods of lower dredging intensity, the effects are likely to cause displacement of bottlenose dolphin for longer periods than other activities. Based on a worst case scenario of dredging seven days a week, potentially as a 24-hour operation, displacement would have to be anticipated during the 19 months of operations. Bottlenose dolphins will be able to use the area during periods of lower dredging intensity, however without a detailed schedule of dredging operations, it is unknown what the duration of these periods will be. Due to these behavioural effects and the very low potential for lethality and injury, the effect magnitude is considered to be **minor** on **very high** value bottlenose dolphin receptors (i.e. EPS individuals and SAC individuals) and effect significance is considered to be **moderate adverse**, which is significant in EIA terms.

Likelihood is considered **certain** for bottlenose dolphin. The species was recorded during the site-specific surveys and is present in the area in abundance throughout the year.

<u>Harbour porpoise</u>

Potential dredging effects and the ranges of effects are presented for harbour porpoise in Table 15.41 below. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study (Kongsberg, 2015)).

Table 15.41: Predicted significance of effects from underwater noise from dredging for Harbour porpoise

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	224 dB re 1 µPa pk
Level A-Injury	82	180 dB re 1 µPa (RMS)
Cumulative PTS	20	215 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	199.7 dB re 1 µPa pk
Cumulative TTS	> 10000	164.3 dB re 1 μPa^2 s
Aversive behavioural reaction	390	174 dB re 1 µPa pk-pk
Aversive behavioural reaction (Cumulative)	> 10000	145 dB re 1 μPa^2 s
Level B-Harassment (Continuous)	59000	120 dB re 1 µPa (RMS)

For harbour porpoise the total area of effect for permanent damage is therefore predicted to be within 82 m. Harbour porpoise individuals are expected to be able to avoid adverse noise arising from the drilling by simply moving out of these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur within > 10 km of Backhoe dredging activity. This would be likely result in avoidance and temporary displacement of harbour porpoise from these areas for the duration of dredging activities. These effects are temporary and not a permanent loss of hearing. Individuals would be expected to forage in adjacent waters for these periods. For a species that is recognised as being highly adaptable with the ability to forage over wide areas, this is not anticipated to cause significant energetic consequences or detrimental effects on foraging ability which could lead to mortality. There is extensive alternative habitat available both offshore and at the coast for the species. Harbour porpoise have an abundant and widely distributed North Sea population and therefore significant effects are not anticipated in respect of displacement. The presence of Girdle Ness will cast an acoustic shadow zone. Instantaneous and cumulative acoustic effects within modelled acoustic shadow zones are assumed to be negligible, and within background noise levels of the existing operational harbour.

The behavioural effects associated with the Level B-Harassment and resultant potential avoidance of affected areas may cause some interruption to harbour porpoise migration, breathing, nursing, breeding, feeding, or sheltering. This has the potential to occur within 59 km. Individuals may be displaced from local foraging areas. Harbour porpoise individuals will likely leave the the area during the periods of very highest dredging activity, returning as dredging intensity reduces of ceases. However, the low NMFS Level B-Harassment criterion is set at 120 dB re 1 µPa. Background noise levels in Aberdeen (and within the river Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1µPa mms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, baseline conditions exceed the threshold level for the Level B-Harassment criterion. For individuals that use Aberdeen Harbour regularly, the potential exists for these individuals to have become habituated to prevailing high noise levels and this is considered likely. The individuals present in the vicinity of Nigg Bay are likely to be the same individuals that will use Aberdeen Harbour. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal. The use of such a criterion in an impact assessment can therefore be deemed precautionary given the high background noise from nearby vessel activity in Aberdeen harbour (Appendix 13-B: Underwater noise impact study (Kongsberg, 2015)).

Dredging will occur intermittently within a 19 month window during construction. However, as details on the duration of dredging operation are not known, the dredging intensity and intermitency cannot be accurately determined at present. There is a very low potential for lethality or injury. Temporary auditory damage (TTS) is predicted to occur over wider areas > 10 km. These effects are temporary and not a permanent loss of hearing. This will likely displace harbour porpoise from these adversely affected areas for varying periods of time during the 19 month dredging window, from an area which has been described as being of only local importance to the species (Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay (Clarkin and McMullan, 2015)). However, it is considered that dredging is likely to result in behavioural effects that are more continuous in nature than for other noise-producing activities e.g. piling, drilling and blasting. Whilst it should be recognised that dredging may be an intermittent activity, and therefore effects would be reduced during periods of lower dredging intensity, the effects are likely to cause displacement of harbour porpoise for longer periods than other activities. Based on a worst case scenario of dredging seven days a week, potentially as a 24-hour operation, displacement would have to be anticipated during the 19 months of operations. Harbour porpoise may still be able able to use the area during periods of lower dredging intensity, however without a detailed schedule of dredging operations, it is unknown what the duration of these periods will be. Due to these behavioural effects and the very low potential for lethality and injury, the effect magnitude is considered to be

minor on a **very high** value receptor and effect significance is considered to be **moderate adverse**. This is therefore considered significant in EIA terms.

Likelihood is considered to be **certain** due to harbour porpoise presence in the area.

White-beaked Dolphin

Potential dredging effects and the ranges of effects are presented for white-beaked dolphin in Table 15.42 below. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study (Kongsberg, 2015)).

Table 15.42: Predicted significance of effects from underwater noise from dredging for White-beaked dolphin

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	224 dB re 1 µPa pk
Level A-Injury	82	180 dB re 1 µPa (RMS)
Cumulative PTS	20	215 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	218 dB re 1 µPa pk
Cumulative TTS	350	195 dB re 1 μPa^2 s
Level B-Harassment (continuous)	59000	120 dB re 1 µPa (RMS)

For white-beaked dolphin the total area of effect for permanent damage is therefore predicted to be within 82 m, and receptors are expected to be able to avoid adverse noise arising from the dredging by simply moving out of these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur up to 350 m, and this would be likely result in avoidance and temporary displacement of white-beaked dolphin from these areas for the duration of dredging activities. These effects are temporary and not a permanent loss of hearing. Individuals would be expected to forage in adjacent waters for these periods.

Behavioural disturbance (Level B-Harassment) is predicted to occur over a wide area up to 59 km. Therefore, white-beaked dolphins may experience some interruption to their migration, breathing, nursing, breeding, feeding, or sheltering within these distances. However, the low NMFS Level B-Harassment criterion is set at 120 dB re 1 µPa. Background noise levels in Aberdeen (and within the river Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1µPa mms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, in Aberdeen Harbour, baseline conditions exceed the threshold level for the Level B-Harassment criterion. The spatial extent of these existing high noise levels is not known, however high noise levels may extend outside of the harbour to areas where white-beaked dolphin may be present. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal.

Dredging will occur within a 19 month window during construction. However, as details on the duration of dredging operation are not known, the dredging intensity and intermitency cannot be accurately determined at present. A worst case scenario would be to assume dredging seven days a week, with up to 24 hour operations. This displacement has the potential to cause stress in individuals, however this is unlikely to compromise feeding ability or cause detrimental energetic consequences, as individuals will likely be able to move out of the adversely affected areas into adjacent offshore and coastal habitat. White-beaked dolphin are a widely dispersed species and are highly seasonal. Therefore, the species does not rely on the coastal habitat for foraging and can forage elsewhere, as they do for the majority of the year. Due to the very low potential for lethality and permanent injury, the effect magnitude is considered to be **minor** on **very high** value white-beaked dolphin receptors and effect significance is considered to be **moderate adverse**. This is therefore considered significant in EIA terms.

Likelihood is considered **near certain** for white-beaked dolphin. The species was sighted during the site-specific surveys, but only on a single occasion with three individuals. The species is highly seasonal, with higher abundance in the summer months, and is known to occur within the region and local area based on relevant literature.

Risso's Dolphin

Potential dredging effects and the ranges of effects are presented for Risso's dolphin in Table 15.43 below. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study (Kongsberg, 2015)).

Table 15.43: Predicted significance of effects from underwater noise from dredging for Risso's dolphin

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	224 dB re 1 µPa pk
Level A-Injury	82	180 dB re 1 µPa (RMS)
Cumulative PTS	20	215 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	218 dB re 1 µPa pk
Cumulative TTS	350	195 dB re 1 μPa^2 s
Level B-Harassment (continuous)	59000	120 dB re 1 µPa (RMS)

For Risso's dolphin the total area of effect for permanent damage is therefore predicted to be within 82 m, and receptors are expected to be able to avoid adverse noise arising from the dredging by simply moving out of these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur up to 350 m, and this would be likely result in avoidance and temporary displacement of Risso's dolphin from these areas for the duration of dredging activities. These effects are temporary and not a permanent loss of hearing. Individuals would be expected to forage in adjacent waters for these periods.

Behavioural disturbance (Level B-Harassment) is predicted to occur over a wide area up to 59 km. Therefore, Risso's dolphins may experience some interruption to their migration, breathing, nursing, breeding, feeding, or sheltering within these distances. However, the low NMFS Level B-Harassment criterion is set at 120 dB re 1 µPa. Background noise levels in Aberdeen (and within the river Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1µPa mms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, in Aberdeen Harbour, baseline conditions exceed the threshold level for the Level B-Harassment criterion. The spatial extent of these existing high noise levels is not known, however high noise levels may extend outside of the harbour to areas where Risso's dolphin may be present. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal.

Dredging will occur within a 19 month window during construction. However, as details on the duration of dredging operation are not known, the dredging intensity and intermitency cannot be accurately determined at present. A worst case scenario would be to assume dredging seven days a week, with up to 24 hour operations. This displacement has the potential to cause stress in individuals, however this is unlikely to compromise feeding ability or cause detrimental energetic consequences, as individuals will likely be able to move out of the adversely affected areas into adjacent offshore and coastal habitat. Risso's dolphin have a wide-ranging and dispersed distribution, and alternative habitat will therefore be available. Therefore, the species does not rely on the coastal habitat for foraging and can forage elsewhere, as they do for the majority of the year. Due to the very low potential for lethality and permanent injury, the effect magnitude is considered to be **minor** on **very high** value Risso's dolphin receptors and effect significance is considered to be **moderate adverse**. This is therefore considered significant in EIA terms.

Likelihood is considered **unlikely** for Risso's dolphin, which has the potential to occur in the local area based upon their ranges as recognised within the literature, although were not sighted in the site-specific surveys.

Minke Whale

Potential dredging effects and the ranges of effects are presented for minke whale in Table 15.44 below. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study (Kongsberg, 2015)).

Table 15.44: Predicted significance of effects from underwater noise from dredging for Minke whale

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	224 dB re 1 µPa pk
Level A-Injury	82	180 dB re 1 µPa (RMS)
Cumulative PTS	20	215 dB re 1 μPa^2 s
Temporary auditory damage effects and behavioural effects		
TTS	< 1	218 dB re 1 µPa pk
Cumulative TTS	350	195 dB re 1 μPa^2 s
Level B-Harassment (Continuous)	59000	120 dB re 1 µPa (RMS))

For minke whale the total area of effect for permanent damage is therefore predicted to be within 82 m, and receptors are expected to be able to avoid adverse noise arising from the dredging by simply moving out of these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur up to 350 m, and this would be likely result in avoidance and temporary displacement of minke whale from these areas for the duration of dredging activities. These effects are temporary and not a permanent loss of hearing. Individuals would be expected to forage in adjacent waters for these periods.

Behavioural disturbance (Level B-Harassment) is predicted to occur over a wide area up to 59 km. Therefore, minke whale may experience some interruption to their migration, breathing, nursing, breeding, feeding, or sheltering within these distances. However, the low NMFS Level B-Harassment criterion is set at 120 dB re 1 µPa. Background noise levels in Aberdeen (and within the river Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1µPa mms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Therefore, in Aberdeen Harbour, baseline conditions exceed the threshold level for the Level B-Harassment criterion. The spatial extent of these existing high noise levels is not known, however high noise levels may extend outside of the harbour to areas where minke whales may be present. It should be noted that the Level B-Harassment criterion relates to sound pressure levels which are not considered injurious to the animal.

Dredging will occur within a 19 month window during construction. However, as details on the duration of dredging operation are not known, the dredging intensity and intermitency cannot be accurately determined at present. A worst case scenario would be to assume dredging seven days a week, with up to 24 hour operations. This displacement has the potential to cause stress in individuals, however this is unlikely to compromise feeding ability or result in detrimental energetic consequences, as individuals will likely be able to move out of the adversely affected areas into adjacent offshore and coastal habitat. Minke whales have a wide-ranging and dispersed distribution, and alternative habitat will therefore be available. The species does not solely rely on coastal habitat for foraging and can forage elsewhere. Due to the very low potential for lethality and permanent injury, the effect magnitude is considered to be **minor** on **very high** value minke whale receptors and effect significance is considered to be **moderate adverse**. This is therefore considered significant in EIA terms.

Likelihood is considered to be **near certain** for minke whale, which although not sighted during the site-specific surveys, are known to be present seasonally and are relatively abundant in the areas adjacent to Aberdeen.

Grey Seal

Potential dredging effects and the ranges of effects are presented for grey seal in Table 15.45 below. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study (Kongsberg, 2015)).

Table 15.45: Predicted significance of effects from underwater noise from dredging for Grey seal

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	218 dB re 1 µPa pk
Level A-Injury	5.3	190 dB re 1 µPa (RMS)
Cumulative PTS	270	203 dB re 1 μPa^2 s
Temporary Auditory Damage Effects and Behavioural Effects		
TTS	< 1	212 dB re 1 µPa pk
Cumulative TTS	1840	183 dB re 1 μPa^2 s

For grey seals the total area of effect for permanent damage is therefore predicted to be within 270 m. Receptors are expected to be able to avoid adverse noise arising from the dredging by simply moving out of these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur up to 1840 m. This would be likely result in avoidance and temporary displacement of grey seals from these areas for the duration of dredging activities. These effects are temporary and not a permanent loss of hearing. Following avoidance reactions and displacement from the area during dredging operations, individuals would be expected to forage in coastal waters waters to the north and south, and offshore waters to the east.

To the south, the areas between Aberdeen and Stonehaven are recognised as feeding areas for grey seal and seals have been observed foraging and eating fish at the sea surface in these areas (Genesis, 2012). Pups show significant concentrated activity around Newburgh and Stonehaven, which has been suggested as a result of the foraging opportunities available to grey seals (Appendix 15-B: Seal Telemetry Analysis (Plunkett and Sparling, 2015)). To the north, the mouth of the River Dee in Aberdeen Harbour and the important haul-out for grey seal at the mouth of the River Don are not predicted to be affected. From telemetry data analysis, adult grey seals have been shown to pass the vicinity of Nigg Bay and Aberdeen, within relatively close proximity to the coast. The potential may exist for this transit activity to be intercepted by the spatial extents of the propagating noise, however the telemetry analysis has also shown adults to use areas further offshore and areas which are significantly offshore when transiting along the east coast. Individuals may alter their route to avoid areas of adverse noise. Telemetry analysis has shown transits to typically pass between 0 – 5 km of the development boundary, and therefore 1840 m of noise propagation is not considered to be of significant consequence to this transit activity.

Dredging will occur within a 19 month window during construction. However, as details on the duration of dredging operation are not known, the dredging intensity and intermitency cannot be accurately determined at present. A worst case scenario would be to assume dredging seven days a week, with up to 24 hour operations. There is a very low potential for lethality or permanent injury. Temporary auditory damage (TTS) is predicted to be within 1840 m, and this will likely result in avoidance and displacement for the duration of dredging activities. Any grey seals present will likely move away from the area and return once dredging insensity reduces or ceases. Individuals will likely be able to move out of the adversely affected areas into adjacent offshore and coastal habitat.

