# CHAPTER 10: MARINE MAMMALS


**Chapter Summary**

This chapter of the EIA Report considers the potential effects of the proposed optimised Seagreen Project (Project Alpha and Project Bravo offshore wind farms) on marine mammals. In line with the 2017 Scoping Report and subsequent 2017 Scoping Opinion, the assessment considers potential effects of underwater noise from pile driving of wind turbine generator (WTG) foundations on bottlenose dolphin, harbour seal, grey seal, harbour porpoise, minke whale and white beaked dolphin. These are scoped in due to changes in the design of WTG foundations, namely the inclusion of a monopile foundation option, and updated best practice guidance, relating to the assessment of underwater noise effects for marine mammals. All other potential impacts on marine mammals are scoped out because design parameters remain unchanged from the assessments completed for the 2012 Offshore ES and there are no equivalent updates to guidance.

Consultation has taken place with Marine Scotland and Scottish Natural Heritage (SNH) to refine the detailed approach taken by the assessment, including baseline marine mammal populations, assumptions for modelling of underwater noise, marine mammal response to noise and threshold effect levels for disturbance and injury.

The marine mammal baseline has been updated with new information that has become available since the 2012 application. This includes, notably SCANS III surveys completed in 2016, updated information on seal populations and recently available analyses of historic marine mammal data. The assessment also refers to new draft management units for seals and final management units for cetaceans.

The impact assessment considers a range of build scenarios, to identify worst cases for each species in terms of the spatial and temporal scale of effects from design options comprising jacket pin pile and monopile foundation solutions and various permutations of simultaneous and sequential installation. The assessment is informed by modelling of underwater noise propagation due to pile driving.

Injury was defined as permanent threshold shift (PTS) to marine mammal hearing based on thresholds published recently by the US National Oceanic and Atmospheric Administration (NOAA: NMFS, 2016), but with reference also to thresholds used in the 2012 Offshore ES (Southall *et al.*, 2007). Disturbance impacts were evaluated using dose response curves and thresholds agreed with statutory consultees for each species.

No significant impacts to any marine mammal species are predicted. This applies to Project Alpha and Project Bravo in isolation, together and in combination with other regional wind farms and other projects.


## INTRODUCTION

10.1. As set out in Chapter 1 (Introduction), the original Seagreen Project (herein referred to as the originally consented Project) received development consents from Scottish Ministers in 2014. This was confirmed in November 2017, following legal challenge to the consent award decision. Seagreen is now applying for additional consents for an optimised design (herein referred to as the optimised Seagreen Project), based on fewer, larger, higher capacity wind turbines that have become available on the market since the 2014 consent decision and inclusion of monopiles as a foundation option.

10.2. This Environmental Impact Assessment (EIA) Report provides an assessment of the potential environmental impacts of the optimised Seagreen Project, to support an additional application for development consents. This chapter of the EIA Report assesses the potential impacts upon marine mammals throughout the construction, operation and decommissioning phases of the Project.

10.3. In line with the 2017 Scoping Opinion received, this EIA Report focuses on the potential effects of underwater noise from pile driving on bottlenose dolphin (*Tursiops truncatus*), harbour seal (*Phoca vitulina*), grey seal (*Halichoerus grypus*), harbour porpoise (*Phocoena phocoena*), minke whale (*Balaenoptera acutorostrata*) and white beaked dolphin (*Lagenorhynchus albirostris*). These marine mammal species are scoped in to the assessment due to proposed changes in the design of WTG foundations and updated best practice guidance relating to the assessment of effects of underwater noise.

10.4. The originally consented project comprises the Seagreen Alpha Offshore Wind Farm (OWF) (herein referred to as 'Project Alpha'), Seagreen Bravo OWF (herein referred to as 'Project Bravo') and the Offshore Transmission Asset. It is noted that the Offshore Transmission Asset has been licenced separately, no changes are proposed and therefore this is not considered further within this assessment. A full description of the optimised Seagreen Project is provided in Chapter 5 (Project Description) of this EIA Report.

10.5. The Structure of this chapter is as follows:

- Legislation, policy and guidance: sets out key legislation, policy context and guidance with reference to latest updates in guidance and approaches;
- Consultation: provides details of consultation undertaken to date and how this has informed the assessment;
- Scope of assessment: sets out the scope of the impact assessment for marine mammals in line with the 2017 Scoping Opinion and further consultation;
- Methodology: sets out the study area, data collection undertaken and approach to the assessment of impacts for marine mammals;
- Baseline Conditions: describes and characterises the baseline environment for marine mammals and information used to inform the baseline;
- Assessment of impacts: confirms the project design parameters to be assessed (the Worst Case Scenario [WCS]) and presents the impact assessment for marine mammals throughout the construction, operation and decommissioning phases and concludes on the likely significance of impacts. The assessment includes the consideration of any mitigation measures (both embedded and additional) and sets out any monitoring proposals for potentially significant impacts, if required;
- Cumulative impact assessment: presents the cumulative impact assessment for marine mammals throughout the construction, operation and decommissioning phases and concludes on the likely significance of impacts with consideration of mitigation measures;
- Interrelationships: Assesses the potential interrelated effects on any given receptor scoped into the assessment;
- Transboundary impacts: Considers the potential for any transboundary impacts in relation to marine mammals; and
- Assessment summary: provides a summary of the impact assessment undertaken.

10.6. All figures supporting this chapter can be found in Volume II: Figures.

10.7. The following documents support this chapter and are provided in Volume III: Appendices:

- Appendix 10A (Marine Mammal Baseline Report);
- Appendix 10B (Noise Modelling Technical Report);
- Appendix 10C (Noise Modelling Plan);
- Appendix 10D (iPCoD Results); and
- Appendix 10E (Piling Noise Impact Assessment using a 1% Acoustic Energy Conversion Factor and use of Acoustic Deterrent Devices).

10.8. This chapter was produced by NIRAS Consulting Limited, incorporating technical input from the Sea Mammal Research Unit (SMRU) Consulting Ltd (marine mammal impact assessment) and Cefas (underwater noise modelling).

## LEGISLATION, POLICY AND GUIDANCE

10.9. This section summarises legislation, policy and guidance informing the marine mammal assessment. Overarching marine planning, renewable energy policy and legislation is summarised in Chapter 4 (Policy and Legislation) of this EIA Report.

### Policy Context

10.10. Policy measures are important when defining the scope of the assessment in order to ensure that the EIA Report reflects the relevant policy issues. The following policy measures have been identified as summarised in Table 10.1.

**Table 10.1 Policy context**

| Policy | Description | Relevance to assessment |
|---|---|---|
| Scotland's National Marine Plan (Marine Scotland, 2015) | This is a framework for marine spatial planning that aims to promote the sustainable development of marine areas and sustainable use of marine resources. | There is no specific mention of marine mammals but the Plan does include a commitment to complying with legal requirements for protected areas and species (e.g. marine mammals) and not having significant impact on Priority Marine Features which include marine mammals (see below). |
| Scottish Priority Marine Features (SNH, 2014) | These are habitats and species which are considered to be conservation priorities in Scottish waters. | The list includes all marine mammal species likely to occur in relation to the Seagreen Project. |
| The Scottish Biodiversity Strategy (Biodiversity Scotland, 2016) | This document sets out how the government will conserve biodiversity for the people of Scotland now and in the future. | Policy includes the objective to halt the loss of biodiversity. |

### Legislative Requirements

10.11. Table 10.2 summarises legislation relevant to the marine mammal assessment.

**Table 10.2 Legislation**

| Legislation | Description | Relevance to assessment |
|---|---|---|
| Habitats Directive (European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora) | The principal aims of the Directive are to: *"contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States* (Article 2.1); and *maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest* (Article 2.2)". | The Directive requires Member States to identify areas (Natura 2000 sites) which are important for species as listed in Annex II of the Directive. This includes four species of marine mammal: harbour porpoise, bottlenose dolphin, grey seal and harbour seal. Annex IV requires Member States to apply strict protection to all species of cetacean. |
| Habitats Regulations (Conservation (Natural Habitats, &c.) Regulations 1994 (as amended), Conservation of Habitats and Species Regulations 2017 and Conservation of Offshore Marine Habitats and Species Regulations 2017) | The Habitats Directive has been transposed into Scottish domestic law by the Habitats Regulations. Together these cover both inshore waters (within 12nm) and UK territorial waters (beyond 12nm). | A competent authority must make an appropriate assessment of the implications of any plan or project (such as the Seagreen Project), either alone, or in combination with other plans or projects, which is likely to have a significant effect on a European offshore marine site. The proponent of such plans or projects is required to provide the competent authority with relevant information to inform the appropriate assessment; this is the HRA Report (Chapter 16) which is informed by information in the marine mammal assessment. |
| | | Animals listed in Annex IV of the Habitats Directive, including all cetaceans, are termed European Protected Species (EPS) by the Habitats Regulations and afforded protection from activities which could result in deliberate injury or disturbance.<br>'Deliberate injury' in this context has been interpreted as occurring if permanent threshold shift occurs to a cetacean while 'disturbance' may occur if the ability of an EPS to breed or reproduce, rear or nurture their young or migrate is impaired, or the local distribution or abundance is significantly affected (JNCC, 2010).<br>These offences are taken to apply to any stage of an animal's life cycle (SNH, 2015).<br>The Seagreen Project expects to apply for an EPS licence in relation to any activity which has potential to result in such an offence and this application would be informed by information in this EIA Report. |
| European Council Directive 2008/56/EC, the Marine Strategy Framework Directive (MSFD) | Requires Member States to prepare national strategies to manage their seas to achieve Good Environmental Status (GES) by 2020. The Directive came into force on 15 July 2008 and was transposed into UK law by the Marine Strategy Regulations 2010. The UK's approach and targets for achieving GES were outlined subsequently in a 'UK programme of measures' (Defra, 2015). The approach ensures that all developments comply with the regulatory regime, and that regulatory assessments take full consideration of any potential impacts that may compromise GES. | Eleven descriptors are listed which outline the characteristics of an environment in which GES has been achieved: Of these, the following descriptors have specific relevance for this assessment:<br>• 'Descriptor 1' relating to the maintenance of biodiversity; and,<br>• 'Descriptor 4' relating to key elements of the food web, including marine mammals.<br>The UK has introduced a noise register in response to the MSFD which requires activities generating certain types of noise, including impulsive noise such as pile driving, to be reported. |

| Legislation | Description | Relevance to assessment |
|---|---|---|
| Marine (Scotland) Act 2010 | The Act provides a framework to balance competing demands on Scotland's seas. It introduces a duty to protect and enhance the marine environment and includes measures to help boost economic investment and growth in areas such as marine renewables. | The Act provides improved protection for seals. Certain haul out sites have been designated where seals are protected from intentional or reckless harassment. Designated haul out sites are detailed in the marine mammal baseline report (Appendix 10A) and summarised in this EIA Report. |
| Nature Conservation (Scotland) Act 2004 | The Act transposes into Scottish national law the obligations of the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention) and variously places duties on public bodies in relation to the conservation of biodiversity, increases protection for Sites of Special Scientific Interest (SSSI) and strengthens wildlife enforcement legislation.<br>Part 3 and Schedule 6 of the Act make amendments to the Wildlife and Countryside Act 1981, strengthening the legal protection for threatened species. The species protection afforded to wild birds, animals and plants is extended to include 'reckless' acts. | The Act makes it an offence to intentionally or recklessly disturb a cetacean. |
| Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention) 1979 | The Convention was adopted in Bonn, Germany in 1979 and came into force in 1985. Contracting Parties, including the UK, work together to conserve migratory species and their habitats by providing strict protection for endangered migratory species (listed in Appendix I of the Convention), concluding multilateral Agreements for the conservation and management of migratory species which require or would benefit from international cooperation (listed in Appendix II), and by undertaking cooperative research activities. | The UK has currently ratified four legally binding Agreements under the Convention, including the Agreement on the Conservation of Small Cetaceans in the Baltic, North-East Atlantic, Irish and North Seas (ASCOBANS) which came into force in 1994 and to promote close cooperation amongst Parties with a view to achieving and maintaining a favourable conservation status for small cetaceans. |
| OSPAR (Convention for the Protection of the Marine Environment of the North-East Atlantic 1998) | The Convention was adopted in Paris, France in September 1992 and entered into force in March 1998. The OSPAR Convention replaced both the Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft (the Oslo Convention) (adopted in 1972) and the Convention for the Prevention of Marine Pollution from Land-Based Sources (the Paris Convention) (adopted in 1974). | The Convention has the intention of providing a comprehensive and simplified approach to addressing all sources of pollution which might affect the maritime area, and all matters relating to the protection of the marine environment. An agreed list of threatened and declining species includes harbour porpoise. The list is not legally binding but Parties are encouraged to work towards the conservation of this species and establish measures to reduce harmful effects, particularly those of an acoustic nature. |

### Guidance

10.12. Key guidance/best practice referred to in undertaking the assessment of impacts for marine mammals is as follows:

- Institute of Ecology and Environmental Management (IEEM) guidelines for marine and coastal ecological impact assessment in Britain and Ireland (IEEM, 2010; CIEEM, in prep);
- European Union Guidance on wind energy developments and Natura 2000 legislation (EC 2011);
- Oslo Paris Convention (OSPAR) Guidance on Environmental Considerations for Offshore Wind Farm Development (OSPAR 2008);
- The marine mammal noise exposure criteria recommended in Southall *et al.* (2007) have been used in this assessment for the assessment of Permanent Threshold Shift (PTS) for the purpose of comparing PTS range estimates with the new thresholds recommended in National Marine Fisheries Service (2016);
- Guidelines relating to injury risk issued by the US National Oceanic and Atmospheric Administration (NOAA) (National Marine Fisheries Service, 2016) have been used in this assessment;
- Noise modelling undertaken by Cefas on behalf of Seagreen conforms to current best practice as described by Farcas *et al.* (2016);
- Position statement from the Joint Statutory Nature Conservation Bodies in relation to the use of ADDs for marine mammal mitigation during offshore wind farm construction (JNCC *et al.* 2016); and
- Guidance on mitigation protocols to minimise the risk of injury to marine mammals from piling noise (JNCC 2010).

## CONSULTATION

10.13. As part of the EIA process Seagreen has consulted with a number of statutory and non-statutory organisations to inform the approach to assessment on marine mammals.

10.14. A Scoping Report was submitted by Seagreen in May 2017. This considered the proposed changes to the optimised Seagreen Project and identified potential requirements for assessment. A Scoping Opinion was issued by Marine Scotland Licensing and Operations Team (MS-LOT) on behalf of Scottish Ministers in September 2017. This considered the information presented within the Scoping Report and set out key issues to be addressed within the impact assessment.

10.15. Table 10.3 sets out the consultation undertaken to date, including the date and type of consultation, the issues raised and how these have been addressed within this EIA Report. Following a summary of the Scoping Opinion, which underpins the approach adopted in this EIA Report, topics are listed and summarised by subject with reference to the date(s) of meetings or relevant correspondence in which issues were discussed. Many issues were discussed over more than a single meeting or clarified by several sets of correspondence. This approach therefore represents a more efficient and clear way to present information than a chronological listing.

**Table 10.3 Summary of consultee responses**

| Consultee and Date | Summary of issues raised | How issues have been addressed |
|---|---|---|
| **Scoping Opinion 2017** | | |
| **MS-LOT Scoping Opinion, 15 September 2017** | | |
| | MS-LOT agreed that the assessment for marine mammals should only consider the effects from underwater noise. | The assessment is focused on underwater noise from wind turbine generator foundation piling. |
| | Bottlenose dolphin, harbour seal, grey seal, harbour porpoise, minke whale and white beaked dolphin should be included in the EIA. | These species have been included in this EIA Report and Appendix 10A (Marine Mammal Baseline Report). |
| | Additional sources of baseline data suggested:<br>• SMRU photo identification project, which could be used for assessing the proportion of bottlenose dolphin from the Moray Firth SAC which can be expected to be utilising the Firth of Tay at any one time (Quick et al. 2014); and<br>• CPoD data from the Marine Scotland Science (MSS) funded survey the East Coast Marine Mammal Acoustic Survey (ECOMMAS). | Included in Appendix 10A (Marine Mammal Baseline Report) and this EIA Report (paragraph 10.67 onwards and subsequent references). |
| | Bottlenose dolphin abundance and distribution off the east coast: 98 animals to be assumed evenly distributed within the 20m depth contour (excluding areas where bottlenose dolphins are known not to be present). | This approach has been adopted (Appendix 10A (Marine Mammal Baseline Report) and summary in Table 10.16 of this EIA report). |
| | Management units for other cetaceans to be based on IAMMWG (2015) other than for harbour porpoises which will use an updated value from SCANS III (Hammond et al., 2017). | This approach has been adopted but with revision in relation to white-beaked dolphin to reflect subsequent discussions (see below in this Table). The final approach adopted is set out Appendix 10A (Marine Mammal Baseline Report) and summary in Table 10.16 of this EIA report). |
| | Harbour porpoise impact should also be expressed relative to the SCANS III block R abundance to consider impacts at a regional level. | SCANS III abundance estimates have been used for harbour porpoise (Appendix 10A (Marine Mammal Baseline Report) and summary in Table 10.16 of this EIA report). |
| | Cetacean distribution data will be used from Original development ES or updates where available. | The assessment is based on updated baseline information detailed in Appendix 10A (Marine Mammal Baseline Report). |
| | For pinnipeds, SCOS 2017 (or 2016) data should be used for East Coast Management Unit abundance. SMRU usage maps for distribution. | 2016 data (Russell *et al.*, 2017) used. See Appendix 10A (Marine Mammal Baseline Report) and summary in Table 10.16 of this EIA report. |
| | An update to the noise propagation modelling will be required. Both instantaneous and cumulative permanent threshold shift ('PTS') should be presented, modelled for each of the species noted above. SNH and MSS agree that Seagreen should provide the total number of individuals from each species that may suffer PTS and the number that may be displaced through disturbance. | Updated noise propagation modelling has been completed (Appendix 10B) and relevant results presented from paragraph 10.157. |

| Consultee and Date | Summary of issues raised | How issues have been addressed |
|---|---|---|
| | PTS thresholds from both Southall et al. (2007) and the NOAA (NMFS, 2016) should be used. This is to allow comparability with the Original Development ES (which used Southall et al. (2007) but takes into account that the NOAA criteria are the most up to date scientific information. Seagreen should note that the NOAA criteria are currently under review. | Results for Southall et al. (2007) thresholds are provided alongside NOAA (2016) thresholds in Appendix 10B (Noise Modelling) and in relevant tables in this EIA Report (from Table 10.19). |
| | For marine mammal flee speeds and startle responses for PTS modelling the mean swim speeds details in SNH guidance note (2016) should be used, including mean swim speed for bottlenose dolphin as a proxy for white beaked dolphin. | These flee speeds have been used (Table 10.8). |
| | Fleeing should be assumed to start from the start of the Acoustic Deterrent Device (ADD) use (i.e. before piling starts). PTS impacts from ADDs do not need to be considered as the ADDs will not be sufficiently loud to cause PTS for the period of time that they will be used. | This approach has been adopted (Appendix 10B Noise Modelling Plan). |
| | SNH and MSS agree that a dose response curve should be used to determine the proportion of animals likely to be disturbed sufficiently to displace them by piling noise. | The potential for behavioural effects was assessed using dose response curves from species specific empirical studies wherever possible. See also further discussion in this Table, below. |
| | For bottlenose dolphin, an assessment of the impacts of the optimised Seagreen Project alone on the East Scotland management unit population as well as cumulatively with other developments that may impact on the same population is required. Seagreen should ensure that the information provided can be used for an Appropriate Assessment in relation to the Moray Firth Special Area of Conservation (SAC). | Potential impacts to bottlenose dolphin are assessed in relation to the optimised Seagreen Project (from paragraph 10.161) and cumulatively with other projects (from paragraph 10.318). |
| | For harbour porpoise, minke whale, white beaked dolphin, harbour seal and grey seal further assessment should only be carried out if the effects of the optimised Seagreen Project are found to be greater than those assessed for the Original Development. | It was subsequently clarified that Negligible and Minor (Not Significant) impacts should be considered as equivalent and the assessment has been undertaken on this basis with population modelling not carried out where impacts are equivalent. |
| | The Scottish Ministers request that, where necessary, the information is provided in a form that means it can be used for the EPS process or, where needed, to inform the Appropriate Assessment as part of an HRA. | Information in this EIA Report has been prepared with future application for EPS licence in mind and has been used to inform the HRA (Chapter 16). |
| | For species where population level impact assessments are undertaken MSS recommend using the Interim Population Consequences of Disturbance (iPCOD) framework. As a minimum parameters must include:<br>• The piling schedule;<br>• The demographic parameters;<br>• Starting population size;<br>• Copy of the code used to run the model; and<br>• Any quality assurance/quality control outputs that the software produces. | iPCoD modelling has been used in this EIA Report (see also Appendix 10D [iPCoD Results]). |

| Consultee and Date | Summary of issues raised | How issues have been addressed |
|---|---|---|
| | The Scottish Ministers advise that the results of the assessment using iPCOD should be presented using the metrics provided in the MSS guidance note. | See Appendix 10D (iPCoD Results). |
| | The Scottish Ministers consider the following projects should be considered for inclusion in the cumulative impact assessment:<br>• Worst case scenario of Neart na Gaoithe (2014 as consented) or Neart na Gaoithe (2017 scoping report);<br>• Worst case scenario of Inch Cape (2014 as consented) or Inch Cape (2017 scoping report);<br>• Worst case scenario of Moray Offshore East Development or Moray East Offshore Wind Farm – Alternative Design;<br>• Beatrice Offshore Wind Farm;<br>• Moray West Offshore Wind Farm; and<br>• Aberdeen Harbour Expansion project.<br>The list of projects to be included may be refined following initial results of the noise modelling. | These projects have been considered and the list updated in line with subsequent discussions which have also informed assumptions to be made in relation to other projects. See below (this Table) and Table 10.54 of this EIA Report. |
| **Issues Discussed After Scoping** | | |
| **Marine mammal densities and management units to use in assessment** | | |
| Approach to assessment meeting with MS-LOT, MSS and SNH, 6 March 2018 | For white-beaked dolphin the SCANS III-based abundance estimate is to be used as the reference population. This will be a conservative underestimate. | Incorporated into Appendix 10A (Marine Mammal Baseline Report) and this EIA Report. |
| MS-LOT, MSS and SNH, 5 February 2018 (Meeting) | SMRU Consulting are replicating the 'Inch Cape approach' for bottlenose dolphin abundance and distribution.<br>Seal abundance counts have been updated (harbour and grey seal) with 2017 SCOS data.<br>Usage maps (Russel et al 2017) will be used for the impact assessment.<br>JCP III density data to be used. SCANS data will also be presented. | |
| MSS, 21 December 2017 (Email from Panos Pliatsikas) | Updated maps for estimated at-sea distribution of grey and harbour seals provided. | |
| **Use of ADDs and fleeing assumptions** | | |
| MS-LOT, MSS and SNH, 5 February 2018 (Meeting) | 25km fleeing threshold to be applied for $SEL_{cum}$ PTS models. | This approach has been adopted (Appendix 10C Noise Modelling Plan) and taken into account in assessment within this EIA Report. |
| MS-LOT, MSS and SNH, 22 November 2017 (Meeting) | Fleeing swim speed of 1.52m/s to be used for bottlenose dolphin (other species speeds as per SNH Guidance), all as per Scoping Opinion. | |

| Consultee and Date | Summary of issues raised | How issues have been addressed |
|---|---|---|
| **Underwater noise modelling locations and other key parameters** | | |
| MS-LOT, 17th July 2018 (Email) | Following review of the draft marine mammals assessment, MS-LOT advised that robust justification, based on scientific evidence, should be provided to support the use of a 0.5% acoustic energy conversion factor, as advised and adopted as standard by Cefas, in the underwater noise modelling completed. Seagreen subsequently provided a technical note which set out the justification by Cefas for the use of a 0.5% conversion factor. Following review of this note MS-LOT advised that additional modelling is undertaken using a 1% conversion factor, in order to provide a comparison with results using a 0.5% conversion factor.<br>MSS also advised that the modelling is run to reflect both with and without the use of ADDs as embedded mitigation. | In response to MS-LOT's advice, Seagreen has developed Appendix 10E (Piling Noise Impact Assessment using a 1% Acoustic Energy Conversion Factor and use of Acoustic Deterrent Devices) which sets out the results of underwater noise modelling and potential impact significance for marine mammals when using a 1% conversion factor with and without ADDs as embedded mitigation. |
| MS-LOT, MSS and SNH, 8 May 2018 (Meeting) | Locations for noise modelling were initially proposed in November 2017 and additional positions and updated parameters added as Project Design was developed over subsequent months. There were ongoing discussions with consultees, culminating in the final Noise Modelling Plan (Appendix 10C), details from which were presented at this meeting with no issues raised. Other key aspects are summarised below. | Adopted in Noise Modelling Plan (Appendix 10C). |
| SNH, 21 December 2017 (Email from Erica Knott) | Agreed with proposal to retain locations used in 2012 Offshore ES. | |
| MS-LOT, 15 March 2018 (Email from Gayle Holland subsequent to meeting on 6 March) | Jacket pin pile installation - use of ADDs/breaks in piling: it will be appropriate to model 15 minutes of ADD use for the first jacket pile only, after that animals are assumed to be stationary during subsequent breaks until the pile driving is complete at any one location or it would be appropriate to undertake modelling using a different assumption (such as deployment of ADD mitigation for each jacket pile). | |
| MS-LOT, MSS and SNH, 6 March 2018 (Meeting) | Updated information on noise modelling plans were presented and no major concerns raised.<br>Lower energy (2,300kJ) 'most likely' hammer energy scenario for monopile piling not to be modelled if significant impacts are not concluded for the 'worst case' (3,000kJ) scenario. | |
| MS-LOT, 1 February 2018 (Email from Sophie Humphries) | Parameters for noise modelling broadly supported. Seagreen advised that stated maximum hammer energies should represent absolute maximum planned energies. | |
| MS-LOT, MSS and SNH, 22 November 2017 (Meeting) | Confirmed basic approach of noise modelling including Cefas model, turbine locations as planned at that time. | |

| Consultee and Date | Summary of issues raised | How issues have been addressed |
|---|---|---|
| **Dose response curves** | | |
| MS-LOT, MSS and SNH, 8 May 2018 (Meeting) | Agreement on seal dose response to be used. Confirmation of porpoise curve for cetaceans and harbour seal curve for seals. | Information on dose response curves from paragraph 10.44. |
| MS-LOT, MSS and SNH, 22 November 2017 (Meeting) | Preference to use an SEL response curve not the distance curve from the BOWL monitoring results.<br>For displacement 100% response probability will be assumed if received SEL >180dB. | |
| **Requirements for population modelling** | | |
| MS-LOT, Marine Scotland Science (MSS) and SNH, 6 March 2018 (Meeting) | If impacts are greater than predicted by the 2012 Offshore ES, the assessment outcomes in terms of significance, not absolute numbers, should be compared. For example, change of significance from Negligible to Minor would not invoke a requirement for population modelling. | Approach adopted in this EIA Report. |
| **iPCoD Population Modelling** | | |
| MS-LOT, 17 May 2018 (Meeting) | It is expected that iPCoD will be used for bottlenose dolphin only | iPCoD modelling undertaken for this EIA Report takes this into account (see also Appendix 10D [iPCoD Results]). |
| | Management unit/starting population for iPCOD to be 195 animals, as presented in Cheney et al. 2013 and to be confirmed in SNH's most recent site condition monitoring report (Cheney *et al.* 2018, in prep). | |
| MS-LOT, MSS and SNH, 6 March 2018 (Meeting) | Very low numbers of white-beaked dolphin predicted to be affected, population modelling is not required and any population level consequences can be considered qualitatively. | |
| MS-LOT, 26 February 2018 (Email from Sophie Humphries) | Re-affirmed Scoping Opinion in relation to bottlenose dolphin and requirement for a quantitative population assessment to be undertaken using iPCOD. | |
| MS-LOT, 15 March 2018 (Email from Gayle Holland subsequent to meeting on 6 March) | Commencement date: the modelling should be run from the start date of Beatrice piling – 2 April 2017 – and it should be presented for a duration (model run period) of 25 years. | |
| | SMRU Consulting's advice in the iPCOD manual, where they recommend that the demographic stochasticity remain at 500, should be followed. | |
| **Cumulative Impact Assessment** | | |
| MS-LOT, 6 November 2017 (Letter) | Broad principles for CIA were outlined, including information sharing between developers where possible. | Information has been shared with other projects where development programmes have permitted. |
| MS-LOT, 15 March 2018 (Email from Gayle Holland subsequent to meeting on 6 March) | Advice received on assumptions to make for CIA in relation to other projects. | Advice is reflected in Table 10.53 of this EIA Report. |
| MSS Email, 29 March 2018 (Email from Panos Pliatsikis) | Detailed discussions were held to agree the approach for including Aberdeen Harbour Development (AHEP) into iPCoD modelling for CIA, culminating in final advice adopted for the assessment. | iPCoD modelling undertaken for this EIA Report takes this into account (see also Appendix 10D [iPCoD Results]). |

| Consultee and Date | Summary of issues raised | How issues have been addressed |
|---|---|---|
| Discussion following meeting with MS-LOT, MSS and SNH, 8th (Email from Gayle Holland dated 16 May) | Where the number of seals likely to be at risk from PTS or disturbance is in the worst case < 1 individual per day at risk of disturbance, MSS advise that there is no requirement for the developer to undertake a cumulative impact assessment for harbour seals. | No CIA has been undertaken for harbour seal. |
| MS-LOT, 26 February 2018 (Email from Sophie Humphries) | Proposed and consented works at Ardersier, Nigg and Cromarty Firth (Invergordon) Ports may have in-combination effects on botttenose dolphin and should be considered qualitatively along with the other waterfront developments. | Advice is reflected in Table 10.53 of this EIA Report. |
| MS-LOT, 20 Dec 2017 (Email from Gayle Holland) | Sequential versus concurrent piling- unclear which will be worst-case before modelling and assessment is completed. | CIA has considered all relevant scenarios. |

## SCOPE OF ASSESSMENT

10.16. With reference to the 2017 Scoping Opinion and confirmed through further consultation, the scope of the assessment for marine mammals considers the potential effects of underwater noise from pile driving on bottlenose dolphin, harbour seal, grey seal, harbour porpoise, minke whale and white beaked dolphin. These potential effects are scoped in due to changes in the design of WTG foundations and updated best practice guidance.

10.17. This is based on the optimised Seagreen Project design set out in Chapter 5 (Project Description) and with the assumption that mitigation measures and consent conditions as set out in Chapter 7 (Scope of EIA Report) will be applied.

10.18. All other potential impacts on marine mammals have been scoped out of the assessment for the optimised Seagreen Project and are not assessed further within this impact assessment.

## METHODOLOGY

10.19. This section presents the impact assessment methodology applied to assess the potential environmental impacts associated with the construction, operation and decommissioning phases of the optimised Seagreen Project.

### Study Area

10.20. The following definitions for the scale of study areas have been used (Figure 10.1):

- **The Immediate Study Area (ISA)** is the optimised Seagreen Project area which was the focus for site-specific surveys completed in support of the 2012 Offshore ES as summarised in this EIA Report (Table 10.4 and Appendix 10A [Marine Mammal Baseline]);
- **The Regional Study Area (RSA)** encompasses regional Special Areas of Conservation (SACs) within the foraging range for each species concerned. For grey seal, the Isle of May SAC and Berwickshire and North Northumberland Coast SAC are within range. For harbour seal, the Firth of Tay and Eden Estuary SAC is included in the study area, and for bottlenose dolphin, there is evidence of connectivity with the Moray Firth SAC; and
- **The Wider Study Area (WSA)** relates to the relevant area describing the reference population for the optimised Seagreen Project impact assessment. This is defined appropriately for each marine mammal species under consideration and is equivalent to the agreed management units for each population, as defined in the marine mammal baseline, detailed in Appendix 10A (Marine Mammal Baseline) and summarised below.

## Data Collection

10.21. Characterisation of the baseline environment was undertaken to understand the spatial and temporal diversity, abundance and density of marine mammals that could potentially be impacted by the optimised Seagreen Project.

10.22. The optimised Seagreen Project has the same area and is within the same application boundaries as the originally consented Project and, therefore, data collected to inform the 2012 Offshore ES remains an appropriate source of information to inform the assessment of impacts for this EIA Report. This includes a range of detailed project specific surveys and site characterisation studies to define baseline conditions. All supporting information, including data from the 2012 Offshore ES and additional literature review data that has been collected since its production, is detailed in Appendix 10A (Marine Mammal Baseline) and summarised below.

10.23. In line with the scoping opinion (Table 10.3) the baseline characterisation for marine mammals has been undertaken using a combination of desk based research to update information in the 2012 Offshore ES which included site specific surveys. Table 10.4 details the principal data sources used to inform this assessment. The data sources used to inform the baseline have been agreed in consultation (see Table 10.3).

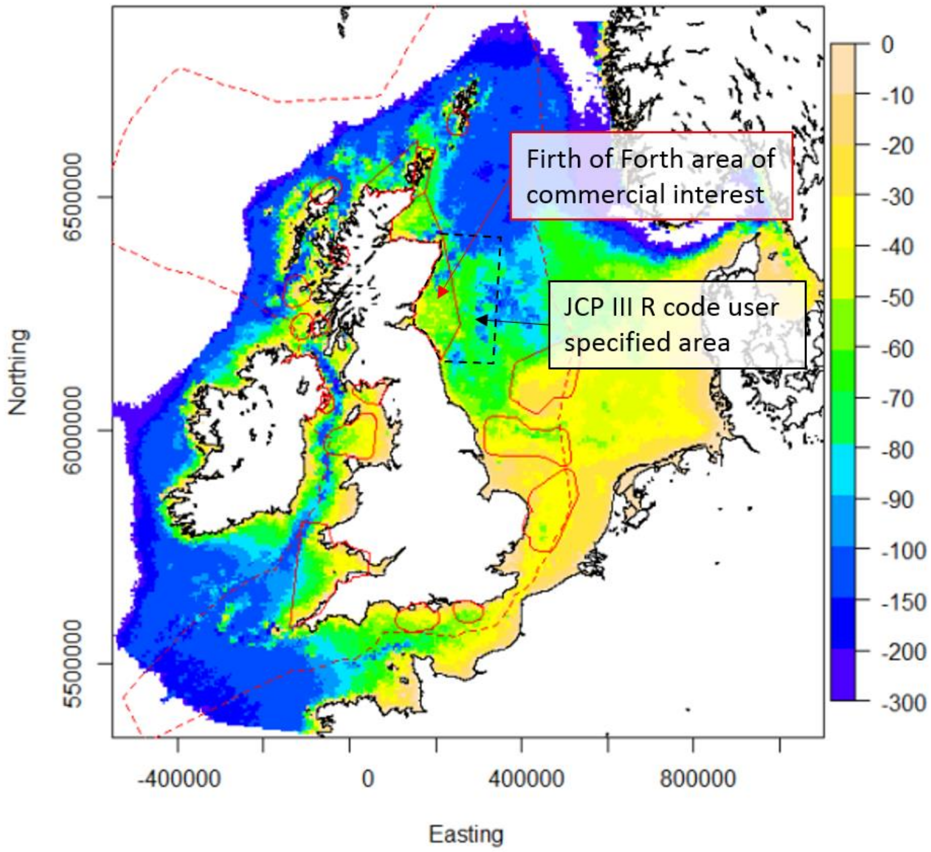
**Table 10.4 Principal sources of information used to inform marine mammal baseline characterisation**

| Source | Details |
|---|---|
| **Project Specific Surveys** | |
| Boat based bird and marine mammal surveys | Boat based surveys undertaken by ECON for marine mammals and birds in the wider Seagreen Zone. Surveys were carried out from December 2009 to November 2011. Additional surveys were carried out during the seabird breeding season May to August 2017. These surveys were focused on birds but marine mammal observations were also noted. |
| Boat based and aerial survey | SMRU Ltd were commissioned in 2011 to analyse existing boat (see above) and aerial (see below) survey data across outer Firth of Forth and Firth of Tay region to provide spatially explicit densities to inform the baselines for harbour porpoise, minke whale and white-beaked dolphin. |
| **Project Specific Desk Studies** | |
| Review of data from aerial surveys | The Crown Estate (TCE) commissioned a series of aerial surveys of offshore wind farm sites during 2009 and 2010 around the UK. SMRU Ltd was commissioned by the Forth and Tay Offshore Wind Developers Group (FTOWDG) to evaluate data collected at the STW and Round 3 Zones within the Firths of Forth and Tay. |
| Collation of aerial and other data on seals | SMRU Ltd was commissioned to collate existing baseline information for seals across the Forth of Firth and Tay region in 2011, including aerial surveys at haul out sites, diet, and telemetry data and to generate at sea densities. |
| Collation and summary of data on bottlenose dolphin between the Firths of Forth and Tay and the Moray Firth and usage in the Forth and Tay | Baseline information on bottlenose dolphin in the east coast region was collated by SMRU Ltd in 2011 for FTOWDG. |
| **Other Studies and Data Sources** | |
| Small Cetaceans in the European Atlantic and North Sea (SCANS) Surveys | The main objective of the SCANS surveys was to estimate small cetacean abundance and density in the North Sea and European Atlantic continental shelf waters. The SCANS I surveys were completed in 1994, SCANS II in July 2005 and SCANS III in July 2016 and all comprised of a combination of vessel and aerial surveys. |

| Source | Details |
|---|---|
| Joint Cetacean Protocol (JCP) Phase III Analysis | The JCP Phase III analysis included datasets from 38 sources, totalling over 1.05 million km of survey effort between 1994 and 2010 from a variety of platforms (Paxton et al., 2016). The JCP Phase III analysis was conducted to combine these data sources, to estimate spatial and temporal patterns of abundance for a number of species of cetacean, including the following of direct relevance to the Seagreen project: harbour porpoise, minke whale, bottlenose dolphin, short-beaked common dolphin and white-beaked dolphin. The 'Firth of Forth' (equivalent to the Round 3 Zone) is included in the analysis as an area of commercial interest for which abundance estimates are presented for 2010 (Plate 10.1). The area of the Firth of Forth area of commercial interest is 14,241km$^2$. In 2017, JNCC released R code[1] that can be used to extract the cetacean abundance estimates for summer 2007 to 2010 (average) for a user specified area. The user specified area used to extract these abundance estimates is shown in Plate 10.1 and consists of a total area of 36,730km$^2$. This area is approximately double the size of that assessed as part of the Firth of Forth area of commercial interest and extends further offshore (the two areas are presented for comparison in Plate 10.1). |
| JNCC Report 544: Harbour Porpoise Density | Heinänen and Skov (2015) conducted a detailed analysis of 18 years of survey data on harbour porpoise around the UK between 1994 and 2011 held in the JCP database. The goal of this analysis was to try to identify "discrete and persistent areas of high density" that might be considered important for harbour porpoise. |
| Special Committee on Seals (SCOS) | Under the Conservation of Seals Act 1970 and the Marine (Scotland) Act 2010, the Natural Environment Research Council (NERC) provides scientific advice to government on matters related to the management of seal populations through the advice provided by the SCOS. The SMRU provides this advice to SCOS on an annual basis through meetings and an annual report. The most recent publicly available SCOS report is SCOS (2017) which presents the data collected up to 2016. |
| SMRU Seal Haul-out Surveys | SMRU carries out surveys of harbour and grey seals in Scotland and on the east coast of England to contribute to NERC's statutory obligation under the Conservation of Seals Act 1970, to provide the (UK government) with scientific advice on matters related to the management of seal populations. The results of these surveys are presented in the SCOS reports annually. |
| Seal At-sea Usage | Russell et al. (2017) have produced revised estimated at-sea distribution usage maps for both grey and harbour seals. The usage maps are based on telemetry data from 270 grey seals and 330 harbour seals tagged within the UK, based on data between 1996 and 2015. |
| Bottlenose dolphin photo-ID surveys | Mark-recapture methods have been used to assess the population using photo-ID data collected by the University of Aberdeen since 1989. These surveys and their analyses are detailed in (Cheney *et al.* 2013, Cheney *et al.* 2018) |
| The Marine Scotland East Coast Marine Mammal Acoustic Study (ECOMMAS) | The ECOMMAS began in 2013 and involved 30 PAM sites along the east coast of Scotland to collect data on the relative abundance of dolphins and porpoise. |
| Analyses of JCP data to inform minke whale MPA site selection | Analyses of the JCP database were commissioned by SNH to identify potential discrete areas of persistent high density of minke whales. These analyses are detailed in Paxton et al., (2014). |

[1] http://jncc.defra.gov.uk/page-7201

**Plate 10.1 The core JCP Phase III regions showing (red) areas of commercial interest. The Firth of Forth area of commercial interest is identified, as is the JCP III R code user specified area for comparison (black dashed line). The colour scale represents water depth.**




## Impact Assessment

10.24. The impact assessment follows the principles of the approach set out within Chapter 6 (EIA Process) of this EIA Report. This includes consideration of Project Alpha alone; Project Bravo alone; Project Alpha and Project Bravo combined (the optimised Seagreen Project) and Project Alpha and Project Bravo in a cumulative scenario.

10.25. The significance of potential impacts has been evaluated using a systematic approach, based upon the sensitivity of receptors to the project activity, together with the predicted magnitude of the impact. The following sections summarise the technical approach to the assessment including a summary of the noise modelling carried out.

## Approach to underwater noise assessment

10.26. It is widely accepted that the main potential impact upon marine mammals from offshore wind farm development comes from underwater noise during construction, resulting from pile driving of foundations (Wursig, 2000; Nedwell *et al*., 2003; Thomsen *et al*., 2006). Therefore, it is appropriate to assess this factor as robustly as possible through the use of methods such as noise propagation modelling (Nedwell *et al*., 2007). Underwater noise propagation modelling completed to inform the marine mammal impact assessment for the Seagreen Project is detailed in Appendix 10B (Noise Modelling Technical Report) and summarised below.

10.27. Underwater noise has the potential to cause both physiological and behavioural impacts on marine mammals. The potential impacts of underwater noise are dependent on the noise source characteristics (frequency [Hz] and decibels [dB]), the receptor species and the distance from the sound source and noise attenuation within the environment.

10.28. Before underwater noise propagation modelling commenced, a number of key parameters had to be established which were discussed and agreed with Marine Scotland and SNH. Initial consultation on locations for noise modelling took place on 21 December 2017 with subsequent development of the modelling approach discussed at meetings up to 15 March 2018 (see Table 10.3). Representative locations for noise propagation modelling were selected for the two potential driven wind turbine foundation solutions (monopiles and jacket pin piles) (Figure 10.2) and installation scenarios representing parameters for pile driving (hammer energy, blow frequency etc.), together with potential build scenarios, were identified. Throughout this process the aim was to evaluate the most likely and worst case scenarios for marine mammal receptors in terms of underwater noise from piling. The Noise Modelling Plan is provided as Appendix 10C, key parameters are summarised in Table 10.5 and build scenarios in Table 10.6.

10.29. It could not be pre-determined what the worst case would be when comparing sequential and concurrent build scenarios. Concurrent piling operations with two vessels operating at the same time in different locations will result in the largest spatial footprint of impact, but the duration of disturbance will be lower due to less time being taken to install the total number of foundations. Single vessel installation will result in a smaller impact footprint at any one time but the overall duration of disturbance will be longer. With the optimised Seagreen Project, the definition of worst case also has to consider the different pile types with jacket foundations requiring four smaller pin piles and monopiles requiring a single larger pile. The same uncertainty applies here with pin piles requiring a longer pile driving duration for each foundation, but a lower overall impact footprint in terms of noise levels (because each pin pile requires a lower amount of energy to drive compared to a monopile). As a result, it was not possible to determine prior to modelling which combination of parameters and build scenarios would represent the worst case for assessment. Therefore a number of scenarios were developed and assessed.

**Table 10.5 Worst Case piling parameters assumed in the noise modelling and resulting impact assessment**

| Foundation | Maximum Hammer Energy (kJ) | Number of events within 24hr | Duration per pile (hrs) | Ramp up duration (min) | % max hammer energy | Strike rate (per min) |
|---|---|---|---|---|---|---|
| 10m diameter Monopile | 3000 | 1 | 4 | 1 | 13 | 7 |
| | | | | 19 | 13-20 gradual ramp up | 31 |
| | | | | 100 | 20-100 gradual ramp up | 35 |
| | | | | 100 | 100 | 35 |
| 2m diameter Pin pile | 1800 | 4 assumed for modelling risk of PTS (maximum energy in 24 hours)<br>2 assumed for assessment of disturbance (maximum total number of days of piling) | 2.25 | 6 | 15 | 45 |
| | | | | 4 | 35 | 45 |
| | | | | 5 | 55 | 45 |
| | | | | 30 | 75 | 45 |
| | | | | 90 | 95 | 45 |

**Table 10.6 Project parameters, foundation options and build scenarios that have been assessed**

| Foundation options | Project | Build Scenario Number | Number of piles | Build scenario |
|---|---|---|---|---|
| Pin pile jackets only | Project Alpha alone | 1 | 280 | Sequential installation (single vessel) |
| | Project Bravo alone | 2 | 280 | Sequential installation (single vessel) |
| | Project Alpha and Project Bravo | 3 | 480 | Sequential installation (single vessel, one project after another) |
| | Project Alpha and Project Bravo | 4 | 480 | Concurrent installation (two vessels, one in each Project area) |
| Monopiles only | Project Alpha alone | 5 | 70 | Sequential installation (single vessel) |
| | Project Bravo alone | 6 | 35 | Sequential installation (single vessel) |
| | Project Alpha and Project Bravo | 7 | 70 | Sequential installation (single vessel, one project after another) |
| Monopiles and pin pile jackets | Project Alpha alone | 8 | 35 MP<br>140 PP | Sequential installation (monopiles then pin pile jackets, single vessel) |
| | Project Alpha alone | 9 | 35 MP<br>140 PP | Concurrent installation (monopiles and pin pile jackets concurrently, two vessels) |
| | Project Bravo alone | 10 | 35 MP<br>140 PP | Sequential installation (monopiles then pin pile jackets, single vessel) |
| | Project Bravo alone | 11 | 35 MP<br>140 PP | Concurrent installation (monopiles and pin pile jackets concurrently, two vessels) |
| | Project Alpha and Project Bravo | 12 | 70 MP<br>200 PP | Sequential installation within and between sites (single vessel, one project after another) |
| | Project Alpha and Project Bravo | 13 | 70 MP<br>200 PP | Concurrent installation within each site, sequential between sites (two vessels on Project Alpha, followed by two vessels on Project Bravo) |

10.30. Underwater noise modelling was undertaken by Cefas. The Cefas noise propagation model (Farcas *et al.*, 2016) is based on RAM (Collins, 1993), a widely applied parabolic equation method of sound propagation modelling. The Cefas model applies RAM to produce a series of transects around the noise source, each with range-dependent propagation loss which varies with bathymetry, sediment type, and water properties.

10.31. Source sound levels for piling (Table 10.7) were calculated using an energy conversion model (De Jong & Ainslie 2008), whereby a proportion of the expected hammer energy is converted to acoustic energy:

$$\boldsymbol{SL_E = 120 + 10log_{10}\left(\frac{\beta E c_0 \rho}{4\pi}\right)}$$

Where E is the hammer energy in joules, $SL_E$ is the source level energy for a single strike at hammer energy E, β is the acoustic energy conversion efficiency, $c_0$ is the speed of sound in seawater in $m^{-1}$, and ρ is the density of seawater in kg $m^{-3}$.

10.32. This yields an estimate of the source level in units of sound exposure level (dB re 1 $\mu Pa^2$ s). This energy is then distributed across the frequency spectrum, based on previous measurements of impact piling (Ainslie *et al*. 2012).

10.33. Hammer energy profiles for the piling scenarios formed the basis of the source level estimates. The above equation was used to compute the source level energies, using an acoustic energy conversion efficiency of 0.5%, which assumes that 0.5% of the hammer energy is converted into acoustic energy. This energy conversion factor is in keeping with current understanding of how much hammer energy is converted to noise (Dahl & Reinhall 2013; Zampolli *et al*. 2013; Dahl *et al*. 2015). The above equation gives the source level energy for a single strike (single-strike SEL). The source level peak pressures, as well as the field peak SPL, were calculated using the empirical linear equations linking the peak SPL and the single-pulse SEL for pile driving sources reported by Lippert *et al*. (2015).

**Table 10.7 Source noise levels used in propagation modelling.**

| Hammer energy (kJ) | SEL (dB re 1 μPa²s @1m) | SL peak (dB re 1 μPa @1m) | Notes |
|---|---|---|---|
| 270 | 202.2 | 243.1 | Start energy pin pile (Build Scenarios 1, 2, 3, 4, 8, 9, 10, 11, 12 and 13) |
| 400 | 203.9 | 245.4 | Start energy monopile (Build Scenarios 5, 6, 7, 8, 9, 10, 11, 12 and 13) |
| 1,710 | 210.2 | 254.3 | Max energy pin pile (Build Scenarios 1, 2, 3, 4, 8, 9, 10, 11, 12 and 13) |
| 3,000 | 212.6 | 257.7 | Max energy monopile (Build Scenarios 5, 6, 7, 8, 9, 10, 11, 12 and 13) |

**Table 10.8 Fleeing speeds assumed for each marine mammal species**

| Species | Harbour Porpoise | Bottlenose Dolphin and White-beaked Dolphin | Minke Whale | Seals |
|---|---|---|---|---|
| Swimming speed (m/s) | 1.4 | 1.52 | 2.1 | 1.8 |
| Minimum depth Constraint (m) | 5 | 5 | 10 | 0 |

10.34. The modelled impact zones for the various marine mammal functional hearing groups are mapped according to noise exposure assessment criteria for injury and disturbance, taking account of the expected fleeing response to underwater noise (Table 10.8). These swim speed parameters were agreed in consultation with SNH and MSS.

## Modelling the population consequences of noise impacts

10.35. The interim Population Consequences of Disturbance (iPCoD) framework (Harwood *et al.* 2014, King *et al.* 2015) was used for population level modelling assessments, to predict the long term consequences of noise related impacts. The model is used to run simulations of future population trajectory with and without the predicted level of impact to allow an understanding of the potential future population level consequences of predicted behavioural responses and auditory injury.

10.36. iPCoD uses a stage structured model of population dynamics with nine age classes and one stage class (adults ten years and older). In the absence of empirical data on the extent to which disturbance affects individual survival and fecundity, the iPCoD framework uses the results of an expert elicitation process, conducted according to the protocol described in Donovan *et al.* (2016), to predict the effects of disturbance and PTS on individual survival and reproductive rates. The process generates a set of statistical distributions for these effects and then simulations for the impacted population are conducted using values randomly selected from these distributions that represent the opinions of a 'virtual' expert. This process is repeated 1000 times to capture the uncertainty among experts.

10.37. Simulations were run comparing projections of the baseline population (i.e. under current conditions, assuming current estimates of demographic parameters persist into the future) with paired 'impact' scenarios, with identical demographic parameters, with the 'impacted' simulations incorporating a range of estimates for disturbance. Each simulation was repeated 1,000 times and each simulation draws parameter values from a distribution describing the uncertainty in the parameters. This creates 1,000 matched pairs of population trajectories, differing only with respect to the effect of the disturbance. The effect of disturbance is drawn from the distribution of expert opinions which relates the days of disturbance received in the simulation, to a predicted effect on the survival and reproductive rates of the affected individuals. The distributions of the two trajectories can be compared, to estimate the magnitude of the long term effect of the predicted impact on the population, as well as demonstrating the uncertainty in predictions.

10.38. The demographic parameters such as survival rates and fertility rates that are used in the iPCoD model, to describe the baseline population parameters are obtained from Harwood and King (2017), who present recommended demographic parameters for marine mammal population management units in the UK.

10.39. Marine Scotland, based on analyses carried out by Jitlal *et al.* (2017), have specified that the following metrics should be reported from population modelling as they were considered to be the least sensitive to mis-specification, therefore enabling more robust assessment of offshore renewable impacts:

- Median of the ratio of impacted to un-impacted population size;
- Median of the ratio of impacted to un-impacted annual growth rate; and
- Centile for un-impacted population which matches the 50$^{th}$ centile for the impacted population.

## *Developments in Assessment Methods*

10.40. Since the 2012 Offshore ES was completed new guidelines have been issued (NMFS, 2016), which provide revised thresholds for permanent threshold shift (PTS), which are used in this assessment to define injury risk (hereafter referred to as the NOAA thresholds). The risk of injury was based on both of the dual criteria: cumulative sound exposure level ($SEL_{cum}$) and peak sound pressure level (peak SPL) (Table 10.9). To assess the $SEL_{cum}$ criterion, the predictions of received sound level are frequency weighted, to reflect the hearing sensitivity of each functional hearing group. The peak SPL criterion is for unweighted received sound level.

**Table 10.9 NOAA (NMFS, 2016) PTS thresholds for pulsed noise used in this assessment for each of the marine mammal hearing groups.**

| | PTS Threshold | |
|---|---|---|
| **Hearing Group** | **$SEL_{cum}$ (dB re 1 μPa$^2$ s ) weighted according to NMFS (2016) Audiogram weighting functions for each hearing group** | **Peak SPL (dB re 1 μPa) unweighted** |
| Low-frequency cetaceans | 183 | 219 |
| Mid-frequency cetaceans | 185 | 230 |
| High-frequency cetaceans | 155 | 202 |
| Phocids | 185 | 218 |

10.41. For the calculation of $SEL_{cum}$, animals were assumed to flee out to a maximum distance of 25km (after which they were assumed to remain stationary at that distance).

10.42. With respect to impact significance levels, PTS thresholds according to Southall *et al.* (2007) (Table 10.10) were also calculated as requested in the 2017 Scoping Opinion. Southall *et al.* thresholds were used to support the 2012 Offshore ES and are provided here for information.

**Table 10.10 Southall et al. (2007) PTS thresholds for pulsed noise used in this assessment for each of the marine mammal hearing groups.**

| | PTS Threshold | |
|---|---|---|
| **Hearing Group** | **$SEL_{cum}$ (dB re 1 µPa² s) M-weighted** | **Peak SPL (flat) (dB re 1 µPa) unweighted** |
| Low-frequency cetaceans | 198 | 230 |
| Mid-frequency cetaceans | 198 | 230 |
| High-frequency cetaceans | 198 | 230 |
| Phocids | 186 | 218 |

10.43. The 2012 Offshore ES relied on the '$dB_{ht}$(*species*)' metric (Nedwell *et al.*, 2007) to assess behavioural effects on marine mammals. The $dB_{ht}$(*species*) metric was also used alongside criteria developed by Southall *et al.* (2007) to evaluate injury risk. This method uses the different hearing sensitivities of each species, to provide a scale that incorporates the concept of 'loudness' for a species.

10.44. Instead of using the $dB_{ht}$ metric, in the current assessment, the potential for behavioural impacts (disturbance leading to displacement) was assessed using dose response curves from species specific empirical studies wherever possible, as requested in the 2017 Scoping Opinion. For this assessment a series of isopleths were modelled, i.e. contours of equal sound levels around the source, with a stepwise decreasing unweighted single strike SEL of 180 to 120dB re 1 µPa²s, with a step size of 5dB. A proportional expected response derived from the dose response curve for each isopleth range was used to predict the number of animals potentially disturbed. The number of animals within each isopleth range was calculated based on species specific density sources presented in Table 10.3 as agreed with statutory consultees. The number of animals predicted to respond within each isopleth were calculated by multiplying the total numbers present by the probability of response as defined by the dose response function. These numbers were added across all isopleths to estimate the total number of animals potentially disturbed during piling. This was carried out for the worst case hammer energies as detailed in Table 10.5.

10.45. It is important to note that this is a precautionary assessment as these maximum hammer energies will only be reached for a small proportion of the time and at only a proportion of piling locations. Previous experience has shown that in practice, lower hammer energies than those assessed are required. For example, the pile driving at Beatrice OWF was assessed in the ES based on a defined maximum hammer energy of 2,300 kJ. During the actual construction, mean max hammer energy across all piles was 1,088 kJ, modal max hammer energy was between 900 and 1000 kJ. Only six locations required the use of hammer energies above 1,800 kJ (BOWL, pers. com.). In addition, piling at the full hammer energy only occurred for 14% of the overall piling duration, not including any breaks in activity. On average, the maximum hammer energy at each location was only maintained for approximately 10 minutes.

10.46. The dose-response curve adopted in this assessment for all cetaceans was developed by Graham *et al*. (2017) and was generated from data on harbour porpoises collected during the first six weeks of piling during Phase 1 of the Beatrice Offshore Wind Farm monitoring program. In the absence of species specific data on bottlenose dolphins, white-beaked dolphins or minke whales, this dose response curve has been adopted for all cetaceans, this has been agreed with statutory consultees (see Table 10.3). For both species of seal, a dose response curve was derived from the data collected and analysed by Russell *et al*. (2016) on harbour seal responses during several months of pile driving at the Lincs Offshore Wind Farm.

10.47. Necessary changes have also been made to the Study Area. Since publication of the 2012 Offshore ES, the UK Marine Mammal Interagency working group has defined draft management units for seals (IAMMWG, 2013) and final management units for cetaceans (IAMMWG, 2015). These management units have been adopted as the appropriate reference populations for the optimised Seagreen Project impact assessment. The appropriate management units and associated abundances are provided in the relevant species accounts in the following sections.

### *Significance Criteria*

10.48. The significance of impacts has been determined in a manner largely consistent with the 2012 Offshore ES (Chapter 13 Marine Mammals), and with the methodology set out in Chapter 6 (EIA Process) of this EIA Report, with the exceptions noted below.

10.49. Definitions of the marine mammal receptor sensitivity are given in Table 10.11. The concept of value is not used as a differentiator in the definition of sensitivity. This is because all marine mammal species are afforded a high degree of legislative protection and are important internationally. However, in line with the previous assessment, levels of receptor sensitivity are defined with regard to the capacity for the receptor to tolerate or adapt to the effects of the impact and the potential for the impact to affect the ability of the receptor to survive and/or reproduce. The magnitude of the potential impacts of the optimised Seagreen Project is based on the intensity or degree of disturbance to baseline conditions and is categorised into four levels of magnitude, high, medium, low or negligible (Table 10.12). No specific numerical thresholds are defined for the different levels; for a group as diverse as marine mammals and for impacts varying in their nature and severity, it is difficult to define quantitative thresholds that can be applied consistently to a range of species and impacts. Instead the assessment is made more qualitatively, using expert judgement and with regard to the spatial and temporal extent of the effect in relation to the size and status of the receptor population.

10.50. Table 10.13 combines the definitions of magnitude with the level of sensitivity of the marine mammal receptor, to provide a prediction of overall significance of the potential impacts. As set out in Chapter 6 (EIA Process), for the purposes of this EIA Report, potential impacts identified as major or moderate are generally considered to be significant in EIA terms and mitigation may be required, while impacts identified as minor or negligible are generally considered to be not significant in EIA terms.

**Table 10.11 Definition of terms relating to sensitivity of marine mammal receptors**

| Sensitivity | Definition |
|---|---|
| High | • No ability to adapt behaviour so that survival and reproduction rates are affected.<br>• No tolerance – effect will cause a change in both reproduction and survival rates.<br>• Limited ability for the animal to recover from the effect. |
| Medium | • Limited ability to adapt behaviour so that survival and reproduction rates may be affected.<br>• Limited tolerance – effect may cause a change in both reproduction and survival rates<br>• Some ability for the animal to recover from the effect. |
| Low | • Ability to adapt behaviour so that survival and reproduction rates are unlikely to be affected.<br>• Some tolerance – effect unlikely to cause a change in both reproduction and survival rates.<br>• Ability for the animal to recover from the effect. |
| Negligible | • Receptor is able to adapt behaviour so that survival and reproduction rates are not affected.<br>• Receptor is able to tolerate the effect without any impact on reproduction and survival rates.<br>• Receptor is able to return to previous behavioural states/ activities almost immediately. |

**Table 10.12 Definition of terms relating to the magnitude of impact**

| Magnitude | Definition |
|---|---|
| High | The impact would affect the behaviour and distribution of sufficient numbers of individuals, with sufficient severity, to affect the favourable conservation status and/ or the long-term viability of the population at a generational scale. |
| Medium | Temporary changes in behaviour and/ or distribution of individuals at a scale that would result in potential reductions to lifetime reproductive success to some individuals, although not enough to affect the population trajectory over a generational scale. Permanent effects on individuals that may influence individual survival but not affecting enough individuals to alter population trajectory over a generational scale. |
| Low | Short-term and/or intermittent and temporary behavioural effects in a small proportion of the population. Reproductive rates of individuals may be impacted in the short term (over a limited number of breeding cycles). Survival and reproductive rates very unlikely to be impacted to the extent that the population trajectory would be altered. |
| Negligible | Very short term, recoverable effect on the behaviour and/or distribution in a very small proportion of the population. No potential for any changes in the individual reproductive success or survival, therefore no changes to the population size or trajectory. |

**Table 10.13 Matrix for determining the impact significance for marine mammals**

| Receptor sensitivity | Magnitude | | | |
|---|---|---|---|---|
| | **High** | **Medium** | **Low** | **Negligible** |
| **High** | Major | Major | Moderate | Minor |
| **Medium** | Major | Moderate | Minor | Negligible |
| **Low** | Moderate | Minor | Negligible | Negligible |
| **Negligible** | Minor | Negligible | Negligible | Negligible |

## Assessment Limitations and Uncertainty

10.51. There are uncertainties relating to underwater noise modelling and impact assessment for the Project. Broadly, these relate to predicting exposure of animals to underwater noise, predicting the response of animals to underwater noise and predicting potential population consequences of disturbance from underwater noise. Further detail of such uncertainty is set out below and includes reference to recent experience from marine mammal monitoring during construction of Beatrice OWF.

### *Predicting the Exposure of Animals to Underwater Noise*

10.52. There are uncertainties relating to the ability to predict the exposure of animals to underwater noise, as well as in predicting the response to that exposure. These uncertainties relate to a number of factors: the ability to predict the level of noise that animals are exposed to, particularly over long periods of time; the ability to predict the numbers of animals affected, and the ability to predict the individual and ultimately population consequences of exposure to noise. These are explored in further detail in the paragraphs below.

10.53. The propagation of underwater noise is relatively well understood and modelled using standard methods. However, there are uncertainties regarding the amount of noise actually produced by each pulse at source and how the pulse characteristics change with range from the source. There are also uncertainties regarding the position of receptors in relation to received levels of noise, particularly over time, and understanding how position in the water column may affect received level. Noise monitoring is not always carried out at distances relevant to the ranges predicted for effects on marine mammals, so effects at greater distances remain un-validated in terms of actual received levels. The extent to which ambient noise and other anthropogenic sources of noise may mask signals from the offshore wind farm construction are not specifically addressed. The dose-response curves for porpoise include behavioural responses at noise levels down to 120 dB SELss which may be indistinguishable from ambient noise at the ranges these levels are predicted.

10.54. Furthermore, the estimated source sound level is a theoretical, idealised concept of the sound at 1m distance from the source calculated either from theoretical considerations (as applied for Seagreen), or from far-field measurements that are back-propagated with a model. In reality the sound, whether from pile driving for a pin pile or monopile, is not a point source at 1m distance but this is a necessary assumption and is believed to be less important than a realistic estimation of sound levels at greater distances, which are of most relevance to marine mammal and other receptors.

### *Predicting the Response of Animals to Underwater Noise*

10.55. There are also uncertainties relating to the ability to predict the responses of animals to underwater noise. The prediction of the numbers of animals potentially exposed to levels of noise that may cause an impact is uncertain. Given the high spatial and temporal variation in marine mammal abundance and distribution in any particular area of the sea, it is difficult to confidently predict how many animals may be present within the range of noise impacts. All methods for determining at sea abundance and distribution suffer from a range of biases and uncertainties and no single method or data source will provide a complete prediction of future conditions. The marine mammal baseline technical report (Appendix 10A) details the data sources used in the assessment in detail and the most robust estimates of density have been agreed with SNH and MSS.

10.56. In addition, there is limited empirical data available to confidently predict the extent to which animals may experience auditory damage or display responses to noise. The current methods for prediction of behavioural responses are based on received sound levels, but it is likely that factors other than noise levels alone will also influence the probability of response and the strength of response (e.g. previous experience, behavioural and physiological context, proximity to activities, characteristics of the sound other than level, such as duty cycle and pulse characteristics). However, at present, it is impossible to adequately take these factors into account in a predictive sense. As mentioned previously, this assessment makes use of the monitoring work that has been carried out during the construction of the Beatrice Offshore Wind Farm and therefore uses the most recent and site specific information on disturbance to harbour porpoise as a result of pile driving noise.

10.57. There is also a lack of information on how observed effects (e.g. short-term displacement around pile-driving activities) manifest themselves in terms of effects on individual fitness, and ultimately population dynamics. For example, it could be assumed that the displacement of an animal from a foraging area could result in increased energy expenditure to move away, in addition to decreased foraging opportunities if the animal is displaced to an area that is of lower quality for foraging. This could ultimately result in a reduction in energy gain which has the potential to lead to reductions in fecundity. However, the amount of disturbance and displacement that is required to impact an animal's fitness is unknown. In this assessment it is conservatively assumed that displacement away from the area will result in an impact to that individual, over the period over which it is displaced. Animals are expected to recover quickly and will return to the area following cessation of piling.

10.58. The duration of disturbance is another uncertainty. Studies at Horns Rev 2 demonstrated that porpoises returned to the area between 1 and 3 days (Brandt *et al.*, 2011) and monitoring at the Dan Tysk wind farm as part of the DEPONS project found return times of around 12 hours (cited in van Beest *et al.*, 2015). Two studies at Alpha Ventus demonstrated using aerial surveys that the return of porpoises was about 18 hours after piling (Dähne *et al.*, 2013). A recent study of porpoise response at the Gemini wind farm in the Netherlands, also part of the DEPONS project, found that local population densities recovered between two and six hours after piling (Nabe-Nielsen *et al.* 2018).

10.59. Analysis of data from monitoring of marine mammal activity during piling of jacket pile foundations at Beatrice Offshore Wind Farm is ongoing (Graham et al., 2017a) but some initial outputs are available which provide useful information for the optimised Seagreen Project. There is evidence that harbour porpoise are displaced during pile driving but return after cessation of piling, with a reduced extent of disturbance over the duration of the construction period (see paragraph 10.145). This suggests that the assumptions adopted in the current assessment are precautionary as animals are predicted to remain disturbed at the same level for the entire duration of the pile driving phase of construction.

10.60. There is no empirical data on the responses of minke whales to pile driving noise, but a recent study of responses to ADDs demonstrated that minke whales responded to ADD signals by swimming directly away from the noise source at speeds increased above baseline (McGarry *et al.* 2017).

10.61. There are no empirical data on the threshold for auditory injury in the form of PTS onset for either porpoise or seals, as to test this would be inhumane. Therefore, PTS onset thresholds are estimated based on extrapolating from Temporary Threshold Shift (TTS) onset thresholds. For pulsed noise, such as piling, NOAA (National Marine Fisheries Service (2016) have set the onset of TTS at the lowest level that exceeds natural recorded variation in hearing sensitivity (6dB), and assumes that PTS occurs from exposures resulting in 40 dB or more of TTS measured approximately four minutes after exposure.

The use of PTS-onset thresholds does not mean that all animals will experience PTS, rather, PTS thresholds are used to indicate the range below which there is certainty that no PTS will occur. PTS-onset is therefore indicative of the numbers of animals potentially at risk of PTS, rather than those predicted to actually develop PTS.