Due to the very low potential for lethality and injury, the effect magnitude is considered to be **minor** on **very high** value grey seal receptors and effect significance is considered to be **moderate adverse**. This is therefore considered significant in EIA terms.

Likelihood is considered to be **certain** for grey seal as the area of potential effect lies within an area where the species is known to occur throughout the year, and sightings were made during site-specific surveys.

Harbour Seal

Potential dredging effects and the ranges of effects are presented for harbour seal in Table 15.46 below. These represent the worst case scenario based on the underwater noise modelling (Appendix 13-B: Underwater noise impact study (Kongsberg, 2015)).

Table 15.46: Predicted significance of effects from underwater noise from dredging for Harbour seal

Effect	Range of Effect (m) (Worst Case Scenario)	Criterion
Lethality and Permanent Injury		
Lethality	< 1	240 dB re 1 µPa pk
PTS	< 1	218 dB re 1 µPa pk
Level A-Injury	5.3	190 dB re 1 µPa (RMS)
Cumulative PTS	270	203 dB re 1 μPa^2 s
Temporary auditory damage effects and behavioural effects		
TTS	< 1	212 dB re 1 µPa pk
Cumulative TTS	1840	183 dB re 1 μPa^2 s

For harbour seals the total area of effect for permanent damage is therefore predicted to be within 270 m, and receptors are expected to be able to avoid adverse noise arising from the dredging by simply moving out of these areas before onset of significant injury or mortality.

Temporary auditory damage (TTS) is predicted to occur up to 1840 m. This would be likely result in avoidance and temporary displacement of harbour seals from these areas for the duration of dredging activities. These effects are temporary and not a permanent loss of hearing. This area of potential effect is localised and individuals would be expected to forage in adjacent waters for these periods. The River Don is known to be used mostly as a haul-out site, whilst the River Dee is used as a foraging location, where the seals feed on mostly salmonids, flounder and other marine fish species (Carter et al., 2001; Genesis, 2012). These areas are not predicted to be within the spatial extent of potential effects and therefore harbour seal are expected to be able to continue using the waters and foraging in these locations.

Dredging will occur within a 19 month window during construction. However, as details on the duration of dredging operation are not known, the dredging intensity and intermitency cannot be accurately determined at present. A worst case scenario would be to assume dredging seven days a week, with up to 24 hour operations. There is a very low potential for lethality or permanent injury. Temporary auditory damage (TTS) is predicted to be within 1840 m, and this will likely result in avoidance and displacement for the duration of dredging activities. Any harbour seals present will likely move away from the area and return once dredging insensity reduces or ceases. This displacement is localised and individuals will likely be able to move out of the adversely affected areas into adjacent offshore and coastal habitat.

Due to the very low potential for lethality and injury, the effect magnitude is considered to be **minor** on **very high** value harbour seal receptors and effect significance is considered to be **moderate adverse**.

Likelihood is considered to be **unlikely** for harbour seal as the area of potential effect lies within the theoretical range of the species, however harbour seals are not known to use the area and were not sighted within the site-specific surveys.

Underwater Noise Summary

A summary of the significance of effects from underwater noise associated with drilling is provided in Table Table 15.47 below. Certainty associated with the assessment is **high** as modelling has informed the assessment and is considered precautionary.

Table 15.47: Predicted significance of effects from underwater noise from dredging

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Harbour porpoise	Minor	Very High	Moderate	Certain	High
Bottlenose dolphin	Minor		Moderate	Certain	High
White-beaked dolphin	Minor		Moderate	Near Certain	Med-High
Risso's dolphin	Minor		Moderate	Unlikely	Low-Med
Minke whale	Minor		Moderate	Near Certain	Med-High
Grey seal	Minor		Moderate	Certain	High
Harbour seal	Minor		Moderate	Unlikely	Medium

In light of this assessment, significant effects have been identified. As injury/disturbance effects have the potential to occur on EPS species, an EPS licence is likely to be required. This will be discussed with the relevant statutory authorities and will be the subject of a subsequent application.

Assessment of Underwater Noise from Dredged Material Disposal

Table 15.48 presents the spatial extents over which noise peak pressures are predicted to elicit physiological and behavioural effects on marine mammals, as a result of underwater noise from dredge material disposal activities.

The noise modelling shows that the peak pressures generated by the spread of vessels associated with seabed material disposal operations are insufficient to cause lethality, but sufficient to cause onset of injury in all species, using the more precautionary PTS limits advised by NMFS, at less than 17 m and 239 m for pinnipeds and cetaceans respectively. Peak to peak noise level predictions indicate aversive behavioural reaction in harbour porpoise up to 462 m, Using the much lower RMS criteria (120 dB re 1 µPa) advised by NMFS, in behavioural terms, harassment is predicted to occur up to 62 km for cetaceans.

Table 15.49 shows the results of the analysis of cumulative exposure (SEL) to noise from dredged material disposal activities. This predicts potential auditory damage, or PTS, to occur up to 280 m for all cetaceans and 300 m for pinnipeds. Temporary hearing damage, as indicated by the TTS effect criterion, may occur at a maximum range of >10 km for harbour porpoise specifically, 320 m for dolphin species (Mf cetaceans), 490 m for minke whale (Lf cetacean) and 2550 km for harbour and grey seals.

Table 15.48: Summary of acoustic effects for seabed material disposal vessel spread

Exposure Limit	Effect	South Breakwater		North Breakwater	
		Winter	Summer	Winter	Summer
240 dB re 1 µPa pk	Lethality	<1 m	<1 m	<1 m	<1 m
224 dB re 1 µPa pk	Auditory injury (PTS) onset in cetaceans	<1 m	<1 m	<1 m	<1 m
218 dB re 1 µPa pk	Auditory injury (PTS) onset in pinnipeds	<1 m	<1 m	<1 m	<1 m
218 dB re 1 µPa pk	Temporary deafness (TTS) onset in cetaceans	<1 m	<1 m	<1 m	<1 m
212 dB re 1 µPa pk	Temporary deafness (TTS) onset in pinnipeds	<1 m	<1 m	<1 m	<1 m
199.7 dB re 1 µPa pk	Temporary deafness (TTS) onset in harbour porpoise	1.8 m	1.8 m	1.8 m	1.8 m
190 dB re 1 µPa (RMS)	Level A-Auditory injury in pinnipeds	17 m	17 m	17 m	17 m
180 dB re 1 µPa (RMS)	Level A-Auditory injury in cetaceans	234 m	122 m	234 m	239 m
174 dB re 1 µPa pk-pk	Aversive behavioural reaction in harbour porpoise	462 m	432 m	441 m	441 m
120 dB re 1 µPa (RMS)	Level B-Harassment in cetaceans exposed to continuous noise	62 km	40 km	51 km	35 km

Table 15.49: Summary of cumulative acoustic effects for seabed material disposal vessel spread

Species	Effect	Threshold dB re 1 μPa^2 s	South Breakwater		North Breakwater	
			Feb	Aug	Feb	Aug
Hf cetaceans	PTS	215	280 m	280 m	270 m	270 m
	TTS	195	300 m	300 m	280 m	280 m
Mf cetaceans	PTS	215	280 m	280 m	270 m	270 m
	TTS	195	320 m	310 m	290 m	290 m
Lf cetaceans	PTS	215	280 m	280 m	270 m	270 m
	TTS	195	490 m	450 m	440 m	410 m
Pn pinniped	PTS	203	300 m	300 m	280 m	280 m
	TTS	183	2550 m	2540 m	2120 m	2070 m
Harbour porpoise	TTS	164.3	>10 km	>10 km	>10 km	>10 km
	Aversive	145	>10 km	>10 km	>10 km	>10 km

Mobile species would be expected to be able to avoid areas of significant adverse underwater noise from other construction activities but dredged material disposal would likely displace marine mammals out of the area before the onset of injury and mortality.

Again, the predicted effects relating to dredge disposal noise should be contextualised against the observations within the mouth of the existing Aberdeen Harbour and the apparent habituation and tolerance of receptor to noise disturbances.

The noise modelling was based on five vessels being used during the activity, whilst the currently anticipated scenario involves a dredger with a split hopper transiting under its own power to the designated area for the disposal of material. The actual activity of the disposal of material through the split hopper is in itself a low noise activity, and dredge disposal activities should be assumed to be as per background noise levels based on previous evidence of the disposal of heavier, coarser materials resulting in noise levels within background values (Appendix 13-B: Underwater noise impact study (Kongsberg, 2015)). The dredger itself will produce underwater noise, however this is considered to be within the context of the background levels for the area. Therefore, disposal of dredged material will not cause a significant increase in noise levels, whilst the transit of the dredger itself is well within what would be expected for an area with high vessel traffic, and will not materially add to baseline noise conditions. Therefore the effect magnitude is considered to be **negligible** on **very high** value receptors, and significance of effect is thus **minor adverse**.

The effects are certain to happen and thus risk is judged to be **med-high**. Certainty associated with this assessment is **medium** as the spatial extents of the effects have not been modelled, however the issues are reasonably well understood and quantitative data is not considered to be necessary in order to support this assessment.

15.6.3.2 Effects Relating to Increased SSCs

Temporary Increases in Suspended Sediment Concentrations (SSCs) due to Dredging in Nigg Bay

Increases in suspended sediment concentrations (SSCs) will occur as a result of the action of the dredger draghead or the backhoe dredging tool on the seabed, and also from any overspill from the dredger hopper. Suspended sediments will be transported from the point of release as sediment plumes via tidal currents, and will be subsequently deposited back to the seafloor during periods of reduced tidal and wave energy.

Peak concentrations of SSCs will be short-lived due the predominant sand component settling back to the seafloor very quickly and in close proximity to the initial disturbance. Finer sediment particles are likely to stay in suspension for longer periods and will be subject to gradual dilution and dispersion out of the area (Guillou and Chapalain, 2010).

At Nigg Bay, typical SSCs are in the range of 24 mg/l (outer embayment) to 144 mg/l (inner embayment) but increase to between 529 mg/l and 899 mg/l during high energy wave events (see Appendix 6-B: Hydrodynamic Modelling and Coastal Processes Assessment).

Greatest SSCs will be created during the trailer suction hopper dredging of the unconsolidated sediments. Appendix 7-D: Sediment Plume Modelling, assumes that the northern and southern breakwaters have been partially constructed and predicts that most sediment fractions disturbed by this dredging will remain within the embayment at Nigg Bay, settling rapidly back to the seafloor close to the point of disturbance. This is due to the comparatively lower current velocities and enhanced settling behind the partial breakwaters. Mud particles however, will remain in suspension for longer and will be transported outside of the bay via tidal currents. Dispersion will be mostly to the north towards the entrance of the River Dee following the dominant current movement.

Peak SSCs during TSHD overspill are predicted to >8,000 mg/l at the immediate dredging location. Coarse sediments are predicted to settle quickly, limiting the spatial extent of plumes, and SSC levels for coarse sediments are predicted to be indistinguishable from natural levels around some of the periphery of the Bay. Finer sediments will travel further, however peak SSCs during TSHD are not predicted to be greater than 100-200 mg/l north of Girdle Ness.In general, it is predicted that that the effects of the dredging will be largely limited to the construction area only.

Alteration to Foraging and Displacement

Increases in turbidity, as a result of sediments entering suspension during dredging, have the potential to impair the foraging success of some marine mammal species which rely on vision to hunt, such as seals. It may also interrupt marine mammals whilst in transit between locations, or displace species from an area completely. This could potentially have a detrimental effect on individuals which forage in, or pass through, the Nigg Bay area with implications for species' populations if sufficient numbers of individuals were to be affected for significant amounts of time. Pirotta et al., (2013) notes that the nature and significance of associated biological effects will depend on how important the disturbed area is to the population in question, in conjunction with the spatial, temporal and intensity of the disturbance activity, and that the perceived risk of the stressor vs available and alternative suitable habitat will result in a trade-off when the marine mammal responds to the stressor, choosing between remaining in the area of disturbance due to the quality of the habitat, or moving from the area due to the perceived risk being too high (Pirotta et al., 2013).

The effects of maintenance dredging within the existing Aberdeen Harbour were studied in respect of the bottlenose dolphin that are known to frequent the harbour waters (Pirotta et al., 2013). The quantitative study found that dolphins spent less time in the harbour as the proportion of dredging time (intensity) increased, with dolphins leaving the harbour completely for approximately 5 weeks during a period of intense dredging activity. Group size was not affected by dredger presence, and therefore all individuals within a group were likely to leave the area if disturbed. Pirotta et al. (2013) concluded that it is likely that a combination of noise and increases in SSC can impair dolphin sight and communication abilities. The individuals would likely have to prioritise between factors such as changes in the quality of the available prey resource, and the stress and energy expenditure of foraging during dredging operations, against the possibility of leaving the area to other areas where efficient foraging would be possible, until they can return to the harbour following the cessation of dredging.

Marine mammals rely on sound to make sense of their environment and to detect and capture prey, and so reduced vision due to increased turbidity, is unlikely to have a significant effect of feeding. In respect of the effects of SSCs on cetaceans, those species which are able to echolocate when hunting prey are not likely to be affected by moderate increases in turbidity, i.e. harbour porpoise, bottlenose dolphin, white-beaked dolphin, Risso's dolphin and minke whale. Active biosonar has been found to enhance the ability of these echolocating species to forage and utilise prey resources in environments where visual sensory mechanisms are of little use (Schusterman et al., 2000).

Pinnipeds are more likely to be inhibited by increased turbidity as a non-echolocating species. However, grey seals are highly mobile and adaptable foragers, and are capable of foraging at the seabed in depths of up to 100 m in poor visibility. Grey seals are skilled in prey detection and navigation due to the development of visual, tactile, hydrodynamic and acoustic sensory systems that combine to enable seals to forage efficiently in a range of conditions (Schusterman et al., 2000).

The modelling for construction dredging predicts that elevated SSC for coarse fractions will be extremely localised and restricted to the confines of the bay itself. These concentrations alone are not considered sufficient to adversely affect individual cetaceans through physiological damage, but may result in avoidance reactions and displacement from within these areas of the harbour as as result of the combination of noise and increased SSCs as recorded during monitoring of the Aberdeen Harbour maintenance dredging (Pirotta et al., 2013). However, based on the effects of dredging noise alone which have been modelled and assessed in Section 15.6.3.1, it is considered likely that all species will avoid the harbour and will therefore be outside of the areas where SSCs are highest. In addition, avoidance of the bay by fish prey due to increased SSCs (see Chapter 13: Fish and Shellfish Ecology) may also result in displacement of marine mammals to areas where prey is available.

Outside of the proposed harbour, where individuals are more likely to be present, SSCs are predicted to consist of lower levels of fine sediments that will be within the range of background natural variation (see 7.3 of Chapter 7: Marine Water and Sediment Quality). Model outputs shows plume SSCs at levels indistinguishable from natural levels at the mouth of River Dee. Again, these levels are well within the natural variation to which local populations of marine mammals will be tolerant.

Where SSCs are at their highest levels within Nigg Bay, it is likely that all marine mammal species will be temporarily displaced from these areas due to underwater noise within the harbour during construction. If such concentrations were to result in a behavioural reaction, as highly mobile species, marine mammal individuals will be able to move away from adversely affected areas into areas of lower SSCs outside of the harbour. SSCs outside of the breakwaters are significantly lower and also within the realms of natural variation and unlikely to deter individuals from foraging or detecting their prey. All species are recognised as being highly adaptable with the ability to forage over wide areas and there is extensive alternative available habitat.