10.62. It is important to note that the SELcum thresholds were determined with the assumption that a) the amount of sound energy an animal is exposed to within 24 hours will have the same effect on its auditory system, regardless of whether it is received all at once or in several smaller doses spread over a longer period (called the equal-energy hypothesis), and b) the sound keeps its impulsive character, regardless of the distance to the sound source. Both assumptions lead to a conservative determination of the impact ranges, as a) the magnitude of TTS induced might be influenced by the time interval in-between successive pulses, with some time for TTS recovery in-between pulses (e.g., Finneran *et al.* 2010, Kastelein *et al.* 2013, Kastelein *et al.* 2014), therefore recovery is possible in the gaps between individual pile strikes and in the breaks in piling activity, and b) an impulsive sound will eventually lose its impulsive character while propagating through the water column, therefore becoming non-impulsive (as described in National Marine Fisheries Service, 2016), and then causing a smaller rate of threshold shift (see above). Analysis of pile driving data by researchers at SMRU has demonstrated that pile strikes may lose their pulse characteristics at ranges of circa 10 km (Hastie *et al.* 2016). Modelling the SELcum impact ranges of PTS with a 'fleeing animal' model, as is typical in noise impact assessments, are subject to both of these uncertainties and the result is a highly precautionary prediction of impact ranges.

10.63. In addition, the consequences of PTS for individuals are uncertain. It is likely that the consequences will depend on the overall magnitude of the loss of sensitivity and it is important to note that PTS is not a complete loss of hearing, but is a reduction in sensitivity in a specific frequency band, called a 'notch' in the hearing, using equivalent terminology for 'noise induced hearing loss' in humans.

### *Predicting the Population Consequences of Disturbance*

10.64. There is a lack of empirical data on the way in which changes in behaviour and hearing sensitivity may affect the ability of individual marine mammals to survive and reproduce. The iPCoD framework therefore uses the results of an expert elicitation process conducted according to the protocol described in Donovan *et al.* (2016), to predict the effects of disturbance and PTS on survival and reproductive rate. While the iPCoD model is subject to many assumptions and uncertainties relating to the link between impacts and vital rates, the model presents the best available scientific expert opinion at this time for the range of species considered within this assessment.

10.65. There are also inherent uncertainties relating to the size and particularly the distribution of receptor populations, although for bottlenose dolphin in particular there is relatively good information in this regard.

10.66. Despite these limitations and uncertainties, this assessment has been carried out according to best practice and using the best available scientific information. The information provided is therefore considered to be sufficient to carry out an adequate assessment. In all cases, where there is uncertainty this has been offset in the impact assessment through the adoption of precautionary, often worst case, assumptions relating to predicted sound levels and effects on marine mammals. Further precaution is built in through worst case assumptions in relation to construction parameters. The consequence of this approach is that the assessment is likely to overstate, rather than underestimate, impact magnitude and this should be considered when interpreting the conclusions of the assessment undertaken.

## BASELINE CONDITIONS

10.67. The 2017 Scoping Opinion confirmed that the 2012 Offshore ES baseline for marine mammals is considered to be largely valid; however, this has been updated and the current marine mammal baseline (detailed in Appendix 10A) is summarised for each identified marine mammal receptor species below. The reference populations used in the assessment, as agreed during Scoping and Consultation (Table 10.3), are stated at the end of each species' account.

### Harbour seal

#### *Current baseline*

10.68. Approximately 30% of European harbour seals are found in the UK; this proportion has declined from approximately 40% in 2002. Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast, their distribution is more restricted with concentrations in the major estuaries of the Thames, The Wash, Firth of Tay and the Moray Firth. In the UK, harbour seals are considered to have an Unfavourable Inadequate Conservation Status (JNCC 2013) which means that "a change in management or policy is required to return the habitat type, or species to favourable status but there is no danger of extinction in the foreseeable future" (ETC/BD 2014).

#### August haul-out surveys

10.69. The most recent UK wide harbour seal count presented in SCOS (2017) collates data collected between 2011 and 2016. This produced a total count for the UK of 31,300 seals, which, scaled to account for the proportion of animals at sea at the time of the count, gives an estimated population size of 43,500 (95% CI: 35,600 to 58,000), of which 80% are located in Scotland.

10.70. The optimised Seagreen Project is located within the East Scotland seal MU (Figure 10.1). The most recent harbour seal August moult count presented for this MU is 368 (2011 to 2016 count period) (SCOS 2017). Accounting for the proportion of the population at sea during the survey, this scales to a MU population estimate of 511 harbour seals (95% CI: 418 to 681). While the MU has shown a large decline in numbers since the 1996 to 1997 count period, the most recent haul-out count in the 2011 to 2016 period (368) was considerably higher than that in the 2007 to 2009 count period (283) (Table 10.14). The number of harbour seals in the East Scotland harbour seal MU accounts for approximately 2.5% of the total population of Great Britain.

**Table 10.14 The most recent August counts (2011 to 2016) of harbour seals at haul-out sites in the East Scotland MU compared with three previous periods: 1996 to 1997, 2000 to 2006 and 2007 to 2009 (SCOS, 2017).**

| Count Period | Harbour seal count | Population Estimate | 95% CI |
|---|---|---|---|
| 1996 to 1997 | 764 | 1,061 | 868 to 1,415 |
| 2000 to 2006 | 667 | 926 | 758 to 1,235 |
| 2007 to 2009 | 283 | 393 | 322 to 524 |
| 2011 to 2016 | 368 | 511 | 418 to 681 |

10.71. In 2016, most harbour seals in the East Scotland MU counted during the August moult survey were located in the Firth of Forth, with relatively few counted in the Firth of Tay (Figure 10.3). The Firth of Tay and Eden Estuary SAC population was relatively stable between 1990 and 2002, with the highest population estimate being 1,074 (878 to 1,431) in 1992. After 2002 the SAC population showed a steady decline to the lowest estimated population size of 40 (33 to 54) in 2014. The population estimate has increased slightly since the lowest estimate in 2014, with a 2015 estimate of 83 (68 to 111) and a 2016 estimate of 71 (58 to 94).

## Telemetry

10.72. Telemetry data from 36 harbour seals tagged at Abertay and the Eden Estuary between 2001 and 2011 confirmed harbour seal usage of both Project Alpha and Project Bravo. However, more recently five adult harbour seals were tagged at the Eden Estuary in 2012. These 2012 tracks show very restricted movement and none of the seals had tracks within the optimised Seagreen Project (Figure 10.4). The average tag duration was 56.2 days (range 41 to 65).

10.73. Sandeels were the dominant prey species found in the diet of harbour seal in the region (Sharples et al., 2009). The Wee Bankie sandbank is a key habitat for sandeels in the area (Daunt et al., 2008). The Wee Bankie area had high usage of harbour seals and is therefore expected to be an important offshore foraging location.

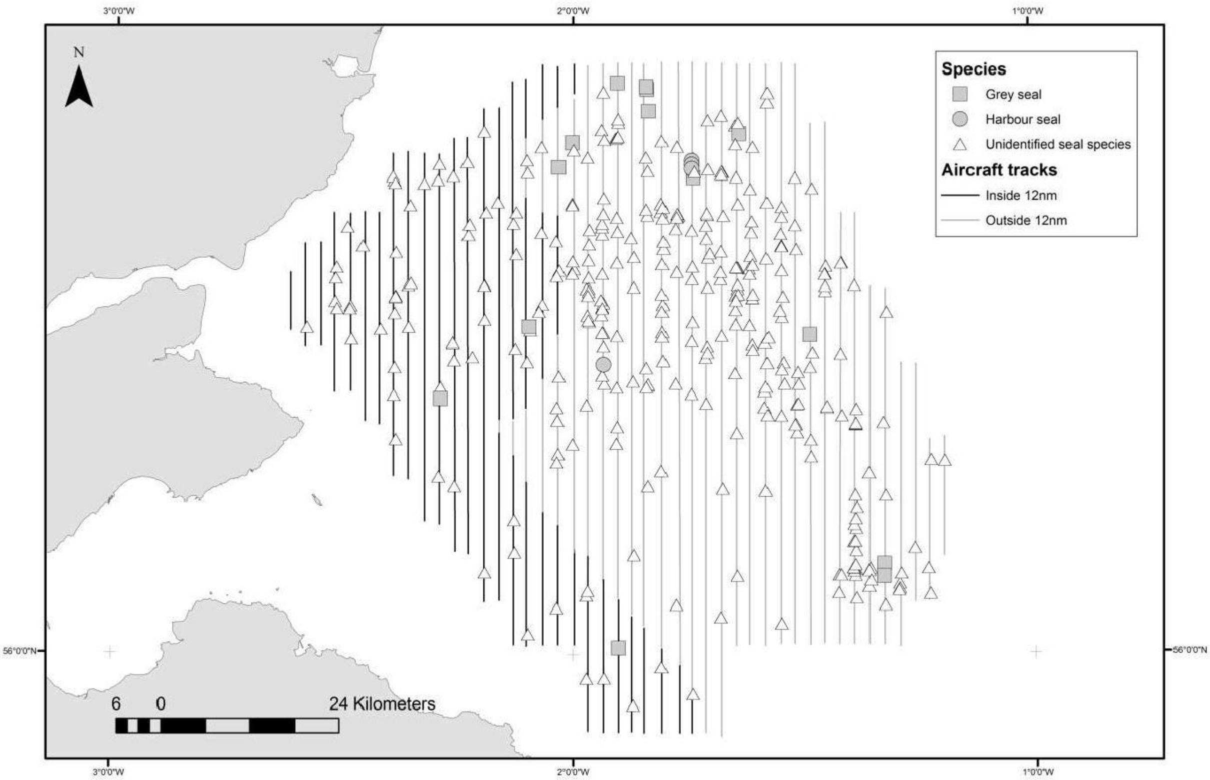
## At-sea usage

10.74. Harbour seal at-sea usage in the East Coast Scotland MU is low (Figure 10.5), with the main area of usage centred within the Firth of Forth where at sea densities reach a maximum of 55.3 harbour seals/cell which, assuming a uniform distribution within grid cells, is an estimated density of 2.2 harbour seals/km$^2$. Across the optimised Seagreen Project the grid cell density is low, with <1 seal/cell.

## Visual surveys

10.75. There were only six harbour seal sightings from the boat based surveys within the optimised Seagreen Project. No harbour seals were recorded during the 2017 optimised Seagreen Project area + 2 km buffer surveys. A number of seals were recorded during the TCE aerial surveys, however, the majority were not identified to species level (Plate 10.2).

**Plate 10.2 Sightings of all seal species recorded during the aerial surveys (2012 Offshore ES Appendix H3).**



### Harbour seal baseline conclusion

10.76. Harbour seals have the potential to be impacted by the effects of underwater noise generated by piling activity, although they are present in very low numbers in the immediate and regional study areas. The spatially explicit harbour seal densities from Figure 10.5 will be used in the quantitative noise impact assessment to quantify the number of seals that might experience noise levels that could cause disturbance. The results of this process will be presented with reference to the total population of the East Coast Seal Management Unit.

## Grey seal

### *Current Baseline*

10.77. Approximately 38% of the world's grey seal population breeds in the UK with 86% of these breeding in Scotland. The grey seal is considered to have a Favourable Conservation Status in the UK (JNCC 2013). The most recent UK wide grey seal pup production count was in 2014, which produced a total UK pup production estimate of 60,500 (95% CI: 53,900 to 66,900), which, modelled to estimate the non-pup portion of the population, gives an estimate of 139,800 aged 1+ grey seals in the UK (95% CI: 116,500 to 167,100) (SCOS 2017). The distribution of UK grey seal breeding sites are shown in 29.

### August Haul-out Surveys

10.78. The number of grey seals counted during the August surveys within the East Scotland MU has varied between years from 2,328 hauled-out in the count period 1996 to 1997, 1,238 for the count period 2007 to 2009 and 3,812 in the count period 2008 to 2016 (SCOS 2017). Accounting for the fact that grey seals only haul-out for approximately 35% of the time (95% CI 32 – 38) (Lonergan *et al.* 2011), this results in a 2008 to 2016 count period East Coast Scotland MU grey seal population size of 10,891 (10,032 to 11,913). Most of the grey seals counted in the Firth of Tay and Eden Estuary SAC during the August surveys are located in the Abertay and Tentsmuir area (Figure 10.6).

10.79. It is important to note that since the timing of the surveys are conducted to coincide with the harbour seal moult, these surveys are not conducted during a key haul-out period for grey seals. Counts of greys seals during these surveys can be highly variable and although these counts are not used as a population index, they provide useful information on the distribution of grey seals in August.

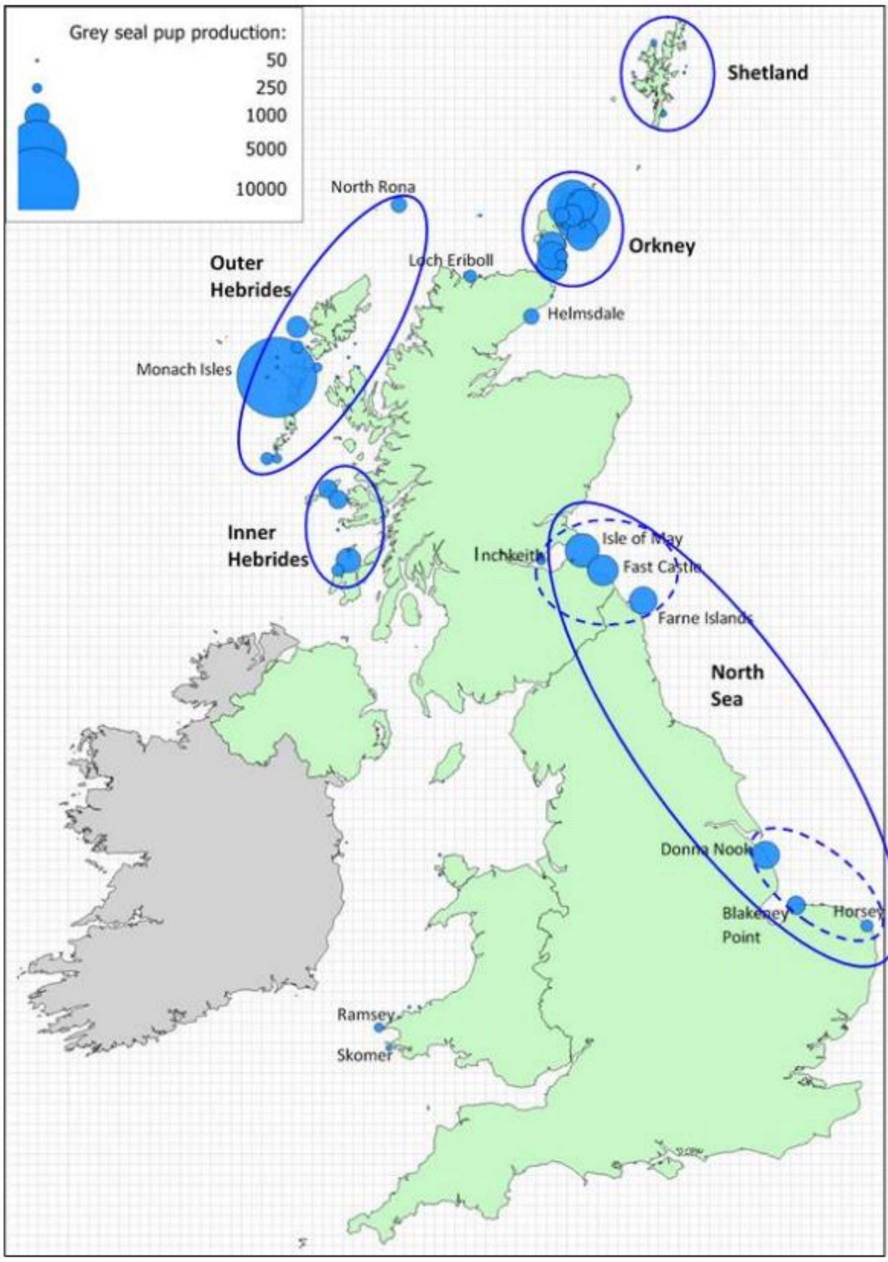
### Pup Production

10.80. The main grey seal pupping sites in relation to the optimised Seagreen Project are; Craigleith, Fast Castle, Inchcolm, Inchkeith and the Isle of May all of which are located in the Firth of Forth (Table 10.15). Grey seal pup production at surveyed breeding sites in the Firth of Forth has increased over the last 10 years (Plate 10.3). The closest grey seal breeding site to the optimised Seagreen Project is the Isle of May which is approximately 47km away.

**Table 10.15 Grey seal pup production counts between 2005 and 2014 for the Firth of Forth grey seal survey region (Individual breeding site data within the Firth of Forth provided by Chris Morris, SMRU and North Sea pup production estimates obtained from SCOS, 2017).**

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Firth of Forth grey seal survey region** | | | | | | | | | | | |
| Craigleith | 39 | 33 | 32 | 23 | 36 | 30 | 51 | 35 | 40 | 40 | 52 |
| Fast Castle | 659 | 764 | 804 | 1,005 | 1,265 | 1,715 | 1,844 | | 2,417 | | 2,940 |
| Inchcolm | | | 5 | | | | 2 | 3 | 2 | 5 | 9 |
| Inchkeith | 55 | 67 | 130 | 178 | 206 | 267 | 252 | 341 | 405 | 460 | 535 |
| Isle of May | 1,953 | 1,954 | 1,827 | 1,751 | 1,875 | 2,065 | 2,153 | | 2,355 | | 2,272 |

**Plate 10.3 Pup production at the main grey seal breeding colonies in the UK in 2014 (SCOS, 2017). The blue circles show breeding colonies grouped by area for reporting. The North Sea group consists of two sub-groups (dashed lines): the Firth of Forth and East of England.**



## Telemetry

10.81. SMRU has deployed telemetry tags on grey seal in the UK since 1988. Grey seals recorded within the Zone are associated with a number of sites along the east coast of England and Scotland including as far south as Donna Nook in England, north of Shetland and as far west as the Outer Hebrides (see inset map in Figure 10.7). Grey seal telemetry locations have been recorded over the whole of the Project area. Grey seal sightings were concentrated to the north of the Zone (Scalp Bank) and on two parallel concentrations of sightings running approximately north north-west through the area, following Marr Bank and Wee Bankie, with another concentration in the south east corner of the area (Berwick Bank). These areas are thought to be important areas for sandeels, an important part of grey seal diet in the region (Hammond and Prime 1990, Hall *et al.* 2000, Hammond and Grellier 2006).

## At-sea Usage

10.82. Grey seal at sea usage in the East Coast Scotland MU is variable with hotspots at the Tay and Eden Estuary and north of Aberdeen at the Ythan Estuary and The Scares (Figure 10.8). The highest density within the Tay and Eden Estuary area is 300 grey seals/cell which, assuming a uniform density across a grid cell, equates to 12 grey seals/km$^2$. There is also a hotspot that extends offshore from the Berwickshire and North Northumberland Coast SAC in northeast England. Within the optimised Seagreen Project the highest predicted usage is 37.8 grey seals/cell which, assuming a uniform density across a grid cell, equates to a density of 1.5 grey seals/km$^2$. The minimum distance between the optimised Seagreen Project and the high density grid cells at the Tay and Eden Estuary is 46km.

## Visual Surveys

10.83. Grey seal sighting rates during the boat based surveys were lowest over the autumn and winter. Overall, encounter rates were reduced in 2011 compared to 2010. Grey seals were seen in every month of the boat based survey, but encounter rates were highly variable between months, with highest encounter rates in June in both years. This may be a result of grey seal spending a period of intense foraging at-sea, to build energy reserves prior to the breeding season.

10.84. The 2017 boat based surveys recorded grey seals in the Phase 1 area + 2km buffer on every trip. Numbers of grey seals recorded was highest, 45 animals in early summer and lowest in late summer, 15 animals.

10.85. A number of seals were recorded during the TCE aerial surveys, however, the majority were not identified to species level (Plate 10.2).

## Grey Seal Baseline Conclusion

10.86. Grey seals have the potential to be impacted by the effects of underwater noise generated by piling activity. The spatially explicit grey seal densities from Figure 10.8 will be used in the quantitative noise impact assessment to quantify the number of seals that might experience noise levels that could cause disturbance. The results of this process will be presented with reference to the total population of the grey seal East Coast Management Unit.

## Bottlenose dolphin

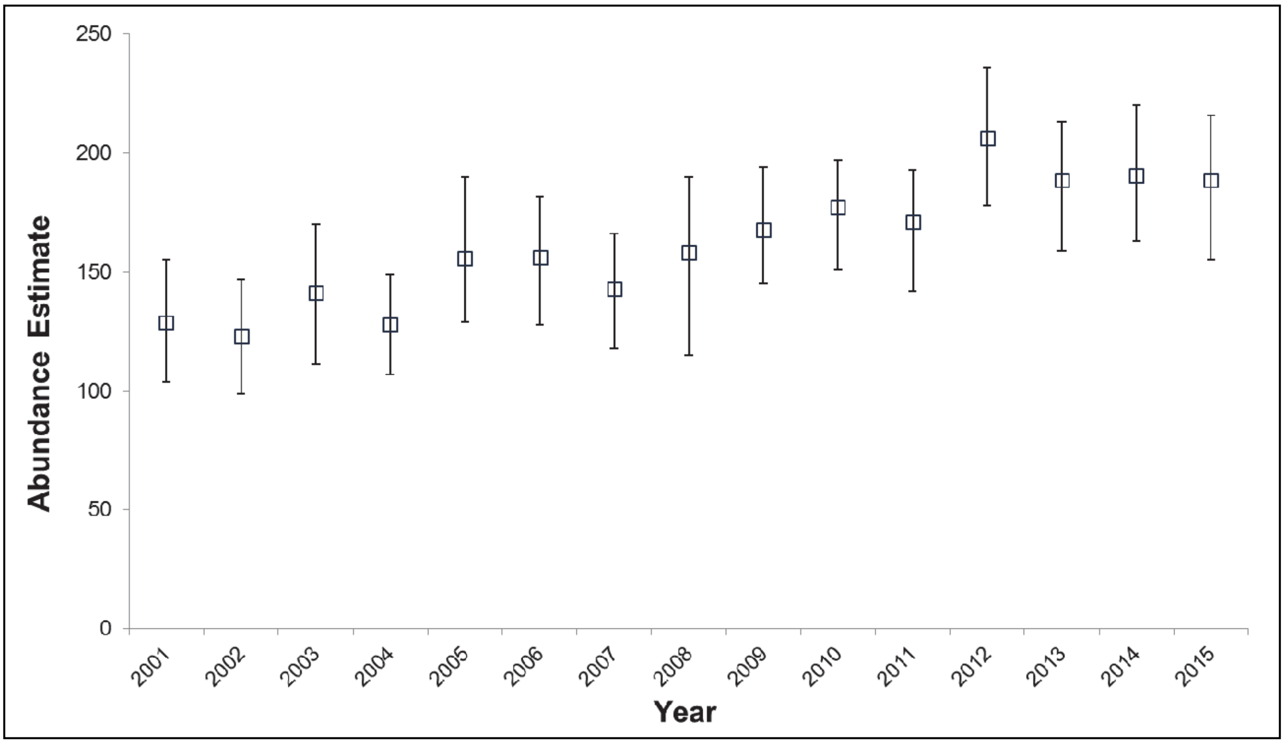
### *Current baseline*

10.87. In the UK, bottlenose dolphins are considered to have a Favourable Conservation Status. The Moray Firth population of bottlenose dolphins is the only known remaining resident population in the North Sea and it was for this reason that the Moray Firth SAC was established in order to protect this population.

### Photo-ID surveys

10.88. The current population estimate of bottlenose dolphin abundance for the Coastal East Scotland MU population is 195 individuals (95% Highest Posterior Density Intervals (HPDI): 162 to 253) based on photo-ID counts between 2006 and 2007 (Cheney et al. 2013). This resulted in a population growth rate estimate of 1.018 (Cheney et al. 2013). The results of further surveys which provide a less robust estimate of absolute abundance, but a confident indication of trends suggest that the east coast Scotland population has continued to increase in size since 2007, therefore the current population size is likely to be larger than this (Plate 10.4) (Cheney *et al.* 2018). However, this can't be confirmed until the analysis carried out by Cheney et al. (2013) can be repeated on more recent data.

**Plate 10.4 Annual estimates of the east coast of Scotland bottlenose dolphin population from 1990 to 2015 with 95% highest posterior density intervals (HPDI) (Cheney *et al.* 2018).**




10.89. Between 1990 and 2015 the number of individuals using the SAC has remained stable, with some inter-annual variability; 98 individuals (95% CI: 83 to 116) whilst the population size has increased, which means that the proportion of the population that uses the SAC has declined (Graham *et al.* 2016). Whilst the Moray Firth is clearly an important area for this population, they are not restricted to the either the Moray Firth SAC or the wider Moray Firth. Instead, these animals are highly mobile, and have a large range that extends east along the outer Moray Firth coastline and south to the Firth of Forth (Cheney *et al.* 2013).

10.90. Overall, the long-term photo-ID data have shown that the East Coast Scotland bottlenose dolphin population has increased since 1990 and is currently considered a healthy population with a favourable conservation status.

10.91. Quick *et al.* (2014) demonstrated that individuals from the Moray Firth are known to range up and down the coast but there is much spatial and temporal variability in individual movements. In the Tayside and Fife area dolphins were encountered more often in and around the Tay estuary in waters less than 20m deep and within 2km of the coast. The Tay estuary has consistently high encounter rates of bottlenose dolphins over the years. Between 71 (95% CI 63-81) and 91 (95% CI 82-100) bottlenose dolphins from the east coast population were estimated to be using the Tay area during 2009 to 2013, representing approximately 35 to 46% of the total Scottish east coast population. Bottlenose dolphins were also frequently encountered along the coast between Montrose and Aberdeen in waters less than 20m deep and within 2km of the coast. Dolphins were frequently found at the entrance to Aberdeen Harbour and adjacent waters. Data collected in 2012-13 indicate that around 25% of the total Scottish east coast population uses the area between Stonehaven and Aberdeen. Based on these recent data, 118 (95% CI: 98-143) and 119 (95% CI: 101-140) individuals were estimated to be using the area between Aberdeen and the Firth of Forth in 2012 and 2013, respectively, representing greater than 60% of the total Scottish east coast bottlenose dolphin population (Quick *et al.* 2014).

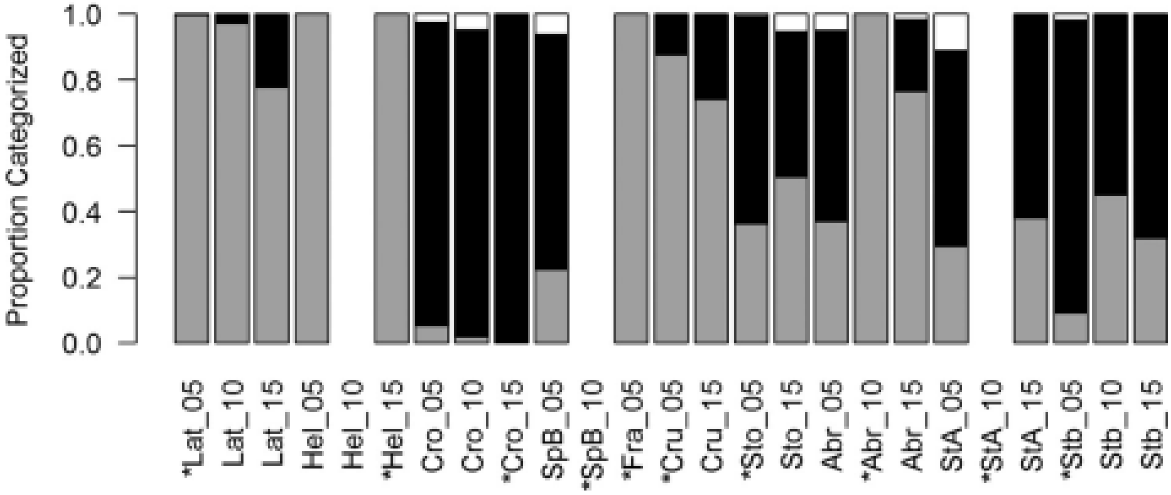
## TPOD acoustic surveys

10.92. T-POD data from Fife Ness show no significant inter-annual difference in the number of days of detections between 2007 and 2008. Dolphins were detected on 24% of days in Arbroath and 18% of days in Fife Ness. Both of these sites show lower detection rates in comparison with a core sites in the SAC (the mouth of the Cromarty Firth), where dolphin were detected on over 70% of days over the same time period (Thompson *et al.* 2012).

## ECOMMAS

10.93. Dolphin acoustic detection rates were low across all of the ECOMMAS PAM sites; on average dolphin were detected on between two and 30% of the surveyed days. Given the data presented in Quick *et al.* (2014) it is highly likely that only the recording stations closest to the shore in each location was regularly detecting bottlenose dolphins. These data have been further analysed to separate the CPOD 'dolphin' detection data into two groups: broad-band echolocation clicks (made by bottlenose and common dolphins) and frequency banded echolocation clicks (made by Risso's and white-beaked dolphins) (Palmer *et al.* 2017). The analysis of the CPOD data from the ECOMMAS surveys have shown that the proportion of these two categories varies amongst the sites closest to the optimised Seagreen Project. At the inshore Arbroath (Arb_05) and St Andrews (StA_05) sites approximately 60% of the detections were potentially bottlenose dolphins (Plate 10.5). Further offshore, the proportion of dolphin positive days were higher but a large proportion of the offshore Arbroath (Abr_10 and Abr_15) detections have mostly been frequency banded echolocation clicks and so are likely to be either Risso's or white-beaked dolphins.

**Plate 10.5 The proportion of click trains recorded at ECOMMAS PAM sites within the ECOMASS study area classified as broadband (black), frequency banded (grey) or unknown (white) by the combination of the Generalised Additive model (GAM) click-train classification and the encounter likelihood ratio (Palmer et al. 2017). Asterisks indicate joint C-POD/SM2M deployment locations from which training data were derived and where CPODs were displaced no data are presented.**




## Density grid

10.94. Given the results of both the ECOMMAS survey data and the photo ID work presented in Quick et al. (2014), a density grid was created for bottlenose dolphins along the east coast of Scotland (excluding the Moray Firth) (Figure 10.9). This grid allocated half of the MU population (98 animals) evenly within cells located within the 20m depth contour between Aberdeen and south of the Firth of Forth.

## Bottlenose dolphin baseline conclusion

10.95. The East Coast bottlenose dolphin population has the potential to be impacted by the effects of underwater noise generated by piling activity. In order to carry out a quantitative assessment of the number of dolphins potentially affected, it is assumed that half of the total management unit population (98) will be spread evenly across the area inside the 20m depth contour as agreed in the 2017 Scoping Opinion and in subsequent discussion with SNH and MSS (22 Nov 2017, Table 10.3).

## Harbour porpoise

### *Current baseline*

10.96. Harbour porpoise are the smallest and most abundant cetacean species in UK waters (Reid *et al.* 2003). Harbour porpoise in the UK are considered to have a Favourable Conservation Status (JNCC 2013). The Seagreen Project is located within the ICES North Sea Assessment Unit for harbour porpoise, which is estimated to have an abundance of 345,373 porpoise (95% CI: 246,526 to 495,752) based on estimates from Hammond *et al.* (2017).

## SCANS

10.97. The SCANS III estimated abundance for block R was 38,646 porpoise (95% CI: 20,584 to 66,524) with an estimated density of 0.599 porpoise/km$^2$ (Hammond *et al.* 2017).

## JCP Phase III

10.98. The JCP Phase III analysis provides estimated abundances for harbour porpoise in 2010 by season for the Firth of Forth area of commercial interest region (see Plate 10.1). This estimates highest abundance in the winter months, with an estimate of 7,000 animals, similar estimates in spring and summer of 3,500 and 4,400 respectively and lowest estimates in autumn of 2,500 animals (Paxton *et al.* 2016). These equate to density estimates of 0.492 porpoise/km$^2$ in the winter, 0.246 porpoise/km$^2$in the spring, 0.309 porpoise/km$^2$ in the summer and 0.176 porpoise/km$^2$ in the winter.

10.99. The scaled abundance of harbour porpoise within the area defined in Plate 10.1 averaged for summer 2007 to 2010 was 11,683 (95% CI 5,675 to 17,358) which equates to a density estimate of 0.318 porpoise/km$^2$ (95% CI 0.154 to 0.473).

## JNCC Report 544: Harbour Porpoise Density

10.100. The Heinänen and Skov (2015) analysis predicted varying densities in both the summer and winter months in the central part of the North Sea MU. The density estimates within the outer Forth and Tay region were predicted to be relatively low compared to other parts of the North Sea. It is also worth highlighting here that the analysis presented in Heinänen and Skov (2015) relies on extensive extrapolation of survey data over space and time. Any such extrapolation is sensitive to the covariates used in models, as opposed to predictions within the support of the data. Subjective decisions in the retention of covariates in Heinänen and Skov (2015) calls into question the validity of such extrapolation.

## ECOMMAS

10.101. Harbour porpoise were detected at all ECOMMAS PAM sites in all survey years. Detection rates were high, with average porpoise positive days across all survey years ranging between 57 and 100%. Most sites (14 of the 15) had average porpoise detection positive days for over 90% of the time surveyed. Most sites had between about eight and 12 porpoise positive hours per day. Together these data suggest that harbour porpoises are frequently found in the coastal area monitored by ECCOMAS. There was no clear pattern in detections with distance to shore based on these metrics.

## Visual surveys

10.102. Boat based sightings of harbour porpoise were made in all months, apart from June and November 2010 and May and October 2011. Generally, encounter rates were highest in the spring and summer.

10.103. Boat based sightings of harbour porpoise in the Phase 1 area + 2 km buffer in summer 2017 recorded the highest counts on 9/10 May, 56 animals and 25/26 July, 39 animals. In all other surveys the number of animals counted was less than 10.

10.104. During the 2009 and 2010 TCE aerial surveys, the greatest number of harbour porpoise (31 out of 50) were recorded during the summer. Summer density estimates were calculated to be 0.099 (CV 0.12) individuals per km$^2$, and winter 0.048 (CV 0.24) individuals per km$^2$.

## Harbour porpoise baseline conclusion

10.105. Harbour porpoise are relatively common in the study area and have the potential to be impacted by the effects of underwater noise generated by piling activity. In order to carry out a quantitative assessment of the number of harbour porpoises potentially affected, it was proposed that in the absence of recent, site specific density estimates at the appropriate spatial scale, the uniform density estimate from the recent SCANS III surveys will be used.