At the mouth of the River Dee where bottlenose dolphins use the riverine and marine mixing front to catch salmon and where seals are also known to forage (Aberdeen Harbour Board, 2012), SSCs will be very low and of no consequence. Grey seals from populations further afield are known to transit past Nigg Bay (Appendix 15-B: Seal telemetry analysis (Plunkett and Sparling, 2015)), and may interact with the plumes which will extend outside of the development boundary offshore. At the point where grey seals will likely intersect the plume whilst in transit, SSCs will be within natural levels, which is the value predicted for a point immediately outside of the harbour entrance. Where seals pass the Development, further offshore than this modelled point, SSCs will be lower as they quickly disperse. Even at higher concentrations, SSCs would not be anticipated to prevent seals from passing through the area to and from their preferred foraging locations.

Effects will be intermittent and temporary, lasting for the duration of the capital dredge (19 months) only and will be highly localised. Temporary displacement from the local area is expected as a result of a combination of high SSCs and construction related noise at the individual level only, although significant impairment of feeding is not expected due to marine mammals' sensing abilities and SSCs which are within natural variation. Effect magnitude is therefore considered to be **negligible** on **very high** value receptors. Effect significance is thus judged to be **minor adverse**.

For the species that occur year-round in the vicinity of Nigg Bay, the likelihood of the species being subjected to the impact is considered certain. For seasonal white-beaked dolphin this is probable, whilst for other species not recorded during the site-specific surveys this is unlikely. Overall risk is presented in Table 15.50.

The effects have been predicted with conservative numerical modelling and certainty associated with this assessment is **high**. For all species, the significance of effect and overall EIA significance is considered within Table 15.50.

Table 15.50: Predicted significance of effects from increases in suspended sediment concentrations (SSCs) due to dredging activity for local and regional marine mammal species likely to be present

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Harbour porpoise	Negligible	Very High	Minor	Certain	Med-High
Bottlenose dolphin				Certain	Med-High
White-beaked dolphin				Probable	Low-Med
Risso's dolphin				Unlikely	Low
Minke whale				Unlikely	Low
Grey seal				Certain	Med-High
Harbour seal				Unlikely	Low

Temporary Increases in Suspended Sediment Concentrations (SSCs) due to Disposal of Dredged Material at a Licensed Site

Although some material may be beneficially used within the development, to represent a realistic worst case scenario, this assessment has assumed that the majority of seabed material arising from the dredging and blasting operations will be transported to a licenced offshore marine disposal site via hopper barge and disposed to the seabed. Disposal activity will be most frequent during the two spring/summer construction periods when the greatest quantities will be generated from the capital dredging and blasting operations.

Numerical modelling shows that upon release, the majority of the disposed dredge material (coarser sands and gravels) will settle rapidly to the seafloor in close proximity to the release point (see Chapter 7: Marine Water and Sediment Quality). The finer components of the material however will remain in suspension for longer and will be dispersed and diluted over a wider area depending on tidal conditions at the time of the release, but will generally settle to the seafloor within a maximum of 3.25 hours and on the next slack water occasion.

Optical Back Scatter observations recorded peak SSC of between 529 mg/l and 899 mg/l during the metocean campaign within and outside Nigg Bay (ES Appendix 6-A). The current annual maintenance dredging of the existing harbour was considered as part of the baseline, where modelled peak SSC at the disposal site reaches 19,524 mg/l.

For disposal of TSHD dredged material modelled peak SSC at the disposal site is predicted to reache 10,192 mg/l, but these peaks are very-short lived and SSC return to background concentrations very rapidly, before the next release, with average SSC at the disposal site of 300.4 mg/l. Within 0.5 km from the disposal site peak SSC falls to between 872 mg/l and 974 mg/l on each release.

Similarly as with the results for the TSHD, the model shows that coarser materials (gravels and coarse sand) will settle quickly on the seabed in the disposal area and immediate vicinity. The mud fraction will create the largest plume, with discernible increases in SSC extending up to 11 km along the plume axis. The peak SSC at the disposal site is 4719 mg/l, though dredged material settles quickly, resulting in an average SSC of 308.5 mg/l. Within 2 km from the disposal site peak SSC fall to 207 mg/l to the north and 123 mg mg/l to the south on each release.

Whilst disposal of construction related material will be more frequent than maintenance dredging, the granular material will settle much faster than river silts and muds and produce much lower average SSC levels.

Concentrations are high at the disposal site, and as the plume reduces in concentration with distance from source, the levels fall within the natural variation to which marine mammals are expected to be tolerant. The important foraging area at the mouth of the River Dee is not forecast to be affected by the disposal of dredged material.

For all cetaceans and pinnipeds, the impact will be short-term, localised in spatial extent, intermittent, and will initially be limited to the spring and summer during the construction period and then infrequently thereafter during operation, which is discussed in Section 15.6.4.2. Marine mammal receptors are considered to be resilient and adaptable to the predicted short term and highly localised increases in SSCs in an area which represents a negligible portion of available alternative habitat. Effect magnitude is therefore considered to be **negligible** on **very high** value receptors. Effect significance is thus judged to be **minor adverse**.

The likelihood of significant effects occurring are considered **unlikely** given the highly localised and short duration of the impact. Furthermore, the area is not of great importance to any of the species. Risk is therefore judged to be **low**.

This assessment is associated with **high** certainty as the spatial extents of the impact have been predicted with conservative numerical modelling. Table 15.51 summarises the significance of effect and overall EIA significance on marine mammals.

Table 15.51: Predicted significance of effects from increases in suspended sediment concentrations (SSCs) due to disposal of sediments at a licensed site for local and regional marine mammal species likely to be present

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
All Species	Negligible	Very high	Minor	Unlikely	Low

Interaction of Pollutants with Marine Mammals Due to Release of Sediment Contaminants

Site specific sediment analyses found all contaminants tested to be below Marine Scotland’s Action Level One (see Appendix 6-B: Hydrodynamic Modelling and Coastal Processes Assessment). This means that the levels of surface sediment contaminants within the development boundary are not considered a danger to the environment if disposed of at sea. Chemical release from suspended sediments should be minimal and short lived (Lasalle 1990 in Vivian et al., 2005).

All Species

For all species, significant increases in the bio-availability of sediment contaminants are not anticipated to occur. No significant adverse effect on marine mammal receptors can therefore occur and effect magnitude is therefore considered to be **negligible**. For **very high** value receptors, the significance of effect is thus judged to be **minor adverse**.

The likelihood of the effect occurring is judged to be **extremely unlikely**.

The assessment is associated with **high** certainty as contaminants from site specific seabed sediment samples have been tested within an accredited laboratory and results compared with Marine Scotland guideline values. Vivian et al. (2005) note that traditional fears of water quality degradation resulting from the re-suspension of sediment during dredging and placement operations are mostly unfounded. For all species, the significance of effect and overall EIA significance is considered within Table 15.52.

Table 15.52: Predicted significance of effects from increases in risk of interaction of pollutants with marine mammals due to release of sediment contaminants for local and regional marine mammal species likely to be present

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Harbour porpoise	Negligible	Very high	Minor	Extremely unlikely	Low
Bottlenose dolphin					
White-beaked dolphin					
Risso's dolphin					
Minke whale					
Grey seal					
Harbour seal					

15.6.3.3 Effects Relating to Construction Vessel Activity

Mortality or Physical Injury Due to Collisions with Vessels

During construction, there will be an increase in the number of vessels in the area, due to the presence of construction vessels. There is therefore the potential for an increased risk of collisions between marine mammals in the area and vessels. This impact is likely to be intermittent during the full construction period (36 months), limited to periods of vessel movement, with implications for affected individuals including injury and mortality. This is likely to result from either hull impacts or propeller (corkscrew) impacts as assessed below.

All vessels will have to adhere to the existing Aberdeen Harbour Dolphin Code. This is mitigation adopted as part of the project, and will help to mitigate against any potential collision effects. The code of practice outlines requirements of vessel operators to consider the presence of dolphins within areas of the harbour. Examples of measures include maintaining a steady course and slow speeds, avoiding direct approaches to the individuals, and ensuring that groups of vessels use single-file formation to avoid herding of dolphins.

Hull Impacts

Hull impacts include blunt traumas which result from a physical collision between a marine mammal and the hull of a vessel. Whilst this is most likely to cause fractures to the bone structure of the species and/or haematomas, mortality is common from secondary causes such as infection or predation (Wilson et al., 2007). Marine mammals are moderately robust to collision with smaller objects in that their thick blubber layers shield the vital organs from a significant proportion of the impacts, although the head is considerably more vulnerable. With regard to minor collisions, resulting abrasion injuries may occur, with seal epidermis of greater resistance than cetaceans and therefore lesser sensitivity. In the wider context of other causes of marine mammal mortality, ship strike is significantly less than common threats such as starvation, stranding or by-catch and many other threats which are species-specific such as bottlenose dolphin attacks on harbour porpoise (CSIP, 2011).

Vessel collisions with marine mammals are, however, known to occur and may account for a proportion of marine mammal 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). 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 (less than 45 m in length) 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 echolocate, communicate vocally (Senior et al., 2008) and detect oncoming vessels, or indeed if the species is distracted during other activities such as social interaction or foraging (Wilson et al., 2007). Collisions with seals have also 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.

Vessels already use Aberdeen Harbour and the surrounding sea areas extensively and it is well documented that marine mammals co-exist with high vessel presence within the harbour. Dolphins are frequently occurring within the existing harbour channel, whilst seals are known to use the Dee for foraging. Some degree of habituation to the presence of vessels should therefore be expected, although the increase in vessel numbers will increase the potential for collisions. However, the bottlenose dolphins which use Aberdeen Harbour have been shown to respond to vessel traffic in a dynamic manner, leaving the harbour and returning based on the levels of vessel traffic, with less dolphins observed when there are periods of higher numbers of vessels in transit (Pirotta et al., 2013). This behavioural response is therefore likely to offset some of the increased collision risk during peak periods of vessel movement. The vessels used during construction will typically be relatively slow moving, therefore presenting a very low risk of causing a collision to such highly mobile species, which will likely move into adjacent waters during periods of vessel movement.

For all species, the impact will be intermittent and localised to the area where the increased vessel presence will be concentrated. Whilst there is the potential for individuals to be subjected to impacts e.g. injury or mortality, the great majority of marine mammal individuals would be expected to react to the perceived threat and to show short-term avoidance responses (lasting for seconds to minutes) to vessels which will likely be travelling at slow speeds. Marine mammals have already demonstrated a degree of habituation to vessel presence in Aberdeen Harbour, however, due to factors such as potential masking effects, there is a very low possibility that collisions could occur between an individual and a vessel. The magnitude of effect is however considered to be **negligible** on **high** value receptors. Effect significance is thus judged to be **minor adverse**.

In respect of likelihood, the potential for an effect to occur is **unlikely**, regardless of species distribution as previously discussed, and this has therefore been considered within the assessment of risk. However, in respect of the species presence in the area where a potential pathway for the impact exists, likelihood is considered to be **certain** for bottlenose dolphin, harbour porpoise, white-beaked dolphin and grey seal due to the confirmed presence of these species within Nigg Bay where ship-transits will take place in higher concentrations. Likelihood is considered to be **near certain** for harbour seal, as they are present around the Dee and may move offshore past Girdleness where vessels will be passing, and minke whale, which although not sighted during the site-specific surveys, they are known to be present seasonally and relatively abundant in the areas adjacent to Aberdeen and may interact with areas of higher vessel concentrations. Likelihood is considered **unlikely** for Risso's dolphin, which has the potential to occur in the areas of increased vessel traffic based upon their ranges as recognised within the literature, although were not sighted in the site-specific surveys.

The certainty associated within this assessment is **medium** due to the availability of literature which documents how numerous natural threats are significantly greater than that of vessel collision, whilst literature has also demonstrated how marine mammals make short-term avoidance reactions to reduce the threat. This is in addition to reports of the marine mammals in Aberdeen Harbour co-existing with a significant level of vessel traffic in a busy harbour. However, uncertainty exists over masking effects, whilst instances of collisions may be underreported and it is still not well understood how much of a threat collision poses to coastal marine mammal species.

For all species, the significance of effect and overall EIA significance is summarised within Table 15.53.

Propeller (Corkscrew) Impacts

This type of impact has only been reported to affect seal species and therefore only grey seal and harbour seal are considered here.

Potential propeller impacts include lacerations, resulting in either mortality or injury. In previous years, 'corkscrew injuries' have been discussed when assessing the potential ecological effects of increased vessel activity in areas where seals are known to be present. The word "corkscrew" was coined due to the physical form of the lacerations that were frequently being reported upon stranded seals that had suffered mortality, with the wounds representing a smooth edged cut, extending from the head and around the body (Thompson et al., 2010; Bexton et al., 2012). Whilst there was no direct evidence to suggest that these deaths were caused by interaction with vessel propellers, studies were undertaken using clamps that mimicked a potential predator's jaw to investigate the effects of tension forces upon a seal's carcass in order to investigate predation as another potential cause aside from propeller impacts (Thompson et al., 2015). The highly characteristic and stereotypical 'corkscrew' lacerations could not be replicated and therefore propeller impacts were previously deemed to be the most logical and likely cause of mortality.

Despite this, SMRU (Thompson et al., 2015) have recently observed, reported and documented detailed visual observations of adult grey seal predation upon weaned grey seal pups on the Isle of May, at the entrance to the Firth of Forth. The Isle of May has been considered to be a hotspot for corkscrew injuries in recent years, and these observations are therefore highly pertinent. An adult grey seal was observed dragging multiple grey seal pups to a freshwater pool over a number of days, forcing their heads under the water and proceeding to bite into their bodies, before spending considerable amounts of time pulling off pieces of blubber and consuming it as food with the pups suffering mortality. The carcasses of the pups were subject to a post-mortem examination, which found 12 out of the 14 carcasses to exhibit injuries consistent with the top category for classifying a corkscrew injury. Other cannibalistic predation events have been noted at locations such as Hegoland, Germany and Skomer, Wales, and also grey seal predation upon juvenile harbour seals have been observed. Records of grey seal predation upon adult harbour seals have not occurred, although the wound patterns are similar in nearly all aspects to those identified in grey seals.

Thompson et al. (2015) have concluded that it is likely that all of the corkscrew cases at the Isle of May since 2010 were caused by grey seal predation. Although it would be premature to disregard propeller interactions as a cause of some corkscrew injuries, grey seal predation could be the cause of many, if not the majority of corkscrew mortalities seen in UK waters. Thompson et al. (2015) concluded that the characteristics of the corkscrew wounds seen around the UK in other locations are of such similarity, that a proportion of these can be concluded to have been a result of grey seal predation events.

Due to the recent observations that corkscrew injuries are highly likely to be associated with predation by grey seals, and the mobile nature of grey seal and harbour seal which will allow them to avoid the slow moving vessels associated with construction, the magnitude of effect is considered to be **negligible** on **high** value receptors. Effect significance is thus judged to be **minor adverse**.

As for hull impacts, the likelihood of an impact pathway existing (the potential for an individual to physically interact with a vessel) is considered to be **certain** for grey seal and **near certain** for harbour seal. However, likelihood of such an event actually occurring is considered to be **unlikely**, and this has therefore been considereds within the consideration of risk.

The level of certainty associated with this effect is **high** due to the availability of documented visual observations and the conclusions of Thompson et al. (2015).

For both seal species, the significance of effect and overall EIA significance is considered within Table 15.53.

Table 15.53: Predicted significance of effects from increases in risk of mortality or physical injury due to collisions with construction vessels for local and regional marine mammal species likely to be present

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Hull Impacts					
Harbour porpoise	Negligible	Very High	Minor	Unlikely	Low
Bottlenose dolphin				Unlikely	Low
White-beaked dolphin				Unlikely	Low
Risso's dolphin				Unlikely	Low
Minke whale				Unlikely	Low
Grey seal				Unlikely	Low
Harbour seal				Unlikely	Low
Propeller (Corkscrew) Impacts					
Grey seal	Negligible	Very high	Minor	Unlikely	Low
Harbour seal				Unlikely	Low

Disturbance Due to Vessel Movements

The types of additional vessels predicted to be using the area associated with the proposed development are described in Chapter 3: Description of the Development. Numbers of vessel transits are not known, however it is predicted that disposal of the dredged material will also take place on a continuous basis, with an estimated 11 to 25 daily trips made by the barges to the disposal site. This impact is likely to be intermittent during the full construction period (up to 36 months), limited to periods of vessel movement, with implications for affected individuals including disturbance and interruption of foraging. In addition, the magnitude of the impact will relate to the amount of time that it will take for a vessel to pass through the area, the frequency of the vessel transits, the regularity and predictability of the vessel direction and the levels of noise emitted by the vessels.

All vessels will have to adhere to the existing Aberdeen Harbour Dolphin Code. This is mitigation adopted as part of the project, and will help to mitigate against any potential disturbance effects. The code of practice outlines requirements of vessel operators to consider the presence of dolphins within areas of the harbour. Measures to avoidance disturbance are included within the code of practice. This includes measures such as maintaining a steady course and slow speeds, avoiding direct approaches to dolphin individuals, controlling vessel engines and ensuring that groups of vessels use single-file formation to avoid herding of dolphins. These combined measures will likely reduce the perception of vessels as a threat and reduce the potential for disturbance.

During construction, there is the potential for vessel movements to disturb marine mammals and to interrupt their activities such as foraging. It is recognised that various factors will determine whether an individual will tolerate the disturbance e.g. high-quality foraging habitat or habituation to the stressor, or whether it will flee from the affected area due to the perceived risk outweighing any benefits of remaining within the area. Chronic exposure to disturbance stressors could potentially have implications for an individual's energy budget, affecting the health of individuals (Pirotta et al., 2015).

Vessel noise has the potential to mask acoustic cues and cause behavioural reactions in marine mammals, with particular potential consequences for species which use sound to navigate and forage.

Pirotta et al. (2015) recently undertook research into the potential effects of vessel movements on bottlenose dolphin foraging behaviour in the Moray Firth. The study showed that moving motorised boats affected dolphin foraging activity, with a reduction by almost half in the probability of dolphins foraging whilst the vessel was transiting through the area in which the species was present. However, this impact was limited to the time it took for the vessel to pass through the area, with no measureable effect as the vessel approached or moved away from the area. Increasing numbers of vessels simultaneously increased the level of effect upon the dolphins. The dolphins were found to remain in the area, but would cease foraging whilst the vessel transited their area, with their foraging recommencing quickly as the boat moved away. The degree of vessel impact varied between study locations, potentially reflecting habitat or prey quality affecting the dolphins' behavioural responses to the disturbance. It was concluded that the behavioural response of a dolphin was based upon the complex interrelationships between the physical presence of a vessel, the noise emissions of the vessel and the behaviour of the vessel, which ultimately combine to govern a response in the marine mammal due to the level of risk-perception. This demonstrated that noise emissions are not the only driver of vessel-related disturbance to marine mammals.

Marine mammals which co-exist with vessel traffic are expected to have some degree of 'habituation' to vessel movements, and are likely to perceive vessels as less of a threat than a mammal which has not been exposed frequently to vessel presence. It should be considered that this habituation or reduction in adverse behavioural responses may indicate a learned behaviour (i.e. that the vessel movement is not a significant threat), which would not necessarily mean that the individual was not experiencing an internal physiological stress response. Weir and Stockin (2001) observed the behaviour of bottlenose dolphins in response to vessel movements in Aberdeen Harbour and noted a range of responses. Dolphins were often recorded in very close proximity to large cargo vessels, passenger ferries and small fishing trawlers. Dolphins would make short movements out of the channel, before returning to re-commence feeding. Sometimes they took longer to return to activities and locations. In contrast to avoidance movements, on occasions bottlenose dolphins were observed bow-riding vessels into the harbour, including large passenger ferries. Again, this strongly indicates that these individuals are able to co-exist with the high vessel traffic, and to respond to vessel disturbance in an adaptive manner without significant stress.

Due to the temporary nature of the construction phase, stress in individuals is not considered to have the potential to result in significant implications for reproduction, aging or sickness-related symptoms and therefore reduction in foraging time is the primary effect under assessment here.

There will be an increase in vessel movements during the 3 year construction period. Vessels already use Aberdeen Harbour extensively and it is well documented that marine mammals co-exist with high vessel presence within the harbour. However, increases in vessel movements are still likely to cause some additional disturbance, with potential reductions in foraging time for any animals which are foraging within a vessel route. These interruptions will be limited to periods of vessel movement and therefore intermittent, short-term and limited in spatial extent. The reduction in foraging time is not considered to be sufficient to cause a reduction in an individual's energy intake. Furthermore, significant adverse effects on fish prey over the wider area are not forecast (see Chapter 13: Fish and Shellfish Ecology) so that alternative foraging area is expected to remain available during construction.

Bottlenose Dolphin

Whilst bottlenose dolphin are known to forage on occasions within Nigg Bay, the reduction in potential foraging time is not anticipated to affect an individual's energy intake. Furthermore, the bottlenose dolphins in the Aberdeen area are evidently habituated to vessel movements to a degree, due to their coexistence with the vessels of Aberdeen Harbour. There is extensive foraging habitat available along the east coast which the dolphins will be able to exploit, in waters located away from the routes used by vessels. The effect magnitude is therefore considered to be **negligible** on **very high** value receptor. Effect significance is thus judged to be **minor adverse** with regard to bottlenose dolphins.

Harbour Porpoise

Although likely to forage on occasions within Nigg Bay, the species is recognised as being highly adaptable with the ability to forage over wide areas and extensive alternative available habitat, especially as a species which has an offshore distribution as well as coastal. Therefore any reduction in potential foraging time is unlikely to have a perceptible effect upon an individual. The effect magnitude is therefore considered to be **negligible** for a **very high** value receptor. Effect significance is thus judged to be **minor adverse**.

White-beaked Dolphin

White-beaked dolphin are not known to use Nigg Bay as an important foraging location. As an offshore species that uses large expanses of the Scottish east coast, there is extensive alternative habitat available to the species. Any reduction in foraging would be for an extremely limited period of time and therefore of no consequence to an individual's energy budget. The effect magnitude is therefore considered to be **negligible** for a **very high** value receptor. Effect significance is thus judged to be **minor adverse**.

Risso's Dolphin

For a wide-ranging and dispersed species, any disturbance by vessel activity will be short lived and infrequent. The effect magnitude is therefore considered to be **negligible** for a **very high** value receptor. Effect significance is thus judged to be **minor adverse**.

Minke Whale

For a wide-ranging and dispersed species, any disturbance by vessel activity will be short lived and infrequent. The effect magnitude is therefore considered to be **negligible** for a **very high** value receptor. Effect significance is thus judged to be **minor adverse**.

Grey Seal

Grey seals are likely to be in transit past the entrance to Nigg Bay, and whilst vessel traffic will intersect grey seal passage routes, any disturbance whilst transiting will be short-lived, before the seal can recommence its transit. Disturbance by vessel activity whilst foraging will be short-lived and infrequent for a wide-ranging and dispersed species. A number of alternative areas of foraging habitat exist between Aberdeen and Stonehaven, which have been recognised as feeding locations for the species. The effect magnitude is therefore considered to be **negligible** for a **very high** value receptor. Effect significance is thus judged to be **minor adverse**.

Harbour Seal

Harbour seals are known to forage within the Dee Estuary and haul-out at the Don. These individuals co-exist with the vessel traffic at Aberdeen Harbour and are not likely to experience a loss in foraging time as a result of the increase in vessel traffic to the north of Aberdeen. Harbour seals from other populations such as the Firth of Tay and Eden Estuary SAC population are not likely to be affected as any disturbance by vessel activity will be short lived and infrequent for a wide-ranging and dispersed species. The effect magnitude is therefore considered to be **negligible** for a **very high** value receptor. Effect significance is thus judged to be **minor adverse**.

In respect of likelihood, the potential pathway for the impact is considered to be **certain** for bottlenose dolphin, harbour porpoise and grey seal due to the confirmed presence of these species within Nigg Bay where vessel activity will occur in higher concentrations. Likelihood is considered to be **near certain** for minke whale, which although not sighted during the site-specific surveys, are known to be present seasonally and are relatively abundant in the areas adjacent to Aberdeen and may interact with areas of higher vessel concentrations, as may harbour seals. This is also the case for white-beaked dolphin, which were sighted during the site-specific surveys, but only on a single occasion with three individuals. Likelihood is considered **unlikely** for Risso's dolphin, which has the potential to occur in the areas of increased vessel traffic based upon their ranges as recognised within the literature, although were not sighted in the site-specific surveys.

There is **medium** certainty associated with this assessment as it is known that marine mammals currently co-exist and forage in areas of very high vessel traffic at Aberdeen Harbour, whilst extensive alternative habitat is available to highly mobile and flexible species, however marine mammal disturbance effects are not well understood.

For all species, the significance of effect and overall EIA significance is considered within Table 15.54.

Table 15.54: Predicted significance of effects from increases in disturbance due to construction vessel movements for local and regional marine mammal species likely to be present

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Harbour porpoise	Negligible	Very High	Minor	Certain	Med-high
Bottlenose dolphin				Certain	Med-high
White-beaked dolphin				Near Certain	Medium
Risso's dolphin				Unlikely	Low
Minke whale				Near Certain	Medium
Grey seal				Certain	Med-high
Harbour seal				Near Certain	Medium

15.6.3.4 Effects Relating to Accidental Release of Pollutants

Interaction of pollutants with marine mammals due to accidental spills

Potentially toxic and harmful substances to marine mammals may be released into the surrounding environments of the proposed development if an accidental spill or release of a toxic substance, such as diesel, oil, cement or sewage was to occur from construction vessels. Marine mammals would be expected to have varying levels of sensitivity to various pollutants, whilst the hydrodynamics of the receiving water body and dispersion and decay characteristics of the pollutant would also contribute in determining the effect magnitude. If the pollutant was an irritant, marine mammal species would avoid adversely affected areas altogether and would move back once conditions improve.

For all species, the magnitude of the effect on marine mammal receptors would depend upon the quantities and nature of the spillage/release, the dilution and dispersal properties of the receiving waters and the bio-availability of the spilt contaminant. The nature and severity of any spill is essentially unquantifiable and so could be up to **major** significance as a spill would have the potential to affect areas regionally, with a change to the behaviour and health of individuals beyond the study area over the long-term or permanently.

Likelihood of a spill occurring is considered to be extremely unlikely, and risk is **low-medium**.

However, development of, and adherence to, an Environmental Monitoring and Management Plan (EMMP) including pollution prevention and contingency plans, would significantly reduce the likelihood of this impact ever occurring by controlling the storage and handling of potential pollutants and imposing contingency, thereby reducing or eliminating the risk of such an event occurring. Therefore, effect significance would be **negligible** for all species.

With an EMMP likelihood of a spill occurring would be considered extremely unlikely, and risk would be **low**.

Certainty is **high**. This reflects confidence that a spill could result in effects of major significance, whilst EMMPs or similar are proven to be highly effective mitigation measures for reducing risk of potential impacts occurring.

15.6.3.5 Effects Relating to Changes in Prey Resource

Effects relating to a change in prey resource have been assessed for the duration of the development in its entirety i.e. for both construction and operation in section 15.6.4.5.

15.6.4 Operation and Maintenance

The following presents the assessments of potential effects that have been identified for the operation and maintenance phase of the development and as outlined in Table 15.10.

15.6.4.1 Effects Relating to Changes in Habitat as a Result of Physical Structures

Reduction in Extent of Foraging Habitat

There will be a permanent net loss of 140,985 m^2 of subtidal habitat from the existing 563,869.34 m^2 of subtidal habitat within the marine development boundary. The presence of the physical structures will occupy the entire water column, therefore also reducing the pelagic habitat.

Whilst the loss of seabed habitat and pelagic habitat in the water column will be highly localised to within the development boundary, there will be a loss of habitat for marine mammal species which use the waters within the development boundary. Individuals will be permanently displaced from these areas within the bay to non-affected areas in adjacent waters or within the remaining areas inside the harbour once constructed, although the area within the harbour would not be expected to constitute foraging habitat during operation.

The effect of a net loss of seabed and pelagic habitat will be permanent, lasting for the duration of the development but will be highly localised to within the development boundary. The species which will be most sensitive to the impact will therefore be those known to use the waters of the development boundary.

Bottlenose Dolphin

Bottlenose dolphin are known to forage and feed within the development boundary. It is not clear how important Nigg Bay is to the species in comparison to other areas of the east coast for prey consumption, especially as the dolphin's presence in the area is most likely related to the foraging opportunities in Aberdeen Harbour where Atlantic salmon (*Salmo salar*) enter the River Dee. Although bottlenose dolphins will be displaced, it is apparent from various and extensive survey studies (e.g. Quick et al., 2014) that the bottlenose dolphins of the east coast are frequently using the full coastline, with high usage of the waters between Aberdeen and Montrose, and aggregations of sightings around various areas including north of Aberdeen Harbour, Portlethen and Stonehaven. The consequences of a loss of pelagic and benthic habitat is therefore considered to be negligible within the context of the extensive alternative habitat in the waters adjacent to Nigg Bay and the wider Scottish east coast. Due to the permanence of the effect and the loss of localised foraging habitat in an area which is considered as regionally important for dolphin activity (Appendix 15-A: Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay (Clarkin and McMullan, 2015)), effect magnitude is considered to be **minor**. As a receptor of **very high** value, effect significance is considered to be **moderate adverse**.

Harbour Porpoise

Harbour porpoise will likely forage in the area, however Nigg Bay is not recognised as critical foraging habitat for harbour porpoise. The species has been reported to be widely distributed in the East Grampian region with no particular area of concentration (Anderwald and Evens, 2010); however previous studies have found the highest numbers of sightings per unit of effort to be in the waters between Aberdeen and Stonehaven to the south, with larger numbers of sightings around Cove and Girdleness (Weir et al., 2007). This may be indicative of the feeding opportunities associated with the presence of the salmon that use the Dee, whilst they will likely feed largely on sandeels in the area as the species is known to do throughout Scottish waters (Clarkin and McMullan, 2015).

The waters between Stonehaven to St Cyrus were found to have the next highest numbers of sightings, with lesser numbers of sightings to the north of Aberdeen before Collieston (Weir et al., 2007). Aberdeen Harbour Board (2012) note the local species distribution to be focussed to the east of Aberdeen Harbour entrance, around Girdleness and Cove Bay, likely due to displacement by the bottlenose dolphins which may show aggression to harbour porpoises. Due to the wide-ranging dispersion of the species in the region and the North Sea, the individuals and populations are highly unlikely to suffer health and productivity implications from a small shift in their available foraging habitat at Nigg Bay. The species uses offshore waters as well as coastal waters, and is flexible in its movements dependent on the location of its prey. The species appears to show avoidance of the waters around Aberdeen and Nigg Bay due to the bottlenose dolphin presence during certain periods, and will forage elsewhere during these periods, typically further offshore from Aberdeen or to the south, again showing flexibility.