## Minke whale

### *Current baseline*

10.106. Minke whales are widely distributed around the UK, with higher densities recorded on the West coast of Scotland and the western North Sea (Reid *et al.* 2003). They occur mainly on the continental shelf in water depths less than 200 m and are sighted more frequently in the summer months between May and September. Minke whales in the UK are considered to have a Favourable Conservation Status (JNCC 2013) and all minke whales in UK waters are considered to be part of the Celtic and Greater North Seas MU (IAMMWG 2015). There is an abundance estimate for this MU of 23,528 animals (95% CI: 13,989 to 39,572).

### SCANS

10.107. The SCANS III estimated abundance for block R was 2,498 minke whales (95% CI: 604 to 6,791) with an estimated density of 0.039 whales/km$^2$ (Hammond *et al.* 2017).

### JCP Phase III

10.108. The JCP Phase III analysis provides estimated abundances for minke whales in 2010 by season for the Firth of Forth area of commercial interest region (see Plate 10.1), and estimates highest abundance in the summer months (360 animals), with similar low estimates in all other seasons (20 to 60 animals). This equates to density estimates between 0.001 whales/km$^2$ and 0.025 whales/km$^2$.

10.109. The scaled abundance of minke whales within the area defined in Plate 10.1 averaged for summer 2007-2010 was 709 (95% CI 402 - 863) which equates to a density estimate of 0.019 whales/km$^2$ (95% CI 0.011 – 0.023).

### Minke whale density

10.110. According to modelling work carried out to inform MPA selection (Paxton *et al.* 2014), off the east coast of Scotland the highest minke whale density is located around the proposed Southern Trench SAC in the outer Moray Firth where densities reach a >10 minke whales/km$^2$. Outside of the Moray Firth, the area with the highest predicted density is located off the coast between Stonehaven and Inverbervie where there is a predicted density of up to 3.6 minke whales/km$^2$. Unfortunately there was almost no overlap between this dataset and the optimised Seagreen Project.

### Visual surveys

10.111. Sixty-two minke whales (0.003 sightings/hour) were recorded during the Seagreen specific boat based surveys. Minke whales were seen throughout the survey area, including both Project Alpha and Project Bravo. A strong seasonal pattern to the sightings data for minke whale was recorded during the boat based surveys, with most encountered during the spring and summer months, with high rates in May 2010 and June 2011. The greatest number of minke whales counted from boat based surveys in the optimised Seagreen Project area + 2km buffer was 13 animals on 25/26 July 2017 where two unidentified whales were also recorded.

10.112. Insufficient sightings were made during TCE aerial surveys to estimate average densities of minke whales using these data alone.

## Minke whale baseline conclusion

10.113. Minke whales have been sighted relatively often in the study area, much more frequently in the summer months. Although present at low densities, they have the potential to be impacted by the effects of underwater noise generated by piling activity. In order to carry out a quantitative assessment of the number of minke whales potentially affected, it is proposed that in the absence of recent, site specific density estimates at the appropriate spatial scale, the uniform density estimate from the recent SCANS III surveys have been be used.

## White-beaked dolphin

### *Current baseline*

10.114. White-beaked dolphins in the UK are considered to have a Favourable Conservation Status (JNCC 2013). The SCANS III surveys produced a white-beaked dolphin abundance estimate of 36,287 across all surveyed blocks (95% CI 18,694 to 61,869) (Hammond *et al.* 2017), however, this is not equivalent to the previous estimate for the total Celtic and Greater North Seas MU as the SCANS III surveys did not cover all of the MU. In the absence of an alternative updated abundance estimate for the entire MU, the SCANS III white-beaked dolphin abundance estimate is considered the most appropriate to take forward as the reference population size for impact assessment.

### SCANS

10.115. The SCANS III estimated abundance for survey Block R was 15,694 white-beaked dolphins (95% CI: 3,022 to 33,340) and a density of 0.243 dolphins/km$^2$ (Hammond *et al.* 2017).

### JCP Phase III

10.116. The JCP Phase III analysis provides estimated abundances for white-beaked dolphin in 2010 by season for the Firth of Forth area of commercial interest, and estimates highest abundance in the spring months (1,760 animals) with lower estimates in all other seasons; summer (720 animals), autumn (540 animals) and winter (410 animals). This equates to density estimates between 0.038 dolphins/km$^2$ in Autumn and 0.124 dolphins/km$^2$ in Spring.

10.117. The number of white-beaked dolphins within the area defined in Plate 10.1 was a scaled abundance estimate averaged for summer 2007 to 2010 of 5,027 (95% CI 108 to 6,068) which equates to a density estimate of 0.137 dolphins/km$^2$ (95% CI 0.003 to 0.165).

### Visual surveys

10.118. During the Seagreen specific boat based survey, white-beaked dolphin was recorded most often during the summer, in both 2010 and 2011.

10.119. The boat based surveys of optimised Seagreen Project area + 2km buffer in summer 2017 recorded white-beaked dolphins on two of the five surveys.

10.120. Density estimates for white beaked dolphin were 0.042 (CV 0.031) individuals per km$^2$ based on TCE aerial surveys. Summer and winter estimates were 0.052 (CV 0.35) and 0.024 (CV 0.66) individuals per km$^2$, respectively.

### White-beaked dolphin baseline conclusion

10.121. White-beaked dolphins have been sighted occasionally in the study area, and similar to minke whales, are seen more frequently in the summer months. Although present at low densities, they have the potential to be impacted by the effects of underwater noise generated by piling activity. In order to carry out a quantitative assessment of the number of white-beaked dolphins potentially affected, it is proposed that in the absence of recent, site specific density estimates at the appropriate spatial scale, the uniform density estimate from the recent SCANS III surveys will be used.

## Baseline summary

10.122. Based on the data obtained from the baseline characterisation desk based study and the site-specific surveys conducted for Seagreen, the abundance and density values for each marine mammal species presented in Table 10.16 have been identified as the most robust values to take forward for the impact assessment.

**Table 10.16 Current species specific MU and density estimates to be taken forward for impact assessment.**

| Species | MU | MU Size | MU Source | Density Estimate | Density Source |
|---|---|---|---|---|---|
| **Harbour seal** | East Coast Scotland | 511 | August 2016 haul-out count | 5x5 km grid cell specific at-sea usage | Russell *et al.* (2017)<br>As agreed in the 2017 Scoping Opinion and subsequent consultation |
| **Grey seal** | East Coast Scotland | 10,891 | August 2016 haul-out count | 5x5 km grid cell specific at-sea usage | Russell *et al.* (2017)<br>As agreed in the 2017 Scoping Opinion and subsequent consultation |
| **Bottlenose dolphin** | Coastal East Scotland | 195 | Cheney *et al.* (2013) | 98 bottlenose dolphins spread evenly across the area inside the 20 m depth contour | As agreed in the 2017 Scoping Opinion and subsequent consultation |
| **Harbour porpoise** | North Sea (ICES Assessment Unit) | 345,373 | SCANS III | SCANS III Block R 0.599 porpoise/km$^2$ | SCANS III<br>As agreed in the 2017 Scoping Opinion and subsequent consultation |
| **Minke whale** | Celtic and Greater North Seas | 23,528 | IAMMWG (2015) | SCANS III Block R 0.039 whales/km$^2$ | SCANS III<br>As agreed in the 2017 Scoping Opinion and subsequent consultation |
| **White-beaked dolphin** | Celtic and Greater North Seas | 36,287 | SCANS III | SCANS III Block R 0.243 dolphins/km$^2$ | SCANS III<br>As agreed in consultation |

### *Predicted future baseline*

10.123. It is challenging to predict the future trajectories of marine mammal populations in the absence of the project. Some UK marine mammal populations have undergone periods of significant change in parts of their range, with a limited understanding of the driving factors responsible. For example there is uncertainty about whether it is pup survival or fecundity that is responsible for the recent exponential growth of grey seals in the North Sea (Russell 2017). Similarly harbour seals in large parts of their range in Scotland have undergone dramatic declines with no clear indication of the responsible factors (Arso Civil *et al.* 2017). Additionally, monitoring is not in place at the relevant temporal or spatial scales to really understand the baseline dynamics of some marine mammal populations. Relevant to this assessment, this includes minke whales and white-beaked dolphins.

10.124. Where possible and required for assessment, specific quantitative predictions of future population trajectories are evaluated for direct comparison with predicted impacted populations in the following sections.

10.125. The bottlenose dolphin population of the east coast of Scotland is thought to be increasing (Cheney *et al.* 2018) and it is expected that this trend might increase throughout 25 year period equivalent to the project design life, although this would be dependent on the carrying capacity of the population not being reached. The population may continue the expansion identified by (Wilson *et al.* 2004) but again, this is difficult to predict.

10.126. Within the East Scotland MU for harbour seals there has been a drastic decline in the Firth of Tay and Eden Estuary SAC population size from a mean count between 1990 and 2002 of 641 animals to a 2016 count of 51 animals, which represents a 90% decrease (SCOS 2017). Population modelling work conducted for the Firth of Tay and Eden Estuary population has concluded that if this declining trend continues, the population will effectively become extinct within the next 20 years (Hanson *et al.* 2015).

10.127. In contrast to harbour seals, the grey seal population within the east Scotland MU is doing well, and latest August counts have increased since the 2007-2009 counts, both overall within the MU and within the Tay and Eden Estuary SAC (SCOS 2017). On a wider scale, the estimates of grey seal pup production have significantly increased within the North Sea with an annual increase in pup production of ~10.8% p.a. between 2012 and 2014. At the Farne Islands, which is located within the Berwickshire and North Northumberland Coast SAC within the northeast England MU and approximately 100km from the Seagreen Project (within normal grey seal travelling distances), the pup production estimate increased by 28% between 2014 and 2016.

10.128. The most recent UK assessment of favourable conservation status resulted in an assessment of Favourable for bottlenose dolphins (JNCC 2013b), harbour porpoise (JNCC 2013a), grey seals (JNCC 2013c), white-beaked dolphins and minke whales (DEFRA 2017). In 2007 harbour seals were classified as "Inadequate" which was updated in the 2013 assessment to 'Bad declining' (JNCC 2013d). These assessments take into consideration the short term and long term trends of the populations and provide an assessment of the future prospects of the population. For harbour porpoise and bottlenose dolphins, both the short and long term trends in population size were categorised as stable and the assessment resulted in a conclusion of both species having Favourable future prospects. For grey seals both the short and long term trends in population size were categorised as increasing and the assessment resulted in a conclusion of the species having Favourable future prospects. For harbour seals both the short and long term trends in population size were categorised as decreasing and the assessment resulted in a conclusion of the species having Bad future prospects.

10.129. The potential impacts of climate change on marine mammals was reviewed and synthesised by Evans and Bjørge (2013). They concluded that the impacts of climate change on marine mammals remains poorly understood. In the UK, changes are predicted to manifest in relation to changes in prey abundance and distribution as a result of warmer sea temperatures, and enhanced stratification forcing earlier occurrence of the spring phytoplankton bloom and potential cascading effects through the food chain (Evans and Bjørge 2013). The authors also conclude that the NW European species likely to be most affected in the future will be those that have relatively narrow habitat requirements and that shelf sea species like the harbour porpoise, white-beaked dolphin and minke whale may come under increased pressure with reduced available habitat, if they experience range shifts northwards. Although the main cause of widespread declines in UK harbour seal population is not known, the prevalence in the population of domoic acid derived from toxic algae may be a contributory factor, and could be exacerbated by increased sea temperatures (Evans and Bjørge 2013). In addition, sea level rise and an increase in storm frequency and associated wave surges could affect the availability of haul out sites for seals. Increased storm frequency and associated conditions could also lead to increased pup and calf mortality.

## ASSESSMENT OF IMPACTS

10.130. As identified within the 'Scope of Assessment' the impact assessment for marine mammals considers the potential impacts of the optimised Seagreen Project in relation to underwater noise due to piling. All other impacts have been scoped out of this EIA Report.

10.131. The assessment considers the potential impacts of Project Alpha alone; Project Bravo alone; Project Alpha and Project Bravo combined (the optimised Seagreen Project) and Project Alpha and Project Bravo in a cumulative scenario. As set out in Chapter 6 (EIA Process), impacts reported are adverse unless stated otherwise. The following sections set out the assessment of potential impacts during construction. Impacts during the operation and decommissioning phases of the Project have been scoped out of the assessment in line with the 2017 scoping opinion.

10.132. Before the assessment of impacts, supporting information is provided on the sensitivity of each marine mammal species to noise impacts from pile driving. The build scenarios in terms of wind turbine foundation piling are then considered so that appropriate worst case scenarios can be taken forward for assessment.

### Sensitivity of Marine Mammals to Noise Impacts from Pile Driving

#### *PTS*

10.133. Exposure to loud sounds can lead to a reduction in hearing sensitivity, which can be (and in general is) restricted to particular frequencies. This reduction (threshold shift) results from physical injury to the auditory system and may be temporary (TTS) or permanent (PTS). For the purposes of this assessment PTS is taken as the appropriate threshold for the assessment of auditory injury, due to the permanent change in hearing sensitivity. The ecological consequences of PTS for marine mammals is uncertain.

10.134. At a recent BEIS funded expert elicitation workshop held at the University of St Andrews, experts in marine mammal hearing discussed the nature, extent and potential consequence of PTS to UK marine mammal species (Booth and Heinis 2018). A number of general points came out in discussions as part of the elicitation. These included that PTS did not mean animals were deaf, that the limitations of the ambient noise environment should be considered and that the magnitude and frequency band in which PTS occurs are critical to assessing the effect on vital rates. Southall *et al.* (2007) defined the onset of temporary threshold shifts (TTS) as "being a temporary elevation of a hearing threshold by 6 dB" (in which the reference pressure for the dB is 1µPa). Although 6 dB of TTS is a somewhat arbitrary definition of onset, it has been adopted largely because 6 dB is a measurable quantity that is typically outside the variability of repeated thresholds measurements. The onset of PTS was defined as a non-recoverable elevation of the hearing threshold of 6 dB, for similar reasons. Based upon TTS growth rates obtained from the scientific literature, it has been assumed that the onset of PTS occurs after TTS has grown to 40 dB. The growth rate of TTS is dependent on the frequency of exposure, but is nevertheless assumed to occur as a function of an exposure that results in 40 dB of TTS, i.e. 40 dB of TTS is assumed to equate to 6 dB of PTS. To put this magnitude of loss of sensitivity into context, in humans, hearing loss due to aging can lead to reduction in sensitivity at the highest frequency part of the hearing spectrum of ~10 dB. By age 40 this increases to 30 dB, by age 60, this can be as much as 70 dB in the highest frequencies and 30 dB in the mid frequencies. 'Mild' hearing loss in humans is defined as a loss of hearing sensitivity of 20-40 dB[2]. Experts agreed that any threshold shifts as a result of pile driving would manifest themselves in the 2-10 kHz range (Kastelein *et al.* 2017), and that a PTS 'notch' of 6 dB in a narrow frequency band in the 2-10 kHz region is unlikely to significantly affect the fitness of individuals.

## Seals

10.135. Seals are less dependent on hearing for foraging than cetaceans, but may rely on sound for communication and predator avoidance (e.g. Deecke *et al.* 2002). Seals have very well developed tactile sensory systems that are used for foraging (Dehnhardt *et al.* 2001), Hastie *et al.* (2015) reported that, based on calculations of SEL of tagged seals during the Lincs OWF construction, at least half of the tagged seals would have received a dose of sound greater than published thresholds for PTS. Based on the extent of the OWF construction in the Wash over the last ten years and the degree of overlap with the foraging ranges of harbour seals in the region (e.g. Russell *et al.* 2016), it would not be unreasonable to suggest that a large number of individuals of the Wash population may have experienced levels of sound with the potential to cause hearing loss. The Wash harbour seal population has been increasing over this period which may provide an indication that either: a) seals are not developing PTS despite predictions of exposure that would indicate that they should; or b) that the survival and fitness of individual seals are not affected by PTS. a) would indicate that methods for predicting PTS are perhaps unreliable and over precautionary, b) would suggest a lack of sensitivity to the effects of PTS. At the recent BEIS funded expert elicitation workshop (Booth and Heinis 2018) experts concluded that the probability of PTS significantly affecting the survival and reproduction of either seal species was low. As a result of this, and the fact that seals do not generally use hearing as their primary sensory modality for finding prey and navigation, in the same way as cetaceans do, the sensitivity of seals to PTS has been assessed as **low**.

## Cetaceans

10.136. It should be noted that most piling noise is relatively low frequency, and therefore the effect of PTS is manifest as a small "notch" at 2-10 kHz, consequently the effect on all cetacean species may be minimal. The low frequency noise produced during piling may be more likely to overlap with the hearing range of low frequency cetacean species such as minke whales. For minke whales, Tubelli *et al.* (2012) estimated the most sensitive hearing

[2] https://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0089568/

range is defined as the region with thresholds within 40 dB of best sensitivity, to extend from 30 to 100 Hz up to 7.5 to 25 kHz, depending on the specific model used. Therefore a 2-10 kHz notch of 6 dB will only affect a small region of minke whale hearing. In addition, minke whale communication signals have been demonstrated to be below 2 kHz (Edds-Walton 2000, Mellinger *et al.* 2000, Gedamke *et al.* 2001, Risch *et al.* 2013, Risch *et al.* 2014). Like other mysticete whales, minke whales are also thought to be capable of hearing sounds through their skull bones (Cranford and Krysl 2015).

10.137. Although the potential for PTS resulting from exposure to pile driving noise to affect the survival and reproduction of individuals is low, given the current uncertainty surrounding these effects and how critical sound can be for echolocation, foraging and communication in cetaceans, all cetaceans have been assessed as having a **medium** sensitivity to PTS.

### *Behavioural effect: displacement*

### Harbour seals

10.138. A study of tagged harbour seals in the Wash has shown that they are displaced from the vicinity of piles during pile-driving activities. Russell *et al.* (2016) showed that seal abundance was significantly reduced within an area with a radius of 25km from a pile, during piling activities, with a 19 to 83% decline in abundance during pile-driving compared to during breaks in piling. The duration of the displacement was only in the short-term as seals returned to non-piling distributions within two hours after the end of a pile-driving event. Unlike harbour porpoise, both harbour and grey seals store energy in a thick layer of blubber, which means that they are more tolerant of periods of fasting when hauled out and resting between foraging trips, and when hauled out during the breeding and moulting periods. Therefore, they are unlikely to be particularly sensitive to short-term displacement from foraging grounds during periods of active piling. Juvenile harbour seals may be more sensitive to displacement from foraging grounds due to a smaller body size and higher energetic needs. Harbour seals also need to continue feeding during lactation to support their pups, and therefore may be more sensitive at particular times of year. Taking the above into consideration, harbour seals have been assessed as having **medium** sensitivity to disturbance and resulting displacement from foraging grounds during pile-driving events.

### Grey seals

10.139. Grey seals are capital breeders and store energy in a thick layer of blubber, which means that, in combination with their large body size, they are tolerant of periods of fasting as part of their normal life history. Grey seals are also highly adaptable to a changing environment and are capable of adjusting their metabolic rate and foraging tactics, to compensate for different periods of energy demand and supply (e.g. Beck *et al.* 2003, Sparling *et al.* 2006). Grey seals are also very wide ranging and are capable of moving large distances between different haul out and foraging regions (e.g. Russell *et al.* 2013). Therefore, they are unlikely to be particularly sensitive to displacement from foraging grounds during periods of active piling. Juvenile grey seals may be more sensitive due to their lower body size but grey seal pups fast immediately post-weaning and therefore may also be physiologically less sensitive to disturbance than harbour seals. As such, grey seals seal have been assessed as having **low** sensitivity to disturbance and resulting displacement from foraging grounds during pile-driving events.

## Bottlenose dolphins

10.140. Bottlenose dolphins have been shown to be displaced from an area as a result of the noise produced by offshore construction activities; for example, avoidance behaviour in bottlenose dolphins has been shown in relation to dredging activities (Pirotta *et al.* 2013).

10.141. In a recent study on bottlenose dolphins in the Moray Firth (in relation to the construction of the Nigg Energy Park in the Cromarty Firth), small effects of pile driving on dolphin presence have been observed, however, dolphins were not excluded from the vicinity of the piling activities (Graham *et al.* 2017b). In this study the median peak-to-peak source levels recorded during impact piling were estimated to be 240 dB re 1µPa (range 8 dB) with a single pulse source level of 198 dB re 1 $\mu Pa^2 s$. The pile driving resulted in a slight reduction of the presence, detection positive hours and the encounter duration for dolphins within the Cromarty Firth, however, this response was only significant for the encounter durations. Encounter durations decreased within the Cromarty Firth (though only by a few minutes) and increased outside of the Cromarty Firth on days of piling activity. These data highlight a small spatial and temporal scale disturbance to bottlenose dolphins as a result of impact piling activities.

10.142. There is the potential for behavioural disturbance and displacement to result in disruption in foraging and resting activities and an increase in travel and energetic costs, however, it has been previously shown that bottlenose dolphins have the ability to compensate for behavioural responses as a result of increased commercial vessel activity (New *et al.* 2013). Therefore, while there remains the potential for disturbance and displacement to affect individual behaviour and therefore vital rates and population level changes, bottlenose dolphins do have some capability to adapt their behaviour and tolerate certain levels of disturbance. Therefore, bottlenose dolphins have been assessed as having a **medium** sensitivity to disturbance and resulting displacement.

## Harbour porpoise

10.143. Previous studies have shown that harbour porpoise are displaced from the vicinity of piling events. For example, studies at wind farms in the German North Sea have recorded large declines in porpoise detections close to the piling (> 90% decline at noise levels above 170 dB) with decreasing effect with increasing distance from the pile (25% decline at noise levels between 145 and 150 dB) (Brandt *et al.* 2016). The detection rates revealed that porpoise were only displaced from the piling area in the short term (1 to 3 days) (Brandt *et al.* 2011, Dähne *et al.* 2013, Brandt *et al.* 2016). Harbour porpoise are small cetaceans which makes them vulnerable to heat loss and requires them to maintain a high metabolic rate with little energy remaining for fat storage. This makes them vulnerable to rapid starvation if they are unable to obtain sufficient levels of prey intake. Studies using Digital Acoustic Recording Tags (DTAGs) have shown that porpoise tagged after captured in pound nets foraged on small prey nearly continuously during both the day and the night on their release (Wisniewska *et al.* 2016). However, Hoekendjik *et al* (2018) point out that this could be an extreme short term response to capture in nets, and may not reflect natural harbour porpoise behaviour. Nevertheless, if the foraging efficiency of harbour porpoise is disturbed or if they are displaced from a high-quality foraging ground, and are unable to find suitable alternative feeding grounds, they could potentially be at risk of changes to their overall fitness if they are not able to compensate and obtain sufficient food intake in order to meet their metabolic demands.

10.144. The results from Wisniewska *et al.*, (2016) could also suggest that porpoises have an ability to respond to short term reductions in food intake, implying a resilience to disturbance. As Hoekendjik *et al.*, (2018) argue, this could help explain why porpoises are such an abundant and successful species. It is important to note that the studies providing evidence for the responsiveness of harbour porpoises to piling noise have not provided any evidence for subsequent individual consequences. In this way, responsiveness to disturbance cannot reliably be equated to sensitivity to disturbance and porpoises may well be able to compensate by moving quickly to alternative areas to feed, while at the same time increasing their feeding rates.

10.145. Monitoring of harbour porpoise activity at the Beatrice Offshore wind farm during pile driving activity has indicated that porpoises are displaced from the immediate vicinity of the pile driving activity – with a 50% probability of response occurring at approximately 7 km (Graham *et al.* 2017a). This monitoring also indicated that the response diminished over the construction period and that porpoise activity recovered between pile driving events.

10.146. Due to observed responsiveness to piling, and their income breeder life history, harbour porpoises have been assessed here as having a **medium** sensitivity to disturbance and resulting displacement from foraging grounds.

### Minke whales

10.147. There is little information available on the behavioural responses of minke whales to underwater noise. Minke whales have been shown to change their diving patterns and behavioural state in response to disturbance from whale watching vessels; and it was suggested that a reduction in foraging activity at feeding grounds could result in reduced reproductive success in this capital breeding species (Christiansen *et al.* 2013). Minke whales have also been reported to respond to ADD signals (McGarry *et al.* 2017). Since minke whales are known to forage in north and east Scotland region during the summer and autumn months (e.g. Robinson and Tetley 2007, Tetley *et al.* 2008, Robinson *et al.* 2009), there is the potential for displacement from foraging areas to impact on reproductive rates. Therefore, minke whales have been assessed as having a **medium** sensitivity to disturbance and resulting displacement from foraging grounds.

### White-beaked dolphins

10.148. There is limited information on the effects of disturbance on white-beaked dolphins specifically. However, there is evidence for bottlenose dolphins (as above) which can be used as a proxy since both species are categorised as mid-frequency cetaceans. By using the sensitivity of bottlenose dolphins as a proxy for white-beaked dolphins, white-beaked dolphins are assessed as having a **medium** sensitivity to disturbance.

### Summary

10.149. A summary of the sensitivity of each species to piling noise related effects is provided in Table 10.17.

**Table 10.17 Summary of marine mammal sensitivity to each potential pile-driving noise impact.**

| Species | Permanent threshold shift (PTS) | Behavioural disturbance/ potential avoidance |
|---|---|---|
| Harbour seal | Low | Medium |
| Grey seal | Low | Low |
| Bottlenose dolphin | Medium | Medium |
| Harbour porpoise | Medium | Medium |
| Minke whale | Medium | Medium |
| White-beaked dolphin | Medium | Medium |

## Worst Case Scenario

10.150. To inform the impact assessment for marine mammals, appropriate worst case scenarios have been defined using the information contained within the design envelope for the optimised Seagreen Project, Chapter 5 (Project Description). The worst case represents, for any given impact, the scenario within the range of options in the design envelope that is expected to result in the greatest potential for change to the receptors assessed.

10.151. Table 10.18 identifies the worst-case scenarios in relation to those issues scoped into the assessment and provides justification as to why no other scenario is expected to result in a greater impact on the receptors considered. It should be noted that, while the WCS is defined for each impact for Project Alpha and Project Bravo in isolation, the WCS would be consideration of the combined projects (the optimised Seagreen Project). The impact assessment undertaken therefore considers the impacts of each project in isolation as well as the projects combined.

10.152. As noted previously, for marine mammals, given their differing spatial usage (coastal and offshore species), the different foundation types under consideration and the different build out scenarios, it was not possible to determine prior to modelling which of the 13 potential build out scenarios listed in Table 10.6 would represent the worst case for disturbance. For example, for coastal species (bottlenose dolphins, harbour seals and grey seals) the build scenarios involving the installation of WTG at Project Alpha are likely to represent the spatial worst case scenario as Project Alpha is located closer to the coast and therefore closer to the highest density areas for the species. By contrast, for more offshore species (harbour porpoise, minke whale and white-beaked dolphins) the build scenarios involving the installation of WTG at Project Bravo are likely to represent the spatial worst case scenario as Project Bravo is located further offshore and therefore impact areas are likely to be larger as they will be less constrained by land.

10.153. In terms of temporal worst case scenarios, the build scenarios that result in the highest number of total piling days over the piling construction will likely represent the worst case scenario for all species. However, without population modelling, it is not known if the worst case scenario would result from higher numbers of animals disturbed for shorter periods of time or lower numbers of animals disturbed for longer periods of time. Therefore, it is not possible to determine which of the temporal and spatial scale combinations would result in the worst case scenario for each marine mammal species. Consequently all 13 potential build out scenarios listed in Table 10.6 have been assessed for each marine mammal species.

**Table 10.18 Worst Case parameters used in the assessment of all build scenarios as detailed in Table 10.6.**

| Type of Effect | Worst Case Parameters | Justification/Rationale of Selected Design Envelope Parameter |
|---|---|---|
| **Construction (piling)** | | |
| PTS | **Worst Case (SPL peak metric) (all species)**<br>Installation of a monopile:<br>• Maximum hammer energy: 3,000kJ; and<br>• 1 pile per day. | **Worst Case ($SPL_{peak}$ metric) (all species)**<br>The NOAA guidance states that PTS should be assessed using a dual criteria: $SPL_{peak}$ and $SEL_{cum}$.<br>The $SPL_{peak}$ is a measure of the risk of 'instantaneous' PTS which is likely to be worst case for the highest hammer energies, which are monopiles in this case. |
| | **Worst Case ($SEL_{cum}$ metric) (all species)**<br>Installation of pin piles:<br>• Maximum hammer energy: 1,800kJ; and<br>• Maximum 4 piles per day. | **Worst Case ($SEL_{cum}$ metric) (all species)**<br>The $SEL_{cum}$ is a measure of the cumulative risk of PTS over a 24 hour period. Therefore the scenario with the most number of piles installed per day is likely to represent the worst case, which is pin piles in this case.<br>**Since it was unknown which exact scenario would be the worst case in terms of PTS ranges, both the $SPL_{peak}$ and $SEL_{cum}$ metrics were assessed under all build scenarios.** |
| Disturbance | **Temporal Worst Case (all species)**<br>Installation of pin piles at Project Alpha and Project Bravo Sequentially:<br>• Maximum number of WTGs: 120 (70 Alpha, 50 Bravo);<br>• Maximum hammer energy: 1,800kJ;<br>• Maximum number of Piles: 280;<br>• Maximum piling days (assuming 2 pin piles per day – slow rate): 240 days; and<br>• Construction period (piling) duration: 2 years. | **Temporal Worst Case (all species)**<br>The installation of pin piles sequentially at Project Alpha then Project Bravo represents the highest number of piling days on which animals can be disturbed. |
| | **Spatial Worst Case (coastal species)**<br>Concurrent installation of monopiles and pin piles at Alpha:<br>• Maximum number of WTGs: 70 (35 MP, 35 PP);<br>• Maximum hammer energy: 3,000kJ (MP), 1,800 kJ (PP);<br>• Number of Piles: 175;<br>• Number of Piling days (assuming 1 monopile per day and 2 pin piles per day): 70 days; and<br>• Construction period (piling) duration: 2 years. | **Spatial Worst Case (coastal species)**<br>For coastal species (bottlenose dolphins, harbour seals and grey seals) the concurrent installation of monopiles and pin piles at Project Alpha represents the largest spatial footprint that overlaps with the highest density areas for the species. |
| | **Spatial Worst Case (offshore species)**<br>Concurrent installation of monopiles and pin piles at Project Bravo:<br>• Maximum number of WTGs: 70 (35MP, 35 PP);<br>• Maximum hammer energy: 3,000kJ (MP), 1,800kJ (PP);<br>• Number of Piles: 175;<br>• Number of Piling days (assuming 1 monopile per day and 2 pins per day): 70 days; and<br>• Construction period duration: 2 years. | **Spatial Worst case (offshore species)**<br>For more offshore species (harbour porpoise, minke whale and white-beaked dolphins) the concurrent installation of monopiles and pin piles at Project Bravo represents the largest spatial footprint. |

## Environmental Measures Incorporated Into the Project

10.154. Throughout the design evolution process measures have been taken to avoid potentially significant impacts wherever possible and practical to do so. Mitigation measures that are incorporated into the design of the project are referred to as 'environmental measures incorporated into the Project'. These measures are intended to prevent, reduce and where possible offset any significant adverse impacts on the environment. These are effectively 'built in' to the impact assessment and as such, the assessment includes consideration of these measures.

10.155. Mitigation measures that were identified for topics scoped out of this EIA Report and consent conditions applied to the originally consented project are provided within Chapter 7 (Scope of EIA Report). Measures relevant to the assessment of marine mammals are detailed below:

- There are environmental measures incorporated into the Project which include the use of a soft-start/ramp-up in hammer energy and the use of ADDs in order to minimise the risk of mortality or injury to marine mammals. The soft-start/ramp-up parameters for both monopiles and pin piles are detailed in Table 10.5. The underwater noise propagation modelling presented in the impact assessment includes an ADD activation period of 15 minutes and the soft-start procedures.
- A Piling Strategy, incorporating a Marine Mammal Mitigation Plan, will be produced for approval by the Scottish Ministers in advance of construction and will subsequently be followed during the construction phase. The Piling Strategy will outline the piling approach, the soft-start procedure, monitoring, and the detailed mitigation procedures to reduce to acceptable levels the potential risk of injury or mortality to marine mammals in close proximity to piling operations. The mitigation strategy will be informed by emerging information from the Beatrice Offshore Wind Farm project.
- A vessel management plan (VMP) will be developed which will determine vessel routing to and from construction areas and ports, to increase awareness of areas of high risk. This will also include codes of conduct for vessel behaviour and for vessel operators, including advice to operators to not deliberately approach marine mammals and to avoid abrupt changes in course or speed, should marine mammals approach the vessel to bow-ride.
- In addition, Seagreen will participate in any Forth and Tay Regional Advisory Group and Scottish Strategic Marine Environment Group (SSMEG) (if formed).

10.156. For clarity and as set out in Chapter 6 (EIA Process), the impact assessment of construction piling noise on marine mammals has been undertaken in the following stages:

- Assessment of projects in isolation
  - Impact Assessment - Construction phase
    - i. Project Alpha in isolation
    - ii. Project Bravo in isolation
    - iii. Project Alpha + Project Bravo combined
- Cumulative Impact Assessment
  - Cumulative Impact Assessment - Construction phase
    - i. Project Alpha + Project Bravo (the optimised Seagreen project) with other projects and plans, including the Transmission Asset.

# IMPACT ASSESSMENT – CONSTRUCTION PHASE

## Project Alpha

### *PTS Impacts from Piling Noise*

### Harbour and Grey Seals

#### *Potential Impacts*

10.157. Table 10.19 indicates the ranges within which there is a risk of PTS occurring to seals at Project Alpha. These ranges were derived from the underwater noise modelling detailed in Appendix 10B. Assuming an appropriate piling strategy and including best practice measures, these are unlikely to result in a risk of PTS to either seal species. Comparative values based on Southall *et al*. (2007) criteria are provided in Table 10.20.