Although a highly-mobile and flexible species with extensive alternative habitat available, due to the higher number of sightings in the areas around Girdleness, the year-round presence of the species in Nigg Bay as evident from the site-specific surveys and the permanent loss of foraging habitat, the effect magnitude is considered to be **minor** for a **very high** value receptor, effect significance is thus judged to be **moderate adverse**.

White-beaked Dolphin

White-beaked dolphin are highly seasonal and are typically a species associated with deeper waters. Only three individuals were sighted during the site specific surveys within the bay, and the dolphins have extensive alternative habitat available. The species may occur in higher numbers in other years and the species has been sighted throughout the east coast waters, with highest numbers of sightings around Aberdeen and along the stretch of coast to areas south of Stonehaven. The species is widely dispersed so that a loss of potential foraging habitat that is only used infrequently and seasonally by the species, is likely to be of negligible consequence to white-beaked dolphin. The effect magnitude is therefore considered to be **negligible** for a **very high** value receptor. Effect significance is thus judged to be **minor adverse**.

Grey Seals

The areas between Aberdeen and Stonehaven are recognised as feeding areas for grey seal, and seals have been observed foraging and eating fish at the sea surface in these areas (Genesis, 2012). Sandeel habitat exists along large stretches of the east coast of Scotland, including to the east of Nigg Bay, and the areas around Nigg Bay are therefore likely to be potential foraging habitat. Telemetry data has shown how grey seals from distant populations tend to transit past Nigg Bay, rather than spending prolonged periods of time within the area which suggests that Nigg Bay is not likely to be a preferred area of foraging habitat for these individuals. However local populations of grey seals haul-out around the Don and Dee, and individuals from these haul-outs may use Nigg Bay for when foraging locally.

With reported foraging ranges of up to 145 km (Thompson et al., 1996), the species is recognised as being highly adaptable with the ability to forage over long distances for durations between 1 and 30 days (SCOS, 2012). The species will typically forage within 100 km from a haul-out site, although they can feed up to several hundred km offshore (SCOS, 2012). Individuals associated with a specific haul-out site will typically return to their haul-out after foraging at the same areas offshore, however on occasions individuals may decide to move to a new haul-out location and forage within a different region (SCOS, 2012).

Due to the wide-ranging foraging capability of the species, the high mobility of grey seals, and the negligible proportion of the available foraging habitat that will be lost in comparison to the wide areas of coastal and offshore foraging habitat available along the Scottish east coast, effect magnitude is therefore considered to be **negligible** for a **very high** value receptor. Effect significance is thus judged to be **minor adverse**.

Other species were absent during the site specific surveys and clearly do not rely on the waters within the development boundary or indeed frequent them in any regularity (i.e. Risso's dolphin, minke whale and harbour seal). Therefore any impact pathway would be tenuous and the effect magnitude is therefore considered to be **negligible** for **very high** value receptors. Effect significance is thus judged to be **minor adverse**.

The likelihood of this effect occurring is considered to be **certain** for those species which regularly use Nigg Bay as foraging habitat (i.e. bottlenose dolphin, harbour porpoise and grey seal), as this habitat will be lost in an area where the species is known to be present in the area year-round. The likelihood of this effect occurring is considered to be **near certain** for white-beaked dolphin as they will only use the habitat seasonally and on few occasions. Likelihood is considered to be **unlikely** for Risso's dolphin, minke whale and harbour seal, as potential foraging habitat will be lost in waters where these species are generally not known to occur, but do lie within their theoretical ranges.

There is high certainty over the area of habitat to be lost. This high certainty also applies to the lower likelihood of certain species to use the area as foraging habitat. For the species that are known to forage in the area year-round and will lose a localised proportion of foraging habitat, there is low certainty as complex interrelationships will govern potential consequences for the health of individuals e.g. the quality of the alternative habitat, the energetic consequences of increased foraging effort, whether prey resource is sufficient at alternative locations for sustainable exploitation by increasing numbers of marine mammal predators, and the implications of these factors for breeding and biological considerations at the population-level. Overall certainty is thus judged to be **medium**. For all species, the significance of effect and overall EIA significance is considered within Table 15.55.

Table 15.55: Predicted significance of effects from reduction in extent of foraging habitat for local and regional marine mammal species likely to be present

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Harbour porpoise	Minor	Very High	Moderate	Certain	High
Bottlenose dolphin	Minor		Moderate	Certain	High
White-beaked dolphin	Negligible		Minor	Near Certain	Medium
Risso's dolphin	Negligible		Minor	Unlikely	Low
Minke whale	Negligible		Minor	Unlikely	Low
Grey seal	Negligible		Minor	Certain	Med-high
Harbour seal	Negligible		Minor	Unlikely	Low

15.6.4.2 Effects Relating to Increased SSCs

Temporary Increases in Suspended Sediment Concentrations (SSCs) Due to Maintenance Dredging within Nigg Bay

Planned maintenance dredging for Nigg Bay will be undertaken to maintain minimum design depths (9 m and 10.5 m below CD). It is anticicpated that the dredge volumes required will be significantly smaller than for the ongoing maintenance dredging at the mouth of the River Dee. Therefore, whilst the activity is likely to increase SSCs and introduce noise into the environment, it is considered that magnitude of effects upon marine mammals from maintenance dredging will be less than those outlined for the capital dredge construction, which was assessed as **negligible** for all species. This is because maintenance dredging will be undertaken on a smaller scale and will occur over a shorter timeframe than that outlined for construction. However, maintenance dredging activities will occur on an intermittent basis throughout the operational life of the project resulting in minor periodic disturbances.

All Species

Marine mammals are expected to be tolerant to the increases in SSCs which will be within those of natural variation. As highly mobile species, marine mammals will be able to temporarily move away from the areas of higher SSCs and will be able to return quickly once the disturbance has ceased. No implications for the health of individuals are anticipated and all species are expected to be highly resilient to the temporary and short-term effects which will occur over a highly localised area on an intermittent basis. The effect magnitude is therefore considered to be **negligible** for **very high** value receptors. Significance of effect is thus considered to be **minor adverse**.

For those species which use Nigg Bay and may be present in and around the harbour where SSCs will be elevated i.e. bottlenose dolphin, harbour porpoise and grey seal, the likelihood of the effect occurring is **certain**. For white-beaked dolphin it is considered **probable**, due to the seasonality of the species, the very few numbers recorded in the site-specific surveys and its preference for waters further offshore. The likelihood is considered **unlikely** for minke whale, Risso's dolphin and harbour seal as they species were not observed within the site-specific surveys and not known to use Nigg Bay.

For all species, the significance of effect and overall EIA significance is considered within Table 15.56.

Table 15.56: Predicted significance of effects from temporary increases in suspended sediment concentrations (SSCs) due to maintenance dredging for local and regional marine mammal species likely to be present

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Harbour porpoise	Negligible	Very high	Minor	Certain	Med-high
Bottlenose dolphin				Certain	Med-high
White-beaked dolphin				Probable	Low-med
Risso's dolphin				Unlikely	Low
Minke whale				Unlikely	Low
Grey seal				Certain	Med-high
Harbour seal				Unlikely	Low

Temporary Increases in Suspended Sediment Concentrations (SSCs) Due to Disposal of Sediments at a Licensed Site

Material from maintenance dredging will be disposed on a regular basis during the operational phase of the Development. It is anticicpated that the dredge volumes required will be significantly smaller than for the ongoing maintenance dredging at the mouth of the River Dee. Therefore, whilst the activity is likely to increase SSCs and introduce noise into the environment, it is considered that magnitude of effects upon marine mammals from maintenance dredging will be less than those outlined for the capital dredge construction, which was assessed as **negligible** for all species.

For all species, the impact will be short-term, localised and intermittent, and will be limited to infrequent periods thereafter. Marine mammal receptors are considered to be resilient and adaptable to the effect as they are able to move away from any temporary adverse areas. The magnitude of the effect is therefore considered to be **negligible** for **very high** value receptors. Significance of effect is thus considered to be **minor adverse**.

The likelihood of species being subjected to the impact is considered to be **unlikely** due to the species having the potential to be in the localised area of the impact, but highly unlikely during the duration of the impact as the area is not of particular importance to any of the species, whilst all species are likely to be dispersed widely in offshore areas.

For all species, the significance of effect and overall EIA significance is considered within Table 15.57.

Table 15.57: Predicted significance of effects from temporary increases in suspended sediment concentrations (SSCs) due to disposal of sediments from maintenance dredging for local and regional marine mammal species likely to be present

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
All Species	Negligible	Very High	Minor	Unlikely	Low

15.6.4.3 Effects Relating to Increased Vessel Activity

Mortality or Physical Injury Due to Collisions with Vessels

The potential impacts are considered to be as per construction, although there will be an increase in vessel movements due to new vessel traffic comprising approximately 550 commercial vessels; 1,700 Platform Supply Vessel (PSV)/Offshore vessels; 40 Diving Support Vessel (DSV) and 33 cruise ships. The impact will be permanent and intermittent, and will occur throughout the operation of the Development.

All vessels will have to adhere to the existing Aberdeen Harbour Dolphin Code. This is mitigation adopted as part of the project, and will help to mitigate against any potential collision effects. The code of practice outlines requirements of vessel operators to consider the presence of dolphins within areas of the harbour. Measures such as maintaining a steady course and slow speeds, avoiding direct approaches to the individuals, and ensuring that groups of vessels use single-file formation to avoid herding of dolphins.

All Species

For all species, the impact is long-term, intermittent and occurs at the local scale where the increased vessel presence will be concentrated, whilst vessel traffic will disperse along new and existing vessel routes once in offshore waters, moving into areas within the wider study area. Whilst there is the potential for individuals to be subjected to effects e.g. injury or mortality, the great majority of marine mammal individuals would be expected to react to the perceived threat and to show short-term avoidance responses. However, due to potential masking effects, there is a very low possibility that collisions could occur between an individual and a vessel. During operation vessel speeds will be relatively low within the approaches to the harbour and within the harbour itself for navigational safety purposes and due to adherence to the Aberdeen Harbour Dolphin Code. Therefore the vessel characteristics and behaviour which pose the greatest threat to marine mammals based upon the available literature, i.e. larger vessels of at least 80 m travelling at 14 knots or faster (Laist et al., 2001), will not be representative of the vessel traffic in the areas of higher vessel concentrations where collisions with marine mammals would be most likely to occur. Furthermore, it is assumed that the largest vessels will not be entering the harbour under their own power alone, and will be guided by tug boats at slow speeds. This is in addition to the records of marine mammal individuals co-existing with very high vessel traffic in Aberdeen Harbour and showing evidence of a large degree of habituation and adaptive behavioural responses to vessel transits.

Despite the extremely low risk of collision mortality and the lack of evidence suggesting that mortalities will occur, due to the permanence of the impact the magnitude of effect is considered to be minor. However, is must be considered that the chance of the effect occurring is extremely low, and that these are the same individuals that are using Aberdeen Harbour without consequence. In the absence of evidence that vessel collisions are a cause for concern in close proximity to Aberdeen Harbour, there is no reason to assume that individuals in proximity to Nigg Bay will be any less able to respond to the potential threat than when at Aberdeen Harbour. Mitigation has been adopted as part of the project through the Aberdeen Harbour Dolphin Code. Based on the use of professional judgement, the magnitude of effect has been assessed as **negligible** on **very high** value receptors. Significance of effect is thus considered to be **minor adverse**.

In respect of likelihood, the potential for an effect to occur is **unlikely**, regardless of species distribution as previously discussed, and this has therefore been considered within the assessment of risk. However, in respect of the species presence in the area where a potential pathway for the impact exists, likelihood is considered to be **certain** for bottlenose dolphin, harbour porpoise, white-beaked dolphin and grey seal due to the confirmed presence of these species within Nigg Bay where ship-transits will take place in higher concentrations. Likelihood is considered to be **near certain** for harbour seal, as they are present around the Dee and may move offshore past Girdleness where vessels will be passing, and minke whale, which although not sighted during the site-specific surveys, they are known to be present seasonally and relatively abundant in the areas adjacent to Aberdeen and may interact with areas of higher vessel concentrations. Likelihood is considered **unlikely** for Risso's dolphin, which has the potential to occur in the areas of increased vessel traffic based upon their ranges as recognised within the literature, although were not sighted in the site-specific surveys.

The certainty associated within this assessment is **medium** due to the availability of literature which documents how numerous natural threats are significantly greater than that of vessel collision, whilst literature has also demonstrated how marine mammals make short-term avoidance reactions to reduce the threat. This is in addition to reports of the marine mammals in Aberdeen Harbour co-existing with a significant level of vessel traffic in a busy harbour. However, uncertainty exists over masking effects, whilst instances of collisions may be underreported and it is still not well understood how much of a threat collision poses to coastal marine mammal species.

For all species, the significance of effect and overall EIA significance is considered within Table 15.58.

Table 15.58: Predicted significance of effects from increases in risk of mortality or physical injury due to collisions with operational vessels for local and regional marine mammal species likely to be present (all traffic)

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Harbour porpoise	Negligible	Very High	Minor	Unlikely	Low
Bottlenose dolphin				Unlikely	Low
White-beaked dolphin				Unlikely	Low
Risso's dolphin				Unlikely	Low
Minke whale				Unlikely	Low
Grey seal				Unlikely	Low
Harbour seal				Unlikely	Low

Disturbance Due to Vessel Movements and Vessel Noise

During operation, the nature of the potential impact will differ to construction in the respect that the potential impact will occur over a long time-frame for the duration of the operation and maintenance of the development. There will be an increase from the baseline (see Chapter 21: Shipping and Navigation) in vessel movements due to new vessel traffic comprising approximately 550 commercial vessels; 1,700 platform supply vessel (PSV)/offshore vessels; 40 diving support vessel (DSV) and 33 cruise ships annually during the operation and maintenance period. Vessel noise, vessel presence and vessel behaviour have the ability to combine in a complex manner to cause disturbance to marine mammal species, and it has been established that it is not noise emissions alone which cause disturbance (Pirrotta et al., 2015).

All vessels will have to adhere to the existing Aberdeen Harbour Dolphin Code. This is mitigation adopted as part of the project, and will help to mitigate against any potential disturbance effects. The code of practice outlines requirements of vessel operators to consider the presence of dolphins within areas of the harbour. Measures to avoidance disturbance are included within the code of practice. This includes measures such as maintaining a steady course and slow speeds, avoiding direct approaches to dolphin individuals, controlling vessel engines and ensuring that groups of vessels use single-file formation to avoid herding of dolphins. These combined measures will likely reduce the perception of vessels as a threat and reduce the potential for disturbance.

Whilst interruptions to foraging are considered to be the same or less than during construction, due to the longer temporal scale at which the impact will occur, consideration must also be given to the persistence of chronic physiological effects on receptors over much longer timeframes (Wright et al., 2007). Marine mammals are likely to exhibit short term avoidance responses to vessel movements such as the cessation of foraging, short term movements and increasing dive duration. In isolation, these avoidance responses may not result in any significant increases in energy expenditure or physiological stress, however persistent and accumulated disturbance and avoidance may result in long-term avoidance (displacement) due to an individual determining that the cost of remaining in the disturbed habitat was greater than the cost of moving into new habitat. Where no alternative habitat is available, this could have potential population effects (Wright et al., 2007).