**Table 10.19 PTS impact ranges (m) at full hammer energy for seal species at Project Alpha using the NOAA (National Marine Fisheries Service (2016) thresholds.**

| Threshold | Project Alpha |
|---|---|
| **Monopile 3,000kJ** | |
| unweighted $SPL_{pk}$ 218 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |
| **Pinpile 1,800kJ** | |
| unweighted $SPL_{pk}$ 218 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |
| **Concurrent Monopile 3,000kJ and Pin pile 1,800kJ** | |
| unweighted $SPL_{pk}$ 218 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |

**Table 10.20 PTS impact ranges (m) at full hammer energy for seal species at Project Alpha using the Southall *et al.* (2007) thresholds.**

| Threshold | Project Alpha |
|---|---|
| **Monopile 3,000kJ** | |
| unweighted $SPL_{pk}$ 218 dB re 1 µPa | <50m |
| $M_{PW}$ weighted $SEL_{cum}$ 186 dB re 1 µPa²s | <50m |
| **Pinpile 1,800kJ** | |
| unweighted $SPL_{pk}$ 218 dB re 1 µPa | <50m |
| $M_{PW}$ weighted $SEL_{cum}$ 186 dB re 1 µPa²s | <50m |

10.158. Based on the ranges presented in Table 10.19, the magnitude of impact of PTS on harbour and grey seals is predicted to be **Negligible.** As described from paragraph 10.133, the sensitivity of harbour and grey seals to PTS is **Low.** The impact of PTS on harbour and grey seals at Project Alpha is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.159. No additional mitigation is either required or proposed in relation to the effect of PTS on harbour and grey seals at Project Alpha as no adverse significant impacts are predicted.

### *Residual Impact*

10.160. The magnitude of impact of PTS on harbour and grey seals is predicted to be **Negligible**. The sensitivity of harbour and grey seals to PTS is **Low**. The residual impact of PTS on harbour and grey seals at Project Alpha is predicted to be **Negligible** and therefore not significant in EIA terms.

## Bottlenose and White-beaked Dolphins

### *Potential Impacts*

10.161. Table 10.21 (and Table 10.22 for Southall criteria) indicates the ranges within which there is a risk of PTS occurring to either species of dolphin at Project Alpha, as revealed by noise modelling (detailed in Appendix 10B). Assuming an appropriate piling strategy and including best practice measures, these are unlikely to result in a risk of PTS to any dolphin.

**Table 10.21 PTS impact ranges (m) at full hammer energy for mid-frequency cetaceans: bottlenose dolphins and white-beaked dolphins at Project Alpha using the National Marine Fisheries Service (2016) thresholds.**

| Threshold | Project Alpha |
|---|---|
| **Monopile 3,000kJ** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |
| **Pin pile 1,800kJ** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |
| **Concurrent Monopile 3,000kJ and Pinpile 1,800kJ** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |

**Table 10.22 PTS impact ranges (m) at full hammer energy for mid-frequency cetaceans: bottlenose dolphins and white-beaked dolphins at Project Alpha using the Southall *et al.* (2007) thresholds.**

| Threshold | Project Alpha |
|---|---|
| **Monopile 3,000kJ** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| $M_{MF}$ weighted $SEL_{cum}$ 198 dB re 1 µPa²s | <50m |
| **Pinpile 1,800kJ** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| $M_{MF}$ weighted $SEL_{cum}$ 198 dB re 1 µPa²s | <50m |

10.162. Based in the ranges presented in Table 10.21 the magnitude of impact of PTS on bottlenose and white beaked dolphins is predicted to be **Negligible**. As described from Paragraph 10.133, the sensitivity of bottlenose and white-beaked dolphins to PTS is **Medium**. The impact of PTS on bottlenose and white-beaked dolphins at Project Alpha is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.163. No additional mitigation is either required or proposed in relation to the effect of PTS on bottlenose and white-beaked dolphins at Project Alpha as no adverse significant impacts are predicted.

### *Residual Impact*

10.164. The magnitude of impact of PTS on bottlenose and white beaked dolphins is predicted to be **Negligible**. The sensitivity of bottlenose and white-beaked dolphins to PTS is **Medium**. The residual impact of PTS on bottlenose and white-beaked dolphins at Project Alpha is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

## Harbour Porpoise

### *Potential Impacts*

10.165. Table 10.23 (and Table 10.24 for Southall criteria) indicates the ranges within which there is a risk of PTS occurring to harbour porpoise at Project Alpha. Assuming an appropriate piling strategy and including best practice measures, these are unlikely to result in a risk of PTS to any harbour porpoise.

**Table 10.23 PTS impact ranges (m) at full hammer energy for harbour porpoise at Project Alpha using the NOAA (National Marine Fisheries Service (2016) thresholds.**

| Threshold | Project Alpha |
|---|---|
| **Monopile 3,000kJ** | |
| unweighted $SPL_{pk}$ 202 dB re 1 µPa | 170m |
| NMFS weighted $SEL_{cum}$ 155 dB re 1 µPa²s | <50m |
| **Pinpile 1,800kJ** | |
| unweighted $SPL_{pk}$ 202 dB re 1 µPa | 98m |
| NMFS weighted $SEL_{cum}$ 155 dB re 1 µPa²s | <50m |
| **Concurrent Monopile 3,000kJ and Pinpile 1,800kJ** | |
| unweighted $SPL_{pk}$ 202 dB re 1 µPa | 137m and 92m |
| NMFS weighted $SEL_{cum}$ 155 dB re 1 µPa²s | <50m |

**Table 10.24 PTS impact ranges (m) at full hammer energy for harbour porpoise at Project Alpha using the Southall *et al.* (2007) thresholds.**

| Threshold | Project Alpha |
|---|---|
| **Monopile 3,000kJ** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| $M_{HF}$ weighted $SEL_{cum}$ 198 dB re 1 µPa²s | <50m |
| **Pinpile 1,800kJ** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| $M_{HF}$ weighted $SEL_{cum}$ 198 dB re 1 µPa²s | <50m |

**10.166.** Based on the ranges presented in Table 10.23, the magnitude of impact of PTS on harbour porpoise is predicted to be Negligible**.** As discussed from Paragraph 10.133 sensitivity of harbour porpoise to PTS is Medium. The impact of PTS on harbour porpoise at Project Alpha is predicted to be Negligible and therefore Not Significant in EIA terms.

### *Additional Mitigation*

10.167. No additional mitigation is either required or proposed in relation to the effect of PTS on harbour porpoise at Project Alpha as no adverse significant impacts are predicted.

### *Residual Impact*

10.168. The magnitude of impact of PTS on harbour porpoise is predicted to be **Negligible**. The sensitivity of harbour porpoise to PTS is **Medium**. The residual impact of PTS on harbour porpoise at Project Alpha is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

## Minke Whale

### *Potential Impacts*

10.169. Table 10.25 (and Table 10.26 for Southall criteria) indicates the ranges within which there is a risk of PTS occurring to minke whales at Project Alpha. Assuming an appropriate piling strategy and including best practice measures, these are unlikely to result in a risk of PTS to any minke whales.

**Table 10.25 PTS impact ranges (m) at full hammer energy for minke whales at Project Alpha using the NOAA (National Marine Fisheries Service (2016) thresholds.**

| Threshold | Project Alpha |
|---|---|
| **Monopile 3,000kJ** | |
| unweighted $SPL_{pk}$ 219 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 183 dB re 1 µPa²s | <50m |
| **Pinpile 1,800kJ** | |
| unweighted $SPL_{pk}$ 219 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 183 dB re 1 µPa²s | <50m |
| **Concurrent Monopile 3,000kJ and Pinpile 1,800kJ** | |
| unweighted $SPL_{pk}$ 219 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 183 dB re 1 µPa²s | <50m |

**Table 10.26 PTS impact ranges (m) at full hammer energy for minke whales at Alpha using the Southall *et al.* (2007) thresholds.**

| Threshold | Project Alpha |
|---|---|
| **Monopile 3,000kJ** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| $M_{LF}$ weighted $SEL_{cum}$ 198 dB re 1 µPa²s | <50m |
| **Pinpile 1,800kJ** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| $M_{LF}$ weighted $SEL_{cum}$ 198 dB re 1 µPa²s | <50m |

10.170. Based on the ranges presented in Table 10.25 the magnitude of impact of PTS on minke whales is predicted to be **Negligible.** As described from paragraph 10.133 sensitivity of minke whales to PTS is **Medium**. The impact of PTS on minke whales at Project Alpha is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.171. No additional mitigation is either required or proposed in relation to the effect of PTS on minke whales at Project Alpha as no adverse significant impacts are predicted.

### *Residual Impact*

10.172. The magnitude of impact of PTS on minke whales is predicted to be **Negligible**. The sensitivity of minke whales to PTS is **Medium**. The residual impact of PTS on minke whales at Project Alpha is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

### *Disturbance Impacts from Piling Noise*

10.173. The duration of the piling noise effects is dependent on the build scenario adopted. Table 10.27 provides a summary of the duration of piling across all build scenarios assessed at Project Alpha in isolation (see Table 10.6).

**Table 10.27 Duration of each build scenario at Project Alpha**

| Build scenario | Description | Number of WTGs | Number of piles | Number of piling days | Number of months over which piling activity spread |
|---|---|---|---|---|---|
| 5 | Monopiles only | 70 | 70 | 70 | 18 |
| 1 | Pin pile jackets only | 70 | 280 | 140 | 18 |
| 8 | Monopiles and Pin pile jackets sequential | 35 MP<br>35 Jackets | 35<br>140 | 105 | 24 |
| 9 | Monopiles and Pin pile jackets concurrent | 35 MP<br>35 Jackets | 35<br>140 | 70 | 24 |

## Harbour Seal

### *Potential Impacts*

10.174. Table 10.28 indicates the number of harbour seals potentially disturbed by each piling scenario at Alpha. These numbers were derived using by combining the noise modelling outputs for the single strike SEL isopleths with the dose response as described from paragraph 10.46. Given the fact that <1 animal is predicted to be disturbed during pile driving activity under any of the scenarios, the magnitude of this impact is considered **Negligible**.

10.175. Based on the numbers presented in Table 10.28, the magnitude of impact of disturbance on harbour seals at Project Alpha is predicted to be **Negligible.** As described from paragraph 10.138, the sensitivity of harbour seals to disturbance is **Medium**. The impact of disturbance on harbour seals at Project Alpha is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

**Table 10.28 Number of harbour seals predicted to be disturbed at Project Alpha as a result of each combination of pile driving parameters.**

| | Project Alpha | |
|---|---|---|
| **Pile driving parameters** | **Number of Animals** | **% Ref Pop** |
| Monopiles only 3,000kJ | 0.28<br>(0.07 to 0.49) | 0.05%<br>(0.01 to 0.10) |
| Pin pile jackets only 1,800kJ | 0.13<br>(0.04 to 0.22) | 0.03%<br>(0.01 to 0.04) |
| Concurrent Monopile 3,000kJ and Pin pile jackets 1,800kJ (Figure 10.10) | 0.29<br>(0.07 to 0.51) | 0.06%<br>(0.01 to 0.10) |
| Note: sequential monopile and pin pile jacket installation are not included in this table, as the numbers affected are the same as for monopiles only or pin pile jackets only, just that these impacts will occur in sequence. | | |

### *Additional Mitigation*

10.176. No additional mitigation is either required or proposed in relation to the effect of disturbance on harbour seals at Project Alpha as no adverse significant impacts are predicted.

### *Residual Impact*

10.177. The magnitude of impact of disturbance on harbour seals is predicted to be **Negligible**. The sensitivity of harbour seals to disturbance is **Medium**. The residual impact of disturbance on harbour seals at Project Alpha is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

## Grey Seal

### *Potential Impacts*

10.178. Table 10.29 indicates the number of grey seals potentially disturbed by each piling scenario at Alpha. These numbers were derived using by combining the noise modelling outputs for the single strike SEL isopleths with the dose response as described from paragraph 10.46. A maximum of 51 grey seals were predicted to be disturbed per day by the installation of monopiles at Project Alpha, which equates to only 0.47% of the MU population. As outlined in Table 10.27, this level of disturbance will occur intermittently over 18 months.

10.179. The expert elicitation carried out to inform the iPCoD modelling of population consequences found that experts considered that disturbance to grey seals could result in reduced foraging efficiency which could in turn affect fertility, but that grey seals could probably tolerate higher levels of disturbance than other species (Harwood *et al.* 2014). Therefore, under the precautionary assumption that disturbance has the potential to effect fecundity rates, a total of up to 51 individuals per piling day may be affected over two breeding cycles; although it is important to consider that actual active piling will only be for a small proportion of this time and that expert opinion varied quite considerably on the duration of disturbance predicted to result in a reduction in fecundity. Given the low proportion of the reference population affected and the temporary nature of the effect, the magnitude of this impact is considered **Low**.

**Table 10.29 Number of grey seals predicted to be disturbed at Project Alpha as a result of each piling scenario.**

| | | Project Alpha | |
|---|---|---|---|
| **Scenario Number** | **Scenario** | **Number of Animals** | **% Ref Pop** |
| 5 and 8 | Monopile only 3,000 kJ (Figure 10.11)[3] | 51 (16 to 86) | 0.47% (0.15 to 0.79) |
| 1 and 8 | Pin pile jacket only 1,800kJ | 27 (8 to 46) | 0.25% (0.07 to 0.42) |
| 9 | Concurrent Monopile 3,000kJ and Pin pile jackets 1,800kJ | 42 (14 to 70) | 0.38% (0.13 to 0.64) |

10.180. The magnitude of impact of disturbance on grey seals at Project Alpha is predicted to be **Low**. As described from paragraph 10.139, the sensitivity of grey seals to disturbance is **Low**. The impact of disturbance on grey seals at Project Alpha is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.181. No additional mitigation is either required or proposed in relation to the effect of disturbance on grey seals at Project Alpha as no adverse significant impacts are predicted.

### *Residual Impact*

10.182. The magnitude of impact of disturbance on grey seals is predicted to be **Low**. The sensitivity of grey seals to disturbance is **Low**. The residual impact of disturbance on grey seals at Project Alpha is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

## Bottlenose Dolphin

### *Potential Impacts*

10.183. Table 10.30 indicates the number of bottlenose dolphins potentially disturbed per piling day by each piling scenario at Project Alpha. A total of 4.5 dolphins are predicted to be disturbed per piling day under the concurrent monopile and pin pile scenario, which represents 2.3% of the bottlenose dolphin reference population (East Coast MU). The equivalent number for monopiles in isolation is 4.1 animals (2.1% of the MU) and pin piles in isolation is 3.0 (1.5% of MU). As outlined in Table 10.27, all disturbance will occur over two years for each scenario, with the exception of pin piles in isolation, which is predicted to occur over 18 months. According to the opinions of the experts involved in the expert elicitation for iPCoD, which forms our best available knowledge on the topic, disturbance would be most likely to affect bottlenose dolphin calf survival, where: "*Experts felt that disturbance could affect calf survival if it exceeded 30 to 50 days, because it could result in mothers becoming separated from their calves and this could affect the amount of milk transferred from the mother to her calf*" (Harwood *et al.* 2014). Therefore, there is a risk of decreased calf survival for a small number of individuals over a maximum of two years of piling (18 months if monopiles or pin pile jackets only). The magnitude of impact is therefore considered **Medium** in terms of the numbers of animals expected to be affected, but **Low** in terms of the intensity and duration.

[3] More grey seals are predicted to be disturbed under the monopile only scenario compared to the concurrent monopile and pin pile scenario due to the differing placement of the noise modelling locations between the two scenarios. The monopile only scenario modelling location was situated closer to shore in order to assume maximum overlap with areas of density for coastal species, while the modelling locations for the concurrent monopile and pin pile scenario were situated at locations that denoted the maximum separation between the two piles.

**Table 10.30 Number of bottlenose dolphins predicted to be disturbed at Project Alpha as a result of each piling scenario.**

| | | Project Alpha | |
|---|---|---|---|
| **Scenario Number** | **Scenario** | **Number of Animals** | **% Ref Pop** |
| 5 and 8 | Monopile only 3,000kJ | 4.1 | 2.11% |
| 1 and 8 | Pin pile jackets only 1,800kJ | 3.0 | 1.52% |
| 9 | Concurrent Monopile 3,000kJ and Pin pile jackets 1,800kJ (Figure 10.12) | 4.5 | 2.30% |

10.184. Based on the numbers presented in Table 10.30 and the overall duration of disturbance being limited to a maximum of two years, the magnitude of impact of disturbance on bottlenose dolphins at Project Alpha is predicted to be **Low**. As described from paragraph 10.140, the sensitivity of bottlenose dolphins to disturbance is **Medium**. The impact of disturbance on bottlenose dolphins at Project Alpha is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.185. No additional mitigation is either required or proposed in relation to the effect of disturbance on bottlenose dolphins at Project Alpha as no adverse significant impacts are predicted.

### *Residual Impact*

10.186. The magnitude of impact of disturbance on bottlenose dolphins is predicted to be **Low**. The sensitivity of bottlenose dolphins to disturbance is **Medium**. The residual impact of disturbance on bottlenose dolphins at Project Alpha is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## Harbour Porpoise

### *Potential Impacts*

10.187. Table 10.31 indicates the number of harbour porpoises potentially disturbed by each piling scenario at Project Alpha. A total of 1,452 porpoise are predicted to be disturbed during pile driving under the concurrent monopile and pin pile scenario, which represents 0.42% of the North Sea reference population. The equivalent number for monopiles in isolation is 1,403 animals (0.41% of the MU) and pin piles in isolation is 971 (0.28% of MU). As outlined in Table 10.27, all disturbance occurring over intermittently over a maximum of two years, with jacket pin piles in isolation and monopiles in isolation occurring intermittently over 18 months.

10.188. According to the best available knowledge on the topic, as provided by the opinions of the experts involved in the iPCoD expert elicitation: "*Most experts felt that disturbance lasting more than 50 to 100 days may result in reduced foraging efficiency which could affect fertility, or induce pregnancy failure, and interfere with mating opportunities due to habitat displacement. Experts also highlighted that elevated stress levels as a result of being displaced from a known location may impact fecundity. The maximum effect on the probability of giving birth was thought to be a 50% reduction*" (Harwood *et al.* 2014). It was not considered that disturbance had the potential to affect adult survival. Although there is uncertainty around individual behavioural responses, the availability of alternative foraging areas and return times, it is unlikely that individuals will experience disturbance throughout the whole of the foundation installation period, although the precautionary assumption is that every affected individual is affected to this extent. Due to the high mobility of harbour porpoises and the availability of alternative foraging areas at the scale of the wider management unit, the survival of individuals is unlikely to be affected.

10.189. The worst case outcome would be that each affected harbour porpoise would fail to breed. Given that only 0.42% of the reference population is predicted to be disturbed on a single piling day, this level of effect may cause a very small and temporary change in the population growth rate, over one or two years, but is highly unlikely to significantly affect the size, or overall health of the harbour porpoise population at the MU scale. Additionally, this assessment is based on the initial response measured at Beatrice and assumes that this does not diminish over the course of the construction period. This may be a highly precautionary assumption in light of preliminary analyses of Beatrice data suggests that the response diminishes over time. Given the low proportion of the reference population affected and the temporary nature of the effect, and the precaution built into this assessment, the magnitude of this impact is considered **Low**.

10.190. Based on the low proportion of the population affected (as detailed in Table 10.31) and the limited duration of the effect, the magnitude of impact of disturbance on harbour porpoise is predicted to be **Low**. As described in from paragraph 10.143 the sensitivity of harbour porpoise to disturbance is **Medium**. The impact of disturbance on harbour porpoise at Project Alpha is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

**Table 10.31 Number of harbour porpoise predicted to be disturbed at Project Alpha as a result of each piling scenario.**

| | | Project Alpha | |
|---|---|---|---|
| **Scenario Number** | **Scenario** | **Number of Animals** | **% Ref Pop** |
| 5 and 8 | Monopile only 3,000kJ | 1,403<br>(747 to 2,415) | 0.41%<br>(0.22 to 0.70) |
| 1 and 8 | Pin pile jackets only 1,800kJ | 971<br>(517 to 1,671) | 0.28%<br>(0.15 to 0.48) |
| 9 | Concurrent Monopile 3,000kJ and Pin pile jackets 1,800kJ (Figure 10.13) | 1,452<br>(773 to 2,499) | 0.42%<br>(0.22 to 0.72) |

### Additional Mitigation

10.191. No additional mitigation is either required or proposed in relation to the effect of disturbance on harbour porpoise at Project Alpha as no adverse significant impacts are predicted.

### Residual Impact

10.192. The magnitude of impact of disturbance on harbour porpoise is predicted to be **Low**. The sensitivity of harbour porpoise to disturbance is **Medium**. The residual impact of disturbance on harbour porpoise at Project Alpha is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## Minke Whale

### *Potential Impacts*

10.193. Table 10.32 indicates the number of minke whales potentially disturbed by each piling scenario at Project Alpha. A total of 94 minke whales are predicted to be disturbed per piling day under the concurrent monopile and pin pile scenario, which represents 0.40% of the reference population. The equivalent number for monopiles in isolation is 91 animals (0.39% of the MU) and pin piles in isolation is 63 (0.27% of MU). As outlined in Table 10.27, all disturbance will occur over a maximum of two years, with jacket pin piles in isolation and monopiles in isolation occurring intermittently over 18 months.

10.194. According to the best available knowledge on the topic, as provided by the opinions of the experts involved in the iPCoD expert elicitation: "*Experts felt disturbance may result in reduced feeding and an increase in energetic costs of movement and therefore a reduction in body condition and elevated stress levels. If disturbance exceeded for 10 to 100 days it could affect fertility.*" (Harwood *et al.* 2014). A total of up to 94 individuals may be affected per piling day, over two years; although it is important to consider that actual active piling will only be for a small proportion of this time and that expert opinion varied quite considerably on the duration of disturbance predicted to result in a reduction in fertility. The most conservative assumption would be that the same individuals are being disturbed each day and that the total disturbance results in a failure to breed in the year of disturbance, therefore the worst case scenario is that 94 minke whales may fail to breed over a total period of two years. Given the low proportion of the reference population affected and the temporary nature of the effect, the magnitude of this impact is considered **Low**.

**Table 10.32 Number of minke whales predicted to be disturbed at Project Alpha as a result of each piling scenario.**

| | | Project Alpha | |
|---|---|---|---|
| **Scenario Number** | **Scenario** | **Number of Animals** | **% Ref Pop** |
| 5 and 8 | Monopile only 3,000kJ | 91<br>(22 to 247) | 0.39%<br>(0.09 to 1.05) |
| 1 and 8 | Pin pile jackets only 1,800kJ | 63<br>(15 to 171) | 0.27%<br>(0.06 to 0.73) |
| 9 | Concurrent Monopile 3,000kJ and Pin pile jackets 1,800kJ (Figure 10.13) | 94<br>(23 to 255) | 0.40%<br>(0.10 to 1.08) |

10.195. The magnitude of impact of disturbance on minke whales is predicted to be **Low**. As described from paragraph 10.147, the sensitivity of minke whales to disturbance is **Medium**. The impact of disturbance on minke whales at Project Alpha is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.196. No additional mitigation is either required or proposed in relation to the effect of disturbance on minke whales at Project Alpha as no adverse significant impacts are predicted.

### *Residual Impact*

10.197. The magnitude of impact of disturbance on minke whales is predicted to be **Low**. The sensitivity of minke whales to disturbance is **Medium**. The residual impact of disturbance on minke whales at Project Alpha is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## White-beaked Dolphin

### Potential Impacts

10.198. Table 10.33 indicates the number of white-beaked dolphins potentially disturbed by each piling scenario at Project Alpha. A total of 590 white-beaked dolphins are predicted to be disturbed per piling day under the concurrent monopile and pin pile scenario, which represents 1.6% of the reference population. The equivalent number for monopiles in isolation is 570 animals (3.6% of the population) and pin piles in isolation is 394 (1.1% of the population). As outlined in Table 10.27, all disturbance will occur intermittently over a maximum of two years, with jacket pin piles in isolation and monopiles in isolation occurring intermittently over 18 months

10.199. White-beaked dolphins were not included as part of the expert elicitation process for iPCoD, therefore it is not possible to present equivalent expert elicitation findings for this species. However, given that there is information for bottlenose dolphins, and that both species are grouped together as mid-frequency cetaceans, the results of the bottlenose dolphin expert explication can be used as a proxy for white-beaked dolphins. Therefore, there is likely to be a risk of failure to breed or decreased calf survival over the two year construction period for a small proportion of the population. Given the low proportion of the reference population affected and the temporary nature of the effect, the magnitude of this impact is considered **Low**.

**Table 10.33 Number of white-beaked dolphins predicted to be disturbed at Project Alpha as a result of each piling scenario.**

| | | Project Alpha | |
|---|---|---|---|
| **Scenario Number** | **Scenario** | **Number of Animals** | **% Ref Pop** |
| 5 and 8 | Monopile only 3,000kJ | 570<br>(110 to 1,210) | 3.58%<br>(0.69 to 7.61) |
| 1 and 8 | Pin pile jackets only 1,800kJ | 394<br>(76 to 838) | 1.09%<br>(0.21 to 2.31) |
| 9 | Concurrent Monopile 3,000kJ and Pin pile jackets 1,800kJ (Figure 10.13) | 590<br>(114 to 1,253) | 1.62%<br>(0.31 to 3.45) |

10.200. The magnitude of impact of disturbance on white-beaked dolphins is predicted to be **Low**. As described from paragraph 10.148, the sensitivity of white-beaked dolphins to disturbance is **Medium**. The impact of disturbance on white-beaked dolphins at Project Alpha is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### Additional Mitigation

10.201. No additional mitigation is either required or proposed in relation to the effect of disturbance on white-beaked dolphins at Project Alpha as no adverse significant impacts are predicted.

### Residual Impact

10.202. The magnitude of impact of disturbance on white-beaked dolphins is predicted to be **Low**. The sensitivity of white-beaked dolphins to disturbance is **Medium**. The residual impact of disturbance on white-beaked dolphins at Project Alpha is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## Project Bravo

### *PTS Impacts from Piling Noise*

### Harbour and Grey Seals

#### *Potential Impacts*

10.203. Table 10.34 indicates the ranges within which there is a risk of PTS occurring to seals at Project Bravo. Assuming an appropriate piling strategy and including best practice measures, these are unlikely to result in a risk of PTS to either seal species.

**Table 10.34 PTS impact ranges (m) at full hammer energy for seal species at Project Bravo using the National Marine Fisheries Service (2016) thresholds.**

| Threshold | Project Bravo |
|---|---|
| **Monopile 3,000kJ** | |
| unweighted $SPL_{pk}$ 218 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |
| **Pin pile 1,800kJ** | |
| unweighted $SPL_{pk}$ 218 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |
| **Concurrent Monopile 3,000kJ and Pin pile 1,800kJ** | |
| unweighted $SPL_{pk}$ 218 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |

10.204. The magnitude of impact of PTS on harbour and grey seals is predicted to be **Negligible**. The sensitivity of harbour and grey seals to PTS is **Low**. The impact of PTS on harbour and grey seals at Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

#### *Additional Mitigation*

10.205. No additional mitigation is either required or proposed in relation to the effect of PTS on harbour and grey seals at Project Bravo as no adverse significant impacts are predicted.

#### *Residual Impact*

10.206. The magnitude of impact of PTS on harbour and grey seals is predicted to be **Negligible**. The sensitivity of harbour and grey seals to PTS is **Low**. The residual impact of PTS on harbour and grey seals at Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

### Bottlenose and White-beaked Dolphins

#### *Potential Impacts*

10.207. Table 10.35 indicates the ranges within which there is a risk of PTS occurring to either species of dolphin at Project Bravo. Assuming an appropriate piling strategy including best practice mitigation, these are unlikely to result in a risk of PTS to any dolphin.

**Table 10.35 PTS impact ranges (m) at full hammer energy for mid-frequency cetaceans: bottlenose dolphins and white-beaked dolphins at Bravo using the National Marine Fisheries Service (2016) thresholds.**

| Threshold | Project Bravo |
|---|---|
| **Monopile 3,000kJ** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |
| **Pinpile 1,800kJ** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |
| **Concurrent Monopile 3,000kJ and Pin pile 1,800kJ** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |

10.208. The magnitude of impact of PTS on bottlenose and white beaked dolphins is predicted to be **Negligible**. The sensitivity of bottlenose and white-beaked dolphins to PTS is **Medium**. The impact of PTS on bottlenose and white-beaked dolphins at Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.209. No additional mitigation is either required or proposed in relation to the effect of PTS on bottlenose and white-beaked dolphins at Project Bravo as no adverse significant impacts are predicted.

### *Residual Impact*

10.210. The magnitude of impact of PTS on bottlenose and white beaked dolphins is predicted to be **Negligible**. The sensitivity of bottlenose and white-beaked dolphins to PTS is **Medium**. The residual impact of PTS on bottlenose and white-beaked dolphins at Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

## Harbour Porpoise

### *Potential Impacts*

10.211. Table 10.36 indicates the ranges within which there is a risk of PTS occurring to harbour porpoise at Project Bravo. Assuming an appropriate piling strategy and including best practice mitigation, these are unlikely to result in a risk of PTS to any harbour porpoise.

10.212. The magnitude of impact of PTS on harbour porpoise is predicted to be **Negligible**. The sensitivity of harbour porpoise to PTS is **Medium**. The impact of PTS on harbour porpoise at Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

**Table 10.36 PTS impact ranges (m) at full hammer energy for harbour porpoise at Project Bravo using the National Marine Fisheries Service (2016) thresholds.**

| Threshold | Project Bravo |
|---|---|
| **Monopile 3,000kJ** | |
| unweighted $SPL_{pk}$ 202 dB re 1 µPa | 165m |
| NMFS weighted $SEL_{cum}$ 155 dB re 1 µPa²s | <50m |
| **Pin pile 1,800kJ** | |
| unweighted $SPL_{pk}$ 202 dB re 1 µPa | 95m |
| NMFS weighted $SEL_{cum}$ 155 dB re 1 µPa²s | <50m |
| **Concurrent Monopile 3,000kJ and Pin pile 1,800kJ** | |
| unweighted $SPL_{pk}$ 202 dB re 1 µPa | 150m and 89m |
| NMFS weighted $SEL_{cum}$ 155 dB re 1 µPa²s | <50m |

### *Additional Mitigation*

10.213. No additional mitigation is either required or proposed in relation to the effect of PTS on harbour porpoise at Project Bravo as no adverse significant impacts are predicted.

### *Residual Impact*

10.214. The magnitude of impact of PTS on harbour porpoise is predicted to be **Negligible.** The sensitivity of harbour porpoise to PTS is **Medium**. The residual impact of PTS on harbour porpoise at Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

## Minke Whale

### *Potential Impacts*

10.215. Table 10.37 indicates the ranges within which there is a risk of PTS occurring to minke whales at Project Bravo. Assuming an appropriate piling strategy and including best practice mitigation, these are unlikely to result in a risk of PTS to any minke whales.

**Table 10.37 PTS impact ranges (m) at full hammer energy for minke whales at Project Bravo using the National Marine Fisheries Service (2016) thresholds.**

| Threshold | Project Bravo |
|---|---|
| **Monopile 3,000kJ** | |
| unweighted $SPL_{pk}$ 219 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 183 dB re 1 µPa²s | <50m |
| **Pin pile 1,800kJ** | |
| unweighted $SPL_{pk}$ 219 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 183 dB re 1 µPa²s | <50m |
| **Concurrent Monopile 3,000kJ and Pin pile 1,800kJ** | |
| unweighted $SPL_{pk}$ 219 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 183 dB re 1 µPa²s | <50m |

10.216. The magnitude of impact of PTS on minke whales is predicted to be **Negligible**. The sensitivity of minke whales to PTS is **Medium**. The impact of PTS on minke whales at Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.217. No additional mitigation is either required or proposed in relation to the effect of PTS on minke whales at Project Bravo as no adverse significant impacts are predicted.

### *Residual Impact*

10.218. The magnitude of impact of PTS on minke whales is predicted to be **Negligible**. The sensitivity of minke whales to PTS is **Medium**. The residual impact of PTS on minke whales at Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

### *Disturbance Impacts from Piling Noise*

10.219. The duration of the effect is dependent on the build scenario adopted. Table 10.38 provides a summary of the duration of piling across all build scenarios assessed (see Table 10.6).

**Table 10.38 Duration of each build scenario at Project Bravo**

| Build Scenario Number | Description | Number of WTGs | Number of piles | Number of piling days | Number of months over which piling activity spread |
|---|---|---|---|---|---|
| 6 | Monopiles only | 35 | 35 | 35 | 18 |
| 2 | Pin pile jackets only | 70 Jackets | 280 | 140 | 18 |
| 10 | Monopiles and Pin pile jackets sequential | 35 MP<br>35 Jackets | 35<br>140 | 105 | 24 |
| 11 | Monopiles and Pin pile jackets concurrent | 35 MP<br>35 Jackets | 35<br>140 | 70 | 24 |

## Harbour Seal

### *Potential Impacts*

10.220. Table 10.39 indicates the number of harbour seals potentially disturbed by each piling scenario at Project Bravo. Given the fact that <1 animal is predicted to be disturbed, the magnitude of this impact is considered negligible.

**Table 10.39 Number of harbour seals predicted to be disturbed at Project Bravo as a result of each piling scenario.**

| | | Project Bravo | |
|---|---|---|---|
| Scenario Number | Scenario | Number of Animals | % Ref Pop |
| 6 and 10 | Monopile only 3,000 kJ | 0.18<br>(0.01 to 0.37) | 0.03%<br>(0.00 to 0.07) |
| 2 and 10 | Pin pile jacket only 1,800 kJ | 0.09<br>(0.00 to 0.19) | 0.02%<br>(0.00 to 0.04) |
| 11 | Concurrent Monopile 3,000 kJ and Pin pile jackets 1,800 kJ (Figure 10.14) | 0.21<br>(0.05 to 0.38) | 0.04%<br>(0.01 to 0.07) |

10.221. The magnitude of impact of disturbance on harbour seals is predicted to be **Negligible**. The sensitivity of harbour seals to disturbance is **Medium**. The impact of disturbance on harbour seals at Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.222. No additional mitigation is either required or proposed in relation to the effect of disturbance on harbour seals at Project Bravo as no adverse significant impacts are predicted.