Cetaceans show highly variable behavioural responses to boat and ship movements. This can range from an attraction to the vessels and social activities such as bow-riding on the ship's wake, no response to the vessel, to short-term behavioural changes such as avoidance or long-term displacement (Senior et al., 2008). It has also been suggested that the behaviour of the vessel influences the perception of risk by cetaceans, with vessels that move predictably along a set route being considered as less disruptive than a vessel which is actively pursuing an individual such as a tourist cetacean-watching boat (Pirotta et al., 2015). Tourism vessels have been shown to have negative effects on female reproductive success in some bottlenose dolphins, whilst also being attributed as a potential cause of displacement to adjacent areas of lesser vessel traffic (Bedjer et al., 2006).

Weir and Stockin (2001) observed the behaviour of bottlenose dolphins in response to vessel movements in Aberdeen Harbour and noted a range of responses. Dolphins were often recorded in very close proximity to large cargo vessels, passenger ferries and small fishing trawlers. Dolphins would make short movements out of the channel, before returning to re-commence feeding. Sometimes they took longer to return to activities and locations. In contrast to avoidance movements, on occasions bottlenose dolphins were observed bow-riding vessels into the harbour, including large passenger ferries. This strongly indicates that these individuals are able to co-exist with the high vessel traffic, and to respond to vessel disturbance in an adaptive manner without significant stress.

In respect of vessel noise alone, the forecast increase in vessel traffic and associated noise is unlikely to significantly affect marine mammal behaviour given the current levels of shipping activity within the locale. Background noise levels in Aberdeen (and within the river Dee itself) have been reported to be high, mainly from shipping, in the region of 118 to 149 dB re 1µPa mms over a wide frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Vessel traffic occurs seven days a week at the mouth of the harbour where the highest intensity of foraging by harbour porpoise and bottlenose dolphins currently occurs, and the same individuals are highly likely to be the same individuals that may be present within the vicinity of Nigg Bay.

Increases in vessel movements associated with the development are likely to cause some level of disturbance to individuals within the area. These interruptions will be limited to periods of vessel movement and therefore intermittent, short-term and limited in spatial extent. The impact is only considered for areas where the increased vessel movements will be concentrated i.e. the development and surrounding waters before the various vessels disperse along numerous shipping routes where impacts would be expected to be far less. It is not clear if habituation/acclimation (i.e. an individual has ceased to respond with physiological stress to a particular stimulus) has occurred in respect of the marine mammal species which co-exist with the high levels of traffic around Aberdeen Harbour. Evidently the River Dee and the abundance of salmon there provides foraging habitat for some species, and therefore it may be that stresses caused by vessel disturbance are tolerated due to the habitat and prey quality. Alternatively, habituation may have occurred to a large degree, with a limited stress response and the ability for the individuals to forage efficiently and maintain their life-cycle activities. Whilst it is not possible to establish this currently, observations of marine mammal co-existence with the vessels within Aberdeen Harbour strongly indicate that marine mammals are able to negotiate vessel traffic in an adaptive manner to maintain their foraging activities.

All Species

For any individuals present within Nigg Bay, there will be a frequent and intermittent disturbance effect to those individuals that may use the area more regularly, limited to the period whereby the vessel passes the point at which an individual is present. The bottlenose dolphins using the waters in the vicinity of Nigg Bay are likely to be the same individuals that use Aberdeen Harbour frequently. Based on observations of bottlenose dolphins at Aberdeen Harbour and the available literature (e.g. Weir and Stockin, 2001), the bottlenose dolphins are known to co-exist with high vessel traffic in an extremely busy harbour environment. These dolphins have been observed to continue partaking in playful activity, do nothing, or to move out of the area temporarily during large vessel transits. Therefore, these dolphins do appear to show evidence of habituation to some extent to vessel traffic. Dolphins present in the vicinity of Nigg Bay are similarly unlikely to show significant avoidance or displacement, and it is considered likey that they will respond to vessel traffic in an adaptive manner as they do currently within Aberdeen Harbour. Similarly, harbour porpoise and grey seal are present year-round in the Aberdeen Harbour area and co-exist with the high vessel traffic. Therefore these species are also unlikely to avoid the area due to a level of existing habituation.

If foraging within the Nigg Bay area, the reduction in foraging time caused by repeated vessel transits is not considered to be sufficient to cause a significant reduction in an individual’s energy intake, due to the short-term nature of each vessel transit. Individuals have been shown to recommence foraging as a boat moves away following a disturbance event (Pirotta et al., 2015). It is also important to consider that vessels will be moving along a predicable pre-defined route as specified within a Vessel Routing Plan and mostly at slow speeds due to the implementation of a Vessel Management Plan. This will likely reduce the perception of vessels as a threat. Whilst subtle changes in the activity budget have the potential to translate into reduced energy intake (Pirotta et al., 2015), there is extensive foraging habitat available in adjacent waters away from the routes used by vessels, and if an individual was to suffer from a reduction in energy intake due to a reduction in foraging time, although unlikely, they could make the trade-off decision to move into an area of adjacent foraging habitat.

The impact is permanent, frequent, intermittent and short-lived, and occurs predominantly at the local scale. Once vessel traffic has left the harbour and dispersed along various shipping routes, the potential impact is not considered. The potential impact within the areas of greater concentration is not anticipated to affect individuals or populations due to the abundance of foraging habitat along the east coast of Scotland, however individuals may be interrupted when foraging within the areas around Nigg Bay. The magnitude of effect is considered to be **negligible** for **very high** value receptors. Significance of effect is thus considered to be **minor adverse**.

The effect is considered **certain** for bottlenose dolphin, harbour porpoise and grey seal as these species have been proven to use the area within Nigg Bay year-round. For white-beaked dolphin and minke whale, the impact is considered to be **near certain** as these species are seasonal visitors to the area, and are not likely to occur in numbers within the most concentrated areas of vessel traffic, and will more likely be present in the areas outside of Nigg Bay where vessels will disperse along various vessel routes. For Risso's dolphin and harbour seal, the impact is considered **unlikely** to occur, as these species are not known to commonly use the areas where vessel traffic will be concentrated and were not seen in the site-specific surveys.

There is **medium** certainty with this assessment as vessel traffic has been provided and the distribution of species is well understood and underpinned by site-specific surveys. However, as acknowledged within the literature, marine mammal disturbance effects are not well understood.

For all species, the significance of effect and overall EIA significance is considered within Table 15.59.

Table 15.59: Predicted significance of effects from increases in disturbance due to operational vessel movements for local and regional marine mammal species likely to be present

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Harbour porpoise	Negligible	Very High	Minor	Certain	Med-high
Bottlenose dolphin				Certain	Med-high
White-beaked dolphin				Near Certain	Medium
Risso's dolphin				Unlikely	Low
Minke whale				Near Certain	Medium
Grey seal				Certain	Med-high
Harbour seal				Unlikely	Low

15.6.4.4 Effects Relating to Changes in Water Quality as a Result of Pollutants

Interaction of Marine Mammals with Pollutants and Displacement

Numerical modelling (Appendix 7-B: Water Quality Modelling Assessment) forecasts a reduction in water quality within the harbour during the operational phase of the scheme. Water quality will reduce gradually due to the retentive properties and reduced flushing capacity of the harbour compared to baseline conditions in Nigg Bay and to the continued presence of wastewater discharges into the bay. Since there will be some water exchange between the harbour and wider receiving marine environment via tidal movements through the harbour entrance, the concentrations of the chemical constituents of the wastewater discharges will eventually achieve an equilibrium (or near equilibrium) status over time and a continuous deterioration in water quality inside the harbour is unlikely to occur throughout its operational phase. The gradual build-up of pollutants to a semi-equilibrium state within the harbour suggests that there will not be any sudden acute toxic affect resulting in any large scale mortalities. Instead, conditions are expected to gradually deteriorate.

Due to cetaceans and pinnipeds having a position of high trophic level, marine mammal species are particularly susceptible to marine pollution and bioaccumulation i.e. contaminants that cannot be metabolised or excreted and accumulate within marine mammal individuals. Due to marine mammals species being top-level predators that live for long periods of time, as they consume prey that are also bioaccumulating species, contaminants can build up within individuals. The consumption of prey is the dominant form of uptake of contaminants by marine mammals (Das et al., 2003). Heavy metals are a particular type of contaminant where bioaccumulation can occur, with particular trace elements of note that can be harmful being chromium, cadmium and mercury. Little is known about the effects of heavy metals on marine mammal physiology, however immunosuppression has been suggested based on the immunotoxic effects of heavy metals on a variety of other species (Das et al., 2003). Direct cause and effect relationships between specific contaminants and population declines have not been established, whilst synergistic effects between various contaminants have been attributed as a possible causes of increased susceptibility of individuals to biotoxins and disease. Studies have shown very high concentrations of heavy metals within marine mammals, with this remarkable tolerance being considered in the context of detoxification processes, which may have its own costs for an individual (Das et al., 2003).

Effects on marine mammals in respect of either exposure or bioaccumulation of pollutants is difficult to predict in the absence of threshold values for adverse effects on marine mammal species and the complexity of synergistic effects between various pollutants. What can be established is that any effects will likely relate to changes to the prey resource for marine mammal species and the extent to which they are affected. Exposure of marine mammals to contaminants in the water column are not likely to cause any instantaneous detrimental effects to individuals, as individuals will only be present within the confines of the new harbour for short intermittent periods, if present at all. If environmental conditions are not favourable to an individual, it will be able to move away from the area into the unaffected areas surrounding the harbour. Due to the removal of benthic habitat during construction and operation within the harbour (see Chapter 12, Benthic Ecology and Chapter 13, Fish and Shellfish Ecology), it is highly unlikely that the harbour will represent foraging habitat for marine mammals and they are likely to use areas outside of the harbour breakwaters.

As described in Chapter 13: Fish and Shellfish Ecology, in addition to contaminants levels, the modelling also predicts a decrease in dissolved oxygen (DO) concentrations. As air-breathing species, marine mammals are only likely to be affected through a secondary effect in that prey species may suffer as a consequence of depleted DO levels. Minimum predicted concentrations are forecast to be as low as 0 mg/l at some locations within the operational harbour although levels of 2.69 mg/l are forecast in the southern part of the bay. It should be noted that the water quality modelling was undertaken on a highly conservative basis and assumed that some of the wastewater discharges into the operational harbour comprised a DO concentration of 0 mg/l. Therefore, prey items for marine mammals are unlikely to be present within the harbour during operation. Marine mammals may change their distribution as a result of low DO displacing their prey into other areas (Craig et al., 2001). Therefore it is considered unlikely that marine mammals will experience changes in water quality, as they are likely to forage elsewhere outside of the harbour. In respect of the consequences of a shift in prey distribution, this potential effect is assessed in Section 15.6.4.5.

<u>All Species</u>

The impact of changes in water quality will be permanent, lasting for the duration of the development but will be highly localised to within the development boundary. Individuals are unlikely to interact with the affected areas within the harbour due to the likely low prey availability; however should marine mammals enter the harbour, this will be on a temporary, short-term and intermittent basis and instantaneous effects would not be expected. The effect magnitude is therefore considered to be **negligible** on **very high** value receptors. Effect significance is thus considered to be **minor adverse**.

The likelihood of the respective species having the potential to interact with the affected areas by water quality changes is considered to be **certain** for bottlenose dolphin, harbour porpoise and grey seal (i.e. the species which use the development boundary). This is considered precautionary as it is considered unlikely that marine mammals will use the harbour in the absence of foraging habitat. Likelihood is considered **near certain** for white-beaked dolphin and minke whale which are known to occur seasonally and regionally in waters off Aberdeen. Again, this is considered precautionary as these seasonal species will be in the region following prey and are therefore unlikely to enter an area where prey are not likely to be present. Likelihood is considered **unlikely** for Risso's dolphin and harbour seal.

There is **low** certainty associated with the assessment due to the lack of understanding of how marine pollutant concentrations affect marine mammal species and the extent to which marine mammals are likely to use the waters within the harbour during construction. However, the spatial extents of the effect are known from modelling and there is therefore confidence that the effect will be highly localised.

Table 15.60: Predicted significance of effects from changes to water quality as a result of pollutants

Species	Effect Magnitude	Value	Significance of Effect	Likelihood	Risk
Harbour porpoise	Negligible	Very High	Minor	Certain	Med-High
Bottlenose dolphin				Certain	Med-High
White-beaked dolphin				Near Certain	Medium
Risso's dolphin				Unlikely	Low
Minke whale				Near Certain	Medium
Grey seal				Certain	Med-High
Harbour seal				Unlikely	Low

15.6.4.5 Effects Relating to Changes in Prey Resource

Changes to Prey Availability

Construction impacts have the potential to cause localised reductions in the abundance of fish prey items (see Chapter 13: Fish and Shellfish Ecology). The use of percussive piling, increase in SSCs due to construction related seabed disturbances and effects on water quality are predicted to cause fish and shellfish to temporarily avoid the development site area for the period of disturbance. Longer term impacts covering one or more fish spawning seasons may also have negative consequences for fish eggs and larvae leading to poor recruitment and weak cohorts during subsequent years. The longer term or permanent change in benthic and pelagic habitat within the development site may lead to a change in the fish assemblages occupying the harbour post construction. This might include a reduced abundance of permanent and seasonal fish residents including juvenile gadoids and flatfish which use the embayment as nursery ground.

Sandeel and herring will congregate over local grounds for spawning, for example, and any behavioural changes due to piling may result in avoidance of local areas resulting in a localised reduction in feeding for marine mammals and seabirds.

However, given the predicted spatial extents of adverse noise and sediment effects and the wider availability of spawning grounds within the wider region, no significant deleterious effects on sandeel breeding and stock size are forecast. Any negative consequences on marine mammal feeding are therefore considered to be negligible. As hearing specialists, herring will be affected by piling noise over a marginally greater distance. Again, the wider availability of herring spawning habitat available within the region suggests any temporary avoidance of affected areas will have negligible effects on herring stocks.

As a worst case, piling will cause a temporary delay in the migration of adult Atlantic salmon, for the duration of the piling activity. Salmon are expected to continue their migration during interim periods between piling events, i.e. due to vessel repositioning, subject to frequency of the noise disturbance. Effects on salmon smolt emerging from the River Dee are unclear at present but may include similar barrier effects and delays to emergence into the marine environment during peak migration. Smolts may also be excluded from the local coastal areas for feeding in areas of adverse underwater noise and may therefore be displaced to other areas nearby. Given the highly mobile and wide ranging nature of the marine mammals under consideration, then a localised and temporary shift in salmon abundance is considered of negligible significance to marine mammal feeding. The effect will be temporary, lasting for the duration of the piling only after which salmon migration behaviour is predicted to return to the baseline condition.

In conclusion, potential fish prey are expected to temporarily avoid areas of adverse noise and sediment influences arising from the construction but longer term or permanent changes to fish and shellfish assemblages may occur within the operational harbour in response to predicted habitat changes. Significant adverse effects on potential fish prey within the wider region are, however, not expected and marine mammal feeding and breeding condition are not expected to be significantly affected over the wider area. Furthermore, foraging by marine mammals within Nigg Bay is already expected to be comparatively reduced due to the construction and operational related vessel activity, so that any additional adverse consequences on marine mammal feeding here are likely to be negligible. Effect magnitude is thus considered to be **negligible** on **very high** value receptors. Effect significance is thus judged to be **minor adverse**.

This assessment is associated with high certainty as the effects on fish and shellfish prey have been predicted with numerical modelling.

15.7 Mitigation Recommendations and Residual Effects

Effects on marine mammals have, in general, been judged to be negligible or minor adverse based on the localised and temporary nature of the effects and the widespread distribution of marine mammal receptors across the region. However, where significant effects have been identified, it is necessary to identify ways in which mitigation can be applied to reduce the significance of effect.

The final design and implementation of the mitigation measures will be developed and agreed in consultation with the regulators and stakeholders for subsequent incorporation within the Construction Plan and Environmental Management Plan.

15.7.1 Measures Adopted as Part of the Project

An Environmental Management Plan (EMP), incorporating a waste management plan and contingency pollution prevention plan, will be developed to control the storage, movement and treatment of fuel and oil on and around the site, which will reduce the risk of accidental spills to the marine environment and potential harm to marine mammals. An Outline EMP is provided in Chapter 26: Outline Environmental Management Plan.

JNCC guidance (2010b; 2010c) will be adhered to during impact piling activities and also blasting activities, as described in more detail below.

All vessels will have regard to the existing Aberdeen Harbour Dolphin Code. This will help to mitigate against any potential disturbance and collision effects as a result of vessel traffic.

AHB will continue to work with St Andrews University during construction to support long-term monitoring of marine mammal activity in the Aberdeen area (including Nigg Bay). The Marine Mammal Monitoring Programme will be developed in consultation with Marine Scotland and SNH, and the monitoring data will be supplied to Marine Scotland and SNH

15.7.2 Construction Mitigation

15.7.2.1 Piling Noise

The effect of marine piling activity is judged to be of **moderate adverse** significance as a result of predicted adverse noise levels of planned percussive impact piling on very high value receptors. A Marine Mammal Protection Programme (MMPP) will be developed in consultation with the relevant statutory authorities and will include mitigation of piling noise effects on marine mammal species. Potential mitigation measures to ameliorate noise effects from piling include:

- Where practical, vibropiling to be used instead of impact piling;
- Impact piling will be restricted to day-time hours only (Monday to Friday 0700 to 1900; Saturday 0900 to 1600; no impact piling on Sunday).
- Use of Marine Mammal Observers and a 1 km mitigation zone, with PAM during hours of darkness. This will form part of a Marine Mammal Protection Programme (MMPP developed in consultation with the relevant statutory authorities);
- Soft-start procedures over a duration of 30 minutes to displace individuals from areas where injury may occur; and
- Bubble curtains, foam sheeting or mattresses to be investigated to establish their suitability and effectiveness in reducing propagation of underwater noise.

No piling will take place in front of the breakwaters. The use of MMOs, PAM (during hours of darkness) and a 1 km mitigation zone will mitigate against all lethality and permanent injury predicted by the underwater noise modelling and assessed in Section 15.6.3.1. This will likely comprise two land-based MMOs stationed at Girdle Ness and Greg Ness. For pinnipeds, soft-start procedures are required in addition to the mitigation measures outlined above. This is discussed below.

A 30 minute period where no marine mammals are sighted will be required before impact piling can begin. Soft-start procedures will then be employed. This will involve a gradual ramp-up in piling energy, which is intended to ensure that marine mammals have the time to move away from areas before adverse noise reaches the highest levels and causes injury. This is particularly important given that pinnipeds are not fully mitigated against in respect of injury by the use of MMOs or PAM (during hours of darkness) and a 1 km mitigation zone, as the area of potential cumulative PTS is 2490 m. Assuming that no pinnipeds will be within the 1 km mitigation zone, any animal outside of this zone will have to swim a maximum of 1490 m to avoid PTS. Based on an assumed swim speed of an individual of 1.5 m/s (as assumed within Appendix 13-B: Underwater Noise Impact Study (Kongsberg, 2015)), 16.5 minutes of soft-start will be required in order for seals to have time to move out of areas of potential injury, at which point piling will only be at approximately half energy. However, in order to account for a delay by an individual in moving out the area, a minimum of 30 minutes of soft-start ramp us is proposed as a precautionary form of mitigation. JNCC piling guidance proposes that soft-start operations should take place for a minimum of 20 minutes (JNCC, 2010 b). The mitigation proposed here is presumed to be precautionary.

Resonance cages and bubble curtains are recognised as potential mitigation for medium-to-high frequency noise. These are bespoke measures and the design and purpose of the mitigation would need to be discussed with specialist consultants for the technologies to determine their suitability for the specific working environment.. Following consultation, if considered to be feasible and appropriate for purpose, the reduction in noise at medium to high frequencies would therefore mitigate against disturbance effects to the following marine mammals; pinnipeds (pinnipeds have a wide range of hearing, including mid-to-high frequencies), mid-frequency cetaceans (i.e. bottlenose dolphin, white-beaked dolphin and Risso's dolphin) or high frequency cetaceans (harbour porpoise). Minke whales are low-frequency cetaceans and bubble curtains may be of lesser benefit to minke whale receptors, however this would be investigated with specialists during the design discussions. Regardless of this, significant disturbance effects are not considered for minke whale receptors.

Whilst it is not proposed as additional mitigation, construction of the breakwaters prior to piling activity would mitigate against adverse disturbance effects in relation to Level B-Harassment and Low-level Disturbance, whilst also reducing the spatial extents of effect ranges for injury and temporary auditory damage. The structures would act to attenuate the noise, with significant retention of noise within the harbour. However, this may not be possible depending on the construction schedule.

The JNCC piling guidance (JNCC, 2010 b) will be adhered to for impact piling activities to ensure best practice. The MMPP will detail the specific protocols to be employed during the implementation of the mitigation.

Potential effects will be reduced as a result of this mitigation. It should also be noted that the assessment of piling noise, presented in ES Appendix 13-B Underwater Noise Impact Study, is highly precautionary and reflects a worst case scenario of large piles installed over months or years during the construction period. A reduction in the size or number of piles to be installed would reduce the levels of adverse noise entering the marine environment whilst the development of the north and south breakwaters prior to the onset of piling activity may attenuate noise propagation beyond the bay. As such, the final design itself may offer additional in-built mitigation to ensure no significant effects on marine mammal receptors.

Once these mitigation measures are applied, lethality and injury are not predicted to occur, whilst significant behavioural effects are also unlikely to occur given that piling will be an inherently intermittent and temporary activity. The magnitude of effect is considered to be reduced to **negligible** on **very High** value receptors, and the residual significance of effect is therefore considered to be **minor**.

15.7.2.2 Drilling

For all species, effect significance has been determined to be **moderate adverse** due to the potential for injury within small localised areas (20 m for cetaceans and 210 m for pinnipeds). It is proposed that a MMO is deployed for all drilling activities (PAM during hours of darkness), with a 500 m mitigation zone. This will mitigate against lethality and injury to all marine mammal receptors.

There is no JNCC guidance for drilling activities; however as a precautionary measure, the JNCC piling guidance (JNCC, 2010 b) will be adhered to during drilling activities to ensure best practice. The MMPP will detail the specific protocols to be employed during the implementation of the mitigation.

Potential effects will be reduced as a result of this mitigation. The magnitude of effect is considered to be **negligible** on **very high** value receptors and the residual significance of effect is therefore considered to be **minor**.

15.7.2.3 Blasting

For all species, effect significance has been determined to be **major adverse** due to the potential for permanent auditory injury within 400 m from an instantaneous blast, which is significant in EIA terms. It is proposed that a MMO is deployed for all blasting activities (PAM during hours of darkness), with a mitigation zone of 1 km. The mitigation zone will be agreed with the statutory nature conservation bodies in the development of the MMPP.

The JNCC blasting guidance (JNCC, 2010 c) will be adhered to for blasting activities activities to ensure best practice. The MMPP will detail the specific protocols to be employed during the implementation of the mitigation.

Potential effects will be reduced as a result of this mitigation. The magnitude of effect is considered to be **negligible** on **very high** value receptors and the residual significance of effect is therefore considered to be **minor**.

15.7.2.4 Dredging

For all species, effect significance has been determined to be **moderate adverse** due to the potential for permanent auditory injury within localised areas i.e. 82 m for cetaceans and 270 m for pinnipeds. This is based on BH dredging which is predicted to be a worst case when compared with TSHD. In respect of behavioural effects, due to the likelihood that dredging will be more continuous than other noise-producing activities, the disturbance effects are considered to be of greater significance. Until a detailed construction schedule for dredging is available, the level of dredging intensity cannot be established.

It should be recognised that this represents a precautionary worst case scenario, based on conservative modelling. The modelling accounted for a vessel spread of five vessels, which resulted in higher predicted noise levels than may be typically expected for dredging activity. The number of vessels used during dredging operations may be less than this and therefore noise effect ranges would be reduced. The modelling also shows that the location of the dredging, or the type of dredging (i.e. THSD), have the potential to reduce the ranges of effect. For example, for TSHD, the worst case scenario predicts permanent auditory injury within 20 m for cetaceans and 150 m for pinnipeds. This is based on a vessel spread including three vessels. Again, less than three vessels may be used during dredging operations and the effect ranges would be reduced further as a result. Therefore, it is considered that there is a very low potential for injury to occur.

However, in the absence of feasible mitigation residual effects, based on this conservative worst case scenario, are considered to remain as **moderate adverse**.

15.7.2.5 Accidental Release of Pollutants

The effect of an accidental spill would be of **major adverse** significance. However, development of, and adherence to, an EMP, including a contingency pollution prevention plan would significantly reduce the likelihood of this impact ever occurring by controlling the storage and handling of potential pollutants and imposing contingency and thereby reducing or eliminating the risk of such an event occurring. Therefore, for all species the residual effect magnitude would be considered to be **negligible**, on **very high** value receptors, leading to a residual significance of effect of **minor adverse.**

15.7.2.6 Collision with vessels

A Vessel Management Plan (VMP) will be implemented during the construction phase. The VMP will be based upon best practice on reducing marine mammal injury, and will include adherence to the Aberdeen Habrour Dolphin Code. An outline of the measures is provided in Chapter 26: Outline Environmental Management Plan. Effect significance is considered to be **minor adverse.**

15.7.3 Operation and Maintenance Mitigation

15.7.3.1 Accidental Release of Pollutants

Development of an EMP as per the mitigation proposed for construction in section 15.7.2.5 would similarly result in a negligible effect of **minor adverse** significance.

15.7.3.2 Loss of Habitat

The loss of habitat associated with the development would result in an effect of **moderate adverse** significance. Due to the nature of the development, there is no possibility to reduce the loss of available habitat. However, the area that will be lost is considered to be an extremely small proportion of the habitat available to all species. Post-construction monitoring is proposed to be undertaken (as described above), which will monitor marine mammal presence. The monitoring will be used to record bird and marine mammal usage of the bay and the immediate vicinity. A monitoring report will be submitted to the regulatory authorities on its completion.

Effect significance remains to be considered **moderate adverse**.

15.7.3.3 Collision with Vessels

Although effects without mitigation relating to collision risk are considered to be **minor adverse**, AHB will ensure that all vessels follow the Aberdeen Harbour Dolphin Code. Effect significance is considered to remain **minor adverse**.

15.8 Potential Biological Removal (PBR)

Following the previous assessments of a range of effects upon grey seal and harbour seals, it is necessary to consider these effects in the context of potential biological removal (PBR). This can be defined as the number of individual seals that can be removed from a population without causing a decline in the population. The PBR threshold is calculated annually by SMRU for the respective Scottish Management Regions. The provisional regional PBR values for Scottish seals in 2015 have been set at 297 individuals for grey seal and 1 individual for harbour seal for the East Coast Management Unit (MU) (SCOS, 2014; Thompson et al., 2014). This is based upon recovery factors F_R of 1 and 0.1 respectively, reflecting the decline in the harbour seal population within the East Coast MU, and the sustained growth in grey seal populations for all MU, including the East Coast.

No mortality is anticipated to occur as a result of the construction or operation of the development. Mitigation has been proposed to reduce the risk of both mortality and injury for marine mammal species including both grey seal and harbour seal. Harbour seals were not sighted within the site-specific surveys and are therefore not considered to be users of the area whereby the potential for mortality or serious injury exists before the introduction of mitigation. With mitigation, effects on harbour seal would be greatly reduced further.

Therefore, the respective PBR thresholds are not expected to be exceeded for either grey seal or harbour seal.

15.9 Cumulative Effects

15.9.1 Projects and Plans

Cumulative impacts and effects have been identified and assessed where the footprints of receptors associated with current scheme overlap with the impacts that are predicted to arise from other relevant developments listed in Table 15.61. The potential cumulative effects are assessed and discussed below.

Table 15.61: Projects and plans considered within the assessment

Project/Proposed Development	Description	Location	Approximate Distance to Project [km]	Status
Aberdeen Maintenance Dredging	Harbour Maintenance Dredging	Aberdeen	2	Consented, ongoing
European Offshore Wind Deployment Centre	Offshore Wind Demonstrator	Aberdeen	10	Consent approved. Under legal challenge
Kincardine Offshore Wind Farm	Floating Offshore Wind Farm	Aberdeen	12	Application
Peterhead Carbon Capture and Storage Project	Subsea Pipeline	Peterhead	30	Application
Hywind Scotland Pilot Park Offshore Wind Farm	Floating Offshore Wind Demonstrator	Offshore of Peterhead	51	Application
Seagreen Alpha and Bravo Round 3 Wind Farm	Round 3 Offshore Wind Farm	Outer Firth of Forth	64	Consent approved. Under judicial review
Inch Cape Round 3 Wind Farm	Scottish Territorial Waters Offshore Wind Farm	Outer Firth of Forth	65	
Neart na Gaoithe Round 3 Wind Farm	Scottish Territorial Waters Offshore Wind Farm	Outer Firth of Forth	95	
Moray Firth Eastern Development Area 1 and 2 Wind Farm	Round 3 Offshore Wind Farm	Outer Firth of Forth	130	Consent approved
Moray Firth Western Development Area	Round 3 Offshore Wind Farm	Outer Moray Firth	130	Concept
Beatrice Round 3 Offshore Wind Farm (BOWL)	Scottish Territorial Waters Offshore Wind Farm	Outer Moray Firth	135	Consent approved

15.9.2 Cumulative Effects Identified

15.9.2.1 Cumulative Noise

There is the potential for cumulative effects from noise sources during construction overlapping with similar construction activities; namely piling, dredging, drilling, blasting and dredge material disposal and the vessel activity related to these noise sources.

Mortality and physical damage is highly unlikely from cumulative noise effects, as the distances at which these types of effects may occur are relatively small within the scope of the current proposed project and distances will be similarly small for nearby (e.g. Aberdeen) comparable construction activities.

Cumulative effects of underwater noise and displacement have been considered with regard the EOWDC and Kincardine offshore floating wind farm. The offshore wind farm and port construction projects in the Moray Firth and Forth and Tay are over 100 km away and so noise impacts will not spatially overlap. They are nonetheless within the range of receptors such as bottlenose dolphin and grey seal that use the full length of the east coast, whilst other species are wide ranging also.

Aberdeen Offshore Wind Limited (2011) predicts behavioural avoidance of bottlenose dolphin to piling at the EOWDC within a range of 8.5 km. Predictions for other species are within 12 km. Some possible overlap of noise impact ranges with those arising from the current project could therefore occur in the event that these projects are undertaken simultaneously. However, avoidance of the EOWDC will only occur during the piling activities and as such will be limited to a maximum of 24 hours per pile (Aberdeen Offshore Wind Limited, 2011). As eleven foundations are planned at the EOWDC, total avoidance over the entire construction period will occur over a maximum of 11 days. Avoidance behaviour is also expected to be reversible as bottlenose dolphin behaviour will revert to the baseline situation on completion of the installation.