### *Residual Impact*

10.223. The magnitude of impact of disturbance on harbour seals is predicted to be **Negligible**. The sensitivity of harbour seals to disturbance is **Medium**. The residual impact of disturbance on harbour seals at Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

## Grey Seal

### *Potential Impacts*

10.224. Table 10.40 indicates the number of grey seals potentially disturbed by each piling scenario at Project Bravo. A maximum of 29 grey seals were predicted to be disturbed per piling day by the installation of monopiles at Project Bravo, which equates to only 0.27% of the MU population. As stated in Table 10.38 all disturbance will occur intermittently over a maximum of two years, with jacket pin piles in isolation and monopiles in isolation occurring intermittently over 18 months.

10.225. The magnitude of disturbance at Project Bravo is less than that predicted at Project Alpha due to the fact that Project Bravo is further offshore and therefore further from areas of grey seal usage compared to Project Alpha. Therefore, given the predicted effects of disturbance a total of up to 29 individuals may be affected per piling day over two breeding cycles. Given the low proportion of the reference population affected and the temporary nature of the effect, the magnitude of this impact is considered **Low**.

**Table 10.40 Number of grey seals predicted to be disturbed at Project Bravo as a result of each piling scenario.**

| | | Project Bravo | |
|---|---|---|---|
| Scenario Number | Scenario | Number of Animals | % Ref Pop |
| 6 and 10 | Monopile only 3,000kJ (Figure 10.15) | 29<br>(13 - 45) | 0.27%<br>(0.12 - 0.42) |
| 2 and 10 | Pin pile jacket only 1,800kJ | 14<br>(6 - 21) | 0.13%<br>(0.06 - 0.19) |
| 11 | Concurrent Monopile 3,000kJ and Pin pile jackets 1,800kJ | 27<br>(12 - 43) | 0.25%<br>(0.11 - 0.39) |
| Note: more grey seals are predicted to be disturbed under the monopile only scenario compared to the concurrent monopile and pin pile scenario due to the differing placement of the noise modelling locations between the two scenarios. The monopile only scenario modelling location was situated closer to shore in order to assume maximum overlap with areas of density for coastal species, while the modelling locations for the concurrent monopile and pin pile scenario were situated at locations that denoted the maximum separation between the two piles. | | | |

10.226. The magnitude of impact of disturbance on grey seals is predicted to be **Low**. The sensitivity of grey seals to disturbance is **Low**. The impact of disturbance on grey seals at Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.227. No additional mitigation is either required or proposed in relation to the effect of disturbance on grey seals at Project Bravo as no adverse significant impacts are predicted.

### *Residual Impact*

10.228. The magnitude of impact of disturbance on grey seals is predicted to be **Low**. The sensitivity of grey seals to disturbance is **Low**. The residual impact of disturbance on grey seals at Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

## Bottlenose Dolphin

### *Potential Impacts*

10.229. Table 10.41 indicates the number of bottlenose dolphins potentially disturbed per piling day by each piling scenario at Project Bravo. A total of 3.8 dolphins are predicted to be disturbed per piling day under the concurrent monopile and pin pile scenario, which represents 1.9% of the bottlenose dolphin reference population (East Coast MU). The equivalent number for monopiles in isolation is 3.1 animals (1.6% of the MU) and pin piles in isolation is 2.0 (1.0% of MU).

10.230. The magnitude of disturbance at Project Bravo is less than that predicted at Project Alpha due to the fact that Project Bravo is further offshore and therefore further from areas of bottlenose dolphin usage compared to Project Alpha. As set out in Table 10.38 all disturbance will occur intermittently over a maximum of two years, with jacket pin piles in isolation and monopiles in isolation occurring intermittently over 18 months. Therefore, there is a risk of decreased calf survival for a small number of individuals over a maximum of two years of piling. The magnitude of the impact is therefore considered **Medium** in terms of the numbers of animals expected to be affected, but **Low** in terms of the intensity and duration of the effect.

**Table 10.41 Number of bottlenose dolphins predicted to be disturbed at Project Bravo as a result of each piling scenario.**

| | Project Bravo | |
|---|---|---|
| **Scenario** | **Number of Animals** | **% Ref Pop** |
| Monopile only 3,000kJ | 3.1 | 1.58% |
| Pin pile only 1,800kJ | 2.0 | 1.01% |
| Concurrent Monopile 3,000kJ and Pin pile jackets 1,800kJ (Figure 10.16) | 3.8 | 1.93% |

10.231. The magnitude of impact of disturbance on bottlenose dolphins at Project Bravo is predicted to be **Low**. The sensitivity of bottlenose dolphins to disturbance is **Medium**. The impact of disturbance on bottlenose dolphins at Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.232. No additional mitigation is either required or proposed in relation to the effect of disturbance on bottlenose dolphins at Project Bravo as no adverse significant impacts are predicted.

### *Residual Impact*

10.233. The magnitude of impact of disturbance on bottlenose dolphins is predicted to be **Low**. The sensitivity of bottlenose dolphins to disturbance is **Medium**. The residual impact of disturbance on bottlenose dolphins at Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## Harbour Porpoise

### *Potential Impacts*

10.234. Table 10.42 indicates the number of harbour porpoise potentially disturbed per piling day by each piling scenario at Project Bravo. A maximum of 1,613 harbour porpoise were predicted to be disturbed per piling day by the installation of monopiles at Project Bravo, which equates to only 0.27% of the MU population. As stated in Table 10.38 all disturbance will occur intermittently over a maximum of two years, with jacket pin piles in isolation and monopiles in isolation occurring intermittently over 18 months.

10.235. The number of animals affected by disturbance at Project Bravo is higher than that predicted at Project Alpha, due to the fact that Project Bravo is further offshore and therefore the impact areas are larger as there is a greater distance between the piling location and the coastline within which porpoise can be impacted. Given the best available knowledge on the effects of disturbance, the worst case outcome would be that each affected harbour porpoise would fail to breed. Given that only 0.47% of the reference population is predicted to be disturbed on a single piling day, this level of effect may cause a very small and temporary change in the population growth rate, over one or two years, but is highly unlikely to significantly affect the size or overall health of the harbour porpoise population at the Management Unit scale. Given the low proportion of the reference population affected and the temporary nature of the impact, the magnitude of this impact is considered **Low**.

**Table 10.42 Number of harbour porpoise predicted to be disturbed at Project Bravo as a result of each piling scenario.**

| | Project Bravo | |
|---|---|---|
| **Scenario** | **Number of Animals** | **% Ref Pop** |
| Monopile only 3,000kJ (Figure 10.17) | 1,613 (859 to 2,776) | 0.47% (0.25 to 0.80) |
| Pin pile jackets only 1,800kJ | 1,103 (587 to 1,898) | 0.32% (0.17 to 0.55) |
| Concurrent Monopile 3,000kJ and Pin pile jackets 1,800kJ | 1,598 (851 to 2,751) | 0.46% (0.25 to 0.80) |
| Note: more harbour porpoise are predicted to be disturbed under the monopile only scenario compared to the concurrent monopile and pin pile scenario due to the differing placement of the noise modelling locations between the two scenarios. | | |

10.236. The magnitude of impact of disturbance on harbour porpoise is predicted to be **Low**. The sensitivity of harbour porpoise to disturbance is **Medium**. The impact of disturbance on harbour porpoise at Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.237. No additional mitigation is either required or proposed in relation to the effect of disturbance on harbour porpoise at Project Bravo as no adverse significant impacts are predicted.

### *Residual Impact*

10.238. The magnitude of impact of disturbance on harbour porpoise is predicted to be **Low**. The sensitivity of harbour porpoise to disturbance is **Medium**. The residual impact of disturbance on harbour porpoise at Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## Minke Whale

### *Potential Impacts*

10.239. Table 10.43 indicates the number of minke whales potentially disturbed per piling day by each piling scenario at Project Bravo. A maximum of 104 minke whales were predicted to be disturbed per piling day by the installation of monopiles at Project Bravo, which equates to only 0.44% of the MU population. As stated in Table 10.38 all disturbance will occur intermittently over a maximum of two years, with jacket pin piles in isolation and monopiles in isolation occurring intermittently over 18 months The magnitude of disturbance at Project Bravo is more than that predicted at Project Alpha, due to the fact that Project Bravo is further offshore and therefore the impact areas are larger as there is a greater distance between the piling location and the coastline within which minke whales can be impacted.

10.240. Given the best available knowledge on the effects of disturbance, there is the potential for disturbance to result in reduced fertility, though the expert opinion varied quite considerably on the duration of disturbance predicted to result in a reduction in fecundity. Given the low proportion of the reference population affected and the temporary nature of the effect, the magnitude of this impact is considered Low.

**Table 10.43 Number of minke whales predicted to be disturbed at Project Bravo as a result of each piling scenario.**

| | | Project Bravo | |
|---|---|---|---|
| **Scenario Number** | **Scenario** | **Number of Animals** | **% Ref Pop** |
| 6 and 10 | Monopile only 3,000 kJ (Figure 10.17) | 104<br>(25 to 283) | 0.44%<br>(0.11 to 1.20) |
| 2 and 10 | Pin pile jackets only 1,800 kJ | 71<br>(17 to 194) | 0.30%<br>(0.07 to 0.82) |
| 11 | Concurrent Monopile 3,000 kJ and Pin pile jackets 1,800 kJ | 103<br>(25 to 281) | 0.44%<br>(0.11 to 1.19) |
| Note: more minke whales are predicted to be disturbed under the monopile only scenario compared to the concurrent monopile and pin pile scenario due to the differing placement of the noise modelling locations between the two scenarios. | | | |

10.241. The magnitude of impact of disturbance on minke whales is predicted to be **Low**. The sensitivity of minke whales to disturbance is **Medium**. The impact of disturbance on minke whales at Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.242. No additional mitigation is either required or proposed in relation to the effect of disturbance on minke whales at Project Bravo as no adverse significant impacts are predicted.

### *Residual Impact*

10.243. The magnitude of impact of disturbance on minke whales is predicted to be **Low**. The sensitivity of minke whales to disturbance is **Medium**. The residual impact of disturbance on minke whales at Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## White-beaked Dolphin

### *Potential Impacts*

10.244. Table 10.44 indicates the number of white-beaked dolphins potentially disturbed per piling day by each piling scenario at Project Bravo. A maximum of 655 white-beaked dolphins were predicted to be disturbed per piling day by the installation of monopiles at Project Bravo, which equates to 1.8% of the MU population. As stated in Table 10.38, all disturbance will occur intermittently over a maximum of two years, with jacket pin piles in isolation and monopiles in isolation occurring intermittently over 18 months.

10.245. The magnitude of disturbance at Project Bravo is more than that predicted at Project Alpha due to the fact that Project Bravo is further offshore and therefore the impact areas are larger as there is a greater distance between the piling location and the coastline within which white-beaked dolphins can be impacted. Given the best available knowledge on the effects of disturbance using bottlenose dolphins as a proxy, there is the potential for disturbance to result in reduced calf survival over the two year construction period for a small proportion of the population. Given the low proportion of the reference population affected and the temporary nature of the disturbance, the magnitude of this impact is considered **Low**.

**Table 10.44 Number of white-beaked dolphins predicted to be disturbed at Project Bravo as a result of each piling scenario.**

| | | Project Bravo | |
|---|---|---|---|
| **Scenario Number** | **Scenario** | **Number of Animals** | **% Ref Pop** |
| 6 and 10 | Monopile only 3,000 kJ (Figure 10.17) | 655<br>(126 to 1,391) | 1.80%<br>(0.35 to 3.83) |
| 2 and 10 | Pin pile jackets only 1,800 kJ | 448<br>(86 to 951) | 1.23%<br>(0.24 to 2.62) |
| 11 | Concurrent Monopile 3,000 kJ and Pin pile jackets 1,800 kJ | 649<br>(125 to 1,379) | 1.79%<br>(0.34 to 3.80) |
| Note: more white-beaked dolphins are predicted to be disturbed under the monopile only scenario compared to the concurrent monopile and pin pile scenario due to the differing placement of the noise modelling locations between the two scenarios. | | | |

10.246. The magnitude of impact of disturbance on white-beaked dolphins is predicted to be **Low**. The sensitivity of white-beaked dolphins to disturbance is **Medium**. The impact of disturbance on white-beaked dolphins at Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### Additional Mitigation

10.247. No additional mitigation is either required or proposed in relation to the effect of disturbance on white-beaked dolphins at Project Bravo as no adverse significant impacts are predicted.

### Residual Impact

10.248. The magnitude of impact of disturbance on white-beaked dolphins is predicted to be **Low**. The sensitivity of white-beaked dolphins to disturbance is **Medium**. The residual impact of disturbance on white-beaked dolphins at Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## Projects Alpha and Project Bravo Combined (the optimised Seagreen Project)

10.249. In the case that both Project Alpha and Project Bravo are constructed, this can either occur sequentially (Project Alpha followed by Project Bravo or vice versa) or concurrently (Project Alpha and Project Bravo constructed at the same time). Both possibilities are assessed below.

### PTS risk from the concurrent construction of Project Alpha and Project Bravo combined

10.250. It should be highlighted that for PTS, the impact ranges presented for both projects in isolation also represent the risk of PTS for the optimised Seagreen Project for all of the build scenarios with the exception of concurrent jacket piling with one operation in Alpha and one piling operation in Bravo. This scenario would lead to the installation of a total of eight piles in 24 hours (four in each Project) resulting in an overall higher amount of acoustic energy exposure than has been previously assessed for each project alone. The results of the PTS assessment for this concurrent pin pile jacket scenario is presented in Table 10.45 for all species.

**Table 10.45 PTS impact ranges (m) for all species during concurrent pin pile jacket installation at Project Alpha and Project Bravo, using the National Marine Fisheries Service (2016) thresholds.**

| Threshold and species | Impact range at A & B |
|---|---|
| **Seal species** | |
| unweighted $SPL_{pk}$ 218 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 185 dB re 1 µPa²s | <50m |
| **Harbour porpoise** | |
| unweighted $SPL_{pk}$ 202 dB re 1 µPa | 80m & 90m |
| NMFS weighted $SEL_{cum}$ 155 dB re 1 µPa²s | <50m |
| **Mid frequency cetaceans: Bottlenose dolphins and white-beaked dolphins** | |
| unweighted $SPL_{pk}$ 230 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 198 dB re 1 µPa²s | <50m |
| **Minke whale** | |
| unweighted $SPL_{pk}$ 219 dB re 1 µPa | <50m |
| NMFS weighted $SEL_{cum}$ 183 dB re 1 µPa²s | <50m |

10.251. Based on the impact ranges presented in Table 10.45, so long as there is an agreed Piling Strategy in place, there will be no change in PTS risk to any marine mammal species as a result of the build out of both projects, compared to that presented by Project Alpha or Project Bravo alone.

### *Disturbance Impacts from Piling Noise: Sequential Construction of Project Alpha followed by Project Bravo*

10.252. In terms of numbers of individuals potentially affected, the results presented in the previous sections for each Project alone represent the same levels of impacts expected on each day of piling as each project is built out in sequence. In the event that both projects are built out, the number of animals affected by each project will be the same as previously assessed for each Project, with the difference being that the total period of disturbance will be longer than for each individual Project built out in isolation. Table 10.46 provides a summary of the duration of piling across all build scenarios assessed.

10.253. The increase in the total number of piling days will not significantly change the magnitude of the PTS or disturbance impacts for any species. This is because the assessment makes the precautionary assumption that the disturbance may persist across the whole foundation installation period of two years or 18 months (depending on build scenario), and the increase in the total number of piling days is not sufficient to increase the magnitude of impact from low to medium in any scenario. Therefore the outcomes of the Project assessments in isolation (set out above) remain the same for the projects built out in combination, under the sequential scenario.

## Population Modelling – Project Alpha and Project Bravo built sequentially

10.254. As advised in the Scoping Opinion and agreed in consultation (Table 10.3), population modelling was conducted for bottlenose dolphins, to investigate effects of disturbance from the construction of the optimised Seagreen Project, on the East Coast Scotland MU population. It was considered that the worst case scenario for bottlenose dolphin disturbance would be the construction of both Project Alpha and Project Bravo and therefore these scenarios were taken forward for population modelling. No population modelling was carried out for the assessment of either Project Alpha or Project Bravo in isolation.

**Table 10.46 Duration of each build scenario for the assessment of Project Alpha then Project Bravo combined, sequential construction.**

| Build Scenario Number | Build scenario description | Number of WTGs (MP) in Alpha | Number of WTGs (MP) in Bravo | Number of WTGs (PP) in Alpha | Number of WTGs (PP) in Bravo | Total number of WTG | Total number of Piles | Total number of Piling Days |
|---|---|---|---|---|---|---|---|---|
| 12 | Single vessel operation in both Project Alpha and Project Bravo: Monopiles in Alpha followed by pin pile jackets in Bravo | 70 | - | - | 50 | 120 | 270 | 170 |
| 13 | Two vessel operations within each site: Monopiles and pin pile jackets being installed concurrently in Project Alpha followed by Monopiles and pin pile jackets being installed concurrently in Project Bravo. | 35 | 35 | 25 | 25 | 120 | 270 | 100 |
| 3 | Single vessel operation within each site: Pin pile jackets only in Project Alpha followed by pin pile jackets in Project Bravo | - | - | 70 | 50 | 120 | 480 | 240 |

10.255. No population modelling was carried out for the optimised Seagreen Project assessment for harbour seals, grey seals, harbour porpoises, minke whales or white-beaked dolphins because, as advised in the 2017 Scoping opinion and agreed in consultation (see Table 10.3) the impact significance was equivalent to, or lower than the assessment made in the 2012 Offshore ES.

10.256. Harwood and King (2017) present suggested demographic parameters for input to iPCoD modelling bottlenose dolphin population management units in the UK, including specific demographic parameters for the Coastal East Scotland MU. The East Coast Scotland MU population size and growth rate of 1.018 was obtained from Cheney *et al.* (2013) and the other demographic rates were obtained from the results of capture-recapture analysis of the dolphin photo-ID study (Lusseau 2013). The parameters chosen for the simulations carried out are given in Data Appendix 10D (iPCoD Results).

10.257. The compiled summary results of the iPCoD modelling for bottlenose dolphins across all three sequential Project Alpha then Project Bravo scenarios are presented in Data Appendix 10D – Table 10.3. This highlights that there was very little difference in the iPCoD predicted population outcomes between the three scenarios run. The scenario involving concurrent piling of monopiles and pin piles at Project Alpha, followed by concurrent piling of monopiles and pin piles at Project Bravo (Build Scenario number 13) resulted in the least effect on the bottlenose dolphin population trajectory. This makes sense, as this was the scenario with the least number of piling days modelled. There was little difference in the results between the scenario involving the installation of monopiles at Project Alpha followed by pin piles at Project Bravo (scenario number 12) and the scenario involving the installation of pin piles at Project Alpha followed by pin piles at Project Bravo (scenario number 3). Both of these scenarios resulted in a median impacted population size that was 99.3% of the size of the baseline population after 24 years. However, scenario 12 resulted in a slightly higher increase in the risk of a 1% decline in Year 1, therefore, this scenario was chosen as the worst case to base the assessment on and is detailed further below.

### *Installation of monopiles at Project Alpha followed by the installation of pin pile jackets at Project Bravo (Build scenario 12)*

10.258. The standard output provided by the iPCoD model provides the probabilistic risk of a 1, 2 and 5% decline in both the baseline and the impacted population, at a series of time points in the simulation. The output also includes a calculation of the difference between the two, providing a measure of the additional risk of decline posed by the modelled disturbance.

10.259. The simulations demonstrated that in probabilistic terms, there was a very small increase in the risk of bottlenose dolphin population decline in the impacted population in the first year of simulation, with a maximum of a 5.7% increase in the probability of a 1% population decline, a 4.9% increase in the probability of a 2% population decline and a 5.2% increase in the probability of a 5% decline. This impact was short term, and by year 12, the increase in the probability of a 1% decline was only 0.7% and by year 18 it was 0.4% (Data Appendix 10D Table 10.4).

10.260. The median predicted population size for the baseline bottlenose dolphin population after 24 years was 274 (95% CI 182 to 394). The median predicted population size for the impacted population after 24 years was 272 (95% CI 182 to 398) which is 99.3% of the size of the baseline population (Data Appendix 10D Table 10.3). This means that after a simulated 24 years the size difference between the median baseline and impacted population was two animals, with a large overlap in confidence intervals. Therefore, there was no significant difference between the predicted baseline (unimpacted) and impacted population sizes as a result of the predicted levels of disturbance.

10.261. None of the bottlenose dolphin impact scenarios resulted in a significant long term population effect. The population trajectory for both the baseline and the impacted populations (the mean and each individual 1,000 simulated outcomes) are presented in Plate 10.6**.** This demonstrates that the mean impacted population is predicted to experience an initial slight decline in growth rate relative to the baseline population, after which it then returns to the same growth rate as the baseline population and continues to increase at the same rate as the baseline population for the remainder of the simulations.

10.262. The magnitude of impact of disturbance on bottlenose dolphins for the installation of monopiles at Project Alpha followed by pin pile jackets at Project Bravo (scenario number 5 then 2) is predicted to be **Low**. The sensitivity of bottlenose dolphins to disturbance is **Medium**. The impact of disturbance on bottlenose dolphins for the installation of monopiles at Project Alpha followed by pin pile jackets at Project Bravo (scenario number 5 then 2) is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

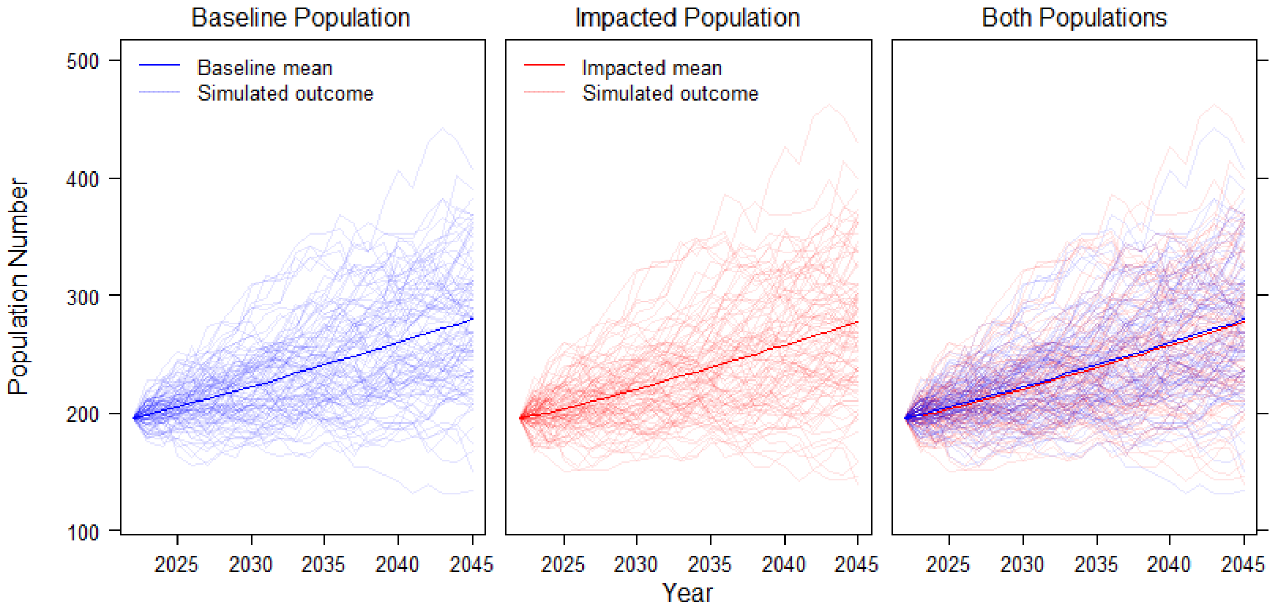
### *Additional Mitigation*

10.263. No additional mitigation is either required or proposed in relation to the effect of disturbance on bottlenose dolphins for the installation of monopiles at Project Alpha followed by pin pile jackets at Project Bravo (scenario number 5 then 2) as no adverse significant impacts are predicted.

### *Residual Impact*

10.264. The magnitude of impact of disturbance on bottlenose dolphins for the installation of monopiles at Project Alpha followed by pin pile jackets at Project Bravo (scenario number 5 then 2) is predicted to be **Low**. The sensitivity of bottlenose dolphins to disturbance is **Medium**. The residual impact of disturbance on bottlenose dolphins for the installation of monopiles at Project Alpha followed by pin pile jackets at Project Bravo (scenario number 5 then 2) is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

**Plate 10.6 Simulated bottlenose dolphin population sizes for both the baseline and the impacted populations under build scenario number 12 (monopile installation at Project Alpha followed by pin pile jacket installation at Project Bravo).**



### *Disturbance Impacts from Piling Noise: Concurrent Construction*

10.265. As noted above, in relation to sequential construction, PTS effects are not re-assessed because the impact ranges presented for both projects in isolation also represent the risk of PTS for the optimised Seagreen Project.

10.266. Table 10.47 provides a summary of the duration of piling under the concurrent Project Alpha and Project Bravo scenario. Note, if concurrent piling occurs at Project Alpha and Project Bravo, then this will only be for the installation of pin pile jacket foundations. There is no build-out scenario that involves the concurrent installation of monopiles at Project Alpha and Project Bravo.

**Table 10.47 Duration of the build scenario for Project Alpha and Project Bravo concurrently.**

| Scenario Number | Build Scenario Description | Number of WTGs (MP) in Alpha | Number of WTGs (MP) in Bravo | Number of WTGs (PP) in Alpha | Number of WTGs (PP) in Bravo | Total number of WTG | Total number of Piles | Total number of Piling Days |
|---|---|---|---|---|---|---|---|---|
| 4 | Pin pile jackets only: concurrent installation with a vessel in Project Alpha and a vessel in Project Bravo installing pin piles at the same time | - | - | 70 | 50 | 120 | 480 | 140 |

## Harbour Seal

### *Potential Impacts*

10.267. Table 10.48 indicates the number of harbour seals potentially disturbed by concurrent piling at Project Alpha and Project Bravo. Given the fact that <1 animal is predicted to be disturbed, the magnitude of this impact is considered **Negligible.**

**Table 10.48 Number of harbour seals predicted to be disturbed at as a result of concurrent piling at Project Alpha and Project Bravo.**

| | Project Alpha and Project Bravo | |
|---|---|---|
| **Scenario** | **Number of Animals** | **% Ref Pop** |
| Concurrent Pin pile jackets 1,800 kJ at Project Alpha and Project Bravo (Figure 10.18) | 0.18 (0.05 to 0.30) | 0.03% (0.01 to 0.06) |

10.268. The magnitude of impact of disturbance on harbour seals is predicted to be **Negligible**. The sensitivity of harbour seals to disturbance is **Medium**. The impact of disturbance on harbour seals as a result of concurrent piling at Project Alpha and Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms**.**

### *Additional Mitigation*

10.269. No additional mitigation is either required or proposed in relation to the effect of disturbance on harbour seals as a result of concurrent piling at Project Alpha and Project Bravo as no adverse significant impacts are predicted.

### *Residual Impact*

10.270. The magnitude of impact of disturbance on harbour seals is predicted to be **Negligible**. The sensitivity of harbour seals to disturbance is **Medium**. The residual impact of disturbance on harbour seals as a result of concurrent piling at Project Alpha and Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

## Grey Seal

### *Potential Effects*

10.271. Table 10.49 indicates the number of grey seals potentially disturbed by concurrent piling at Project Alpha and Project Bravo. A total of 24 grey seals are predicted to be disturbed under the concurrent Project Alpha and Project Bravo scenario, which represents 0.22% of the grey seal reference population (East Scotland MU). The total number of piling days is 140 days over two years. Therefore, a total of up to 24 individuals may be affected per piling day over two breeding cycles. Given the low proportion of the reference population affected and the temporary nature of the effect, the magnitude of this impact is considered low.

**Table 10.49 Number of grey seals predicted to be disturbed as a result of concurrent piling at Project Alpha and Project Bravo.**

| | Project Alpha and Project Bravo | |
|---|---|---|
| **Scenario** | **Number of Animals** | **% Ref Pop** |
| Concurrent Pin pile jackets 1,800kJ at Project Alpha and Project Bravo (Figure 10.19) | 24<br>(8 to 39) | 0.22%<br>(0.08 to 0.36) |

10.272. The magnitude of impact of disturbance on grey seals is predicted to be **Low**. The sensitivity of grey seals to disturbance is **Low**. The impact of disturbance on grey seals as a result of concurrent piling at Project Alpha and Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.273. No additional mitigation is either required or proposed in relation to the effect of disturbance on grey seals as a result of concurrent piling at Project Alpha and Project Bravo as no adverse significant impacts are predicted.

### *Residual Impact*

10.274. The magnitude of impact of disturbance on grey seals is predicted to be **Low**. The sensitivity of grey seals to disturbance is **Low**. The residual impact of disturbance on grey seals as a result of concurrent piling at Project Alpha and Project Bravo is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

## Bottlenose Dolphin

### *Potential Impacts*

10.275. Table 10.50 indicates the number of bottlenose dolphins potentially disturbed by concurrent piling at Project Alpha and Project Bravo. A total of 3.2 dolphins are predicted to be disturbed under the concurrent Project Alpha and Project Bravo scenario, which represents 1.6% of the bottlenose dolphin reference population (East Coast MU). The total number of piling days is 140 days over two years. Therefore, there is a risk of decreased calf survival over a maximum of two years of piling.

10.276. The magnitude of impact of disturbance on bottlenose dolphins is predicted to be **Low.** The sensitivity of bottlenose dolphins to disturbance is **Medium.** The impact of disturbance on bottlenose dolphins as a result of concurrent piling at Project Alpha and Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

10.277. This is further confirmed by the results of the iPCoD modelling presented in Appendix 10D.

**Table 10.50 Number of bottlenose dolphins predicted to be disturbed as a result of concurrent piling at Project Alpha and Bravo.**

| | Project Alpha and Project Bravo | |
|---|---|---|
| **Scenario** | **Number of Animals** | **% Ref Pop** |
| Concurrent Pin pile jackets 1,800kJ at Project Alpha and Project Bravo (Figure 10.20) | 3.2 | 1.64% |

## *Additional Mitigation*

10.278. No additional mitigation is either required or proposed in relation to the effect of disturbance on bottlenose dolphins as a result of concurrent piling at Project Alpha and Project Bravo as no adverse significant impacts are predicted.

## *Residual Impact*

10.279. The magnitude of impact of disturbance on bottlenose dolphins is predicted to be **Low.** The sensitivity of bottlenose dolphins to disturbance is **Medium.** The residual impact of disturbance on bottlenose dolphins as a result of concurrent piling at Project Alpha and Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## Harbour Porpoise

## *Potential Impacts*

10.280. Table 10.51 indicates the number of harbour porpoises potentially disturbed as a result of concurrent piling at Project Alpha and Project Bravo. A total of 1,177 harbour porpoise are predicted to be disturbed under the concurrent Project Alpha and Project Bravo scenario, which represents 0.34% of the reference population. The total number of piling days is 140 days over two years. Given the best available knowledge on the effects of disturbance, the precautionary assumption would be that each affected harbour porpoise would fail to breed. Given that only 0.34% of the reference population is predicted to be disturbed on a single piling day, this level of effect may cause a very small and temporary change in the population growth rate over two years, but is highly unlikely to significantly affect the size or overall health of the harbour porpoise population at the Management Unit scale. Given the low proportion of the reference population affected and the temporary nature of the effect, the magnitude of this impact is considered **Low**.

**Table 10.51 Number of harbour porpoise predicted to be disturbed as a result of concurrent piling at Project Alpha and Project Bravo.**

| | Project Alpha and Project Bravo | |
|---|---|---|
| **Scenario** | **Number of Animals** | **% Ref Pop** |
| Concurrent Pin pile jackets 1,800kJ at Project Alpha and Project Bravo (Figure 10.21) | 1,177 (627 to 2,027) | 0.34% (0.18 to 0.59) |

10.281. The magnitude of impact of disturbance on harbour porpoise is predicted to be **Low.** The sensitivity of harbour porpoise to disturbance is **Medium.** The impact of disturbance on harbour porpoise as a result of concurrent piling at Project Alpha and Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.282. No additional mitigation is either required or proposed in relation to the effect of disturbance on harbour porpoise as a result of concurrent piling at Project Alpha and Project Bravo as no adverse significant impacts are predicted.

### *Residual Impact*

10.283. The magnitude of impact of disturbance on harbour porpoise is predicted to be **Low.** The sensitivity of harbour porpoise to disturbance is **Medium.** The residual impact of disturbance on harbour porpoise as a result of concurrent piling at Project Alpha and Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## Minke Whale

### *Potential Impacts*

10.284. Table 10.52 indicates the number of minke whales potentially disturbed as a result of concurrent piling at Project Alpha and Project Bravo. A total of 76 minke whales are predicted to be disturbed under the concurrent Project Alpha and Project Bravo scenario, which represents 0.32% of the reference population. The total number of piling days is 140 days over two years. Given the best available knowledge on the effects of disturbance, there is the potential for disturbance to result in reduced fertility, though the expert opinion varied quite considerably on the duration of disturbance predicted to result in a reduction in fecundity. Given the low proportion of the reference population affected and the temporary nature of the effect, the magnitude of this impact is considered **Low**.

**Table 10.52 Number of minke whales predicted to be disturbed as a result of concurrent piling at Project Alpha and Project Bravo.**

| | Project Alpha and Project Bravo | |
|---|---|---|
| **Scenario** | **Number of Animals** | **% Ref Pop** |
| Concurrent Pin pile jackets 1,800 kJ at Project Alpha and Project Bravo (Figure 10.21) | 76 (18 to 207) | 0.32% (0.08 to 0.88) |

10.285. The magnitude of impact of disturbance on minke whales is predicted to be **Low.** The sensitivity of minke whales to disturbance is **Medium.** The impact of disturbance on minke whales as a result of concurrent piling at Project Alpha and Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.286. No additional mitigation is either required or proposed in relation to the effect of disturbance on minke whales as a result of concurrent piling at Project Alpha and Project Bravo as no adverse significant impacts are predicted.