Mitigation will be employed to reduce underwater noise levels. This will reduce the potential for adverse noise levels at the entrance of Aberdeen Harbour and will ensure that this local hotspot for marine mammal feeding will remain accessible throughout the respective construction periods. Background noise levels in Aberdeen (and within the river Dee itself) have been reported to be high, mainly from shipping, in the region of 118-149 dB re 1µPa mms over a frequency bandwidth of 10 Hz to 10 kHz (Evans, Anderwald and Hepworth, 2008). Disturbance effects may therefore fall within background levels. Because of the 11 day duration and reversibility of the predicted avoidance behaviour associated with the EOWDC, together with the mitigation proposed, no significant cumulative effects with the current project at Nigg Bay will occur. This applies to all species.

The introduction of underwater noise from the construction of any of the other projects located within the range could result in the displacement of individuals from preferred habitat cumulatively with their displacement from Nigg Bay. However, with mitigation in place, marine mammals will likely be able to access the preferred feeding habitat at the entrance to Aberdeen Harbour throughout the construction of Nigg Bay as the disturbance levels are likely to be within background levels. Marine mammals are highly mobile and wide ranging. Consequently, no significant cumulative effects are predicted.

Conclusion (underwater noise)

Marine mammals will be displaced from Nigg Bay during the construction as a result of adverse noise from ‘noise-producing’ activities. The value of the bay as a feeding resource during the operational phase will be reduced due to the forecast reduction in the numbers of seasonal and permanent fish and shellfish residents. Nigg Bay is very small in the context of the wide range movement of the marine mammal populations, including bottlenose dolphin that are a mostly coastal species. Other preferred feeding locations including the stretches of water between Stonehaven and Montrose will remain unaffected. With mitigation, or through final contruction design, the preferred feeding location at the entrance to Aberdeen Harbour will also remain unaffected. In conclusion, displacement from Nigg Bay is not forecast to have any significant adverse effect on marine mammal species.

15.9.2.2 Cumulative Increased SSCs

As described in Section 15.6.3.2, capital dredging operations in Nigg Bay will result in a series of localised short-lived episodes of increased SSC restricted to Nigg Bay itself. Peak SSCs from TSHD overspill is not predicted to exceed 100 mg/l to 200 mg/l north of Girdle Ness (see Figure 7.3, Chapter 7: Marine Water and Sediment Quality), and average plumes are not predicted to extend beyond the mouth of Nigg Bay.

The disposal of the dredged material at the licensed disposal site will also result in intermittent short-lived episodes of elevated SSC. However, the spatial extent of maximum and average SSC of plumes caused by TSHD and backhoe dredge material disposal during construction are significantly smaller than for the existing baseline of licensed maintenance dredging for the existing harbour (refer to Figure 7.5 and Figure 7.6, Chapter 7: Marine Water and Sediment Quality).

The characteristics of the disposed sediment and local hydrodynamic regime predicted quick settling times and extremely localised high SSC predicted for coarse sediments for both baseline maintenance dredging and construction dredging individually. This is also the case for modelling cumulative impacts for maintenance and construction dredging combined.

Peak rates were modelled for cumulative TSHD and AHB maintenance disposal, but this is unlikely to have any relevance to real world scenarios as the peak SSCs are extremely short-lived events at the point of release, and two vessels would be unlikely to release at the same time. However, comparisons between the disposal site and nearby data extract points, and comparisons between peak and average SSCs demonstrates the localised and short-lived nature of these events, even when considered cumulatively.

Peak SSC for cumulative TSHD and AHB at the disposal site was 29,169 mg/l, falling more than an order of magnitude to 2,774 mg/l at 708 m to the north, and to 2,363 mg/l at 886 m to the south. Average SSC was more than 35 times lower at the disposal site, at 813 mg/l. Average SSC falls to 101 mg/l at 463 m to the north and to 106 mg/l at 463 m to the south. These cumulative average levels are within natural background variability less than 0.5 km from the disposal site.

Cumulative effects therefore have the potential to occur on marine mammal individuals, as there will be an increase in SSCs if maintenance and construction dredging are considered cumulatively. However, as stated above, two vessels would be unlikely to release at the same time and the peak values are extremely short-lived at the point of release before rapidly decreasing. Peak baseline SSC at the disposal site reaches 19,524 mg/l during annual maintenance dredging at Aberdeen Harbour. Therefore, adverse localised SSCs already occur in the area. Marine mammals are expected to respond to cumulative effects as they would do for the baseline scenario with the existing annual maintenance dredging at Aberdeen Harbour. This will likely comprise avoidance and short-term movements into adjacent waters where the SSCs fall into levels of natural background variability. The areas of the highest SSCs are localised, and represent a negligible proportion of the habitat available to marine mammals. The licensed disposal site is highly unlikely to be of any importance to marine mammals, and therefore effect magnitude is considered negligible and no significant cumulative effects are predicted.

The Kincardine Offshore Wind Farm (KOWF) will comprise floating turbines, therefore any increased SSCs from the construction activities will be limited to installation of the subsea cables. These impacts are anticipated to be very localised and temporary (Atkins, 2014), however, there is the potential for the timing of operations to overlap with dredging operations for Aberdeen Harbour Expansion Project. In addition, one of the two cable routes proposed for the KOWF lands at Nigg Bay. Installation of the turbine foundations and offshore cables at the EOWDC will disturb up to 428,100 m^3 (23,100 m^3 for foundation installation and 405,000 m^3 for cable laying) of sediment during seabed preparation works. Therefore, there is the potential for cumulative effects from these proposals.

No numerical modelling of SSC arising as a result of the proposed works at the KOWF has been undertaken, given that the ES is in preparation at the time of writing. However, modelling was undertaken to assess impacts from the European Offshore Wind Deployment Centre (EOWDC). Results show that localised maximum increases in SSC of 100 mg/l occur as a result of foundation installation works in the wind farm area and the northern side of Girdle Ness. These SSC are however short-lived, and 64 days after installation of all turbines, SSCs return to 4 mg/l to 16 mg/l in the Nigg Bay area and up to 60 mg/l in the northern side of Girdle Ness. SSC as a result of cable installation works reach similar levels of up to 100 mg/l in the EOWDC area, although these are also localised and short term; and SSC in the Nigg Bay area stay within background levels (Vattenfall, 2011). Similar localised increases in SSC can be anticipated from cable laying works for the KOWF given the close proximity of both proposals to Nigg Bay.

In the context of the SSCs predicted to arise from capital dredging in Nigg Bay, the reported increases in SSCs of up to 100 mg/l as a result of the EOWDC are not considered to be significant for marine mammals, whilst no modelling exists for KOWF. As no information is available on construction schedules and when operations would take place in relation to the construction of the Aberdeen Harbour Expansion Project, cumulative effects cannot be predicted or assessed at this stage.

In respect of all plans and projects along the east coast of Scotland, the significance of potential exposures to multiple separate plumes by wide ranging species is considered to be negligible. A cumulative effect in this regard can only occur if the effect of a repeat encounter adds to the effect of the previous one, for instance if a marine mammal fails to forage efficiently and cannot feed repeatedly due to consecutive plumes interrupting them. The likelihood of this occurring is considered highly remote due to marine mammals not being reliant on these specific areas for foraging and would only occur where construction of respective projects are undertaken at the same time and where the plumes interacted in significant concentrations. So far, only the Beatrice wind farm development in the Moray Firth has achieved consent and the necessary finance agreements to proceed to construction along comparable timelines as the proposed Aberdeen Harbour Expansion Project. However, the Beatrice project is located 135 km away suggesting that any significant cumulative effects in this regard would be negligible.

15.9.2.3 Cumulative Vessel Presence

Due to the highly mobile nature of marine mammals, they may also interact with vessels associated with projects which have been considered cumulatively, with interactions increasing cumulatively as more projects occur in the region. However, due to the high existing levels of marine vessel traffic in the region, the increase in vessels associated with the Development are not considered to increase the overall level of regional vessel traffic sufficiently in order for the potential effects upon marine mammals to increase notably in areas distant or close to the Development, when consideration is given to the species' wide-ranging spatial and temporal distributions. In offshore areas, marine mammals will be dispersed and will not be subjected to frequent repeat vessel transits, as they will likely be utilising different areas during different times, dependent on factors such as the movement of their prey resource.

The potential reductions in foraging time when considered cumulatively are not likely to be sufficient to have implications for an individual's condition due to a reduced energy intake, whilst there is sufficient alternative foraging habitat available along the coast should the disturbance cause individuals to forage elsewhere temporarily during busier periods of vessel traffic, such as construction periods for other projects. In respect of collision-related impacts, this is not expected to have the potential to result in cumulative effects on individuals, which would be expected to show short-term avoidance movements as they will do currently. The magnitude of effect is therefore considered to be negligible.

15.9.2.4 <u>Cumulative Habitat Change</u>

The construction of the projects considered cumulatively would result in a cumulative reduction in benthic and pelagic habitat, therefore reducing areas in which marine mammals can use for their life-cycle processes e.g. breeding or foraging. However, the cumulative area of habitat-take is considered to be negligible in relation to the alternative high quality coastal and offshore habitat that characterises the Aberdeenshire and Scottish east coast. Marine mammal populations are inherently highly-mobile and well adapted in order to exploit such wide-ranging resources. The magnitude of effect is therefore considered to be negligible.

15.9.2.5 <u>Cumulative Prey Effects</u>

Cumulative effects on fish and shellfish receptors are not anticipated to occur or result in significant cumulative effects as detailed within Chapter 13, Fish and Shellfish Ecology. Therefore it is considered highly unlikely that a cumulative reduction in the prey resource of marine mammal species will occur. All changes to the prey resource will be limited in their spatial and temporal extents. Although prey within the harbour may be affected permanently, this will be highly localised and wider prey populations will not be affected.

15.10 Summary and Conclusions

The marine mammals known to utilise the Aberdeenshire coastal waters are listed in Table 15.6. A number of the species that are known to occur within the region are rare or infrequent visitors, whilst others are seasonally occurring species or regular and resident species. The most frequent species in close proximity to Aberdeen are harbour porpoise, bottlenose dolphin, white-beaked dolphin, Risso's dolphin, minke whale, grey seal and harbour seal. Harbour porpoise, bottlenose dolphin and grey seal were identified to use the area of Nigg Bay immediately to the south of Girdleness year-round during site-specific surveys, and white-beaked dolphin was sighted on one occasion.

The bottlenose dolphins present around Aberdeen are known to be part of the resident population associated with the Moray Firth SAC, and use Aberdeen Harbour as key foraging habitat due to the salmon resource that exists around the mouth to the River Dee. As a coastal and wide-ranging species, this population is distributed along the east coast, with a number of hotspots existing within this. Harbour porpoise are highly abundant throughout both UK and Aberdeenshire waters, and are considered to have no area of particular concentration within the east coast region, although they do appear to be particularly abundant in certain areas, with areas around Girdleness and Cove being two of these.

Grey seals are present within the area, as shown by site-specific surveys. Telemetry data has suggested that the grey seals will often directly pass Nigg Bay on transit to more northerly locations.

Grey seals from with the Isle of May SAC Berwickshire and north Northumberland Coast SAC and the Humber Estuary SAC used the areas around Aberdeen, with individuals from the Isle of May spending more time in the area than individuals form the other SACs. Only one individual tagged harbour seal used the areas around Aberdeen and Nigg Bay, which was tagged at the Firth of Tay and Eden Estuary SAC, suggesting extremely limited connectivity with this area. Local populations of harbour seal do exist however in the areas around Aberdeen at the mouths of the River Dee and River Don, as do for grey seal also.

In general, impacts relating to the construction and operation of the Development are anticipated to be localised and temporary on very high value receptors, and significance of effect is largely considered to be minor or moderate adverse. Moderate adverse effects have been identified during construction due to underwater noise having the very low potential to cause lethality or injury to individuals of certain marine mammal species. Blasting has the potential to result in an effect of major significance, in the absence of mitigation. Based on the outcomes of these assessments, a range of mitigation options have been proposed to reduce residual effects.

Mitigation options to ameliorate the effects of noise-producing activities have been proposed and will form the basis of a Marine Mammal Protection Programme (MMPP), which will be agreed in consultation with the relevant authorities. In respect of piling, soft-start procedures have been included as a measure adopted as part of the project. Additional mitigation following the impact assessment has been proposed, including of the use of vibropiling where practical and restricted periods of impact piling. MMOs, Passive Acoustic Monitoring (during hours of darkness) and mitigation zones are also necessary mitigation requirements.The use of resonance cages with bubble curtains or similar is proposed to be investigated, with the potential to reduce adverse noise propogation. The construction of breakwaters prior to piling has been identified as a potential form of mitigation, however this will be dependent on whether the construction schedule allows for this to occur. Drilling and blasting will all require the use of MMOs, Passive Acoustic Monitoring (during hours of darkness) and mitigation zones. Other additional mitigation has been proposed, such as an the development of a pollution prevention plan to address the potential for a chemical spill. Plans/codes of practice relating to vessel operation will reduce the risk or marine mammal disturbance and collision risk, despite no significant effects being forcast for these effects. Monitoring has been proposed during construction and operation.

Mortality is not anticipated for marine mammal individuals and therefore the respective PBR thresholds are not anticipated to be breached for either grey seal or harbour seal.

No cumulative effects have been identified which are considered to have the potential to result in significant cumulative effects.

The residual effect significance for all effects is presented in Table 15.62.

Table 15.62: Summary of effects

Impact	Significance of Effect	Mitigation Proposed	Residual Significance of Effect
Construction			
Underwater noise - Piling	Moderate adverse	Vibropiling where possible, soft-start procedures, MMOs, PAM (during hours of darkness) and a mitigation zone and resonance cages/bubble curtains.	Minor adverse
Underwater noise – Drilling	Moderate adverse	MMOs, PAM (during hours of darkness) and a mitigation zone.	Minor adverse
Underwater noise – Blasting	Major adverse	MMOs, PAM and a mitigation zone.	Minor adverse
Underwater noise – Dredging	Moderate adverse	None	Moderate adverse
Underwater noise – Spoil Disposal	Minor adverse	None	Minor adverse
Increased SSCs from dredging	Minor adverse	None	Minor adverse
Increased SSCs from sediment disposal	Minor adverse	None	Minor adverse
Release of sediment contaminants	Minor adverse	None	Minor adverse
Collisions with vessels – Hull Impacts	Minor adverse	Aberdeen Harbour Dolphin Code	Minor adverse
Collisions with vessels – Corkscrew Impacts	Minor adverse	Aberdeen Harbour Dolphin Code	Minor adverse
Disturbance due to vessel movements	Minor adverse	Aberdeen Harbour Dolphin Code	Minor adverse
Accidental Release of pollutants	Major adverse	Pollution Prevention Plan	Negligible adverse
Operation			
Underwater noise – disturbance due to vessel noise	Minor adverse	None	Minor adverse
Reduction in foraging habitat	Moderate adverse	Post-construction monitoring	Moderate adverse
Increased SSCs from maintenance dredging	Minor adverse	None	Minor adverse
Increased SSCs from sediment disposal	Minor adverse	None	Minor adverse
Collisions with vessels – Hull Impacts	Minor adverse	Aberdeen Harbour Dolphin Code Vessel routing plan Vessel Management Plan	Minor adverse
Disturbance due to vessel movements	Minor adverse	Aberdeen Harbour Dolphin Code Vessel routing plan Vessel Management Plan	Minor adverse
Interaction of Marine Mammals with Pollutants and Displacement	Minor adverse	None	Minor adverse
Changes to prey resource	Minor adverse	None	Minor adverse

15.11 References

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