### *Residual Impact*

10.287. The magnitude of impact of disturbance on minke whales is predicted to be **Low.** The sensitivity of minke whales to disturbance is **Medium.** The residual impact of disturbance on minke whales as a result of concurrent piling at Project Alpha and Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## White-beaked Dolphin

### Potential Impacts

10.288. Table 10.53 indicates the number of white-beaked dolphins potentially disturbed by concurrent piling at Project Alpha and Project Bravo. A total of 478 white-beaked dolphins are predicted to be disturbed under the concurrent Project Alpha and Project Bravo scenario, which represents 1.32% of the reference population. The total number of piling days is 140 days over two years. Given the best available knowledge on the effects of disturbance using bottlenose dolphins as a proxy, there is the potential for disturbance to result in reduced calf survival over the two year construction period for a small proportion of the population. Given the low proportion of the reference population affected and the temporary nature of the effect, the magnitude of this impact is considered **Low**.

**Table 10.53 Number of white-beaked dolphins predicted to be disturbed as a result of concurrent piling at Project Alpha and Project Bravo.**

| | Project Alpha and Project Bravo | |
|---|---|---|
| **Scenario** | **Number Animals** | **% Ref Pop** |
| Concurrent Pin pile jackets 1,800 kJ at Project Alpha and Project Bravo (Figure 10.21) | 478 (92 to 1,016) | 1.32% (0.25 to 2.80) |

10.289. The magnitude of impact of disturbance on white-beaked dolphins is predicted to be **Low.** The sensitivity of white-beaked dolphins to disturbance is **Medium.** The impact of disturbance on white-beaked dolphins as a result of concurrent piling at Project Alpha and Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### Additional Mitigation

10.290. No additional mitigation is either required or proposed in relation to the effect of disturbance on white-beaked dolphins as a result of concurrent piling at Project Alpha and Project Bravo as no adverse significant impacts are predicted.

### Residual Impact

10.291. The magnitude of impact of disturbance on white-beaked dolphins is predicted to be **Low.** The sensitivity of white-beaked dolphins to disturbance is **Medium.** The residual impact of disturbance on white-beaked dolphins as a result of concurrent piling at Project Alpha and Project Bravo is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## Population Modelling: Concurrent installation of pin pile jackets at Project Alpha and Project Bravo (Build scenario 4)

10.292. The iPcoD modelling simulations for bottlenose dolphin for the concurrent installation of pin pile jackets at Project Alpha and Project Bravo (scenario number 4) demonstrated that in probabilistic terms, there was a very small increase in the risk of population decline in the impacted population in the first year of simulation with a maximum of a 6.1% increase in the probability of a 1% population decline, a 6.5% increase in the probability of a 2% population decline and an 7% increase in the probability of a 5% decline (Appendix 10D Table 10.5). This impact was short term, and by year 12, the increase in the probability of a 1% decline was only 1.7% and by year 18 it was 0.8% (Data Appendix 10D Table 10.5).

10.293. The median predicted population size for the baseline bottlenose dolphin population after 24 years was 272 (95% CI 182 - 390). The median predicted population size for the impacted population after 24 years was 271 (95% CI 176 - 392) which is 99.6% of the size of the baseline population (Data Appendix 10D Table 10.6). This means that after a simulated 24 years the size difference between the median baseline and impacted population was one animal, with a large overlap in confidence intervals. Therefore, there was no significant difference between the predicted baseline (unimpacted) and impacted population sizes as a result of the predicted levels of disturbance.

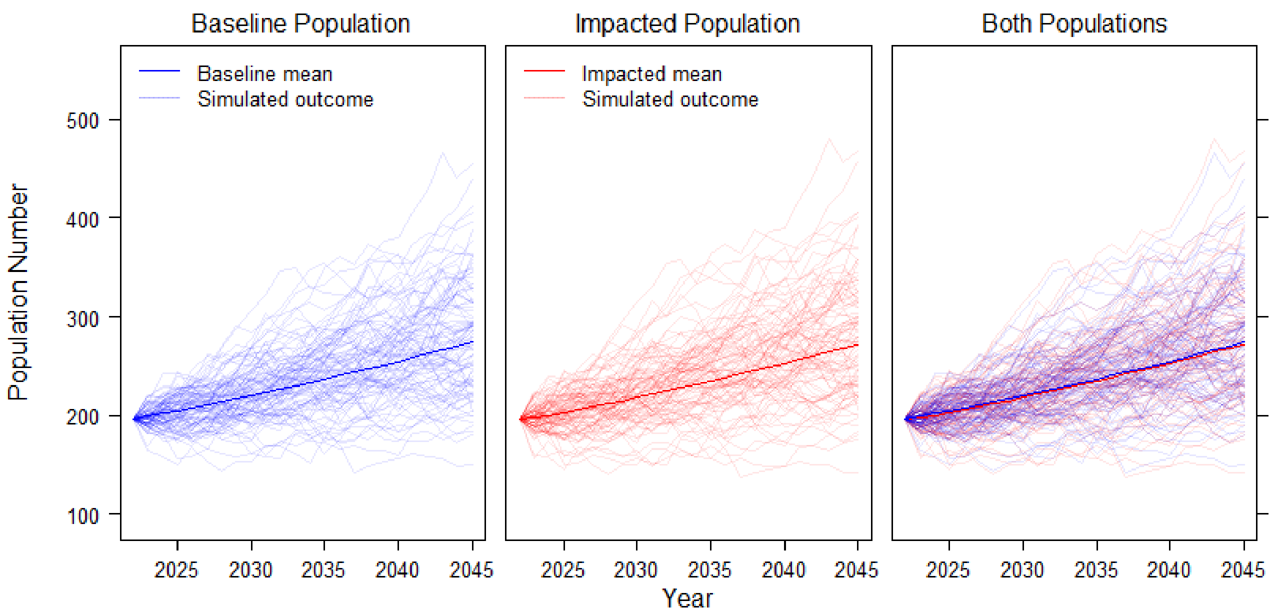
10.294. None of the bottlenose dolphin impact scenarios resulted in a significant long term population effect. The population trajectory for both the baseline and the impacted populations (the mean and each individual 1,000 simulated outcomes) are presented in Plate 10.7. This demonstrates that the mean impacted population is predicted to experience an initial slight decline in growth rate relative to the baseline population, after which it then returns to the same growth rate as the baseline population and continues to increase at the same rate as the baseline population for the remainder of the simulations.

10.295. The magnitude of impact of disturbance on bottlenose dolphins for concurrent installation of pin pile jackets at Project Alpha and Project Bravo (scenario number 4) is predicted to be **Low**. The sensitivity of bottlenose dolphins to disturbance is **Medium**. The impact of disturbance on bottlenose dolphins for the installation of monopiles at Project Alpha followed by pin pile jackets at Project Bravo (scenario number 5 then 2) is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.296. No additional mitigation is either required or proposed in relation to the effect of disturbance on bottlenose dolphins for concurrent installation of pin pile jackets at Project Alpha and Project Bravo (scenario number 4) as no adverse significant impacts are predicted.

**Plate 10.7 Simulated bottlenose dolphin population sizes for both the baseline and the impacted populations under the concurrent pin pile scenario.**



### *Residual Impact*

10.297. The magnitude of impact of disturbance on bottlenose dolphins for concurrent installation of pin pile jackets at Project Alpha and Project Bravo (scenario number 4) is predicted to be **Low**. The sensitivity of bottlenose dolphins to disturbance is **Medium**. The residual impact of disturbance on bottlenose dolphins for concurrent installation of pin pile jackets at Project Alpha and Project Bravo (scenario number 4) is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### Summary

10.298. No significant PTS or disturbance impacts are predicted for any species of marine mammal under any of the 13 potential build scenarios.

## IMPACT ASSESSMENT: CUMULATIVE

10.299. The EIA Regulations require the assessment of cumulative impacts. This requires consideration and assessment of existing projects, projects under construction and consented, or proposed projects identified in relevant development plans and programmes that have the potential to impact cumulatively with the optimised Seagreen Project.

10.300. Cumulative impacts can occur when the impacts from one project on an identified receptor combine (through either spatial or temporal overlap) with similar impacts from other projects on the same receptor. The purpose of considering cumulative impacts is to understand if the impacts from the optimised Seagreen Project parameters (Project Alpha and Project Bravo), when considered together (combined), or cumulatively with other plans and projects are different, or more significant than from the optimised Seagreen Project in isolation. This enables additional mitigation to be identified, as appropriate.

10.301. Cumulative impacts are considered for the optimised Seagreen Project throughout construction. It should be noted that the Transmission Asset is already licenced and is unchanged, therefore this is considered alongside the other identified projects and plans.

10.302. Identification of relevant projects and developments has been informed by scoping and wider consultation, as set out within Chapter 7 (Scope of EIA Report). Potential cumulative impacts are considered within the assessment set out below based on the projects and species set out in Table 10.54.

10.303. As set within the impact assessments above, because there is determined to be a negligible risk of injury (PTS) to all marine mammal receptors there is concluded to be no risk of significant cumulative effects with other projects. The cumulative impact assessment therefore focuses on the risk of disturbance effects where there is potential for spatial and temporal overlap in effects of individual projects.

10.304. It is important to note that the assessments for each of the projects assessed quantitatively have used a variety of different methods and thresholds to indicate levels of disturbance and they are not generally comparable. Given uncertainty in the degree of temporal and spatial overlap of these activities summing the number of animals predicted to be disturbed at each project would give an overestimate of the total number of animals impacted. There is also the possibility that the same individuals might be affected on multiple occasions across projects sequentially. Given uncertainties surrounding animal turnover and movements at this temporal and spatial scale it is very challenging to predict a realistic overall level of disturbance. However, this assessment presents the total numbers summed across all projects (based on the maximum number of individuals from each project, and taking the maximum from either the consented or revised envelopes for the Forth and Tay offshore wind projects) as an indication of the potential cumulative impact.

**Table 10.54 Projects included quantitatively in the cumulative impact assessment for marine mammals.**

| Project | Harbour Seal | Grey Seal | Bottlenose Dolphin | Harbour porpoise | Minke Whale | White-beaked dolphin |
|---|---|---|---|---|---|---|
| Neart na Gaoithe | Yes | Yes | Yes | Yes | Yes | Yes |
| Inch Cape | Yes | Yes | Yes | Yes | Yes | Yes |
| Aberdeen Harbour Expansion Project | No: harbour seal scoped out of cumulative assessment | Yes | Yes | Yes | Yes | Yes |
| Moray East | No: only assessing projects within the East Scotland MU for seals | | Yes | Yes | Yes | Yes |
| Moray West | No: only assessing projects within the East Scotland MU for seals | | Yes | Yes | Yes | Yes |
| Cromarty Firth Port Invergordon Service Base Phase 4 Development | No: only assessing projects within the East Scotland MU for seals | | No: The EIA Report (Affric, 2018) did not quantify the number of animals predicted to be disturbed. The low hammer energies that will be used for cylindrical piling (500kJ) and sheet piling (120kJ) resulted in small impact ranges presented from the noise modelling (impact ranges of 145+ dB SELss were highly localised around the development and did not extend outside of the Cromarty Firth). In addition there is a low likelihood of encountering bottlenose dolphins in the vicinity of the development (as it is located so far up the Cromarty Firth). Therefore this development has not been assessed quantitatively. | | | |
| Beatrice | No: only assessing projects within the East Scotland MU for seals | | No: The numbers of animals disturbed were not presented as part of the Beatrice ES. | | | |
| Port of Ardersier | No: only assessing projects within the East Scotland MU for seals | | No: Port of Ardersier Ltd went into administration in 2015 and future construction plans for this site are currently unknown. | | | |
| Kincardine Floating Offshore Windfarm | No: pile driving will not be used and SNH have previously advised that this wind farm will not give rise to any significant levels of disturbance. | | | | | |
| Forthwind Wind Farm | No: pile driving will not be used and SNH have previously advised that this wind farm will not give rise to any significant levels of disturbance. | | | | | |
| Aberdeen Offshore Wind Farm | No: pile driving will not be used and SNH have previously advised that this wind farm will not give rise to any significant levels of disturbance. | | | | | |

## Harbour Seal Cumulative Impact of Disturbance

10.305. This EIA Report has predicted that <1 harbour seal will be at risk of disturbance on each piling day under any of the monopile/jacket scenarios (maximum number of individuals at risk of disturbance on any piling day = 0.29). Therefore, the assessment has resulted in a **Negligible** impact on harbour seals. As such, this species has not been taken forward to cumulative impact assessment. This approach was agreed with Statutory Consultees by email from Marine Scotland dated 16th May (Table 10.3).

## Grey Seals Cumulative Impact of Disturbance

10.306. Table 10.55 presents compiled information on the predicted effects from a range of projects included in the cumulative assessment for grey seals. For the other Forth and Tay offshore wind farm projects, which are currently undergoing assessment for revised project design envelopes (Inch Cape and Neart na Gaoithe), the worst case between the consented and revised assessments has been considered in the assessment. To enable a direct comparison to be made, both consented and revised parameters are included in Table 10.55 with the parameters included in the assessment highlighted.

10.307. The total numbers summed across all projects (based on the maximum number of individuals from each project, and taking the maximum from either the consented or revised envelopes for the Forth and Tay offshore wind projects) is 2,209, which represents 20.3% of the total reference population (East Scotland MU).

10.308. It should, however, be highlighted that the use of the East Scotland MU as a discrete reference population for grey seals is considered to be highly precautionary, given the wide ranging nature of grey seals. Grey seals can range widely to forage and frequently travel over 100km between haul-out sites and telemetry data have shown grey seals foraging several hundred kilometres offshore (SCOS 2017). The telemetry data presented in the baseline characterisation has shown that there is considerable movement between the Forth and Tay area, the Farne Islands, The Linconshire and Norfolk coasts, Shetland and the Outer Hebrides. Acknowledging that the East Scotland MU does not contain a discrete population and that connectivity is high with the adjacent Northeast England MU, it is more realistic to consider the two MUs as one population for modelling purposes. The most recent August haul-out count for grey seals in the Northeast England MU is 6,948 (SCOS 2017) which, scaled to account for the proportion of the population at sea at the time of the count, provides an estimated population size of 19,851 (CI: 18,284 – 21,713). When the East Scotland and Northeast England MU population estimates are summed the resulting population size is 30,743 grey seals. An impact of 2,209 grey seals therefore represents 7.2% of the combined East Scotland and Northeast England MUs.

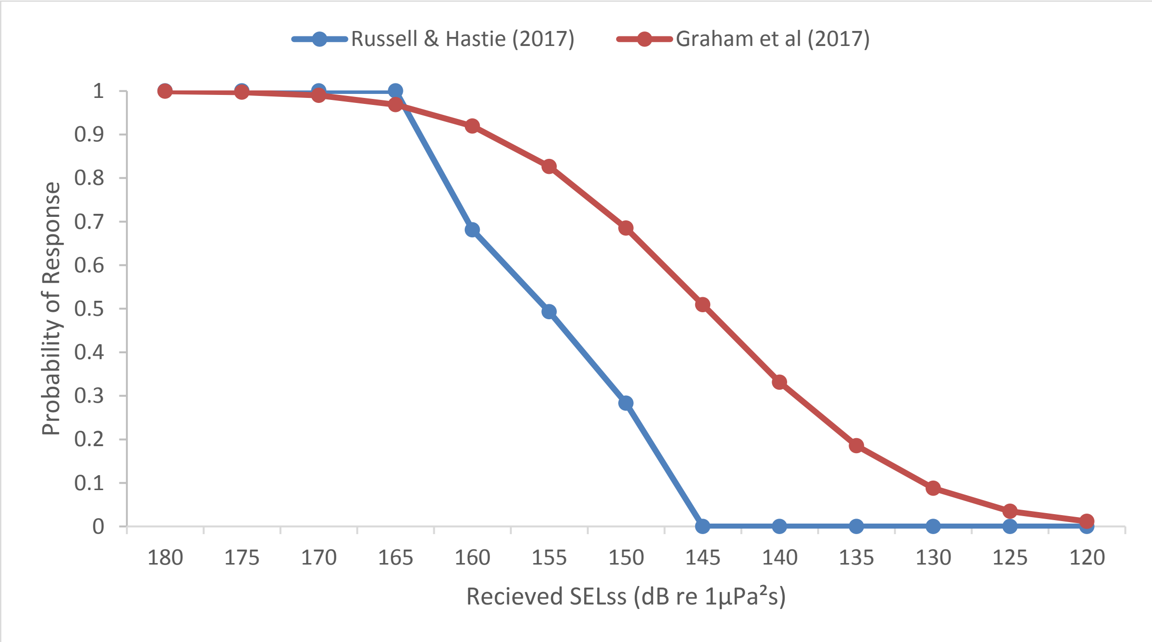
10.309. It is key to note that these overall cumulative levels of impact are driven by the high predictions of grey seals disturbed at Neart na Gaoithe (1,357 disturbed per day) and Inch Cape (810 disturbed per day) compared to Seagreen (42 disturbed per day). These differences in impact levels are likely due to the different dose-response curves used for seals between the three assessments.

**Table 10.55 Grey seal cumulative assessment – numbers predicted to be disturbed as a result of underwater noise from construction activities. For projects which have both consented and revised parameters, the row shaded in blue is the one considered the highest numbers of animals impacted per day of piling. WC = Worst Case, ML = Most Likely.**

| Project | Methodology/ Disturbance Threshold | Number of WTG | Total Number of Piles | Scenario | Assumed Number of Piles/ day/ vessel | No. of Piling Days | Max Number of Animals Affected per Piling Day |
|---|---|---|---|---|---|---|---|
| Optimised Seagreen Project | Dose response curve (Russell & Hastie, 2017) | 120 | 480 | Project Alpha then Project Bravo | 2 | 240 | 42 then 27 |
| | | 120 | 480 | Project Alpha + Project Bravo Concurrent | 2 | 140 | 24 |
| Neart na Gaoithe (consented) | 90 dBht | 125 | 500 | Single vessel | 2 | 250 | 113 |
| Neart na Gaoithe (revised) | Dose response curve (Brandt et al., 2016) | 54 | 324 | Single vessel | 6 | 54 | 821 |
| | | 54 | 324 | Concurrent | 6 | 27 | 1357 |
| Inch Cape (consented) | 90 dBht | 213 | 852 | ML Single | 2 | 426 | 526 |
| | | 213 | 852 | WC Concurrent | 4 | 107 | 684 |
| Inch Cape (revised) | Dose response curve (Graham *et al.*, 2017) | 76 | 304 | ML single vessel | 4 | 76 | 431 |
| | | 76 | 304 | WC single vessel | 6 | 51 | 675 |
| | | 76 | 304 | ML concurrent | 4 | 38 | 533 |
| | | 76 | 304 | WC concurrent | 6 | 26 | 810 |

10.310. The assessment for the optimised Seagreen Project used the dose-response curve generated by Russell & Hastie (2017) which was based on data collected from tagged harbour seals in response to the pile driving activities at the Lincs offshore wind farm. By comparison, the Inch Cape revised assessment used the dose-response curve generated by Graham *et al.* (2017) which was based on data collected on harbour porpoise detections at CPODs during the piling at the Beatrice offshore wind farm. Likewise, the dose-response curve used in the revised Neart na Gaoithe assessment was based on the data from Brandt *et al*. (2016) which again, was generated from harbour porpoise detections at CPODs at various windfarms. Compared to the Graham *et al.* (2017) dose-response curve, the Russell & Hastie (2017) dose-response curve predicts a much lower probability of response at received SELss below 165 dB (Plate 10.8). The Russell & Hastie curve predicts no response at SELss 145 dB and below, while the Graham et al (2017) curve still predicts a 50% response at SEL 145 dB and a continued response down to SELss 120 dB (Plate 10.8). It is therefore highly likely that the use of dose-response curves based on harbour porpoise detection data is unsuitable for grey seals, and therefore the resulting predictions of disturbance are considerably overestimated.

**Plate 10.8 Comparison of the dose-response curve from Graham et al. (2017) and from Russell & Hastie (2017).**




## *Population modelling*

10.311. In order to assess whether or not the cumulative impacts of the optimised Seagreen Project, Inch Cape and Neart na Gaoithe had a population level effect, population modelling was conducted for grey seals, using the scenarios from each project that resulted in the highest number of piling days. The scenarios input into the model are outlined in Table 10.56. Given that the population size numbers are based on 2016 counts, the modelling was conducted to start in 2017 and run for 25 years.

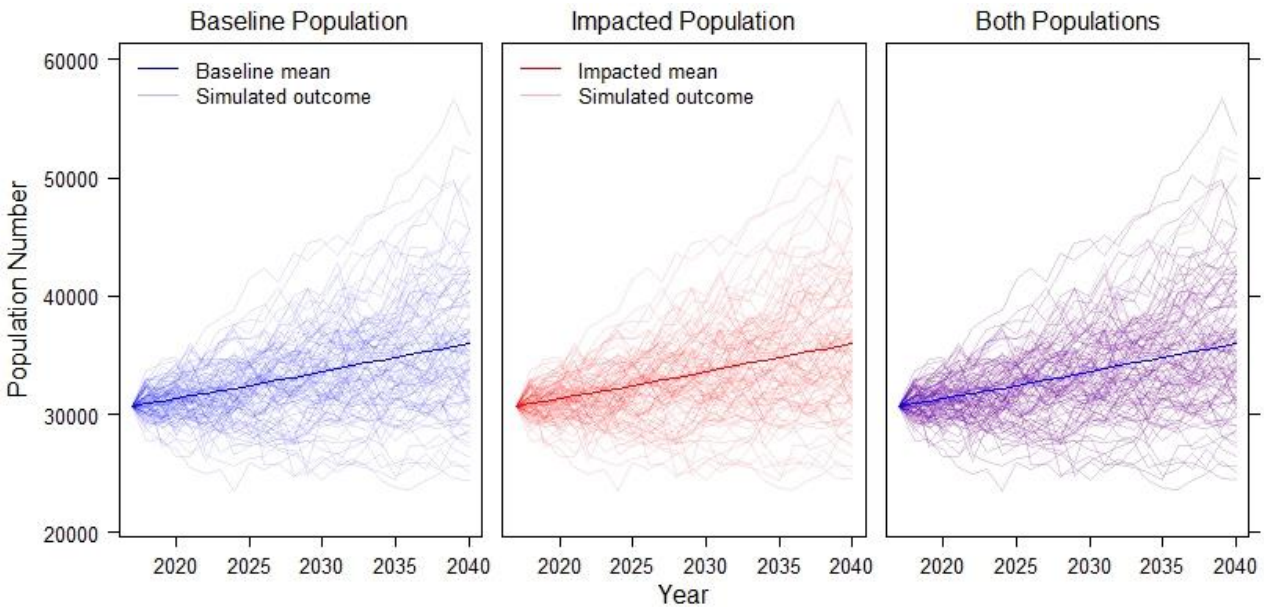
10.312. Harwood and King (2017) present suggested demographic parameters for grey seals in UK waters and recommended that the same parameters are used for all MUs, given the fact that telemetry data have shown that females can breed at colonies outside of the MUs in which they are found the rest of the year. Based on SCOS (2012) the growth rate was set to 1% per year and demographic rates were taken from annually monitored colonies as provided in SCOS (2012) and adjusted to achieve a 1% annual growth rate. These demographic parameters are listed in Data Appendix 10D Table 10.2.

10.313. The compiled summary results of the iPCoD modelling for grey seals under the cumulative scenario, using the maximum number of piling days from each Project, results in minimal impact on the grey seal population (Data Appendix 10D Table 10.7). The median baseline population size in year 24 was 35,548 animals (95% CI: 25,841 – 48,317) while the median impacted population size in year 24 was 35,545 animals (95% CI: 25,834 – 48,315), which is a difference of three animals and is 99.99% of the size of the baseline population. There was no additional risk of a 1% decline across all years, and the 50$^{th}$ centile for the un-impacted population matched the 50$^{th}$ centile for the impacted population. The minimum ratio of the impacted to un-impacted population size was 0.9864 in year 24 which means that the smallest impacted population size was 98.64% of the size of the un-impacted baseline population. Plate 10.9 shows that the population trajectory for the impacted population does not differ from the baseline population under this cumulative assessment scenario. Given that there are no population consequences predicted from the population modelling under the cumulative scenario, the magnitude of impact has been assessed as **Negligible**.

**Table 10.56 Modelled scenarios for the grey seal cumulative impact assessment.**

| Project | Number of WTG | Number of Piles | Number of Piles/ Day | Total Piling Days | Piling Period | No. of Seals Disturbed per Day | Years | Source |
|---|---|---|---|---|---|---|---|---|
| Inch Cape (consented) | 213 | 852 | 2 | 426 | Year round | 526 | 2020 to 2021 | Original Inch Cape ES |
| NNG (consented) | 125 | 500 | 2 | 250 | Year round | 113 | 2021 to 2022 | Original NNG ES old |
| Optimised Seagreen Project (Alpha then Bravo) | 120 | 480 | 2 | 140 | Year round (80% between Apr-Oct) | 42 then 27 | 2022 to 2023 | This ES |

**Plate 10.9 Simulated grey seal population sizes for both the baseline and the impacted populations under the cumulative scenario.**




10.314. The magnitude of impact of disturbance on grey seals for the cumulative assessment is predicted to be **Negligible.** The sensitivity of grey seals to disturbance is **Low.** The impact of disturbance on grey seals as a result of the cumulative assessment of the optimised Seagreen Project, Inch Cape and Neart na Gaoithe is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

10.315. The cumulative assessment within the 2012 Offshore ES (including the originally consented Seagreen Project, Inch Cape and Neart na Gaoithe) assessed grey seals as having a high magnitude of impact and resulted in a conclusion of moderate adverse impact which was significant in ES terms. Therefore this new assessment predicts a much lower cumulative impact on grey seals compared to the previous assessment.

### Additional Mitigation

10.316. No additional mitigation is either required or proposed in relation to the effect of disturbance on grey seals as a result of the cumulative assessment of the optimised Seagreen Project, Inch Cape and Neart na Gaoithe, as no adverse significant impacts are predicted.

### Residual Impact

10.317. The magnitude of impact of disturbance on grey seals is predicted to be **Negligible.** The sensitivity of grey seals to disturbance is **Low.** The residual impact of disturbance on grey seals as a result of the cumulative assessment of the optimised Seagreen Project, Inch Cape and Neart na Gaoithe is predicted to be **Negligible** and therefore **Not Significant** in EIA terms.

## Bottlenose Dolphin Cumulative Impact of Disturbance

10.318. The potential impact of disturbance from underwater noise from the construction the optimised Seagreen Project cumulatively with other projects and plans was assessed quantitatively for bottlenose dolphin. Where available, the quantitative estimates for magnitude and duration of disturbance were included in the iPCoD modelling.

10.319. At the Aberdeen Harbour Expansion project, the predicted disturbance range of 7.17km resulting from blasting activities was assumed to apply across all days of blasting. This impact range was overlain on the bottlenose density surface to predict that on average, there are likely to be 3.5 dolphins within this impact range on each day of blasting. A schedule for the blasting activity was developed based on the following assumptions which were informed by consultation with MS-LOT (Table 10.3):

- Blasting was expected to take place once or twice a day and was followed by dredging for a period of up to one week (i.e. a break in blasting for up to one week);
- These works were expected to last for up to seven consecutive months;
- Based on this information, one day of blasting followed by a seven day break over a seven month period was a reasonable and precautionary estimate of the blasting schedule;
- Blasting was assumed to commence in May 2018; and
- No piling was included since only rotary piling is to be used at the project.

10.320. The scenario assessed for Moray East was based on the Moray East Piling Strategy (Moray Offshore Renewables Ltd 2016). The Moray East Piling Strategy was based on the construction of 100 WTGs (Project One of the Telford, Stevenson and MacColl consents), rather than the 339 WTGs assessed in the Moray East ES (2012). The Piling Strategy is therefore considered to be more representative of the realistic worst case scenario for the Moray East offshore wind farm development which comprises 100 turbines and three offshore substation platforms (OSPs).

10.321. The Moray East Piling Strategy is also based on the use of two concurrent vessels (as opposed to six concurrent piling vessels presented in the Moray East ES (2012)) using the number of animals disturbed on one day of piling as presented in the Moray East ES (2012). The Moray East ES (2012) anticipated piling over a maximum of five years (2016 to 2020). However, this has been also revised, with construction of Moray East, based on the realistic worst case scenario, now expected to take up to 9 months to complete, with the worst case of piling occurring over two consecutive summers in 2019 and 2020.

10.322. The number of bottlenose dolphins predicted to experience disturbance as a result of the Moray East assessment is likely to be a significant overestimate of actual disturbance due to the fact that the assessment used an old bottlenose dolphin density surface which predicted bottlenose dolphin presence in the outer Moray Firth and along the Northern coast. The results of the ECOMMAS surveys have found that these are more likely to be Risso's dolphins or white-beaked dolphins based on their click characteristics. Since the Moray East development is further from the coastal areas used by bottlenose dolphins, the number of bottlenose dolphins predicted to experience behavioural disturbance from Moray East should lower than the numbers predicted for Moray West (which used the revised density surface). However, keeping the predictions of impact from the Moray East assessment will ensure a precautionary assessment.

10.323. Two different scenarios for each project were taken forward for population modelling: the shortest duration of piling (2 vessels constructing concurrently) and the longest duration of piling (single vessel construction). These values are presented in Table 10.57. When assessing which was the worst case between the consented and revised for the Inch Cape projects, it was the scenario with the longest number of piling days that was selected for modelling. Since previous work conducted by SNH and Marine Scotland had determined that there was no significant effect of the consented Neart na Gaoithe project on bottlenose dolphins, the revised Neart na Gaoithe assessment parameters were taken forward for modelling.

10.324. While none of the projects considered in the cumulative impact assessment for bottlenose dolphins have predicted a significant effect of disturbance for the projects in isolation, there is the potential for significant effects to arise when all six projects are considered together. Therefore, population modelling has been conducted to assess this level of cumulative impact on the East Coast Scotland bottlenose dolphin population.

### *Bottlenose Dolphin Cumulative Construction Scenarios*

10.325. As was carried out for the project alone, iPCoD was used to run simulations including the worst case parameters from the projects indicated in Table 10.58. Two scenarios were explored: the maximum spatial extent of impact and the shortest duration (concurrent, multiple vessel outcomes) and the smallest spatial extent but longest duration from each project (single vessel sequential outcomes). Publicly available information from Environmental Statements were used to develop the piling schedules for use in the model.

10.326. The iPCoD scenario runs from the start of 2017 for 25 years, beginning at the start of the Beatrice Offshore Wind Farm construction period. However, no impact was predicted to bottlenose dolphins as a result of BOWL piling and the effects of AHEP do not begin until 2018 and piling at Moray East does not commence until 2019, therefore the first two years of the simulation will experience very little disturbance impact. Overall, the single vessel piling (longest duration) cumulative assessment scenario resulted in higher levels of population level impact compared to the shortest duration scenario (as shown in Data Appendix 10D Table 10.8). This indicates that for bottlenose dolphins, a shorter more intense period of disturbance is associated with lower predicted levels of population impact, compared to a longer period of lower levels of disturbance. Therefore the results from this single vessel (longest duration) scenario are presented in full below.

**Table 10.57 Bottlenose dolphin cumulative assessment – numbers predicted to be disturbed as a result of underwater noise from construction activities. For projects which have both consented and revised parameters, the rows shaded are those considered in the cumulative assessment population modelling.**

| Project | Methodology/ Disturbance Threshold | No of WTG | Total No Piles | Scenario | Assumed Piles/day/ vessel | No Piling Days | Max No Animals Affected per Piling Day |
|---|---|---|---|---|---|---|---|
| Optimised Seagreen Project | Dose response curve (Graham *et al.*, 2017) | 120 | 480 | Project Alpha then Project Bravo | 2 | 240 | 3 Alpha 2 Bravo |
| | | 120 | 480 | Project Alpha + Project Bravo Concurrent | 2 | 140 | 4 |
| Neart na Gaoithe (consented) | 90 dBht SAFESIMM | 125 | 500 | Single | 2 | 250 | 1 |
| Neart na Gaoithe (revised) | Dose response curve (Brandt *et al.*, 2016) | 54 | 324 | Single | 6 | 54 | 2 |
| | | 54 | 324 | Concurrent | 6 | 27 | 2 |
| Inch Cape (consented) | 90 dBht | 213 | 852 | ML Single | 2 | 426 | 3 |
| | | 213 | 852 | WC Concurrent | 2 | 213 | 3 |
| Inch Cape (revised) | Dose response curve (Graham *et al.*, 2017) | 76 | 304 | ML single | 4 | 76 | 4 |
| | | 76 | 304 | WC single | 6 | 51 | 5 |
| | | 76 | 304 | ML concurrent | 4 | 38 | 4 |
| | | 76 | 304 | WC concurrent | 6 | 26 | 6 |
| Moray West | Dose response curve Graham et al (2017) | 85 | 85 | Single MP | 0.98 | 87 | 14 |
| | | 85 | 85 | Concurrent MP | 1.93 | 44 | 15 |
| | | 85 | 340 | Single PP | 2.6 | 133 | 10 |
| | | 85 | 340 | Concurrent PP | 2.6 | 67 | 12 |
| Moray East | Dose response curve (Thompson et al., 2013) | 100 | 400 | Single | 3 | 134 | 17 |
| | | 100 | 400 | Concurrent | 3 | 67 | 19 |
| Aberdeen Harbour Expansion Project (blasting) | 160dB re 1 µPa (RMS) 'US Level B Harassment' out to 1.7km | NA | NA | Blasting | 2 blasts | 36 | 4 |

**Table 10.58 Modelled scenarios for the bottlenose dolphin cumulative impact assessment.**

| Project | Number of WTG | Number of Piles | Number of Vessels | Number of Piles/Day/vessel | Total Piling Days | Piling Period | Number of Dolphins Disturbed per Day | Years | Source |
|---|---|---|---|---|---|---|---|---|---|
| **Concurrent piling, shortest duration** | | | | | | | | | |
| Moray East | 100 | 400 | 2 | 3 | 67 | April to Oct | 19 | 2019 to 2020 | Moray East Piling Strategy |
| Inch Cape (consented) | 213 | 852 | 2 | 2 | 213 | Year round | 3 | 2020 to 2021 | Inch Cape ES old |
| NNG (revised) | 54 | 324 | 2 | 6 | 27 | Year round | 2 | 1/7/21 to 30/9/22 | NNG ES 2018 |
| Optimised Seagreen Project | 120 | 480 | 2 | 2 | 140 | Year round (80% between Apr to Oct) | 4 | 2022 to 2023 | This ES |
| Moray West | 85 | 85 | 2 | 1 | 44 | Year round | 15 | 2022to 2023 | Pre-application information |
| Aberdeen Harbour Expansion | NA | NA | NA | 2 blasts | 36 | May to Nov | 4 | 2018 | AHEP & MS-LOT |
| **Single piling, longest duration** | | | | | | | | | |
| Moray East | 100 | 400 | 2 | 3 | 134 | April - Oct | 17 | 2019 to 2020 | Moray East Piling Strategy |
| Inch Cape (consented) | 213 | 852 | 1 | 2 | 426 | Year round | 3 | 2020 to 2021 | Inch Cape ES old |
| NNG (revised) | 54 | 324 | 1 | 6 | 54 | year round | 2 | 1/7/21 to 30/9/22 | NNG ES 2018 |
| Optimised Seagreen Project | 120 (70 A, 50 B) | 480 | 1 | 2 | 240 | year round (80% between Apr to Oct) | 3 A 2 B | 2022 to 2023 | This ES |
| Moray West | 85 | 85 | 1 | 3 | 133 | Year round | 10 | 2022 to 2023 | Pre-application information |
| Aberdeen Harbour Expansion | NA | NA | NA | 2 blasts | 36 | May to Nov | 4 | 2018 | AHEP & MS-LOT |

### Consideration of PTS

10.327. The only project included in the cumulative assessment for bottlenose dolphins that predicted any impact from PTS was the consented Inch Cape project. By including PTS impacts at Inch Cape, the population modelling resulted in a significant long term population level effect on the bottlenose dolphin population. The full results of this simulation are presented in the Data Appendix 10D.

10.328. However, there are a number of issues which raise question as to whether the inclusion of PTS impacts is appropriate. There are a number of differences between the methodology used in the original Inch Cape assessment and current best practice. The primary reasons are detailed below:

- The assessment used the Southall *et al.* (2007) PTS SEL threshold and weighting for impulsive noise ($M_{lf}$ weighted SEL 198 dB re 1 µPa²/s) which is likely to have overestimated the PTS risk relative to the use of the updated NOAA ( National Marine Fisheries Service (2016) weighting which is more closely aligned to the functional group's audiogram compared to the 'flat' weighting of the Southall M weighting functions; and
- The assessment used the SAFESIMM framework to predict the number of animals at risk; SAFESIMM adopts highly precautionary assumptions in relation to animal responsive movement, where animals move in a 'directed random walk' in response to exposure rather than the direct 'fleeing' assumed in other models. In addition, the swim speeds adopted are much lower than the values agreed in the current assessment.

10.329. As a result of these considerations, if the consented Inch Cape piling parameters were assessed using the same methodology applied in the revised assessment, no PTS would be predicted.

10.330. In addition, Condition 11 of the original Inch Cape consent stipulates that a piling strategy should be developed and approved which must demonstrate how mitigation measures will reduce the risk of PTS to negligible. Therefore, in reality, given the mitigation measures that will be implemented if the original consented Inch Cape Project is constructed, no bottlenose dolphins will be expected to experience PTS. Therefore, the most realistic cumulative assessment scenarios are those that considered behavioural disturbance only.

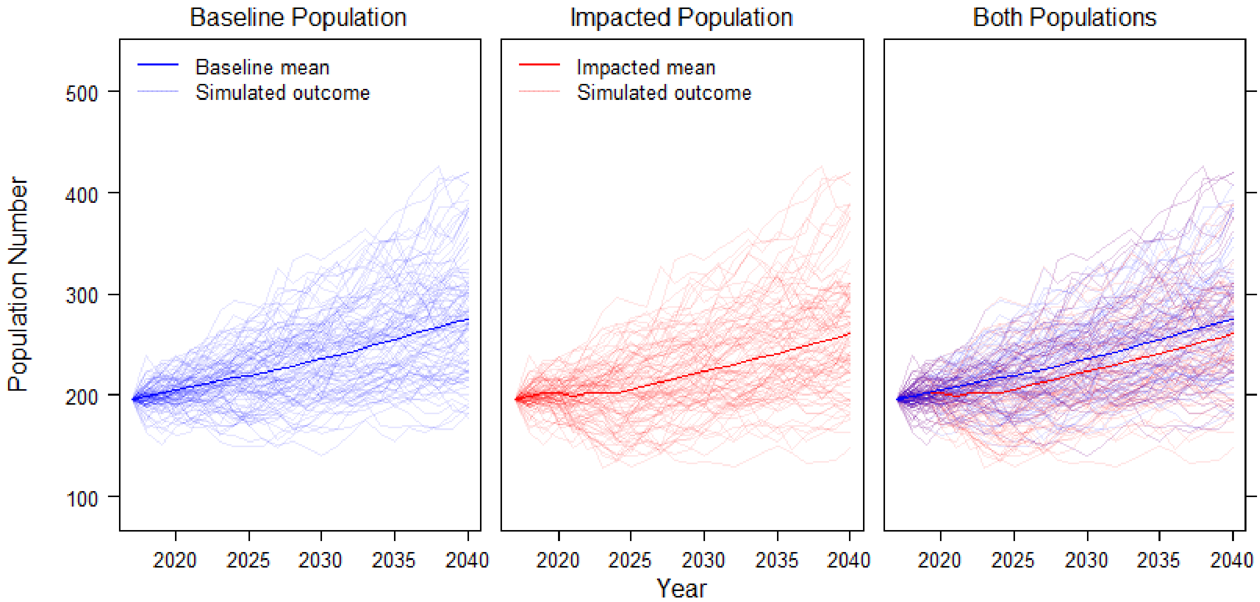
10.331. The realistic worst case scenario for the cumulative assessment for bottlenose dolphins is therefore the single vessel (shortest duration) scenario without PTS impacts for Inch Cape (or any other project).

### Bottlenose Dolphin Cumulative Assessment: Single vessel (longest duration) without PTS at Inch cape

10.332. The longest duration scenario resulted in an impacted population size after 24 years that was 94.1% of the size of the baseline population (Data Appendix 10D Table 10.8). The model predicted only a 17% increase in the risk of a 1% decline in Year 6 (Data Appendix 10D Table 10.11).

10.333. The model resulted in no significant long term population effects. The population trajectory for both the baseline and the impacted populations (the mean and each individual of the 1,000 simulated outcomes) are presented in Plate 10.10. This demonstrates that the mean impacted population is predicted to experience an initial decline in growth rate relative to the baseline population, after which it then returns to the same growth rate as the baseline population and continues to increase at the same rate as the baseline population for the remainder of the simulations.

**Plate 10.10 Simulated bottlenose dolphin population sizes for both the baseline and the impacted populations under the longest duration cumulative scenario without PTS at Inch Cape.**




10.334. Across all 1,000 paired simulations, the median ratio of baseline and impacted population sizes was between 0.99 and 1.00 and the mean ratio of the impacted to the baseline population was around 0.94 (excluding year 1) which indicates that a small number of the simulations resulted in impacted populations that were smaller than the paired baseline population in all simulation years, although the effect was very small; mean ratios (excluding year 1) were between 94.5 and 94.8% of the paired baseline population size (Data Appendix 10D Table 10.12). The maximum ratio of the impacted to the baseline population (excluding year 1), ranged between 1.04 and 1.07, which means that in a very small number of the 1,000 paired simulations, the impacted population size was greater than that of the baseline population size. The minimum ratio between the impact and the baseline population size (excluding year 1) was between 0.54 and 0.66, which means that in a small number of the paired simulations, the minimum impacted population size was between 54% and 66% of the size of the baseline population.

10.335. The ratio of the impacted to baseline population size is further demonstrated in Plate 10.10, which clearly demonstrates that in most of the 1,000 paired simulations, the impacted population size is equal to or only slightly less than the baseline population size.

10.336. Overall, for the longest duration cumulative scenario, the bottlenose dolphin population showed a small initial decline relative to the baseline as a result of the disturbance events, after which it then returns to the same growth rate as the baseline population and continued to increase at the same rate as the baseline population for the remainder of the simulations. Therefore, there is no predicted long term effect on the East Coast Scotland bottlenose dolphin population as a result of the cumulative disturbance from Moray East, Moray West, AHEP, Neart na Gaoithe, Seagreen and Inch Cape. Due to the lack of any density dependent mechanism being included in the modelling, the mean impacted population is not predicted to increase above the baseline growth rate and therefore although the population growth rate is expected to recover once the period of disturbance is over; the population size may remain slightly lower than the equivalent baseline population.

10.337. The sensitivity of bottlenose dolphins to behavioural disturbance has been assessed as **Medium**. Given the results of the longest duration cumulative assessment iPCoD population modelling without PTS, with the lack of an overall long term difference in population growth rates, and a median ratio of growth rates and population size between matched pairs of one across all years examined, the magnitude has been assessed as **Low** in terms of the effect on the long term population trajectory. Therefore the impact of disturbance on bottlenose dolphins as a result of the cumulative assessment of the optimised Seagreen Project, Moray West, Moray East, AHEP, Inch Cape and Neart na Gaoithe is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

### *Additional Mitigation*

10.338. No additional mitigation is either required or proposed in relation to the effect of disturbance on bottlenose dolphins as a result of the cumulative assessment of the optimised Seagreen Project, Moray West, Moray East, AHEP, Inch Cape and Neart na Gaoithe as no adverse significant impacts are predicted.

### *Residual Impact*

10.339. The magnitude of impact of disturbance on bottlenose dolphins is predicted to be **Low**. The sensitivity of bottlenose dolphins to disturbance is **Medium**. The residual impact of disturbance on bottlenose dolphins as a result of the cumulative assessment of the optimised Seagreen Project, Moray West, Moray East, AHEP, Inch Cape and Neart na Gaoithe is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## Harbour Porpoise Cumulative Impact of Disturbance

10.340. Table 10.59 presents compiled information on the predicted effects from a range of projects included in the cumulative assessment for harbour porpoise. For the other Forth and Tay projects which are currently undergoing assessment for revised project design envelopes (Inch Cape and Neart na Gaoithe), the worst case between the consented and revised assessments was considered in the assessment. So that a direct comparison can be made, both consented and revised parameters are included in Table 10.59, with the parameters included in the assessment highlighted.

10.341. The total numbers summed across all projects (based on the maximum number of individuals from each project, and taking the maximum from either the consented or revised envelopes for the Forth and Tay offshore wind projects) is 8376, which represents 2.4% of the total reference population. If a precautionary assumption that Beatrice is of similar impact magnitude as Moray West is made (given its proximity and therefore similar expected levels of porpoise occurrence within impact areas, although note that impact areas are likely lower than predicted at Moray West due to smaller pile sizes and lower hammer energies), this would increase this value to approximately 2.9%. Based on the worst case assumption detailed in the project alone assessment that each year of disturbance would result in a failure to breed for each disturbed individual, this is considered low magnitude relative to the overall size of the MU population.

10.342. Totalling the predicted number of animals disturbed across these projects provides the maximum number that would be impacted if all projects were constructing at once, assuming no overlap in impact ranges. The greater the temporal overlap across these individual projects, the shorter the period of impact but the more intense the impact will be.

**Table 10.59 Harbour porpoise cumulative assessment – numbers predicted to be disturbed as a result of underwater noise from construction activities. For projects which have both consented and revised parameters, the rows shaded are the ones considered in the cumulative assessment.**

| Project | Methodology/ Disturbance Threshold | No. of WTG | Total No. Piles | Scenario | Assumed No. Piles/ day/ vessel | No. Piling Days | Max No. Animals Affected per Piling Day |
|---|---|---|---|---|---|---|---|
| Optimised Seagreen Project | Dose response curve (Graham *et al.*, 2017) | 120 | 480 | Alpha then Bravo | 2 | 240 | 971 at Alpha then 1103 at Bravo |
| | | 120 | 480 | Alpha + Bravo Concurrent | 2 | 140 | 1177 |
| Moray West | Dose response curve Graham *et al.*, (2017) | 85 | 85 | Single MP | 0.98 | 87 | 1377 |
| | | 85 | 85 | Concurrent MP | 1.93 | 44 | 1609 |
| | | 85 | 340 | Single PP | 2.6 | 133 | 639 |
| | | 85 | 340 | Concurrent PP | 2.6 | 67 | 1348 |
| Beatrice | 75 dBht | | | | | | Not quantified |
| Aberdeen Harbour Expansion Project (blasting) | 140 dB re 1 µPa (RMS) 'low level disturbance' out to 7.18km | NA | NA | Blasting | 2 blasts | 36 | 4 |
| | 160 dB re 1 µPa (RMS) "US Level B Harassment" out to 1.7km | NA | NA | Blasting | 2 blasts | 36 | 61 |
| Moray East | Dose response curve (Thompson *et al.*, 2013) | 100 | 400 | Single | 3 | 134 | 2933 |
| | | 100 | 400 | Concurrent | 3 | 67 | 3442 |
| Neart na Gaoithe (consented) | 90 dBht | 125 | 500 | single | 2 | 250 | 460 |
| Neart na Gaoithe (revised) | Dose response curve (Brandt *et al.*, 2016) | 54 | 324 | Single | 6 | 54 | 144 |
| | | 54 | 324 | Concurrent | 6 | 27 | 1880 |
| Inch Cape (consented) | 90 dBht | 213 | 852 | ML Single | 2 | 426 | 108 |
| | | 213 | 852 | WC Concurrent | 4 | 107 | 137 |
| Inch Cape (revised) | Dose response curve (Graham *et al.*, 2017) | 76 | 304 | ML single | 4 | 76 | 117 |
| | | 76 | 304 | WC single | 6 | 51 | 175 |
| | | 76 | 304 | ML concurrent | 4 | 38 | 142 |
| | | 76 | 304 | WC concurrent | 6 | 26 | 207 |

10.343. A simulation modelling exercise carried out by (Booth *et al.* 2017) used the iPCoD framework to predict the long term consequences of planned offshore wind developments in the eastern North Sea concluded that, even with a total of 15% of the population being predicted to be disturbed, with that disturbance occurring over a period of 12 years, there was no evidence for any significant risk to the long term health of the North Sea harbour porpoise population. As discussed above, there is no empirical information to inform the consequences of disturbance from pile driving at the population level, but the iPCoD framework represents best available scientific expert judgement on the links between individual disturbance and vital rates.

10.344. More recent population modelling using the DEPONS model has demonstrated that the North Sea harbour porpoise population was not affected by the construction of 65 offshore wind farms within the North Sea (assuming porpoise responded in the same way as recorded during construction at the Gemini wind farm) (Nabe-Nielsen *et al.* 2018). The modelling results demonstrated that, at the North Sea scale, the population dynamics of the impacted population (when responding out to 8.9 km from construction sites) was indistinguishable from the baseline scenario.

10.345. In addition, harbour porpoise have a very widespread distribution and individuals have been documented moving relatively large distances on a daily basis (Sveegaard *et al.* 2011). The availability of alternative suitable habitat elsewhere in the management unit and the mobility of the species suggests that individuals will move to alternative foraging grounds and at most will suffer a reduction in breeding success in a limited number of breeding cycles. Based on this, the magnitude of this level of disturbance is considered to be **Low**.

10.346. The magnitude of impact of disturbance on harbour porpoise is predicted to be **Low.** The sensitivity of harbour porpoise to disturbance is **Medium.** The residual impact of disturbance on harbour porpoise as a result of the cumulative assessment of the optimised Seagreen Project, Moray West, Moray East, AHEP, Inch Cape and Neart na Gaoithe is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

10.347. The cumulative assessment within the 2012 Offshore ES (including Seagreen, Inch Cape and Neart na Gaoithe) also assessed harbour porpoise as not significant. Therefore this new assessment is no worse than the previous assessment and therefore no population modelling has been conducted for harbour porpoise.

### *Additional Mitigation*

10.348. No additional mitigation is either required or proposed in relation to the effect of disturbance on harbour porpoise as a result of the cumulative assessment of the optimised Seagreen Project, Moray West, Moray East, AHEP, Inch Cape and Neart na Gaoithe as no adverse significant impacts are predicted.

### *Residual Impact*

10.349. The magnitude of impact of disturbance on harbour porpoise is predicted to be **Low.** The sensitivity of harbour porpoise to disturbance is **Medium.** The residual impact of disturbance on harbour porpoise as a result of the cumulative assessment of the optimised Seagreen Project Moray West, Moray East, AHEP, Inch Cape and Neart na Gaoithe is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## Minke Whale Cumulative Impact of Disturbance

10.350. Given the large area covered by the minke whale Celtic and Greater North Sea MU, the cumulative assessment was approached in the following way: projects within the East coast of Scotland were assessed quantitatively while the other projects in the wider North Sea were considered qualitatively.

10.351. The numbers of minke whales potentially affected by disturbance from a range of projects is presented in Table 10.60. Based on the worst case in terms of total numbers of animals affected from each project, (and the worst of consented compared to the revised for the Forth and Tay projects), the total number of minke whales affected is 609. This is equivalent to 2.6 % of the Management Unit population. The maximum numbers are generally associated with the concurrent piling scenarios which are of the shortest duration in terms of overall disturbance. Based on the longest duration of disturbance the proportion of the population impacted will be lower, although the duration of the impact will be longer.

10.352. Minke whales are highly mobile and are generally seasonal visitors to the Scottish East coast. As such individuals temporarily displaced from the areas of pile driving and other noise activity are likely to find suitable alternative habitat.

10.353. The number of individuals, if summed, represents a relatively low proportion of the overall population. Even if every affected minke whale failed to breed during the years of disturbance, this would not result in a significant change in the trajectory of the population.

10.354. Unlike for harbour porpoise, no wider strategic impact assessment has been carried out at the scale of the management unit for minke whales. Although not included quantitatively in the table below, there are a total of four other projects in the wider minke whale management unit which have the potential for overlapping construction periods with construction at the optimised Seagreen Project. It is not anticipated that these spatial wider scale impacts will significantly increase the magnitude of the impact as assessed here. Therefore, overall, this level of impact is considered of low magnitude at the management unit scale.

10.355. The magnitude of impact of disturbance on minke whales is predicted to be **Low.** The sensitivity of minke whales to disturbance is **Medium.** The impact of disturbance on minke whales as a result of the cumulative assessment of the optimised Seagreen Project, Moray West, Moray East, AHEP, Inch Cape and Neart na Gaoithe is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

10.356. The cumulative assessment within the 2012 Offshore ES (including Seagreen, Moray West, Moray East, AHEP, Inch Cape and Neart na Gaoithe) for minke whales was also not significant. Therefore this new assessment is no worse than the previous assessment, therefore no population modelling has been conducted for minke whales.

### *Additional Mitigation*

10.357. No additional mitigation is either required or proposed in relation to the effect of disturbance on minke whales as a result of the cumulative assessment of the optimised Seagreen Project, Moray West, Moray East, AHEP, Inch Cape and Neart na Gaoithe as no adverse significant impacts are predicted.

**Table 10.60 Minke whale cumulative assessment – numbers predicted to be disturbed as a result of underwater noise from construction activities. For projects which have both consented and revised parameters, the row shaded is considered in the cumulative assessment.**

| Project | Methodology/ Disturbance Threshold | No. of WTG | Total No. Piles | Scenario | Assumed No. Piles/ day/ vessel | No. Piling Days | Max No. Animals Affected per Piling Day |
|---|---|---|---|---|---|---|---|
| Optimised Seagreen Project) | Dose response curve (Graham *et al.*, 2017) | 120 | 480 | Alpha then Bravo | 2 | 240 | 63 at Alpha then 71 at Bravo |
| | | | | Alpha + Bravo concurrent | 2 | 140 | 76 |
| Moray West | Dose response curve Graham *et al.*, (2017) | 85 | 85 | single MP | 0.98 | 87 | 29 |
| | | | | concurrent MP | 1.93 | 44 | 30.1 |
| | | 85 | 340 | single PP | 2.6 | 133 | 23 |
| | | | | concurrent PP | 2.6 | 67 | 24.5 |
| Aberdeen Harbour Expansion Project (blasting) | 140 dB re 1 µPa (RMS) 'low level disturbance' out to 7.18km | NA | NA | blasting | 2 blasts | 36 | <1 |
| | 160 dB re 1 µPa (RMS) 'US Level B Harassment' out to 1.7km | | | | | | 4 |
| Moray East | Dose response curve (Thompson *et al.*, 2013) | 100 | 400 | single | 3 | 134 | 168 |
| | | | | concurrent | 3 | 67 | 185 |
| Neart na Gaoithe (consented) | 90 dBht | 125 | 500 | single | 2 | 250 | 88 |
| Neart na Gaoithe (revised) | Dose response curve (Brandt *et al.* 2016) | 54 | 324 | single | 6 | 54 | 23 |
| | | | | concurrent | 6 | 27 | 123 |
| Inch Cape (consented) | 90 dBht | 213 | 852 | ML single | 2 | 426 | 159 |
| | | | | WC concurrent | 4 | 107 | 191 |
| Inch Cape (revised) | Dose response curve (Graham *et al.*, 2017) | 76 | 304 | ML single | 4 | 76 | 63 |
| | | | | WC single | 6 | 51 | 93 |
| | | | | ML concurrent | 4 | 38 | 76 |
| | | | | WC concurrent | 6 | 26 | 110 |

## *Residual Impact*

10.358. The magnitude of impact of disturbance on minke whales is predicted to be **Low.** The sensitivity of minke whales to disturbance is **Medium.** The residual impact of disturbance on minke whales as a result of the cumulative assessment of the optimised Seagreen Project, Moray West, Moray East, AHEP, Inch Cape and Neart na Gaoithe is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## White-beaked Dolphin Cumulative Impact of Disturbance

10.359. Given the large area covered by the white-beaked dolphin MU, the cumulative assessment was approached in the following way: projects within the East coast of Scotland were assessed quantitatively while the other projects in the wider North Sea were considered qualitatively.

10.360. The numbers of white-beaked dolphins potentially affected by disturbance from a range of projects is presented in Table 10.61. Based on the worst case in terms of total numbers of animals affected from each project, (and the worst of consented vs revised for the Forth and Tay projects), the total number of white-beaked dolphins affected is 1,298; this is equivalent to 3.6% of the Management Unit population. The maximum numbers are generally associated with the concurrent piling scenarios which are of the shortest duration in terms of overall disturbance. Based on the longest duration of disturbance the proportion of the population affected will be lower, although the duration of the effect will be longer.

**Table 10.61 White-beaked dolphin cumulative assessment – numbers predicted to be disturbed as a result of underwater noise from construction activities. For projects which have both consented and revised parameters, the rows shaded are the ones considered in the cumulative assessment.**

| Project | Methodology/ Disturbance Threshold | No. of WTG | Total No. Piles | Scenario | Assumed No Piles/ day/ vessel | No. Piling Days | Max No. Animals Affected per Piling Day |
|---|---|---|---|---|---|---|---|
| Optimised Seagreen Project | Dose response curve (Graham *et al.*, 2017) | 120 | 480 | Alpha then Bravo | 2 | 240 | 394 at Alpha then 448 at Bravo |
| | | | | Alpha + Bravo concurrent | 2 | 140 | 478 |
| Aberdeen Harbour Expansion Project (blasting) | 140 dB re 1 µPa (RMS) 'low level disturbance' out to 7.18km | NA | NA | blasting | 2 blasts | 36 | 2 |
| | 160 dB re 1 µPa (RMS) 'US Level B Harassment' out to 1.7km | | | | | | 25 |
| Neart na Gaoithe (consented) | 90 dBht | 125 | 500 | single | 2 | 250 | 28 |
| Neart na Gaoithe (revised) | Dose response curve (Brandt *et al.* 2016) | 54 | 324 | single | 6 | 54 | 478 |
| | | | | concurrent | 6 | 27 | 763 |
| Inch Cape (consented) | 90 dBht | 213 | 852 | ML single | 2 | 426 | 4 |
| | | | | WC concurrent | 4 | 107 | 12 |
| Inch Cape (revised) | Dose response curve (Graham *et al.*, 2017) | 76 | 304 | ML single | 4 | 76 | 16 |
| | | | | WC single | 6 | 51 | 25 |
| | | | | ML concurrent | 4 | 38 | 21 |
| | | | | WC concurrent | 6 | 26 | 32 |

10.361. Based on the low percentage of the reference population affected and the temporary nature of the impact, the magnitude of impact of disturbance on white-beaked dolphins is predicted to be **Low.** The sensitivity of white-beaked dolphins to disturbance is **Medium.** The impact of disturbance on white-beaked dolphins as a result of the cumulative assessment of the optimised Seagreen Project, AHEP, Inch Cape and Neart na Gaoithe is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

10.362. The cumulative assessment within the 2012 Offshore ES (including Seagreen, AHEP, Inch Cape and Neart na Gaoithe) for white-beaked dolphins was also Minor and Not significant. Since no greater impact was predicted for white-beaked dolphin compared to the previous assessment no population modelling has been undertaken.

### *Additional Mitigation*

10.363. No additional mitigation is either required or proposed in relation to the effect of disturbance on white-beaked dolphins as a result of the cumulative assessment of the optimised Seagreen Project, AHEP, Inch Cape and Neart na Gaoithe as no adverse significant impacts are predicted.

### *Residual Impact*

10.364. The magnitude of impact of disturbance on white-beaked dolphins is predicted to be **Low.** The sensitivity of white-beaked dolphins to disturbance is **Medium.** The residual impact of disturbance on white-beaked dolphins as a result of the cumulative assessment of the optimised Seagreen Project, AHEP, Inch Cape and Neart na Gaoithe is predicted to be **Minor** and therefore **Not Significant** in EIA terms.

## INTERRELATIONSHIPS

10.365. Interrelationships describe the potential interaction of multiple project impacts upon one receptor and have a spatial and/or temporal component. Impacts may occur throughout different phases of the project (construction, operation or decommissioning) and/or different project impacts may have spatial overlap and may interact to create a more significant impact on a receptor than when considered in isolation. Interrelated impacts may be short term, temporary or longer term over the lifetime of the Project.

10.366. No interrelationships have been identified in relation to marine mammals. Only the impacts of underwater noise have been scoped into the assessment. It is noted that operational noise impacts will be at a much lower level than construction noise and therefore spatially restricted and not anticipated to interact (e.g. between operational turbines) in such a way as to result in significant combined impacts.

## TRANSBOUNDARY EFFECTS

10.367. Although the scale of management units for certain marine mammal receptors extends beyond the limits of Scottish waters (Figure 10.1) in the absence of significant impacts resulting from the Seagreen Project, either alone or in combination with other projects, no significant transboundary effects are anticipated.

## MITIGATION AND MONITORING

10.368. No additional mitigation or monitoring has been identified as a result of the assessment presented in this EIA Report.

10.369. There is very recent evidence Brandt *et al.* (2018) that harbour porpoise leave offshore construction areas well before the start of piling and activation of ADDs, possibly as a result of the piling vessel set up and generally increased activity on site and associated disturbance. In addition, recent preliminary analysis of data collected at the Beatrice offshore wind farm, also suggested that porpoise activity reduced prior to the ADD deployment and that the use of ADDs may contribute to disturbance. The implication of this could be that ADD use is unnecessary. Appropriate measures for the Piling Strategy in light of the best available evidence will be discussed with statutory consultees.

## IMPACT ASSESSMENT SUMMARY – THE OPTIMISED SEAGREEN PROJECT

10.370. This chapter has assessed the potential impacts on marine mammals of the construction of the optimised Seagreen Project, both in isolation and cumulatively. No significant impacts have been identified, therefore no additional mitigation has been considered or incorporated into the assessment. Table 10.62 summarises the impact assessment undertaken and the conclusion of residual impact significance, following the application of additional mitigation (where applicable).

10.371. The 2012 Offshore ES concluded equivalent **Negligible** or **Minor** impacts which were considered **Not Significant** in EIA terms for all marine mammal receptors in relation to underwater noise from installation of jacket pin piles with the following exceptions which related to multiple piling events, e.g. all piling at Project Alpha:

- Project Alpha
  - PTS (**Moderate** adverse and **Significant** in harbour seal);
  - Disturbance (**Moderate** adverse and **Significant** in harbour seal);
- Project Bravo
  - PTS (**Moderate** adverse and **Significant** in harbour seal);
  - Disturbance (**Moderate** adverse and **Significant** in harbour seal);
- Project Alpha and Bravo together
  - PTS (**Major** adverse and **Significant** in harbour seal);
  - Disturbance (**Major** adverse and **Significant** in harbour seal);
- Cumulative with other Projects
  - PTS and disturbance (**Major** adverse and **Significant** in harbour seal);
  - PTS and disturbance (**Moderate** adverse and **Significant** in harbour porpoise; bottlenose dolphin and grey seal).

10.372. The above differences are believed to relate to the following principal factors:

- The population levels of harbour seal have reduced since the 2012 Offshore ES and they are present in very low numbers in the immediate and regional study areas (Paragraph 10.68 to 10.76), so that at-sea usage in the area of the Seagreen Project is low with <1 seal per cell (Figure 10.5). The baseline populations therefore differ markedly between the 2012 Offshore ES and this EIA Report with the consequence that harbour seal are now considered less likely to be present and the potential for significant impacts is reduced;
- The maximum number of wind turbine foundations has reduced (from 150 to 120) with a consequential reduction in the duration of impact;
- This EIA Report has made use of current best practice/guidance in relation to effect thresholds for injury/disturbance to marine mammals and population modelling, as agreed during consultation with SNCBs, and up to date underwater noise modelling methods. This includes use of the best available dose response curves for both seals and cetaceans with the aim of accounting for potential disturbance more accurately than the fixed threshold approach adopted in the 2012 Offshore ES.

**Table 10.62 Summary of Predicted Impacts for the Optimised Seagreen Project**

| Receptor | Potential Impact | Phase (C, O or D) | Impact Significance | Additional Mitigation Measures | Residual Impact Significance |
|---|---|---|---|---|---|
| **Project Alpha** | | | | | |
| Harbour seal | PTS<br>Disturbance | C | Negligible (not significant)<br>Negligible (not significant) | NA | Negligible (not significant)<br>Negligible (not significant) |
| Grey seal | PTS<br>Disturbance | C | Negligible (not significant)<br>Negligible (not significant) | NA | Negligible (not significant)<br>Negligible (not significant) |
| Bottlenose dolphin | PTS<br>Disturbance | C | Negligible (not significant)<br>Minor (not significant) | NA | Negligible (not significant)<br>Minor (not significant) |
| Harbour porpoise | PTS<br>Disturbance | C | Negligible (not significant)<br>Minor (not significant) | NA | Negligible (not significant)<br>Minor (not significant) |
| Minke whale | PTS<br>Disturbance | C | Negligible (not significant)<br>Minor (not significant) | NA | Negligible (not significant)<br>Minor (not significant) |
| White-beaked dolphin | PTS<br>Disturbance | C | Negligible (not significant)<br>Minor (not significant) | NA | Negligible (not significant)<br>Minor (not significant) |
| **Project Bravo** | | | | | |
| Harbour seal | PTS<br>Disturbance | C | Negligible (not significant)<br>Negligible (not significant) | NA | Negligible (not significant)<br>Negligible (not significant) |
| Grey seal | PTS<br>Disturbance | C | Negligible (not significant)<br>Negligible (not significant) | NA | Negligible (not significant)<br>Negligible (not significant) |
| Bottlenose dolphin | PTS<br>Disturbance | C | Negligible (not significant)<br>Minor (not significant) | NA | Negligible (not significant)<br>Minor (not significant) |
| Harbour porpoise | PTS<br>Disturbance | C | Negligible (not significant)<br>Minor (not significant) | NA | Negligible (not significant)<br>Minor (not significant) |
| Minke whale | PTS<br>Disturbance | C | Negligible (not significant)<br>Minor (not significant) | NA | Negligible (not significant)<br>Minor (not significant) |
| White-beaked dolphin | PTS<br>Disturbance | C | Negligible (not significant)<br>Minor (not significant) | NA | Negligible (not significant)<br>Minor (not significant) |

| Receptor | Potential Impact | Phase (C, O or D) | Impact Significance | Additional Mitigation Measures | Residual Impact Significance |
|---|---|---|---|---|---|
| **Projects Alpha and Bravo Combined** | | | | | |
| Harbour seal | PTS<br>Disturbance | C | Negligible (not significant)<br>Negligible (not significant) | NA | Negligible (not significant)<br>Negligible (not significant) |
| Grey seal | PTS<br>Disturbance | C | Negligible (not significant)<br>Negligible (not significant) | NA | Negligible (not significant)<br>Negligible (not significant) |
| Bottlenose dolphin | PTS<br>Disturbance | C | Negligible (not significant)<br>Minor (not significant) | NA | Negligible (not significant)<br>Minor (not significant) |
| Harbour porpoise | PTS<br>Disturbance | C | Negligible (not significant)<br>Minor (not significant) | NA | Negligible (not significant)<br>Minor (not significant) |
| Minke whale | PTS<br>Disturbance | C | Negligible (not significant)<br>Minor (not significant) | NA | Negligible (not significant)<br>Minor (not significant) |
| White-beaked dolphin | PTS<br>Disturbance | C | Negligible (not significant)<br>Minor (not significant) | NA | Negligible (not significant)<br>Minor (not significant) |
| **Cumulative Impact Assessment** | | | | | |
| Harbour seal | Not assessed. | | | | |
| Grey seal | Disturbance | C | Negligible (not significant) | NA | Negligible (not significant) |
| Bottlenose dolphin | Disturbance | C | Minor (not significant) | NA | Minor (not significant) |
| Harbour porpoise | Disturbance | C | Minor (not significant) | NA | Minor (not significant) |
| Minke whale | Disturbance | C | Minor (not significant) | NA | Minor (not significant) |
| White-beaked dolphin | Disturbance | C | Minor (not significant) | NA | Minor (not significant) |
| Key:<br>C = Construction, O = Operational, D = Decommissioning | | | | | |

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